

PREOPERATIVE SMOKING CESSATION INTERVENTION: A CRITICAL APPRAISAL OF THE
EVIDENCE WITH PRACTICE RECOMMENDATIONS

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Preoperative Smoking Cessation Intervention: A Critical Appraisal of the Evidence with Practice
Recommendations

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Abstract

Smoking is the single most important risk factor in the development of postoperative complications. Daily smoking increases the risk of postoperative complications by a factor of two to four. Smoking cessation preoperatively is beneficial in increasing rates of cessation and therefore reducing the incidence of complications postoperatively. As a result, smoking cessation should be recognized as a core element of care for the preoperative management of the surgical patient. Although the benefits of smoking cessation are well established, as is substantial evidence demonstrating that brief interventions are effective in increasing cessation rates among users, clinicians fail to consistently address the issue of tobacco use or provide smoking cessation interventions. Referral to elective surgical procedures provides an excellent opportunity for primary providers to promote smoking cessation interventions.

Preoperative Smoking Cessation Intervention: A Critical Appraisal of the Evidence with Practice
Recommendations

In the United States, 53.3 million surgical and non-surgical procedures are performed annually with eight to ten million procedures being performed on cigarette smokers (Mills et al., 2011). Smokers who undergo surgery have a higher incidence of postoperative complications than nonsmokers and are a greater burden on health care resources (Gourgiotis et al., 2011; Moller & Tonnesen, 2006; Moller, Villebro, Pedersen, & Tonnesen, 2002; Warner, 2005). Smoking is well established as a significant risk factor in the development of postoperative complications, particularly those related to impaired wound healing, cardio-pulmonary complications, infectious complications, requirement of postoperative intensive care, and mortality (Gronkjaer et al., 2014; Moller, Pedersen, Villebro, & Munksgaard, 2003; Schmid et al., 2015; Thomsen, Villebro, & Moller, 2014; Turan et al., 2011). Acquired postoperative complications require additional surgical or medical intervention, prolonged hospitalization, delays in discharge, and increases in health care costs (Meyers, Hajek, Hinds, & McRobbie, 2011). Although the effects of smoking on postoperative outcomes are well documented, the recommended duration of smoking cessation to avoid the incidence of these complications vary.

Smoking cessation preoperatively is beneficial in reducing the incidence of postoperative complications and for this reason, it is strongly recommended that all patients be counseled on smoking cessation prior to surgery (Mills et al., 2011; Moller et al., 2003; Thomsen et al., 2014; Zaman, Mahmood, & Tang, 2012). Unfortunately, clinicians fail to consistently address the issue of tobacco use or provide smoking cessation intervention to patients undergoing elective surgery, despite being aware of the significant health threats of tobacco's use and substantial evidence demonstrating that brief interventions are effective in increasing cessation rates among

tobacco users (Shannon-Cain, Webster, & Cain, 2002; U.S. Department of Health & Human Services [USDHHS], 2008; Wolfenden et al., 2005). Two million complications could be avoided if a smoking cessation intervention were offered to all patients undergoing surgery, assuming a 25% rate of cessation (Mills et al., 2011).

Because of the complications inherent in smoking, cessation should be recognized as a core element of care in the preoperative management of the surgical patient (Warner, 2005; Wolfenden et al., 2005). Referral to elective surgical procedures would provide an excellent opportunity for primary care providers (PCPs) to promote smoking cessation interventions. Counseling on smoking cessation and postoperative outcomes should be initiated at the time of the referral to achieve optimal smoking cessation periods (Tonnesen et al., 2010; Warner, 2005). Preoperative visits with surgical teams are often too brief or too close to the time of operation to ensure this optimal period of cessation is achievable.

The purpose of this project is to critically appraise the available literature to explore the effects of preoperative smoking on the incidence of postoperative complications and to identify the value of smoking cessation interventions preoperatively in the adult patient undergoing elective surgery. Findings from this critical appraisal were combined with current guidelines to establish a recommended period for cessation and to provide an evidenced-based intervention for preoperative smoking cessation. An understanding of the current information in relation to smoking cessation provided valuable insight into appropriate interventions and improved clinical practice. The outcomes of this evidence-based study were to:

- Understand the effects of preoperative smoking on the incidence of postoperative complications in patients undergoing elective surgery;

- Identify the optimal intervention period of preoperative smoking cessation in patients undergoing elective surgery;
- Identify an effective and easily implemented smoking cessation intervention recommendation for primary care providers consistent with current evidence-based practice guidelines and research recommendations.

Background and Significance

Tobacco use remains the single largest most preventable cause of death and disease in the United States. Despite downward trends in smoking prevalence, an estimated 42.1 million, or 17.8% of U.S. adults are cigarette smokers (Centers for Disease Control and Prevention [CDCP], 2013). Smoking places a heavy burden on the individual and on society as a whole. Cigarette smoking causes approximately 480,000 deaths annually, equating to approximately 1,300 deaths daily (CDCP, 2013). In addition, the total economic cost of smoking was more than \$300 billion in 2013, including nearly \$170 billion in direct medical care for adults and \$156 billion in lost productivity (CDCP, 2013).

In general, individuals who smoke are less healthy when compared to those who do not, are ill more often, seek medical treatment more frequently and have a higher incidence of hospital admissions and absenteeism from work (CDCP, 2013). Beginning at an earlier age and in adult life, these individuals suffer health consequences related to smoking (CDCP, 2013). Because smokers are more vulnerable to disease, they are at an increased risk of dying from otherwise common health events such as pneumonia or complications from routine surgeries (Gourgiotis et al., 2011). Smoke-attributable diseases will continue to cause premature deaths and high costs to the nation if the prevalence of use is not reduced.

Relevance to Alaska

Compared with the national average of 17.8%, the smoking prevalence in Alaska of 22.9% exceeds the rates of other states in the nation (CDCP, 2013). Furthermore, Alaska Native/American Indians have the highest prevalence of smoking when compared to other racial/ethnic groups making cigarette smoking a major concern to the health of this population (CDCP, 2013). When compared to urban communities, smoking prevalence in both adults and adolescents in rural communities is notably higher and has not experienced the same declines over the years (American Lung Association, 2012; Hutcheson et al., 2008).

Literature Review

Smoking harms nearly every organ in the body. Even in the absence of smoking-related illness, tobacco induced damage to organ systems in combination with surgical trauma result in increased risk of postoperative complications (Gourgiotis et al., 2011). Pathological changes are fully or at least partially reversible with preoperative smoking cessation (Gourgiotis et al., 2011).

Smoking Effects on Body Systems

The effects of smoking on the respiratory system involve the impairment of ciliary function, enhanced mucous production, alterations in immune response (macrophage activity), and narrowing of small airways (Gourgiotis et al., 2011; Moller & Tonnesen, 2006; Warner, 2005). Cilia are destroyed by the toxins present in cigarette smoke, resulting in impediment of mucous clearance. Poor immobilization of mucous and impaired ciliary function can eventually lead to upper and lower respiratory tract infections. Smoking cessation gradually improves pulmonary function, and becomes similar to that of nonsmokers after a cessation period of four to eight weeks with longer periods of cessation reducing risk (Nakagawa, Tanaka, Tsukuma, & Kishi, 2001; Thomsen et al., 2014; Wong, Lam, Abrishami, Chan, & Chung, 2012).

The effects of smoking on the cardiovascular system are short and long-term. Most short-term complications are related to the two main components of cigarette smoke, which include carbon monoxide (CO) and nicotine. CO impairs hemoglobin's binding capacity to oxygen, resulting in a decrease of oxygen content to the tissues and myocardium (Gourgiotis et al., 2011; Moller & Tonnesen, 2006; Sorensen, 2012). Decreases in oxygen result in increased erythrocyte production. This compensation mechanism comes at the expense of increased blood viscosity and coagulability (enhancing thrombosis risk) and decreased tissue perfusion. Nicotine stimulates the stress responses of the sympathetic nervous system, resulting in increasing heart rate, blood pressure, sympathetic tone, and peripheral vasoconstriction. Long-term cardiovascular risks associated with smoking accelerate atherosclerosis and increase risks of postoperative myocardial ischemia and infarction (Moller & Tonnesen, 2006; Sorensen, 2012; Warner, 2005).

Of the 7,000 chemical compounds found in cigarettes, 4,000 can adversely affect wound healing (Kuri, Nakagawa, Tanaka, Hasuo, & Kishi, 2005). Site infections, delayed wound healing, dehiscence, hernia, development of fistula and impaired bone healing occur two times more often in smokers when compared to nonsmokers; necrosis occurs four times more frequently (Sorensen, 2012). The combination of chemical compounds like nicotine, CO, and cyanide compete with the utilization of oxygen and impair enzyme formation necessary in the transport and metabolism of oxygen at the cellular level (Kuri et al., 2005; Moller & Tonnesen, 2006; Warner, 2005). These substances have been linked as contributing factors for delayed wound healing and wound complication. Significant reductions in surgical site infection and impaired wound healing are demonstrated with three to eight weeks of smoking cessation (Kuri et al., 2005; Sorensen, 2012; Wong et al., 2012).

Smoking Risks Postoperatively

To answer the first clinical question, literature addressing the issue of postoperative smoking complications were reviewed. Across the spectrum of surgical specialties, the link between smoking and postoperative complications is well established. Smoking is associated with an increased risk in the development of postoperative complications. Impaired wound healing, cardio-pulmonary and infectious complications, postoperative intensive care, and increased mortality are directly related to preoperative smoking (Gronkjaer et al., 2014; Moller, et al., 2003; Schmid et al., 2015; Thomsen et al., 2014; Turan et al., 2011).

Turan et al. (2011) studied the effects of smoking on surgical outcomes 30 days after major surgery in a large retrospective cohort study involving 520,242 non-cardiac surgical patients. Findings indicated that smokers were 1.38 times more likely to die after surgery when compared to nonsmokers. Moreover, smokers experienced significantly greater odds of adverse events postoperatively including: higher rates of pneumonia, unplanned intubation, myocardial infarction, stroke, superficial and deep incisional infections and sepsis.

Other researchers report positive correlations between smoking and postoperative outcomes. Gronkjaer et al. (2014) conducted a systematic review and meta analysis of 107 studies to test the pooled data for statistical significance between preoperative smoking and postoperative complications. In this study, the increased risk of complications was evident in patients who smoked compared to nonsmokers. Smokers were at a significantly higher risk for various postoperative complications including: general morbidity, wound complications, general infection, pulmonary complications, neurological complications and admission to intensive care after an operation.

The results of a meta analysis by Schmid and colleagues (2015) are in agreement with Gronkjaer et al. (2014). In this study, Schmid et al., (2015) analyzed the impact of smoking on postoperative outcomes in 141,802 patients undergoing one of the sixteen major cardiovascular, orthopedic, or oncologic surgical procedures. Each patient was stratified according to smoking status; current smokers had significantly higher odds of developing pulmonary, wound, and septic shock complications when compared to nonsmokers. Retrospectively, the risk of developing one complication was 12.5% in nonsmokers, 14.6% in former smokers and 14.9% in current smokers.

Sorensen (2012), conducted a meta analysis and systematic review of cohort studies and RCTs to clarify, the effects of smoking on postoperative healing complications and to estimate the impact of perioperative smoking cessation interventions on postoperative healing complications across surgery specialties. A total of 140 cohort studies, with 479,150 total patients were included in the analysis. Overall, smokers experienced a significantly increased risk of combined postoperative healing complications and wound complications when compared to nonsmokers.

The Impact of Smoking Cessation Interventions on Postoperative Outcomes

Preoperative smoking cessation is effective in reducing a variety of potential postoperative complications with relative postoperative risk for complications varying depending on length of cessation. The exact duration of cessation required to elicit benefit, however is inconsistent and likely depends on what outcomes are measured. Mills et al. (2011) conducted a systematic review of all randomized control trials (RCTs), which evaluated the effects of smoking cessation on postoperative outcomes, along with all observational studies evaluating risk complications in smokers and nonsmokers. In total, six RCTs and fifteen observational

studies were used in this analysis. The review demonstrated the benefits associated with preoperative cessation and postoperative risk reduction. Relative reductions in pulmonary complications were statistically significant among former and current smokers (RR 0.81; 95% confidence interval (CI) 0.70-0.93). Reductions in complications of wound healing were also statistically significant among former and current smokers (RR 0.73; 95% CI 0.61-0.87). RCTs, which initiated smoking interventions preoperatively, showed significant decreases in postoperative complications, with longer periods of cessation being more effective in reducing the incidence of complications. With each week of cessation, postoperative complications were reduced by 19%, affirming that risks steadily decrease as the interval of smoking cessation is increased. Findings from the observational studies examined showed similar results.

In a RCT, Moller et al. (2002) investigated the effectiveness of a preoperative smoking intervention on the frequency of postoperative complications in 120 patients undergoing elective hip and knee arthroplasty. Participants were assigned six to eight weeks preoperatively to either a standard care group or a smoking intervention group. Participants in the smoking intervention group were given smoking cessation education, nicotine replacement therapy, and weekly counseling sessions with a trained nurse if necessary. The impact of a smoking cessation intervention six to eight weeks in length reduced wound-related complications, and to a lesser extent, cardiovascular complications. The standard care group had an overall risk reduction of 18% and the intervention group experienced a 52% reduction in risk. Based on the study findings, the authors recommend smoking cessation of at least six weeks preoperatively.

A large systematic review and meta analysis (Wong et al., 2012) appraised the literature of 25 studies to determine the effects of a short-term preoperative smoking cessation on postoperative outcomes in 21,381 patients. When compared with shorter periods of cessation

(less than two weeks), longer periods of cessation had a greater effect on the overall reduction of postoperative complications. Smoking cessation gradually improves pulmonary function, and becomes similar to that of nonsmokers after cessation periods of four to eight weeks (Nakagawa, 2001; Thomsen et al., 2014; Wong et al., 2012). Perioperative smoking cessation for a minimum of four weeks reduced respiratory complications by 23% (RR 0.77; 95% CI 0.61-0.96) and was further reduced by 47% in patients who had abstained from smoking longer than eight weeks before surgery (RR 0.53; 95% CI 0.37-0.76). Reductions in wound-related complications were also noted with cessation periods between three to four weeks (RR 0.69; 95% CI 0.56-0.84).

A well-known RCT by Sorensen and Jorgensen (2003) sought to determine whether short-term preoperative smoking cessation, two to three weeks prior to colorectal surgery reduced the incidence of wound complications. Sixty colorectal surgery patients who smoked daily were randomly assigned to either an intervention group ($n = 27$) or control group ($n = 30$). Members of the intervention group were asked to abstain from smoking at a minimum, the day prior to surgery up until the time of suture removal while the control group maintained smoking habits. This study did not demonstrate statistical significance between the intervention (33%) and control groups (27%) regarding the incidence of postoperative complications or overall postoperative hospital stay. Although the negative effects of smoking were not found to be affected by brief periods of smoking cessation in this study, a longer intervention period may have proven to be more beneficial. Similar results were reflected in a RCT trial in Denmark, which examined the effects of a brief smoking cessation in patients undergoing breast cancer surgery (Thomsen et al., 2010). The purpose of this study was to examine if the effects of a short term smoking intervention (two to ten days) would influence postoperative complications. Complication rates in both groups were 61% (RR 1.0; 95% CI 0.75-1.33). The study concluded

that a brief smoking intervention shortly before breast cancer surgery had no impact on the overall rates of postoperative complications.

Lindstrom et al. (2008) performed a RCT to evaluate the effects of a four week smoking intervention on postoperative complications in patients undergoing general and orthopedic surgery. Participants were randomly assigned to an intervention group or control group. The intervention group received individual counseling and nicotine replacement therapy for four weeks before surgery and continued four weeks postoperatively. The control group received standard preoperative care. The study found that abstainers had fewer complications (15%) than those who continued to smoke (35%); these results however were not found to be statistically significant. In addition, the study concluded that the motivating effects of surgery may influence the success of a smoking cessation intervention and the "...preoperative period might therefore represent a golden moment for smoking cessation" (p. 744).

A Cochrane systematic review (Thomsen et al., 2014) concluded that successful smoking cessation interventions initiated at least four weeks before surgery "could potentially reduce perioperative complications and lead to long-term health gains if cessation were sustained" (Thomsen et al., 2014, p. 5). RCTs, which enrolled smokers into intervention programs to encourage cessation while waiting planned surgery, were reviewed. In total, 13 studies were included in the review. The authors' also concluded that brief interventions immediately before surgery do not demonstrate reduction in risk postoperatively but may be slightly beneficial in modifying smoking behaviors.

A study conducted in 1989 by Warner et al. raised concerns that smoking cessation shortly before surgery was ineffective in reducing postoperative complications and that short term smoking cessation actually contributed to overall poorer pulmonary outcomes (Meyers et

al., 2011). This study reported that smokers who stopped smoking closest to their operation date or less than eight weeks before surgery, were more likely to experience pulmonary complications but the results of this study were not found to be statistically significant. Although this study reported poorer outcomes, the concern for worse outcomes is unfounded and not supported by the data; regardless of the anticipated date of surgery, smoking cessation should be encouraged. This finding was supported by a systematic review and meta analysis conducted by Meyers et al. (2011). A total of nine observational studies were included in the analysis, which contained 889 patients. The results of this review concluded that smoking cessation less than eight weeks does not infer increase risks postoperatively and quitting smoking shortly before surgery does not increase postoperative complications. A systematic review of twelve cohort studies by Theadom and Cropley (2006), also confirmed that short-term cessation periods do not increase risk. Smoking cessation just prior to surgery does not increase the rate of postoperative complications.

Recommendations from Expert Panels and Advocacy Groups

Patients referred for elective surgery should be encouraged to stop smoking before the operation according to the National Institute for Health and Care Excellence (NICE). The Australian and New Zealand Colleagues (2007), professional statement on smoking cessation goes even further to recommend at least six to eight weeks of smoking abstinence during the preoperative period. For optimization of pre- and postoperative care in the adult patient with chronic obstructive pulmonary disease (COPD), the same six to eight week period of smoking cessation is recommended by the Veteran's Health Administration. Both of these guidelines are consistent with a National Guideline Clearinghouse recommendation for risk reduction preoperatively, this guideline recommends smoking cessation six weeks before surgery (Strength of Evidence = B). The American College of Surgeons supports smoking cessation counseling

during elective surgical consults as well as educational programs to promote effective smoking cessation strategies.

Surgery as a Teachable Moment

Primary care providers (PCPs) are key players in the delivery of surgical services and often facilitate the initial referral to surgery and evaluate patients to ensure medical clearance for surgery and anesthesia (Warner, 2005). Health events, like surgery and disease diagnosis can serve as “teachable moments” for smoking cessation. Teachable moments can motivate a person to change behaviors by increasing the perceptions of “risk and negative outcome expectancies related to smoking, prompting strong affective or emotional responses” and redefining ones self-concept and social roles (Shi & Warner, 2010, p. 105). These key concepts addressing the use of tobacco during the preoperative period can improve cessation rates and eventually lead to decrease incidence of postoperative outcomes.

Surgical patients who smoke are not routinely informed of the risks associated with continued use of tobacco preoperatively or the benefits of smoking cessation on surgical outcomes. This was demonstrated in a prospective, nonrandomized, non-controlled descriptive study by Shannon-Cain et al. (2002), which investigated the information provided to surgical patients preoperatively regarding smoking’s effects. This study’s aim was to determine why patients who smoke regularly do not abstain from tobacco use prior to surgery. Eighty-one participants from two major hospitals with a high volume of outpatient procedure were enrolled in the study. A questionnaire, written at a sixth-grade reading level was distributed by a registered nurse to all patients in the post anesthesia care unit (PACU) with a history of smoking. This study found that patients were not routinely informed of the risks involving tobacco use preoperatively or informed of the potential benefits associated with abstinence. Lack of clarity

regarding the effects of smoking cessation on complications as well as concern for worse surgical outcomes with recommendations of brief smoking cessation periods were reported as reasons for not informing patients. The study concluded that patients who were informed of the overall effects of smoking or specifically the risks of smoking preoperatively were more likely to abstain from smoking prior to surgery, resulting in a four- to five-fold increase in smoking cessation. The study also concluded that the perioperative period could be optimal for smoking intervention.

A similar study by Haddock and Burrows (1997), demonstrated comparable results. The study demonstrated an increase in smoking cessation rates when patients were given knowledge preoperatively regarding the risks associated with smoking prior to surgical intervention. Eighty percent of the patients in the intervention group and 50% of those in the control group reduced or stopped smoking prior to admission. When patients are provided with knowledge about their disease process or treatment, outcomes are typically more favorable. Although this study was done several years ago, positive outcomes were demonstrated for an educational intervention.

Literature Review Synthesis

The optimal period of perioperative smoking cessation to promote postoperative benefit remains unclear. Despite differences in the optimal periods of smoking cessation studied in the literature, the effect of smoking cessation on postoperative outcomes is evident. A synthesis of the evidence suggest: (a) smokers overall had a higher incidence of complications when compared with nonsmokers; (b) active intervention programs to reduce or sustain from smoking preoperatively, with each week of cessation increasing the magnitude of effect, are effective in reducing postoperative cardio-pulmonary complications and wound-related complications of impaired healing and infection (Gronkjaer et al., 2014; Lindstrom, et al., 2008; Mills et al., 2011;

Moller, et al., 2002; Schmid et al., 2015; Sorensen & Jorgensen, 2003; Thomsen et al., 2014; Tonnesen, et al., 2010; Turan et al., 2011; Wong, 2011; Zaman et al., 2012); (c) the exact duration of cessation required to elicit benefit, is inconsistent and likely depends on what outcomes are measured and (d) tobacco cessation interventions preoperatively are effective in reducing risk.

Theoretical Framework

A significant contribution from behavioral science has been made in the form of social-psychological models, which aim to explain and predict health behaviors—why individuals take or fail to take measures that maintain or protect their health. One of the most widely accepted and well-known approach is the health belief model (HBM). The HBM was originally developed in the 1950s by social psychologists working in the public health service as a way of explaining the failure of people to participate in preventative health actions. It has since advanced to include a motivational component. This model emphasizes that the meaning of health varies among individuals. Health and illness are linked to a person's individual social or cultural position and are shaped by their experience, attitude, knowledge, motivation, values, and expectations (Glanz, Rimer, & Viswanath, 2008). This HBMs core assumptions are based on the understanding that individuals will take health-related action if (a) they are susceptible to the condition, (b) they feel a negative health outcome can be avoided, (c) there would be serious consequences as a result of the condition, and (d) the benefits of taking action outweigh the costs (Glanz et al., 2008). An individual's readiness to act is defined under six constructs. These include perceived *susceptibility*, perceived *severity*, perceived *benefits*, perceived *barriers*, cues to action, and self-efficacy (Glanz et al., 2008).

In the context of this analysis, perceived susceptibility is defined as perceived likelihood of developing a postoperative complication. The belief that pre- and postoperative smoking has serious consequences on surgical outcomes is defined as perceived severity in this analysis. Perceived benefits are defined as behavior changes related to an individual's belief regarding perceived benefits of cessation. Self-efficacy is a surgical patient's confidence that he or she can successfully abstain from smoking for the recommended four to eight week period.

Successful smoking cessation can depend on a variety of factors including; demographic characteristics, knowledge regarding the specific disease or condition, and cues to action for the engagement of a desired behavior, in other words a recommendation by a provider (Glanz et al., 2008). To effectively develop a comprehensive evidence-based intervention, providers must have an understanding of basic social and behavioral theories. The HBM can be valuable in enhancing the effectiveness of smoking cessation interventions and addressing individual reasons for noncompliance.

Methodology

A critical appraisal of the available literature was conducted to ensure that the highest level of evidence is utilized for practice change. The methodical framework for this project will follow the progressive, sequential approach of the seven steps of evidence-based practice by Melynk and Fineout-Overholt (2005). This process includes the following steps: Cultivate a spirit of inquiry, problem identification, literature search for the best evidence, critical appraisal of the evidence, integration of the evidence, evaluation of outcomes and dissemination of results. A literature review was conducted utilizing the databases ProQuest, Cumulative Index to Nursing and Allied Health Literature (CINHAL), Cochrane Library, and UpToDate. Articles were also identified through a general search using the University of Alaska Anchorage (UAA)

“QuickSearch” search engine on the UAA consortium library website. Database searches included the search terms smoking, smoking cessation, smoking cessation intervention, smoking cessation program, perioperative tobacco use, tobacco abstinence, perioperative cessation, surgery, operation, complications, and postoperative complications. The search was further refined by combining context search terms “OR” & “AND.” The search terms “smoking cessation” AND “postoperative complications”, “preoperative smoking” AND “postoperative outcomes” OR surgery, “preoperative smoking cessation intervention” AND “postoperative complications”, “preoperative smoking cessation” AND “postoperative complications” were used. Reference lists were also checked to ensure all relevant articles had been identified.

Articles were then selected for critical appraisal based on their significance to the three project topics, whether they were written in the English language, peer-reviewed, whether they related to adult human subjects, and those published between 2000 and 2015. The initial search from ProQuest, CINAHL, Cochrane Library and UAA “QuickSearch” combined resulted in approximately 1,471 articles. The title and abstract of each article was reviewed to determine if inclusion criteria were met. Initial evaluation excluded 1,402 articles. The remaining 69 articles were fully read and individually reviewed, paying careful attention to study design, validity of findings, and usefulness of results. Reference lists from those articles as well as identified from the online source UpToDate were reviewed in a similar fashion and an additional 13 relevant articles were identified. Of those, 28 articles were selected for cataloging into an evidence-based table (EBT) (Appendix A). Each grid of the EBT contains the following information: American Psychological Association (APA) citation, study objectives, level of evidence, research design, participants, intervention, outcomes measures, and study limitations. To determine the overall strength of each article included in the EBT, the John Hopkins nursing evidence based practice I-

V hierarchy of evidence was utilized with level I being the strongest level of evidence and level V the weakest. Systematic reviews of randomized control trials, experimental/randomized control trials and meta-analysis of randomized control trials were assigned a level I. Level II evidence was assigned to well-designed quasi-experimental studies. Level III was assigned to non-experimental (cohort/case-controlled/retrospective studies), qualitative, and meta-synthesis studies. Systematic reviews of descriptive studies, qualitative studies and clinical practice guidelines were assigned as level IV. Level V was assigned to evidence from the opinion of authorities or reports of expert committees. Of the total twenty-eight articles selected for cataloging into the EBT, thirteen of those articles were of level I evidence, five articles were of level II evidence, nine articles were of level III evidence and one article was of level IV evidence.

The most current pertinent guidelines from the United States, Australia & New Zealand, and the United Kingdom were reviewed and combined with the results of the literature review. The National Guideline Clearing House, Turning Research into Practice (TRIP) Database, BMJ Clinical Evidence, and U.S. Preventative Services Task Force were assessed for quality recommendations relevant to the topic. The strength of the evidence supporting the principal recommendation was evaluated using the strength of recommendation grading system. The three strength-of-evidence ratings utilized for each principle recommendation was developed by the US Department of HHS “Treating Tobacco Use and Dependence: 2008 Update” (Appendix B).

Discussion

Given that eight to ten million procedures in the United States are performed on individuals who smoke, a small increase in abstinence rates could have a significant effect on public health (Shi & Warner, 2010). The adverse effects of tobacco use on surgical outcomes

and on general overall health combined with the potential public health benefits of permanent smoking cessation strongly supported the need for improved routine preoperative interventions. There are numerous evidence-based strategies that can be employed in the practice setting to improve the implementation of a smoking cessation intervention. Interventions range in complexity from brief advice offered by a provider to more intensive behavioral interventions with a trained counselor who has extensive knowledge regarding tobacco dependence. There is evidence to suggest that intense smoking cessation interventions are slightly more effective than brief interventions with respect to increasing quit rates, more specifically long-term quit rates among users (Stead et al., 2013). The impact of brief smoking cessation interventions on quit rates should not be underestimated. Minimal interventions, which last three or less minutes, have been proven to increase abstinence rates (Strength of Evidence = A; USDHHS, 2008). Not only are brief intervention methods effective, the approach is also lucrative, and more applicable in the rapid pace of the primary care setting.

The U.S. Department of HHS (2008), established perhaps the most notable evidenced-base framework for structuring smoking cessation. The clinical guideline was created from both expert panel opinions and systematic review and meta-analysis of the current literature in 8,700 articles. It serves as a critical evidence-based framework to guide the efforts of reducing smoking by identifying all smokers and offering quit support. The approach to smoking cessation is widely accepted and adopted in guidelines from the World Health Organization (WHO), CDC, The U.S Preventative Service Task Force (USPSTF) and Veteran's' Health Administration (VHA), among other government and nonprofit organizations. The U.S Department of HHS guideline is also adopted in modified forms in international guidelines in Japan, Australia, New Zealand and the United Kingdom.

The national clinical guideline recommends a brief smoking cessation intervention commonly known as the 5 As model. This model is an effective and easily implemented smoking cessation intervention method for primary care providers. The 5 As model can be employed in the primary care setting and is designed to utilize three minutes or less of the clinician's direct patient time. The model is intended for use in patients who are willing to make a quit attempt. The steps of this model include: *Ask* about the current and past use of tobacco, *advise* the patient to quit, *assess* willingness to quit, *assist* in the quit attempt, and *arrange* for future follow up. A relevant question still exists as to how this information will be presented by the primary care provider in order to meet the needs of the individual patient undergoing elective surgery. Using the critical framework as a guide, the intervention can be tailored to the individual and upcoming surgical event (Appendix C).

Ask. All patients should be asked about current and past tobacco use (Strength of Evidence = A; USDHHS, 2008). "It is essential that clinicians and health care delivery systems consistently identify and document tobacco use status and treat every tobacco user seen in the health care setting" (USDHHS, 2008, p. 7). *Recommendation:* - Tobacco users should be systematically identified and their tobacco use status documented at every visit (Strength of Evidence = A; USDHHS, 2008). Screening for current or past tobacco use results in three responses: the patient *currently* uses tobacco, the patient used tobacco in the *past* (ask about length of cessation), or the patient has *never* used tobacco.

Advise. Most smokers report that they are willing or want to quit, but despite the intervention programs available, utilization of these resources is low (Shi & Warner, 2010). When an intervention program is not utilized, success rates are modest (Shi & Warner, 2010). Many smokers will make an attempt to quit on their own but fail to maintain cessation despite

the desire to quit completely. Difficulties in the quitting process will result in, on average, five failed attempts before permanent cessation is achieved. Physician advice to quit has been proven to increase quit attempts. *Recommendation:* - “All *physicians* should strongly advise every patient who smokes to quit because the evidence shows that physician advice to quit smoking increases abstinence rates” (Strength of Evidence = A; USDHHS, 2008, p. 82). The advice from other primary providers such as nurse practitioners and physician assistants has also been proven effective (USDHHS, 2008).

Recommendation: - Every tobacco user should be encouraged to quit in a clear, strong, and personalized manner (Strength of Evidence = A; USDHHS, 2008). Quit advice should be offered to all patients regardless of receptivity to interventions or long-term quit goals (Strength of Evidence = A; USDHHS, 2008). In the content of this analysis, quit messages should be tailored to take advantage of the unique circumstances of surgery. Patients should be advised of the risks of continued smoking on postoperative outcomes and the benefits of smoking cessation. Patients should be advised to abstain from smoking four to eight weeks preoperatively. Taking advantage of surgery as a “teachable moment”, patients should also be advised to consider permanently quitting.

The busy nature of the primary care setting does not always present as an optimal environment to conduct such interventions. Evidence suggests that involvement from all levels of the healthcare system is necessary for smoking cessation efforts to be successful (Quraishi, Orkin & Roizen, 2006; USDHHS, 2008). Ideally, interventions should be a collaborative effort among other medical staff members, and delivery of information by one individual clinician would serve as just one component of the process as a whole. *Recommendation:* - “Treatment delivered by a variety of clinician types increases abstinence rates. Therefore, all clinicians

should provide smoking cessation interventions” (Strength of Evidence = A; USDHHS, 2008, p. 87).

Other providers involved in the surgical process such as anesthesiologists and surgeons should seize the opportunity to reinforce smoking cessation messages. Brief, consistent, positive reinforcement of these messages has a powerful effect on smoking behaviors and could potentiate long-term cessation beyond the surgical encounter (Azodi et al., 2009; Quraishi et al., 2006; USDHHS, 2008; Warner, 2005). Smoking cessation interventions can be delivered by a variety of providers with equal effectiveness (Warner, 2008). *Recommendation:* - “Treatments delivered by multiple types of clinicians are more effective than interventions delivered by a single type of clinician. Therefore, the delivery of interventions by more than one type of clinician is encouraged” (Strength of Evidence = C; USDHHS, 2008, p. 87).

Assess. Every patient who reports using tobacco should be assessed for willingness to make a quit attempt. *Recommendation:* - “Once a tobacco user is identified and advised to quit, the clinician should assess the patient’s willingness to quit at this time” (Strength of Evidence = C; USDHHS, 2008, p. 79). Clinician delivered brief interventions, lasting three or fewer minutes, are effective in enhancing motivation and likeliness of future quit attempts even in patients unwilling to quit (USDHHS, 2008). Advice to quit and follow-up at the next clinical encounter is recommended for those patients unwilling to make a quit attempt.

Utilizing the key constructs of the HBM when delivering quit advice can be useful in increasing motivation and willingness to make a quit attempt. If the patient does not believe smoking preoperatively has consequences (*susceptibility*) or is a threat to the development of complications postoperatively (*severity*), there is no stimulus to act. To effectively change health behavior, the patient must believe in both susceptibility and severity (Glanz, Rimer, &

Viswanath, 2008). The patient must also believe that the benefits of taking action are beneficial and that the necessary changes can be realistically accomplished (Glanz, Rimer, & Viswanath, 2008). The patient's perceived severity or belief that preoperative smoking has serious consequences on surgical outcomes, together with perceived benefits or behavior changes related to an individual's belief regarding perceived benefits of cessation, will predict the likelihood of successfully abstaining from smoking for the recommended four to eight week period.

Assist. Pharmacotherapy is an important element of strategies to aid in the quit attempt, the odds of successful cessation almost double with the use of medication (USDHHS, 2008; Warner, 2008). Nicotine can be replaced by using a variety of first line delivery systems, including inhalers, gum, lozenges, nasal spray and patches. All systems are effective in promoting cessation and each system has its potential advantages and can be tailored to meet the individual needs of the patient. Medication and counseling in combination have been proven to be highly effective in increasing quit rates and enhancing treatment outcomes.

Recommendation: "The combination of counseling and medication is more effective for smoking cessation than either medication or counseling alone. Therefore, whenever feasible and appropriate, both counseling and medication should be provided to patients who are trying to quit smoking" (Strength of Evidence = A; USDHHS, 2008, p. 101).

Arrange. For the patient willing to make a quit attempt, arrange for follow-up. Success of smoking cessation for those willing to quit should be addressed at subsequent clinical visits. Preferably, after initiating a smoking cessation intervention, assessment of smoking status should occur in one week (USDHHS, 2008). *Recommendation:* "...abstinent patients should have their success acknowledged, and the clinician should offer to assist the patient with problems associated with quitting. Patients who have relapsed should be assessed to determine whether

they are willing to make another quit attempt” (Strength of Evidence = C; USDHHS, 2008, p. 94).

In addition to provider advice to quit, patients should routinely be referred to quit lines. Quit lines have the potential to reach a large number of smokers and serve as an alternative resource to assist patients in the quit process. Quit lines deliver more intensive counseling by a trained specialist and serve as additional support for interventions delivered by providers. In addition, quit lines are highly cost-effective and have proven to enhance quit rates (USDHHD, 2008).

Significance to Nursing

Primary care providers are in a favorable position to assist and play a pivotal role in helping support patients in maintaining smoking cessation prior to surgical intervention. Providers can improve cessation rates by simply asking patients about their use of tobacco and by utilizing a brief intervention for smoking cessation. Furthermore, smokers who are advised by their provider to quit have higher odds of quitting and increased motivation to quit when compared to smokers who did not receive such advice. Prior to surgery, patients should be educated on the postoperative risks associated with smoking and the benefits of smoking cessation. For primary care providers to better inform their patients, providers must be aware of the associated risks of continued smoking on postoperative outcomes and the current literature regarding best practices for smoking cessation intervention.

Dissemination

A recommended period for cessation and an evidenced-based intervention for preoperative smoking cessation will be submitted as a manuscript to the *Journal of Advanced Nursing (JAN)*. This journal is an international, peer-reviewed journal dedicated to addressing

aspects of evidence-based nursing. As the most cited and read nursing journal in the world, the *JAN* would serve as an ideal avenue to reach a broad spectrum of nurse practitioners in all specialties. An alternative dissemination plan would include a local poster presentation at the annual AANP conference.

Conclusion

It is well documented in the literature that smoking cessation interventions of four to eight weeks' duration significantly lowers the incidence of postoperative complications. Patients who smoke and are undergoing elective surgical procedures can benefit from smoking cessation interventions in the preoperative period. With such high volume of surgery annually and the preoperative period representing a teachable moment, smoking cessation interventions could potentially have a substantial effect on tobacco use during the preoperative period and in the long term. Benefit accrues not only in terms of postoperative complications but in general overall health.

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Appendix A

EBT Preoperative Smoking Cessation

Author	Study Objectives	Level	Design	Participants	Intervention	Outcome	Results	Limitation/Comments
Azodi, O.S., Lindstrom, D., Adami, J., Tonnesen, H., Nasell, H., Gilljam, H., & Wladis, A. (2009). The efficacy of a smoking cessation programme in patients undergoing elective surgery-a randomized clinical trial. <i>Anesthesia, 64</i>, 259-265.	To investigate short-term and long-term efficiency of a preoperative smoking cessation program initiated 4 weeks preoperatively and lasting 4 weeks following surgery.	1	Randomized Control Trial	1117 patients randomly assigned to intervention (n=48) and control groups (n=54).	Weekly meetings or telephone counseling with a nurse professionally trained in smoking cessation therapy, phone calls from national cessation helplines, free nicotine replacement therapy. Goal=cessation 3 weeks prior to surgery and 4 weeks after surgery.	Intervention group: smoking status and consumption recorded weekly. Self-administered questionnaire about smoking habits and repeated carbon monoxide measurements. Successful short-term abstinence= No tobacco for 3 weeks prior to surgery and 4 weeks after and if inhaled carbon monoxide 2-3 weeks postop was < or equal to 10ppm.	20/55 (36%) intervention and 1/62 (2%) in control were successful in remaining abstinent per study guidelines. 13 months later: 48/55 (87%) intervention remained smoke free and 52/62 (84%) of control. Successful smoking cessation program can be initiated as early as 4 weeks.	13 month results did not include verified measurements of CO, small sample size, possible type II error. Refusal rates were high among users.
Gourgiotos, S., Aloizos, S., Aravosita, P., Mystakelli, C., Isaia, E., Gakis, C., & Salemis, N. (2011). The effects of tobacco smoking on the incidence and risk of intraoperative and postoperative complications in adults. <i>The Surgeon, 9</i>, 225-232.	Effects of smoking cessation on risk of intra- and post-operative complications and to identify the value of preoperative smoking cessation.	3	Meta-synthesis	Not reported.	None	Complications were defined as secondary disease or a negative reaction occurring during, or after a surgical procedure-respiratory, cardiovascular, gastrointestinal, wound infection, mortality and duration of hospital stay. Studies that did not explore these risks were excluded.	Provider education = smoking cessation.	Possible selection bias
Gronkjaer, M., Eliassen, M., Skov-Ettrup, LS., Tolstrup, JS., Christiansen, A., Mikkelsen, S., Becker, U., & Flensburg-Madsen, T. (2014). Preoperative smoking status and postoperative complications: a systematic review and meta-analysis. <i>Ann Surgery 259</i>(1), 52-71.	Summarize the evidence of an association between preoperative smoking and postoperative complications.	1	Meta-analysis with systemic review	107 studies	None	Postoperative complications within 30 days after surgery reported as mortality, morbidity, and admission to intensive care	Smokers were at a higher risk for various postoperative complications including: general morbidity (Relative Risk (RR) 1.54; 95% Confidence Interval (CI) 1.33-1.75), wound complications (RR 2.15; 95% CI 1.87-2.49), general infection (RR 1.38; 95% CI	Ambiguous definitions of smoking status, diverse time intervals (no sensitivity analysis by time), majority of studies included few participants or no confounder adjustment

							1.32-1.79), pulmonary complications (RR 1.73; 95% CI 1.35-2.23), neurological complications (RR 1.38; 95% CI 1.01-1.88) and admission to intensive care (RR 1.60; 95% CI 1.14-2.25) after an operation.	
Haddock, J., & Burrows, C. (1997). The role of the nurse in health promotion: an evaluation of a smoking cessation program in surgical pre-admission clinics. <i>Journal of Advanced Nursing</i> 26 (6), 1098-110.	To improve the health status of individuals admitted for surgery and prepare them for the no smoking policy.	2	Quasi experimental, randomized, convenience sample	n = 60. 30 to control and 30 to treatment. Treatment received educational interventions and self assessment questionnaires	treatment group- educational intervention, self-assessment, questionnaire, cessation aids, diary, 15 minute counseling. Control group: routine information or usual care	stop or reduce smoking prior to hospital admission	80% of treatment group and 50% of control group abstained from smoking or stopped before admission.	no reliability or validity testing. Generalization of results. Small sample size. No control group. Uses subjective rather than empirical indicators.
Kuri, M., Nakagawa, M., Tanaka, H., Seiko, H., & Kishi, Y. (2005). Determination of the duration of preoperative smoking cessation to improve wound healing after head and neck surgery. <i>Anesthesiology</i> 102(5), 892-896.	to assess the duration of preoperative smoking cessation that reduces the incidence of impaired wound healing in patients who undergo reconstructive head and neck surgery that would reduce the rate of postoperative complications.	3	Retrospective cohort study: Non-experimental	n=188 (Smokers n=28, Ex-smokers n=120 (smoke free between 8-21 days n=34, between 22-42days n=20 & >/= 43days n=66) & Nonsmokers n=40)	None	wound complications- postoperative debridement, resuture, or reconstruction of their flap before hospital discharge.	impaired wound healing began to decrease in pts who stopped smoking 1-4 weeks before surgery. Further declining trends seen in 5-8wks. Longer than 3 weeks preoperatively	Older study. The definition of smoking status. Was not confirmed using biological techniques. Miscalculation could over estimate the risk of developing a postoperative pulmonary complication. Urges the development of an effective cessation program for outpatients to obtain the necessary length of cessation and to make primary care physicians aware of such programs.
Lauerman, C.J. (2008). Surgical patient education related to smoking. <i>AORN Journal</i>, 87(3), 599-609.	to determine what information is provided to education surgical patients who smoke about the effects of continued smoking on surgery outcomes	3	Meta-synthesis	Nine studies	None	Addressed smoking education provided before surgical intervention	Smoking cessation education for the surgical patient is not consistent	Small number of studies

Lindström, D., Sadr Azodi, O., Wladis, A., Tønnesen, H., Linder, S., Nåsell, H., & Adami, J. (2008). Effects of a perioperative smoking cessation intervention on postoperative complications: A randomized trial. <i>Annals of Surgery</i>, 248(5), 739-745.	To determine whether smoking cessation intervention 4 weeks prior to surgery would reduce frequency of postoperative complications	1	Randomized Control Trial	patients having inguinal and umbilical hernia repair. Control: n=54, Intervention: n=48. Median age~55	Individual smoking counseling and NRT 4 weeks preoperatively and continued 4 weeks postoperatively	Frequency of any postoperative complication.	Complication rate in intervention group was 21% (p = 0.03) and control 41%. Abstainers had fewer complications (15%) than those who continued to smoke or only reduced smoking (35%)-Not statistically significant. >4 weeks	Frequency of patients who declined participation may effect external validity, small number of patients may increase the risk of type II error, smoking status, definition of postoperative complications and possible information bias.
Mills, E., et al. (2011). Smoking cessation reduced postoperative complications: A systemic review and meta-analysis. <i>The American Journal of Medicine</i>, 124(2), 144–154.	To review RCT and observational evidence to establish the effect of preoperative smoking cessation on postoperative complications and to determine if there is an optimal cessation period before surgery.	1	Meta-analysis	Review of 6 RCT and 15 observational studies evaluating the effect of smoking cessation on postoperative complications for past and current smokers.	Smoking abstinence at a defined time point before surgery: Any classification of cessation	postoperative complications, secondary outcomes (wound healing, cardiopulmonary complications, all cause mortality and all cause LOS)	Each week of cessation result in a larger effect size. No optimal time given. >4 weeks	heterogeneous reporting of outcomes, inconsistent definitions of past smoking status, and differences in study designs across observational studies.
Møller, A.M., Pedersen, T., Villebro, N., & Munksgaard, A. (2003). Effect of smoking on early complications after elective orthopedic surgery. <i>The Journal of Bone and Joint Surgery. British Volume</i>, 85(2), 178-181.	To study effects of smoking on the outcomes after elective orthopedic procedures	3	Retrospective cohort study: Non-experimental	n=811 (smokers: 232 and non smokers: 579) mean age smokers: 68, non: 73. 14 cigs/day, 35 pack years	None	cardiac events ICU admits, wound healing, death, surgical revision, length of hospital stay	the number of smokers with any postoperative complication was significantly (p = 0.02) higher than the number of nonsmokers. Wound complications prolonged hospital stays on average four days and any complication 3 days.	Variance in age of smokers-were 5 years younger than the nonsmoker counterparts. Variation between subjects.

Moller, A.M., Villebro, N., Pedersen, T., & Tonnesen, H. (2002). Effect of preoperative smoking intervention on postoperative complications: A randomized clinical trial. <i>Lancet</i> 359, 114-117.	To determine effects of smoking cessation on postoperative complications	1	Randomized Control Trial	Intervention: n=56, mean age=66, pack years=35. Control: n=52, age=64, pack years=37. Hip or knee arthroplasty between Jan 1999-Dec 2000	Randomly assigned to Intervention: weekly meetings with study nurse, Nicotine replacement therapy, and counseling 6-8 weeks before surgery. Control: standard perioperative care with no active intervention program	postoperative complications, death morbidity, 4 weeks after surgery, length of stay	reduction of postoperative complications with intervention program 6-8 weeks prior to surgery, most relevant decrease post op complication is wound related. The overall postoperative complication rate was 18% in the intervention group and 52% in the control group. Greatest benefit observed was in wound complications (hematoma, infection, subfascial involvement) with respective 5% and 31% in control group. Lower cardiovascular complications (MI and chronic heart failure) 0% vs. 10% and secondary surgery 4% vs. 15%. 6-8 weeks minimum. 3 weeks improvement in wounds.	Non-randomized material and differences in baseline risk motivation for smoking cessation. Exact duration of smoking abstinence necessary to reduce complications cannot be concluded.
Myers, K., Hajek, P., Hinds, C., McRobbie, H. (2011). Stopping smoking shortly before surgery and postoperative complications: A systemic review and meta-analysis. <i>Archives of Internal Medicine</i>, 171(11), 983-989.	To examine existing smoking studies and to compare surgical patients who have recently quit smoking with those who continue to smoke to provide an evidence based recommendation for staff.	1	Systematic review with meta analysis	889 patients in 9 studies	None	effects (beneficial vs. detrimental) of quitting smoking	combined studies show no benefit or detriments to quitting for less than 8 weeks.	Meta-analysis combined different types of surgical procedures and had various definitions of postoperative outcomes.

Nakagawa, M., Tanaka, H., Tsukuma, H., & Kishi, Y. (2001). Relationship between the duration of the preoperative smoke-free period and the incidence of postoperative pulmonary complications after pulmonary surgery. <i>Chest, 120(3), 705.</i>	To examine the relationship between the duration of preoperative smoking free period and the development of postop pulmonary complications (PPC) in patients who underwent pulmonary surgery and to determine the optimal period of smoking cessation.	3	Retrospective cohort study: Non-experimental	288 consecutive patients who underwent pulmonary surgical procedure at institution from 1997-1998. Current smokers (CS) (n=37): smoked within 2 weeks of operation; Recent smokers (RS) (n=13): Smoke free 2-4 weeks prior to surgery; Ex-smokers (EX) (n=121): Smoke free for >4 weeks; Never smoked (NS) (n=117)	None	atelectasis, pneumonia, PACo ₂ > 50mmhg, air leak/effusion, fistula, empyema, chylothorax, hemothorax, tension pneumothorax, pulmonary embolism, lobar gangrene, mechanical ventilation, intercostal tube drainage. Many PPC had time limits applied-see article for details.	PPC: CS: 43.2%; RS: 53.8%; ES: 34.7%; NS 23.9%. 8 weeks cessation ES experienced similar PPC as NS. PPC incidence began to decrease with 5-8 weeks preoperative smoking cessation. 5 weeks minimum.	nicotine use was self reported (not confirmed with CO or nicotine metabolite recording).
Shannon-Cain, J., Webster, S.F., & Cain, B.S (2002). Prevalence of and reasons for preoperative tobacco use. <i>AANA J, 70, 33-40.</i>	To determine why patients who smoke regularly will not abstain from tobacco use before surgery and describe patients perception of the reasons they did not abstain from tobacco use.	3	Descriptive study, non-experimental, retrospective	n= 81 scheduled for outpatient surgery. Researcher developed questionnaire on preoperative tobacco use	None	Smoking cessation 24 hours before elective surgery. Variables measured were smoking history, tobacco addiction, and preoperative education.	37 patients received no instruction to quit smoking preoperatively, 2 patients abstained from smoking on their own, 44 were counseled to abstain from smoking. Counseling resulted in a 5 time increase in cessation rates.	Non randomized participant selection

Schmid, M., et al. (2015). Impact of smoking on perioperative outcomes after major surgery. <i>The American Journal of Surgery</i>, 210, 221-229.	To determine the impact of smoking on postoperative outcomes	1	Meta-analysis and systemic review	141,802 patients undergoing one of the 16 major cardiovascular, orthopedic or oncologic surgical procedures were analyzed.		16 major cancer and noncancerous surgical procedures: "Cardiovascular surgery": carotid endarterectomy, coronary artery bypass grafting, lower extremity bypass surgery, abdominal aortic aneurysm repair, cardiac valve repair or replacement, "orthopedic surgery": total hip or knee replacement and "oncologic surgery": esophagectomy, gastrectomy, pancreatectomy, colectomy, radical prostatectomy, cystectomy, nephrectomy, hysterectomy, or pneumonectomy	current smokers had higher odds of developing pulmonary, wound, and septic shock complications when compared to nonsmokers. Retrospectively, the risk of developing one complication was 12.5% in nonsmokers, 14.6% in former smokers and 14.9% in current smokers. Procedure dependent.	Restricted by the lack of data on duration of smoking cessation, current smokers were identified as those who smoked within the last year so those patients who successfully discontinued smoking prior to surgery remained categorized as current smokers which may lead to an underestimated effect of smoking on postoperative complications, quantity of cigarettes smoked per day were not captured, and particulars of the surgical encounter.
Sørensen, L.T., & Jørgensen, T. (2003). Short-term pre-operative smoking cessation intervention does not affect postoperative complications in colorectal surgery: A randomized clinical trial. <i>Colorectal Disease</i>, 5(4), 347-352.	To determine whether short term preoperative smoking cessation in colorectal surgery reduced incidence of wound complications	1	Randomized Control Trial	n=60 initially, 57 at completion (27 intervention, 30 control). Mean age 65, 66, cigs/day: 20,13	Intervention: smoking cessation immediately following preoperative consult (2-3 weeks prior to colorectal surgery), nicotine replacement (patch, gum, spray), phone call from nurse after one day of cessation, one visit to clinic or patient's home. Control: typical pre op treatment, no consults, maintain typical smoking habits	occurrence of adverse events within 30 days of surgery (wound dehiscence, infection, necrosis, pulmonary complications, length of hospital stay)	No significant difference between control and intervention for all variables measured (Fisher's Exact, Mann-Whitney U, P= 0.05). Recommended > 6weeks. No effect if cessation is < 2weeks.	intervention group was not nicotine free. Approximately half of the control group quit or reduced number of cigarettes per day following surgery, some intervention patients smoked even though they weren't supposed to

Sørensen, L.T. (2012). Wound healing and infection in surgery: The pathophysiological impact of smoking, smoking cessation, and nicotine replacement therapy: A systematic review. <i>Annals of surgery</i>, 255(6), 1069.	To clarify how smoking and nicotine affect wound healing processes and to establish if smoking cessation and nicotine replacement therapy reverse mechanisms involved	1	Meta-analysis	177 articles	None	Wound healing	Smoking cessation restores the tissue microenvironment rapidly and the inflammatory cellular functions within 4 weeks	This article was mainly concerned with the examination of the physiology effects of smoking on the body, and at the cellular level. Mention is made of the lengths of cessation for certain processes to return to normal. Several of these changes occur at the 4 week cessation mark, hinting at an optimal minimum time for smoking cessation preoperative.
Sørensen, L.T. (2012). Wound healing and infection in surgery: The clinical impact of smoking cessation: A systemic review and meta-analysis. <i>Arch surgery</i>, 147(4), 373–383.	To clarify the evidence on smoking and postoperative healing complications across surgical specialties and to determine the impact of perioperative smoking cessation intervention.	2	Systematic review with meta analysis	Smokers and nonsmokers were compared in 140 cohort studies including 479,150 patients and 4 RCT including 477 patients		All types of adverse healing events: skin incision, short-term healing outcomes (wound and tissue flap necrosis, healing delay, dehiscence of wounds and sutured tissue, surgical site infections, non-specified wound complications) and long term-healing outcomes (hernia and lack of fistula or bone healing)	Postoperative healing complications occur significantly more often in smokers compared with nonsmokers and in former smokers compared with those who never smoked. See study for specifics. Smoking cessation >4 weeks before surgery to reduce surgical site infections.	Possible error and bias during review process and poor quality of cohort studies.
Sørensen, L. T., Hemmingsen, U., & Jørgensen, T. (2007). Strategies of smoking cessation intervention before hernia surgery—effect on perioperative smoking behavior. <i>Hernia</i>, 11(4), 327-333.	To study the effect on perioperative smoking behavior and on postoperative wound infection of different types of low intensive intervention before herniotomy	2	Experimental pretest-posttest with quasi experimental after only component	n=180 smokers, 15-20 cigs/day, mean age 54-56. Preoperative for hernia repair surgery in Denmark.	Smoking cessation: standard advice to stop smoking preoperative (n=48), standard plus telephone intervention, standard plus nurse visit intervention. For data analysis, both intervention groups were combined (n=101) A fourth group of smokers who received no advice to quit smoking (n=64) were added retrospectively (chart audit).	Nicotine test and CO breath test initial appointment, day of surgery day of suture removal; Fagerstrom nicotine dependence score. LASA motivation score, % who stopped, % maintained abstinence, appearance of wound at suture removal.	preoperative 19% of advised cohort had stopped smoking vs. 2% in non-advised cohort. (No significant difference between reminder group and standard group). Reminded pts reduced median cigarettes, while standard and non-advised did not change. CO for reminder groups were lower than for standard group. NSD in post op infections between groups.	highly intensive smoking cessation interventions is necessary to achieve high cessation rate for long preoperative period (3 months in this study), CO level was a better predictor of cessation than Fagerstrom score. Low intensity intervention had no effect on postop wound infection (due to insufficient sample size). Simple prop advice helped ~20% of patients to stop smoking.

Theadom, A., & Cropley, M. (2006). Effects of preoperative smoking cessation on the incidence and risk of intraoperative and postoperative complications in adult smokers: A systematic review. <i>Tobacco Control, 15(5), 352-358</i>	To establish the effect of preoperative smoking cessation on the risk of postoperative complications and to identify the effect of the timing of preoperative cessation	3	Prospective cohort studies: Non-experimental	12 research articles reviewed current smokers (CS), past smokers (PS), and nonsmokers (NS).	None	% of patients experiencing postoperative complications (general pulmonary, coughing, respiratory infections, wound infection), sputum volume, amount of anesthesia required, mortality. Complication is defined as a secondary disease or a negative reaction during the course of or after surgery	studies revealed: higher complications in pts who stopped smoking more than 4w before breast recon surgery, compared to nonsmokers; pts who stopped smoking within 2 months of surgery had an increase risk of complications when compared to pts who stopped more than 2 months preoperative; pts who stopped smoking for more than 6 months preoperative had reduced mortality; pts who stopped smoking less than four weeks before surgery had lower incidence of all pulmonary complications than CS; pts. who quit one month before surgery had same pneumonia rate as NS	Definition of postoperative complication, smoking status, differences in characteristics of sample and surgical procedure performed, publication bias. Generally, CS had a higher rate of postop complications than NS. Only one study found a significant increase in postop complications from short term preoperative smoking cessation. It appears that patients who quit even short term reduce their risk of complications compared to CS.
Thomsen, T., Tonnesen, H., & Moller, A.M. (2009). Effect of preoperative smoking cessation interventions on postoperative complications and smoking cessation. <i>British Journal of Surgery, 96, 451-461.</i>	To examine the effect of preoperative smoking cessation interventions on postoperative complications and smoking cessation short and long term	1	Systematic Review	Eleven RCTs with 1194 patients	Smoking cessation interventions of intensive, medium intensity and less intensive. Could include 5 a's, behavioral counseling tailored at stage of change, motivational interviewing, or other methods (person-person phone, groups or computer)	Postoperative complications 30 days after surgery. Wound healing complications, respiratory, cardiovascular and urological complications and other complications requiring treatment.	Intensive interventions increased smoking cessation rates preoperatively (pooled risk ration 0.56 and 12months thereafter. Medium intensity to less intensive interventions were not significant for long-term smoking cessation or significant reductions in postoperative complications, Cessation at least 4 weeks preoperatively.	variation between samples

<p>Thomsen, T., Tonnesen, H., Okholm, M., Kroman, N., Maibom, A., Sauerberg, M., & Moller, A. (2010). Brief smoking cessation intervention in relation to breast cancer surgery: A randomized controlled trial. <i>Nicotine Tobacco Research, 12</i>(11), 1118-24. doi: 10.1093/ntr/ntq158</p>	<p>Examine if a brief smoking cessation intervention shortly before breast cancer surgery would influence postoperative complications and smoking cessation</p>	<p>1</p>	<p>Randomized Control Trial with Blinded Outcome</p>	<p>130 patients were randomly assigned to brief smoking intervention (n=65) or standard care (n=65)</p>	<p>Followed principles of motivational interviewing and included personalized nicotine replacement therapy, aimed at supporting cessation 2 days before to 10 days after surgery.</p>	<p>Overall complication rates; defined as death or postoperative morbidity requiring treatment within 30 days after surgery, including seroma with aspiration. Length of hospital stay, need for secondary surgery and readmission within 30 days due to complication to primary surgery</p>	<p>Overall postoperative complication rate was 61% in both groups, risk ratio (RR) 1.00 (95% CI 0.75-1.33). Wound complications 44% versus 45%. Perioperative smoking cessation, 28% intervention versus 11% control. No effect on smoking cessation at 12months, 13% versus 9%.</p>	<p>Strength: allocation concealment was secure and blinded outcomes assessment. Limits: Classification of postoperative complications, small sample size, self report of smoking cessation, potential contamination of effect of intervention (not biochemically validated), potential reveal of group allocation over time (decrease in internal validity) and generalization to other cancer patients, gender or surgical procedures.</p>
<p>Thomsen, T., Villebro, N., & Møller, A.M. (2014). Interventions for preoperative smoking cessation. <i>Cochrane Database Syst Rev, 27</i>(3), doi: 10.1002/14651858.CD002294.pub4.</p>	<p>The objectives of this review are to assess the effect of preoperative smoking intervention on smoking cessation at the time of surgery and 12 months postoperatively, and on the incidence of postoperative complications.</p>	<p>1</p>	<p>Meta-analysis</p>	<p>Randomized controlled trials that recruited people who smoked prior to surgery, offered a smoking cessation intervention, and measured preoperative and long-term abstinence from smoking or the incidence of postoperative complications or both outcomes.</p>	<p>None</p>	<p>Smoking cessation at the time of surgery and 12 months afterwards. Morbidity and mortality: wound complications, secondary surgery, cardiopulmonary complications, admission to intensive care, intra and postoperative mortality, length of stay.</p>	<p>preoperative smoking interventions providing behavioral support and offering Nicotine replacement therapy increase short-term smoking cessation and may reduce postoperative morbidity. he optimal preoperative intervention intensity remains unknown. Based on indirect comparisons and evidence from two small trials, interventions that begin four to eight weeks before surgery, include weekly counseling and use Nicotine replacement therapy are more likely to have an impact on complications and on long-term smoking cessation. 4 weeks minimum</p>	<p>Differences between studies definitions of postoperative complications and smoking cessation, specifically smoking at the time of surgery could be sources effecting the heterogeneity of the strength of conclusions drawn. Attitudes around smoking cessation may have changed in more recent studies used in this analysis.</p>

Tønnesen, H., Faurschou, P., Ralov, H., Mølgaard-Nielsen, D., Thomas, G., & Backer, V. (2010). Risk reduction before surgery: The role of the primary care provider in preoperative smoking and alcohol cessation. <i>BMC Health Services Research, 10</i>(1), 121-121.	To evaluate integrated clinical practice for smokers and drinkers admitted for elective surgery, focusing on GP referral to smoking cessation program	2	Quasi experimental, before and after intervention	n=72 high risk (daily smokers, drinkers >14 drinks/week for women, >21 for men)	instruction of general providers to refer patients to smoking cessation program preoperatively. Identification of barriers to patients and general providers. Attempt at minimizing and removing barriers during study. Duration: 9 months	number of patients referred by general providers to smoking cessation program concurrent with referral to elective surgery	7/72 were referred to program by 11 different general providers (poor referral rate). This was an increase of 10%. 4-8 weeks	Effect of the study was limited to the participation of the general provider and hospital surgical departments.
Turan, A., Mascha, E.J., Roberman, D, et al. (2011). Smoking and perioperative outcomes. <i>Anesthesiology, 114</i>, 837-846.	The effects of smoking on outcomes 30 days after major surgery were evaluated	3	Retrospective cohort study-Non-experimental	520,242 non-cardiac surgical patients from the college of surgeons national surgical quality improvement program database	None	Classified based on major morbidity (30d mortality, surgical site infection, Pneumonia, unplanned intubation, PE, vent >48h, stroke/CVA, coma >24h, cardiac arrest, MI, bleeding/transfusions, sepsis and septic shock). And minor morbidity (superficial site infection, deep incisional infection, wound disruption, renal insufficiency, UTI, DVT	Smokers experienced significantly greater odds of adverse events postoperatively including: higher rates of pneumonia, unplanned intubation, myocardial infarction, stroke, superficial and deep incisional infections and sepsis.	Small studies focusing on specific results, smoking status in weeks or days was not recorded, missing values in the ACS-NSQIP, unable to adjust for each type of hospital, and study includes heterogeneous set of surgical procedures
Warner, D.O. (2005). Preoperative smoking cessation: the role of primary care provider. <i>Mayo Clinic Proceedings, 80</i>(2), 252-258.	Review examines why it is important for surgical patients to abstain from tobacco in the perioperative period and how primary providers can help them do so.	4	Systematic reviews of descriptive studies	None	None	None	Perioperative period is a unique time to intervene with smoking cessation messages. Teachable moment.	This is a "review" for primary providers. A critical appraisal of the evidence?
Wolfenden, L., Wiggers, J., Knight, K., Campbell, E., Spigelman, A., Kerridge, R., & Moore, K. (2005). Increasing smoking cessation care in the preoperative clinic: A randomized controlled trial. <i>Preventative Medicine, 41</i>(1), 264-290.	To assess the efficiency, acceptability and cost of a comprehensive smoking cessation care program in preoperative clinics and to facilitate the provision of patients attending the smoking cessation care program	1	Experimental- Random	n= 81 treatment group/n=62 control group	Computerized smoking assessment program, printed materials, tailored self-help material	smoking cessation at least 24 hours before surgery	73% in treatment group/ 53% in control group. 50% of the experimental group and 13% of usual care group received all appropriate elements of care. 40% of experimental group did not receive cessation advice from anesthesiologist	no reliability or validity testing

<p>Wong, J., Lam, D.P., Abrishami, A., Chan, M.T.V., & Chung, F. (2012). Short-term preoperative smoking cessation and postoperative complications: A systematic review and meta-analysis. <i>Canadian Journal of Anesthesia/Journal Canadien d'Anesthésie</i>, 59, 268-279.</p>	<p>To determine the risks or benefits of short-term smoking cessation on postoperative complications and to derive the minimum duration of preoperative abstinence from smoking required to reduce such complications in adult surgical patients</p>	2	Meta-analysis	<p>review of 25 selected cohort studies and RCTs that examined post operative complications of patients who quit smoking within 6 months of surgery compared to those in current smokers</p>	None	<p>respiratory, cardiovascular, and wound healing complications</p>	<p>Respiratory: abstinence >8w: risk same as NS; 4-8w lower than CS, 2w & 2-4w NSD from CS. CV: NSD between NS, CS and ex smokers. Wound: 2x risk in CS vs. NS, <3-4w had greater risk than NS, >3-4w NSD to NS. Bottom line: cessation >4w before surgery reduced respiratory complications by 23%, >8w by 47% (comparable with NS). Abstinence >3-4w had fewer wound complications than CS. Quit >4 weeks less pulmonary and wound complications. <4 weeks, no effect.</p>	<p>Limitations: few studies had high methodological quality, most studies were retrospective observational. Many studies did not adjust for confounding factors between groups. Most studies relied on self reporting of smoking status. Smoking cessation intervals in some studies were not clearly defined, intervals overlapped.</p>
<p>Zaman, M., Bilal, H., Mahmood, S., & Tang, A. (2012). Does getting smokers to stop smoking before lung resections reduce their risk? <i>Interactive Cardiovascular and Thoracic Surgery</i>, 14(3), 320-323.</p>	<p>To determine whether the incidence of major pulmonary morbidity after lung resection is associated with timing of smoking cessation</p>	3	Meta-synthesis	<p>49 papers were found (Medline search 1950-2011 using OVID:</p>	None	<p>examined overall pulmonary complications for patients quitting or not quitting at various intervals before surgery</p>	<p>Smoking cessation reduces risk of pulmonary complications, however an optimal interval of cessation is not clear. Evidence indicates that risk declines with longer smoke free period. Patients should be counseled to quit smoking prior to surgery, regardless of the time period. No optimal time defined.</p>	<p>Study selection bias</p>

Appendix B

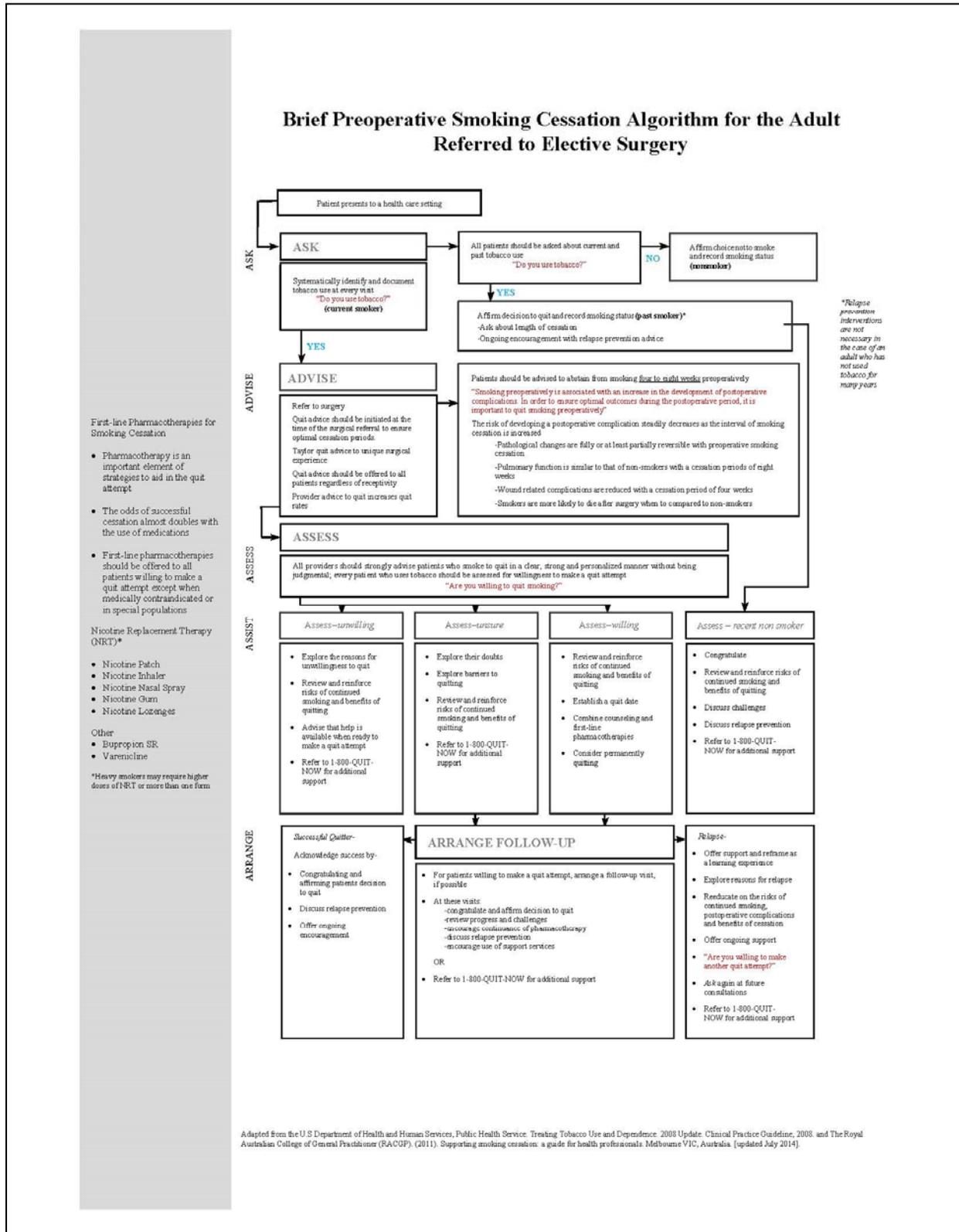
Strength-of Evidence Classification	Criteria
Strength of Evidence = A	<p data-bbox="667 415 1382 449">There is good evidence to support the recommendation.</p> <ul data-bbox="574 491 1430 667" style="list-style-type: none"><li data-bbox="574 491 1430 667">• Multiple well-designed randomized clinical trials, directly relevant to the recommendation, yielded a consistent pattern of findings.
Strength of Evidence = B	<p data-bbox="667 783 1360 816">There is fair evidence to support the recommendation.</p> <ul data-bbox="574 858 1398 1186" style="list-style-type: none"><li data-bbox="574 858 1398 1186">• Some evidence from randomized clinical trials supported the recommendation, but the scientific support was not optimal. For instance, few randomized trials existed, the trials that did exist were somewhat inconsistent, or the trials were not directly relevant to the recommendation.

Strength of Evidence = C	<p>There is poor evidence regarding the inclusion or exclusion of the recommendation but recommendations may be made on other grounds.</p> <ul style="list-style-type: none">• Reserved for important clinical situations in which the Panel achieved consensus on the recommendation in the absence of relevant randomized controlled trials.
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Adapted from the U.S Department of Health and Human Services, Public Health Service.

Treating Tobacco Use and Dependence. 2008 Update. Clinical Practice Guideline, 2008. p. 77.

Appendix C



Smoking harms nearly every organ in the body. When compared to nonsmokers, smokers can experience:

- Longer hospitalizations
- Delays in discharge
- Transfer to more intensive levels of care
- Increases in healthcare costs
- Additional surgical or medical intervention
- Pneumonia
- Sepsis
- Stroke
- Unplanned intubation
- Increases in mortality

Pathological changes are fully or at least partially reversible with preoperative smoking cessation:

- Smoking cessation gradually improves pulmonary function, and becomes similar to that of nonsmokers after a cessation period of four to eight weeks with longer periods of cessation reducing risk.
- Of the 7,000 chemicals compounds found in cigarettes, 4,000 can adversely affect wound healing. Significant reductions in surgical site infection and impaired wound healing are demonstrated with three to eight weeks of smoking cessation.

Quit Line:

- Call for FREE help: **1-800- QUIT- NOW** (1-800-784-8669)
- Text QUIT to 47848, answer a few questions, and you'll start receiving messages

