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Efficacy of a Smoking-Cessation Intervention for Elective-Surgical Patients

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Abstract: We tested an intervention to help smokers abstain (fast) from smoking before surgery, maintain abstinence postoperatively, and achieve long-term cessation. A randomized experiment included 237 patients admitted for presurgical assessment who smoked. The intervention included counseling and nicotine replacement therapy. Treatment group participants (73.0%) were more likely to fast than were controls (53.0%): $\chi^2(1, N=228)=8.89$, $p=.003$, and more likely to be abstinent 6 months after surgery (31.2% vs. 20.2%). There was no significant difference in the abstinence rates at 12 months after surgery, $\chi^2(1, N=169)<.001$, $p=1.00$. Encouraging patients to fast from smoking before surgery and postoperative support are efficacious ways to reduce preoperative and immediate postoperative tobacco use. © 2004 Wiley Periodicals, Inc. Res Nurs Health 27:148–161, 2004

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Currently an estimated 5.4 million Canadians—21% of those 15 years of age and older—smoke cigarettes daily or occasionally (Statistics Canada, 2003). Despite substantial efforts to reduce both the prevalence and incidence of smoking over the past 30 years, the challenge of identifying effective ways to help people stop smoking remains a pressing public health concern. One avenue of potential success involves the strategic provision of cessation support at times and in settings that facilitate the cessation process. For example, we previously examined the benefit of using temporary abstinence during pregnancy as a springboard toward permanent cessation following birth via the provision of in-hospital, face-to-face counseling and ongoing telephone support (Johnson, Ratner, Bottorff, Hall, & Dahinten, 2000; Ratner, Johnson, Bottorff, Dahinten, & Hall, 2000).

Our research rested on the notion that there are identifiable situations (e.g., during pregnancy or in the hospital) that enhance the potential for smoking cessation and that it is possible to capitalize on these opportunities by providing tailored cessation support. Given that a sizable proportion of smokers find themselves in need of surgery at some time in their lives, the hospital may be an excellent setting for initiating and supporting smoking-cessation efforts. Faced with illness or the need for surgery, patients who smoke are likely to heed the advice of medical professionals (Emmons & Goldstein, 1992). Despite this apparent window of opportunity, few physicians and nurses engage in regular smoking-cessation counseling (McCarty, Zander, Hennrikus, & Lando, 2001; Sarna, Wewers, Brown, Lillington, & Brecht, 2001; Smith & Herbert, 1993). The purpose of this study was to determine the efficacy of an intervention designed to assist patients to abstain from smoking before surgery, to maintain abstinence in the postoperative period, and ultimately to achieve long-term cessation.

Effects of Cigarette Smoking on Surgical Outcomes

Approximately 4,000 substances have been identified in cigarette smoke, many of which adversely affect the cardiovascular system and have direct physiological links to surgical outcomes (Akrawi & Benumof, 1997; Egan & Wong, 1992). Carbon monoxide (CO), present in cigarette smoke, has several effects on oxygen transport, including reducing the oxygen-carrying capacity of blood by shifting the oxygen–hemoglobin saturation curve and affecting the storage and use of oxygen in muscle, most notably the heart. Nicotine has many deleterious effects on the cardiovascular system; it increases blood pressure, heart rate, myocardial excitability, and peripheral vascular resistance and is associated with ST segment depression (Woehlck, Connolly, Cinquegrani, Dunning, & Hoffmann, 1999). Because the half-lives of CO and nicotine are such that even short periods of withdrawal from smoking (greater than 12 hr) can completely eliminate these substances from the blood and thereby reduce some of their harmful effects, surgical patients often are advised to undergo smoking fasts before surgery (Deller, Stenz, & Forstner, 1991; Egan & Wong, 1992; Moores, 2000). Longer periods of presurgical smoking abstinence were shown to improve intra- and postoperative outcomes (Nakagawa, Tanaka, Tsukuma, & Kishi, 2001).

The benefits of short-term smoking abstinence before surgery are primarily limited to improvements in cardiovascular function. Smoking, however, also affects the pulmonary system; exposure to smoke causes hypersecretion of mucus, ciliary dysfunction, and airway reactivity. These changes increase the incidence of postoperative pulmonary complications in smokers from two- to sixfold (Akrawi & Benumof, 1997). Although research evidence suggests that abstaining from smoking for 6–8 weeks is required to reduce most pulmonary complications (Bluman, Mosca, Newman, & Simon, 1998; Warner et al., 1989), some improvements, including reduction in upper airway reflex sensitivity, can occur within 24 hr of abstinence (Erskine, Murphy, & Langton, 1994).

Smoking abstinence may enhance wound healing during the postoperative period, particularly following orthopedic, vascular, and plastic surgery (Chang, Buncke, Slezak, & Buncke, 1996; Haverstock & Mandracchia, 1998). Because of smoking-induced immune system impairment, smokers have higher rates of pulmonary and wound infections. With abstinence that has lasted from 1 week to 2 months, these rates approach normal (Akrawi & Benumof, 1997).

The recognition of the benefits of smoking abstinence before and following surgery has led to the call for clinical guidelines similar to those for preoperative fasting from water and food (Nel & Morgan, 1996). With the introduction of preadmission clinics, most surgical patients are seen as outpatients between 1 and 3 weeks before surgery, and consequently, there is an excellent opportunity to assist many smokers in their efforts to stop smoking before admission for surgery.

The Hospital as an Appropriate Setting for Smoking Cessation

The U.S. Agency for Health Care Policy and Research (AHCPR) smoking-cessation guideline panel reviewed research related to smoking cessation to identify effective, experimentally validated smoking-cessation treatments and to develop evidence-based practice guidelines (Fiore et al., 1996, 2000). Its recommendations advised clinicians to: (a) identify smokers; (b) encourage all smokers to quit; (c) identify smokers interested in quitting; (d) provide information, advice, and support for smoking cessation; and (e) provide follow-up care. These recommendations, based on knowledge acquired in primary care settings, are not applied widely within the hospital setting. Although the guidelines emphasized the importance and cost effectiveness of cessation efforts by health providers and recommended that smoking-cessation treatments be provided to hospitalized patients, the evidence supporting the recommendation was graded *B* because the scientific support was not optimal. Further research was needed to determine the efficacy of interventions provided by different hospital-based health professionals, including nurses.

Surprisingly few clinical trials of smoking-cessation interventions for surgical patients have been reported in the published literature since the publication of the AHCPR smoking-cessation guidelines. In most published works, investigators continued to describe the populations of hospitalized patients who smoke and the predictors of cessation (e.g., Lando, Hennrikus, McCarty, & Vessey, 2003; Ramsey, Brown, Strong, & Sales, 2002) or to focus on cardiovascular patients, who may have strong motivation to abstain because their health problems are often smoking related (e.g., Reid et al., 2003). Haile et al. (2002) described a pilot study designed to determine the potential effectiveness, feasibility, and acceptability of computer-delivered smoking-cessation advice to surgical preadmission patients in Australia. They concluded that this approach was an acceptable and feasible method of encouraging surgical preadmission clinic patients to stop or to reduce their smoking, but they could not determine the efficacy of the approach because of study design limitations.

Patients' Readiness for Cessation

An important aspect of professional intervention is smokers' readiness for cessation. Five stages of change have been identified within the smoking-cessation process: precontemplation, contemplation, preparation, action, and maintenance (Prochaska & DiClemente, 1992). Those in the precontemplation stage are not yet considering cessation, whereas those in contemplation anticipate a cessation attempt within the next 6 months. Those in the preparation and action stages are making plans for, or actively engaging in, smoking-cessation efforts. Finally, those in the maintenance stage have been abstinent for at least 6 months. Closely related is the notion of self-efficacy, the confidence in one's ability to behave in such a way as to produce a desirable outcome (Bandura, 1977). Several researchers have called attention to the consistent, predictive value of self-efficacy for behavior change in smoking-cessation treatment participants (Gwaltney et al., 2001; Mudde, Kok, & Strecher, 1995; Ockene et al., 2000).

We developed a smoking-cessation intervention for elective surgical patients to assist them in abstaining from tobacco use immediately before surgery, sustaining their abstinence in the postoperative period, and ultimately maintaining long-term abstinence. The following hypotheses were tested:

1. Hypothesis 1. Treatment participants will be significantly more likely than control participants to abstain from smoking for at least 24 hr prior to surgery.
2. Hypothesis 2. The 6-month postsurgery smoking-abstinence rate of treatment participants will be significantly higher than that of control participants.
3. Hypothesis 3. The 12-month postsurgery smoking-abstinence rate of treatment participants will be significantly higher than that of control participants.

METHOD

Design and Setting

A randomized pretest–posttest control group experiment was conducted in the preadmission clinic (PAC) of a large, urban teaching hospital in western Canada. Most elective-surgical patients are seen in this clinic as outpatients 1–3 weeks before surgery for presurgical assessment (e.g., blood tests, X-rays) and teachings related to surgery and recovery. Patients from 10 surgical services (e.g., cardiovascular, ophthalmology,

orthopedics, plastics, and urology) are seen routinely in this PAC, which was selected because of its volume and diversity of patients. During the study the clinic staff did not offer any routine smoking-cessation counseling or smoking-related printed materials. Although individual anesthetists, surgeons, and nurses may have advised patients to stop smoking, their efforts would have been uncoordinated and applied inconsistently, and if advice was offered, it would have been accompanied by little tangible assistance or support.

The participants in this research were treated in accordance with the ethical principles specified in the Canadian *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans* (Medical Research Council of Canada, Natural Sciences and Engineering Research Council of Canada, & Social Sciences and Humanities Research Council of Canada, 2003). The Ethics Review Boards of the university and the hospital approved the research. All participants signed consent forms and were advised that they were enrolling in a study to evaluate new ways to help patients stop smoking before surgery and possibly remain nonsmokers after surgery. They were advised that they would be randomly assigned to one of two groups; those in the control group were advised that they would receive standard hospital care. Those participants who had their telephone support sessions audiotaped provided additional consent for that component of the study.

Participants

The target population for this study was composed of all patients admitted for presurgical assessment between November 1999 and October 2001 who met the following criteria: (a) self-identified as current smokers who had smoked in the previous 7 days; (b) expected to remain in the hospital for at least 24 hr following surgery; (c) able to comprehend spoken and written English; (d) able to be contacted by telephone; and (e) willing and able to participate (i.e., sign informed consent, no cognitive impairment).

Measures

Smoking status. Data regarding abstinence, lapses, amount smoked, and patterns of smoking were collected by self-report. Self-reports, however, may be unreliable because smokers may misrepresent their smoking behavior out of embarrassment or a desire to please (Patrick et al., 1994; Pokorski, William, & Bertolf, 1994). Biochemical measures including CO readings and cotinine (the major metabolite of nicotine) assays not only verify self-reports but also enhance the validity of self-reports, especially because smokers are usually unaware of the detection time of these measures, although no measure is 100% sensitive to active smoking (Miwa, Fujita, & Miyagi, 1994; Murray, Connett, Lauger, & Voelker, 1993; Secker-Walker, Vacek, Flynn, & Mead, 1997). Reported abstinence was verified during face-to-face contacts (at intake and at the postoperative visit) with measures of CO in expired air, using the Bedfont EC50 Smokerlyzer. CO readings of 10 or greater parts per million (ppm) were considered indicative of recent smoking; this cutoff has been demonstrated to have 88% sensitivity and 84% specificity in discriminating self-reported smoking status (Jarvis, Tunstall-Pedoe, Feyerabend, Vesey, & Saloojee, 1987). When participants denied smoking but had CO readings $\geq$10 ppm, they were classified as "not abstinent." When participants admitted to smoking but had CO readings $<$10 ppm, perhaps because they smoked irregularly, they were classified as "not abstinent." The 6- and 12-month self-report verifications relied on urinary cotinine measurements with the Accutest NicoMeter Cotinine Test (Jant Pharmacal Corp., n.d.). This approach is semiquantitative and provides a crude estimate of the concentration range of cotinine. NicoMeter levels exceeding 100 ng/mL, as recommended by the manufacturer, are indicative of recent smoking (cotinine has a half-life of 10–40 hr). The sensitivity and specificity of the NicoMeter are 92% and 100%, respectively, when contrasted with self-reports of tobacco use in the previous 48 hr.

Smoking-cessation self-efficacy. Smoking-cessation self-efficacy was measured with the Smoking Self-Efficacy/Temptation Scale, designed to assess smokers' confidence that they would not smoke in three types of challenging situations: positive affect/social situations, negative affect situations, and habitual/craving situations (DiClemente & Prochaska, 1985; Prochaska, DiClemente, Velicer, Ginpil, & Norcross, 1985). The instrument contains nine items (three items for each subscale) measured on a 5-point Likert scale scored from 1, *not at all tempted*, to 5, *extremely tempted*. The instrument has demonstrated acceptable construct and predictive validity and internal consistency, with Cronbach's alphas ranging from .88 to .92 (DiClemente & Prochaska; Prochaska et al., 1985; Velicer, DiClemente, Rossi, & Prochaska, 1990).

Smoking stage of change. Questions from the short form of the Smoking: Stage of Change questionnaire determined whether participants were precontemplating, contemplating, preparing for, or actively engaged in smoking cessation (Velicer et al., 1995).

Demographic and personal characteristics. Data were collected on gender, age, total household income, and education. These questionnaire items were derived from well-established national surveys.

Smoking history and nicotine dependence. The Mayo Nicotine Dependence Center (1993) Participant Questionnaire was adapted for this research. The items measure smoking patterns, including duration and amount smoked and presence of other smokers in the participants' homes. The Fagerstrom Test for Nicotine Dependence was also included to assess nicotine (physiological) dependence (Fagerstrom & Schneider, 1989; Kozlowski, Porter, Orleans, Pope, & Heatherton, 1994; Payne, Smith, McCracken, McSherry, & Antony, 1994). Evidence supports the reliability and validity of the instrument; criterion-related validity was confirmed with highly correlated CO and cotinine assays and the addictive factor of the Classification of Smoking by Motives Questionnaire (Pomerleau, Carton, Lutzke, Flessland, & Pomerleau, 1994; Tate & Schmitz, 1993). Construct validity has been confirmed with factor analysis; a unidimensional construct was identified (Tate & Schmitz).

Psychological state. The anxiety and depression subscales from the Brief Profile of Mood States (POMS) were included as measures of psychological distress (McNair, Lorr, & Droppleman, 1992). This instrument has been used in smoking-cessation trials (Thorsteinsson et al., 2001; Ward, Swan, & Jack, 2001); both subscales have been shown to be internally consistent (coefficient alphas $>.84$), and six analyses of the factor structure confirmed their construct validity. Nyenhuis, Yamamoto, Luchetta, Terrien, & Parmentier (1999) established criterion-related validity by correlating the anxiety and depression subscale scores with the State-Trait Anxiety Inventory (state: $r=.72$, trait: $r=.70$; Spielberger, Gorsuch, & Lushene, 1970), the Beck Depression Inventory (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961; $r=.69$), and the Geriatric Depression Scale (Yesavage et al., 1982; $r=.78$).

Procedure

Registered nurses (RNs) were employed and trained by the investigators in smoking-cessation counseling. These RNs recruited all participants, collected baseline and in-hospital data, and provided the intervention. The RNs approached potential participants in the PAC, explained the study, screened for eligibility, and obtained informed consent. Limited data were collected from all PAC patients, enabling some description of those who did not consent to participate (e.g., surgical service, age, gender, smoking status, and stage of change). The RNs administered the baseline data collection instruments to all participants, including CO measurements. They then opened a sealed envelope containing a computer-generated, randomly determined group allocation. Participants randomly chosen to be in the control group were thanked for their participation and reminded that they would be visited following surgery and contacted at home at 6 and 12 months. Treatment group participants received phase one of the intervention (see Intervention Protocol).

Within 24 hr or once stable after surgery, all participants were visited in their hospital rooms, and their recent smoking behavior was assessed, including the measurement of CO in expired air. Treatment group participants received the second phase of the intervention. Once home, the treatment group participants received scheduled telephone counseling sessions, usually delivered by the RN whom they had met while in the hospital. Field notes were used to record the contents of each session, its duration, and the participant's progress and smoking status. Selected telephone sessions were audio-recorded so that further analysis of the content of the dyadic interactions could be done (see Bottorff et al., 2004). Notes were kept for all participant-initiated calls to a hotline. Research assistants who had no previous contact with the participants and who were blind to the hypotheses and group assignment telephoned the participants to collect 6- and 12-month follow-up data. Biochemical verification of smoking status was completed with urine assays of cotinine. All participants were mailed testing reagents with instructions and asked to return them by mail to the research office; it was not possible to verify whether participants had tested their own urine.

Intervention Protocol

The intervention was based on current understanding of the addiction, cessation, and relapse processes and effective programming for sustained behavior change, derived from the clinical guidelines published by the AHCPR (Fiore et al.,

2000). The intervention protocol built on the investigators' previous experience with clinical smoking-cessation interventions for use with other patient populations (Johnson, Budz, Mackay, & Miller, 1999; Johnson et al., 2000; Ratner et al., 2000). Six principles underlay the protocol: (a) stopping smoking for even a short time minimizes some of the risks of surgery, enhances postoperative recovery, and increases self-efficacy for smoking-cessation efforts; (b) the potential risks of anesthesia and surgery serve as powerful inducements to stop smoking; (c) the provision of skills, knowledge, and intensive ongoing support is essential to successful cessation; (d) smoking cessation is a process that occurs over time; (e) lapses and relapses are not irrevocable states; and (f) successful interventions are characterized by their adaptability, responsiveness to individual needs and concerns, and attention to capacity building or self-efficacy.

The intervention was comprised of three components: the PAC intervention, the in-hospital intervention, and the telephone counseling intervention

The PAC intervention. This was a 15-min face-to-face counseling session that included the provision of advice, information sharing, and skill building supplemented with printed materials. The advice included recommendations about stopping smoking for at least 24 hr before surgery. The information provided outlined the hazards of smoking immediately before surgery and the benefits of even short-term fasting. Skill building involved setting a stop date and helping the participant prepare for stopping. Strategies for successful stopping were reviewed, including techniques for dealing with cravings and high-risk situations, for mobilizing social support, and for using nicotine replacement therapy. Participants were provided with a kit that included nicotine replacement gum, pamphlets, and stress reduction aids and distracters (e.g., chewing gum, stress balls). Participants also were given a telephone number (hotline) to call for further cessation assistance and advice from the study RNs.

In-hospital postoperative intervention. Within 24 hr after surgery or once stable, participants were visited by a study RN to review the progress of their smoking fast and to encourage movement to the next stage of the smoking-cessation process. Participants who had successfully stopped were congratulated and advised to continue their fast for the next 10 days or longer to promote healing. They were encouraged to consider the benefits of long-term cessation and advised to take advantage of their current abstinence by converting their fast to a cessation effort. Skills associated with relapse prevention were suggested and reviewed. Those using nicotine replacement therapy or bupropion hydrochloride were encouraged to continue, and participants were provided with and encouraged to use self-help cards. The two-sided card outlined strategies to prevent lapses in high-risk situations and how to cognitively restructure the meaning of slips (lapses) if they occurred. Participants were encouraged to draw on the support of someone in their social network and were reminded of the hotline number.

Participants who were not able to observe or maintain a smoking fast were asked to consider stopping for the 10 days immediately following surgery to promote healing. The nonsmoking policy of the hospital, which included forced withdrawal from cigarettes during the postoperative period, was presented as an ideal opportunity. The challenges that made fasting impossible for that participant were reviewed and strategies to overcome those particular challenges were mutually formulated. Other elements of the previously described in-hospital intervention were included (i.e., skill building, self-help card, social support).

Telephone counseling intervention. About 1 week after the in-hospital visit, the participants were contacted by telephone and provided support for their smoking-cessation effort (3 remained in the hospital and were contacted there). These calls continued weekly for the first month and biweekly for the second and third months following discharge. The ninth and final support call was made 16 weeks following discharge. During the contacts the study RN focused on efforts to maintain cessation, reviewed high-risk situations and how they were managed, and if indicated, provided counseling regarding the management of slips or lapses. These sessions were problem-focused and emphasized appropriate responses consistent with the messages and support provided in all other components of the intervention. Throughout each session the RN assumed an empathetic and encouraging stance.

Treatment fidelity is a gold standard of clinical research. We incorporated several means to maintain treatment fidelity and adherence including: (a) structured and rigorous training of research staff; (b) role playing to evaluate competence; (c) checkouts every 3–6 months where role playing was done to assess the extent of drift among the study RNs; (d) regular staff meetings to review the protocol and to address complex situations; (e) checklists for every timed interven-

tion to ensure that all components were covered; and (f) a video recording of an enactment of the intervention protocol, which the study RNs reviewed as necessary.

Analysis Strategy

Univariate descriptive statistics were examined to ensure accuracy of the data file and to determine the extent of missing data and outliers. Checks for consistency between self-reported smoking status and biochemical verification were done. The treatment and control groups were compared for preintervention differences specifically related to all covariates, and the distributional properties of the variables were assessed.

To test hypotheses 1, 2, and 3, the binary dependent variable, smoking abstinence, was analyzed using contingency tables and chi-square tests. A multistep logistic regression model-building strategy based on the work of Hosmer & Lemeshow (1989) was used to test for the effect of treatment at 6 and 12 months, after adjusting for potential covariates measured at intake. In the first step of the model-building strategy, all variables considered for inclusion in the model were examined independently for a relationship with smoking abstinence. In the second step, those variables with a p value $\leq .25$ were included in an initial logistic regression model. Next, the predictor variable in the initial model with the lowest Wald statistic and highest p value was removed, and the model was run again. If the removal of the variable did not result in a significant reduction in model fit (as indicated by a change in the model -2 log likelihood), then the variable was removed from further steps. The removal and subsequent testing of change in model fit was repeated until all nonsignificant predictors were tested. Group assignment was maintained in all models to provide a test for treatment effect regardless of significance. Potential covariates included in the first step of both the 6- and 12-month logistic regression models were: number of days from surgery to date of follow-up assessment, age, education, self-efficacy (craving, positive affect, and negative affect), POMS: Tension-anxiety, POMS: Depression-dejection, Fagerstrom Test for Nicotine Dependence, presence of others in the home who smoked (yes/no), and smoking stage of change. All possible two-way interactions were tested. The same analysis procedure was used in an intention-to-treat analysis (effectiveness), in which all participants who withdrew or were lost to follow-up were classified within their assigned groups as continuing smokers. This intention-to-treat analysis did not include the number of days from surgery intake to date of survey as a covariate because these data were not available for participants who withdrew or were lost to follow-up.

RESULTS

A total of 3,063 patients were screened during the recruitment period. Of those screened, 2,645 patients were considered ineligible for the following reasons: 1,121 (42.4%) had never smoked; 1,270 (48.0%) had smoked but not in the past 6 months; 121 (4.6%) had smoked in the past 6 months but not in the previous 7 days; and 133 (5.0%) were excluded for miscellaneous reasons including not having a telephone or having limited English language skills.

Out of the 418 patients who met the eligibility criteria, 237 (57%) agreed to participate. Participants ranged in age from 17 to 77 years ($M = 50$, $SD = 13.6$) and underwent a wide range of surgical procedures including general (24%), obstetrical/gynecologic (18.6%), cardiovascular (16.9%), orthopedic (15.2%), urologic (10.1%), vascular (8.4%), and other (6.8%) surgeries. The treatment and control groups did not differ significantly on any demographic or smoking-related characteristics at baseline (see Table 1). The median length of postoperative stay was 5 days for both study groups; 9.3% of the treatment group and 11.0% of the control group were hospitalized for 10 or more days following surgery, $t(121.7) = -1.27$, $p = .21$ (two-tailed).

Participant Dropout

The mean duration from intake to 6-month interview was 209 days ($SD = 24$) and from intake to 12-month interview was 432 days ($SD = 86$), with no significant difference between treatment and control groups, $t(200) = 1.1$, $p = .29$; $t(167) = 0.74$, $p = .46$. Of the 237 participants, 228 (96.2%) completed the postoperative survey, 202 (85.2%) completed the 6-month survey, and 169 (71.3%) completed the 12-month survey. Although more treatment group participants than control group participants were lost to follow-up at 6 months, there was no differential loss to follow-up at 12 months (see Table 2). Of the 68 participants who did not complete the study, 13.2% died, 58.8% withdrew from the study, and 27.9% could not be located.

Table 1. Comparison of Demographic and Personal Characteristics of Control and Treatment Groups at Baseline

Variables	Control ($n=120$)	Treatment ($n=117$)	Statistic[a]
Gender (% female)	51.3	52.5	$\chi^2=0.00$[b]
Age (*M*, *SD*)	48.8 (13.1)	50.7 (14.1)	$t=1.07$
Education level (%)			$\chi^2=1.59$
Less than high school	25.0	24.8	
High school	30.8	25.6	
Some/completed trade/community college	21.7	20.5	
Some/completed university	22.5	29.1	
Annual Income (%)			$\chi^2=6.14$
≤ $29,999	27.7	33.9	
$30,000–$49,999	26.8	15.2	
$50,000–$69,999	17.9	14.3	
$70,000+	27.7	36.6	
Stage of change (%)			$\chi^2=1.65$
Precontemplation	14.2	19.0	
Contemplation	37.5	33.6	
Preparation	45.0	42.2	
Action	3.3	5.2	
Age of initiation (*M*, *SD*)	15.5 (4.4)	15.8 (5.7)	$t=0.55$
Cigarettes per day (*M*, *SD*)	12.6 (8.7)	11.8 (8.7)	$t=-0.76$
Nicotine dependence (*M*, *SD*)	3.7 (2.4)	3.2 (2.5)	$t=-1.34$
Years since initiation (*M*, *SD*)	33.4 (13.3)	34.9 (14.6)	$t=0.84$

[a]None of the test statistics was statistically significant at $p < .05$.
[b]Yates's continuity correction applied.

Biochemical Verification

Not all participants returned their NicoMeter strips or returned strips that were readable. Of those who reported being a nonsmoker, 55.8% and 53.1% returned readable strips at 6 and 12 months, respectively. The difference between the return rates of self-reported smokers and nonsmokers did not differ significantly, although more nonsmokers complied than did smokers (the latter group may have thought it was redundant in light of disclosing they did not smoke; see Table 3). We

Table 2. Participant Dropout by Group Assignment at 6- and 12-Month Follow-ups

Study Status	Group Assignment: Treatment n (%)	Group Assignment: Control n (%)	Statistic
At 6 months			
Lost (missed 6-month follow-up only)	3 (12.5)	2 (18.2)	
Lost (died)	5 (20.8)	1 (9.1)	
Lost (withdrew)	10 (41.7)	5 (45.5)	
Lost (missed 6- and 12-month follow-ups)	6 (25.0)	3 (27.3)	
Lost to follow-up (total)	24 (20.5)	11 (9.2)	
Completed follow-up	93 (79.5)	109 (90.8)	$\chi^2(1)=5.19$[a,*]
At 12 months			
Lost (died)	6 (16.7)	3 (9.4)	
Lost (withdrew)	20 (55.6)	20 (62.5)	
Lost (missed)	10 (27.8)	9 (28.1)	
Lost to follow-up (total)	36 (30.8)	32 (26.7)	
Completed	81 (69.2)	88 (73.3)	$\chi^2(1)=0.31$[a]

*$p < .05$.
[a]Yates's continuity correction applied.

Table 3. NicoMeter Return by Self-Reported 6- and 12-Month Smoking Status

NicoMeter Status	Self-Reported Smoking Status: Smoker *n* (%)	Nonsmoker *n* (%)	Statistic[a]
At 6 months			
Returned and readable	68 (45.3)	29 (55.8)	
Not returned	82 (54.7)	23 (44.2)	$\chi^2 = 1.29$[b]
At 12 months			
Returned and readable	45 (37.5)	26 (53.1)	
Not returned	75 (62.5)	23 (46.9)	$\chi^2 = 2.85$[b]

[a]None of the test statistics was statistically significant at $p < .05$.
[b]Yates's continuity correction applied.

classified self-reported nonsmokers who did not return readable NicoMeter strips as nonsmokers. We also report the 6- and 12-month abstinence rates for the experimental groups, compared with these participants classified as smokers.

In the 6-month follow-up, two participants reported being abstinent yet had NicoMeter results indicating that they had been exposed to nicotine. One of these participants was using nicotine replacement therapy (patch and gum) and was coded as a nonsmoker, whereas the other was classified as a smoker. At the 12-month follow-up, five self-reported nonsmokers had NicoMeter results indicating nicotine exposure. One was on nicotine replacement therapy (patch) and was treated as a nonsmoker, whereas the other four were classified as smokers in subsequent analyses.

Hypothesis 1

The percentage of participants who fasted successfully (i.e., were abstinent for at least 24 hr before surgery) was significantly higher in the treatment group (73.0%; $n = 81$) than in the control group (53.0%; $n = 62$): $\chi^2(1, N = 228) = 8.89$, $p = .003$, with Yates's continuity correction applied. There was also a significant difference between the treatment (46.8%; $n = 52$) and control (21.2%; $n = 25$) groups in the percentage of participants who reported using something to help them stop smoking (e.g., nicotine replacement therapy) prior to surgery, $\chi^2(1, N = 229) = 15.74$, $p < .001$. The control group members (25.4%; $n = 30$) were far more likely than the treatment group members (9.9%; $n = 11$) to increase the amount smoked before surgery (rather than smoke the same amount, reduce the amount smoked, or stop altogether), $\chi^2(1, N = 229) = 8.34$, $p = .004$.

Hypothesis 2

The percentage of participants who were abstinent at 6 months after surgery was higher in the treatment group (31.2%; $n = 29$) than in the control group (20.2%; $n = 22$); however, the unadjusted effect of treatment was not statistically significant, $\chi^2(1, N = 202) = 2.66$, $p = .10$. After controlling for covariates in the logistic regression analysis, a significant effect of treatment was found. Significant covariates of abstinence included self-efficacy (craving), self-efficacy (negative affect), and smoking stage of change at intake (see Table 4). No significant two-way interactions were found among predictors in the final model. Had we taken a more conservative approach and classified all self-reported nonsmokers who had not returned readable NicoMeter strips as smokers (n = 23), the abstinence rates would be 15.1% ($n = 14$) for the treatment group and 11.9% ($n = 13$) for the control group, $\chi^2(1, N = 202) = 0.20$, $p = .66$.

After imputing the smoking status (positive) for participants lost to follow-up for the intention-to-treat analysis, the percentage of participants who were abstinent at 6 months after surgery was higher in the treatment group (24.8%; $n = 29$) than in the control group (18.3%; $n = 22$); however, the unadjusted effect of treatment was not statistically significant, $\chi^2(1, N = 237) = 1.10$, $p = .29$. After controlling for covariates in the logistic regression analysis, the effect of treatment remained nonsignificant. Significant predictors of abstinence included self-efficacy (craving), self-efficacy (negative affect), and smoking stage of change at

Table 4. Logistic Regression Models Predicting Smoking Abstinence at 6 and 12 Months after Surgery

Predictor Variables	Efficacy[a]			Intention-to-Treat[b]		
Model 1: Abstinence at 6 months	*OR*	95% CI		*OR*	95% CI	
Group assignment						
Control[c]	1.00			1.00		
Treatment	2.05	1.00	4.19	1.50	.77	2.93
Self-efficacy (craving)	1.24	1.07	1.43	1.18	1.04	1.35
Self-efficacy (negative affect)	1.22	1.07	1.39	1.15	1.02	1.29
Stage of change						
Precontemplation[c]	1.00			1.00		
Contemplation	5.83	1.52	22.34	3.95	1.15	13.56
Preparation	5.08	1.40	18.35	2.94	.90	9.63
Action	13.05	1.93	88.13	8.23	1.44	46.96
Model 2: Abstinence at 12 months						
Group assignment						
Control[c]	1.00			1.00		
Treatment	1.02	.50	2.07	.92	.47	1.78
Self-efficacy (negative affect)	1.22	1.08	1.37	1.18	1.05	1.32

[a]At 6 months $n = 201$, at 12 months $n = 169$.
[b]At 6 months $n = 236$, at 12 months $n = 237$. Participants lost to follow-up were coded as smokers.
[c]Indicates reference group.

intake (see Table 4). No significant two-way interactions were found.

Hypothesis 3

There was no significant difference between the treatment (27.2%; $n = 22$) and control groups (26.1%; $n = 23$) in the percentage of participants who were abstinent at 12 months after surgery, $\chi^2(1, N = 169) < .001$, $p = 1.00$. The effect of treatment remained nonsignificant after adjusting for covariates in the logistic regression model (see Table 4). Had we taken a more conservative approach and classified all self-reported nonsmokers who had not returned readable NicoMeter strips as smokers ($n = 23$), the abstinence rates would be 12.3% ($n = 10$) for the treatment group and 12.5% ($n = 11$) for the control group, $\chi^2(1, N = 169) = 0.00$, $p = 1.00$.

After imputing the smoking status (positive) for participants lost to follow-up, for the intention-to-treat analysis, the percentage of participants who were abstinent at 12 months after surgery was the same in the treatment (18.8%; $n = 22$) and control groups (19.2%; $n = 23$), $\chi^2(1, N = 237) < 0.001$, $p = 1.00$. After controlling for covariates in the logistic regression analysis, the effect of treatment remained nonsignificant (see Table 4).

DISCUSSION

The findings of this study suggest that intervening and asking patients to fast from smoking before surgery is an effective way to reduce preoperative tobacco use. Indeed, without intervention, as many as 25% of smokers might increase the amount smoked. Although protracted abstinence before surgery is ideal, stopping for even brief periods can be beneficial and ought to be encouraged by those working in surgical areas. Clinical practice guidelines outline the importance of consistently approaching patients, asking about tobacco use, providing advice to quit, and supporting cessation efforts (Fiore et al., 2000). Nurses have yet to incorporate these well-established guidelines into their clinical practice consistently and routinely (Sarna et al., 2000; Wewers, Ahijevych, & Sarna, 1998). In this report we have outlined a mechanism by which nurses can engage patients in the process of smoking cessation by highlighting the opportunity that arises because of hospitalization and offering expert advice and support. Short periods of attempted abstinence may provide important learning opportunities in which self-efficacy and motivation are enhanced for future efforts (Hughes, 2000; Klesges, Haddock, Lando, & Talcott, 1999).

As noted in other studies, the likelihood of smoking cessation varies according to the strength of smokers' self-efficacy and their stage of change at baseline (Gwaltney et al., 2002; Lando et al., 2003). Once these factors were controlled, we found that our nursing-delivered, multipronged intervention was somewhat effective; those who received the treatment were twice as likely as the controls to be abstinent 6 months following their surgery. Indeed, 25.9%–31.2% of the intervention

group achieved abstinence (depending on how those lost to follow-up are treated).

This strong effect, however, was not sustained; there was no difference in the abstinence rates of the two groups 12 months after surgery. What might explain the diminishment of the effect over time? Perhaps the heightened health consciousness that occurs at the time of elective surgery, coupled with ongoing professional support (e.g., phone support), was enough to foster abstinence in the short term. As the participants' health returned and normal activities were resumed in the postrecovery period, these advantages or motivations likely weakened. For those who continued to struggle with health problems, the stress and strains experienced may have undermined their resolve and capacity to remain abstinent.

This study is noteworthy in that it engaged patients with a wide variety of diagnoses as well as those who were not contemplating a smoking-cessation attempt when first approached. As Lando et al. (2003) recently noted, most hospital-based interventions have focused on patients with smoking-related illnesses or those who were contemplating cessation (i.e., in a more advanced stage of readiness). Unlike Lando et al., however, we did not find that stage of change or age were predictive of smoking status at 12 months. Indeed, the only variable associated with 12-month smoking status in this sample was self-efficacy related to negative affect (e.g., confidence in the ability to resist the urge to smoke when anxious, stressed or angry).

A possible limitation of our study is the colorimetric method we used to determine whether cotinine was present in the participants' urine. The criterion we applied to identify smokers corresponded to a concentration of cotinine of ≥ 100 ng/mL. The Society for Research on Nicotine and Tobacco, Subcommittee on Biochemical Verification (2002) reported that a cut point for urinary cotinine of 50 ng/mL has been "widely used and . . . [is] likely to be appropriate for most circumstances" (p. 151). Consequently, misclassification error (misclassification of smokers as nonsmokers) may have biased the results.

One of the greatest challenges facing tobacco reduction programmers is determining how to reach the heavily addicted smoker. Programs have been effective at engaging those individuals who are ready to quit and perhaps less addicted. What is promising about our intervention is that it enables an engagement with precontemplators in a nonthreatening context because they undoubtedly are considering the implications of hospital-imposed smoking bans and may be receptive to such interventions. This might account for our finding that about 20% of the control group was able to achieve abstinence at 12 months following surgery. Others have noted a similar phenomenon; whereas 7.9% of patients seen in physicians' offices are reported to spontaneously stop smoking, when no advice is provided, hospitalized patients have been noted to abstain at a rate of 19.2% when exposed to usual care (Fiore et al., 2000).

Another explanation of the relatively high abstinence rate in the control group is the possibility that, in light of the information that they were provided in the recruitment and informed consent procedures, they were aware of their group assignment and tried to demonstrate that they could do as well as the treatment group despite not getting treatment benefits. This possibility serves as a potential threat to validity, referred to as compensatory rivalry by Shadish, Cook, & Campbell (2002).

Our experience is that health professionals are often reluctant to raise the issues of tobacco use and to discuss the importance of smoking cessation. Most patients we approached expected to have the topic of tobacco use raised and were amenable to engaging in a discussion of tobacco use. This initial advantage was observed clearly in our ability to enroll 57% of eligible patients. Further, among those enrolled, 17.7% were precontemplators (other studies have typically had great difficulty enrolling smokers in this stage of the change process). This recruitment rate is much greater than that observed in most community-based intervention trials. McDonald (1999) reported that the median recruitment rate for smoking-cessation interventions targeted at the general population of smokers is 2.0%.

One of the greatest challenges in the field of tobacco reduction is to move from efficacy trials to demonstrating that interventions can work in day-to-day practice. Although we demonstrated that nurse-delivered interventions can be somewhat efficacious, much work is required to enable nurses to adopt clinical practice guidelines and the latest evidence from the field of smoking-cessation research. Researchers have found that many nurses indicate that they do not have the knowledge and skills to intervene effectively with patients who smoke (Pelkonen & Kankkunen, 2001; Sarna et al., 2001). Even in advanced nursing practice educational programs, little attention is paid to tobacco use and dependence (Heath, Andrews, Thomas, Kelley, & Friedman, 2002). Nurses are making advances in the field of

tobacco research (Sarna & Lillington, 2002); the next frontier is nursing education.

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