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Brief Report

A Preoperative Contingency Management Intervention for Smoking Abstinence in Cancer Patients: A Preliminary Randomized Controlled Trial

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Abstract

Introduction: The purpose of this study was to evaluate a pilot preoperative contingency management (CM) intervention for smoking abstinence.

Aims and Methods: This multisite pilot study was conducted at two cancer center-based tobacco treatment programs. Participants who were smoking, diagnosed with or suspected to have any type of operable cancer, and had a surgical procedure scheduled in the next 10 days to 5 weeks (*N* = 40) were randomized to receive standard care plus monitoring only (MO) or CM prior to surgery. All patients received breath carbon monoxide (CO) tests 3 times per week, nicotine patches, and counseling. The CM group also earned payments for self-reported smoking abstinence confirmed by CO breath test ≤6 ppm on an escalating schedule of reinforcement (with a reset if they smoked). Seven-day point prevalence abstinence rates on the day of surgery and at 3-month follow-up were compared between groups using repeated measures log-linear regression models utilizing generalized estimating equations. Participants lost to follow-up are assumed to have returned to smoking.

Results: The sample was 50% female and 75% White. In covariate adjusted models, patients in the CM group had a greater probability of reported abstinence. On the day of surgery (end of treatment), 52% of CM patients were abstinent compared with 16% of patients in MO (risk ratio = 3.2 [1.1–9.3]; *p* = .03). At the 3-month follow-up, 43% of CM patients were abstinent compared with 5% in MO (risk ratio = 8.4 [1.5–48.3]; *p* = .02).

Conclusions: Providing monetary incentives contingent on abstinence prior to cancer surgery may produce significant improvements in smoking abstinence rates relative to breath CO MO.

Implications: In this pilot preoperative CM intervention for smoking abstinence, patients receiving a CM intervention prior to cancer surgery had a greater probability of smoking abstinence at the end of treatment compared with a breath MO group (52% vs. 16%, respectively). Thus, providing monetary incentives contingent on abstinence may produce significant improvements in smoking abstinence rates prior to cancer surgery relative to breath CO monitoring.

Introduction

Many smokers diagnosed with cancer continue to smoke, with prevalence rates as high as 58%.[1] Continued smoking following cancer diagnosis causes adverse outcomes including increased overall mortality, cancer-specific mortality, poor wound healing, and increased risk of infection and respiratory complications following surgery.[2] These risks can be reduced by quitting smoking. Yet few smoking cessation interventions for cancer surgery patients have been investigated, and none have shown large treatment effects.[3,4]

Contingency management (CM), a behavioral intervention in which abstinence from smoking is reinforced with financial incentives, has been used successfully to reduce the prevalence of smoking in various populations of smokers,[5] including those with medical comorbidities.[6] To date, only two trials have evaluated the use of financial incentive interventions for smoking cessation with cancer patients with mixed results,[5,7,8] and none have been evaluated as a preoperative intervention. Robust interventions in this context are needed.[9]

We conducted a preliminary evaluation of CM for smoking cessation among cancer patients who also received a combination behavioral and pharmacological intervention prior to surgery. We hypothesized that CM added to standard care treatment would produce higher rates of cessation compared with monitoring only (MO) plus standard care at the time of surgery and at the 3-month follow-up.

Methods

This study was conducted at Yale Cancer Center (YCC) in New Haven, CT and Hollings Cancer Center (HCC) in Charleston, SC. This study was approved by the Medical University of South Carolina Institutional Review Board (#00054733) and the Yale University Human Investigation Committee (#1407014258). Clinical trial registration number: NCT02402023.

Participants

Participants were recruited from YCC and HCC clinics from 2014 to 2017. Inclusion criteria: ≥18 years old, smoking ≥1 cigarette per day, diagnosis or suspicion of any type of operable cancer, and a scheduled surgery 10 days to 5 weeks from study entry. Exclusion criteria: unstable psychiatric/medical conditions such as suicidal ideation, acute psychosis, severe alcohol dependence, or dementia.

Study Intake

At the initial surgical consultation, research staff informed patients about the study. Those who expressed interest completed informed consent, baseline assessments, and a breath carbon monoxide (CO) reading (Bedfont Micro+ Smokerlyzer). Participant disposition throughout the study is presented in Table 1.

Randomization

After the intake appointment, patients were randomized in blocks to the two arms, with stratification by (1) primary tumor type (tobacco-related[2] or non-tobacco related) and (2) study site. The two arms were (1) MO condition: standard care (counseling + nicotine replacement therapy [NRT]) + breath tests with no payments, or (2) CM condition: standard care (counseling + NRT) + monetary payment delivered contingent on abstinence. Allocation was concealed, and each participant was assigned the next sequential number by a research staff member who was blinded to the allocation sequence.

Cessation Counseling

Following randomization, participants met a provider (advanced practice registered nurse, clinical pharmacist, or psychologist) from the hospital-based tobacco treatment program for their first counseling session and were asked to set a quit date within 1 week. Participants received two to five additional sessions depending on the length of the preoperative period. A counseling manual was used by the provider and was based on cognitive behavioral tobacco treatment approaches.[10]

Nicotine Replacement Therapy

Nicotine patches were provided to all participants based on baseline smoking levels (21 mg for >10 cigarettes per day and 14 mg for ≤10 cigarettes per day). Participants received enough patches at each appointment to last until their next visit, ending with surgery.

Breath CO Testing

All participants provided breath CO tests 3 times per week during their presurgical period (minimum breath tests = 6; maximum = 16). The MO condition received no financial incentives for breath tests. In the CM condition, payment for abstinence was contingent on self-report of no smoking since the last visit confirmed by breath CO ≤6 ppm. The incentive schedule began at $15 and increased in $5 increments until participants reached $55 per negative breath test. Incentives were withheld for breath CO >6 ppm and missing samples ($0), resulting in a reset (to $15) for the next sample if CO ≤6, and resumption of the prior earning schedule for subsequent negative samples. Participants could earn a maximum of $645 for 5 weeks of abstinence. Research staff prearranged the meetings each week and conducted breath tests at the cancer center or at a convenient location in the community. The 3 times per week

Table 1. Participant Disposition

	MO	CM	Total
	N (%)	N (%)	N (%)
All eligibility criteria met and consented			42
Randomized to study conditions	19	21	40 (95%)
Received study treatment	16 (84%)	19 (90%)	35 (83%)
Discontinued after treatment initiation	3 (16%)	2 (10%)	5 (12%)
Assessed at time of surgery (EOT)	16 (84%)	19 (90%)	35 (88%)
Completed 3-month follow-up*	11 (58%)	18 (86%)	29 (69%)

MO (monitoring only) refers to the control condition. CM (contingency management) refers to the treatment condition. EOT refers to end of treatment.
*$p < .05$.

schedule allowed for some flexibility such that patients could be seen on any 3 days of the week, but research staff attempted to space out the sampling schedule such that samples were collected approximately every other day. Thus, the exact amount of time between samples varied between participants in the weeks leading up to surgery. However, every participant had an end of treatment sample taken within 24 hours of surgery to calculate 7-day point prevalence abstinence.

Measures

At intake, participants completed assessments that included demographics, smoking history, and others.[11] Participants received $5 for completing weekly assessments throughout the treatment period and $30 for completing the 3-month follow-up.

Data Analysis

The primary outcome was 7-day point prevalence assessed on the day of or the day prior to surgery (end of treatment). Seven-day point prevalence was defined as self-reported abstinence in the past 7 days with biochemical confirmation of CO ≤6 ppm. The secondary outcome was 7-day point prevalence at the 3-month postoperative follow-up. Participant drop out and missing samples were coded as positive for smoking. NRT use was assessed at each breath monitoring session with the question: "Is the participant wearing a patch?" (yes/no). Missing patch use data at a breath monitoring session was coded as negative for patch use.

Descriptive statistics were used to quantify participants' demographic and clinical characteristics. Longitudinal analysis of abstinence at the end of treatment and 3-month follow-up between treatment group was analyzed with repeated measures log-linear regression models using generalized estimating equations.[12,13] Model-based outcomes are reported as risk ratios of abstinence between treatment groups and the associated 95% confidence intervals stratified by timepoint. Statistical analyses were conducted using SAS version 9.4.

Results

Participant Demographics

Demographic and clinical information for the 40 enrolled participants is presented in Table 2. There were no significant differences in baseline characteristics between groups ($ps > .05$). CM participants earned between $0 and $635 in contingent incentives (median = $210).

Abstinence Outcomes

Abstinence outcome data stratified by study visit are presented in Table 3. At the end of treatment visit, 52% of the participants in the CM group were abstinent as compared with 16% in the MO group (adjusted risk ratio = 3.2 [1.1–9.3]; $p = .03$). At the 3-month follow-up visit, 43% of the participants in the CM group were abstinent as compared with only 5% in the MO group (adjusted risk ratio = 8.4 [1.5–48.3]; $p = .02$).

Intervention Engagement

Study participants attended a median of seven CO monitoring sessions prior to surgery (IQR = 5–11); CO session attendance rates did not differ between treatment group (CM: median = 7, IQR = 6–12 vs. MO: median = 7 IQR = 5–8; treatment group difference p =

Table 2. Baseline Demographic and Clinical Variables

	MO (*n* = 19)	CM (*n* = 21)	Total (*n* = 40)
Age, y, mean (SD)	56.9 (8.6)	56.9 (9.8)	56.9 (9.1)
Women, no. (%)	8 (42.1)	12 (57.1)	20 (50.0)
White, no. (%)	14 (73.7)	16 (76.2)	30 (75.0)
Married, no. (%)	6 (31.6)	7 (33.3)	13 (32.5)
Education >12 y, no. (%)	8 (42.1)	12 (57.1)	20 (50.0)
Household income <$20 000,* no. (%)	8 (44.4)	5 (29.4)	13 (37.1)
CPD, mean (SD)	17.1 (9.2)	15.7 (10.4)	16.4 (9.7)
Years smoking, mean (SD)	38.8 (10.5)	40.1 (9.6)	39.5 (9.9)
FTND, mean (SD)	5.2 (2.0)	4.4 (2.5)	4.8 (2.3)
Time to first cigarette ≤5 min of waking, no. (%)	7 (36.8)	7 (33.3)	14 (35.0)
Tobacco-related cancer, no. (%)	11 (57.9)	13 (61.9)	24 (60.0)

MO (monitoring only) refers to the control condition. CM (contingency management) refers to the treatment condition. CPD refers to lifetime average number of cigarettes per day. FTND refers to the Fagerström Test for Nicotine Dependence. *There are five missing datapoint for household income (final *n* = 35).

Table 3. Intent to Treat Sample

	% Abstinent		Design adjusted model		Covariate adjusted model	
Outcome timepoint	MO (*n* = 19)	CM (*n* = 21)	Risk ratio (95% CI)	*p*	Risk ratio (95% CI)	*p*
Surgery (EOT)	15.8% (3/19)	52.4% (11/21)	3.2 (1.1–9.6)	.04	3.2 (1.1–9.3)	.03
Three-month follow-up	5.3% (1/19)	42.9% (9/21)	7.9 (1.1–58.1)	.04	8.4 (1.5–48.3)	.02

Model-based design and covariate adjusted risk ratio of abstinence for the sample stratified by outcome timepoint. Data are shown as the abstinence results in the contingency management (CM) group as compared with the monitoring only group (MO). Design adjusted model contains treatment arm, outcome timepoint, and study site. Covariate adjusted model contains treatment arm, outcome timepoint, study site, baseline years of regular smoking, gender, and study site × timepoint interaction. Participant drop out and missing samples were coded as smoking. CI = confidence interval; EOT = end of treatment.

.32). NRT use did not differ between treatment group. Those in the CM group reported NRT use at an average of 64% of monitoring sessions, and those in the MO group reported NRT use at an average of 69% of monitoring sessions ($p > .05$).

Discussion

This pilot study is the first preoperative CM intervention for smoking cessation for patients undergoing cancer surgery. The CM intervention resulted in high rates of abstinence prior to surgery, and showed evidence of durability through the 3-month follow-up, well after the contingencies had been removed. These quit rates are markedly greater than quit rates for other smoking cessation interventions[10] and the sustained treatment effect after incentive discontinuation is consistent with pooled analyses of mixed-population studies.[5] This study demonstrates compelling preliminary evidence that providing abstinence-contingent incentives prior to cancer surgery produces significant improvements in smoking abstinence rates versus monitoring alone in a sample also receiving NRT and counseling.

The study has several limitations. First, this was a preliminary study with a consequently small sample size. A full-scale trial is needed to confirm intervention efficacy. Second, the application of CM in clinical care was complicated by the fact that the length of the presurgical time period cannot be controlled. Thus, several of the intervention variables (eg, number of counseling sessions, days of NRT use) varied between participants. Third, the 3 times per week sampling schedule may have created discrete periods in which a participant might have smoked without detection by exhaled CO. Fourth, the MO group had significantly more attrition at the 3-month follow-up. This finding may be due to the nature of the control group not receiving incentives contingent on abstinence, or may be driven by the nature of the small sample size.

This pilot study shows that CM may be a valuable tool in promoting smoking cessation in individuals undergoing cancer surgery. For many cancer patients, the thought of improved future health may not be enough to motivate cessation, but delivering tangible, immediate, and high-magnitude contingencies for cessation may result in the desired behavior change. A larger, fully powered clinical trial is warranted given the positive results of the present study.

Supplementary Material

A Contributorship Form detailing each author's specific involvement with this content, as well as any supplementary data, are available online at https://academic.oup.com/ntr.

Declaration of Interests

Drs Toll and Carpenter have consulted to Pfizer for an advisory board. Dr Toll testifies as an expert witness on behalf of plaintiffs who filed litigation against the tobacco industry.

Author Contributions

Alana M. Rojewski: conceptualization, data curation, investigation, methodology, writing—original draft, writing—review and editing; Lisa M. Fucito: investigation, methodology, supervision, writing—review and editing; Nathaniel L. Baker: data curation, formal analysis, writing—original draft, writing—review and editing; Suchitra Krishnan-Sarin: conceptualization, funding acquisition, methodology, writing—review and editing; Matthew J. Carpenter: interpretation of data, review, and editing; Steven L. Bernstein: conceptualization, funding acquisition, methodology, writing—review and editing; Benjamin A. Toll: conceptualization, funding acquisition, investigation, methodology, supervision, writing—review and editing.

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