Health, Health Care, and Economic Impacts of Hospital-initiated Smoking Cessation Interventions

Kerri-Anne Mullen

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Faculty of Graduate and Postdoctoral Studies
Institute of Population Health
University of Ottawa

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ABSTRACT

Cigarette smoking causes many chronic diseases that are costly and result in frequent hospitalization and re-hospitalization. Smoking cessation leads to improved morbidity and reduced risk of death. Hospital-initiated smoking cessation interventions increase the likelihood that patients will become smoke-free. Despite this, few Canadian hospitals have in place policies, protocols, and reminder systems that support the consistent and effective identification and treatment of tobacco users.

The Ottawa Model for Smoking Cessation (OMSC), developed at the University of Ottawa Heart Institute (UOHI), is a systematic approach to identifying and treating smokers in the hospital setting. In order for health care funders and hospital administrators to begin supporting effective prevention interventions, like the OMSC, a compelling cost-effectiveness argument must be made. Few studies have looked at the downstream health, health care, and cost implications of such programs, particularly in the Canadian context and none using actual health care administrative data. In response to this gap, three studies were completed, applying theories and methodologies related to health services and population health research.

Study 1:

From the hospital payer's perspective, what is the short-term (one year) and long-term (lifetime) cost-effectiveness of the OMSC intervention, as compared to a usual care condition, among high-risk smokers with chronic diseases?

A cost-effectiveness analysis was completed based on a decision-analytic model to assess smokers hospitalized in Ontario, Canada for acute myocardial infarction, unstable angina, heart failure, and chronic obstructive pulmonary disease, their risk of continuing to smoke, and the effects of quitting on re-hospitalization and mortality over a one year period. Short- and long-term cost-effectiveness ratios were calculated. The primary outcome was one-year cost per quality-adjusted life year (QALY) gained.

Study 2:

What are the effects of the OMSC intervention on: 1) mortality, and 2) downstream health care utilization?

An effectiveness study was completed comparing patients who received the OMSC intervention (n=726) to usual care controls (n=641). The study took place at 14 hospitals in Ontario. Baseline data was linked to Ontario health care administrative data. Unadjusted and adjusted competing-risks regression models were constructed, clustered by hospital, to compare the cumulative incidence of death, re-hospitalization, emergency department (ED) visits, and physician visits at 30 days, one, and two years following index hospitalization between groups.

Study 3:

From the health system perspective, what are the cumulative mean health care costs at 30-day, 1-year, and 2-year follow-up among smoker-patients that receive the OMSC compared to those that do not? What are the predictors of direct health care costs for patients that receive the OMSC compared to those who do not?

Expanding on Study 2, a cost-analysis was completed to assess 30-day, 1-year, and 2-year health care costs between intervention and control groups. Costs were broken down by service type (e.g. inpatient, ED visits, laboratory, physician visits). To calculate cumulative mean costs, costs were grouped into the study's 24 monthly intervals and weighted by the inverse probability of not being censored at the beginning of each month. Covariate-adjusted generalized linear models were performed for each of the 24 monthly intervals to determine the association between independent variables and health care costs.

CO-AUTHORSHIP

The studies presented in this thesis are the works of Kerri-Anne Mullen (KAM) in collaboration with co-authors and evaluation committee members. KAM developed the research questions, proposed the methods to be used, completed the data analyses, and wrote and managed all drafts of all three manuscripts.

Manuscript 1: Economic evaluation of a hospital-initiated intervention for smokers with chronic disease in Ontario, Canada

This paper was published in Tobacco Control (Mullen, K.A., et al., Economic evaluation of a hospital-initiated intervention for smokers with chronic disease, in Ontario, Canada. Tob Control. 2014 Jun 16). Co-authors are Douglas Coyle, Douglas Manuel, Hai V. Nguyen, Ba' Pham, Andrew L. Pipe, and Robert D. Reid. KAM and RDR conceived the study. KAM developed the research questions. KAM compiled the sources and developed and analyzed the economic model with the guidance of DC, HVN, and BP. KAM wrote the manuscript. All authors contributed to reviewing and editing of the final manuscript.

Manuscript 2: Effectiveness of a hospital-initiated smoking cessation program: health and health care outcomes

This paper has been prepared for initial submission to the New England Journal of Medicine. An evaluation committee was formed to oversee the study including co-authors and a third party chair, Dr. Heather Manson, Chief of Health Promotion, Chronic Disease and Injury Prevention at Public Health Ontario. Co-authors are Douglas Manuel, Steven Hawken, Andrew L. Pipe, Douglas Coyle, Laura A. Jones, Jaime Younger, George Wells, and Robert D. Reid. KAM, RDR, and DM conceived the study. KAM developed the research questions. KAM proposed the methods, which were approved by DM, SH, DC, GW, and RDR. KAM wrote the analysis plan, which was reviewed and approved by SH and JY. LJ assisted in baseline data preparation. JY completed the data linkage. KAM and JY completed the blinded and primary data analyses. KAM completed all other data analyses. KAM wrote the manuscript. All authors contributed to

the reviewing and editing of the final manuscript. This study received research ethics approval by the Ottawa Hospital Research Ethics Board (Protocol #: 2011889-01).

Manuscript 3: Health care utilization and costs following a hospital-initiated smoking cessation intervention

This paper has been prepared for submission to the Journal of Health Economics. Co-authors are Douglas Manuel, Kednapa Thavorn, Douglas Coyle and Robert D. Reid. KAM, RDR, and DM conceived the study. KAM developed the research questions. KT and DC advised on the methodology. DM and RDR provided feedback on the design and outcomes. KAM finalized the methods. KAM completed all data analyses. KAM wrote the manuscript. All authors will review and edit the submitted manuscript. This study received research ethics approval by the Ottawa Hospital Research Ethics Board (Protocol #: 2011889-01).

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1 INTRODUCTION

1.1 Overview and Purpose of the Thesis

The purpose of this research project was to evaluate the health, health care, and economic impacts of the Ottawa Model for Smoking Cessation hospital-initiated intervention. Three studies were completed which applied theories and methodologies pertinent to epidemiology, health services, and population health research.

1.2 Rationale

Tobacco smoking remains a major population health issue, one that has caused the most deadly non-communicable disease epidemic in recent history (1). Nearly 5.0 million Canadians smoke cigarettes daily and while smoking rates in Canada have fallen substantially since the mid-20th century, there is evidence for the first time that the decline is slowing (2). Smoking is the leading cause of preventable morbidity and mortality in Canada, resulting in nearly 40,000 premature deaths per year and placing an immense economic burden on the Canadian health care system (3-5). Considering that tobacco-use is a leading cause of hospitalization and re-hospitalization, it is surprising that few Canadian hospitals have in place policies, protocols, and systems that support the consistent and effective identification and treatment of tobacco use.

In order for health care funders and hospital administrators to support the implementation of evidence-based tobacco cessation interventions, detailed cost and cost-effectiveness assessments must be made. Many studies have examined the cost-effectiveness of smoking cessation interventions; however, few have looked at the downstream health, health care, and cost implications of hospital-based cessation programs, particularly in the Canadian context and none using actual health care administrative data.

1.3 Background

Tobacco-use, its Consequences, and the Importance of Cessation

Tobacco smoke contains numerous powerful carcinogens and harmful constituents that cause severe damage to blood vessels and arteries and increase the risk of developing cancer (6, 7). Heart disease and stroke are 2 to 4 times more common in smokers than in non-smokers and

smoking accounts for 80 - 90% of all chronic obstructive pulmonary disease and 30% of all cancer deaths (3, 8). Smokers have a 30% to 40% greater chance of developing type II diabetes, and smokers with diabetes have a greater risk of morbidity and premature mortality due to macro-vascular complications (9, 10). Smokers have higher hospitalization rates than non-smokers, average at least twice the number of hospital bed-days, and evidence suggests a causal relationship between tobacco-use and adverse surgical outcomes (8, 11).

There is overwhelming evidence that quitting smoking has a beneficial effect on smoking-related outcomes, such as cancer, vascular, and respiratory problems (8, 12). Smoking cessation has been shown to completely reverse the risk of cardiovascular disease, making it potentially the single most effective and lifesaving intervention available for those susceptible to or with existing disease (13). The benefits of quitting smoking begin almost instantly (14), with the risk of cardiovascular events, including stroke, decreasing substantially within 5 years after cessation (15, 16). Cessation also decelerates the regression of lung function and improves the odds of survival, even in those with severe chronic obstructive pulmonary disease (17). A person's risk of dying from a smoking-related cancer is reduced significantly upon quitting. The chance of death due to lung cancer, in particular, is reduced by up to 70% when one stops smoking (18). Furthermore, the risk of developing lung cancer drops when a smoker quits, and if cessation occurs before middle age, the risk is reduced by nearly 90% (19).

Hospital-based Smoking Cessation and the Ottawa Model

A hospital admission presents a unique opportunity to identify and engage smokers, initiate tobacco dependence treatments, and facilitate appropriate follow-up and support (20). Hospitals are particularly well-suited to address tobacco dependence since: hospitals are smoke-free environments; at least 20% of admitted patients are smokers who tend to stay for long periods (21, 22); smoking is directly associated with many admitting diagnoses (23); trained health professionals can provide effective assistance with cessation (24); and, smokers are often more motivated to quit at the time of hospitalization (25). A systematic review and meta-analysis examining hospital-initiated interventions for smoking cessation showed that quit rates were higher among smoker-patients who received in-patient cessation treatment and follow-up support

after discharge, as compared to control conditions (risk ratio (RR) = 1.37, 95% confidence interval (CI) 1.27 to 1.48; 25 trials) (25).

The intervention examined as part of this thesis, the Ottawa Model for Smoking Cessation (OMSC), was developed by smoking cessation researchers at the University of Ottawa Heart Institute (UOHI) (26). The OMSC includes the following components:

1) Identification of smoking status of all patients admitted to hospital, documentation of smoking status on all intake and history forms, and subsequent request for in-patient smoking cessation consultation;

2) Treatment – offer of first-line pharmacotherapies for smoking cessation and strategic advice for patients at all stages of readiness to quit;

3) Post-hospitalization follow-up – telephone follow-up support for 6 months and/or link to community cessation programs.

In 2006, UOHI outreach facilitators ("implementation consultants") began assisting other hospitals to embed the OMSC's evidence-based cessation intervention within their own institutions (27). In 2014, over 120 hospitals across Canada had implemented the program. Long-term quit rates increased by an absolute 15% (from 29% to 44%) following implementation of the OMSC program at UOHI (a cardiac population) (26) and by 11.1% (from 18.3% – 29.4%) across 9 Ontario hospitals (general hospital population) (27). The downstream health and health care impacts of the OMSC have not yet been evaluated.

Health and Economic Impacts of Smoking Cessation Interventions

Studies have found smoking cessation to have positive effects on smoking-attributable morbidity and mortality, particularly for chronic lung diseases, vascular diseases, and lung cancer (28-32). Cessation interventions (including a multitude of behavioural and pharmacological treatments) have been assessed across a range of patient populations, in a number of different health care settings, and from a variety of perspectives. These interventions have generally been found to be highly cost-effective in terms of cost per years of life saved (33-38).

One Canadian study found that smoking cessation counselling resulted in a lower risk of mortality over one year of follow-up compared to no counselling in 9041 in-patients admitted with acute myocardial infarction (AMI) who were discharged from 83 hospital corporations in Ontario (hazard ratio 0.63, 95% CI 0.44-0.90) (31). A recent review of pre-surgical cessation interventions presented evidence that the provision of intensive cessation interventions (behavioural and pharmacological support) significantly reduced the risk of any complications (risk reduction [RR], 0.42; 0.27 to 0.65, 2 trials, 210 participants) as well as wound-specific complications (RR 0.31; 0.16 to 0.62, 2 trials, 210 participants) (39). A modeling study of patients admitted with acute myocardial infarction found hospital-based smoking cessation with two to three months of follow-up support was far more cost-effective than several other common treatments following an AMI (e.g. β-blocker, statin-use, hypertension medication) (40). A randomized controlled trial of patients with heart disease demonstrated a relative risk reduction of 44% for re-hospitalization and of 77% for all-cause mortality over a 2-year follow-up period in smokers who received an intensive smoking cessation intervention (30). And, most recently, a randomized controlled trial of patients hospitalized with a psychiatric diagnosis found that those who received a cessation intervention were less likely to be re-hospitalized due to psychiatric illness over 18 month follow-up (OR, 1.92; 1.06 to 3.49, p=0.04) (41). These previous studies used mathematical modelling or relied on self-reported health care utilization. There are no studies, to our knowledge, that have examined the downstream health, health care, and cost implications of hospital-based cessation programs using actual health care administrative data.

1.4 Research Questions and Hypotheses

The research questions examined during this project included:

1. From the hospital payer's perspective, what is the short-term (one year) and long-term (lifetime) cost-effectiveness of the OMSC intervention, as compared to a usual care condition, among high-risk smokers with chronic diseases? We hypothesized that implementation of the OMSC would result in favourable cost-effectiveness ratios (e.g. cost per quitter, cost per hospital-day avoided, cost per death avoided, cost per life year gained, and cost per quality adjusted life year gained).

2. What are the effects of the OMSC intervention on: 1) mortality and 2) downstream health care utilization? We hypothesized that patients who received the intervention would experience reduced mortality, fewer all-cause hospital re-admissions, fewer smoking-related re-admissions, fewer all-cause or smoking-related emergency department visits, and fewer all-cause or smoking-related physician visits (specialist and general practitioner) at three time points following their index hospitalization – 30 days, one year, and two years.

3. What are the effects of the OMSC intervention on cumulative mean health care costs? What are the determinants of downstream health care costs among hospitalized smokers? We hypothesized that the OMSC would result in lower direct health services costs over two years and that the intervention would be an independent predictor of costs.

1.5 Potential Contributions to the Advancement of Knowledge and Population Health

To help answer our research questions, theories and principles from the fields of health services and policy research (HSPR) and population health were employed. HSPR is a multidisciplinary field that blends concepts from the domains of sociology, epidemiology, ecology, economics, and population health (42-46). It investigates how upstream and midstream determinants interact and impact access to health care, quality and cost of health care, and ultimately health outcomes (44, 47). Population health, as an approach, strives to enhance the health of an entire population while reducing health inequities among population subgroups and focuses on the interplay of determinants that influence health over the life-course (48). We know that access to care, smoking rates, and smoking-related health issues are unequally distributed in Canada (49). Smokers are more likely to be from low socio-economic status (SES) groups and are more likely to be hospitalized than non-smokers (50). In order to assess population-specific impacts of the OMSC program, we analyzed the effectiveness of the intervention among several specific population sub-groups, including low and high SES groups, patients living in urban versus rural communities, patients with and without a history of mental illness, and patients with and without other co-morbidities.

Across Canada, the financial burden experienced by provincial health care systems has been steadily increasing, partly due to an aging population and the incidence of chronic diseases (51). The Ontario government spends over 40 per cent of its budget on health care (52). Over the past ten years, annual increases in health care spending have far surpassed rates of inflation. In an era of rising health care costs and recognizing the need for budgetary restraint and evidence-based decision-making, there needs to be a shift in focus from simply treating disease to preventing disease as a means of controlling health care spending. Well-conducted economic analyses and health services research can greatly assist hospital administrators and health care funders in decision-making related to prioritization of efforts and resource allocation. Principally, this project examined the gap in our understanding of the effects of smoking cessation interventions on “hard” outcomes (e.g. morbidity, mortality).

2 MANUSCRIPT 1

Economic evaluation of a hospital-initiated intervention for smokers with chronic disease in Ontario, Canada

2.1 Abstract

Introduction

Cigarette smoking causes many chronic diseases that are costly and result in frequent hospitalization. Hospital-initiated smoking cessation interventions increase the likelihood that patients will become smoke-free. We modelled the cost-effectiveness of the Ottawa Model for Smoking Cessation (OMSC), an intervention that includes in-hospital counselling, pharmacotherapy, and post-hospital follow-up, compared to usual care among smokers hospitalized with acute myocardial infarction (AMI), unstable angina (UA), heart failure (HF), and chronic obstructive pulmonary disease (COPD).

Methods

We completed a cost-effectiveness analysis based on a decision-analytic model to assess smokers hospitalized in Ontario, Canada for AMI, UA, HF, and COPD, their risk of continuing to smoke, and the effects of quitting on re-hospitalization and mortality over a one year period. We calculated short- and long-term cost-effectiveness ratios. Our primary outcome was one-year cost per quality-adjusted life year (QALY) gained.

Results

From the hospital payer perspective, delivery of the OMSC can be considered cost effective with one-year cost per QALY gained of $1,386 and lifetime cost per QALY gained of $68. In the first year, we calculated that provision of the OMSC to 15,326 smokers would generate 4689 quitters, and would prevent 116 re-hospitalizations, 923 hospital-days, and 119 deaths. Results were robust within numerous sensitivity analyses.

Discussion

The OMSC appears to be cost-effective from the hospital payer perspective. An important consideration is the relatively low intervention cost compared to the reduction in costs related to re-admissions for illnesses associated with continued smoking.

2.2 Introduction

Smoking-related illnesses are principal drivers of health care spending; they are estimated to contribute up to 15% of health care expenditures in developed nations (53). Many of the chronic diseases caused by cigarette smoking result in frequent hospitalization making the hospital an ideal setting to initiate cessation treatment (9). Rigotti and colleagues recently updated a review and meta-analysis of studies examining the efficacy of hospital-initiated smoking cessation interventions. The interventions included in the review were offered by hospital staff (e.g. physicians, nurses, or other allied health professionals) and could involve the provision of advice, intensive counselling, pharmacotherapy, and follow-up contact after hospital discharge. The authors concluded that smoking cessation support that began in hospital and continued for at least one month after discharge significantly increased the likelihood of patients being smoke-free in the long-term (risk ratio = 1.37, 95% confidence interval (CI) 1.27 to 1.48; 25 trials) and that strategies that included both counselling and pharmacotherapy were more efficacious than simply counselling alone (RR = 1.54, 95% CI 1.34 to 1.79, six trials) (25).

One of the studies included in the Rigotti review was by researchers at the University of Ottawa Heart Institute of an intervention that is now known as the Ottawa Model for Smoking Cessation (OMSC) (26). The OMSC is a systematic approach to the identification, treatment, and follow-up of smokers that is embedded within hospital management systems using organizational change strategies. The OMSC has been found to significantly increase long-term cessation rates by an absolute 15% (from 29% - 44%) in cardiac patients and by 11% (from 18% - 29%) in general hospital populations (26, 27).

Patients who quit smoking during hospitalization are less likely to be re-hospitalized or to die during follow-up (30, 40). Despite such evidence, most hospitals fail to deliver cessation interventions due, in part, to concerns about the perceived costs of such programs. Economic evaluations are becoming increasingly popular in helping health care administrators choose whether or not to fund interventions and where to devote resources (54). Cost-effectiveness analysis (CEA) is a type of economic evaluation that examines the consequences or gains of an intervention compared to an alternative. The results of CEA are expressed as cost-effectiveness ratios. For example, outcomes of CEA for a smoking cessation program might include the cost

per number of people who quit smoking, cost per number of hospital-days prevented by the program, or cost per number of years of life gained by the program. Cost-utility analysis (CUA) is a form of CEA that examines the cost of an intervention relative to the benefit it produces in terms of the number of years of life gained, combined with the quality of those years lived. The quality-adjusted life-year (QALY) is the most common outcome measured in a CUA; it is a cost-effectiveness ratio that takes into account both quantity and health-related quality of life (55).

The purpose of this study was to determine, from the hospital payer perspective, the short-term (one-year) and long-term (lifetime) cost-effectiveness of the OMSC intervention, as compared to a usual care condition, among smokers hospitalized with acute myocardial infarction (AMI), unstable angina (UA), heart failure (HF), or chronic obstructive pulmonary disease (COPD). This perspective and these four diagnoses were selected for our analysis due to the particular burden of these tobacco-related diseases on hospitalization and re-hospitalization and the availability of data.

2.3 Methods

Setting

Our study examined patients hospitalized in Ontario, a Canadian province with a population of approximately 12.8 million. The smoking prevalence among Ontarians aged 15 and older was 15.4% in 2009 (56). The smoking prevalence among Canadian hospital populations is higher, at 20% (57); consequently, on a given day in Ontario, approximately 6400 of the province's 32,000 hospital beds are occupied by current smokers. Health care is publicly funded through the Ontario Health Insurance Plan, where medically necessary services including primary- and specialty-care, hospital stays, diagnostic investigations, and surgical procedures are available at no cost to residents. There are 211 hospital sites in Ontario that recorded an estimated 987,757 acute care inpatient admissions in 2009 (58).

Population

Our analysis included smokers hospitalized for one of the four selected diagnoses. In 2009, there were 20,503, 5,370, 16,339, and 17,585 unique admissions to Ontario hospitals for AMI, UA, HF, and COPD, respectively, for a total of 59,797, as reported by the Canadian Institute for

Health Information's (CIHI) Discharge Abstract Database (DAD) (59). We combined data from a previously published quasi-experimental, before and after cohort study of the OMSC conducted at nine Ontario hospitals (27) with data from similar evaluations that took place at an additional 19 Ontario hospitals in order to estimate the number of these unique admissions that involved smokers and to estimate program quit rates. Our study dataset included patients (n=3269) aged 18 years or older that were hospitalized for either AMI (n=750), UA (n=705), HF (n=855), or COPD (n=956). Smokers were defined as anyone who reported having smoked daily (≥1 cigarette per day) in the six months leading up to their hospitalization. The overall smoking prevalence was 25.4%; disease-specific smoking rates are displayed in Table 2.1. Applying the disease-specific smoking prevalence to the number of unique admissions, we estimated that 15,326 smokers were hospitalized in 2009 for AMI (n=5,194), UA (n=1,424), HF (n=2,804), and COPD (n=5,904).

Intervention

The OMSC was selected as the intervention in our model for several reasons. It is the most widely implemented hospital-initiated smoking cessation intervention in Canada. As of 2014, it had been implemented in approximately 100 (14%) Canadian hospitals. It features a large program database where data were available to generate some of our model's data elements, broken down by disease group. A Canadian intervention was preferred as our estimates of cost and risk of re-hospitalization were derived from Canadian sources.

As part of the OMSC intervention, the following takes places with each admitted smoker: 1) A 10- to 30-minute consultation is completed by a nurse or other health care professional (e.g. respiratory therapist) at the bedside employing a standardized consultation and assessment form. The form gathers information on smoking history and readiness to quit. It guides the health professional in the selection and ordering of quit smoking medication, in giving practical advice, and registering the patient in the follow-up support program; 2) Pharmacotherapy (primarily nicotine replacement therapy - NRT) is offered to the patient for the duration of their hospital admission and ordered through the hospital pharmacy using standard medication order forms; 3) Guidance regarding the use of smoking cessation pharmacotherapy following hospital discharge is provided; 4) A patient education booklet with information for those thinking about quitting,

preparing to quit, ready to quit, or wanting to stay smoke-free is provided; 5) Enrolment in a telephone follow-up system for 6 months after discharge is offered. The telephone follow-up is conducted using an automated system that places eight programmed calls to smokers on days 3, 14, 30, 60, 90, 120, 150, and 180 after their discharge date. Patients respond to automated questions about their smoking status and their confidence in remaining smoke-free. Their responses serve as a triage tool and the system flags those who have relapsed to smoking or who may have low confidence in remaining-smoke free. Nurse counsellors who specialize in smoking cessation treatment and relapse prevention monitor the system and call patients who are flagged as experiencing difficulty. The OMSC protocol and follow-up system have been previously described in greater detail (26, 27, 60).

Usual Care

A number of guidelines exist recommending the integration of tobacco cessation interventions within clinical practices in Canada (61, 62); however, the large majority of hospitals in Canada do not have in place smoking cessation protocols or programs. Therefore, the most common alternative to our intervention is usual care, which may consist of the recording of smoking status on the patient chart and possibly the provision of a patient education booklet.

Model Framework

A decision analytic model was developed using an Excel spreadsheet (Microsoft Corporation, United States). It included smokers hospitalized with AMI, UA, HF, and COPD (15,326 in each the usual care and OMSC branches), their relative risks of continuing to smoke, and the transitions to various states relating to health outcomes among those who continued to smoke versus those who had quit over the one-year period (Figure 2.1). The following one-year health states were included: no adverse outcomes, one re-hospitalization, two or more re-hospitalizations, or death.

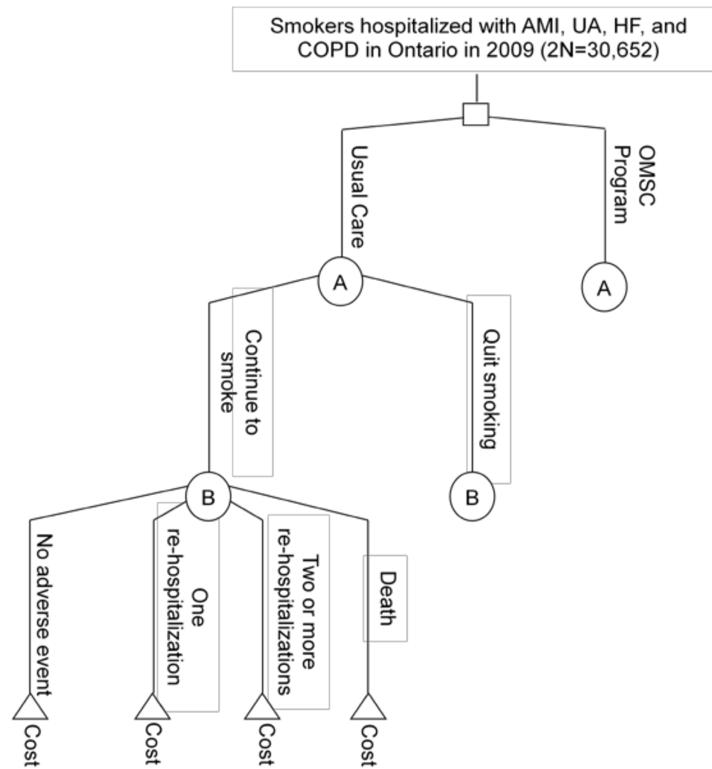

Figure 2.1. Decision analytic model. The square represents a decision node. In this case we are evaluating the difference between hospitalized smokers with AMI, UA, HF, or COPD receiving either usual care or the OMSC program. Circles A and B are chance nodes and indicate where probabilities of two or more events occur (the events are identical for each group but are only displayed for usual care). The triangles indicate terminal nodes and are the end points we wish to evaluate.

Data Elements

The data elements used in our model's base case analysis are listed in Table 2.1 and their sources identified.

Smoking abstinence rates

Smoking abstinence rates were obtained from our study dataset. Self-reported six-month continuous quit rates (i.e. patient responded "no" when asked "have you used any form of

tobacco in the past 6 months?) had been collected on a sample of smokers that received either usual care (n=369) or OMSC (n=439). They were calculated using intention to treat analysis (i.e. we assumed that those who were lost to follow-up were still smoking) and were broken down by diagnosis. A 5% relapse rate was applied to our 6-month quit rates in order to estimate one-year quitting in our model based on a 2008 meta-analysis of relapse by Hughes and colleagues (63). Overall, the 12-month quit rate (95% confidence interval) was 17.9% (14.0% – 21.8%) for usual care and 28.5% (24.3% – 32 .7%) for the OMSC intervention. Disease-specific rates are presented in Table 2.1.

Re-hospitalization

We obtained values for the risk of being readmitted to hospital once or two or more times in the year following the index hospitalization for each diagnosis using data provided by CIHI. These values were assigned to patients that had quit smoking. For continued smokers, the risk values were multiplied by the following relative risks (RR) of being re-hospitalized: 1.21 for AMI or UA (30); 1.20 for HF (64); and, 1.25 for COPD (65). To calculate a total number of re-hospitalizations, we multiplied the number of patients in each group by the RRs and by a factor of 1 for one re-hospitalization and a factor of 2.5 for two or more re-hospitalizations. The total cost of re-hospitalizations was obtained by multiplying the number of re-hospitalizations by the mean diagnosis-specific hospital admission costs in 2009, as per the Ontario Case Costing Initiative (OCCI) (66). We calculated the number of hospital-days used in the one-year period following index hospitalization for recent quitters and continued smokers by multiplying the total number of re-hospitalizations in each group by the mean length of stay for each diagnosis, obtained from OCCI.

Deaths

We obtained disease-specific mortality rates using published studies of Ontario or Canadian patients (67-69). These rates were assigned to patients that had quit smoking. For continued smokers, the mortality rates were multiplied by the following RR values for death: 1.50 for AMI or UA (70); 1.41 for HF (64); and, 1.71 for COPD (65).

Table 2.1. Data Elements included in the Base Case Analysis

		AMI	UA	HF	COPD	Sources
Smoking prevalence rates (95% CI)		.25 (.22-.29)	.27 (.23-.30)	.17 (.14-.21)	.34 (.29-.38)	(27)
Age, mean (SD)	Usual Care	56.9 (10.2)	58.0 (10.5)	60.8 (13.0)	62.3 (15.4)	(27)
	OMSC	57.4 (13.1)	56.6 (12.9)	61.4 (10.4)	65.9 (10.6)	(27)
12-month smoking abstinence rates (95% CI)	Usual Care	.22 (.15-.30)	.20 (.13-.30)	.17 (.10-.27)	.13 (.08-0.21)	(27)
	OMSC	.38 (.28-.51)	.35 (.25-.48)	.28 (.20-.39)	.24 (.19-.30)	
Risk of one re-hospitalization in first year (95% CI)	Continue to smoke	.05 (.03-.06)	.10 (.09-.12)	.17 (.16-.19)	.18 (.17-.20)	(30, 64, 65, 71, 72)
	Quit smoking	.04 (.03-.05)	.08 (.07-.10)	.14 (.13-.16)	.15 (.14-.16)	
Risk of two or more re-hospitalizations in first year (95% CI)	Continue to smoke	.03 (.02-.04)	.03 (.02-.05)	.09 (.07-.11)	.14 (.12-.15)	(30, 64, 65, 71, 72)
	Quit smoking	.02 (.01-.04)	.03 (.01-.04)	.08 (.06-.09)	.11 (.10-.13)	
Re-hospitalization cost, mean (SD)		$9,559 ($14,539)	$5,950 ($6,932)	$10,029 ($16,696)	$8,808 ($16,795)	(66)
Length of stay of re-hospitalization (days), mean (SD)		5.6 (9.8)	4.1 (4.9)	9.7 (12.8)	8.4 (14.5)	(66)
Risk of death in first year (95% CI)	Continue to smoke	.14 (.13-.15)	.09 (.08-.10)	.48 (.47-.49)	.09 (.09-.09)	(64, 65, 67-70)
	Quit smoking	.09 (.08-.10)	.06 (.05-.07)	.31 (.30-.31)	.06 (.06-.06)	

Utility Scores	Continue to smoke	0.53	0.52	0.48	0.50	(73, 74)
	Quit smoking	0.55	0.54	0.50	0.52	
Life expectancy, mean number of years remaining	Continue to smoke	7.58	7.42	5.19	7.75	(75-77)
	Quit smoking	8.76	8.64	6.07	9.01	
Intervention costs (per patient)						
Personnel costs to complete in-hospital consultation		$20.63	$20.63	$20.63	$20.63	
In-hospital pharmacotherapy		$13.95[a]	$9.23[a]	$21.60[a]	$21.25[a]	
Automated follow-up system fee		$10.30	$10.30	$10.30	$10.30	
Personnel costs to complete follow-up counselling calls		$27.24	$27.24	$27.24	$27.24	
Total intervention cost		$71.50	$66.98	$78.81	$76.44	

Note: AMI = acute myocardial infarction; UA = unstable angina pectoris; HF = heart failure; COPD = chronic obstructive pulmonary diseases; CI = confidence interval; SD = standard deviation

[a]Pharmacotherapy costs differ by diagnosis due to differing mean lengths of stay (LOS): AMI, mean LOS 5.6 days; UA, mean LOS 4.1 days; HF, mean LOS 9.7 days; COPD, mean LOS 8.4 days.

Utility scores and life expectancies

Utility scores are estimates of health-related quality of life and are used to calculate the outcome of quality adjusted life year (QALY). Utility values can be between 1 and 0, with a score of 1 indicating perfect health and 0 representing death. The following utility values used were obtained from a catalogue of scores for chronic conditions in the United States: AMI (0.70), UA (0.69), HF (0.64), and COPD (0.66) (73). These chronic condition utilities were then multiplied by utility scores of 0.75 for continued smokers and 0.78 for recent quitters (74). Life expectancies for continued smokers and quitters were obtained from published studies (75-77) and were discounted by 5% in the base case, as recommended by Canadian guidelines for the economic evaluation of health technologies (78).

Usual care costs

The estimated staff time involved with recording smoking status and providing a patient education booklet is one minute at a cost of $0.69 per smoker. Currently in Canada, the most widely used patient education booklets are provided through the Canadian Cancer Society (www.cancer.ca) and are available at no charge to hospitals. The personnel costs for both usual care and intervention were based on the average 2009 hourly rate of a mid-level registered nurse of $33.28 (79) plus 24% extended benefits (80) for a total of $41.27.

Intervention costs

Intervention costs did not include costs related to implementing the program, but included costs incurred by the hospitals for operating the program. These costs were based on previous evaluations of the OMSC, and included: 1) personnel costs associated with providing 30 minutes of bedside intervention ($20.63 per patient); 2) the average daily cost of NRT ($2.15 per patient, as determined by the University of Ottawa Heart Institute Department of Pharmacy) multiplied by the relative length of stay for each diagnosis (determined by OCCI); 3) telephone follow-up system and program database management fees ($10.30 per patient; TelASK Technologies, Ottawa, Ontario, Canada); and, 4) personnel costs associated with 40 minutes of monitoring of the follow-up system ($27.24 per patient).

Base Case Outcomes

Our base case analysis produced the following intermediate outcomes for usual care and OMSC groups: number of quitters, number of re-hospitalizations, number of hospital-days, number of deaths, number of life-years, and number of QALYs. The net cost (total re-hospitalization costs saved minus total intervention costs) and intermediate outcomes were used to calculate the cost-effectiveness ratios. Our primary short-term outcome was one-year cost per QALY gained. Additional one-year outcomes were: cost per quitter, cost per hospital-day avoided, and cost per death avoided.

Long-term (i.e. over the patient's lifetime) outcomes included lifetime cost per QALY gained and cost per life-year gained (LYG). Mean age and life expectancies were used to calculate total life-years for both usual care and OMSC groups. Mean age by diagnosis was obtained from the OMSC database. For long-term QALYs, we multiplied the average life expectancy in each group by the corresponding utility scores.

Sensitivity Analyses

Univariate sensitivity analysis

We conducted a series of interviews with hospital decision-makers (n=22) and provincial health care policy analysts (n=5) to determine what additional intervention components to consider in our sensitivity analysis. The most common component of interest was the addition of 12 weeks of cost-free NRT for patients once they are discharged from hospital. Based on recent reviews evaluating the efficacy of population-based and hospital-based interventions that include NRT, we estimated that the addition of 12 weeks of NRT would increase our program effectiveness by a relative 58% (25, 81).

For long-term outcomes, costs and benefits were discounted at 5% in the base case. We used rates of 0% and 3% in the sensitivity analysis as recommended by Canadian guidelines for the economic evaluation of health technologies (78).

Probabilistic sensitivity analysis

We performed a probabilistic sensitivity analysis to generate uncertainty in the model using Monte Carlo simulation technique for our primary short-term outcome of one-year cost per QALY gained as well as for lifetime cost per QALY gained. This is a common method used when economic evaluations are based on patient-level or observational data to handle the fact that data elements or "input parameters" that go into the model are imprecisely estimated from sampled data. In our case, this applies to our input parameters of costs, quit rates, re-hospitalization rates, length of stay values, and death rates. Each of these parameters included a standard deviation or 95% confidence interval which were the distributions used to handle the uncertainty in our model. The uncertainty of all the parameters was assessed simultaneously and was characterized as beta distributions (probability between 0 and 1). Our model was evaluated 5000 times, with each simulation involving a random draw from each of the input parameter distributions. In our study, 5000 estimates of costs and QALYs were obtained and were presented by two cost-effectiveness acceptability curves (CEAC) – one for short-term and one for long-term QALYs. The CEACs report the probability that the intervention is cost effective compared to usual care for alternative values of a QALY (54).

2.4 Results

Base Case Analysis

Short-term

Table 2.2 presents the cost outcomes of the OMSC intervention compared to usual care by diagnosis. From the hospital payer perspective, providing the OMSC program to 15,326 smokers with AMI, UA, HF, or COPD would cost an average of $74 per smoker, or $1,139,070 per year. This investment would generate 4,689 new quitters and would prevent 116 repeat hospitalizations, 923 hospital-days, and 119 deaths in the first year. The base case intermediate outcomes are presented in Table 2.3.

Table 2.2. Projected cost outcomes of OMSC intervention compared to usual care in patients with AMI, UA, HF and COPD

Cost	Usual Care (n=15,326)	OMSC (n=15,326)	Costs (Savings) from intervention
Intervention Costs			
	$10,575	$1,139,070	$1,128,495
Repeat hospitalization costs in year following index hospitalization			
AMI	$5,984,453	$5,808,343	($176,110)
UA	$1,474,391	$1,433,128	($41,263)
HF	$10,991,834	$10,777,828	($214,007)
COPD	$26,901,393	$26,289,058	($612,335)
Total	$45,362,645	$45,447,426	$84,781
Per patient	*$2,960*	*$2,965*	*$5*

Note: AMI = acute myocardial infarction; UA = unstable angina pectoris; HF = heart failure; COPD = chronic obstructive pulmonary diseases

Table 2.3. Base case outcomes of OMSC compared to usual care in 2009 cohort of patients with AMI, UA, HF and COPD

Outcome		Usual Care (n=15,326)	OMSC (n=15,326)	Outcomes prevented (gained) by intervention
Patients who continue to smoke, n		12,657	10,637	2,020
One year repeat hospitalizations, n				
	AMI	626	608	
	UA	248	241	
	HF	1,096	1,074	
	COPD	3,054	2,985	
	Total	5,024	4,908	116
One year hospital-days, n				
	AMI	3,506	3,403	
	UA	1,016	988	
	HF	10,631	10,424	
	COPD	25,655	25,071	
	Total	40,808	39,886	923
One year mortality, n				
	AMI	687	644	
	UA	124	117	
	HF	1,197	1,156	
	COPD	541	515	
	Total	2,550	2,431	119
Life-years, n				
	AMI	40,703	41,701	
	UA	9,975	10,282	
	HF	8,616	9,015	
	COPD	42,497	43,479	
	Total	101,791	104,476	(2,685)
QALYs (one-year), n				
	AMI	2584	2612	
	UA	716	722	
	HF	1059	1074	
	COPD	2816	2835	
	Total	7175	7244	(69)
QALYs (lifetime), n				
	AMI	21,701	22,383	
	UA	5,741	5,920	
	HF	7,189	7,353	
	COPD	23,386	23,911	
	Total	58,017	59,568	(1,551)

Overall, the intervention resulted in the following one-year cost-effectiveness ratios: cost per QALY gained of $1,386, cost per quitter of $20, cost per hospital-day avoided of $103, and cost per death avoided of $803. The disease-specific and overall cost-effectiveness ratios are summarized in Table 2.4.

Long-term

The OMSC intervention resulted in an overall lifetime cost per QALY gained of $61 and cost per LYG of $36. The OMSC was dominant (i.e. overall costs are lower and QALYs and life-years are higher) over usual care in patients with COPD and resulted in greater lifetime QALY and life-years for each of the diagnoses. The lifetime QALY gained were 0.31 per smoker with AMI, 0.29 per smoker with UA, 0.15 per smoker with HF, and 0.20 per smoker with COPD. The overall number of life-years gained per smoker was 0.40.

Sensitivity Analyses

The univariate sensitivity analysis results are presented in Table 2.4. In the base case analysis, quit smoking medications were only provided to the patients during their hospital admission. The provision of 12 weeks of NRT to patients following their hospitalization increased the per patient intervention cost by $346 and produced an overall one-year cost per QALY gained of $24,606 and lifetime cost per QALY gained of $1071. For the long-term cost-effectiveness ratios, the program remained cost-effective when 0% and 3% discounting was applied.

Figure 2.2 presents the CEAC for one-year QALY by diagnosis. The probability that the OMSC is most cost-effective compared to usual care was greater than 90% for AMI and HF and over 70% for UA and COPD for all values of one-year QALY from $0 to $100000. In the case of lifetime QALY, the CEACs in Figure 2.3 demonstrate that the probability that the OMSC is the most cost-effective alternative was greater than 90% for all diagnoses.

Table 2.4. Cost-effectiveness ratios of OMSC compared to usual care in 2009 cohort of patients with AMI, UA, HF and COPD

		Univariate Sensitivity Analyses		
	Base Case	12 weeks of additional pharmacotherapy	Discount rate of 0%	Discount rate of 3%
Short-term outcomes				
One-year cost per QALY gained				
AMI	$6,874	$25,496		
UA	$8,482	$32,328		
HF	$472	$19,834		
COPD	Dominant	$24,126		
Overall	$1,386	$24,606		
Cost per quitter				
AMI	$99	$552		
UA	$107	$608		
HF	$9	$523		
COPD	Dominant	$469		
Overall	$20	$528		
Cost per hospital-day avoided				
AMI	$1,893	$7,020		
UA	$1,904	$7,259		
HF	$34	$1,244		
COPD	Dominant	$796		
Overall	$103	$1,808		
Cost per death avoided				
AMI	$4,494	$16,668		
UA	$7,790	$27,784		
HF	$169	$7,544		
COPD	Dominant	$17,435		
Overall	$803	$14,658		

Long-term outcomes				
Lifetime cost per QALY gained				
AMI	$286	$1,062	$109	$207
UA	$303	$1,154	$118	$220
HF	$42	$1,564	$23	$34
COPD	Dominant	$885	Dominant	Dominant
Overall	$68	$1,071	$24	$45
Cost per LYG				
AMI	$196	$726	$68	$137
UA	$177	$674	$69	$128
HF	$17	$723	$11	$15
COPD	Dominant	$474	Dominant	Dominant
Overall	$36	$629	$14	$26

Note: AMI = acute myocardial infarction; UA = unstable angina pectoris; HF = heart failure; COPD = chronic obstructive pulmonary disease; QALY = Quality-adjusted life-year; LYG = Life-year gained

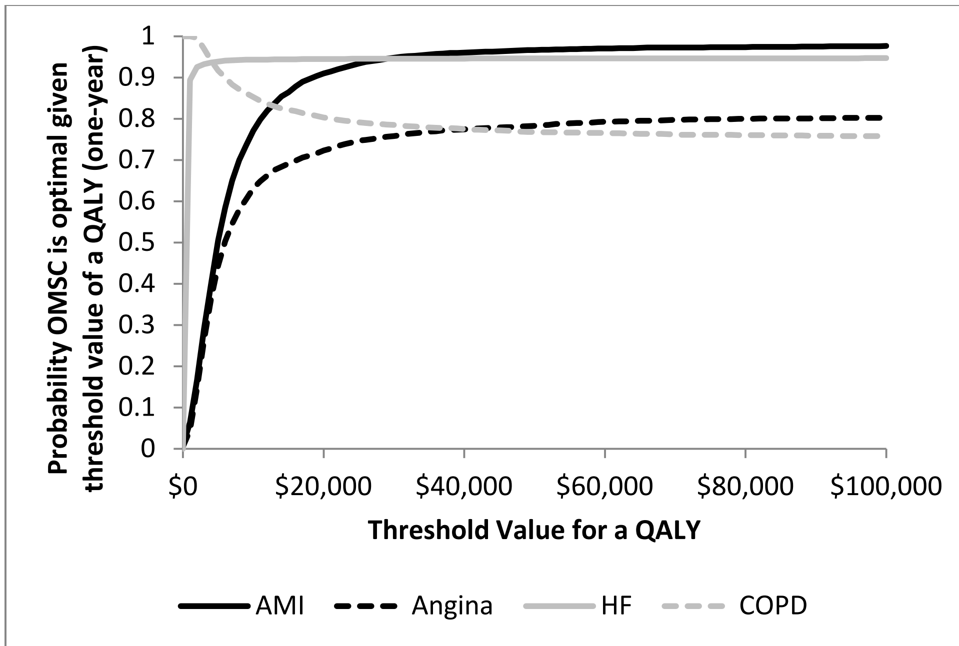

Figure 2.2. Cost effectiveness acceptability curves by disease showing change in the probability that the OMSC is cost-effective as the value of QALY (one-year) changes.

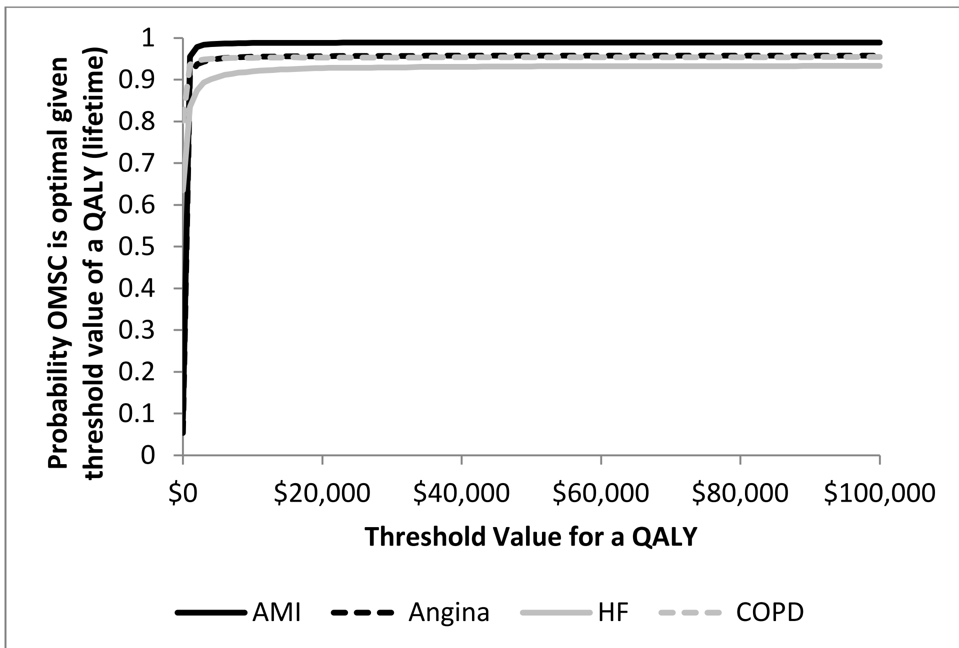

Figure 2.3. Cost effectiveness acceptability curves by disease showing change in the probability that the OMSC is cost-effective as the value of QALY (lifetime) changes.

2.5 Discussion

Not surprisingly, our results indicate the economic burden to the hospital system of continued smoking is large. Hospitalization is an opportune time to initiate smoking cessation treatment as smokers are frequent and high cost users of the health care system and are often highly motivated to quit smoking during their admission. Smokers would benefit significantly from receiving cessation support while in hospital in terms of being able to quit smoking and reducing their risk of morbidity and mortality. An estimated $547 million is spent each year in Ontario on hospitalizations for AMI, UA, HF, and COPD alone. Our study estimates that provision of the OMSC intervention to smokers admitted with these issues would represent 0.20% of this cost, yet could result in several individual and health system benefits and, in the case of COPD patients, could result in actual cost-savings.

However, there is an apparent expectation of behavioural or preventative interventions, including smoking cessation, to demonstrate that they are cost-saving or able to save lives with little investment. In contrast, this requirement does not exist to nearly the same extent when it comes to other medical or procedural interventions for chronic diseases, for instance treatments for hyperlipidaemia or vascular surgeries. Given the known benefits of smoking cessation on morbidity and mortality, it is our opinion that cessation interventions should be adopted regardless of their ability to save money. If smoking cessation interventions are indeed cost-saving, this should be seen simply as a favourable consequence of helping people to quit.

Results as Compared to Other Studies

An earlier investigation revealed that a nurse-led smoking cessation intervention for patients hospitalized for AMI cost $220 per LYG in 1991 US dollars (approximately $628 per LYG in current Canadian dollars) (82). In that study, the intervention was estimated to reduce smoking by 26%, more than twice as much as our estimate. We believe our estimate of the effect of the OMSC intervention on quitting is a more accurate reflection of what can be achieved in 2012. More recently, Ladapo *et al.* projected the cost-effectiveness of smoking cessation interventions for a hypothetical US cohort of 327,600 smokers hospitalized with AMI employing in-hospital counselling and follow-up telephone calls from a nurse after discharge, but did not include the use of pharmacotherapy in the base case; their program would cost $540 per quitter and $4350

per LYG (40). Comparatively, the OMSC cost-effectiveness ratios for smokers with AMI of $99 per quitter and $196 per LYG can be considered highly appealing.

Our long-term cost-effectiveness ratios are also highly attractive when compared to several other interventions routinely used to treat patients with smoking-related conditions (or their sequelae), including: beta-blocker use after AMI (≈$10,000 per LYG) (83); inhaled corticosteroids for treatment of COPD (≈$30,000 per LYG) (84); cardiac resynchronization therapy for heart failure (≈$50,000 per LYG) (85); hemodialysis for renal insufficiency (≈$50,000 per LYG) (86); and, percutaneous coronary intervention for coronary artery stenosis (>$200,000 per LYG) (87).

Study Limitations

Our study has several limitations. We did not model dynamic changes in smoking status that can occur over time, nor did we have data concerning effects of the OMSC on quit rates longer than 12 months after hospitalization. Only a small percentage of smokers (3-5%), however, spontaneously quit smoking and smokers who are abstinent at 12 months have a 95% likelihood of being smoke-free at 24-month follow-up (88).

We did not account for smoking cessation interventions that may have occurred outside of the hospital in either group. It is possible that smokers may have received support that would have generated additional costs; however, we did not model these potential costs in our current study. Before applying our results, readers need to consider that four distinct patient populations were examined in our model and results may not be transferable to other patient populations. We examined a moderately intensive intervention provided in an acute care setting and application of our data to other interventions or health care settings should be done with caution. Further, usual care or the most common alternatives available in other countries may differ from the usual care scenario in Canada that was applied in our model.

Some of our data elements, for instance our relative risks of re-hospitalization and death and our utility score estimates, were drawn from older studies and in the case of COPD risks, a longitudinal observational trial (64, 65, 70, 74, 77). We included distributions for all input parameters except utility scores and life expectancies as they were unavailable in the studies we

used; therefore, we were unable to assess the uncertainty of these parameters in our probabilistic sensitivity analysis.

It might be speculated that patients who quit smoking after hospitalization are sicker than those who continue to smoke. Because our risk estimates were drawn from observational data, they likely underestimate the harms of continued smoking. We did not consider the effects of quitting smoking on preventing other important smoking-attributable illnesses (e.g. cancers, stroke, peripheral vascular disease, other respiratory diseases, and other cardiac diseases). We chose to examine costs and outcomes specifically related to hospitalizations. There is a dearth of information when it comes to the impact of smoking cessation on other important health care system costs and savings, for instance those related to emergency department, specialty- and primary-care visits. Future studies should examine a wider array of health care impacts and consider a societal perspective that would also take into account productivity gains or losses. Quitting smoking has been associated with gains in societal productivity; it is thought that the inclusion of such information would further improve an understanding of the cost-effectiveness of the intervention (89, 90). Our study only examined costs and benefits that occurred in the first year. Evidence suggests that patients who quit may be at reduced risk for hospitalization, morbidity, and death in subsequent years as the benefits of cessation accrue over time (30, 67, 76, 77).

2.6 Conclusions

Due to population ageing and the costly burden of chronic diseases that exists globally, hospitals and health care payers are searching for cost-effective solutions, including primary and secondary prevention strategies. Implementation of the OMSC hospital-initiated intervention for smoker-patients appears to be a highly cost-effective option from the hospital payer perspective. Important consideration is the relatively low intervention cost compared to the reduction in costs related to re-admissions for illnesses associated with continued smoking.

What this Paper Adds

Most hospitals fail to offer tobacco cessation interventions due, in part, to concerns about the perceived costs of such programs. Cost-effectiveness analyses provide health care administrators with information needed to guide the allocation of resources.

This study demonstrated that hospital-initiated smoking cessation interventions, like the Ottawa Model for Smoking Cessation, can be implemented with relatively small investment and can be extremely cost-effective when applied to high risk smokers with existing chronic disease.

Given the known benefits of smoking cessation on morbidity and mortality, cessation interventions should be adopted by hospitals regardless of their ability to save money. If these interventions result in cost-savings, this should be seen simply as favourable consequence of helping people to quit.

3 MANUSCRIPT 2

The effectiveness of a hospital-initiated smoking cessation program: health and health care outcomes

3.1 Abstract

Introduction: The impacts of hospital-initiated smoking cessation interventions on mortality and health care utilization have not been well-studied. The objective of this study was to determine the effects of a hospital-initiated smoking cessation intervention on 30-day, 1-, and 2-year mortality and health care utilization.

Methods: We completed an effectiveness study comparing patients who received the Ottawa Model for Smoking Cessation (OMSC) intervention to usual care controls. The study took place at 14 hospitals in Ontario, Canada. Participants were: >17 years of age; smokers (smoked ≥ 1 cigarette per day in the past 6 months); and, Ontario residents. The control group included 641 patients recruited from a consecutive sample of patients admitted to each hospital prior to implementing the OMSC. The intervention group included 726 patients recruited after the OMSC intervention had been implemented. Baseline data was linked to Ontario health care administrative data. We used competing-risks regression analysis to compare the cumulative incidence of death, re-hospitalization, emergency department (ED) visits, and physician visits at 30 days, one, and two years following index hospitalization between groups and clustered by hospital.

Results: The intervention group experienced lower probabilities of: all-cause mortality at one year (hazard ratio [HR], 0.55; 0.36 to 0.82, $p<0.001$) and two years (HR, 0.60; 0.42 to 0.85, $p<0.001$); all-cause hospital re-admission at 30 days (HR, 0.50; 0.34 to 0.72, $p<0.001$), one year (HR, 0.72; 0.61 to 0.86, $p<0.001$), and two years (HR, 0.79; 0.68 to 0.92, $p<0.001$); and all-cause ED visits at 30 days (HR, 0.70; 0.55 to 0.89, $p=0.001$), one year (HR, 0.88; 0.79 to 0.98, $p=0.02$), and two years (HR, 0.91; 0.83 to 0.99, $p=0.04$).

Conclusions: Implementation of a systematized, in-hospital smoking cessation (OMSC) intervention was associated with significant reductions in mortality and rates of health care utilization. Greater adoption of cessation interventions by hospitals should be considered to enhance rates of smoking cessation, reduce mortality, improve patient outcomes and reduce associated health care utilization.

3.2 Introduction

Tobacco smoking remains the leading cause of premature death worldwide (1). It is causally related to a number of chronic illnesses, including vascular and respiratory diseases, at least 15 types of cancer, and diabetes mellitus (8). In middle and high-income countries, these illnesses are primary reasons for hospitalization and re-hospitalization (3, 5, 91-94). The magnitude of the excess morbidity, mortality and health care utilization caused by tobacco addiction is immense (1, 9). Ironically, smoking remains almost unparalleled as being a condition that "presents such a mixture of lethality, prevalence and neglect despite effective and readily available interventions" (24).

Health care systems worldwide are under increasing pressure to reduce "avoidable" hospital re-admissions. In the United States, the Hospital Readmissions Reductions Program was introduced as part of the Affordable Care Act (ACA); consequently, thousands of hospitals will have Medicare payments deducted by up to 3% in 2015 if patients with certain conditions (e.g. acute cardiac, pneumonia, chronic obstructive pulmonary disease) return to hospital within 30 days of discharge (95). Other provisions of the ACA provide opportunities to enhance the delivery of smoking cessation interventions (96).

In Canada, smokers average approximately twice as many hospital days compared to never-daily smokers (11). Given the number of smokers admitted to hospitals, the relevance of smoking to their illness, the realities of nicotine addiction and the challenges of withdrawal, hospitalization presents a significant and strategic opportunity for delivery of smoking cessation interventions (97). There is abundant evidence that hospital-based interventions are highly effective at helping patients quit, particularly when pharmacotherapy is offered alongside counseling and post discharge support is provided (risk ratio (RR), 1.37; 95% confidence interval (CI) 1.27 to 1.48; 25 trials) (25). One such intervention, the "Ottawa Model" for Smoking Cessation (OMSC), is a systematic, integrated approach to tobacco dependence treatment delivered within health care settings which ensures: the identification and documentation of the smoking status of all patients; the provision of brief counseling and in-hospital pharmacotherapy; and, the offer of follow-up support post-hospital discharge (27). As of 2014, the OMSC had been implemented in over 300 health care settings in Canada. Evaluations of the model have found it to improve long-term quit

rates by an absolute 15% (from 29% to 44%) among cardiovascular patients, and 11% (from 18% to 29%) among general hospital patients (26, 27).

Evidence of the benefits of quitting smoking in terms of reductions in morbidity and mortality is overwhelming, particularly for younger people without existing disease, but also for higher risk individuals with existing, smoking-related chronic illnesses (8, 12, 13, 17, 18). A small number of investigations have assessed the health and health care consequences following a smoking cessation intervention delivered in hospital. They have relied on self-report, assessed only condition-specific morbidity and mortality, or relied on mathematical modeling to obtain their outcomes (21, 30, 31, 41).

Our main objectives were to determine the effects of a hospital-initiated smoking cessation intervention (the OMSC) on: 1) mortality and, 2) downstream health care utilization.

3.3 Methods

Study design and Setting

We completed a two-group effectiveness study comparing patients who received the OMSC intervention to pre-implementation "usual care" controls. This expanded on a previous study that examined smoking cessation effectiveness by individually linking study participants to health care administrative data to obtain health care utilization and mortality outcomes (27). Our study was conducted in Ontario, Canada where the provincial smoking prevalence was on average 16% throughout the study (56). Participants were recruited from one of 14 hospitals that, at baseline, did not have a formal smoking cessation intervention in place but were planning to implement the OMSC. Table 3.1 describes the hospital characteristics. This study protocol was approved by the Ottawa Hospital Research Ethics Board (Protocol: 2011889-01).

Participants

Patients were eligible for the study if they were: 18 years of age or older; a smoker (defined as smoked ≥ 1 cigarette per day in the six months prior to their index hospitalization); an Ontario resident; and, eligible for the Ontario Health Insurance Plan (OHIP) for the duration of the study.

A total of 1,649 patients were eligible and enrolled in the study, 741 smokers who received usual care and 908 smokers who received the OMSC (Figure 3.1).

Table 3.1. Description of participating hospitals and patient recruitment periods

Hospital	Type	Participating units / total possible units	Control Group Recruitment					Intervention Group Recruitment				
			Start date	Recruitment length (months)	Expected smokers	Smokers screened	BPs in place	Start date	Recruitment length (months)	Expected smokers	Smokers screened	BPs in place
1	M, TC, T	3/6	Jan/05	3	86	47	5	July/06	6	172	177	10
2	S, G	1/1	Jan/06	2	25	19	2	Feb/07	2	16	9	7.5
3	L, TC, T	2/14	Jan/06	2	62	61	2	Mar/07	0.8	24	31	9
4	S, G	2/4	Jan/06	5	206	41	1	May/07	1	45	40	9.9
5	S, G	5/5	Feb/06	1	44	46	1	Oct/07	2	79	37	9
6	L, TC, T	5/15	Mar/06	2	123	114	0	May/07	2	121	75	8.5
7	L, TC, T	4/15	May/06	0.3	77	98	2	Sep/08	0.8	187	129	8
8	S, G	1/1	June/06	2	8	9	2.5	Oct/07	8	46	28	10
9	M, G	6/6	June/06	3	433	128	2	Feb/07	1	123	129	9.25
10	S, G	2/3	June/06	1	17	20	1	May/07	2	34	44	10
11	S, G	1/1	Aug/06	1	29	29	1.5	Nov/07	1	29	29	8
12	S, G	1/1	Mar/07	1	5	4	2.5	Apr/08	6	22	18	8.5
13	L, TC, T	5/14	Mar/07	2	183	62	2.5	Jan/08	4	363	82	9.15
14	M, G	3/4	Sep/07	2	113	63	2.5	May/09	1	65	80	9.5
					1410	741				1326	908	

Note: S= Small; M=Medium; L=Large; G=General; TC=Tertiary Care; T=Teaching; BP=Best Practices

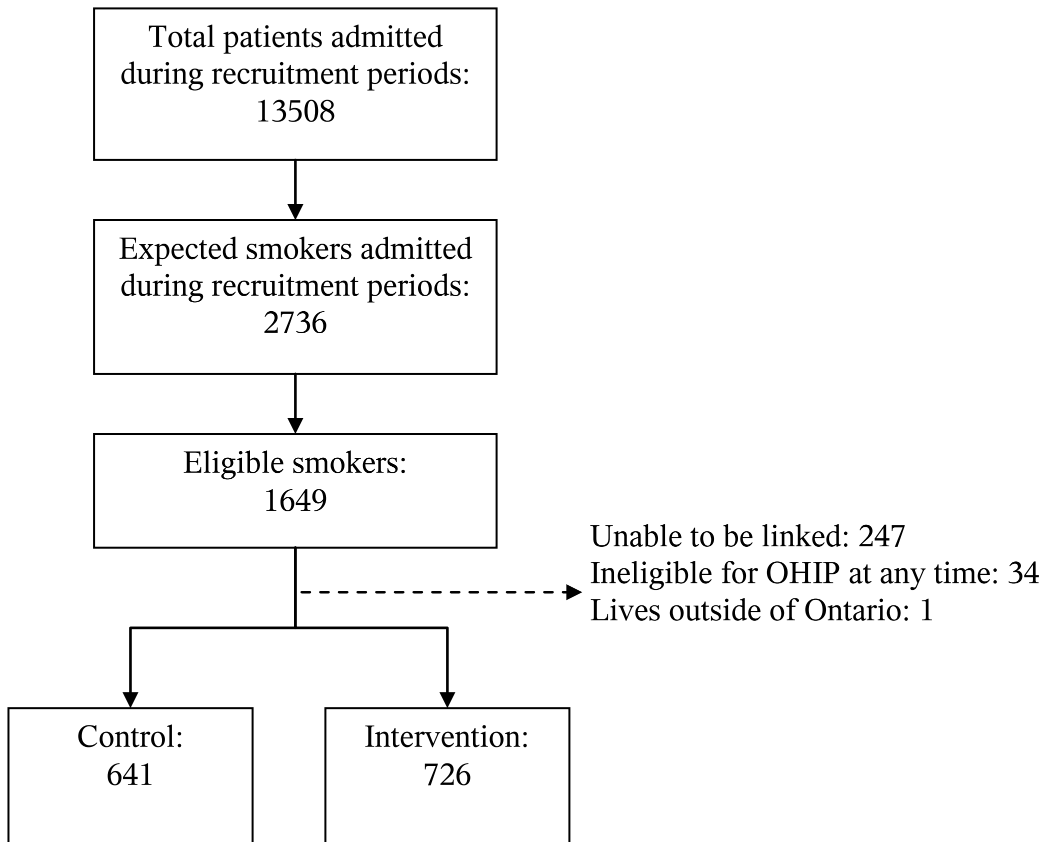

Figure 3.1. Participant flow.

Control group

Prior to implementing the OMSC, a consecutive sample of patients admitted to each participating hospital was screened for tobacco-use using a standardized screening tool (Appendix A). Hospitals were providing 'usual care' (typically the availability of self-help brochures) during this recruitment period.

Intervention group

Following control group recruitment, participating hospitals implemented the OMSC intervention. The OMSC is implemented at the organization level and involves the introduction of a new standard of care including 10 "Best Practices for Treating Tobacco Use Dependence" (Appendix B). Implementation of the program has been previously described in greater detail (26, 27, 60). Following OMSC implementation, regardless of intentions to quit, smokers

admitted to participating hospitals received the following intervention: 1) A health care professional (e.g. nurse or respiratory therapist) completed a bedside consultation using a standardized smoking cessation form (Appendix C). The form documented smoking history and guided staff in recommending cessation pharmacotherapies, providing brief counselling, and enrolling patients in post-hospitalization follow-up; 2) Pharmacotherapies (i.e. nicotine replacement therapy, varenicline, or bupropion) were offered to patients during hospitalization and were ordered through hospital pharmacies using pre-printed medication order forms (Appendix D). Printed recommendations for the continuation of pharmacotherapies beyond hospitalization were provided; 3) A patient education booklet was given; 4) Registration in the program's automated telephone follow-up system after discharge was facilitated. The system contacted consenting smokers eight times over six months. Patients replied to a series of automated questions and those who had relapsed to smoking or had low confidence were flagged. Smoking cessation nurse-specialists called such patients in order to provide counselling. After the OMSC had been operating for at least two months, the intervention group was recruited using the same process and screening tool as was used during control group recruitment.

Data linkage

Participants were individually linked to administrative databases at the Institute for Clinical Evaluative Sciences (ICES) to ascertain health care use and vital statistics (mortality). ICES is an independent, non-profit organization that undertakes research on a variety of issues and is a "prescribed entity" under Ontario's Personal Health Information Protection Act (98). Deterministic data linkage (using unique health care number) was available for 46.1% of participants and probabilistic matching, based on institution, hospital chart number, first name, last name, and date of birth, was completed for 53.9%.

Baseline Covariates

The following covariates were collected at the time of recruitment: age, sex, smoking status (yes or no to "have you smoked any form of tobacco in the past 6 months?"), average number of cigarettes smoked per day, and hospital to which the patient was admitted during their index hospitalization. Additional baseline covariates were available through data linkage and are summarized in Table 3.2.

Table 3.2. Covariates obtained through data linkage, their descriptions, and sources

Variable	Description	Scale	Source
Income quintile	A measure of socio-economic status (SES)	1 = least affluent 5 = most affluent	Statistics Canada Postal Code Conversion File (99)
Resource Utilization Band (RUB) score	A ranking system of a person's overall morbidity, taking into account all diagnoses ascribed to them during medical visits and hospitalizations in the year before their index event	0=non-user 1=healthy user 2=low morbidity 3=moderate morbidity 4=high morbidity 5=very high morbidity	Johns Hopkins Adjusted Clinical Group® Case Mix System, Version 9.0
Rurality Index for Ontario (RIO) score	Classifies the degree of rurality of each patient's community taking into account community population, population density, and time to travel to basic and advanced health care referral centres	0=most urban 100=most rural	Ontario Medical Association and Ministry of Health and Long Term Care (100)
History of acute myocardial infarction (AMI)	Whether or not the patient had ever been admitted to hospital for ICD-9 code '410' or ICD-10 codes 'I21' or 'I22'	n/a	Canadian Institutes of Health Information Discharge Abstract Database (CIHI-DAD) (101)
History of asthma	Whether or not the patient had been registered as a prevalent case	n/a	ICES-derived ASTHMA database (102)
History of recent cancer	Whether or not the patient had been registered as an incident case in the 10 years prior to their index hospitalization	n/a	Ontario Cancer Registry (OCR) (103)
Diagnosis of chronic obstructive pulmonary disease (COPD)	Whether or not the patient had been registered as a prevalent case	n/a	ICES-derived COPD database (102)
Diagnosis of congestive heart failure (CHF)	Whether or not the patient had been registered as a prevalent case	n/a	ICES-derived CHF database (102)
Diagnosis of diabetes	Whether or not the patient had been registered as a	n/a	ICES-derived Ontario Diabetes Database (102)

	prevalent case		
Diagnosis of hypertension	Whether or not the patient had been entered as a diagnosed case	n/a	Ontario Hypertension Database (102)
History of mental illness	Whether or not the patient had ever been admitted to hospital for ICD-9 codes 295-297, 300-302, 306-311 or ICD-10 codes F20-F49 or F60-F69	n/a	CIHI-DAD (101)
History of stroke or transient ischemic attack (TIA)	Whether or not the patient had been registered as an incident case	n/a	Registry of Canadian Stroke Network (102)

An evaluation committee formed for this study identified all covariates that could, ideally, have been included. Covariates that were unavailable were: smoking history in pack-years; education; exposure to secondhand smoke at home or work environment; dietary history; physical activity levels; social support; alcohol consumption; body mass index; and, waist circumference.

Outcomes

Outcomes were assessed at 30 days, one year, and two years following index hospitalization. Our primary analyses compared the cumulative incidence of all-cause mortality and all-cause hospital re-admission between intervention and control groups. We also compared the cumulative incidence of: smoking-related re-admissions; all-cause and smoking-related emergency department (ED) visits; and all-cause and smoking-related physician visits (specialist and general practitioner). Mortality data were acquired from the Registered Persons Database (104); hospital re-admission data from the Canadian Institutes of Health Information (CIHI) – Discharge Abstract Database (101); ED visit data through the CIHI National Ambulatory Care Reporting System (105); and, specialist and general practitioner visit data through the Ontario Health Insurance Program (OHIP) database. We created a binary variable identifying whether or not events were smoking-related based on conditions listed in “The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General” (8, 106).

Bias

Several strategies were employed to ensure transparency and address potential biases. First, an evaluation committee, which included all study investigators and a third party chair, was formed prior to study commencement. The committee documented all real and potential conflicts of interest and approved the study design, outcomes, covariates, analysis plan, and dissemination plan. Once analyses were completed, the committee reviewed the study findings to verify that all plans had been followed. A second strategy included an initial, blinded analysis of the data. An analyst not involved in the main analysis created a "blinded" dataset by removing identifying information, randomly adding observations from all other groups to the smallest group in order that all be identical in size, and randomly assigning group numbers. Two independent analysts then used this dataset to complete initial blinded analyses of the study's main outcomes. Once consensus from the individual analyses was reached (i.e. statistical coding and final outputs matched), the primary analyses were repeated using the "unblinded" study dataset and independent results compared.

Power Calculation

We completed a power calculation using PASS Software 12.0.3 (NCSS, LLC). Using a competing-risks model and a sample of 1400 (700 control and 700 intervention), we had greater than 90% power to detect a hazard ratio as modest as 0.56, estimated from a published randomized control trial (30).

Statistical methods

Baseline characteristics were compared using t-tests for continuous variables and chi-square tests for categorical variables. For our principal analyses, we used Fine and Gray's method of competing-risks regression (107). Competing-risks regression allows the comparison of the cumulative incidence of an event (i.e., hospitalization, ED visit, physician visit) between two groups over a period of time in the presence of a competing risk (i.e., death). Participants who experienced neither an event of interest nor the competing event of death were right censored at end of each analysis period. The primary independent variable in our statistical models was group (control or intervention). Adjusted models included all baseline covariates, which were

treated as fixed at baseline. Hospital (n=14) was used as the clustering variable in all models (108). We completed multiple imputations for missing data. An alpha level of .05 and two-tails were used for all tests of significance. Interval estimates were based on 95% CIs. All statistical analyses were carried out using SAS version 9.3 (Cary, NC).

Sensitivity Analyses

We examined consistency and potential confounding for our primary outcomes of 2-year mortality and all-cause re-hospitalization by assessing stratum-specific hazard ratios. Subgroups included: age (<45 vs. 45-55 vs. >55), sex (male vs. female); socioeconomic status (SES) (lowest two income quintiles vs. highest three quintiles); overall morbidity (low to moderate [RUB score of 1-3] vs. high [RUB score of 4 or 5]); urban vs. rural residence (RIO score <11 vs. >10); and co-morbidities (history of acute myocardial infarction (AMI) vs. no AMI, asthma vs. no asthma, chronic obstructive pulmonary disease (COPD) vs. no COPD, congestive heart failure (CHF) vs. no CHF, hypertension vs. no hypertension, diabetes vs. no diabetes, mental illness vs. no mental illness, stroke/transient ischemic attack (TIA) vs. no stroke/TIA).

To assess the effect of quitting smoking on primary outcomes, we examined a subsample of smokers in both groups who agreed to receive a follow-up call six months after their index hospitalization. These participants responded yes or no to “Have you smoked any form of tobacco in the past 6 months?”. Intent-to-treat analysis was used to calculate smoking abstinence rates, assuming that patients who were not reached had resumed smoking. We combined the quitters and continued smokers from each group and used smoking status as the main independent variable in our primary competing-risks regression analyses.

It was important to assess whether differences between groups were specific to hospitalized smokers and could be attributed to intervention exposure, rather than secular temporal trends unrelated to the intervention. To explore this, we compared the 2-year probabilities of all-cause mortality and all-cause re-hospitalization between two consecutive samples of non-smoking patients that were recruited alongside the control and intervention smoker-patients. The intervention could not conceivably have influenced outcomes in these patients, so any observed trends would suggest external factors were at play.

3.4 Results

Participants

Our final study dataset included 641 smokers in the control group and 726 smokers in the intervention group. Table 3.3 presents baseline participant characteristics. The intervention group had a higher baseline history of AMI (22.2% compared to 12.5%) while control group had a higher baseline history of cancer (11.5% compared to 6.2%), due mostly to higher recruitment on certain hospital units. In all other respects the groups were similar. There were three variables for which missing data imputation was used: number of cigarettes smoked per day was missing for 28% of control participants and 20% of intervention participants; RIO score was missing in 0.2% of control cases and 0.6% of intervention cases; and, income quintile was missing in 0.6% of intervention group cases.

Figure 3.2 displays the results of our competing-risks regression analyses, including attributable risks (AR), and numbers needed to treat (NNT) for each outcome. The intervention group experienced significant reductions in the probabilities of all-cause re-admissions, smoking-related re-admissions, and all-cause ED visits at all time points. The largest absolute risk reductions (ARR) were observed for all-cause re-admission rates at 30-days (13.3% vs. 7.1%; ARR, 6.1%; 2.9 to 9.3%, p<0.001), one year (38.4% vs. 26.7%; ARR, 11.7%; 6.7 to 16.6%, p<0.001), and two years (45.2% vs. 33.6%; ARR, 11.6%; 6.5 to 16.8%, p<0.001). The greatest reduction in risk of all-cause ED visits was at 30 days (20.9% vs. 16.4%; ARR, 4.5%; 0.4 to 8.7%, p=0.03). Reduction in mortality was not evident at 30 days, but there were significant reductions in mortality evident by one year (11.4% vs. 5.4%; ARR 6.0%; 3.1 to 9.0%, p<0.001) and two-year follow-up (15.1% vs. 7.9%; ARR, 7.3%; 3.9 to 10.7%, p<0.001). Figures 3.3 and 3.4 present the two-year cumulative incidence curves for all-cause re-admissions and mortality.

Table 3.3. Patient characteristics at time of index event

	Control (n=641)	Intervention (n=726)	p-value
Age, mean (SD)	52.1 (16.9)	52.3 (14.8)	.86
Male sex, n (%)	295 (46.0)	367 (50.5)	.09
Low SES (lowest two income quintiles), n (%)	321 (50.0)	357 (49.1)	.68
Smokes > 20 cpd, n (%)	205 (32.0)	235 (32.4)	.28
Rurality (RIO) score, mean (SD)	17.3 (21.2)	16.2 (22.8)	.37
High overall morbidity (RUB score >3), n (%)	439 (68.5)	531 (73.1)	.08
History of AMI, n (%)	80 (12.5)	161 (22.2)	<.001
Asthma, n (%)	123 (19.2)	125 (17.2)	.35
Cancer, n (%)	74 (11.5)	45 (6.2)	<.001
CHF, n (%)	70 (10.9)	79 (10.9)	.98
COPD, n (%)	191 (29.8)	213 (29.3)	.85
Diabetes, n (%)	127 (19.8)	138 (19.0)	.71
Hypertension, n (%)	266 (41.5)	306 (42.2)	.81
History of Mental Illness, n (%)	59 (9.2)	90 (12.4)	.06
History of Stroke or TIA, n (%)	59 (9.2)	48 (6.6)	.07

Note: AMI=Acute Myocardial Infarction; CHF=Heart Failure; CPD=Cigarettes per day; COPD=Chronic Obstructive Pulmonary Disease; n=Number; RIO=Rurality Index of Ontario; RUB=Resource Utilization Band; SD=Standard Deviation; SES=Socio-economic Status; TIA=Transient Ischemic Attack

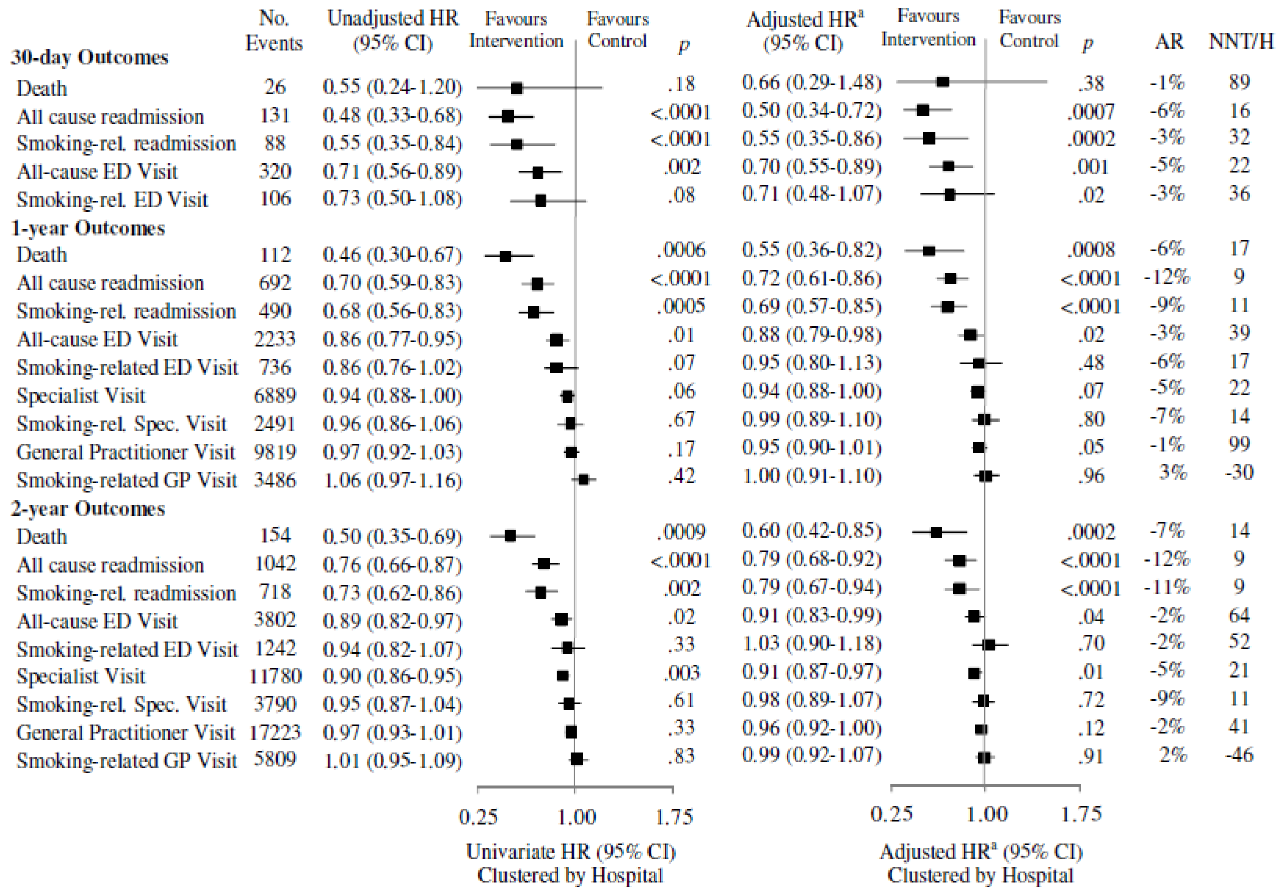

Figure 3.2. 30-day, 1-year and 2-year outcomes of competing-risk regression for smokers receiving either OMSC (Intervention, n=726) or usual care (Control, n=641). *Note:* AR = Attributable Risk; ED=emergency department; GP=General Practitioner; HR=Hazard Ratio; NNT/H=Number needed to treat/harm (negative values represent number needed to harm); Phys=physician; rel=related.

[a] Adjusted for baseline covariates: Age, Sex, Income, number of cigarettes smoked per day, community size, resource utilization prior to index event, and history of: acute myocardial infarction, asthma, chronic obstructive pulmonary disease, heart failure, diabetes, hypertension, mental illness, stroke/transient ischemic attack

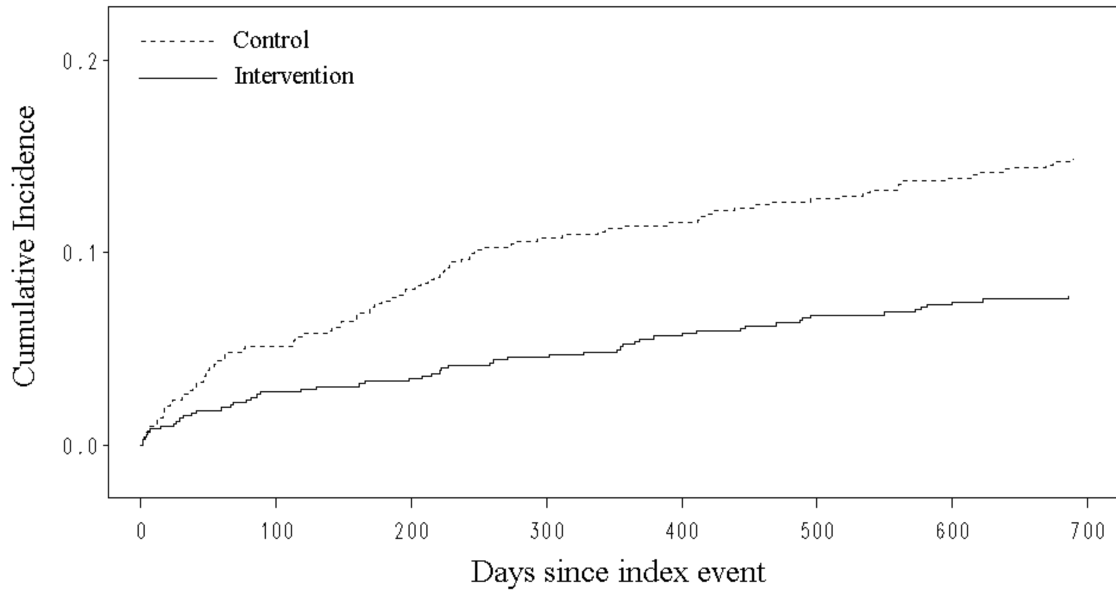

Figure 3.3. Cumulative incidence of death from index hospitalization to 730-day follow-up in the control (n=641) and intervention (n=726) groups.

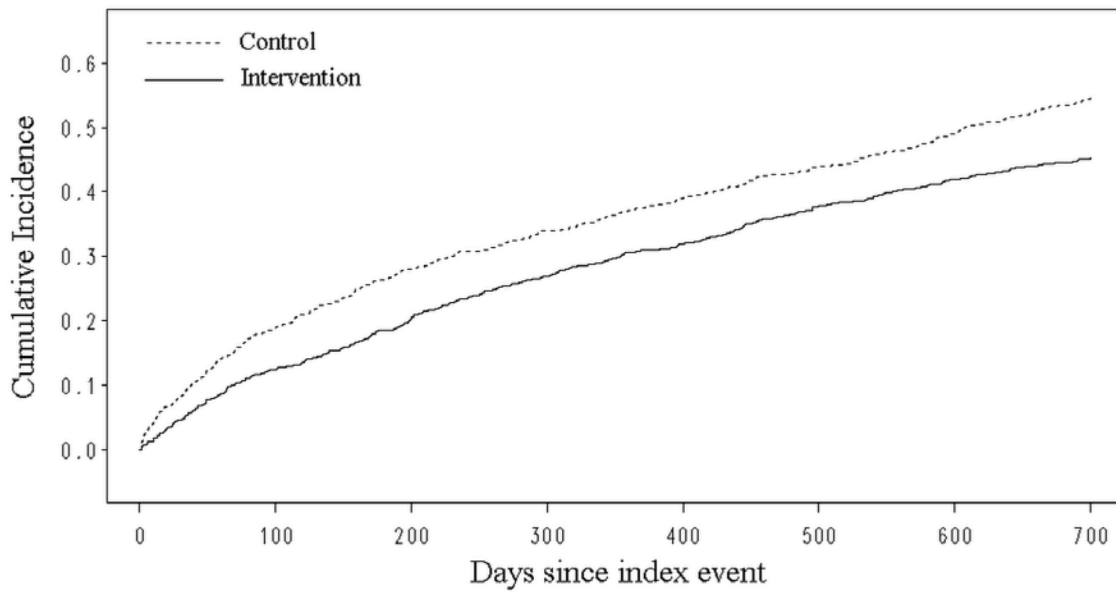

Figure 3.4. Cumulative incidence of all-cause re-hospitalization from index hospitalization to 730-day follow-up in the control (n=641) and intervention (n=726) groups.

Sensitivity Analyses

The majority of subgroups produced results consistent with our primary analyses (i.e. stratum-specific estimates were similar for 2-year mortality and hospital re-admission) with some exceptions. For 2-year all-cause mortality, the intervention had an impact on patients with no history of mental illness (hazard ratio (HR), 0.68; 0.58 to 0.79, p<0.001) and those living in urban areas (HR, 0.36; 0.21 to 0.59, p<0.001); however, not on those with a history of mental illness (HR, 1.31; 0.40 to 5.01, p=0.69) or living in rural areas (HR, 1.10; 0.47 to 2.68, p=0.79). We saw differences in the risk of 2-year re-admission in the following subgroups: patients with lower SES (HR, 0.68; 0.57 to 0.80, p<0.001) compared to higher (HR, 1.01; 0.78 to 1.31, p=0.96); patients with CHF (HR, 1.07, 0.78 to 1.47, p=0.42) compared to patients without (HR, 0.68; 0.58 to 0.80, p<0.001); and, patients with a history of mental illness (HR, 1.41; 0.96 to 2.11, p=0.005) compared to those without (HR, 0.68 [0.58-0.79], p<0.001).

In our subsample of smokers with self-reported six-month smoking abstinence data, 45 of 221 (20.4%) control patients had quit compared to 90 of 256 (35.2%) intervention patients (χ^2, 12.8, p<0.001). Over two years, those who had been smoke-free at six months were 22% less likely to be re-hospitalized (HR, 0.78; 0.58 to 1.03, p=0.04) and 47% less likely to die (HR, 0.53; 0.32 to 0.83, p=0.07).

Twelve of the 14 hospitals collected non-smoker data. The baseline characteristics of our non-smoking patient are summarized in Table 3.4. The non-smokers were on average 12 years older than the smokers, were more likely to be female, had higher SES, and had higher overall morbidity. The non-smokers had higher rates of CHF, diabetes, hypertension, and stroke or TIA. We observed no differences in 2-year all-cause mortality (HR, 1.14; 1.21 to 1.61, p=0.12), 2-year all-cause re-hospitalization (HR, 0.99; 0.92 to 1.08, p=0.97), or 2-year smoking-related re-hospitalization (HR, 1.08; 0.98 to 1.19, p=0.64) between the "control" and "intervention" non-smokers.

Post Hoc Analysis

We sought to determine whether the baseline group difference in cancer history explained our observed difference in mortality. We completed a subgroup analysis comparing patients with a

Table 3.4. Characteristics of non-smoking patients at time of index event

	Non-smokers		
	Control (n=2009)	Intervention (n=1529)	*p*-value
Age, mean (SD)	64.0 (19.6)	64.9 (20.4)	.18
Male sex, n (%)	861 (42.9)	597 (39.0)	.02
Low SES (lowest two income quintiles), n (%)	754 (37.5)	562 (36.8)	.42
Smokes > 20 cpd, n (%)	n/a	n/a	
Rurality (RIO) score, mean (SD)	16.4 (21.1)	17.0 (20.3)	.36
High overall morbidity (RUB score >3), n (%)	1683 (83.8)	1290 (84.4)	.77
History of AMI, n (%)	219 (10.9)	131 (8.6)	.02
Asthma, n (%)	342 (17.0)	257 (16.8)	.87
Cancer, n (%)	261 (11.3)	175 (11.7)	.70
CHF, n (%)	430 (21.4)	347 (22.7)	.35
COPD, n (%)	490 (24.4)	412 (26.9)	.08
Diabetes, n (%)	535 (26.6)	411 (26.9)	.87
Hypertension, n (%)	1203 (59.9)	903 (59.1)	.62
History of mental illness, n (%)	97 (4.8)	80 (5.2)	.59
History of Stroke or TIA, n (%)	278 (13.8)	229 (15.0)	.34

Note: AMI=Acute Myocardial Infarction; CHF=Heart Failure; CPD=Cigarettes per day; COPD=Chronic Obstructive Pulmonary Disease; n=Number; RIO=Rurality Index of Ontario; RUB=Resource Utilization Band; SD=Standard Deviation; TIA=Transient Ischemic Attack

history of cancer to those without. Thirty-four of 74 (45.9%) smokers with cancer in the control group had died by year two, compared to 20 of 45 (44.4%) in the intervention group; there was no significant difference in the probabilities of 2-year death between cancer sub-groups (HR, 0.84; 0.43 to 1.56, p=0.51).

3.5 Discussion

Our objectives were to determine the effects of hospital implementation of the Ottawa Model for Smoking Cessation on mortality and health care utilization in a real-world effectiveness study with usual care controls. We found that implementation of the OMSC at 14 Ontario hospitals resulted in significant reductions in 30-day, 1-year, and 2-year health care utilization, particularly for costly services like re-hospitalizations and ED visits. Patients who received the OMSC experienced significant reductions in the risk of mortality at one year and two years following their index hospitalization.

We saw a difference in the incidence of smoking-related ED visits at 30 days, but not at one year or two years. We did not see differences in smoking-related specialist or GP visits at any time point; not surprising given the proportion of participants who had existing chronic diseases requiring regular medical management. However, the observed reduction in acute care services suggests that the severity of disease or exacerbations of smoking-related illnesses may have improved.

Our main outcomes were consistent among the majority of subgroups and we did not see differences between our "before" and "after" program non-smoking controls over time suggesting that results were specific to hospitalized smokers that received the intervention. Patients who had quit smoking experienced similar reductions in the probabilities of re-hospitalization and mortality as the intervention group, further supporting our hypothesis.

Our findings are consistent with previous studies that have shown smoking cessation to reduce morbidity and mortality in high-risk and general populations of hospitalized smokers (12, 13, 17, 18, 30, 109). We are aware of two other studies that examined rates of hospital re-admission following a hospital-based smoking cessation intervention. The first, a 2007 randomized control trial by Mohiuddin *et al*., observed a 77% relative risk reduction in mortality (95% CI, 27% to 93%, p=0.014) and 44% relative risk reduction in hospital re-admission (95% CI, 16% to 63%, p=0.007) among patients with acute cardiovascular conditions who received an intensive hospital-initiated smoking cessation program (30). Our absolute risk reduction in mortality at two years of 7.2% was similar to theirs at 9.2%. A second, more recent randomized control trial

assessed rates of psychiatric re-admission in patients hospitalized with mental illness (41). Patients who received a computerized intervention with offer of six months of nicotine replacement therapy were less likely than controls to be re-hospitalized for a psychiatric illness over 18 month follow-up (OR, 1.92; 1.06 to 3.49, p=0.04). Both of the above studies relied on self-reported re-admission data. To our knowledge, ours is the first study to examine health outcomes in a general hospital population of smokers by linking to actual health care utilization data.

The OMSC intervention was highly effective among low SES patients. Many smoking cessation interventions have either not reached or have not been effective in low SES populations, populations that tend to have higher smoking rates and use a higher proportion of health care resources (110). The OMSC approach is a potentially important population health intervention in the hospital setting due to its systematic, proactive and accessible nature, and the fact that it is offered to patients regardless of age, sex or SES.

The results of our descriptive statistics revealed some interesting, albeit not entirely surprising differences between the smokers and non-smokers. It appears that smokers are being hospitalized on average 12 years earlier than non-smokers, likely due to the fact that smoking-related illnesses occur sooner in this group. Though on average 12 years younger, smokers had a higher history of AMI and COPD compared to non-smokers. The non-smokers had higher resource use in the year leading up to their index hospitalization. This could be attributed to their older age and higher prevalence of age-related conditions of CHF, diabetes, hypertension, and stroke (111-113). Half of the smokers in our study were in the lowest two income quintiles and 11% had a history of mental illness. In contrast, over 60% of the non-smokers were in the top 3 income quintiles and only 5% had a history of mental illness, confirming previously identified health disparities among low SES and smokers with mental illness (110, 114).

Limitations

Our study included data specific to health care utilization in Ontario; we did not have access to data concerning services patients may have received in other provinces or countries during the study. We used data from an effectiveness study, not a randomized control trial; however, given

the inclusion of a pre-implementation control group and that data were collected during a high quality tobacco-use evaluation involving a consecutive sample of patients from each hospital, we feel confident in the quality of our results. Our only smoking-related variable was self-reported number of cigarettes smoked per day. Pack-years would have been our preferred smoking variable in order to assess whether or not a dose-response effect was present. We did not have information about exposure to other smoking cessation services patients may have encountered during follow-up and smoking abstinence data were only available on a subsample of patients. We did not have information on second-hand smoke exposure for any of our participants, nor did we have smoking history information from our non-smoking cohort. The intervention studied was the Ottawa Model for Smoking Cessation. Other hospital or community-based interventions may differ in intensity and efficacy.

Conclusions

The OMSC hospital-based intervention appears to produce significant early and sustained reductions in mortality, re-hospitalization and ED use among hospitalized smokers. Our findings are consistent among various patient groups. Health care payers are seeking cost-saving solutions amid tight economic circumstances. Our study supports the case for the implementation of systematic smoking cessation interventions within hospitals as a way to prevent frequent short and long-term health care utilization, to reduce the burden of the "revolving door" patient, and most importantly to enhance the health and well-being of our patients.

4 MANUSCRIPT 3

Health care utilization and patient costs following a hospital-initiated smoking cessation intervention

4.1 Abstract

Purpose: The objectives of this study were to: (a) determine the downstream health services costs of smokers that received an in-hospital smoking cessation intervention compared to smokers from a pre-implementation control group; and (b) determine the predictors of downstream health care costs among hospitalized smokers.

Methods: Data from 726 patient-smokers that received an in-hospital smoking cessation intervention (the Ottawa Model for Smoking Cessation, OMSC) and 641 patient-smokers that were "usual care" controls were linked to health care administrative data to determine provincially covered health services costs (e.g. inpatient, ambulatory care, physician services, day surgery, home care, laboratory) over two-year follow-up. To compare cumulative mean costs between intervention and control groups, costs were grouped into 24 monthly intervals and weighted by the inverse probability of not being censored at the beginning of each month. Covariate-adjusted generalized linear models were performed for each of the 24 monthly intervals to determine the association between independent variables and health care costs.

Results: Mortality was significantly lower for the intervention group compared to controls at two-year follow-up (7.9% compared to 15.1%, $p<0.001$). The mean covariate-adjusted health services cost, conditional on survival, was $4104 lower for intervention participants over two year follow-up, primarily due to much lower inpatient costs. The intervention had the largest effect on cost among smoker-patients with asthma (52% lower costs), chronic obstructive pulmonary disease (35% lower costs), hypertension (34% lower costs), diabetes (28% lower), and 3 or more chronic diseases (28% lower costs).

Conclusions: The OMSC intervention resulted in increased survival and reduced costs over two years. If implemented broadly across all Canadian hospitals, the potential financial impact in terms of direct health care dollars saved would be immense.

4.2 Introduction

Nearly five million Canadians smoke tobacco and while the nation's smoking rate has dropped significantly in recent decades, there is evidence that the decline is slowing (2). Smoking remains the leading preventable cause of premature death in Canada, resulting in nearly 40,000 deaths each year, and smoking-related illnesses are associated with greater health care resource-use (3, 5, 115). Canada spends more than $4.4 billion annually on direct health care related to tobacco-related illnesses, over half of which is spent on acute care hospital stays (115). At least 20% of hospitalized patients are current smokers; this rate is much higher among specific chronic disease groups, including those with vascular and respiratory diseases, many cancers, and mental illnesses (8, 21). Smoking cessation has been found to improve morbidity in several patient populations (21, 30, 40).

Given the particular financial burden of tobacco-use and the known benefits of cessation, it is surprising that more hospitals and health care funders do not prioritize the management and treatment of tobacco dependence by implementing recommended evidence-based interventions to help patients quit. In order for hospitals and health system payers to make informed decisions about allocating resources toward tobacco dependence treatment, detailed data regarding resource-use and costs are needed. Most previous studies of the cost-effectiveness of smoking cessation have relied on mathematical modeling, self-reported resource-use, or resource-use in specific patient populations (21, 35, 36, 40, 116). The objectives of the current study were to: (a) determine the downstream health services costs of smokers that received an in-hospital smoking cessation intervention compared to usual care controls; and, (b) determine the predictors of downstream health care costs among hospitalized smokers.

4.3 Methods

Study Design

Data from a previous study examining the effect of the Ottawa Model for Smoking Cessation (OMSC) hospital-initiated smoking cessation program on downstream health care utilization and mortality were linked to health care cost data available at the Institute for Clinical Evaluative Sciences (ICES). The original study design, intervention, and primary health care outcomes have

been previously reported in detail (Refer to Section 3.3 Methods of Manuscript 2). This study protocol was approved by the Ottawa Hospital Research Ethics Board (Protocol: 2011889-01).

Setting

The study took place in Ontario, Canada. Participants were recruited from one of the 14 hospitals that did not offer a systematic smoking cessation intervention to patients at baseline but that were planning to implement the OMSC intervention.

Participants

Patients were eligible for the study if they: were over 17 years of age at the time of their index hospitalization; smoked ≥ 1 cigarette per day in the six months leading up to their index hospitalization; were an Ontario resident; and, were eligible for the Ontario Health Insurance Plan (OHIP) for the duration of the study.

Control

A consecutive sample of smokers admitted to each hospital prior to implementing the OMSC received "usual care" between January 2005 and September 2007 and were recruited to the control group (n=641). Usual care, at most, consisted of the provision of self-help booklets if requested by the patient and available.

Intervention

Intervention patients were recruited from a consecutive sample of smokers after the OMSC intervention had been in place at each hospital for at least two months. Intervention patients were offered the following: (a) a bedside consultation completed by attending health care staff using a standardized smoking cessation consultation form (Appendix C); (b) quit smoking pharmacotherapies (e.g. nicotine replacement therapy) throughout their hospitalization; (c) follow-up for six months post-hospitalization via the OMSC telephone follow-up counselling system. A total of 726 eligible smoker-patients were recruited to the intervention group between July 2006 and May 2009. The costs of operating the OMSC intervention has been previously examined and are summarized in Table 4.1 (21). The OMSC does not typically include coverage of quit smoking pharmacotherapies once a patient leaves the hospital; however, best practices

Table 4.1. Ottawa Model for Smoking Cessation Hospital-based Intervention Costs (2012, Canadian $)

	Unit	Cost/unit	Per Patient Cost	Source
Bedside smoking cessation consultation by health care staff	0.5 hours	$44/hour	$22	(79)
Nicotine replacement therapy	ALOS 7 days	$2.50/day	$17	(117)
Follow-up database fees	Patient	$12/patient	$12	(60)
Follow-up counseling calls by health care staff	0.66 hours	$44/hour	$29	(79)
Subtotal			$80	
Quit smoking medications post discharge	12 weeks	$30/week	$360	(118)
Total			$440	

Note: ALOS= Average Length of Stay

would recommend that smokers attempting to quit continue the use of medication for at least 12 weeks in order to improve the odds of quitting (24). Therefore, we also estimated the mean per patient cost of the intervention if 12 weeks of free quit smoking pharmacotherapies (e.g. nicotine replacement therapies, varenicline, or bupropion) were offered at standard dosing.

Data Sources

Our baseline data were individually linked to administrative databases at the Institute for Clinical Evaluative Sciences (ICES). ICES is an independent, non-profit health research organization and a “prescribed entity” under Ontario’s Personal Health Information Protection Act. Survival data were obtained from the Registered Persons Database (104); inpatient utilization data and day surgeries from the Canadian Institute for Health Information-Discharge Abstract Database (101); emergency department (ED) visits from the National Ambulatory Care Record System (105); physician visits, home care, long-term care, rehabilitation services, laboratory tests, and other medical services from the Ontario Health Insurance Plan (OHIP) database (106); and, chronic disease information from registries and ICES-derived chronic disease databases (102, 103).

Covariates

The following covariates were collected at the time of recruitment: age (calculated as year of index hospitalization minus year of birth), sex (male or female), smoking status (yes or no to "have you smoked any form of tobacco in the past six months?"), and average number of cigarettes smoked per day.

Additional baseline covariates thought to be potentially important determinants of health care expenditures were available through data linkage. They included: socio-economic status (SES) (measured as income quintile); level or resource-use in the year leading up to index event (Resource Utilization Band, RUB); degree of rurality of the patient's community (Rurality Index of Ontario, RIO, Score); history of acute myocardial infarction (AMI); history of asthma; recent history of cancer (last 10 years); diagnosis of chronic obstructive pulmonary disease (COPD); diagnosis of congestive heart failure (CHF); diagnosis of diabetes; diagnosis of hypertension (HTN); history of mental illness; history of stroke or transient ischemic attack (TIA); and, total number of chronic diseases (99-103).

Cost Outcomes

Health services costs were independently gathered and were examined from the perspective of the health care payer (the Ontario Ministry of Health and Long-term Care) over the two-year period following the index hospitalization. Indirect costs, societal costs, and costs incurred by patients were not included. All eligible smoker-patients were covered under OHIP. Costs of all medically necessary services (including hospital stays and ED visits), home care visits, day surgeries, long-term care, rehabilitation services, laboratory tests, and non-physician medical services were collected. While OHIP does offer a medication coverage program (Ontario Drug Benefit Program, ODB), these costs were excluded as ODB is only available to a portion of the population (e.g. over the age of 65, living in a long-term care facility, of lower income, receiving social assistance). All costs were presented in Canadian dollars and were adjusted to the year 2012.

Statistical Analysis

Baseline characteristics for intervention and control group participants were compared using t-tests for continuous variables and chi-square tests for categorical variables.

Survival for each group was calculated using the Kaplan-Meier estimator and log-rank tests. To calculate cumulative mean costs and determine the association between independent variables and health care costs, the methods of Bang and Tsiatis (119) and Lin (120) were used. Costs were grouped into 24 monthly intervals and were weighted by the inverse probability of not being censored at the beginning of each month. Twenty-four inverse probability weighted (IPW) regression analyses were completed where the cumulative monthly costs for each patient were regressed on the independent variables. The incremental costs related to each independent variable were estimated by summing the coefficients of each variable from each of the monthly intervals. The cumulative mean cost was calculated by summing all weighted monthly costs and dividing the sum by the total number of participants in each group. Since patients no longer consume health care resources after death, the cumulative mean cost taking into account survival was also calculated by dividing the sum of the monthly weighted costs by the number of patients that survived each interval. All baseline characteristics but number of chronic diseases (given its correlation with the individual co-morbidity variables) were used in the adjusted regression models.

To determine what effect the intervention had on costs among various subgroups, each covariate was stratified and regression analyses were repeated. During the original study, a subsample of participants from the control (n=221) and intervention (n=256) groups were contacted by telephone six months following their index hospitalization to determine continuous smoking abstinence rates. A regression analysis was repeated on this subsample to assess the association between quitting smoking and cost. All analyses were performed using SAS/IML Version 9.3 (Cary, NC).

4.4 Results

Table 4.2 presents the baseline characteristics of participants.

Table 4.2. Patient characteristics at time of index event

	Control (n=641)	Intervention (n=726)	*p*-value
Age, mean (SD)	52.1 (16.9)	52.3 (14.8)	.86
Male sex, n (%)	295 (46.0)	367 (50.5)	.09
Low SES (lowest two income quintiles), n (%)	321 (50.0)	357 (49.1)	.68
Smokes > 20 cpd, n (%)	205 (32.0)	235 (32.4)	.28
RIO Score, mean (SD)	17.3 (21.2)	16.2 (22.8)	.37
High baseline resource-use (RUB score >3), n (%)	439 (68.5)	531 (73.1)	.08
History of AMI, n (%)	80 (12.5)	161 (22.2)	<.0001
Asthma, n (%)	123 (19.2)	125 (17.2)	.35
Cancer, n (%)	74 (11.5)	45 (6.2)	.0005
CHF, n (%)	70 (10.9)	79 (10.9)	.98
COPD, n (%)	191 (29.8)	213 (29.3)	.85
Diabetes, n (%)	127 (19.8)	138 (19.0)	.71
HTN, n (%)	266 (41.5)	306 (42.2)	.81
History of mental illness, n (%)	59 (9.2)	90 (12.4)	.06
History of Stroke or TIA, n (%)	59 (9.2)	48 (6.6)	.07
3+ chronic diseases, n (%)	147 (22.9)	158 (21.8)	.46

Note: AMI=Acute Myocardial Infarction; CHF=Heart Failure; CPD=Cigarettes per day; COPD=Chronic Obstructive Pulmonary Disease; HTN=hypertension; n=Number; RIO=Rurality Index of Ontario; RUB=Resource Utilization Band; SD=Standard Deviation; SES=Socio-economic Status; TIA=Transient Ischemic Attack

Survival and Resource-use

The mortality rate was significantly lower in the intervention group compared to controls at two years (7.9% compared to 15.1%, p<0.001) (Figure 4.1). The control group experienced 850 hospitalizations per 1000 smoker-patients over two years. The mean (standard deviation) length of stay among control participants was 8.7 (20.1) days, resulting in 7395 total hospital days per

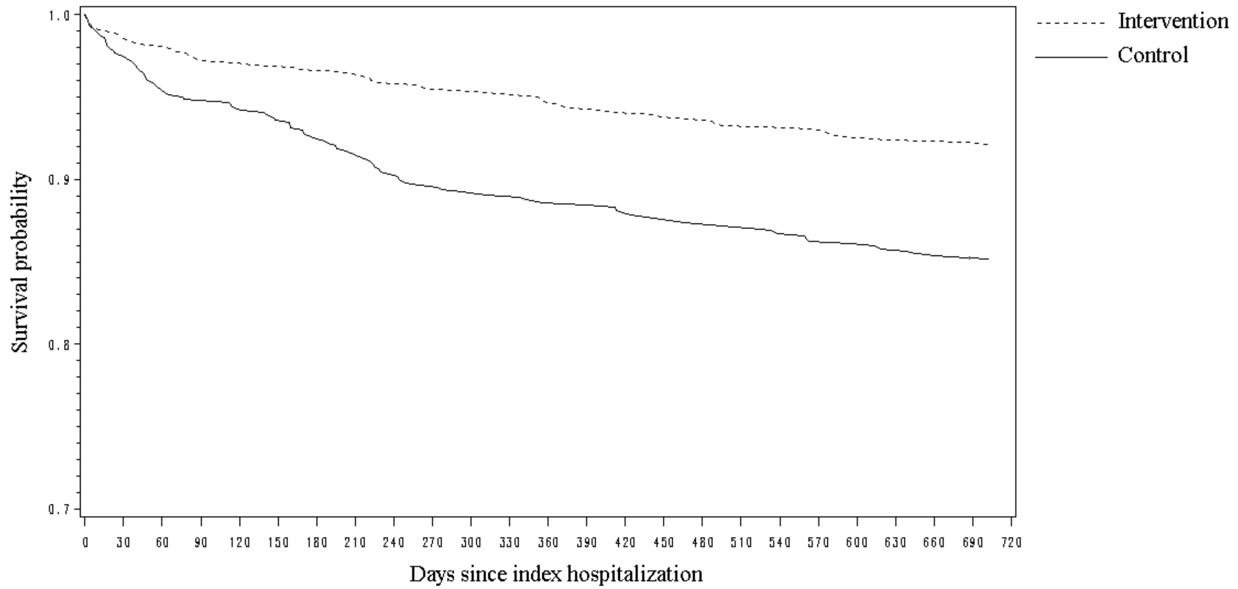

Figure 4.1. Two-year survival probability comparisons of intervention (n=726) versus control (n=641)

1000 smoker-patients. The intervention group had 660 hospitalizations per 1000 smoker-patients. The mean length of stay for the intervention group was of 8.6 (15.2) days, resulting in a total of 5676 hospital days per 1000 smoker-patients – a difference of 1719 hospital-days between groups. The control group experienced 248 more ED visits per 1000 smoker-patients than the intervention group (2913 versus 2665). Rates of physician visits were similar between groups; the control group had 20,786 physician visits per 1000 smoker-patients over two years (8605 specialist and 12,181 general practitioner) and the intervention group had 21,596 (8628 specialist and 12,968 general practitioner).

Costs

Table 4.3 displays the cumulative mean costs overall and by health service at 30-days, one-year, and two-years and adjusted for baseline covariates.

Table 4.3. Covariate-adjusted cumulative mean health services costs (2012, Canadian $) 30 days, one year and two years following index hospitalization

	Control		Intervention		Diff.
	Mean	(95% CI)	Mean	(95% CI)	
30-Day					
Total	$1,695	($1,326, $2,185)	$1,361	($1,069, $1,746)	$334
Inpatient	$1,146	($863, $1,524)	$898	($684, $1,181)	$248
Physician services	$256	($197, $333)	$239	($185, $309)	$17
Home care	$139	($135, $142)	$66	($64, $67)	$73
ED	$61	($47, $80)	$50	($38, $65)	$11
Rehabilitation	$34	($33, $36)	$35	($33, $36)	($0)
Long-term care	$26	($25, $27)	$35	($33, $36)	($8)
Day surgery	$21	($16, $27)	$26	($20, $33)	($5)
Laboratory	$11	($9, $14)	$11	($9, $14)	$0
Non-phys. services	$2	($1, $2)	$3	($2, $4)	($1)
365-Day					
Total	$16,392	($12,434, $21,921)	$14,380	($10,855, $19,282)	$2,012
Inpatient	$10,410	($7,498, $14,518)	$9,013	($6,533, $12,492)	$1,397
Physician services	$2,682	($1,974, $3,660)	$2,723	($2,014, $3,697)	($41)
Home care	$1,575	($1,539, $1,613)	$767	($749, $786)	$808
ED	$626	($457, $860)	$582	($426, $801)	$43
Rehabilitation	$411	($392, $430)	$415	($396, $435)	($4)
Long-term care	$309	($294, $323)	$404	($385, $425)	($96)
Day surgery	$234	($173, $317)	$307	($229, $414)	($74)
Laboratory	$129	($96, $175)	$128	($97, $175)	$2
Non-phys. services	$17	($12, $24)	$39	($27, $58)	($23)
730-Day					
Total	$23,653	($16,695, $23,137)	$20,830	($14,590, $58,349)	$2,823
Inpatient	$14,076	($9,292, $4,125)	$11,917	($7,950, $36,838)	$2,160
Physician services	$4,121	($2,743, $9,832)	$4,255	($2,833, $10,837)	($134)
Home care	$2,321	($2,260, $2,384)	$1,223	($1,189, $1,258)	$1,098

ED	$993	($650, $2,604)	$990	($636, $3,144)	$3
Rehabilitation	$659	($607, $724)	$614	($570, $667)	$45
Long-term care	$720	($667, $783)	$898	($830, $981)	($179)
Day surgery	$478	($295, $1,763)	$586	($367, $2,410)	($109)
Laboratory	$228	($149, $582)	$247	($161, $673)	($19)
Non-phys. services	$58	($31, $342)	$101	($53, $1,540)	($43)

Note: Diff. = Difference, ED = emergency department, SDS = Same day surgery, Phys=Physician

Compared to smokers that received usual care, the mean total health services costs of those who received the OMSC intervention were considerably lower at 30-day, one-year, and two-year follow-up, with differences of $334, $2012, and $2823, respectively. After adjustment for survival, the one- and two-year differences increased to $2660 and $4104, respectively (Table 4.4 and Figure 4.2). The intervention group had lower costs for all services except long-term care, day surgery, and non-physician services. In most cases, the lower costs were associated with lower service-use, except in the case of physician services where intervention group participants had a slightly higher number of physician visits but lower service costs.

Regression Models

Based on the univariate regression analysis, the intervention group had 21% lower costs over two years compared to the control group. Intervention remained a significant predictor of two-year cost after adjustment for covariates, with the effect decreasing slightly by 3% ($p<0.001$) (Table 4.5). All independent variables but SES and history of stroke or TIA remained significant predictors in the multivariate analysis.

The results of our stratified regression analyses estimating the cost effects of the intervention among various subgroups are summarized in Table 4.6. The largest improvements were found among intervention patients with asthma (52% lower costs), COPD (35% lower costs), HTN (34% lower costs), diabetes (28% lower costs) and 3 or more chronic diseases (28% lower costs). Intervention patients with a recent cancer history had 39% higher costs and with a history of mental illness, 30% higher costs.

Table 4.4. Covariate-adjusted cumulative mean health services costs (2012, Canadian $) 30 days, one year and two years following index hospitalization, conditional on survival

	Control		Intervention		Diff.
	Mean	(95% CI)	Mean	(95% CI)	
365-Day					
Total	$17,487	($13,257, $23,404)	$14,827	($11,185, $19,883)	$2,660
Inpatient	$11,077	($7,970, $15,465)	$9,286	($6,727, $12,874)	$1,792
Physician services	$2,871	($2,111, $3,922)	$2,809	($2,077, $3,815)	$62
Home care	$1,688	($1,649, $1,729)	$792	($772, $811)	$897
ED	$670	($489, $923)	$601	($439, $826)	$69
Rehabilitation	$441	($42, $463)	$428	($409, $449)	$13
Long-term care	$332	($317, $348)	$418	($398, $439)	($86)
Day surgery	$251	($185, $341)	$317	($236, $428)	($67)
Laboratory	$139	($103, $188)	$136	($100, $180)	$3
Non-phys. services	$18	($12, $26)	$41	($28, $60)	($23)
730-Day					
Total	$25,837	($18,147, $67,986)	$21,733	($15,180, $62,091)	$4,104
Inpatient	$15,293	($10,027, $46,565)	$12,396	($8,242, $39,194)	$2,897
Physician services	$4,526	($2,992, $11,096)	$4,450	($2,952, $11,523)	$76
Home care	$2,546	($2,479, $2,615)	$1,280	($1,245, $1,317)	$1,266
ED	$1,091	($711, $2,950)	$1,037	($664, $3,357)	$54
Rehabilitation	$727	($668, $801)	$641	($596, $698)	$86
Long-term care	$805	($745, $877)	$947	($874, $1,035)	($142)
Day surgery	$532	($326, $2,024)	$616	($384, $2,585)	($84)
Laboratory	$253	($165, $661)	$259	($168, $718)	($7)
Non-phys. services	$65	($34, $396)	$106	($55, $1,664)	($41)

Note: Diff. = Difference, ED = emergency department, SDS = Same day surgery, Phys=Physician

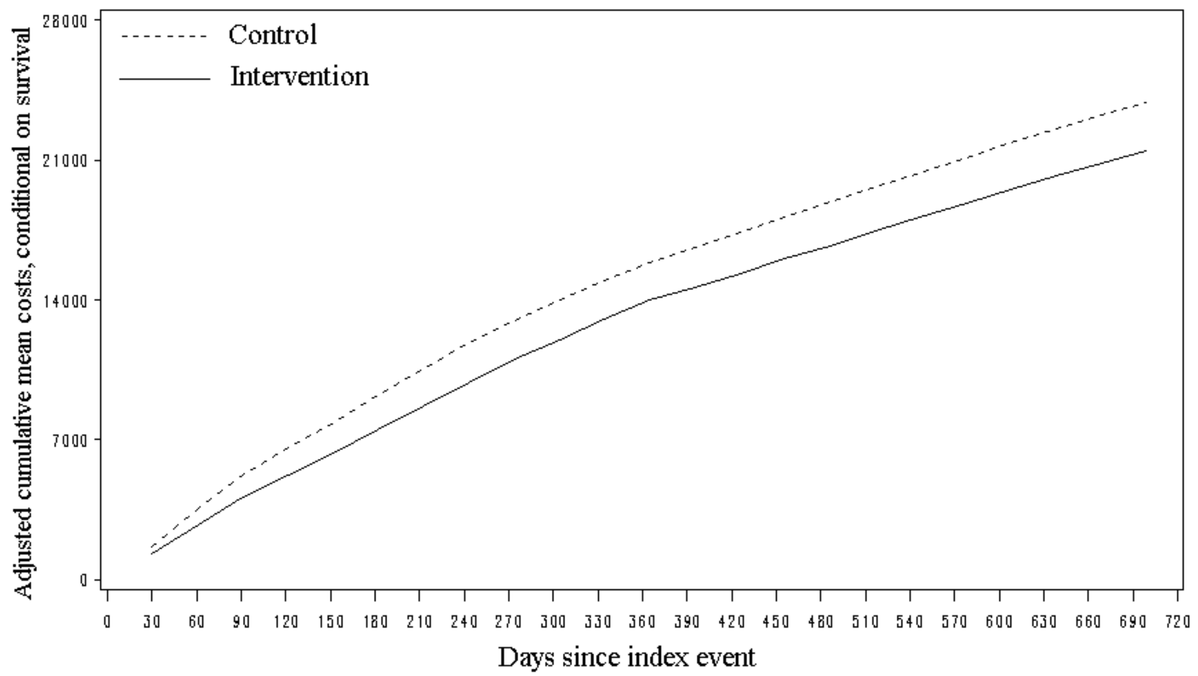

Figure 4.2. Covariate-adjusted cumulative mean health services costs (2012 CAD $) over two-years, conditional on survival.

Table 4.5. Multivariate Regression Model for Costs, Conditional on Survival

Parameter	Estimate	(95% CI)	*p*-value
Int. group	-0.18	(-0.21, -0.15)	<0.001
Age < 53	-0.67	(-0.72, -0.62)	<0.001
Urban	-0.12	(-0.16, -0.08)	<0.001
Female	-0.23	(-0.26, -0.20)	<0.001
Heavy smoker	0.17	(0.14, 0.21)	<0.001
High RUB	0.63	(0.59, 0.67)	<0.001
Higher SES	-0.03	(-0.06, -0.0007)	0.06
AMI	-0.19	(-0.24, -0.15)	<0.001
Asthma	0.16	(0.11, 0.20)	<0.001
Cancer	0.93	(0.87, 0.99)	<0.001
CHF	0.66	(0.60, 0.72)	<0.001
COPD	0.05	(0.01, 0.10)	0.01
Diabetes Mellitus	0.35	(0.31, 0.40)	<0.001
HTN	0.14	(0.11, 0.18)	<0.001
Mental illness	0.39	(0.34, 0.44)	<0.001
Stroke/TIA	0.007	(-0.06, 0.07)	0.83

Note: AMI=Acute Myocardial Infarction; CHF=Heart Failure; CI=Confidence interval; CPD=Cigarettes per day; COPD=Chronic Obstructive Pulmonary Disease; HTN=hypertension; Int=intervention; RUB=Resource Utilization Band; SES=Socio-economic Status; TIA=Transient Ischemic Attack

Table 4.6. Stratified regression analyses, adjusting for covariates, with group as primary independent variable in each model.

Variable		Estimated Cost Effect	95% LCL	95% UCL	*p*-value
Age	<54	↓20%	↓27%	↓13%	<0.001
	>53	↓36%	↓43%	↓29%	<0.001
Sex	F	↓4%	↓8%	↑0.7%	0.10
	M	↓22%	↓27%	↓17%	<0.001
SES	High	↓10%	↓15	↓5%	<0.001
	Low	↓22%	↓27%	↓17%	<0.001
Community	Urban	↓9%	↓13%	↓4%	<0.001
	Rural	↓21%	↓27%	↓16%	<0.001
RUB	Low	↓0.9%	↓7%	↓5%	0.78
	High	↓21%	↓24%	↓17%	<0.001
AMI	Yes	↓26%	↓35%	↓17%	<0.001
	No	↓11%	↓15%	↓7%	<0.001
Asthma	Yes	↓52%	↓60%	↓44%	<0.001
	No	↓9%	↓12%	↓5%	<0.001
Cancer	Yes	↑39%	↑24%	↑53%	<0.001
	No	↓18%	↓21%	↓14%	<.0001
CHF	Yes	↑1%	↓10%	↑12%	0.82
	No	↓16%	↓19%	↓12%	<0.001
COPD	Yes	↓35%	↓41%	↓28%	<0.001

	No	↓10%	↓14%	↓6%	<0.001
Diabetes	Yes	↓28%	↓36%	↓21%	<0.001
	No	↓12%	↓15%	↓8%	<0.001
HTN	Yes	↓34%	↓38%	↓27%	<0.001
	No	↓3%	↓7%	↑1%	0.18
MI	Yes	↑30%	↑19%	↑42%	<0.001
	No	↓21%	↓24%	↓17%	<0.001
Stroke/TIA	Yes	↓5	↓20%	↑9%	0.49
	No	↓15%	↓18%	↓11%	<0.001
# of CDs	0	↓1%	↓8	↑4%	0.56
	1-2	↓17	↓22	↓13%	<0.001
	3+	↓28	↓36%	↓21%	<0.001

Note: CHF=congestive heart failure; COPD=chronic obstructive pulmonary disease; HTN=hypertension; MI=mental illness; TIA=transient ischemic attack; CD=chronic disease; LCL=Lower confident limit; UCL=Upper confident limit

In our analysis estimating the effect of quitting on health care expenditures, patients who reported abstinence at six months had 25% lower costs at two years compared to those who did not quit (χ^2=70.3, p<0.001). However, this effect reduced to 5% and lost statistical significance after controlling for covariates (χ^2=2.6, p=0.11). The covariates with the greatest effect on cost in the adjusted model were high RUB score (54% greater costs), high CPD (45% greater costs), history of mental illness (35% greater costs), and hypertension (35% greater costs),

Post Hoc Analyses

We sought to examine the potential reasons for higher costs among intervention patients with cancer and with a history of mental illness. Although we were not powered to compare quit rates

between control and intervention patients stratified by cancer or mental illness diagnosis, a subgroup analysis revealed no significant difference in quitting between groups with or without these conditions. There were differences in morbidity scores among patients with histories of cancer and mental illness. Among intervention patients with cancer, 71% had a RUB score of 5 (the highest level of morbidity in the year leading up to the index event) compared to 61% of participants in the control group. A total of 33% of intervention patients with a history of mental illness had 3 or more chronic diseases, compared to just 17% in the control group. It is possible that these differences in baseline morbidity may have factored into the increased costs observed in our primary results.

4.5 Discussion

This is the first study to compare the cumulative mean costs of smokers that received an in-hospital smoking cessation intervention to usual care controls using actual health care administrative cost data. Adjusting for greater survival in the intervention group, smokers that received the in-hospital intervention incurred, on average, $4104 fewer total health care expenditures in the two years following their index hospitalization. Given the relatively low per patient cost of the intervention, this produced a significant cost-savings of between $3664 and $4024 per smoker-patient, depending on the intensity of the intervention.

The intervention had the greatest effect among patients with asthma and COPD. Respiratory issues are leading causes of ED-use and hospitalization (71). Nearly 1/3 of patients in both groups had a diagnosis of COPD and nearly 1/5 had asthma. Not surprisingly, helping people with respiratory issues to quit smoking can lead to reduced health care costs. While we were not powered to determine the effect of continuous smoking abstinence on cost, our analysis found quitting to be an independent predictor of cumulative mean costs; though, the effect was lost once we adjusted for covariates. A recent study examined annual health care expenditures in Ontario among the highest resource users versus the lowest (121). In their adult sample (n= 91,223), 18.4% of the highest users were current smokers and nearly 63% were over the age of 65. Our mean patient age was 52, yet our mean annual costs were between the top 5% and top 1% of users in the province ($13,450 and $53,150, respectively).

Compared to other chronic disease interventions, at $80-$440 per patient, the cost of the OMSC intervention is extremely low. In Ontario, the mean cost of a coronary artery bypass graft is $22,949, of a percutaneous coronary intervention is $7,636, and of an ambulatory care respiratory distress intervention is $681 (66). The lifetime cost of pharmacological treatment for smoking cessation would be approximately $9000 for a person aged 54, five to 12 times lower than the estimated lifetime direct medical costs to treat COPD ($45,000) (122), type II diabetes ($85,000) (123), and heart failure ($112,000) (124). While there is no disputing the necessity of chronic disease interventions in the management of existing disease, consideration must be given to the provision of cessation treatment due to its potential to prevent or delay the onset of several costly chronic diseases in the first place.

Smoking cessation, generally, has been found to be cost-effective from a number of different perspectives, interventions, and patient populations (35, 36, 40, 116, 125). A study by Kahn modelled the costs of eleven preventative interventions if implemented across the entire U.S. population and found that, over 30 years, smoking cessation was the only intervention that would result in money saved (126). Unlike our study where savings were evident in the first year, Kahn estimated that savings would not occur until after eight years. An older retrospective cohort study of health maintenance organization (HMO) enrollees found that those who quit smoking had significantly higher health care costs in the year immediately following cessation, compared to continued smokers, but that the costs of quitters started to fall in year two (127). In contrast and similar to our findings, a more recent randomized controlled trial of over 1300 smokers recruited from United States primary care clinics found that quitters experienced lower health care costs within the first few months of cessation, which was sustained beyond one year of follow-up (34).

Smoking cessation interventions, generally, have either not reached or have been less effective for people with lower SES (110). The current study observed that the OMSC intervention had a greater effect on health care expenditures among patients with low SES compared to those with high SES. In Canada, as is the case in many countries, people with lower SES consume a disproportionate amount of health care resources, primarily due to higher prevalence of chronic diseases (128). Despite hospitals not traditionally offering health promotion or prevention

interventions, hospital-initiated smoking cessation appears to be a strategy that can potentially reduce health and cost disparities among SES groups.

There were two subgroups in which intervention patients had greater cumulative costs: patients who had had a cancer diagnosis in the past 10 years and patients with a history of mental illness. It is not entirely surprising that costs would be higher for patients with cancer given the initial burden of cancer care and the fact that early benefits of cessation are often the result of other, more acute, chronic disease outcomes like circulatory or respiratory improvements (129). Unfortunately, we did not have information about the stage of cancer, nor were we powered to analyse by type of cancer, but given the differences in prognoses among various cancers, it is possible that costs would vary depending on stage and tumour site. Cancer survival has improved significantly in recent years, therefore, as cancer survivors are living longer, cessation becomes important in the primary prevention of new cancers and other chronic illnesses (130). We were not able to analyse our data by type of mental illness nor were we powered to examine the quit rates among patients with and without a history of mental illness. Intervention patients with a history of mental illness had a higher baseline rate of chronic diseases possibly impacting the results.

Strengths

This cost analysis builds on a previous real-world study examining the effectiveness of the OMSC intervention on health care utilization, and includes the comparison of a pre-implementation control group. Our primary outcome was gathered using actual health care cost data that was independently gathered and broken down by type of health service. Cumulative mean costs were adjusted for survival, strengthening our estimates.

Limitations

The study included cost data for Ontario only. Health care is publicly funded in Ontario and patterns of health care use and expenditures may differ from other jurisdictions. It is possible that patients accessed health care resources in other provinces or countries over the two-year follow-up. The study was not a randomized controlled trial; however, control and intervention groups each comprised a consecutive sample of patients admitted to each hospital, recruited using

identical methods. We did not have smoking abstinence data on every patient, so were limited in our ability to assess the impact of quitting smoking on costs. Further, we did not have information on the number of pack-years smoked by patients, which would have enabled us to determine wither there was a dose-response relationship with cost outcomes. Applying these findings to other situations should be done with caution. The OMSC is initiated in hospital and its effect may differ from other smoking cessation interventions.

Conclusions

Amid tight fiscal environments, health care funders are seeking ways to reduce expenditures, particularly among its most costly and vulnerable users. Current smokers consume a substantial amount of health care resources. Smoking cessation interventions that begin in hospital and offer follow-up post-hospitalization, like the OMSC, are effective at helping people quit smoking, increasing survival, reducing health care utilization, and reducing downstream costs. It has been said that there is no intervention more important than smoking cessation in terms of preventing illness and saving lives (131). It appears the same may be true when it comes to preventing costs. Our study confirms that smoking cessation needs to be prioritized within health care systems and considered a key strategy for the management of chronic diseases. If implemented broadly across all Canadian hospitals, the potential financial impact in terms of direct dollars saved would be immense.

5 SYNTHESIS AND CONCLUSIONS

5.1 Summary of Key Findings

This project used three distinct methods to examine the health care and economic impacts of a hospital-initiated smoking cessation program. The first manuscript used available and relevant data to estimate the cost-effectiveness of the Ottawa Model for Smoking Cessation among high-risk patients hospitalized in Ontario with acute myocardial infarction, unstable angina, heart failure, and chronic obstructive pulmonary disease. The intervention was found to be highly cost-effective, with a lifetime cost per QALY gained of $68 and the impact among patients with COPD. In the first year, we calculated that provision of the OMSC to 15,326 smokers would generate 4689 quitters, and would prevent 116 re-hospitalizations, 923 hospital-days, and 119 deaths.

Manuscript 2 sought to determine the effects of the OMSC on survival and downstream health care utilization. We linked OMSC patient-level data to health care administrative data to obtain our outcomes. We observed significant short (30-day) and long (2-year) term decreases in the probabilities of all-cause mortality, all-cause re-hospitalization, smoking-related re-hospitalization, and all-cause emergency department visits for the intervention group. The intervention was more effective among patients with low socio-economic status (SES) than those with higher SES, patients without a history of mental illness compared to those with, and patients living in urban areas as opposed to those in rural communities.

Manuscript 3 built on the findings of Manuscript 2 by examining in detail the impact of the intervention on subsequent health care costs by assessing the determinants of costs among hospitalized smokers. The intervention group had substantially lower adjusted cumulative mean costs at 30-day, one-year and two-year follow-up. Receiving the intervention was a significant predictor of cost in both univariate and multivariate regression models. The largest effects in terms of reduced health care costs were observed for patients: with asthma, COPD, diabetes, hypertension, and those living with 3 or more chronic diseases.

Collectively, the three papers suggest that the OMSC intervention: 1) can be considered cost-effective when offered to the most at risk and high-cost users of the health care system, 2) is an

effective strategy for reducing mortality, 3) is an effective strategy to prevent hospital days and ED visits, 4) is effective at reducing downstream health care costs, particularly acute inpatient costs, and 5) is effective among historically hard to reach segments of the population (e.g. low SES, high resource users).

5.2 Strengths of the Thesis

The studies completed as part of this thesis are the first, to the awareness of the authors, to examine the health, health system, and economic impacts of a hospital-based smoking cessation program in the Canadian context and by linking patient-level data to actual health care administrative data. The thesis combined strong health economics and health services research methodologies. All three studies were extensions of a high quality, real-world effectiveness study of the OMSC conducted at 14 Ontario hospitals. In study 1, the data used to derive the study cohorts and determine chronic disease specific smoking prevalence and quit rates were from OMSC patient-level data. We were able to source the mortality and health care utilization for our models primarily from Ontario or, if unavailable, Canadian studies. We used decision-analytic modeling to develop a framework with the aim of informing appropriate decision-making around the allocation of funding for smoking cessation under conditions of uncertainty. Study 2 and had several methodological strengths. In order to reduce potential bias, an evaluation committee was formed to oversee the project and to agree upon study methodology, covariates, and outcomes. A novel technique was tested where the doctoral candidate and a second, arm's length analyst first completed a blinded analysis of the data to test the data analysis plan and make any necessary adjustments. Once consensus was reached, they independently repeated the analysis using the main study dataset. While having two analysts is resource intensive and not always feasible, this strategy was felt to be a significant strength and one to consider in other studies at risk of bias. The approach used in study 3 resulted in important and practical outcomes relevant to health care decision-makers. Being able to quantify the cumulative mean cost of the intervention, while adjusting for covariates and on condition of survival, presented a more accurate picture of downstream per patient costs. Put together, the three studies give a well-rounded assessment of the health and health system impacts of a hospital-initiated smoking cessation intervention.

5.3 Limitations of the Thesis

There were potentially important baseline variables that were not collected (e.g. pack-years, alcohol use, body mass index); none-the-less, the covariates that were included in our analyses were relevant and important in relation to the study outcomes. Our follow-up data was limited. Smoking abstinence was only available on a subsample of patients and the follow-up was at six months. Patient participation in other cessation programs following the index hospitalization was not determined; however, it is estimated that current cessation services in the Champlain Local Health Integration Network in Eastern Ontario (where 12/14 of the hospitals in this study are situated) reach only 5% of all smokers in the region, therefore, we do not believe that participation in other programs would have been high among those in our study (132). We chose to take a hospital-payer and health system perspective. Given the known impacts of smoking cessation on productivity, modelling these costs would have provided meaningful information from a societal perspective. Our outcomes do not extend beyond two-year follow-up. Arguably, the health services outcomes and costs with the most immediate relevance to health care administrators are those occurring in the first month to first year post-hospitalization. The ability to impact short-term utilization and costs is of major importance from the health care perspective. From a patient and societal perspective, understanding the longer-term impacts will be important. Each of the studies took place in Ontario using Ontario and Canadian data. Applying the results to regions outside of Ontario and to populations beyond the ones that we studied should be done with caution.

5.4 Contribution to Population Health

Smoking cessation remains a significant public and population health issue. Traditionally, “clinical” interventions, or ones that take place in clinical environments, have not been considered population health approaches given they would target, perhaps, only the highest risk individuals. However, it has been shown that treating the most at risk individuals can indeed have a significant population level impact since the majority of the risk or burden lies within this segment of the population (133). From an equity stand-point, a systematic intervention, like the OMSC, which is offered to all patients regardless of age, race, sex, SES, or diagnosis, has the ability to reach everyone admitted to hospital or other health care setting. Many interventions,

including smoking cessation, tend to reach fewer and be less effective among individuals with lower SES (110). Individuals in the lowest income quintiles tend to have higher smoking prevalence and use a greater amount of health care resources (128). A surprising finding within our studies was that the intervention had a greater effect among patients with lower SES than those with higher SES in terms of mortality, hospital re-admission, and total cost. There is an opportunity to reach individuals at all ages visiting the hospital and perhaps help people quit smoking before they are diagnosed with chronic disease, immediately reducing their risk of developing disease and potentially adding years to their life (12).

5.5 Policy Implications

Historically, publically funded health systems, like that in Ontario, have provided no real incentive for hospitals to implement cessation programs. The Ontario hospital system is still organized, for the most part, to treat acute conditions with interventions that cost hundreds of thousands of dollars each year. The cost savings observed in our studies would not necessarily be realized by the hospital itself, rather the health system overall. However, in 2010, the Ontario government introduced the Excellent Care For All Act (ECFAA), a strategy aimed at improving how health care is organized and focused on high quality patient care (134). Through Quality Improvement Plans (QIPS), hospitals set performance targets with regard to various quality improvement initiatives. Three priority objectives of the Act are of particular relevance to our three studies include: 1) reducing avoidable hospital re-admissions, 2) reducing emergency department wait times, and 3) focus on prevention and early intervention. Our results indicate that smoking cessation interventions initiated in hospital provide an inexpensive and cost-saving solution to preventing re-admissions and reducing ED visits. While the case seems fairly simple, the reality is that many hospitals are still reluctant to implement such programs due to their “perceived cost”.

One recent strategy aligned with the ECFAA was implemented to improve the adoption of cessation programs among hospitals in the Champlain Local Health Integration Network (LHIN) in 2010. As part of the hospital accountability agreements between the LHIN and 15 regional organizations, performance targets were set within hospital QIPs regarding the number of inpatient smokers being reached by hospital cessation interventions each year. Since being held

accountable, these 15 hospitals have improved the number of smokers reached annually by an absolute 37% (from 32% in 2010 to 69% in 2014) (135). Establishing accountabilities and setting quality improvement performance targets appear to be strategies that improve delivery of smoking cessation interventions within hospitals.

Ontario's Action Plan for Health Care (2012) stated the following in regard to the current fiscal environment (134):

> *"Limited resources will require us to choose carefully between health priorities so that we can best serve patients as we transform our system to improve quality of care…We're going to have to make tough trade-offs and shift spending to where we get the best value for the dollar."*

Health care and health benefits payers should give greater consideration to the coverage of smoking cessation interventions and pharmacotherapies, perhaps even lifetime coverage, given the relatively low cost of such treatments, the potential prevention or delay in the onset of other costly chronic diseases, and the observed benefits of cessation in terms of health care utilization and health care expenditures.

There are nearly 2.8 million acute inpatient hospitalizations in Canada each year, approximately 560,000 of which involve current smokers. While this only represents 12% of the smokers in Canada, if smoking cessation interventions were offered to all smoker-patients, the potential health and economic impact would be enormous. Applying our numbers, such a strategy would result in nearly 170,000 quitters, 40,000 deaths avoided, 65,500 fewer hospital re-admissions, and $2.3 billion in health service expenditures saved over a two-year period.

It is hoped that, following dissemination of our results, more health authorities and hospitals will consider adopting systematic approaches to smoking cessation in order to help patients quit smoking, improve survival and health outcomes, and reduce resource-use and health care costs.

5.6 Future Research Directions

Further research is needed to determine the impact of the OMSC as implemented in other health care settings with different patient populations. For instance, the average age of OMSC patients

seen in primary care settings is approximately 7 years younger than those intervened with at OMSC hospitals. A longitudinal study looking at the health, health services, and cost impacts of the model in primary care would be valuable in order to determine if outcomes could be delayed or avoided with earlier intervention. Further analysis as to why the intervention has greater efficacy among certain subgroups would be important in determining what intervention components work best and for whom and whether there is a need for tailoring. There are significant disparities when it comes to smoking and health among the mentally ill. The smoking prevalence among those with mental illness is high. Life expectancy among this group is on average 25 years less than in the general population (114). More research is needed to determine the effectiveness of hospital-based cessation programs for patients with mental illness and what the best method of follow-up and relapse prevention is for this population. The OMSC has been implemented at five regional cancer centres in Ontario. More research is needed to understand why results differed among patients with a history of cancer and what effect the program has when delivered within outpatient cancer services.

5.7 Conclusions

The three studies that were presented confirmed the importance of smoking cessation and emphasized the hospital as an effective setting to deliver cessation interventions. Hospitalized smokers tend to be at higher risk with elevated rates of pre-existing disease; none-the-less, by intervening with inpatient smokers we observed substantially positive impacts on resource-use and health care expenditures, and most importantly on survival and the health and well-being of patients.

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Appendix A: Standardized screening tool used for participant recruitment

UNIVERSITY OF OTTAWA HEART INSTITUTE
INSTITUT DE CARDIOLOGIE DE L'UNIVERSITÉ D'OTTAWA

OTTAWA MODEL FOR SMOKING CESSATION
MODÈLE D'OTTAWA POUR L'ABANDON DU TABAC

Patient ID: ____________________
First Name: ____________________
Last Name: ____________________
Gender: ❑ Male ❑ Female
Address: ____________________
City: ____________ Postal Code: ____________
Date of Birth: DD/MM/YY____________________

Pre-Implementation Screening Form

Institution: ____________________ **Unit/Clinic:** ____________________

Today's Date: ____________________ **Diagnosis:** ____________________

1. Have you used any form of tobacco in the last 6 months?

❑ Yes ❑ No → No further questions

↓

❑ Cigarettes ❑ Pipe ❑ Cigars ❑ Other (Explain): ____________________

2. Have you used any form of tobacco in the past 7 days?

❑ Yes ❑ No → When was your Quit Date: ____________

↓

What is the average # of cigarettes/cigars/pipes per day that you have smoked in the last 6 months? ____________

3. We would like to contact you in 6 months to see how you are with respect to your smoking. Do you agree to be contacted once in the next 6 months?

❑ Yes ❑ No *Why?* → ❑ No Telephone ❑ Deceased ❑ Other
❑ Refusal ❑ End Stage
❑ Transfer ❑ Language

↓

Contact Number for a one-time 6-month Evaluation Call (Incl. area code, no extension): ____________

Alternative Number (incl. area code): ____________

Preferred Language: ❑ English ❑ French

Preferred Time of Call: ❑ Early morning ❑ Morning ❑ Afternoon ❑ Evening ❑ Anytime

Patient's Signature: **Date of Discharge/Visit:**

Comments:

Screener's Signature: ____________________

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Appendix B: Best Practices for Treating Tobacco Use Dependence

Best Practices for Treating Tobacco Use and Dependence

Date of Completion ______________________

Institution ______________________ **Main Contact (Coordinator)** ______________________

Unit/Clinic* ______________________ **Telephone** ______________________

Unit/Clinic Type** ☐ **Inpt** ☐ **SC** ☐ **PC** **E-mail** ______________________

*Ensure Unit/Clinic names are consistent with the SCPM database (if applicable). ** Inpt=Inpatient, SC=Specialty Care, PC=Primary Care

Please complete one form per year for each unit/clinic implementing or planning to implement the OMSC.

Practice	Select all that apply	Comments
Tobacco use queried and documented for all admissions/visits.	☐ Never ☐ Sometimes ☐ All of the time	Where documented?
Training for tobacco dependence treatment offered to health care providers.	☐ Never ☐ Sometimes ☐ All of the time	What is offered? ☐Workshops ☐In-services ☐New Staff Orientation ☐Other:
Designated staff responsible for smoking cessation program.	☐ Yes ☐ No	Title of position? (e.g. Program Coordinator, Smoking Cessation Counsellor/Educator).
Tobacco dependence treatment included on clinical management tools and/or in Electronic Medical Records (EMR).	☐ Admission/Registration Forms ☐ Clinical Assessment Forms ☐ Discharge/Referral Forms	Which forms include Smoking Cessation? (e.g. Clinical Pathways, Care Maps, Kardex, Vital Sign Stamp, Nursing Hx)
Patient self-help materials readily available.	☐ Never ☐ Sometimes ☐ All of the time	Which self-help materials are available? Where are self-help materials available?
Links to community resources readily available.	☐ Never ☐ Sometimes ☐ All of the time	Which community resources are available? Where are community resources available?
Quit Smoking Medications available to patients.	☐ Patch ☐ Bupropion ☐ Gum ☐ Varenicline ☐ Inhaler ☐ Lozenge ☐ Spray	Which processes are in place? ☐Hospital Formulary ☐Standing Orders ☐Medical Directives ☐Pre-Printed Prescriptions ☐Other:
Processes in place to follow up with tobacco users for at least one month after initial consultation.	☐ Yes ☐ No	Which processes are in place? ☐Automated Telephone Follow-up ☐Smokers' Helpline ☐Manual Follow-up ☐Other:
Processes in place to evaluate the degree to which health care providers are identifying, documenting, and treating patients who use tobacco (quality control).	☐ Yes ☐ No	Which processes are in place? (e.g. Auditing Patient Charts/EMR/ Program Database)
Processes to provide feedback to health care providers about performance and program effectiveness.	☐ Yes ☐ No	Which processes are in place?

Program Model (if implementing)
Who is responsible for completing Smoking Cessation Consult Forms?
☐Smoking Cessation Specialist(s) ☐Frontline Nurse(s) ☐Respiratory Therapist(s) ☐Other:

Appendix C: Standardized smoking cessation consultation form

HOSPITAL LETTERHEAD

Smoking Cessation Consult

Addressograph

SAMPLE

Date:	Diagnosis:	Hospital:	Unit:

Cessation aids at time of admission: ❑ Patch ❑ Inhaler ❑ Gum ❑ Lozenge ❑ Varenicline ❑ Bupropion

Have you used any form of tobacco in the past 7 days? Yes ❑ No ❑

Allergy:
Pregnant: Yes ❑ No ❑
Breastfeeding: Yes ❑ No ❑

ASK:

1. *What form(s) of tobacco do you currently use?* ❑ Cigarette ❑ Pipe
2. *Amount smoked daily?________ (cig./day)* *If not a daily smoker________ (cig./month)*
3. *Total number of years smoked? ________ (years)*
4. *How soon after you wake up do you smoke your first cigarette? ________ (minutes)*
5. Number of hours since last intake of tobacco? ________ (hours)
6. *Do others smoke in the home?* ❑ Yes ❑ No
7. *How many quit attempts (lasting ≥ 24 hours) have you made in the past year? ________ (attempts)*
8. *On a scale of 1-5, how important is it to you to quit smoking/ remain smoke-free? (5=most important)* 1 2 3 4 5
9. *On a scale of 1-5, how confident are you that you can quit smoking/ remain smoke-free? (5=most confident)* 1 2 3 4 5

ADVISE: Patient given personalized advice to quit smoking ________________
Clinician's Initials

ASSESS:
Which of the following best describes your feelings about smoking right now?

- ❑ *I have quit in the last 6 months* ***Quit date*** ____________
- ❑ *I would like to quit during this hospital admission*
- ❑ *I am planning to quit in the next month*
- ❑ *I would like to quit in the next 6 months*
- ❑ *I am not planning to quit in the next 6 months*

Withdrawal Scale
Please rate symptom based on the last 24 hours

0	1	2	3	4
none	slight	mild	moderate	severe

Withdrawal Symptom	Pre-medication	Post-medication
Desire or craving to smoke		
Anger, irritability, frustration		
Anxiety		
Difficulty concentrating		
Restlessness		
Insomnia, waking at night		
Depressed mood		
Other (i.e.headache,coughing,sore throat)		

ASSIST:

Counselling	Notes:
Pros/Cons Reasons for smoking ❑	
Potential challenges & triggers ❑	
Quitting history ❑	
Pharmacotherapy options ❑	
Encouragement ❑	

Self-Help Materials Given
- ❑ For Smokers Who Want to Quit
- ❑ For Smokers Who Don't Want to Quit
- ❑ List of Community Cessation Resources

Cessation aid(s) recommended to be ordered

Type	❑ Patch	❑ Inhaler	❑ Gum	❑ Lozenge	❑ Varenicline	❑ Bupropion
Dose						

ARRANGE: Automated follow-up calls can be offered to all patients - ready to quit, recently quit (in last 6 mths), and not ready to quit.
❑ ***Telephone Follow Up:*** *You will be provided with a series of automated follow-up calls. If you require further help with your quit attempt, you will be contacted by the Smoking Cessation program to assist you.*

❑ Patient given "Telephone Support" handout ❑ Patient referred to *Quit Smoking Program*
❑ Patient referred to Quit Line

Contact # for IVR follow up calls (________)____________________ *(no ext.)*

Alternate contact # for live follow up (________)________________ext.________

Requested call time:
❑ *Early Morning* ❑ *Morning* ❑ *Afternoon*
❑ *Evening* ❑ *Any time*

If for some reason patient cannot receive follow-up calls: Why?
❑ *No telephone* ❑ *Unable to Speak English or French*
❑ *Deceased* ❑ *Transferred* ❑ *Refused*
❑ *End Stage Disease* ❑ *Already receiving calls* ❑ *Other*

Discharge Date: ________________

COMMENTS:

*** Consult to be entered into database as soon as possible post discharge**

Nurse's Signature____________________

OTTAWA MODEL FOR SMOKING CESSATION INPATIENT WORKPLAN
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Appendix D: Pre-printed medication order forms

HOSPITAL LETTERHEAD

Physician's Orders

Addressograph

Medication Allergies/Reactions	Substance or Food Allergies/Reactions
❑ none known	❑ none known

SMOKING CESSATION PHARMACOTHERAPY

Init	I.V. & Medication (Meds, dose, frequency, route)
NICOTINE REPLACEMENT THERAPY (NRT)	
	❑ **Patient smoking < 10 cigarettes per day:** Nicotine Patch 7 mg daily x 6 weeks
	❑ **Patient smoking 10-20 cigarettes per day:** Nicotine Patch 14mg daily x 6 weeks; then Nicotine Patch 7 mg x daily x 4 weeks.
	❑ **Patients smoking >20 cigarettes per day:** Nicotine Patch 21 mg daily x 6 weeks; then Nicotine Patch 14 mg daily x 2 weeks; then Nicotine Patch 7 mg daily x 2 weeks.
	❑ **Patients smoking >30 cigarettes per day:** Nicotine Patch 28 mg (21 mg + 7 mg) daily x 6 weeks; then Nicotine Patch 21 mg daily x 4 weeks; then Nicotine Patch 14 mg daily x 2 weeks; then Nicotine Patch 7 mg daily x 2 weeks.
	❑ **Patients smoking >40 cigarettes per day:** Nicotine Patch 42 mg (21 mg + 21 mg) daily x 6 weeks; then Nicotine Patch 35 mg (21 mg + 14 mg) daily x 2 weeks; then Nicotine Patch 28 mg (21 mg + 7 mg) daily x 2 weeks; then Nicotine Patch 21 mg daily x 2 weeks; then Nicotine Patch 14 mg daily x 2 weeks; then Nicotine Patch 7 mg daily x 2 weeks.
	PLUS Adjunctive Therapy: ❑ Nicotine (Nicorette) Gum 2 mg pieces PRN, max.______ pieces per day ❑ Nicotine (Nicorette) Inhaler PRN, max.______ cartridges per day Patch may be removed at HS, if patient complains of insomnia. It may be necessary for some patients to remain on NRT longer. If patient continues to have urges to smoke, please consult smoking cessation.
VARENICLINE (CHAMPIX TM) ONLY	
	❑ 0.5 mg PO daily ______ Days 0.5 mg PO twice daily ______ Days 1 mg PO twice daily ______ Weeks It may be necessary to have the dose lowered temporarily or permanently if patient experiences nausea or other side effects.
BUPROPION (ZYBAN) ONLY	
	❑ 150 mg PO daily ______ Days 150 mg PO twice daily ______ Days 150 mg PO twice daily ______ Weeks It may be necessary to have the dose lowered temporarily or permanently if patient experiences nausea or other side effects.

Date (yyyy/mm/dd) :	Time :	Physician :	Signature :

Appendix E: List of diagnosis and service codes considered causally related to smoking

OHIP Code	ICD-10 Code	
140	C00	(C00) Malignant neoplasm of lip
141	C01	(C01) Malignant neoplasm of base of tongue
141	C02	(C02) Malignant neoplasm of other and unspecified parts of tongue
143	C03	(C03) Malignant neoplasm of gum
144	C04	(C04) Malignant neoplasm of floor of mouth
145	C05	(C05) Malignant neoplasm of palate
145	C06	(C06) Malignant neoplasm of other and unspecified parts of mouth
194	C07	(C07) Malignant neoplasm of parotid gland
194	C08	(C08) Malignant neoplasm of other and unspecified major salivary glands
149	C09	(C09) Malignant neoplasm of tonsil
146	C10	(C10) Malignant neoplasm of oropharynx
147	C11	(C11) Malignant neoplasm of nasopharynx
149	C12	(C12) Malignant neoplasm of piriform sinus
149	C13	(C13) Malignant neoplasm of hypopharynx
149	C14	(C14) Malignant neoplasm of other and ill-defined sites in the lip, oral cavity and pharynx
150	C15	Malignant neoplasm of Esophagus
151	C16	(C16) Malignant neoplasm of Stomach
151	C16.0	Cardia
151	C16.1	(C16.1) Fundus of stomach
151	C16.2	(C16.2) Body of stomach
151	C16.3	(C16.3) Pyloric antrum
151	C16.4	(C16.4) Pylorus
151	C16.5	(C16.5) Lesser curvature of stomach, unspecified
151	C16.6	(C16.6) Greater curvature of stomach, unspecified
151	C16.8	(C16.8) Overlapping lesion of stomach
151	C16.9	(C16.9) Stomach, unspecified
152	C17	Malignant neoplasms of small intestine
152	C17.0	Duodenum
152	C17.1	(C17.1) Jejunum
152	C17.2	(C17.2) Ileum
152	C17.3	(C17.3) Meckel's diverticulum
152	C17.8	(C17.8) Overlapping lesion of small intestine
152	C17.9	(C17.9) Small intestine, unspecified
153	C18	Malignant neoplasm of colon
153	C18.0	Caecum
153	C18.1	(C18.1) Appendix

153	C18.2	(C18.2) Ascending colon
153	C18.3	(C18.3) Hepatic flexure
153	C18.4	(C18.4) Transverse colon
153	C18.5	(C18.5) Splenic flexure
153	C18.6	(C18.6) Descending colon
153	C18.7	(C18.7) Sigmoid colon
153	C18.8	(C18.8) Overlapping lesion of colon
153	C18.9	(C18.9) Colon, unspecified
154	C19	Malignant neoplasm of rectosigmoid junction
154	C20	(C20) Malignant neoplasm of rectum
154	C21	(C21) Malignant neoplasms of anus and anal canal
155	C22	(C22) Malignant neoplasms of liver and intrahepatic bile ducts
155	C22.0	Liver cell carcinoma
155	C22.1	(C22.1) Intrahepatic bile duct carcinoma
155	C22.2	(C22.2) Hepatoblastoma
155	C22.3	(C22.3) Angiosarcoma of liver
155	C22.4	(C22.4) Other sarcomas of liver
155	C22.7	(C22.7) Other specified carcinomas of liver
155	C22.9	(C22.9) Liver, unspecified
156	C23	Malignant neoplasm of gallbladder
156	C24	(C24) Malignant neoplasm of other and unspecified parts of biliary tract
157	C25	(C25) Malignant neoplasm of pancreas
157	C25.0	Head of pancreas
157	C25.1	(C25.1) Body of pancreas
157	C25.2	(C25.2) Tail of pancreas
157	C25.3	(C25.3) Pancreatic duct
157	C25.4	(C25.4) Endocrine pancreas
157	C25.7	(C25.7) Other parts of pancreas
157	C25.8	(C25.8) Overlapping lesion of pancreas
157	C25.9	(C25.9) Pancreas, unspecified
159	C26	(C26) Malignant neoplasms of other and ill-defined Digestive Organs
160	C30	(C30) Malignant neoplasm of nasal cavity and middle ear
160	C30.0	(C30.0) Nasal cavity
160	C30.1	(C30.1) Middle ear
160	C31	(C31) Malignant neoplasm of accessory sinuses
161	C32	(C32) Malignant neoplasm of larynx
161	C33	(C33) Malignant neoplasm of trachea
162	C34	(C34) Malignant neoplasm of bronchus and lung
162	C34.0	(C34.0) Main bronchus

162	C34.1	(C34.1) Upper lobe, bronchus or lung
162	C34.2	(C34.2) Middle lobe, bronchus or lung
162	C34.3	(C34.3) Lower lobe, bronchus or lung
162	C34.8	(C34.8) Overlapping lesion of bronchus and lung
164	C37	(C37) Malignant neoplasm of thymus
165	C39	(C39) Malignant neoplasms of other and ill-defined sites in respiratory system and intrathoracic organs
180	C53	(C53) Malignant neoplasm of cervix uteri
189	C64	(C64) Malignant neoplasm of kidney, except renal pelvis
189	C65	(C65) Malignant neoplasm of renal pelvis
189	C66	(C66) Malignant neoplasm of ureter
188	C67	(C67) Malignant neoplasm of bladder
189	C68	(C68) Malignant neoplasm of other and unspecified urinary organs
230	D00	(D00) Carcinoma in situ of oral cavity, oesophagus and stomach
230	D01	(D01) Carcinoma in situ of other and unspecified digestive organs
231	D02	(D02) Carcinoma in situ of middle ear and respiratory system
233	D06	(D06) Carcinoma in situ of cervix uteri
233	D07	(D07) Carcinoma in situ of other and unspecified genital organs
248, 250	E10 – E14	Diabetes Mellitus
413	I20	(I20) Angina pectoris
413	I20.0	(I20.0) Unstable angina
413	I20.1	(I20.1) Angina pectoris with documented spasm
413	I20.8	(I20.8) Other forms of angina pectoris
413	I20.9	(I20.9) Angina pectoris, unspecified
410, 412	I21	(I21) Acute myocardial infarction
410, 412	I22	(I22) Subsequent myocardial infarction
410, 412	I23	(I23) Certain current complications following acute myocardial infarction
410, 412	I23.0	(I23.0) Haemopericardium as current complication following acute myocardial infarction
410, 412	I23.1	(I23.1) Atrial septal defect as current complication following acute myocardial infarction
410, 412	I23.2	(I23.2) Ventricular septal defect as current complication following acute myocardial infarction
410, 412	I23.3	(I23.3) Rupture of cardiac wall without haemopericardium as current complication following acute myocardial infarction
410, 412	I23.4	(I23.4) Rupture of chordae tendineae as current complication following acute myocardial infarction
410, 412	I23.5	(I23.5) Rupture of papillary muscle as current complication following acute myocardial infarction
410, 412	I23.6	(I23.6) Thrombosis of atrium, auricular appendage, and ventricle as

		current complications following acute myocardial infarction
410, 412	I23.8	(I23.8) Other current complications following acute myocardial infarction
413	I24	(I24) Other acute ischaemic heart diseases
410	I24.0	(I24.0) Coronary thrombosis not resulting in myocardial infarction
410	I24.1	(I24.1) Dressler's syndrome
410	I25	(I25) Chronic ischaemic heart disease
440	I25.0	(I25.0) Atherosclerotic cardiovascular disease, so described
440	I25.1	(I25.1) Atherosclerotic heart disease
412	I25.2	(I25.2) Old myocardial infarction
441	I25.3	(I25.3) Aneurysm of heart
441	I25.4	(I25.4) Coronary artery aneurysm
413	I25.5	(I25.5) Ischaemic cardiomyopathy
413	I25.6	(I25.6) Silent myocardial ischaemia
413	I25.8	(I25.8) Other forms of chronic ischaemic heart disease
413	I25.9	(I25.9) Chronic ischaemic heart disease, unspecified
394	I35.0	(I35.0) Aortic (valve) stenosis
394	I35.1	(I35.1) Aortic (valve) insufficiency
394	I35.2	(I35.2) Aortic (valve) stenosis with insufficiency
428	I50	(I50) Heart failure
428	I50.0	(I50.0) Congestive heart failure
428	I50.1	(I50.1) Left ventricular failure
428	I50.9	(I50.9) Heart failure, unspecified
429	I51	(I51) Complications and ill-defined descriptions of heart disease
429	I51.6	(I51.6) Cardiovascular disease, unspecified
429	I51.9	(I51.9) Heart disease, unspecified
429	I52	(I52) Other heart disorders in diseases classified elsewhere
435	I63	(I63) Cerebral infarction
435	I63.0	(I63.0) Cerebral infarction due to thrombosis of precerebral arteries
435	I63.1	(I63.1) Cerebral infarction due to embolism of precerebral arteries
435	I63.2	(I63.2) Cerebral infarction due to unspecified occlusion or stenosis of precerebral arteries
435	I63.3	(I63.3) Cerebral infarction due to thrombosis of cerebral arteries
435	I63.4	(I63.4) Cerebral infarction due to embolism of cerebral arteries
435	I63.5	(I63.5) Cerebral infarction due to unspecified occlusion or stenosis of cerebral arteries
435	I63.6	(I63.6) Cerebral infarction due to cerebral venous thrombosis, nonpyogenic
436	I64	(I64) Stroke, not specified as hemorrhage or infarction
437	I65	(I65) Occlusion and stenosis of precerebral arteries, not resulting in cerebral infarction

437	I65.0	(I65.0) Occlusion and stenosis of vertebral artery
437	I65.1	(I65.1) Occlusion and stenosis of basilar artery
437	I65.2	(I65.2) Occlusion and stenosis of carotid artery
437	I65.3	(I65.3) Occlusion and stenosis of multiple and bilateral precerebral arteries
437	I65.8	(I65.8) Occlusion and stenosis of other precerebral artery
437	I65.9	(I65.9) Occlusion and stenosis of unspecified precerebral artery
437	I66	(I66) Occlusion and stenosis of cerebral arteries, not resulting in cerebral infarction
437	I66.0	(I66.0) Occlusion and stenosis of middle cerebral artery
437	I66.1	(I66.1) Occlusion and stenosis of anterior cerebral artery
437	I66.2	(I66.2) Occlusion and stenosis of posterior cerebral artery
437	I66.3	(I66.3) Occlusion and stenosis of cerebellar arteries
437	I66.4	(I66.4) Occlusion and stenosis of multiple and bilateral cerebral arteries
437	I66.5	(I66.5) Occlusion and stenosis of other cerebral artery
437	I66.6	(I66.6) Occlusion and stenosis of unspecified cerebral artery
432, 435, 436, 437	I67	(I67) Other cerebrovascular diseases
298	I67.2	(I67.2) Cerebral atherosclerosis
298, 440	I67.7	(I67.7) Cerebral arteritis, not elsewhere classified
437	I69	(I69) Sequelae of cerebrovascular disease
440	I70	(I70) Atherosclerosis
441	I71	(I71) Aortic aneurysm and dissection
447	I71.1	(I71.1) Thoracic aortic aneurysm, ruptured
447	I71.2	(I71.2) Thoracic aortic aneurysm, without mention of rupture
441	I71.3	(I71.3) Abdominal aortic aneurysm, ruptured
441	I71.4	(I71.4) Abdominal aortic aneurysm, without mention of rupture
441	I71.5	(I71.5) Thoracoabdominal aortic aneurysm, ruptured
441	I71.6	(I71.6) Thoracoabdominal aortic aneurysm, without mention of rupture
441	I71.8	(I71.8) Aortic aneurysm of unspecified site, ruptured
441	I71.9	(I71.9) Aortic aneurysm of unspecified site, without mention of rupture
443	I73	(I73) Other peripheral vascular diseases
443	I73.1	(I73.1) Thromboangiitis obliterans (Buerger)
443	I73.8	(I73.8) Other specified peripheral vascular diseases
443	I73.9	(I73.9) Peripheral vascular disease, unspecified
437	I78	(I78) Diseases of capillaries
147, 486, 487	J10.0	(J10.0) Influenza with pneumonia, influenza virus identified

147, 487	J10.1	(J10.1) Influenza with other respiratory manifestations, influenza virus identified
147, 486, 487	J11.0	(J11.0) Influenza with pneumonia, virus not identified
147, 487	J11.1	(J11.1) Influenza with other respiratory manifestations, virus not identified
486	J12	(J12) Viral pneumonia, not elsewhere classified
486	J12.0	(J12.0) Adenoviral pneumonia
486	J13	(J13) Pneumonia due to Streptococcus pneumoniae
486	J14	(J14) Pneumonia due to Haemophilus influenzae
486	J15	(J15) Bacterial pneumonia, not elsewhere classified
486	J15.0	(J15.0) Pneumonia due to Klebsiella pneumoniae
486	J15.1	(J15.1) Pneumonia due to Pseudomonas
486	J15.2	(J15.2) Pneumonia due to staphylococcus
486	J15.3	(J15.3) Pneumonia due to streptococcus, group B
486	J15.4	(J15.4) Pneumonia due to other streptococci
486	J15.5	(J15.5) Pneumonia due to Escherichia coli
486	J15.6	(J15.6) Pneumonia due to other aerobic Gram-negative bacteria
486	J15.7	(J15.7) Pneumonia due to Mycoplasma pneumoniae
486	J15.8	(J15.8) Other bacterial pneumonia
486	J15.9	(J15.9) Bacterial pneumonia, unspecified
486	J16	(J16) Pneumonia due to other infectious organisms, not elsewhere classified
486	J16.0	(J16.0) Chlamydial pneumonia
486	J16.8	(J16.8) Pneumonia due to other specified infectious organisms
486	J17	(J17) Pneumonia in disease classified elsewhere
486	J17.0	(J17.0) Pneumonia in bacterial diseases classified elsewhere
486	J17.1	(J17.1) Pneumonia in viral diseases classified elsewhere
486	J17.2	(J17.2) Pneumonia in mycoses
486	J17.3	(J17.3) Pneumonia in parasitic diseases
486	J17.8	(J17.8) Pneumonia in other diseases classified elsewhere
486	J18	(J18) Pneumonia, organism unspecified
486	J18.0	(J18.0) Bronchopneumonia, unspecified
486	J18.1	(J18.1) Lobar pneumonia, unspecified
486	J18.2	(J18.2) Hypostatic pneumonia, unspecified
486	J18.8	(J18.8) Other pneumonia, organism unspecified
486	J18.9	(J18.9) Pneumonia, unspecified
466, 493	J20	(J20) Acute bronchitis
466, 493	J21	(J21) Acute bronchiolitis
460	J22	(J22) Unspecified acute lower respiratory infection

477	J30	(J30) Vasomotor and allergic rhinitis
477	J30.0	(J30.0) Vasomotor rhinitis
477	J31	(J31) Chronic rhinitis, nasopharyngitis and pharyngitis
477	J31.0	(J31.0) Chronic rhinitis
460	J31.1	(J31.1) Chronic nasopharyngitis
460	J31.2	(J31.2) Chronic pharyngitis
461, 473	J32	(J32) Chronic sinusitis
460	J39.2	(J39.2) Other diseases of pharynx
460	J39	(J39) Other diseases of upper respiratory tract
460	J39.3	(J39.3) Upper respiratory tract hypersensitivity reaction, site unspecified
460	J39.8	(J39.8) Other specified diseases of upper respiratory tract
460	J39.9	(J39.9) Disease of upper respiratory tract, unspecified
466, 491, 493	J40	(J40) Bronchitis, not specified as acute or chronic
491	J41	(J41) Simple and mucopurulent chronic bronchitis
491	J42	(J42) Unspecified chronic bronchitis
492	J43	(J43) Emphysema
496	J44	(J44) Other chronic obstructive pulmonary disease
493	J45	(J45) Asthma
493	J46	(J46) Status asthmaticus
494	J47	(J47) Bronchiectasis
769	J80	(J80) Adult respiratory distress syndrome
785	J81	(J81) Pulmonary oedema
288	J82	(J82) Pulmonary eosinophilia, not elsewhere classified
398	J84	(J84) Other interstitial pulmonary diseases
518	J84.0	(J84.0) Alveolar and parietoalveolar conditions
515	J84.1	(J84.1) Other interstitial pulmonary diseases with fibrosis
398	J84.8	(J84.8) Other specified interstitial pulmonary diseases
398	J84.9	(J84.9) Interstitial pulmonary disease, unspecified
518	J85	(J85) Abscess of lung and mediastinum
518	J85.1	(J85.1) Abscess of lung with pneumonia
519	J95	(J95) Postprocedural respiratory disorders, not elsewhere classified
398	J95.0	(J95.0) Tracheostomy malfunction
398	J95.1	(J95.1) Acute pulmonary insufficiency following thoracic surgery
398	J95.2	(J95.2) Acute pulmonary insufficiency following nonthoracic surgery
398	J95.3	(J95.3) Chronic pulmonary insufficiency following surgery
398	J95.4	(J95.4) Mendelson's syndrome
398	J95.5	(J95.5) Postprocedural subglottic stenosis
398	J95.8	(J95.8) Other postprocedural respiratory disorders

398	J95.9	(J95.9) Postprocedural respiratory disorder, unspecified
398	J96	(J96) Respiratory failure, not elsewhere classified
398	J98	(J98) Other respiratory disorders
398	J98.0	(J98.0) Diseases of bronchus, not elsewhere classified
398	J98.1	(J98.1) Pulmonary collapse
492	J98.2	(J98.2) Interstitial emphysema
492	J98.3	(J98.3) Compensatory emphysema
398	J98.4	(J98.4) Other disorders of lung
398	J98.5	(J98.5) Diseases of mediastinum, not elsewhere classified
398	J99	(J99) Respiratory disorders in diseases classified elsewhere
633	O00	(O00) Ectopic Pregnancy
658	O42	(O42) Premature rupture of membranes
641	O44	(O44) Placenta praevia
641	O45	(O45) Premature separation of placenta (abruptio placentae)
669	O60	(O60) Preterm delivery
366	H25	(H25) Senile cataract
744, 366	H26	(H26) Other cataract
744, 366	H28	(H28) Cataract and other disorders of lens in diseases classified elsewhere
379	H35.3	(H35.3) Macular Degeneration
369	H54	(H54, H54.1, H54.4) Blindness
531	K25	(K25) Gastric ulcer
532	K26	(K26) Duodenal ulcer
534	K27	(K27) Peptic ulcer, site unspecified
534	K28	(K28) Gastrojejunal ulcer
531, 532, 534	K63.3	(K63.3) Ulcer of intestine
730, 733	M81.0	(M81.0) Postmenopausal osteoporosis
730, 733	M85	(M85) Other disorders of bone density and structure
730, 733	M85.8	(M85.8) Other specified disorders of bone density and structure
786	R05	(R05) Cough
786	R06	(R06) Abnormalities of breathing
786	R06.2	(R06.2) Wheezing
785	R07	(R07) Pain in throat and chest
785	R07.0	(R07.0) Pain in throat
785	R07.1	(R07.1) Chest pain on breathing
785	R07.2	(R07.2) Precordial pain
785	R07.3	(R07.3) Other chest pain
785	R07.4	(R07.4) Chest pain, unspecified
786	R06.8	(R06.8) Other and unspecified abnormalities of breathing

786	R06.0	(R06.0) Dyspnoea
786	R06.1	(R06.1) Stridor
786	R06.3	(R06.3) Periodic breathing
786	R06.4	(R06.4) Hyperventilation
786	R06.5	(R06.5) Mouth breathing
459, 519, 786	R09	(R09) Other symptoms and signs involving the circulatory and respiratory systems
799	R09.0	(R09.0) Asphyxia
012, 511	R09.1	(R09.1) Pleurisy
769	R09.2	(R09.2) Respiratory arrest
786	R09.3	(R09.3) Abnormal sputum
769	R09.8	(R09.8) Other specified symptoms and signs involving the circulatory and respiratory systems
821	S72	(S72) Fracture of femur
821	S72.0	(S72.0) Fracture of neck of femur
821	S72.1	(S72.1) Pertrochanteric fracture
821	S72.2	(S72.2) Subtrochanteric fracture
821	S72.7	(S72.7) Multiple fractures of femur
821, 808	S72.8	(S72.8) Fractures of other parts of femur
821, 808	S72.9	(S72.9) Fracture of femur, part unspecified