Economic Report

Economic surveillance for chronic obstructive pulmonary disease (COPD) in Alberta

REVISED, August 2016

IHE
INSTITUTE OF HEALTH ECONOMICS
ALBERTA CANADA

INSTITUTE OF HEALTH ECONOMICS

The Institute of Health Economics (IHE) is an independent, not-for-profit organization that performs research in health economics and synthesizes evidence in health technology assessment to assist health policy making and best medical practices.

IHE BOARD OF DIRECTORS

INSTITUTE OF HEALTH ECONOMICS
ALBERTA CANADA

Economic Report

Economic surveillance for chronic obstructive pulmonary disease (COPD) in Alberta

Contributing authors:

A.E. Waye, PhD, Institute of Health Economics

P. Jacobs, PhD, CMA, Department of Medicine, University of Alberta

M.B. Ospina, PhD, MSc, Department of Medicine, University of Alberta, Respiratory Health Strategic Clinical Network, Alberta Health Services

M.K. Stickland, PhD, Department of Medicine, University of Alberta, Respiratory Health Strategic Clinical Network, Alberta Health Services

I. Mayers, MD, FRCPC, Department of Medicine, University of Alberta

Acknowledgements

We would like to acknowledge our Expert Advisory Committee for overseeing this study: Dr. Jean Bourbeau, Dr. Darcy Maciniuk, Dr. Michael Stickland, Dr. Irvin Mayers, Dr. Paul Hernandez, and Leigh Allard. In addition, we appreciate the contributions of Alberta Health Services staff for data collection, including Kar Leung, Darrell Melvin, Verna Mehaney, Maria Ospina, Saiful Kabir, and Deborah Katz.

We would also like to thank Stefanie Kletke for her support in formatting and editing this report.

Corresponding Author

Please direct any inquiries about this report to Arianna Waye, awaye@ihe.ca.

Funding

This report was supported by a financial contribution from Boehringer Ingelheim.

The views expressed herein do not necessarily represent the official policy of Boehringer Ingelheim.

Declared Competing Interest of Authors

Competing interest is considered to be financial interest or non-financial interest, either direct or indirect, that would affect the research contained in this report or create a situation in which a person's judgement could be unduly influenced by a secondary interest, such as personal advancement.

The authors of this publication claim no competing interest.

Suggested Citation (ICMJE or Vancouver Style)

Waye AE, Jacobs P, Ospina MB, Stickland MK, Mayers I. *Economic surveillance for chronic obstructive pulmonary disease (COPD) in Alberta*. Edmonton (AB): Institute of Health Economics; 2016.

Web Address

This publication is available for free download from the IHE website at http://www.ihe.ca.

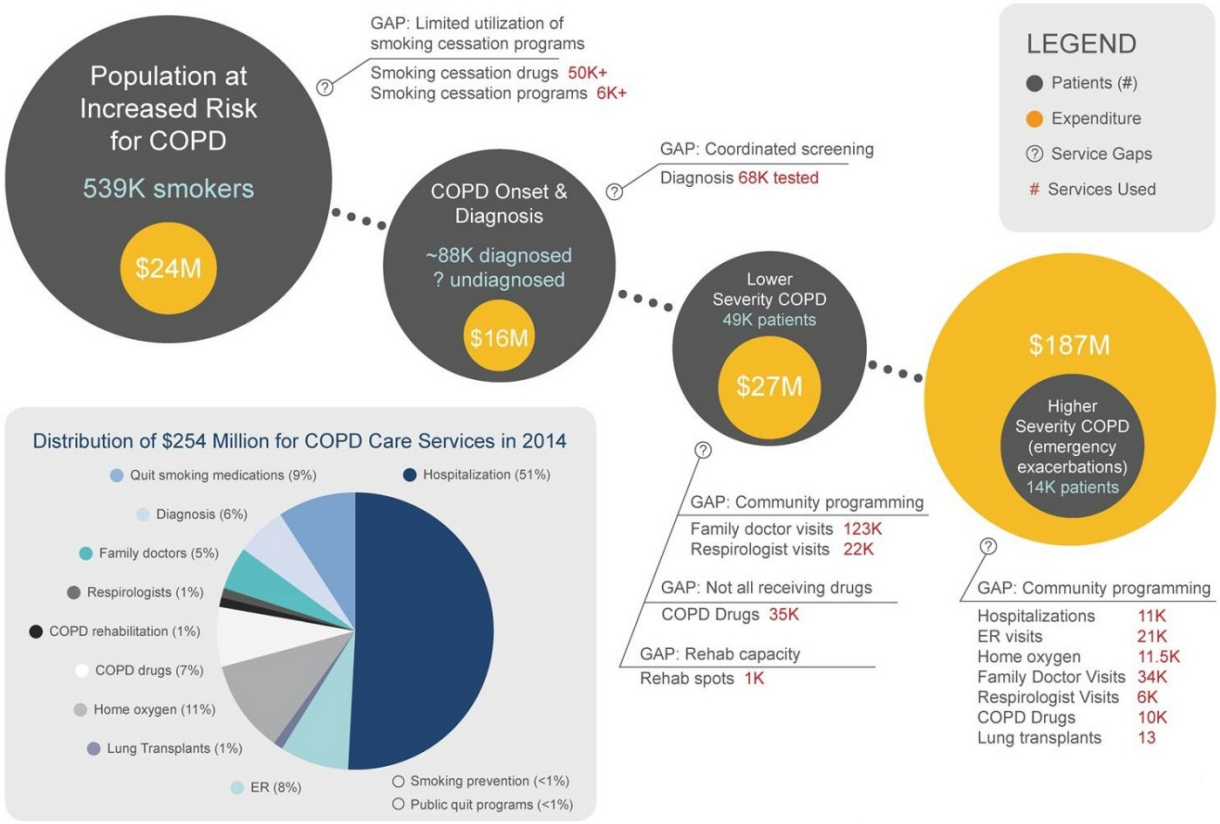
Executive Summary

In Alberta, according to Alberta Health's Interactive Health Data Application (IHDA), over 90,000 people within the current population have been diagnosed with chronic obstructive pulmonary disease (COPD). Using a similar method to the IHDA but with a more restricted case definition, we obtained a sample of approximately 68,000 persons who had been diagnosed with COPD. We then obtained estimates of the costs of physician services (general practitioner and specialist), hospital services (outpatient emergency and inpatient), and prescription drugs that were used by this sample. In order to obtain provincial data on the entire spectrum of services for high-risk pre-COPD and diagnosed persons, we supplemented this sample with additional estimates on smoking prevention, smoking cessation, pulmonary rehabilitation, diagnosis, and advanced-stage services.

Using these data, we obtained a cross-sectional estimate of the entire sweep of COPD-related services for a COPD population during a given year (2013/14), and identified total expenditures on COPD to be $254 million (see Figure ES.1). These expenditures were highly skewed towards services that are associated with higher severity, advanced-stage COPD, notably hospitalization ($131 million), emergency department visits ($19 million), and home oxygen therapy ($27 million). The advanced-stage costs comprise 75% of the total identified COPD costs.

Typically, economic costing studies for chronic conditions do not focus on the entire sweep of services over all stages of the disease. However, in the absence of such information, it would be impossible to determine whether current arrangements or policies are targeting the appropriate groups. Only when we know the entire range of services and their costs for all persons who are affected by the disease can we begin addressing system-wide appropriateness of the current distribution of healthcare resources and expenditures. Our analysis strongly suggests that lower severity, early-stage care is likely to be underfunded, as very few services are provided in the form of COPD programs in primary care and pulmonary rehabilitation. Furthermore, little documentation is made in terms of smoking cessation program cost and utilization; however, it appears that available services are underutilized.

Figure ES.1: Alberta COPD economic surveillance



Abbreviations

All abbreviations that have been used in this report are listed here unless the abbreviation is well known, has been used only once, or has been used only in tables or appendices, in which case the abbreviation is defined in the figure legend or in the notes at the end of the table.

ACPLF	Alberta Cancer Prevention Legacy Fund
AHS	Alberta Health Services
COPD	chronic obstructive pulmonary disease
CTS	Canadian Thoracic Society
DAD	Discharge Abstracts database
FEV	forced expiratory volume
FTE	full-time equivalent
GOLD	Global Initiative on Obstructive Lung Disease
ICD	International Classification of Diseases
IHDA	Interactive Health Data Application
NIV	non-invasive
PCN	Primary Care Network
RBP	Respiratory Benefits Program

Table of Contents

1. Chronic Obstructive Pulmonary Disease: Nature of the Disease

Chronic obstructive pulmonary disease (COPD) is a major respiratory disorder that is primarily caused by smoking, and is characterized by progressive airflow obstruction that is not fully reversible (GOLD 2016). Clinical manifestations of COPD include cough, sputum production, and dyspnea, with increasing frequency and severity of symptom exacerbation over time. Early treatment alternatives, including smoking cessation, pulmonary rehabilitation, and medications, may prolong the decline in lung function caused by the disease. As the condition progresses, people develop more severe airflow obstruction, which is associated with increased disability and decreased health-related quality of life. Patients with COPD whose condition progresses typically develop increased frequency of exacerbations, some of which lead to emergency department visits and hospital admissions. With end-stage disease, patients frequently require home oxygen and consideration of possible lung transplantation.

According to the Public Health Agency of Canada (PHAC)'s measure of the Economic Benefits of Illness in Canada (EBIC), COPD is a very expensive disease, and is the most costly in terms of hospitalization. In 2008, persons with COPD in Canada incurred $791 million in costs. The next most expensive disease in terms of hospitalizations was acute myocardial infarction, which generated $666 million in hospital costs. Costs for COPD drugs were $305 million, and for physician expenses were $161 million. Khakban et al. (2015) estimated that COPD patients cost the British Columbia healthcare system $5,452 more per year than a case-matched comparison. However, another study by Maleki-Yazdi et al. (2012) demonstrated that the per-patient cost of managing COPD varied according to disease severity.

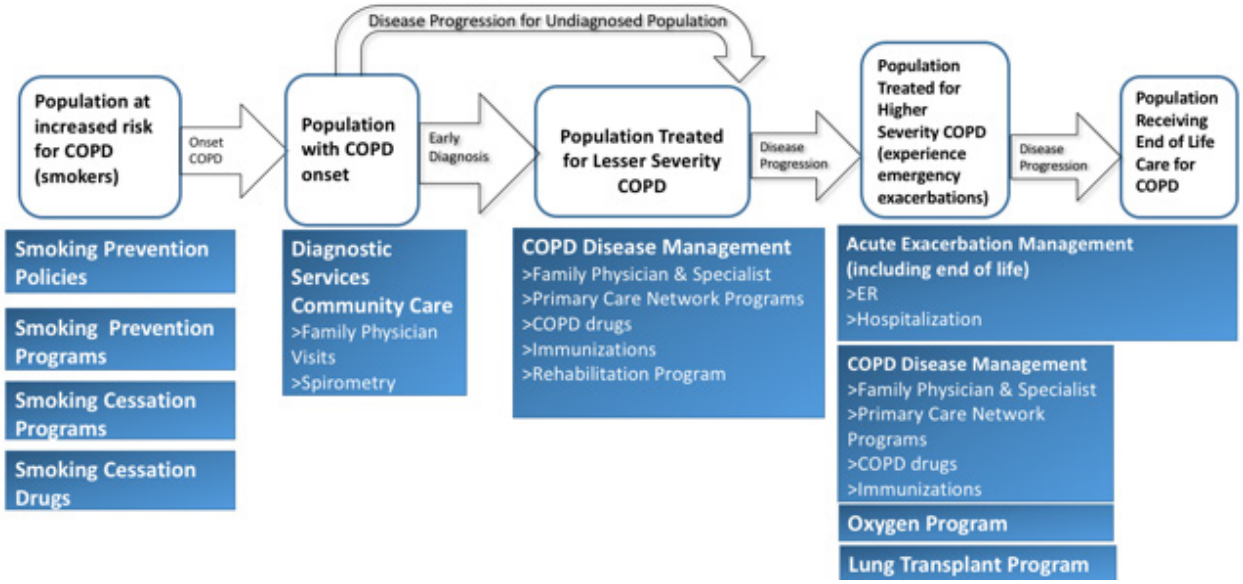
Along the continuum of COPD care, ranging from pre-COPD prevention of those at-risk (mainly smoking cessation) to care for advanced cases (that is, patients requiring oxygen and transplantation), health services are provided in different settings. Many of these settings appear to be operated as silos, with more severe, later cases getting priority. Managers and clinicians in the various settings do not coordinate services throughout the healthcare system, and there is little objective guidance on how to direct resources to their highest valued use. In this paper, we present the results of an economic surveillance analysis on the components of the Alberta healthcare system that are devoted to COPD prevention and treatment. We focus on epidemiology (prevalence and incidence), service use, and cost indicators. We also identify gaps in the system that presumably add to the overall economic burden of COPD.

2. Economic Surveillance

"Economic surveillance" is a mapping of the market for COPD services that are available to address each stage of the continuum of COPD respiratory health, as well as their utilization and cost. A "market" for COPD services describes the services supplied by producers of health care (largely funded by the government) and consumed by COPD patients. Services that are supplied and demanded include: healthcare services preventing patients at risk of developing COPD; screening and diagnosis; services for those who develop COPD and are diagnosed; community-based disease management for lower severity, early-stage COPD; acute exacerbation management (including advanced-stage diagnosis and end-of-life care) and decompensation treatment (oxygen and possible lung transplantation) for higher severity, advanced-stage COPD; and end-of-life care or palliative services. Figure 1 illustrates the stages along this continuum, as well as services required at each

stage. Each stage will be described in turn below, along with the associated service utilization, cost, and system-level care gaps.

Figure 1: Continuum of COPD respiratory health and Alberta program surveillance



2.1 Economic surveillance data sources

Our economic surveillance model is a cross-sectional model that identifies the services that are provided to a prevalent group who are at-risk or have been diagnosed with COPD. These persons are pre-COPD or at different stages of the disease. The economic surveillance model was populated using data linkage from four Alberta administrative health databases between April 1, 2013 and March 31, 2014. A health services profile was created for each person with an Alberta personal health number who was using specific health services. The following databases were used to create this group:

1) Discharge Abstracts Database (DAD), which contains discharges from inpatient hospital stays;
2) Physician Claims database, which contains information on services provided on a fee-for-service basis, as well as shadow billings for physicians under alternative remuneration plans;
3) Pharmaceutical Information Network (PIN) database, which contains medications dispensed at pharmacies in the province; and
4) National Ambulatory Care Reporting System, which contains outpatient visits to hospitals and ambulatory care services, as well as emergency department visits.

Individual-level data were aggregated into total and average measures of service utilization.

A cohort of 62,840 patients with COPD was identified and selected based upon a validated case definition of COPD; patients were identified if they were more than 35 years of age and had at least one COPD-related hospitalization (identified using ICD-10 codes J41-44 in the first or second diagnostic field) or one physician claim (identified using ICD-9 codes 491, 492, and 496), emergency

department visit, or outpatient visit between April 1, 2013 and March 31, 2014.[1] Similar definitions have been validated and used elsewhere, with a sensitivity of 85% and a specificity of 78.4% (Gershon et al. 2009).

Aggregate spirometry testing data for individuals aged 35 years and over were obtained separately from Alberta Health, drawn from 2014 physician claims data based on claims codes 0.37* and 0.38*. It is assumed that all tested individuals aged 35 years and over were tested for COPD. The amount paid for bills, including shadow billing, was also obtained.

Program-specific data were obtained for the Respiratory Benefits, lung transplants, and smoking cessation programs. Aggregate program data were also obtained from Alberta Health Services and Primary Care Network smoking cessation programs, the Alberta Respiratory Benefit Program, and lung transplant services.

2.2 Resource utilization and cost

Service utilization is presented on a per-case or per-service basis. For some types of services, we do not know how many individual persons received these services, and so these are expressed on a per-service basis (for example, hospitalization and emergency department visits). Costs are expressed on a per-service or per-person basis, depending on the unit of measure that was available.

2.3 Stages of COPD

In Figure 1, we set out the sub-groups of the population that are at risk for COPD, including those who have developed COPD. This begins with smokers, many of whom progress to early-stage, lower severity COPD, and over time further progress to advanced-stage, higher severity COPD (which consists of patients that experience emergency exacerbations).

Out of the identified COPD cohort of 62,840 patients, 49,107 (78.15%) are considered lower severity COPD patients because they did not visit the emergency room with an acute exacerbation in 2013/14, while 13,733 (21.85%) are considered higher severity COPD patients because they did visit the emergency department with an acute exacerbation in 2013/14.

2.4 Transitions between services

Over time, there are transitions between stages of the disease and also between services, though transitions for a population cannot be estimated in a cross-sectional analysis, which does not capture events over time. At each stage, individuals transition to subsequent stages over years. The transition rates between disease stages depend on the availability and use of screening and diagnosis services, and on the treatments that are received. The transition between disease stages is the meaning of "transition" used in most economic models.

There is also a transition between services. These should, but in fact may not, mirror transitions between stages of the disease. Specifically, as part of a patient's care management plan, patients often require a collection of services provided by different professionals. Access to these services may be obtained through referral from a healthcare professional or self-referral. For example, if a physician suspects that a patient has COPD, the physician may refer the patient for lung function testing. The

[1] The Respiratory Health Strategic Clinical Network, Alberta Health Services, and its collaborators are in the process of refining the case definition for COPD. As such, the definition used in this paper is subject to change in the future.

test results are sent back to the physician and, if positive, the physician can prescribe medications or refer the patient to a specialist. Some of the more important transitions occur after hospital discharge, as referrals from a primary care physician to a specialist. If the patient is prescribed drugs, they "transition" to a drug regime. Both primary care and specialty physicians can also refer patients for immunizations and rehabilitation. Adequate integration and coordination across these services are essential for patients to obtain the services needed.

2.5 Defining care gaps in the market for COPD care services

In the context of a market for COPD services, a "gap" is defined as the difference between the amount of care demanded or needed by services users and the amount of care services that are available, as defined by budgetary allocations. Several types of gaps will be considered in this paper:

1) lack of capacity (or, capacity constraint) resulting in restricted access or wait lists, which may result because of high demand or insufficient services supply;
2) lack of demand, which may result in excessive services supply;
3) missing service, whereby care needs are unmet because services (supply) are not provided at all; and
4) lack of integration or coordination of care, whereby the costs associated with searching for services or coordinating services are high.

There may be a number of reasons for care gaps. These can be explained in terms of supply and demand drivers that need to be understood in order for policy recommendations to be made. For example, drivers of demand for a service include the out-of-pocket price for the service (for example, smoking cessation drugs), lack of consumers' knowledge, or a low level of referrals by a general practitioner. Drivers of supply include barriers to entry by suppliers, suppliers regulations (for example, strict limits of prescriptions), and inadequate incentives.

Gaps and their causes are not easily measurable. However, we can do a much better job at identifying gaps and their causes than we have done. For example, linking primary care data to existing administrative data would allow for the accurate identification of individuals who have a diagnosis of COPD, and allow tracking of service use such as whether the person has been immunized, hospitalized, or admitted to the emergency department for COPD, or whether the person has obtained COPD medications or attended a rehabilitation clinic.

3. The Alberta Population with COPD

Program services utilization depends to a large degree upon the number of identified patients with COPD. As can be seen in Table 1, a total of 62,840 patients matched our COPD case definition between 2013 and 2014. Alberta Health's Interactive Health Data Application (IHDA) uses the same case definition, except that it identifies patients over a two-year time period as opposed to a one-year period, and finds that there were 96,811 prevalent cases and 11,966 incident cases of COPD in Alberta in 2013. The IHDA age groups do not separate individuals between the ages of 35 and 40 years, where 35 years of age is the standard cut-off point for identifying COPD cases in administrative data. For the age group of 40 years and over for which data was identifiable, there were 88,018 individuals identified with COPD in Alberta, accounting for a prevalence rate of 4.96% of the Alberta population over the age of 40 years. These numbers agree with a study conducted by the Canadian Primary Care Sentinel Surveillance Network that reported a prevalence rate of 4%, based upon primary care data across eight provinces (Green et al. 2015). The proportion of people

with COPD in Alberta has steadily increased over time, increasing by about 35.7% between 2009 and 2013; Canadian rates have remained fairly stable, increasing by only 6.6% (see Table 1 and Figure 2).

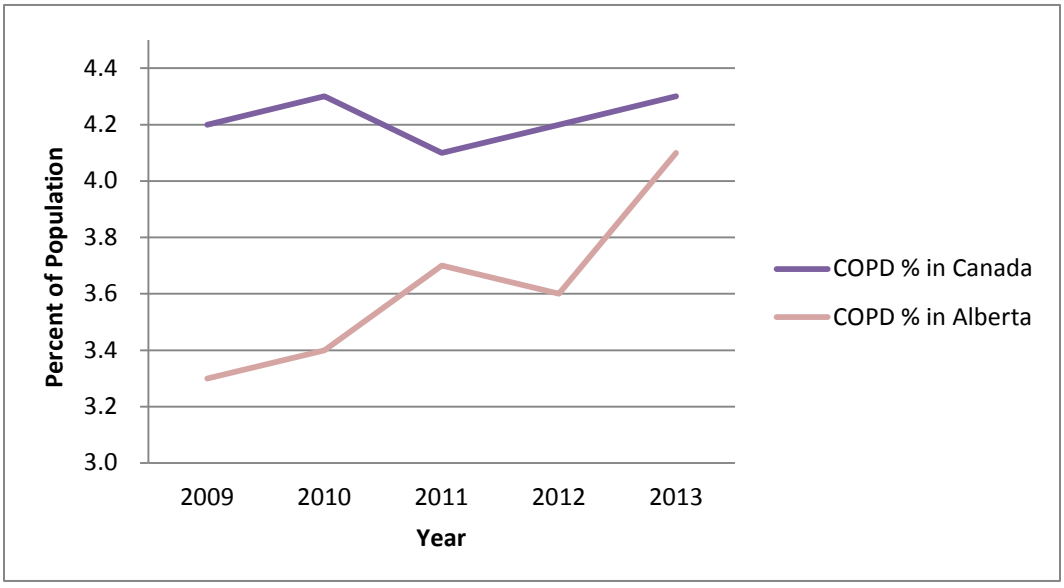
Table 1: Number of COPD cases in Alberta (2009 to 2013)

Sex	2009	2010	2011	2012	2013
Study population (COPD patients who met case definition for this study)					
Both sexes	NA	NA	NA	NA	62,840
Alberta COPD incident cases, aged 40 years and over (IHDA)					
Both sexes	9,586	9,632	9,749	9,918	10,142
Female	4,560	4,596	4,655	4,714	4,806
Male	5,026	5,036	5,094	5,204	5,336
Alberta COPD prevalent cases, aged 40 years and over (IHDA)					
Both sexes	69,855	73,781	78,542	83,438	88,018
Female	34,315	36,390	38,755	41,224	43,434
Male	35,540	37,391	39,787	42,214	44,584

IHDA: Interactive Health Data Application

Source: Alberta IHDA, Chronic Obstructive Pulmonary Disease – Age-Sex Specific Incidence and Prevalence (*http://www.ahw.gov.ab.ca/IHDA_Retrieval/selectSubCategoryParameters.do*)

Figure 2: Percent of population diagnosed with COPD in Alberta and Canada, aged 12 years and over (2009 to 2013)



Source: Statistics Canada, CANSIM Table 105-0501 (*http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=1050501*)

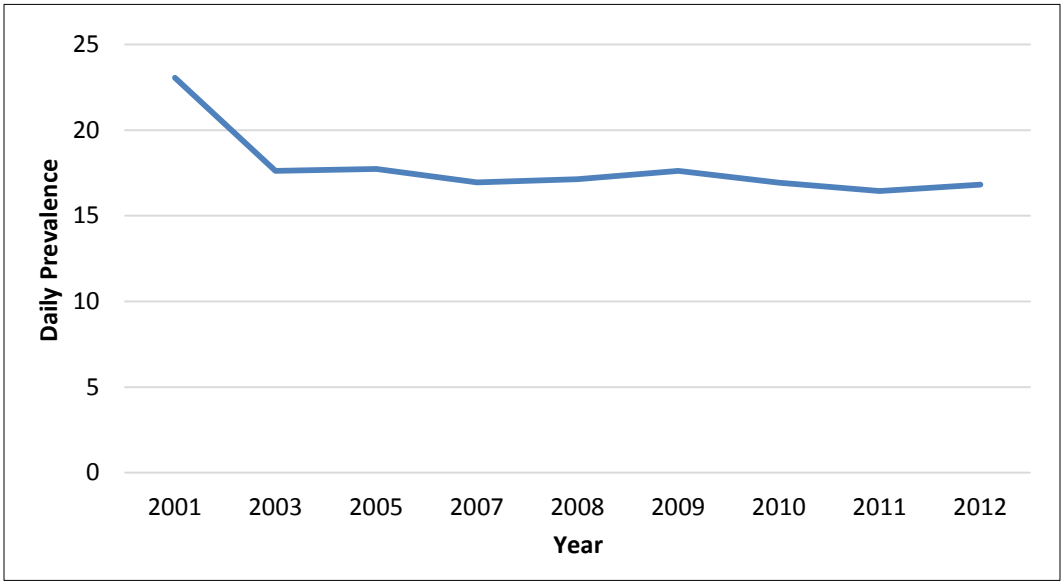
4. Smoking Prevention and Cessation

Smoking is the major risk factor of COPD. Approximately 20 to 50% of smokers develop COPD, depending upon the length of study follow-up (Løkke et al. 2006; Lundbäck et al. 2003). It is

estimated that 64 to 90% of COPD patients are current or former smokers (Lindberg et al. 2006). The remaining 10 to 36% of COPD patients who have not smoked may have developed the disease as a result of genetics (alpha-1 antitrypsin deficiency) or occupational hazards (for example, from coal or hard rock mining, and concrete manufacturing) (Boschetto et al. 2006).

Both current and former smokers are at a high risk of developing COPD. According to Statistics Canada, between 18 and 20% of Albertans smoke daily or occasionally (Statistics Canada 2015b) (see Figure 3), which accounts for about 539,000 current smokers in the province (*www.tobaccoreport.ca*). This number has remained fairly constant since 2001. An equal number of Albertans are former smokers, amounting to over 1 million Albertans estimated to be at risk of developing COPD because of current or past smoking exposure.

Figure 3: Individuals reporting daily smoking in Alberta (2001 to 2012)



Source: Alberta IHDA (*http://www.ahw.gov.ab.ca/IHDA_Retrieval/selectSubCategoryParameters.do#*)

4.1 Alberta smoking prevention policies

Within Alberta, there is a web of anti-smoking policies, enacted and enforced by the federal, provincial, and municipal governments (Jacobs 2013). These include the provision of information, taxation of cigarettes, banning smoking in public buildings, and cessation counselling. Alberta Health has developed a strategy to prevent and reduce tobacco use, under the initiative "Creating Tobacco-Free Futures, 2012-2022" (*www.health.alberta.ca/documents/Tobacco-Reduction-Strategy-2012.pdf*). The four strategic directions (prevention, protection, cessation, and knowledge translation and capacity building) offer a comprehensive approach to reducing tobacco use and exposure through partnering with Alberta Health Services, non-governmental organizations, schools, and workplaces. Funding allocated to this initiative is unknown.

Alberta Health Services (AHS), under this direction from Alberta Health, as well as in keeping with internal policies and clinical practice guidelines, developed the *Tobacco Free Futures Guideline* (*www.albertaquits.ca/files/AB/files/library/TFF_Web_2015_04_21(1).pdf*). The guideline was funded for 2010 to 2014 through the Alberta Cancer Prevention Legacy Fund (ACPLF). The ACPLF targeted

funding allowed for the development of provincial standards of care, practice guidelines, documentation standards (paper and electronic), training, and supplementary resources. The exact amount allocated to this initiative by the ACPLF is not known (Alberta Lung Association, personal communication, 2015). The work that was funded by the ACPLF in developing standards of care, guidelines, training, and documentation has been completed. However, work has continued in liaising and preparing sites, creating site champions, training, and distributing materials. This work is now sustained through core funding, though the amount allocated is not known.

4.2 Alberta smoking prevention programs

Smoking prevention programs include youth engagement, changes to tobacco regulation, and taxation. Youth engagement is operated by the Alberta Lung Association, and makes community champions. The cost of this program has been $350,000 per year, including media campaigns and student recruitment (Alberta Lung Association, personal communication, 2015).

Changes to the regulation of tobacco products have been significant over the last few years in Alberta, the most recent being the banning of flavoured tobacco and menthol. The legislation-related costs are not known. Similarly, the cost of legislation related to changes in taxation of tobacco products has not been documented.

4.3 Alberta smoking cessation programs: utilization and cost

There were 2,570 contacts who made 3,922 calls to the AlbertaQuits Helpline in 2014/15. The funding for the helpline comes out of operational budgets, and the amount allocated is not known. There is also an AlbertaQuits website, with an unknown number of users and an estimated budget of $350,000 (based upon 2010 budgets at the time the program was operated by the Alberta Lung Association).

Another key program for smoking cessation is QuitCore, a group-based program that consists of five to eight 90-minute classes for up to nine weeks. Between April 1, 2014 and March 31, 2015, 248 clients booked and 165 clients attended the program, and there were a total of 637 spaces available across 40 sessions within the year (AHS, personal communication, 2015). The cost of each session is estimated to be $948 based upon 24 hours of session time, given an hourly wage rate of $39 for the session leader. Additional support of 0.2 FTE is required to coordinate the program, with an annual wage of $80,000, which amounts to $16,000 for 0.2 FTE (AHS Tobacco Reduction Program, personal communication, 2015). The total annual cost of staff time for all sessions is then $53,400. Sessions are generally held within an AHS clinic, so rental costs are not required.

Smoking cessation services are also offered at family doctor's offices, often by a team of healthcare professionals, as most family physicians belong to one of the 42 Primary Care Networks (PCNs) in Alberta. PCNs are groups of family doctors and allied healthcare professionals that work together to deliver primary care, and each network is flexible to develop programs to meet the local needs of patients.[2] Smoking cessation program data were obtained from the PCNs in Alberta (see Appendix A, Table A.1). While many PCNs in the province do not track the number of patients enrolled in

[2] Together, the 42 PCNs consist of more than 3,300 primarily fee-for-service healthcare providers (family physicians, pediatricians), as well as more than 800 allied healthcare providers (nurses, dieticians, social workers, and pharmacists), funded through supplemental funding from the government (Alberta Health). The PCNs receive funding for approximately 3.2 million Albertans (out of a total of 3.7 million people in the province).

smoking cessation, 11 of the 42 PCNs that do collect these data indicate that 1,892 patients were enrolled in a smoking cessation program, including 81 in QuitCore. Fourteen PCNs use QuitCore as the primary smoking cessation program, though 11 do not provide the total number of referrals. Ten PCNs provide one-on-one patient consultations, though few provide information on the estimated cost of these consultations. Two PCNs, the Calgary Rural and Red Deer PCNs, are currently employing the Mayo Clinic Program.

Of the PCNs reporting a total cost of providing smoking cessation services, the Red Deer PCN expended the most, seeing 525 patients at a total cost of $123,000 in 2014/15 (amounting to $234 per patient). The Calgary Foothills PCN provides its own smoking cessation program, and served 85 patients for four to five hours each in 2014/15, at a cost of $82,500 (amounting to $970 per patient). The remaining PCNs that reported an annual budget were in the range of $1,000 (for 1.2% of chronic patients) to $5,400 (for 96 patients), or suggested that their chronic disease management budget is used for service provision. None of the PCNs reported a wait list for smoking cessation services. Given inconsistent reporting across PCNs, the total cost of smoking cessation at the PCN-level is unknown.

A new initiative in the province allows pharmacists trained in smoking cessation to provide one-on-one tobacco cessation services. At the time of writing, there were 45 pharmacies in the province offering this service (*www.rxa.ca/for-the-public/smoking-cessation-services.aspx*). Utilization of this service, the billing procedure, and amounts paid are unclear.

4.4 Alberta smoking cessation drugs: utilization and cost

In Alberta, there is also a prescription medication program that provides education as well as drugs to help patients quit smoking. People are generally prescribed an 8- to 12-week supply of either Champix® (varenicline) or Zyban® (bupropion), at a cost of $148 to $270 for a 12-week supply.

There are two primary forms of public pharmaceutical insurance in Alberta: the public Alberta Health Supplementary Benefit Program, and publicly subsidized Alberta Blue Cross insurance. There is also private health insurance, largely through employment. The Alberta Health Supplementary Benefit Program covers $500 of nicotine replacement therapy in a lifetime, or 12 weeks of free bupropion or varenicline, for people under the following plans: Assured Income for the Severely Handicapped, Income Support; Alberta Adult Health Benefit; and Alberta Child Health Benefit (Canadian Partnership Against Cancer 2015). Alberta Blue Cross also covers smoking cessation drugs; coverage varies depending upon the employer plan, though lifetime maximums do also apply. There will be some people with COPD who either do not receive these benefits and must purchase nicotine replacement therapy out of pocket, or for whom the maximum amount is insufficient.

As seen in Table 2, in 2013/14, in Alberta 33,796 people received at least one prescription of varenicline; 7,453 received at least one prescription for nicotine replacement therapy; and 48,957 COPD patients received bupropion. However, only a third of those of those prescribed bupropion is expected to be for smoking cessation (16,319 people) (Patten et al. 2007).

Table 2: Smoking cessation drug prescriptions and costs in Alberta (2013/14)

Smoking Cessation Drug	Individuals Receiving Prescription 2013/14	Total Prescriptions Dispensed	Cost per Prescription	Total Cost
Total Albertans				
Varenicline	33,796	86,754	$178.64/100-day supply	$15,497,735
Nicotine	7,453	20,594	$313/1,000 pieces	$6,445,922
Bupropion (all reasons)	48,957	285,696	$22.97/100-day supply	$6,562,437
Estimated bupropion (assuming 1/3 for smoking cessation)*	16,319	95,253	$22.97/100-day supply	$2,187,479

* Bupropion may also be prescribed for mood disorders such as depression. One Canadian study suggests that one-third of all antidepressant medications are prescribed for reasons other than depression (Patten et al. 2007); this scenario has been costed separately in the above table.

As seen in Table 3, 2,251 patients in the COPD study cohort received at least one prescription of bupropion as a smoking cessation drug, 2,924 received at least one prescription of varenicline, and 1,455 received at least one prescription for nicotine. The annual cost of these drugs total $3.4 million. The number of individuals using nicotine replacement therapy and the total cost is not known, because these therapies are sold over the counter.

Table 3: Smoking cessation drug prescriptions and costs in study population (2013/14)

Smoking Cessation Drug	Individuals Receiving Prescription 2013/14	Total Prescriptions Dispensed	Cost per Prescription	Total Cost
Study population (COPD patients who met case definition for this study)				
Varenicline	2,924	8,576	$178.64/100-day supply	$1,532,017
Nicotine	1,455	4,138	$313/1,000 pieces	$985,324
Bupropion (all reasons)	2,251	21,147	$22.97/100-day supply	$485,747
Estimated bupropion (assuming 1/3 for smoking cessation)*	750	7049	$22.97/100-day supply	$161,916

* Bupropion may also be prescribed for mood disorders such as depression. One Canadian study suggests that one-third of all antidepressant medications are prescribed for reasons other than depression (Patten et al. 2007); this scenario has been costed separately in the above table.

5. Diagnosing COPD

Initial screening for COPD consists of a series of questions about smoking habits. This usually occurs in a family doctor's office, and, if the person is deemed to be at high risk, then a diagnostic test is performed. Recently, Alberta Health has begun to pay pharmacists to counsel patients, but there is no available information on smoking cessation counselling by pharmacists. There is also no available information about COPD screening by general practitioners in Alberta. Such information would have to come from questionnaires answered by providers.

The Global Initiative on Obstructive Lung Disease (GOLD) staging system recommends diagnosing COPD with spirometry based on a post-bronchodilator forced expiratory volume in one second

(FEV_1) divided by forced vital capacity (FVC) less than or equal to 0.7. It then further recommends classifying individuals with COPD based on their degree of airflow limitation (obstruction) as per their FEV_1; this classification includes four severity stages ranging from GOLD 1 (mild, $FEV_1 \geq 80\%$ predicted) to GOLD 4 (very severe, $FEV_1 < 30\%$ predicted). International guidelines for COPD state that diagnostic best practice is to use post-bronchodilator spirometry to diagnose airflow obstruction in patients with respiratory symptoms. Full lung function tests (spirometry, lung volume, and diffusion capacity evaluation) are sometimes conducted in conjunction with measurements of arterial blood gas or chest x-ray for a more complete assessment (Qaseem et al. 2011), but these are not typically required for the initial diagnosis of COPD.

5.1 COPD case finding in Alberta

In Alberta, there is no official screening program or targeted testing in individuals with risk factors or symptoms to detect early cases of COPD. Spirometry testing in Alberta is conducted in physicians' offices or private diagnostic labs, both paid by Alberta Health on a fee-for-service basis, or in AHS facilities. When a patient is diagnosed by a family physician, labs provide spirometry testing, interpret the results, and send a report back to the family physician. The family physician notifies the patient in a follow-up appointment, and begins disease treatment and management.

The estimated cost of COPD diagnosis in the community includes the cost of physician consult and follow-up, as well as the cost of spirometry testing. The technical costs of spirometry testing, interpretation, initial general practitioner visit for spirometry ordering, and follow-up are billed to the province. In our data, we included only the technical and interpretation portions of spirometry billings. All general practitioner and pulmonologist billings, including those related to diagnostic visits, are included in physician service costs.

Based on Alberta Health data, a total of 67,554 persons aged 35 years and over in 2014 had their lung function tested (using pulmonary function tests, spirometry, or vitalometry), which may have resulted in a diagnosis of COPD or other lung disease. It is not known how many of these individuals tested positive for COPD or other respiratory illness. The cost of lung function testing alone (that is, without the associated physician visits) was $15,832,551. See Appendix A, Table A.3 for more details.

There are additional tests that are run at AHS facilities, and these do not appear in the fee-for-service data; not all of these tests were for COPD, and we could not separate the COPD-specific tests from those for other conditions. However, COPD was most likely to be an underlying cause of symptoms for the population over 35 years of age.

A recent update for primary care physicians from the Canadian Thoracic Society (CTS) suggests that most patients are not diagnosed until the disease is advanced, though no explicit data was presented to substantiate this statement (O'Donnell et al. 2008).

5.2 Diagnostic care gaps: missing services, underserved populations, and the undiagnosed

The number of undiagnosed COPD patients in Canada is difficult to ascertain. A recent Health Canada report suggests that the prevalence of measured airflow obstruction is two to six times higher than the prevalence of self-reported symptoms of chronic bronchitis or diagnosed COPD (Evans et al. 2014). In addition, the prevalence is 5 to 16% in former smokers, and 14 to 34% among current smokers. Those who smoke 40 or more packs per year have a prevalence of 17 to

53% (Chapman et al. 2001). It is unclear whether this problem has persisted over the last decade, and whether it is true in Alberta.

Estimates in the United States National Health and Nutrition Examination Survey (NHANES) phase III study suggest that 12 million Americans have been diagnosed with COPD, and as many as a further 12 million have evidence of impaired lung function but remain undiagnosed (National Center for Chronic Disease Prevention and Health Promotion, Division of Adult and Community Health 2011). This means that roughly half of all those with COPD remain undiagnosed in the United States. More than 70% of these individuals are younger than 65 years of age, and had visited a clinic in the year prior to survey (National Center for Chronic Disease Prevention and Health Promotion, Division of Adult and Community Health 2011).

In Canada, it is estimated that the number of undiagnosed COPD patients could be closer to two-thirds (Labonté et al. 2016). This means that there may be as many as three undiagnosed COPD patients for every one (of the 88,000) that has been identified, or as many as 264,000 COPD patients in Alberta.

6. Disease Management

COPD symptoms can be treated at any stage of the disease. COPD is generally managed by family physicians through medication and referrals to respirologists and pulmonary rehabilitation. Treatments have been demonstrated to diminish the number of COPD exacerbations, improve lung function and quality of life, and prevent hospitalizations (Benady 2010; Criner et al. 2015).

The CTS clinical guidelines provide direction on disease management for healthcare providers, and highlight several key areas requiring services to be in place for needs to be met. These will be examined below, as well as service availability, utilization, and cost in the Alberta context.

6.1 CTS clinical guidelines and the Alberta context

First, smoking cessation and regular vaccination for influenza and pneumococcal disease are recommended for all COPD patients (Benady 2010; Criner et al. 2015).

- Most of the PCNs in Alberta provide some form of smoking cessation (see section 4.2, though the level of provision is highly variable).
- Adult vaccination rates for influenza and pneumococcal disease are not tracked in Alberta.

Second, COPD education in conjunction with case management and an action plan is recommended for preventing acute exacerbations (Criner et al. 2015).

- The extent of the provision of case management and action plans is unclear. As of November 2015, only two of the 42 PCNs have a formal COPD program in place (see Appendix A, Table A.1). Funding for these programs is unclear, as is program utilization.

Third, enabling patients and their caregivers to recognize and respond to COPD exacerbations through action plans is recommended (Criner et al. 2015). Unlike cardiology action plans, COPD action plans are not often provided, and it is argued that this should become the new standard of care (Hernandez et al. 2013). As a result, patients have been found to have a poor understanding of the causes of COPD and their role in managing the disease, especially through exacerbations (Hernandez et al. 2013).

- According to the Alberta fee schedule, physicians may claim $193.97 for providing documentation and administration of a comprehensive annual care plan for a patient with complex needs (Alberta Health Care Insurance Plan Schedule of Medical Benefits [Part B] code 03.04J). "Complex needs" are defined as a combination of COPD and one of: obesity, addictions, mental health, or tobacco reduction. Comprehensive care plans serve as a self-management tool to help patients manage their condition and navigate the healthcare system. These plans have multiple components including reviewing current therapies, which should include what actions should be taken based on symptoms (Alberta Health). Of the 4,510 family doctors in Alberta in 2014, only 1,377 (30.5%) billed for providing a comprehensive annual care plan for COPD patients, for a total of $3.3 million (see Appendix Table A.4 for more details).

Fourth, patients with a history of exacerbations should be followed monthly to reduce the likelihood of exacerbation and associated hospitalizations (Criner et al. 2015). Recommendations are not made for the frequency of follow-up for patients without history of exacerbation.

- See section 6.2.1 below.

Fifth, recommendations are made regarding pharmaceutical treatment (drugs and inhalers), which depend upon the severity of disease. Further details can be located in the clinical guidelines (Benady 2010; Criner et al. 2015).

- See section 6.2.2 below.

Sixth, patients with moderate, severe, or very severe COPD with a recent exacerbation are advised to receive pulmonary rehabilitation (Criner et al. 2015). For those who have not had an exacerbation within four months, rehabilitation is not expected to reduce exacerbation risk. However, evidence does not indicate that this intervention will reduce hospitalizations, though evidence is well-established that it will enhance quality of life, exercise tolerance, and dyspnea (Criner et al. 2015). Rehabilitation for moderate and severe cases has been shown to be highly effective in reducing the likelihood of hospital admissions by 74%, and mortality by 55% (Puhan et al. 2005).

- See section 6.2.3 below.

6.2 Service availability, utilization, and cost in Alberta

6.2.1 Physician care utilization and costs for lower and higher severity COPD patients

COPD patients visit their family doctors for medication prescriptions and to address condition-specific concerns. According to AHS data, 49,039 patients (out of our sample of 62,840) with a COPD diagnosis visited their family doctor for COPD-related issues on average 3.2 times per year each, for a total of 156,803 visits. We estimate that 21.85% of these visits were by higher severity COPD patients (34, 261 visits), and the remainder by lower severity COPD patients (122,542 visits).

Total family doctor costs for COPD-diagnosed people are estimated to be $8.5 million. It is unclear how many hospitalized COPD patients were followed post-hospitalization as per the guidelines above.

COPD is managed by family physicians, as well as through referrals to respirologists. Respirologists frequently receive referrals if there is diagnostic uncertainty, if a patient presents with frequent infections, if severe COPD is suspected, or if oxygen therapy assessment is required. According to AHS data, 9,083 patients with COPD (14% of identified COPD patients) made 27,626 visits to a

respirologist in 2013/14. We estimate that 21.85% of these visits were by higher severity COPD patients (6,036 visits), and the remainder by lower severity COPD patients (21,590 visits). The total number of COPD patients visiting other specialists was 10,172, or 80,460 visits. The total respirologist costs for COPD patients are estimated to be $3.7 million.

6.2.2 Pharmaceutical utilization and costs for lower and higher severity COPD patients

There are a number of different pharmaceutical treatments available in Alberta, all of which are covered under Alberta Blue Cross. Of the study cohort of 62,840 persons with COPD in Alberta, only 44,575 received pharmaceutical treatment for COPD (of these, we estimate 21.85% or 9,740, are higher severity COPD patients and 34,835 are lower severity patients), at a total cost of $16.8 million (including public and private payers) (see Appendix A, Table A.2). Public payment is roughly half of all payments for all prescription drugs in the province. We could not tell if prescription patterns match the recommended CTS clinical guidelines.

6.2.3 Pulmonary rehabilitation utilization and costs

Rehabilitation for COPD – if it includes exercise, a case manager, a specific care plan, and an education component – has been shown to be effective in reducing severe exacerbations and improving quality of life (Brooks et al. 2007; Puhan et al. 2005). Rehabilitation is recommended for moderate, severe, and very severe COPD patients (Marciniuk et al. 2010). On the other hand, the British National Institute for Health and Care Excellence (NICE) recommends that all COPD patients (including those with recent hospitalization for COPD) be referred to rehabilitation (NICE 2010). However, despite the success of this intervention, there are far fewer available rehabilitation openings in Alberta compared to the number of patients with COPD. There are currently about 1,000 rehabilitation positions available per year for the 88,018 prevalent patients with COPD (this is the prevalence number using the Albert Health two-year province-wide sample), and the waiting list for rehabilitation services is approximately 400 patients at any given time (Dr. Michael Stickland, AHS, personal communication, 2015). It is unknown how many of these 1,000 positions were filled by patients with a recent exacerbation, as per the aforementioned clinical guidelines. Our findings concur with a recent report from the CTS that estimate the national capacity for pulmonary rehabilitation services to be only 10,280, meaning roughly 0.4% of all COPD patients can access this service in Canada (Camp et al. 2015).

The cost per person in pulmonary rehabilitation is estimated at $1,530, based upon costs taken from a study of cost-effectiveness of interventions for COPD in Ontario (Chandra et al. 2012). Based upon these data, the total amount expended on pulmonary rehabilitation programs in Alberta is $1.5 million per year.

6.2.4 Emergency exacerbation care in Alberta and costs for higher severity patients

Acute care management in hospital may include treatment with supplemental oxygen and non-invasive ventilation, as well as management of acute respiratory failure and co-morbid conditions. Later stages of COPD result in visits to the emergency department, where more than 75% of patients are then admitted (Dr. Brian Rowe, University of Alberta, personal communication, 2015). In 2013/14, there were 13,733 patients who are considered higher severity COPD patients because they visited the emergency department with an acute exacerbation. These patients visited an average of 1.49 times each, for a total of 20,528 visits. The cost of these visits is estimated to be $19.5 million. Also in 2013/14, there were 7,983 people with COPD who were hospitalized an average of

1.36 times each (for a total of 10,855 admissions). The length of hospital stay averaged 9.77 days, with the total cost estimated to be $130.7 million.

6.2.5 COPD decompensation programs and costs for higher severity patients

Oxygen, home care, and lung transplants are provided to Albertans as part of provincial health care. The Respiratory Benefits Program (RBP) is one of the benefit areas under the Alberta Aids to Daily Living (AADL) program. The RBP provides funding for respiratory equipment and services to eligible Albertans in three areas: oxygen, positive airway pressure, and other respiratory equipment (tracheostomy tubes, suction machines, aerosol compressors). Requests are submitted by respirologists and reviewed by the Benefit Consultants to ensure that the client meets evidence-based eligibility criteria developed by medical experts. Funding is denied if eligibility criteria are not met. Contracted providers are responsible for providing the type of equipment that is required to meet the client's needs. Short-term oxygen funding is provided initially until adequate testing determines that clients will require oxygen for the remainder of their lives. Once clients have met the requirements for long-term oxygen funding, no further testing is required. The RBP served 11,550 Albertans in 2014 with an average cost of $2,348 per patient. The total cost of this program is thus estimated at about $27 million per year.

Home care programs vary considerably across Alberta, and across the country. There is no available information on how many patients are provided home care, or how many patients in our sample receive oxygen support and are in home care.

Patients on oxygen support may experience decline over the course of the disease. Some of these patients may meet stringent requirements for lung transplant. Forty lungs are transplanted every year in Alberta, and about a third of these are due to COPD (AHS lung transplant team, personal communication, 2015). This implies that 13 lungs were transplanted into COPD patients in Alberta in 2014. Estimated costs for the initial hospitalization for lung transplantation is in the range of $100,000 to $150,000, plus an additional cost of $51,570 for post-transplant care (Gagnon et al. 2004; Public Health Agency of Canada 2007). Therefore, the total cost of COPD lung transplants is an estimated $2 million in 2014.

6.2.6 Gap in disease management: coordination and availability of care services for both higher and lower severity COPD patients, and missing services for higher severity COPD patients

Integration and coordination of care across service providers is essential to good patient care. However, systems are not always in place to ensure that these transitions are smooth, and Alberta is no exception.

Patients with COPD are required to access all services through their family physicians, including specialists, oxygen, palliative care, rehabilitation, and home care services. In order to meet the needs of COPD patients, family physicians interface with a number of different care providers, including specialists (respirologists) and possibly palliative care, depending upon the severity of their disease. Family physicians also receive patients from acute care settings, and refer patients for allied health services such as rehabilitation, education, smoking cessation services, and home care.

In order for physicians to effectively manage patients with COPD, services must be available. Existing capacity for smoking cessation services appears to exist in Alberta, but that may be because of a very low demand for these services. This is not true for pulmonary rehabilitation services; as mentioned above, there are far more patients with COPD that meet the criteria for rehabilitation

than there are spaces. Patients with severe COPD are in need of home care services, but currently there is no available information on home care visits in Alberta.

In addition, pharmaceutical therapy should be used by all patients with COPD. Only 71% of the COPD patients in this cohort (44,575 out of 62,840 patients) received a COPD pharmaceutical therapy.

There is evidence to suggest that the use of non-invasive (NIV) therapy in the emergency department, which is generally administered by a respiratory therapist, is highly effective. Specifically, a Cochrane review suggests that NIV results in fewer complications of treatment (68% reduction), lower risk of intubation (58%), reduced mortality risk (59%), and shorter hospital length of stay (3.24 fewer days) (Lightowler et al. 2003). There is no available information on the use (or availability) of NIV therapy in emergency departments and/or the hospital setting in Alberta.

7. Management of End-Stage COPD

End-stage COPD occurs when lung function declines to the point where a patient requires home care and eventually palliative care. The utilization and cost of end-of-life care services are examined below.

According to Alberta Health, the mortality rate for people with COPD in Alberta was 24.5% between 2011 and 2013. Statistics Canada reports that 1,043 people died from COPD in Alberta in 2011, a number that has increased nearly 40% since 2000 (Statistics Canada 2011).

The cost of end-of-life care for patients with organ failure is estimated to be $40,000 per patient (Fassbender et al. 2009). The sample for this estimate came from Alberta data from 2008 and included COPD patients and those with chronic heart failure and other organ failure. Based on these estimates, more than $40 million per year is spent on end-of-life care for COPD patients in Alberta. For the purposes of this study, these costs are already included in the acute care costs above, as it was not possible to differentiate end-of-life hospitalization costs from the rest. In addition, end-of-life costs might be costs that are only extended to a later time, rather than completely avoided.

8. Distribution of Costs across the Spectrum of Respiratory Health

The use of various COPD-related services and the projected need for these services is shown in Table 4. This table is divided into sequential groups: the entire population over 15 years of age (potential smokers), current and former smokers, people with COPD, and people with end-stage COPD.

Table 4: Alberta healthcare system utilization, cost, and system gaps by stage of respiratory health continuum

Stage of Respiratory Health Continuum	Description of Service	System Utilization	System Service Cost		System Gap in Care		Notes
			Unit Cost	Total Cost	Albertans Served	Cost of Stage	
Prevention	Smoking Prevention Program	NA	NA	$350,000	unknown	$350,000	The Alberta Lung Association holds a youth prevention program.[a]
Smoking Cessation	AlbertaQuits (helpline)	3,922	unknown	$350,000	2,570	$24,576,142	Inbound calls to hotline.
	QuitCore[b,c] (group counselling)	165		$53,400	165		There were 680 spaces available.
	Primary Care Network (PCN) smoking cessation programs	1,892	varies by program	unknown	1,892		There are a number of smoking cessation programs employed. Costs paid through operating budget, could not be deciphered.
	Smoking cessation drugs (ATC code)[d]						57,568 using smoking cessation drugs, assuming individuals only use one drug and do not switch.
	Varenicline (N07BA03)	86,796	$179	$15,536,484	33,796		Per 100-day supply.
	Nicotine	20,594	$313	$6,445,922	7,453		10 per day with 100-day supply.
	Bupriopion (N06AX12)	95,232	$23	$2,190,336	16,319		It is assumed that 1/3 of patients in Alberta taking bupropion is for the purpose of smoking cessation (as opposed to antidepressant).
Diagnosis	Pulmonary function tests[e]	548,074	variable, depending on pulmonary function test	$15,832,552	67,554	$15,832,552	All billing codes 03.37* and 03.38*. See Appendix A, Table A.3 for details.
Lower Severity COPD Treatment (49,107 patients)[f]	General practice[g]	122,542	$54	$6,607,640	38,324	$26,767,366	
	Complex fee code[h]	11,835	$194	$2,547,840	11,829		
	PCN COPD management programs	unknown	unknown	unknown	unknown		Only 2 out of 42 PCNs have an established COPD management program.
	Pulmonologist/ respirologist visits[i]	21,590	$136	$2,931,929	7,098		
	Pulmonary rehabilitation therapy[j]	1,000	$1,530	$1,530,000	1,000		There are waitlists for pulmonary rehabilitation in the province.

	COPD pharmacotherapy	284,808	variable, depending on pharma-ceutical prescribed	$13,149,957	34,835		All drugs prescribed for COPD. See Appendix A, Table A.2 for details.
	Immunizations	unknown	variable, depending on vaccine	unknown	unknown		There are no electronic immunization records in Alberta.
Higher Severity COPD Treatment (13,733 patients)[f]	General practice[g]	34,261	$54	$1,841,856	10,715	$186,959,581	
	Complex fee code[h]	3,301	$194	$710,201	3,307		
	Pulmonologist/respirologist visits[i]	21,604	$136	$817,265	1,985		
	COPD pharmacotherapy	79,629	variable, depending on pharma-ceutical prescribed	$3,665,503	9,740		
	Visits to the emergency room[k]	20,528	$950	$19,501,600	13,733		
	Hospital admissions[k]	10,855	$12,039	$130,683,345	7,983		
	Immunizations	unknown	variable, depending on vaccine	unknown	unknown		There are no electronic immunization records in Alberta.
	Provincial oxygen program[l]	11,550	$2,348	$27,119,400	11,550		Serving as many people as meet criteria for being accepted into the program.
	Received home care for COPD	unknown	variable, depending on level of need	unknown	unknown		
	Received lung transplant for COPD	13	$201,570	$2,620,410	13		

End-of-Life Care	Received end-of-life care	unknown	variable, depending on level of need	unknown	unknown	unknown	End-stage COPD is generally treated in hospital, though start period difficult to identify.
TOTAL COST				**$254,485,641**			

[a] Funding information for smoking prevention youth program obtained from the Alberta Lung Association (personal communication, 2015).

[b] The cost of each session is estimated to be $948 based upon 24 hours of session time, given an hourly wage rate of $39 for the session leader. Additional support of 0.2 FTE is required to coordinate the program, given an annual wage of $80,000 (which amounts to $16,000 for 0.2 FTE) (AHS Tobacco Reduction Program, personal communication, 2015). The total annual cost of staff time for all sessions is then $53,400.

[c] From the AlbertaQuits Helpline Activity and Outcomes Report: April 1, 2014-March 31, 2015. AHS 2015.

[d] Alberta Health 2015a. Bupropion may also be prescribed for mood disorders such as depression. One Canadian study suggests that one-third of all antidepressant medications is prescribed for reasons other than depression (Patten et al. 2007); this scenario has been costed separately in the above table.

[e] Alberta Health 2015a.

[f] Out of the identified COPD cohort of 62,840 patients, 49,107 (78.15%) are considered lower severity COPD because they did not visit the emergency room in the last year (2013/14) with an acute exacerbation, while 13,733 (21.85%) are considered higher severity COPD patients because they did visit the emergency department with an acute exacerbation in the last year. This proportion (21.85%) is used to estimate utilization for which data was unavailable by severity (general practice visits, complex fee code, respirologist visits, and receipt of COPD drugs).

[g] Unit cost for a family physician consultation taken from CIHI (2011) p. 156, and inflated to 2014 Canadian dollars.

[h] Alberta Health 2015a. See Appendix A, Table A.4. Unit cost taken from the 2015 Alberta Schedule of Medical Benefits (*www.health.alberta.ca/professionals/SOMB.html*).

[i] Unit cost for a Respiratory Specialist consultation taken from CIHI (2011) p. 159, and inflated to 2014 Canadian dollars.

[j] Stickland et al. 2012.

[k] 2012 emergency department cost, as well as hospital admission cost, from Alberta IHDA (*www.ahw.gov.ab.ca/IHDA_Retrieval/ihdaData.do)*. Visit data from Alberta Health 2015a.

[l] Alberta Respiratory Benefits Program Data (Mayers 2015).

[m] Number of lung transplants from AHS lung transplant team (personal communication, 2015). Cost estimate based on Public Health Agency of Canada (2007) and data for 2002 for British Columbia (Gagnon et al. 2004), updated to 2012 using the general Consumer Price Index for Alberta (a factor of 1.34).

In Alberta's 2011 population of 3 million (persons over 15 years of age), there were approximately 539,000 current smokers and about the same number of former smokers. Of the current smokers in 2014, an estimated 50,115 to 57,000 people participated in public smoking cessation programs (including PCN programs, AlbertaQuits, QuitCore, and/or used smoking cessation drugs). These data cannot describe the exact number of people who attempted to quit smoking by participating in these programs or therapies, as some may have tried more than one type of drug or program. When interpreting these results, it should be noted that bupropion may be prescribed for depression in addition and/or for smoking cessation purposes.

It is unknown how many current smokers have been screened. Of the current and former smokers, approximately 88,018 individuals aged 40 years and over have been diagnosed with COPD. Currently, we do not have good information on how many are in early or advanced stages of disease progression. However, we do know that, in total, about 1,000 receive pulmonary rehabilitation each year. There are few COPD programs at the PCN-level; as a result, it can be assumed that few patients receive COPD-specific programming and case management.

Of the higher severity, advanced-stage COPD cases, 13,711 visited an emergency department and 7,977 were admitted to hospital, some more than once. Also, 11,550 persons with COPD were oxygen-dependent and 13 received lung transplants.

As seen in Table 4, the total costs of COPD that we could identify or estimate amounted to $254 million. A breakdown of these costs is seen in Figures 4 and 5, including population-based preventive services (for the entire population), services for smokers and former smokers (smoking cessation, counselling, drugs, and screening and testing for COPD), and physician (general practitioners and respirologists) and program services (rehabilitation, COPD drugs) for those with COPD. Individuals with higher severity, advanced stages of disease are defined as those who are treated in an emergency department and may be subsequently hospitalized for COPD (acute exacerbations).

Figure 4: Components of COPD costs in Alberta, total of $254 million (2013)

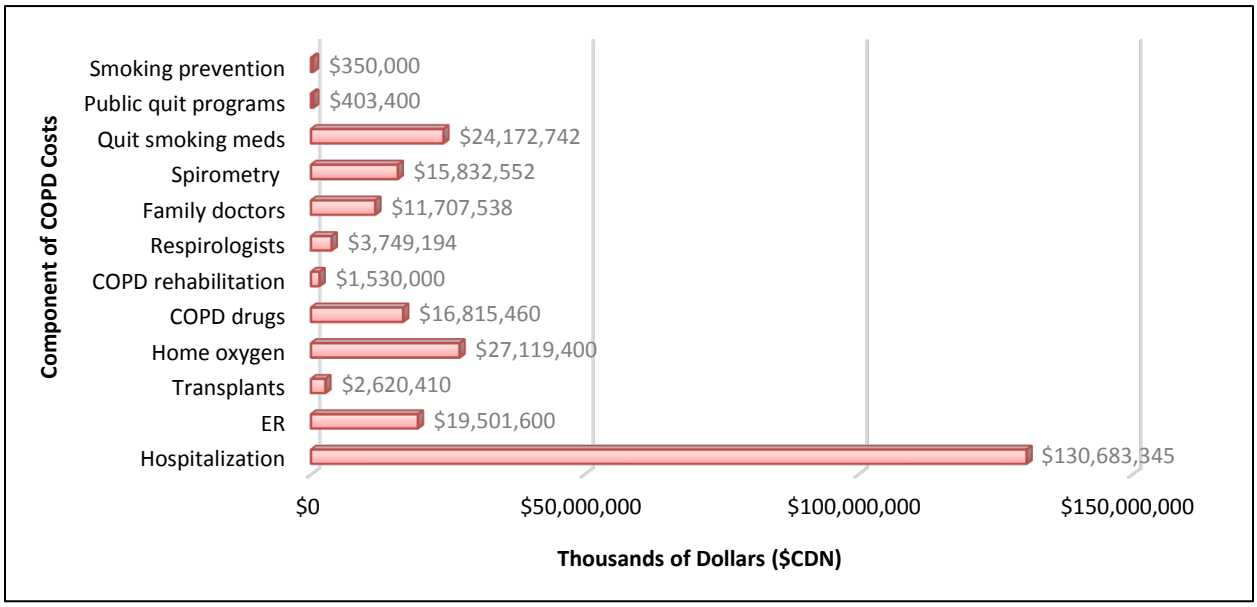
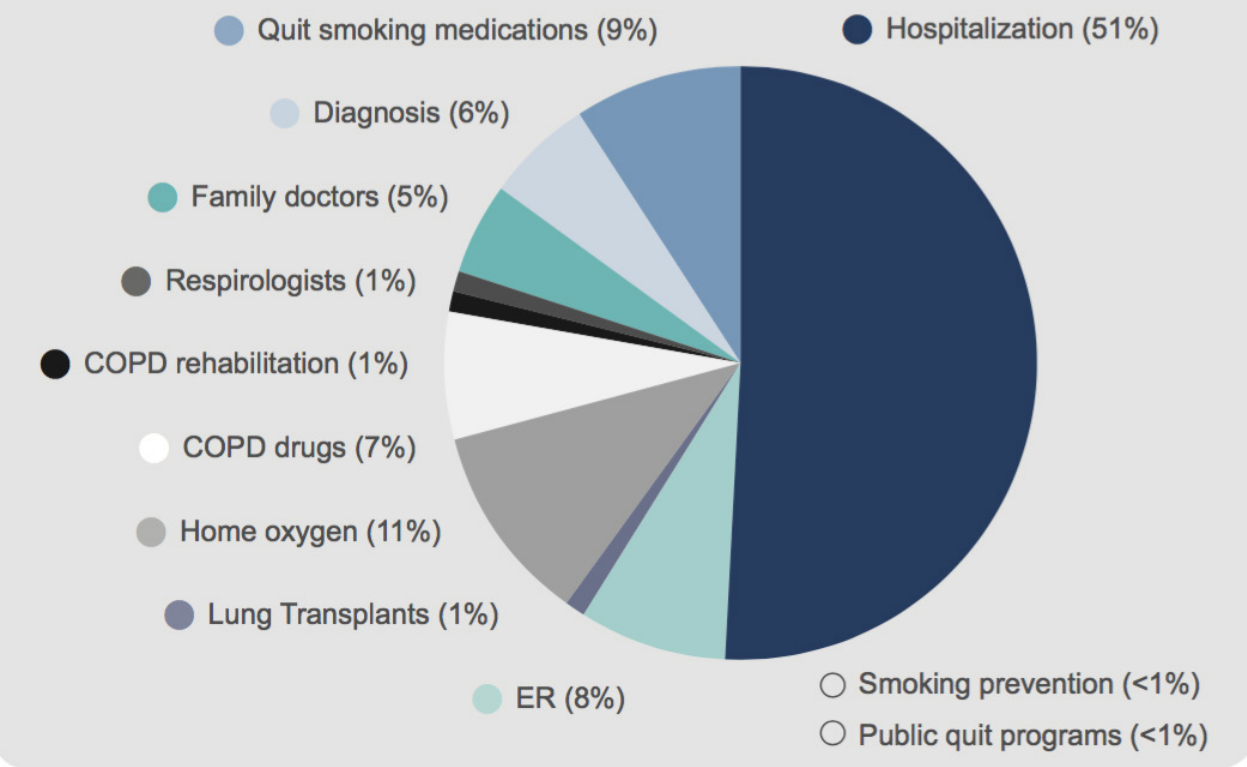


Figure 5: Distribution of $254 million for COPD care services



There are very few services at the beginning of the respiratory health continuum. Anti-smoking and public tobacco cessation programs each make up less than 1% of total expenditures for COPD. Medical services and COPD drugs together make up about 15% of the total costs, while COPD rehabilitation uses less than 1% of COPD resources. Hospital and emergency department services use over 50% of the total amount spent. Together, crisis services use about three-quarters of COPD resources, whereas primary and secondary prevention use less than 2% of all resources.

9. Study Limitations

Our study results should be considered in light of the following limitations:

1) This study is only a one-year snapshot of current resource utilization by a cohort of COPD patients in Alberta. Patient transitions over time in terms of timing of disease progression and associated changes in care and cumulative cost are not captured.
2) The severity of disease is not explicitly available within the administrative datasets, nor is undiagnosed COPD.
3) Hospital and emergency department visits were for patients with COPD but not necessarily because of COPD, as the COPD case definition selected patients with COPD-ICD codes in the primary or secondary diagnosis fields in the administrative datasets. Therefore, the number of visits may overstate COPD-specific visits. Similarly, it may under-estimate the burden/cost, as individuals with COPD may have been admitted for pneumonia or respiratory failure attributable to COPD, but not be captured as being COPD patients in either the primary or secondary diagnosis field.

4) The prevalent cases were likely undercounted, as only two years of records were searched. There is currently no consistent case definition for identifying patients with COPD in the scientific literature; however, we use one of the most common case definitions, which has been previously validated.
5) We were unable to obtain home care costs and costs of COPD care within the PCNs, which would perform the case management function.
6) It was not possible to look at total (or variation) resource utilization at an individual level because all data were aggregated. In other words, it was not possible to link utilization data from our study cohort from AHS (for physician visits, hospitalization, emergency department, and prescription drugs) to program utilization data (rehabilitation, smoking cessation, oxygen, and transplant). This type of analysis would be useful, but would require significant work across many programs and government.
7) Data gaps exist in the cost of tobacco prevention and cessation, especially where funding is derived from operating budgets instead of targeted funding.
8) The number of people taking bupropion for smoking cessation versus all other reasons is not known for this population. Estimated proportions were drawn from the literature and applied to this study sample.
9) Patients with COPD often have multiple comorbid conditions, resulting in possible complications that may be attributed to COPD. Cost estimates may be understated, as only the primary and secondary reasons for a patient's healthcare visit were considered.

10. Conclusions

There is a vicious circle of resource use in the care of persons with COPD. The highest costs are expended for higher severity, advanced stages of COPD, in the form of frequent hospitalizations, emergency department visits, and oxygen supplementation. People with COPD progress through the disease until they reach a point where they need costly and urgent treatments. At the start of the respiratory health continuum, where the movement to progressed disease can be slowed, very few services are provided in the form of primary care and rehabilitation COPD programs, and little documentation is created or made available, especially for smoking cessation and prevention.

Appendix A: Supporting Data

Table A.1: PCN smoking cessation programs and COPD patient care protocol

Zone	PCN	# of patients who utilized PCN tobacco cessation programs 2014/15	Status of current wait list	Annual budget tobacco cessation program	Total amount of time spent counselling each patient	For chronic disease management, indicate if a specific protocol is in place for COPD
Calgary	Bow Valley	96 x 1:1 consultations provided by RNs, LPNs, and Behavior Change Specialist 22 participants in 2 QuitCore courses, each 6 weeks in length (total of 9 hours per course)	Do not gather this information	$1,000 plus % of role for variety of Inter-Professional Team members (this is an expectation of all clinical staff; all clinical staff are trained in the 2-day Tobacco Reduction and Cessation [TRAC] course via AHS)	Do not gather this information	Not in place
Calgary	Calgary Foothills	85	No wait list	$82,500	4-5 hours	Not in place
Calgary	Calgary Rural	Mayo Clinic classes offered 4 times per year, approximately 10 participants per class	No wait list			Not in place
Calgary	Calgary West Central	3T (Tackling Tobacco Together) course is offered 2 times per month	1-month wait list			Not in place
Calgary	Highland	QuitCore is their formalized group program for which 9 patients enrolled in total (4 completed). 1:1 Tobacco cessation is done at the clinic level. 1.2% of patients that see a Chronic Disease Team Member are referred for tobacco cessation. QuitCore: 2 sessions offered (Airdrie and Didsbury) and 2 sessions cancelled due to lack of registrants (Carstairs and		$5,400	QuitCore sessions are 1.5 hours each (typical 1:1 session would be 1 hour for an initial visit and 30 minutes for a follow-up)	Not in place; most clinicians use the COPD Action Plan

Zone	PCN	# of patients who utilized PCN tobacco cessation programs 2014/15	Status of current wait list	Annual budget tobacco cessation program	Total amount of time spent counselling each patient	For chronic disease management, indicate if a specific protocol is in place for COPD
		Crossfield). A total of 6 registered for the session in Airdrie, with 3 people completing the series and 2 completing the evaluation. Both of the registrants completing the evaluations indicated that they were not currently using any tobacco products at all and had not used tobacco products in the last 30 days. In Didsbury, 3 registered, only 1 completed. Evaluation sent directly to QuitCore as per their protocol. It is unknown how many patients received individual counselling for tobacco cessation directly from physicians or members of the Health Management Team.				
Calgary	Mosaic	TRAC - offered monthly (3-session workshop)	No wait list			Initial conversations in regards to developing a COPD program
Calgary	South Calgary	Do not provide any group classes	No wait list			Not in place
Central	Big Country	Tobacco cessation and AHS partner for QuitCore				
Central	Camrose	Do not offer tobacco cessation program; refers all patients into AHS programs				
Central	Drayton Valley	Do not offer tobacco cessation program				
Central	Kalyna Country	Do not offer tobacco cessation program				
Central	Lloydminster	Kick Butt 1:1 cessation counselling and QuitCore				
Central	Peaks to Prairies	52	0	Chronic disease management budget	3 hours (average)	None
Central	Provost	Do not offer tobacco cessation program				

Zone	PCN	# of patients who utilized PCN tobacco cessation programs 2014/15	Status of current wait list	Annual budget tobacco cessation program	Total amount of time spent counselling each patient	For chronic disease management, indicate if a specific protocol is in place for COPD
Central	Red Deer	525, including initial assessments and follow-up (Tobacco Free Family Nurse individual quit smoking program provide 1:1 counselling based on Mayo Clinic model of motivational interviewing; see patients 4 times in person and then follow-up by phone as recommended by evidence.)	Wait time to see provider is 40 days, but do not have a wait list. Factors that affect patient ability to get in include inability of administrative staff to contact patient, TNA in small clinics, and patient schedule.	$123,000	1 hour for initial assessments, 15-30 minute follow-up appointments	Spirometry recommended for: - smokers over 45 - smokers 40+ with: a regular cough, frequent persistent colds, coughing phlegm regularly, a wheeze on exertion or at night, persistent activity related to shortness of breath
Central	Rocky Mountain House	Refer their patients for tobacco cessation to the AHS Respiratory Therapist within AHS, or the physicians make referrals directly to other programming from within their offices				
Central	Wainwright	Do not offer tobacco cessation program				
Central	Wetaskiwin	QuitCore group cessation				
Central	Wolf Creek	All of the clinics (Ponoka, Lacombe, Rimbey, Sylvan) screen all patients for tobacco use Physicians advise, then refer to cessation programs targeting patients over the age of 18 years PCN staff in each community are trained in QuitCore/TRAC Rimbey is currently only community doing Group Classes QuitCore Patients are accepted by self- or professional- referral to Wolf Creek PCN Services				
Edmonton	Alberta Heartland	71	No wait list	Within CDM budget	1 hour (initial appointments) 30 minutes (clinic follow-ups) 15-30 minutes (phone call follow-ups)	None

Zone	PCN	# of patients who utilized PCN tobacco cessation programs 2014/15	Status of current wait list	Annual budget tobacco cessation program	Total amount of time spent counselling each patient	For chronic disease management, indicate if a specific protocol is in place for COPD
Edmonton	Edmonton North	30 (Tobacco cessation program started in 2014 and referrals have been low. Since January 2015, initial appointments, both internal and external referrals, were around 30; 25% of those were no-shows.)	NA	Within department budget	75 minutes (plus follow-up in person or phone, as needed)	None
Edmonton	Edmonton Oliver	QuitCore 5-week program for PCN clients only				
Edmonton	Edmonton Southside	431	No wait list			
Edmonton	Edmonton West	Tobacco reduction education program - workshops can be self-referral				
Edmonton	Leduc Beaumont Devon	Tobacco cessation 1:1				
Edmonton	Sherwood Park Strathcona	27 (TRAC - smoking cessation program has been operating for approximately 3 years. Program consists of a Nurse Practitioner [NP] seconded from AHS to provide support to patients to lower tobacco intake or quit smoking. The NP works about 1FTE and comes in weekly. Patients referred by general practitioner but also accept self-referrals. For whatever reason, there has not been much uptake on the program.)	1 week, maximum			Protocol in place
Edmonton	St. Albert & Sturgeon	Not tracked	No wait list	Within primary care budget	Not tracked	Protocol in place for PC Nurses (2013) currently under review
Edmonton	WestView	Tobacco cessation 3-session program				
North	Aspen	QuitCore program runs in 2 communities as needed, also has a Breathe Easy Program and a Healthy Lung Clinic		Within Chronic Care Program budget		Healthy Lung clinic established

Zone	PCN	# of patients who utilized PCN tobacco cessation programs 2014/15	Status of current wait list	Annual budget tobacco cessation program	Total amount of time spent counselling each patient	For chronic disease management, indicate if a specific protocol is in place for COPD
North	Bonnyville	Tried QuitCore program for group counselling and had poor turnout, resorted to 1:1 consultation by RN	NA	Within Chronic Care Program, budgeted for approximately $550,000 per year		In collaboration with AHS in-kind Respiratory Therapist offer group classes for COPD
North	Cold Lake	1:1 counselling for patients for tobacco intervention. Patients are seen either with the NP or the RN for counselling. The PCN does not have this program, as it would be a duplication of services that is already offered through AHS.	NA	Part of targeted care program – 1:1 counselling	RN and NP doing some counselling about 20 minutes	Started "Lung Wellness" program in February 2015 - this is an outside program brought in as a partner, does spirometry and sees patients on an individual basis, done for 2 days in past year
North	Grande Cache	PCN focused on "Complex care and Chronic disease care", and one main area is tobacco reduction/cessation		Within "Chronic Disease Management" program budget		
North	Grande Prairie	In 2014/15, the "Care Coordination Team" initiated the planning and development of a smoke cessation program to be led by one of Exercise Therapist		Within "Care Coordination Team" program budget		
North	Lakeland	Alberta Screening and Prevention (ASaP) Program to screen for smoking and refer to AADAC who has a program in St. Paul. Sent 50 and 39 quit (in a 2-year period).	NA	Part of targeted care program – 1:1 counselling	RN and/or physician spends 15-20 minutes	Low referrals for Lung clinic where they are able to do Pulmonary Function Tests (PFT), but intending to start up again in the fall
North	McLeod River	Do not offer tobacco cessation program				

Zone	PCN	# of patients who utilized PCN tobacco cessation programs 2014/15	Status of current wait list	Annual budget tobacco cessation program	Total amount of time spent counselling each patient	For chronic disease management, indicate if a specific protocol is in place for COPD
North	Northwest					PCN has 0.6 FTE Respiratory Therapist position (the other 0.4 is covered by AHS). The RT works with PCN's CDM team to assist clients and families to achieve optimal physical health through the provision of consultation, assessment and therapy.
North	Peace Region	Clinic implemented process change in Electronic Medical Record to improve consistency in identifying tobacco users. Tobacco cessation supports identified patients through handouts, relevant websites, info card. Patients can be referred to a Clinical Assistant for follow-up and/or continue to be referred to AHS Addictions and Mental Health for smoking cessation counselling.		Within "Health promotion" program budget		
North	Sexsmith Spirit River	Clinical staff have been trained through the pcnACT program, utilizing the 5A approach. These skills are used mainly in conjunction with the CDM/Complex Care Plan program at present.		Within "Health promotion/Weight management" program budget		
North	West Peace	Clinical staff have been trained through the pcnACT program, utilizing the 5A approach, and continue to utilize tools on a day-to-day basis with patients.		Within "Health promotion/Weight management" program budget		

Zone	PCN	# of patients who utilized PCN tobacco cessation programs 2014/15	Status of current wait list	Annual budget tobacco cessation program	Total amount of time spent counselling each patient	For chronic disease management, indicate if a specific protocol is in place for COPD
North	Wood Buffalo	230 (this does not include brief tobacco cessation counselling during other appointments)	0 (self-referral or physician referral); three staff are available to offer these appointments	No current allotted budget as consumables are free through Alberta Quits (Quit Kits, product information, etc.)	Appointments are booked for 60 minutes; follow-up is per patient request as often as needed to be successful	Working on identifying patients that see us for tobacco cessation that may benefit from being screened for COPD. If they meet the "criteria" we will suggest a PFT to the family physician. If they are diagnosed with COPD, we will then provide them with information on other programs available to them (Pulmonary Rehabilitation, COPD Check) if appropriate.
South	Chinook	224				
South	Palliser	Variable offerings per clinic and no data recorded for Tobacco Cessation programs				

Source: AHS Strategy Implementation Support Primary Health Care, personal communication, 2015

Table A.2: COPD patient drug utilization and cost

Drug group	Description	Number of patients with at least one prescription	Number of prescriptions filled	Unit cost	Cost per prescription filled	Total cost of drugs prescribed
Smoking cessation medication (pills with 100-day supply) - ALL ALBERTANS						
Smoking cessation drugs	Varenicline	33,796	86,754	1.7864	$178.64	$15,497,735
	Bupropion (all reasons)	48,956	285,696			$6,562,437
	Bupropion (assuming 1/3 for cessation)	16319	95,232	0.2297	$22.97	$2,187,479
	Nicotine (10 per day)	7453	20,594	0.313	$313	$6,445,922
Grand total						**$24,131,136-28,506,094**
Inhalers - COPD PATIENTS						
Combination Long Acting Beta Agonists (LABA) and Inhaled Corticosteroids (ICS)	Salmeterol and fluticasone	17,749	61,965	1.6238	$97.43	$6,037,126
	Formoterol and budesonide	13,024	42,720	0.699	$83.88	$3,583,354
	Vilanterol and fluticasone furoate	17	21	4	$120.00	$2,520
Short Acting Beta2 Agonists (SABAs)	Salbutamol	28,386	101,814	0.0252	$5.04	$513,143
Long Acting Muscarinic Antagonists (LAMAs)	Tiotropium bromide	23,904	89,482	2.1667	$65.00	$5,816,419
	Glycopyrronium bromide	468	851	1.77	$53.10	$45,188
	Aclidinium bromide	43	64	0.885	$53.10	$3,398
Short Acting Muscarinic Antagonists (SAMAs)	Ipratropium bromide	6,313	19,692	0.0946	$18.92	$372,573
Long Acting Beta2 Agonists (LABAs)	Salmeterol	409	1,341	0.935	$56.10	$75,230
	Formoterol	396	1,416	0.8181	$49.09	$69,506
	Indacaterol	177	406	1.55	$46.50	$18,879
Combination SABAs and SAMAs	Salbutamol and ipratropium bromide	908	3,517	0.1198	$23.96	$84,267
Medication (pills with 100-day supply) - COPD PATIENTS						
Xanthine bronchodilator	Theophylline	742	4,782	0.135	$40.50	$193,671
Long acting inhibitor of phosphodiesterase type 4 (PDE-4)	Roflumilast	459	2,288	Not covered		
Grand total		**44,575**	**364,437**			**$16,815,460**

Source: AHS data, September 18, 2015, retrieved by AHS Data Integration Management and Reporting

Table A.3: Pulmonary function testing in Alberta (2013/14)

Billing Code	Description	# Claims	# of Discrete Individuals*	# of Discrete Physicians**	Sum of Actual Amount Paid for Fee for Service Bills	Sum of System Amount for Shadow Bills	Total Amount
03.37A	Vital capacity	469	431	22	$4,716	$0	$4,716
03.37B	Timed vital capacity	1,754	1,668	3	$16,681	$0	$16,681
03.38A	Pulmonary function tests, flow volume loops, interpretation	61,625	51,965	59	$824,664	$7,890	$832,554
03.38B	Pulmonary function tests, closing volumes, before and after bronchodilators, interpretation	9,039	8,158	17	$107,293	$0	$107,293
03.38C	Spirometry	58,772	50,371	49	$3,040,863	$0	$3,040,863
03.38D	Vitalometry alone	18,039	15,852	191	$307,193	$425	$307,618
03.38E	Vitalometry before and after bronchodilators	27,804	23,630	107	$541,252	$370	$541,622
03.38F	Flow volume loop measurement before and after bronchodilators only, technical	53,906	46,172	49	$2,173,842	$726	$2,174,568
03.38G	Flow volume loop measurement before bronchodilators only, technical	4,368	3,543	28	$112,814	$623	$113,437
03.38H	Lung volumes, diffusing capacities, mixing efficiency and alveolar CO_2 interpretation	49,528	44,068	46	$1,611,146	$0	$1,611,146
03.38K	Lung compliance	7,617	7,274	16	$554,594	$0	$554,594
03.38M	Residual lung volume	28,535	26,047	29	$885,441	$0	$885,441
03.38N	CO diffusion capacity at rest	49,687	44,236	47	$1,748,486	$0	$1,748,486
03.38P	Oxygen saturation	35,734	28,941	38	$563,168	$0	$563,168
03.38Q	Inhalation challenge test	548	545	21	$124,007	$0	$124,007
03.38R	Interpretation of diagnostic procedures involving vitalometry	46,263	39,183	209	$625,501	$8,302	$633,803
03.38S	Body, plethysmography, technical	47,175	42,075	46	$1,660,560	$0	$1,660,560

03.38T	Body, plethysmography, interpretation	47,170	42,075	46	$906,607	$0	$906,607
03.38X	Asthma exercise test utilizing treadmill or bicycle ergometer	41	41	4	$5,389	$0	$5,389
Total		**548,074**	**67,554**	**332**	**$15,814,215**	**$18,337**	**$15,832,552**

Note: Captures medical billings only, with Out of Province bills and Basic Medical Reciprocal bills excluded.

*The sum of Discrete Individuals in each specific Billing Code will be greater than the overall count of Discrete Individuals because individuals may show under more than one Billing Code.

**The sum of Discrete Physicians in each specific Billing Code will be greater than the overall count of Discrete Physicians because physicians may show under more than one Billing Code.

Source: Alberta Health data, September, 9, 2015, retrieved by Health System Accountability and Performance

Table A.4: Practitioner claims for service code 03.04J with diagnostic codes 291, 492, or 496 (patient age at service 35 years or over) (2014)

Billing Code	# Claims	# of Discrete Individuals	# of Discrete Physicians	Total # of GPs in Alberta	Sum of Actual Amount Paid for Fee for Service Bills	Sum of System Amount for Shadow Bills	Total Amount
03.04J (Complex Care Fee Code)	15,144	15,136	1,377	4,510	$3,253,750.44	$4,291.48	$3,258,041.92

Source: Alberta Health data, November 5, 2015, retrieved by Health System Accountability and Performance

References

Alberta Health [Internet]. Health research in Alberta. Edmonton (AB): Government of Alberta; 2015 [cited 2015 Sept 18]. Available from: *http://www.health.alberta.ca/initiatives/health-research.html*.

Alberta Health [Internet]. Primary Care Networks (PCN). Edmonton (AB): Government of Alberta; 2015 [cited 2015 Oct]. Available from: *http://www.health.alberta.ca/services/primary-care-networks.html*.

Alberta Health and Wellness. *Comprehensive Annual Care Plan*. Edmonton (AB): Government of Alberta; 2009. Available from: *http://www.health.alberta.ca/documents/AHCIP-Bulletin-Med-SpEd-CACP.pdf*.

Alberta Health Services (AHS). AlbertaQuits Helpline Activity and Outcomes Report: April 1, 2014-March 31, 2015. Alberta Health Services; 2015.

Alberta Interactive Health Data Application (IHDA) [Internet]. Edmonton (AB): Government of Alberta; c2016 [cited 2015 Oct]. Available from: *http://www.ahw.gov.ab.ca/IHDA_Retrieval/selectSubCategoryParameters.do*.

Benady S. *The human and economic burden of COPD: A leading cause of hospital admission in Canada.* Canadian Thoracic Society; 2010.

Boschetto P, Quintavalle S, Miotto D, Lo Cascio N, Zeni E, Mapp CE. Chronic obstructive pulmonary disease (COPD) and occupational exposures. *J Occup Med Toxicol* 2006;1(11).

Brooks D, Sottana R, Bell B, Hanna M, Laframboise L, Selvanayagarajah S, et al. Characterization of pulmonary rehabilitation programs in Canada in 2005. *Canadian Respiratory Journal* 2007;14(2):87-92.

Camp PG, Hernandez P, Bourbeau J, Kirkham A, Debigare R, Stickland MK, et al. Pulmonary rehabilitation in Canada: A report from the Canadian Thoracic Society COPD Clinical Assembly. *Canadian Respiratory Journal* 2015;22(3):147-152.

Canadian Institute for Health Information (CIHI). National Physician Database, 2010-2011 Data Release. Ottawa (ON): CIHI; 2011 [cited 2016 Jan 11]. Available from: *https://secure.cihi.ca/estore/productSeries.htm?pc=PCC476*.

Canadian Partnership Against Cancer. Cessation aids and coverage in Canada [infographic]. Toronto (ON): Canadian Partnership Against Cancer; 2015 [cited 2016 Jan 11]. Available from: *http://www.cancerview.ca/idc/groups/public/documents/webcontent/cessation_aid_coverage.pdf*.

Chandra K, Blackhouse G, McCurdy BR, Bornstein M, Campbell K, Costa V, et al. Cost-effectiveness of interventions for chronic obstructive pulmonary disease (COPD) using an Ontario policy model. *Ontario Health Technology Assessment Series* 2012;12(12):1-61. Available from: *http://www.hqontario.ca/en/mas/tech/pdfs/2012/rev_COPD_Economic_March.pdf*.

Chapman KR, Tashkin DP, Pye DJ. Gender bias in the diagnosis of COPD. *Chest Journal* 2001;119(6):1691-1695.

Criner GJ, Bourbeau J, Diekemper RL, Ouellette DR, Goodridge D, Hernandez P, et al. Prevention of acute exacerbations of COPD: American College of Chest Physicians and Canadian Thoracic Society guideline. *Chest Journal* 2015;147(4):894-942.

Evans J, Chen Y, Camp PG, Bowie DM, McRae L. Estimating the prevalence of COPD in Canada: Reported diagnosis versus measured airflow obstruction. *Statistics Canada Catalogue no.82-003-X, Health Reports* 2014;25(3):3-11.

Fassbender K, Fainsinger RL, Carson M, Finegan BA. Cost trajectories at the end of life: The Canadian experience. *Journal of Pain and Symptom Management* 2009;38(1):75-80.

Gagnon YM, Levy AR, Iloeje UH, Briggs AH. Treatment costs in Canada of health conditions resulting from chronic hepatitis B infection. *J Clin Gastroenterol* 2004;38(10 Suppl 3):S179-S186.

Gershon AS, Wang C, Guan J, Vasilevska-Ristovska J, Cicutto L, To T. Identifying individuals with physcian diagnosed COPD in health administrative databases. *COPD: Journal of Chronic Obstructive Pulmonary Disease* 2009;6(5):388-394.

Global Initiative for Chronic Obstructive Lung Disease (GOLD). *Global Strategy for the Diagnosis, Management and Prevention of COPD*. Global Initiative for Chronic Obstructive Lung Disease (GOLD); 2016 [cited 2016 Jan 11]. Available from: *http://www.goldcopd.org/guidelines-global-strategy-for-diagnosis-management.html*.

Green ME, Natajaran N, O'Donnell DE, Williamson T, Kotecha J, Khan S, et al. Chronic obstructive pulmonary disease in primary care: An epidemiologic cohort study from the Canadian Primary Care Sentinel Surveillance Network. *Canadian Medical Association Open Access Journal* 2015;3(1):E15-E22.

Hernandez P. Current status of COPD guidelines in Canada. *Canadian Respiratory Journal* 2006;13.

Hernandez P, Balter MS, Bourbeau J, Chan CK, Marciniuk DD, Walker SL. Canadian practice assessment in chronic obstructive pulmonary disease: Respiratory specialist physician perception versus patient reality. *Canadian Respiratory Journal* 2013;20(2):97-105.

Jacobs P, Moffatt J, Ohinmaa A, Jonsson E. Everybody's business: Economic surveillance of public health services in Alberta, Canada. *The European Journal of Public Health* 2013;23(1):79-82.

Khakban A, Sin DD, FitzGerald JM, Ng R, Zafari Z. Ten-year trends in direct costs of COPD. *Chest* 2015;148(3):640-646.

Labonté LE, Tan WC, Li PZ, Mancino P, Aaron SD, Benedetti A, et al. Undiagnosed COPD contributes to the burden of health care utilization: Data from the CanCOLD study. *American Journal of Respiratory and Critical Care Medicine* 2016.

Lightowler JV, Wedzicha JA, Elliott MW, Ram FSF. Non-invasive positive pressure ventilation to treat respiratory failure resulting from exacerbations of chronic obstructive pulmonary disease: Cochrane systematic review and meta-analysis. *BMJ* 2003;326(7382):185.

Lindberg A, Bjerg A, Rönmark E, Larsson LG, Lundbäck B. Prevalence and underdiagnosis of COPD by disease severity and the attributable fraction of smoking: Report from the Obstructive Lung Disease in Northern Sweden Studies. *Respiratory Medicine* 2006;100(2):264-272.

Løkke A, Lange P, Scharling H, Fabricius P, Vestbo J. Developing COPD: A 25 year follow up study of the general population. *Thorax* 2006;61(11):935-939.

Lundbäck B, Lindberg A, Lindström M, Rönmark E, Jonsson AC, Jönsson E, et al. Not 15 but 50% of smokers develop COPD? Report from the Obstructive Lung Disease in Northern Sweden Studies. *Respiratory Medicine* 2003;97(2):115-122.

Maleki-Yazdi MR, Kelly SM, Lam SS, Marin M, Barbeau M, Walker V. The burden of illness in patients with moderate to severe chronic obstructive pulmonary disease in Canada. *Canadian Respiratory Journal: Journal of the Canadian Thoracic Society*. 2012;19(5):319.

Marciniuk DD, Brooks D, Butcher S, Debigare R, Dechman G, Ford G, et al. Optimizing pulmonary rehabilitation in COPD - Practical issues: A Canadian Thoracic Society clinical practice guideline. *Canadian Respiratory Journal* 2010;17(4):159-168.

Mayers, I. Alberta Respiratory Benefits Program [data file]. Alberta Respiratory Benefits Program; 2015. Unpublished dataset, cited with permission.

National Center for Chronic Disease Prevention and Health Promotion, Division of Adult and Community Health. *Public health strategic framework for COPD prevention*. Atlanta (GA): Centers for Disease Control and Prevention (CDC); 2011.

National Institute for Health and Clinical Excellence (NICE). *Chronic obstructive pulmonary disease: Management of chronic obstructive pulmonary disease in adults in primary and secondary care (partial update). This guideline partially updates and replaces NICE clinical guideline 12*. London: National Institute for Health and Clinical Excellence; 2010.

O'Donnell DE, Hernandez P, Kaplan A, Aaron S, Bourbeau J, Marciniuk D, et al. Canadian Thoracic Society recommendations for management of chronic obstructive pulmonary disease - 2008 update - Highlights for primary care. *Canadian Respiratory Journal* 2008;15(Suppl A):1A-8A.

Patten SB, Esposito E, Carter B. Reasons for antidepressant prescriptions in Canada. *Pharmacoepidemiology and Drug Safety* 2007;16(7):746-52.

Public Health Agency of Canada. *Life and breath: Respiratory disease in Canada*. Ottawa (ON): Public Health Agency of Canada; 2007. Available from: *http://www.healthyenvironmentforkids.ca/sites/healthyenvironmentforkids.ca/files/Respiratory_Disease.pdf*.

Puhan MA, Scharplatz M, Troosters T, Steurer J. Respiratory rehabilitation after acute exacerbation of COPD may reduce risk for readmission and mortality - a systematic review. *Respir Res* 2005;6(1):54.

Qaseem A, Wilt TJ, Weinberger SE, Hanania NA, Criner G, van der Molen T, et al. Diagnosis and management of stable chronic obstructive pulmonary disease: A clinical practice guideline update from the American College of Physicians, American College of Chest Physicians, American Thoracic Society, and European Respiratory Society. *Annals of Internal Medicine* 2011;155(3):179-191.

Statistics Canada [Internet]. CANSIM Table 102-0561: Leading causes of death, total population, by age group and sex, Canada. Ottawa (ON): Statistics Canada; 2011 [updated 2014 Jan 28; cited 2015 Oct]. Available from: *http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=1020561&&pattern=&stByVal=1&p1=1&p2=-1&tabMode=dataTable&csid=*.

Statistics Canada [Internet]. CANSIM Table 105-0501: Health indicator profile, annual estimates, by age group and sex, Canada, provinces, territories, health regions (2013 boundaries) and peer groups, occasional. Ottawa (ON): Statistics Canada; 2015 [updated 2015 Jun 17; cited 2015 Oct]. Available from: *http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=1050501&&pattern=&stByVal=1&p1=1&p2=37&tabMode=dataTable&csid=*.

Statistics Canada [Internet]. Smokers, by sex, provinces and territories (percent). Ottawa (ON): Statistics Canada; 2015 [updated 2015 Jun 17; cited 2015 Oct]. Available from: *http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/health74b-eng.htm*.

Stickland M, Mody C, Graham J, Daniels C, Jensen-Ross C, AHS COPD Working Group. *Chronic obstructive pulmonary disease in Alberta: A summary report*. Edmonton (AB): Alberta Health Services; 2012.

Author Contribution Statements

Arianna Waye contributed to study conception and design, data analysis and interpretation, and approved the final version for publication.

Philip Jacobs contributed to study conception and design, data analysis and interpretation, revision of manuscript for critical content/manuscript preparation, and approved the final version for publication.

Maria Ospina contributed to study conception and design, data collection, and approved the final version for publication.

Michael Stickland contributed to study conception and design, data collection, revision of manuscript for critical content, and approved the final version for publication.

Irvin Mayers contributed to study conception and design, revision of manuscript for critical content, and approved the final version for publication.

This report provides the results of an economic surveillance analysis on the components of the Alberta healthcare system that are devoted to COPD prevention and treatment. It focuses on epidemiology (prevalence and incidence), service use, and cost indicators, and identifies gaps in the system that presumably add to the overall economic burden of COPD.

Institute of Health Economics
1200 – 10405 Jasper Avenue
Edmonton AB Canada T5J 3N4
Tel. 780.448.4881 Fax. 780.448.0018
info@ihe.ca

www.ihe.ca

ISBN 978-1-926929-67-5 (online)