Spirometry in Yukon:
Options for Improved Service Delivery

River Walton, MPA Candidate
School of Public Administration
University of Victoria
2022

Supervisor:	**Dr. Rebecca Warburton** **School of Public Administration, University of Victoria**
Second Reader:	**Dr. Astrid V. Pérez Piñán** **School of Public Administration, University of Victoria**
Chair:	**Dr. Richard Marcy** **School of Public Administration, University of Victoria**

Table of Contents

List of Tables

List of Figures

Acknowledgements

First and foremost, thank you to my friends and family for supporting me through this process. It has been a long road, and I wouldn't be taking these final steps without your encouragement.

Thank you to the Chronic Disease Management Team for acting as my client in the early days of this project. It was a pleasure learning from and working alongside all of you.

I would also like to acknowledge the Government of Yukon for supporting me in my pursuit of this master's degree. I have had the pleasure of working with some of the most dedicated and passionate public servants in the country and would encourage anyone thinking about a career in public service to consider the Yukon. It is quite simply a wonderful place to live, work, and play.

Thank you to Dr. Rebecca Warburton for your patience over the course of this project. It has been several more years than either of us probably expected, but your guidance and unwavering support has been so appreciated.

To my wife, Justine, thank you for being with me for every step of this journey. And thank you to our beautiful baby girl, Mina Rose, for being such a force in this world. You make everything worth it.

Executive Summary

Diseases related to lung health, such as chronic obstructive pulmonary disease (COPD) and asthma, have serious impacts on the health and wellbeing of Canadians. COPD is a leading cause of mortality in Canada. It is also an expensive disease to manage, posing significant economic challenges to provinces and territories working to administer health services within their budget. More importantly, COPD causes significant challenges with an individual's quality of life.

Better management of the disease leads to a better quality of life and reduced costs to the health care system. An important factor in managing COPD is the appropriate diagnosis of the disease. Spirometry, a technique used to measure lung function, is a tool used by health care providers to appropriately diagnose and manage lung conditions. For several reasons, this tool continues to be underutilized.

The purpose of this project is to provide recommendations to senior leadership within the Government of Yukon that will improve the delivery of spirometry services in the territory. By providing leadership with accurate information, the researcher intended to support an evidence-informed decision on how best to provide spirometry services to Yukon residents.

The primary research question is:

- What can the Government of Yukon do to ensure that quality spirometry testing is available when clinically appropriate?

To answer this question, an analysis of the current state as well as an exploration of possible solutions was undertaken. To that end, this project aims to:

- provide an accurate estimate of required tests per year, based on promising practice guidelines;
- identify an acceptable wait time standard for testing;
- identify what components are required for the successful delivery of spirometry services;
- identify the deficiencies that exist with the current model; and
- identify other models of service available and describe how they could be successfully implemented.

Methods

To determine appropriate spirometry service delivery in the territory, the project used available data from Yukon to understand the current context and explored the effectiveness of other models through a jurisdictional scan. A literature review was undertaken to identify the promising practices and lessons learned through academic research.

Key findings

The literature review identified two leading spirometry guidelines: the American Thoracic Society / European Respiratory Society guidelines, as well as the GOLD guidelines. A third set of guidelines, the Canadian Thoracic Society Guidelines, build off the ATS/ERS guidelines, providing a list of concrete recommendations for the Canadian context.

The CTS guidelines provide recommendations related to individuals conducting and interpreting a spirometry test, training for spirometry, appropriate reference values, proper equipment and calibration for use, and quality assurance in testing.

Through rigorous analysis of the literature review and jurisdictional scan, the researcher has identified several key themes for a successful spirometry program. These include:

- appropriate credentials for testing
- appropriate credentials for interpretation
- proper training for staff
- proper quality control
- appropriate equipment
- standardized spirometry protocols

Recommendations

To provide the best service to the most Yukoners possible, the researcher submits the following five recommendations for consideration:

Short-term action

1. That the Government of Yukon standardize spirometry testing protocols by either adopting the CTS guidelines for spirometry or drafting territory-specific guidelines.

2. That the Government of Yukon turn to a company specializing in lung health services for the delivery of spirometry in the territory.

Medium-term action

3. That the Government of Yukon develop a quality assurance program to ensure that those performing spirometry continue to provide reliable testing results. It is strongly recommended that the quality assurance program include minimum educational requirements and training standards for those conducting a spirometry test.

Long-term action

4. That the Government of Yukon implement regulations limiting spirometry interpretation to physicians or nurse practitioners who have completed an interpretation course, if interpretation were to be considered within Yukon in the future. At this time, all

spirometry interpretation is conducted by specialist physicians in respirology in British Columbia.

5. That the Government of Yukon consider working with Yukon First Nations governments to understand how the lack of reference values for the Indigenous population affects the diagnosis of lung disease.

1. Introduction

Diseases related to lung health, such as chronic obstructive pulmonary disease (COPD) and asthma, have serious impacts on the health and wellbeing of Canadians. In 2011, COPD was the primary factor in 4.4 per cent of all deaths in Canada for individuals 40 years of age and older (Bryan and Navaneelan, 2015, p. 4). According to Dang-Tan, TIsmaila, Zhang, Zarotsky and Bernauer (2015). COPD is the fourth leading cause of death in Canada, behind only heart disease, cancer, and stroke (p. 465). COPD is one of the most common causes of hospitalizations in Canada (Gershon, Hwee, Croxford, Aaron and To, 2014, p. 272). This may be attributed to the link between smoking and the onset of COPD. The World Health Organization (WHO) has also declared COPD as the fourth most common cause of death worldwide.

Not only is COPD a leading cause of mortality in Canada, it is also an expensive disease to manage, posing significant economic challenges to provinces and territories working to administer health services within their budget. More importantly, COPD causes significant challenges with an individual's quality of life.

Better management of the disease leads to a better quality of life and reduced costs to the health care system. An important factor in managing COPD is the appropriate diagnosis of the disease. Spirometry – a technique used to measure lung function – is a tool used by health care providers to appropriately diagnose and manage lung conditions.

1.1 General problem

Smoking and tobacco use continue to contribute to the preventable deaths of Canadians every year. Health Canada estimates that 45,000 Canadians die from tobacco-related disease each year (Government of Canada, 2021). A majority of patients diagnosed with COPD are current smokers or have smoked in their lifetime (Bryan and Navaneelan, 2015, p. 3). Yukon has one of the highest smoking rates in Canada, so one would anticipate that a higher rate of COPD and lung disease likely exists in the territorial population. While smoking is the leading factor in developing COPD, other contributing factors may include second-hand smoke, air pollution (wood smoke, traffic pollutants), and occupational pollutants or noxious substances.

In a national survey, four per cent of respondents self-reported a diagnosis of chronic bronchitis, emphysema, or COPD (the Canadian Community Health Survey, as cited in Evans, Chen, Camp, Bowie, and McRae, 2014, p. 3). Research indicates that these diseases are often misdiagnosed, suggesting their prevalence is even higher than reported. Evans et al. (2014, p. 7) estimate that actual prevalence of airflow obstruction and lung issues is two to six times

greater than the self-reported numbers, meaning between 10 to 25 per cent of all Canadians may experience some form of airflow obstruction disease in their life. While asthma is more likely to be found in younger individuals, the prevalence of COPD increases significantly for individuals forty and older (Soriano, Zielinksi and Price, 2009, p. 721). Due to continued exposure to COPD risk factors and an aging population, the COPD burden in Canada, and across the world, is expected to increase in the coming decades (Global Initiative for Chronic Obstructive Lung Disease, 2017, p. 7).

Appropriate testing is an important tool in the diagnosis and management of lung disease. The spirometry test allows medical practitioners to diagnose an individual with a lung-related illness such as asthma or COPD and rule out other contributors such as congestive heart failure (Camp and Levy, 2008, p. 83).

Proper diagnosis of debilitating lung function diseases can lead to better treatment outcomes and better management of the disease. Without proper testing, patients may be prescribed unnecessary medications or be misdiagnosed with a disease with similar symptoms. Misdiagnosis could also result in patients being unable to access appropriate medications that can help alleviate symptoms. There are many steps that can be taken to improve patient health; accurate diagnosis is the first step.

Spirometry is the most common lung function test and the most valid method for establishing a COPD diagnosis. It is also used to diagnose other diseases related to lung function, such as asthma. This test is important for the early identification and treatment of lung disease; however, estimates suggest that only thirty to fifty per cent of Canadians with COPD are diagnosed using spirometry (Gershon et al., 2017, p. E530). Clinical best practice for the management of lung disease is to diagnose the issue as early as possible as well as to monitor disease progression.

Unfortunately, spirometry services are underutilized (Kaplan, Levitz and Petrasko, 2017, p. 229). Historically, the Yukon Hospital Corporation (YHC) has been the main provider of spirometry services in Yukon. Tests have been performed through the laboratory at Whitehorse General Hospital. Though possibly underutilized, the number of spirometry requisitions has increased over the years, putting undue pressure on the laboratory to provide the requested number of spirometry tests. Senior management within the Department of Health and Social Services requested the researcher recommend a long-term solution for spirometry services by May 31, 2018 (see S. 1.3 for more explanation about the client). The current structure of spirometry services in Yukon is not sustainable, particularly with an aging population and further stresses on the acute care environment. Senior management was interested in learning about efficient and effective service models that were flexible to changing government resources and staff capacity.

1.2 Research question and project objectives

The purpose of this project is to provide recommendations to senior leadership within the Government of Yukon that will improve the delivery of spirometry services in the territory. By providing leadership with accurate information, the researcher intended to support an evidence-informed decision on how best to provide spirometry services to Yukon residents.

The primary research question to be answered is:

> What can the Government of Yukon do to ensure that quality spirometry testing is available when clinically appropriate?

In order to answer this question, an analysis of the current state as well as an exploration of possible solutions was undertaken.

To that end, this project aims to:

- provide an accurate estimate of required tests per year, based on promising practice guidelines;
- identify an acceptable wait time standard for testing;
- identify what components are required for the successful delivery of spirometry services;
- identify the deficiencies that exist with the current model; and
- identify other models of service delivery and describe how they could be successfully implemented.

1.3 Project client

The researcher was an employee of the Department of Health and Social Services with the Government of Yukon from 2010 to 2018. The project client was the Project Manager of the Chronic Disease Management stream of the Territorial Health Investment Fund (THIF). The Project Manager reported directly to the Assistant Deputy Minister of Health Services.

The THIF is time-limited federal funding provided to all three territories to help facilitate the transformation of their health systems (Government of Canada, 2016). This funding was set to end on March 31, 2018; however, the federal government announced an extension to funding through March, 2023.

At the time of the request for this research project in 2017, THIF funding in Yukon had been allocated to two initiatives within the Department of Health and Social Services: the Mental Wellness stream and the Chronic Disease Management stream (Government of Yukon, 2017). Both streams focus on improving quality of care across the territory, increasing access to services, and improving capacity of providers.

The Chronic Disease Management stream had several projects that relate to improving access to care for patients living with a chronic condition. Some of the projects completed by the Chronic Disease Management team included the introduction of home health monitoring for patients with COPD; the improvement of spirometry services in the territory; a pilot evaluation of virtual visits for home care clients; improved wound care management; and a pilot project and evaluation on the use of continuous glucose monitors for individuals 25 and under with Type 1 Diabetes.

In June 2018, the researcher began a new position with the Government of Yukon, working on improving services in palliative care. In 2019, the researcher transitioned to the Executive Council Office, working in intergovernmental relations. These career transitions did not allow appropriate focus for this 598 project. The researcher used parental leave in 2021 to complete the remaining work required to submit this paper.

Prior to leaving the position with the Chronic Disease Management team, the researcher submitted an options paper to senior management on spirometry services in Yukon. The paper was based on an initial literature scan.

1.4 Methods

To determine appropriate spirometry service delivery in the territory, the project used available data from Yukon to understand the current context and explored the effectiveness of other models through a jurisdictional scan. A literature review was undertaken to identify the promising practices and lessons learned through academic research.

1.5 Deliverables

The primary deliverable for this project is the final report produced through this research, including a literature review, jurisdictional scan, and recommendations to assist Government of Yukon senior management with evidence-informed decision-making related to the delivery of pulmonary function testing in Yukon.

1.6 Ethical review

This research project did not require University of Victoria Human Research Ethics Board approval. Due to the methodology selected, research only required the review of aggregate data and relevant documentation from the Government of Yukon, the review of various documents received from jurisdictions contacted in the jurisdictional scan, and a literature review. No interviews or use of person-level health data were involved.

1.7 Organization of report

The report is structured in the following eight sections:

Section 1: Introduction
This section summarizes the problem of lung disease, COPD and the delivery of spirometry services. It also details the primary and secondary research questions and the objectives of this project.

Section 2: Background
This section provides an overview of Yukon's context, as well as a brief description of health services in the territory. The section also introduces COPD and spirometry services in Yukon.

Section 3: Methods
This section provides a summary of the methods used to conduct the research and answer the primary and secondary research questions. It also includes a breakdown of the scope and limitations of the research.

Section 4: Literature Review
In the fourth section, an overview of the literature related to COPD and spirometry is examined. It describes how the literature review was completed and provides in-depth definitions of COPD and spirometry. The section provides a brief overview of the main guidelines discussed in the literature related to spirometry services, then goes on to describe some of the models of delivery reviewed in the research. Finally, the section describes some of the main barriers to spirometry delivery.

Section 5: Jurisdictional Scan
This section examines the different models of delivery identified through the jurisdictional scan, including provincial and territorial jurisdictions in Canada.

Section 6: Findings
In this section, the results of the different methods are described. This includes an overview of the data related to spirometry delivery in Yukon, and the key aspects of a spirometry program identified in the literature and jurisdictional scan.

Section 7: Discussion
This section provides an analysis of the findings and literature review, describing the key themes identified and how an appropriate model of delivery can be implemented in Yukon's unique context.

Section 8: Conclusion and recommendations
Drawing from the findings and discussion, this section provides recommendations to direct the best way forward for spirometry service delivery in Yukon. It also provides concluding remarks on the project.

2. Background

Yukon is a territory in the northwest of Canada, bordered by British Columbia, the Northwest Territories and Alaska. It is the smallest of the territories, both geographically and in terms of demographics, with a 2020 population of 42,230 (Yukon Bureau of Statistics, 2021, p. 1). While it remains the smallest jurisdiction in Canada, the population of Yukon is growing, experiencing a 21 per cent increase in population between 2010 and 2020. By way of comparison, the population of British Columbia increased by 14 per cent over the same period.

Whitehorse, the capital city of Yukon, is home to 78 per cent of the population. The remainder live in a dozen communities spread across the rest of the territory. These towns have a population ranging from 59 to 2,277 inhabitants (Yukon Bureau of Statistics, 2021, p. 18).

All citizens of Yukon are entitled to quality healthcare, similar to what is available in the southern provinces. The Government of Yukon spends more per person on health services than almost any other jurisdiction in Canada. The dollar figure is estimated to be approximately $8,000 per Yukoner per year, which is more than 1.65 times the national average (McLennan, Green, Marchildon, Strand and Zelmer, 2020, p. 20).

2.1 Healthcare delivery challenges

The Department of Health and Social Services works to deliver the right services, at the right time, and in the right place. Several factors make the delivery of health services more challenging and more expensive in Yukon compared to the rest of the country. Not only is Yukon a small, remote jurisdiction, but geographic and demographic challenges further exacerbate the issue.

The population of Yukon is aging. From 2010 to 2020, the population of Yukon experienced a 70 per cent increase in individuals aged 60 and older (Yukon Bureau of Statistics, p. 2). The incidence of chronic conditions is closely tied to age, so an aging population will mean an increase to the number of chronic and complex conditions in Yukoners. Given the current spending pattern, and the significant costs associated with chronic conditions, costs are only expected to increase.

As part of an audit of the health services and programs available in Yukon, Fraser (2011) acknowledged a number of issues that affect the sustainability of health care systems in Yukon, including: an aging population, increase in incidence of chronic disease, advances in technologies and pharmaceuticals and their expense, human resource challenges, and rising costs of service delivery (p. 3). Geographical challenges further impact the delivery of health services. While services are available in Whitehorse, many are also needed in smaller communities across the territory.

Chronic diseases may ultimately lead to death, but also lead to many interactions between patients and the healthcare system. Emergency department visits, physician visits, home care, and hospice care are all associated with lung disease. Interactions between the patient and these providers increase as the disease progresses. Not only will more resources within the health service be utilized, but more importantly patient quality of life deteriorates. As symptoms progress, patients find activities of daily living more and more difficult.

Life expectancy and perceived health status are worse in Yukon than in other parts of Canada. This could in part be explained by the fact that Yukon has some of the highest rates of smoking and heavy drinking in Canada. McLennan et al. (2020) indicate that 20.2 per cent of Yukoners smoke daily or occasionally, compared to a national average of 16 per cent across Canada. Similarly, they note that Yukon has one of the highest rates of heavy drinking in the country.

Health data indicates that Yukon has a higher incidence of smoking, asthma and COPD than the national average (Yukon Bureau of Statistics, p. 24). According to the Canadian Lung Association (2005), the territories have the highest COPD hospitalization and mortality rates in Canada (p. 35).

3. Methodology

This section introduces and describes the methodology used for this qualitative study, which employed a multi-methods approach. The research project used three sources of information, including available data from Yukon, a literature review, and a jurisdictional scan.

3.1 Yukon data

Using available data for Yukon provides context for the issue. It helps describe the current state of spirometry services in the territory and allows the researcher to extrapolate the needs if the territory were to meet promising practices in service delivery identified through the literature review and jurisdictional scan.

To better understand the current context, the researcher was interested in knowing the rates of COPD in Yukon, asthma rates in the territory, and the history of spirometry services in the territory, including the number of tests performed and the location of service.

Research was conducted using both public and private sources. Information was sought through public access to data sources such as CIHI and the Yukon Bureau of Statistics. There is limited public data available regarding spirometry services in Yukon. Much of the documentation reviewed was accessed through employment with the Government of Yukon. The documents are internal to the department and cannot be accessed by outside sources. These sources included the Yukon Hospital Corporation, the Insured Health Services division of the Department of Health and Social Services, and TrueNorth Respiratory Services.

3.2 Literature Review

The literature review covered academic sources available across the globe, with a particular emphasis on research conducted in North America and Europe. Both academic and grey literature were reviewed. Literature was acquired using the University of Victoria library catalogue, as well as other academic search engines like Google Scholar. A department librarian was also consulted on the literature search and based on feedback received, the database MEDLINE was also used.

The following search terms were included in the research, in various combinations:

- spirometry
- lung function
- test
- best practice
- smart practice
- promising practice

- Canada
- province
- rural
- remote
- northern
- standards
- delivery
- obstructive
- lung disease

To reduce analysis, the search terms were limited to article titles published in the last twenty years. Only articles written or translated into English were reviewed. Additional sources were found within the reference lists of articles reviewed.

3.3 Jurisdictional Scan

A jurisdictional scan enables comparison between different organizations – in this case within provinces and territories in Canada. It complements the literature review by providing examples of spirometry delivery in the provincial and territorial government context. Kilian, Nidumolu and Lavis (2016) believe that jurisdictional scans can reveal how other jurisdictions have framed the problem as well as provide potential options to consider in proposing more efficient and effective solutions. Using this method may provide promising practices being utilized outside of Yukon.

Attempts were made to contact each province and territory in Canada. The researcher visited each jurisdiction's public health website to review information on spirometry publicly available. Emails were sent to health inquiry contacts, or general inquiry contacts if not specific to health. Lung health associations in each jurisdiction were also contacted. Some organizations responded with email contact information of another organization that may have additional information. These groups and organizations were also contacted.

Each inquiry requested documents that would provide information on the number of spirometry tests performed each year, the average wait time for a test, the model of service delivery, the responsible care provider for conducting the spirometry test, and the individual performing interpretation of spirometry tests.

In total, thirty emails were sent to various jurisdictions and organizations. The researcher received a total of fourteen responses that provided useful public or internal government documents. The findings were interpreted using a thematic analysis by categorizing the themes identified through the responses received and grey literature available on provincial and territorial government websites.

3.4 Scope and Limitations

Timing of the research is a limiting factor. Research was conducted from 2017 to 2018. Due to personal and professional circumstances, the researcher took time away from this project. While the paper was completed in 2021, new research was not conducted. There may be important new research available in the realm of spirometry that is not captured in this project.

Another limitation lies within the literature review. While a comprehensive review of the literature was conducted, it is possible that important studies or documents may have been missed. For example, only research available in English was reviewed. The researcher decided not to reference any materials produced before 2000, believing that any research in spirometry before that time would likely be dated and possibly unhelpful. The researcher consulted with a department librarian to focus the research and analyzed the reference list for each article to guide further research.

Another limitation included a lack of response from some jurisdictions and organizations. Several provinces and one territory did not respond to the researcher's request for documents. All organizations and individuals contacted in writing were informed that their responses, and the report itself, could be kept confidential if the information they shared was sensitive or privileged. No responses shared with the researcher requested that it be kept confidential; though some did ask that the final report be shared for their information and to inform decisions in other jurisdictions. The researcher confirmed that a copy of the final research report would be provided to those that requested follow-up.

Finally, the researcher is a permanent employee with the Government of Yukon, and had worked within the Department of Health and Social Services at the time the research was being done. While this indicates there is a possibility for researcher bias, every effort was made to be as objective as possible in the research and analysis. Senior leadership supported an objective review, asking the researcher to review all possible options and recommendations for the delivery of spirometry services for the Yukon.

4. Literature Review

This literature review was conducted to better understand the academic evidence associated with COPD, spirometry and clinical promising practices related to service delivery. This chapter will define COPD and spirometry. It will also explore the specific activities and approaches that have been used to deliver effective spirometry in Canada and internationally. Finally, barriers to spirometry delivery will be identified.

Information gathered through the literature review ensures the relevant and noteworthy findings and research are identified. The literature review will contribute to identifying promising practices and objectives for the delivery of spirometry services. If possible, any evidence related to diagnostic analysis for lung disease, including suggested wait times for referral and testing will be used to support proper implementation in Yukon.

4.1 Defining chronic obstructive pulmonary disease

Chronic obstructive lung disease (COPD) is a debilitating disease that causes breathlessness due to an obstruction or blockage in the airway (Lareau, Fahy, Meek and Wang, 2019). COPD is a chronic condition, meaning that the disease progresses over a long period of time. Symptoms of COPD include: shortness of breath, coughing or wheezing, mucus production, chest tightness, recurring respiratory infections, and energy loss. Flare-ups of COPD symptoms, more commonly known as exacerbations, cause damage to the lungs due to inflammation and eventual scarring of the airways and alveoli. There is no cure for COPD; however, managing symptoms can help slow the progress of the disease.

From the literature reviewed, there seemed to be consensus that, while environmental factors play a role, the major risk factor in acquiring COPD comes from smoking tobacco (Hill, 2010, p. 673; Bryan and Navaneelan, 2015, p. 3). Bourbeau et al. (2019) conclude smoking history is the most important risk factor in developing COPD (p. 211). This is particularly true in North America; however, in developing countries, indoor biomass exposure is another important risk factor. While smoking is the leading factor in developing COPD, other contributing factors may include second-hand smoke, air pollution (wood smoke, traffic pollutants), and occupational pollutants or noxious substances. There is also evidence that low socioeconomic status is a risk factor in developing COPD (Global Initiative for Chronic Obstructive Lung Disease, 2017, p. 13).

Gershon, Warner, Cascagnette, Victor and To (2011) conducted a longitudinal cohort study to estimate the risk of developing COPD in North America. They found that one in four individuals are likely to be diagnosed with COPD during their lifetime. Their findings suggest that the risk is even higher for those in rural or remote settings, where the risk is calculated to be 33 per cent (p. 994).

As a chronic illness, COPD can require significant interaction with the healthcare system. It is common for patients to require physician support and emergency department visits to address symptoms and exacerbations. As the disease progresses, and activities of daily living become more challenging, individuals with COPD will likely see their interactions with the healthcare system increase further, be it for home or hospice care. Significant resources are needed to address the symptoms, and patient quality of life is poor. Hill et al. (2010) believe that early intervention could result in reduced mortality and use of health care resources related to COPD (p. 677).

Though COPD is known to be a serious disease across the world, there seems to be underdiagnosis of COPD among primary care providers. Some estimates suggest that only half of individuals with COPD have been properly diagnosed (Mann and Nichols, 2009, p. 458). The disease shares symptoms with several other chronic conditions, including asthma and congestive heart failure. Lung function testing is a tool that can distinguish between these diseases, supporting healthcare providers in confirming an accurate diagnosis.

Unfortunately, there is considerable evidence that physicians rely solely on clinical examination of symptoms to make these important determinations (Saad, Dedeno, Metz and Bourbeau, 2014, p. 1). For example, Moore (2007) found that 19 of the 25 physicians interviewed in her research had not used spirometry to diagnose COPD (p. S24). Instead, they relied on smoking history, symptoms and past diagnoses to make the determination. Waiting for serious symptoms to be present before making a diagnosis has serious consequences for the patient. Enright (2008a) asserts that COPD is often undetected until an individual loses more than half of their lung function (p. 387). Due to the anatomy of the lungs, this function cannot be regained and any airflow limitations cannot be fully reversed.

Diagnosis based on symptoms can also lead to overdiagnosis or misdiagnosis (Gershon et al., 2014, p. 277). Detecting the disease early may help decrease the burden of the disease, both on the patient and on the healthcare system. Desjardins, Boulay, Gagne, Simon and Boulet (2020) note that COPD is often confused with other chronic conditions, resulting in increased morbidity and mortality of patients (p. 149). They believe that untreated symptoms lead to preventable exacerbations, affecting both the quality of life of the individual with undiagnosed COPD as well as the healthcare system that sees a higher number of emergency room visits and hospitalizations as a result (p. 150).

4.2 Defining spirometry

The leading lung function test – spirometry – is a non-invasive way to measure the amount of air inhaled, the volume of air exhaled as well as the rate and force with which the air is exhaled over time. The results of a spirometry test help

diagnose chronic lung diseases such as asthma and COPD. It is also used to check the condition of an individual's lungs, to help determine the progression of a disease or to determine the effectiveness of prescription drugs in managing symptoms.

It is clear from the literature that spirometry is the most valid method for establishing a COPD diagnosis. The Global Initiative for Chronic Obstructive Lung Disease (2017, p. 27) confirmed spirometry as the gold standard for the diagnosis and management of COPD. In fact, spirometry testing can detect COPD even before significant symptoms develop, confirming its presence in early or moderate stages of the disease (Mehta, Desai and Patel, 2016, p. OE09).

Traditionally, spirometry testing has been performed within a hospital laboratory by respiratory therapists or pulmonary function technologists (Cawley and Warning, 2015, p. 727). The standardization of spirometry was first discussed by the American Thoracic Society in 1979 (Miller et al., 2005, p. 320). European standardization followed in 1983.

By using spirometry to appropriately diagnose COPD, healthcare providers are better able to manage their patient's health status, reducing exacerbation rates and improving quality of life over a longer period (Joo, Au, Fitzgibbon, McKell and Lee, 2011, p. 1272).

4.2.1 The spirometry procedure

There are three phases to a spirometry test maneuver: maximal inhalation, a "blast" of exhalation, and continued, complete exhalation to end the test (Miller et al., 2005, p. 323). These three phases determine an individual's forced vital capacity (FVC) and forced expiratory volume in one second (FEV1). The FVC is the maximum volume of air exhaled from full inspiration. The FEV1 is the volume of air exhaled in the first second of the FVC maneuver. Forced expiration should take no more than fifteen seconds.

Once a spirometry maneuver is completed, the subject can rest before completing another maneuver. The technician ensures the subject completes three acceptable maneuvers. This may take more than three attempts, but generally should not require more than eight.

After a baseline is established, the subject is given bronchodilator medication and asked to perform the test again. This helps determine whether airflow limitation can be improved by therapy, allowing the interpreter to appropriately diagnose the disease in question.

The spirometry procedure can take up to 30-45 minutes to complete.

Table 1: Spirometry procedure
1. Check spirometer calibration. 2. Explain the test procedure, demonstrate to subject. 3. Subject inhales completely with a short pause (<1s) at total lung capacity. 4. Subject exhales maximally until no more air can be expelled. 5. Repeat instructions as necessary, coaching vigorously. 6. Repeat for a minimum of three maneuvers, no more than eight attempts. 7. Provide bronchodilator medication and repeat procedure. Adapted from Miller et al., 2005

4.3 Identified spirometry guidelines

Throughout the literature reviewed, three distinct guidelines were identified that provide some direction on the use of spirometry. The American Thoracic Society (ATS) and European Respiratory Society (ERS) guidelines (Miller et al., 2005) were the most cited throughout the literature. The Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines were also cited by several sources, particularly those from outside North America. Some literature included the Canadian Thoracic Society (CTS) guidelines (Coates et al., 2013), but these were not prominent in literature outside of Canada. The CTS guidelines were developed based on the standards identified by the ATS/ETS guidelines.

All three guidelines are relatively similar, relying on spirometry results to diagnose and stage the disease, as well as to support appropriate treatment based on disease severity.

4.3.1 American Thoracic Society / European Respiratory Society

A significant number of articles reviewed through this research project identified the ATS/ERS as a guide for the use of spirometry.

The ATS first released a statement on the standardization of spirometry in 1979, with updates in 1987 and 1994. A similar process developed in Europe, with the first European standardization statement released in 1983 and updated in 1993. In 2005, the ATS and ERS came together to develop a joint statement on spirometry standardization, with a goal of broad application of similar definitions, processes, and qualifications in spirometry across the globe (Miller et al., 2005, p. 320).

The 2005 ATS/ERS standardization of spirometry guidelines provide detailed analysis and technical instruction on the proper delivery of spirometry, based on significant academic research reviewed by the authors. It covers equipment,

calibration, quality control, the test procedure, acceptable test criteria, repeatability, reference values, and appropriate interpretation of results. While the technical instruction is extensive, the guidelines are silent on the qualifications needed to conduct and interpret a spirometry test (Miller et al., 2005).

4.3.2 Canadian Thoracic Society

The Canadian Thoracic Society (CTS, 2018) is Canada's national inter-professional society for respirology. It represents healthcare professionals working in respiratory health. The CTS plays an important role in developing clinical practice guidelines that will inform respiratory health professionals' practice throughout the country. Coates et al. (2013), on behalf of the CTS, developed clinical guidelines for asthma and COPD. These promising practice standards for spirometry use in primary care clearly indicate that spirometry is the optimal diagnosis tool for these diseases (p. 13). These guidelines provide recommendations related to the use of spirometry, the training of individuals conducting spirometry tests and those that are interpreting the results, as well as the appropriate tools used for spirometry. The CTS guidelines were developed based on the standards identified by the 2005 ATS/ETS guidelines.

4.3.3 Global Initiative for Chronic Obstructive Lung Disease

The GOLD has been referenced in several articles as a leading organizational expert in lung disease and standard practice (Evans et al., 2014). It is used worldwide as a tool for healthcare providers to implement management strategies related to lung disease in their local healthcare systems.

The GOLD program was first launched in 1998 with a goal of producing COPD management recommendations based on the best scientific evidence available (Global Initiative for Chronic Obstructive Lung Disease, 2017, p. x). It published its first report, *Global Strategy for Diagnosis, Management and Prevention of COPD* in 2001. The report was updated in 2006 and 2011. A fourth update was completed in 2017, incorporating the latest scientific evidence related to the diagnosis, assessment and treatment of COPD.

The 2017 updated *Global Strategy for Diagnosis, Management and Prevention of COPD* report provides both practical and technical recommendations on a number of topics associated with COPD (Global Initiative for Chronic Obstructive Lung Disease, 2017). It covers appropriate definitions, the diagnosis and assessment of the disease, as well as evidence supporting appropriate therapies and management of COPD and exacerbations.

4.4 Models of spirometry delivery in the literature

Several models of spirometry delivery were identified through the literature review, all specific to the primary care field. While specialist and laboratory spirometry testing are the most controlled environment for quality results, much of the research reviewed discussed spirometry services outside of the medical laboratory. Three specific models of delivery are reviewed in more detail below: spirometry in a general practitioner's office; spirometry delivered by itinerant or embedded trained staff; and spirometry delivered by pharmacists.

4.4.1 Spirometry in general practitioner's office

Some of the literature reviewed described spirometry delivery in a physician's office. In this model, patients reporting symptoms of lung function decline are immediately tested in the physician's office to determine a diagnosis. The physician conducts the spirometry test and interprets the result.

Derom et al. (2008) see office spirometry as playing an important role in the diagnosis and management of respiratory disease. They argue that, by investing in spirometry in this setting, health systems can yield the most benefits for public health because general practitioners are the largest group of medical professionals and are in regular contact with patients in their communities (p. 201).

Upon deeper review, however, the literature did not seem to provide strong support for this model. Enright (2008) observed that general practitioners often had untrained office staff performing the spirometry test due to limited time available for the physician (p. 239). He also suggested that physicians would only have a few tests to conduct each month. Without repetition to keep skills sharp, the quality of testing was poor.

4.4.2 Spirometry by itinerant trained staff or embedded trained experts

An interesting model that builds off the delivery in a physician's office is to incorporate dedicated experts into the patient experience and the patient flow. This includes either trained itinerant staff visiting offices or embedding dedicated experts directly into the physician's office.

Walters, Hansen, Johns, Blizzard, Walters and Wood-Baker (2008) compared the impacts of spirometry delivery provided by trained travelling nurses to spirometry by general practitioners during regular office visits. They found that trained itinerant staff were more likely to conduct a spirometry test and were more likely to receive a high-quality test from their subject compared to general practitioners that provided spirometry as part of their regular practice (p. 412).

Bednarek, Maciejewski, Wozniak, Kuca and Zielinski (2008) similarly reviewed the outcomes when nurses were provided specialized training in spirometry and embedded within a general practice. Their results indicated that these properly trained itinerant staff overwhelmingly completed quality spirometry tests. They concluded that individuals with appropriate training who conduct an adequate number of tests are more likely to return quality spirometry tests than those that provide the service on an ad hoc basis.

Enright (2008b) reviewed several studies and concluded the best solution to spirometry delivery may be to refer individuals to a local third-party trained in pre- and post-bronchodilator spirometry and interpretation, particularly in urban settings (p. 240).

An interesting example from Finland was discovered during the literature review that provides noteworthy results for consideration. In 1998, the Finland Minister of Social Affairs and Health launched a national 10-year COPD program. The goals of the program were to reduce the prevalence of COPD, improve COPD diagnosis rates, reduce exacerbations and hospitalizations related to COPD, and reduce the overall treatment costs of the disease (Kinnula et al., 2011, p. 179). The program was run in all primary health care centres in the country from 1998 to 2007. Kinnula et al. (2011) reviewed the outcomes of the 10-year program to determine whether the objectives had been met. While the prevalence of COPD remained unchanged throughout the study period, significant improvements in spirometry quality were obtained (p. 180). More importantly, COPD hospitalization rates were reduced by nearly forty per cent over the ten-year period.

The program demonstrated that a national strategy, designed to increase COPD awareness, tackle smoking cessation and expand the use of spirometry, reduced COPD exacerbations, hospitalizations and health care costs associated with the disease (Weiss et al., 2014, p. 138). While it cannot be stated that spirometry alone led to these improvements, it is plausible to suggest that with an accurate diagnosis, individuals with COPD were provided appropriate medication and follow-up to monitor the disease. This likely led to reduced exacerbations requiring hospitalizations.

4.4.3 Spirometry by pharmacists

If a lung disease is suspected, there is a strong likelihood that if diagnosed, the patient will require medication therapies to support the patient and improve their quality of life. Pharmacists are the most knowledgeable professionals in medication management. Some researchers believe they may be best positioned to conduct lung function testing. In this model, pharmacists are tasked with the delivery of spirometry testing, working collaboratively with physicians to interpret the results.

Cawley and Warning (2015) reviewed the evidence of pharmacists performing spirometry testing. They found that pharmacists that had received specialized training in performing spirometry testing demonstrated the ability to return appropriate quality testing of their subjects (p. 726). They referenced proper training and credentialing as a key factor in maintaining quality testing.

Kaplan, Levitz and Petrasko (2017) encourage the inclusion of pharmacists in the delivery of spirometry services. While the interpretation of results cannot be done by pharmacists, they maintain that the pharmacist with a good collaborative relationship with physicians can conduct the test and request interpretation from a qualified provider. Since many Canadians interact more regularly with their pharmacists than with their primary care provider, Kaplan et al. believe they are well positioned, and potentially have the time resources necessary, to conduct spirometry testing.

Cawley and Warning noted several benefits to this delivery model, including convenient access to the general public, and established, collaborative partnerships with physicians in the community setting.

4.5 Underutilization of spirometry

A common theme from the literature was a conclusion that, regardless of the delivery model, spirometry is underutilized. Bednarek, Maciejewski, Wozniak, Kuca and Zielinski (2008) argue that while the expected prevalence of COPD using spirometry testing is 9-10 per cent, data compiled from physicians in Canada found only a three per cent COPD diagnosis rate (p. 402). They concluded that only a fraction of those with COPD were appropriately diagnosed. In their research, Gershon et al. (2017) suggest that only 30-50 per cent of Canadians with COPD are appropriately diagnosed using spirometry (p. E530).

In another example, Lee, Rhee, Jung and Yoo (2016) described a study in South Korea where 13.4 per cent of their subjects were found to have COPD. However, of all the subjects, only 2.4 per cent (9/353) were diagnosed with the disease by a physician (p. 122). This result clearly demonstrates the underdiagnosis and undertreatment of COPD.

This underutilization of spirometry extends beyond COPD. Aaron et al. (2017) conducted an asthma study across ten Canadian cities. They found that 33 per cent of the study cohort was misdiagnosed, and that only 50.8 per cent (269 of 530) of patients in the study had some form of pulmonary function test to confirm their asthma diagnosis. The rest had diagnosis confirmed based on symptoms or physical findings alone (p. 276).

To et al. (2015) found similar results in a study of Ontarians with asthma. They found that only fifty per cent of patients with asthma were diagnosed using spirometry (p. 9). Further, they found that though regular monitoring of asthma

should be done with spirometry, only twenty per cent of patients underwent spirometry in the past year. Much like patients with COPD, spirometry was underused as a diagnostic tool for confirmation and monitoring of asthma.

4.6 Identified barriers to spirometry delivery

Consistent themes were identified and discussed as barriers to spirometry delivery throughout the literature. These barriers are captured in the table below.

Table 2: Perceived barriers to spirometry
• lack of spirometry equipment • lack of training in conducting a spirometry test • lack of training in interpreting a spirometry test • lack of knowledge in proper calibration of spirometers • lack of knowledge of spirometry guidelines • lack of time to include testing in patient flow • lack of patients to keep skills up to date • poor test quality

Desjardins et al. (2020) identified limited access to spirometry, lack of training or knowledge of spirometry testing and/or interpretation (p. 150). Gupta, Moosa, MacPherson, Allen and Tamari (2016) identified similar themes, such as limited access, lack of interpretation skills, and concerns with quality of testing as barriers.

Testing validity and calibration are also areas of concern. Salinas et al. (2011) noted unfamiliarity with COPD and spirometry guidelines, access to a spirometer, inability to include spirometry into office patient flow, and inadequate confidence in interpreting spirometry data.

A study by Weiss et al. (2014) found barriers to spirometry testing to be limited time to conduct appropriate testing and performing too few tests to keep training and knowledge up to date (p. 141). In their research into the implementation of spirometry in the primary care setting, Saad, Sedeno, Metz and Bourbeau (2014) found similar results. In their study, regular clinic staff did not have the time required to conduct the test themselves. As spirometry testing generally requires fifteen to thirty minutes at a minimum, they found it was most effective to have a respiratory therapist in clinics on a part-time basis to conduct the spirometry testing (p. 4).

Saad et al. also observed that staff confidence in conducting a spirometry test was tied to the quantity and frequency of testing. If testing was not done often

enough, staff would lose their skill and confidence in testing, producing further barriers to spirometry delivery.

4.7 Summary of literature

COPD is one of the leading causes of death in Canada. Significant healthcare expenses are associated with lung disease, including COPD and asthma. It leads to significant use of the acute care system, including emergency room visits and hospitalizations. Smoking is the greatest risk factor in acquiring COPD.

Appropriate diagnosis is the first step in supporting an individual with lung disease. While spirometry is the gold standard for lung function diagnosis, evidence suggests most healthcare providers base their diagnoses on symptoms, leaving spirometry underutilized and COPD underdiagnosed. This underutilization has harmful impacts on the patient, and on the healthcare system. The literature outlined several barriers to spirometry. A lack of knowledge of spirometry performance and interpretation are major barriers to uptake, particularly in primary care. Spirometry improves with proper training and mentorship. Access to a trained health care professional is the most powerful facilitator to spirometry use (Boulet, Bourbeau, Skomro and Gupta, 2013, p. 268).

The literature identified two leading guidelines in the use of spirometry, the ATS/ERS and GOLD guidelines. For the Canadian context, the Canadian Thoracic Society developed a set of guidelines based on the ATS/ERS standards. While guidelines are published and available online, evidence suggests that recommendations within COPD guidelines are misunderstood or not adhered to. Salinas, Williamson, Kahlan et al. surveyed primary care physicians, determining that over one-third of respondents were unfamiliar with any COPD guidelines, including GOLD and ATS/ERS guidelines (p. 173).

5. Jurisdictional Scan

In 2005, the Canadian Lung Association released a COPD National Report Card (2005), which reviewed the gaps in management of the disease across Canada. The report concluded that while access to spirometry by physicians is high, use of spirometry and perceived confidence in interpreting results is low (p. 12). The Canadian Lung Association called on provincial and territorial governments to do more to address the burden of COPD in Canada by increasing awareness, improving diagnosis, and better managing the disease progression.

The researcher contacted all provinces and territories to get a better understanding of how spirometry is delivered in their respective jurisdictions. The researcher also reviewed any public information available related to spirometry. It was evident from the information reviewed that there has been an effort to improve COPD management in Canada. A summary of the results of the jurisdictional scan is provided in Table 3, below.

Table 3: Spirometry delivery in Canada (2016/17)

	Number of tests	Average wait time for test	Model of delivery	Individual performing test	Individual interpreting test result
BC	N/A	N/A	• Physician office • Hospital	• Specialist Physician	• Specialist Physician
AB	N/A	N/A	• Physician office (Level I) • Respiratory lab (private and public, levels II-IV)	• Level I –supervised by physician, no specific training needed • Level II – graduate of science program with training in pulmonary function lab (PFL); Registered Nurse (RN) with training in PFL • Level III/IV – Respiratory Therapist (RT) with training in PFL; individual with pulmonary registration with CACPT	• Physician
SK	N/A	N/A	• Primary health care clinic • Home care NP • RN at cardiac and pulmonary clinic • Hospital • Health centre • Private settings	• RT • RN • Nurse Practitioner (NP) • Licensed Practical Nurse (LPN) • Physician • Lab technician • X-ray technician • Pharmacist • Certified Respiratory Educator • Medical Office Assistant	• Respirologist • Internist • Physician • Nurse Practitioner
MB	N/A	N/A	• Physician office • Traveling CDM clinician • Outpatient within hospital • Access centre	• Licensed professional with formal spirometry training	• Physician • Physician Assistant • Nurse Practitioner
ON	N/A	N/A	• Physician office • Private PFT lab • Hospital • Community health centre	• RT • RN • LPN • Registered cardiopulmonary technologist • Pharmacist	• Physician • Nurse Practitioner
PEI	N/A	N/A	• Community health centre • Hospital	• RN • RT	• Internist
NWT	592	Two to ten weeks	• Hospital	• RT	• RT

5.1 British Columbia

In 2004, the Government of British Columbia released “A Snapshot of COPD Care in British Columbia 2003/4”. This report indicated that approximately fifty per cent of individuals with COPD had not yet been diagnosed. It estimated COPD prevalence in the province at 4.3 per cent, or approximately 74,000 British Columbians (p. 1). The report also indicated that only 37 per cent of newly diagnosed COPD patients had received a spirometry test, a clear indication of the spirometry test being underutilized in 2003.

By 2017, six per cent of British Columbians aged 45 and older were diagnosed with COPD, though there is acknowledgement that this number is likely conservative due to additional individuals going undiagnosed (Guidelines and Protocols Advisory Committee of British Columbia, 2017, p. 1).

The Guidelines and Protocols Advisory Committee of British Columbia (2017) authored provincial guidelines in the diagnosis and management of COPD and asthma. The guidelines confirm that spirometry is the most reliable test for the diagnosis of COPD and asthma (p. 3).

Spirometry services in British Columbia can only be provided by appropriately credentialed physicians in both publicly and privately owned facilities. These facilities (including physician offices) must be approved by the Medical Services Commission of BC in order to provide outpatient spirometry services. A total of 103 locations provide spirometry services in the province.

The Guidelines and Protocols Advisory Committee acknowledges that “timely access to spirometry may be a challenge in rural and remote communities, but should remain a reasonable goal” (2017, p. 3). There is no evidence, however, of what they define “timely access” to a spirometry test to be. The information requested from the province did not include a target for time on a waitlist for services.

The College of Physicians and Surgeons of British Columbia (2018) has directed that all spirometry services within British Columbia be conducted by an individual or facility accredited by their Diagnostic Accreditation Program. This program ensures that spirometry services are delivered according to the Canadian Thoracic Society guidelines, as well as the 2005 ATS/ERS standards. Due to the importance of coaching and patient technique, as well as proper maintenance and calibration of equipment used for accurate results, the Diagnostic Accreditation Program quality control for spirometry program receives results from all testing across the province twice each year, reviewing the tests for any indication of equipment or technician quality errors.

The researcher was not provided documentation regarding the number of spirometry tests conducted or the average wait time for a test.

5.2 Alberta

In Alberta, spirometry may be provided in a physician's office as part of direct patient care. Alternatively, both public and private respiratory laboratories also provide more extensive pulmonary function testing. Depending on the examinations performed, facilities will be provided a level of service, ranging from Level I to Level IV. Any facility providing extensive pulmonary function testing services must be accredited by the College of Physicians & Surgeons of Alberta (CPSA). Spirometry can be provided in any level of facility.

Level I facilities do not require accreditation. These would include physician offices, where the individual physician supervises spirometry tests and interprets results for their own patients.

Level II facilities require accreditation through CPSA. These facilities perform the same examinations as Level I facilities, but these tests are performed by technicians on behalf of physicians. All facilities must have a medical director overseeing the laboratory. Specific technical qualifications for personnel in Level II facilities include:

- Up-to-date health care provider level certified CPR.
- Graduation from a science program in a technical institute, college or university with at least three months' training in a pulmonary function laboratory.
- Graduation from a nursing program with training in a pulmonary function laboratory for at least one year.

Level III and IV facilities can perform the same tests as levels I and II, as well as more complicated or sensitive testing. For this reason, technicians require more training or a specific registration to work in these facilities.

Approximately 100 facilities, both public and private, have been accredited by the CPSA for pulmonary function testing, including spirometry. Tests and interpretation conducted in physician offices on their own patients do not require physician accreditation; however, it is a requirement when offered as a service to other physicians or patients. Accreditation ensures compliance with standards of performance in testing and interpretation.

The researcher was not provided data on the number of spirometry tests conducted per year or the average wait for a test.

5.3 Saskatchewan

In 2009, Saskatchewan launched a chronic disease management collaborative focused on improving the care experience of people living with COPD. Walling, Hack and Cole (2012), with the Saskatchewan Health Quality Council, noted that participating organizations hoped to better diagnose and manage COPD, be

more consistent in their use of spirometry standards, and ultimately improve the care experience and health outcomes for their patients (p. 3). By focusing on diagnosis through spirometry, the initiative improved the percentage of patients having their diagnosis confirmed by a spirometry test from 28 per cent to 63 per cent (p. 5). They note that this number may have been limited by those who continued to have issues with spirometry access, particularly in rural areas.

Participating practices that accessed both training in spirometry testing and spirometry data interpretation were eligible to receive a grant for purchasing a new spirometer (Walling et al., 2012, p. 5). This resulted in 19 organizations receiving a spirometer, increasing the ability for testing throughout the province. Walling, Hack and Cole concluded that while access to spirometry had improved, work remained to increase the availability of spirometers and train more care providers in spirometry (p. 15).

Saskatchewan developed a COPD strategy, hoping to identify COPD clients to help manage the disease progression once diagnosed. The province's strategy was to make training available to appropriate staff in both the spirometry test and spirometry interpretation. They also made funds available to purchase spirometers to those organizations that completed the training, making the test more accessible to all Saskatchewan citizens.

While no provincial data was provided, the Regina Qu'appelle Health Region (RQHR) (2017) reports that by identifying COPD as a provincial improvement target to receive practice care, 80 family practice physicians and 12 nurse practitioners were trained in spirometry testing and interpretation in 2016/17 (p. 13). While the region only performed 206 spirometry tests in 2015/16, it managed to produce 686 tests in 2016/17. That number was projected to double in 2017/18 to nearly 1,300 tests.

5.4 Manitoba

Manitoba Health, Seniors and Active Living (2017) reported that the rate of COPD among Manitoba residents over 35 years of age was 12.6 per cent in 2016 (p. 23). These rates were determined based on at least one hospitalization or physician visit over the previous year for COPD-related symptoms, such as emphysema or bronchitis (p. 93).

Anthonisen, Dik, Manfreda and Roos (2001) conducted a research project on spirometry in Manitoba. They concluded that approximately three per cent of the population of Manitoba was tested using spirometry each year (p. 423). Residents of Winnipeg were more likely to be tested than individuals from rural communities. In fact, the rate of testing was five to ten percentage points higher in Winnipeg residents than the provincial average (p. 424).

The Winnipeg Regional Health Authority (WRHA) is one of five health authorities in the province. The WRHA spirometry testing guideline (2017a) provides care providers with guidance on the education, training and support required to provide spirometry testing. It also provides a standard process for ensuring ongoing quality assurance, following the CTS spirometry guidelines (p. 2). The WRHA guidelines also suggest that individuals performing spirometry are health care professionals who have taken a recognized spirometry training course, specifically RESPTREC. After initial training, care providers must submit 15 completed spirometry tests for review by the trainer, who is to be a member of the regional respiratory therapy program of the province.

To interpret results, a physician, a physician assistant, or a nurse practitioner must have completed a specific training course in the interpretation of spirometry. The WRHA notes that interpretation results must be received within 14-30 days of the test being completed (p. 8).

As part of the WRHA guidelines for spirometry, it was found that practitioners in primary care clinics were required to conduct at least five spirometry tests per month to retain proper technique and quality (Winnipeg Regional Health Authority, 2017b). Quality assurance was the responsibility of the primary care clinic, as well as the regional respiratory therapy program, which is responsible for reviewing and providing feedback to all clinics on a periodic basis of a sample of their spirometry tests.

5.5 Ontario

Gershon et al. (2017) studied the diagnosis of COPD using spirometry testing in Ontario. Between 2005 and 2012, COPD was diagnosed in 68,898 patients, but only 41.2 per cent of those diagnoses were confirmed using spirometry (p. E532). They also found that for those who did have a spirometry test, patients were nine per cent less likely to be admitted to hospital for COPD. They concluded that appropriate spirometry is associated with a decreased risk of admission to hospital due to better management of medications and symptoms (p. E530).

The College of Physicians and Surgeons of Ontario (2014) require independent facilities providing spirometry services to have specific qualifications for the technologist staff, including:

- A registered cardiopulmonary technologist;
- A registered respiratory therapist; or
- A healthcare professional with formal training in anatomy and physiology of the cardiorespiratory system AND at least one month of training in spirometry.
- Current certification in basic cardiac life support.

They also require medical staff to oversee the clinic. These staff members require specific qualifications, including:

- Qualification as respirologist by the College of Physicians and Surgeons of Ontario
- Qualification as a specialist by the College of Physicians and Surgeons of Ontario and have three months of training and experience on the respiratory disease services, including training in the delivery and interpretation of pulmonary function testing
- A minimum of six months experience in the delivery and interpretation of pulmonary function testing.

The response from Ontario did not include information about the number of spirometry tests delivered in the province, nor did it indicate the average wait time for a test.

5.6 New Brunswick

The researcher did not receive a response from the province requesting additional information about spirometry services; however, according to the Government of New Brunswick (2016), approximately one in nine citizens (11.1 per cent) have been diagnosed with COPD (p. 1). That number increases to one in five individuals (20 per cent) over 65 years old. The province also reports that COPD is the cause of the second-most hospitalizations every year and is the recorded cause of approximately five percent of all deaths (p. 4). However, that number is most likely higher, as many deaths are attributed to other factors (e.g. pneumonia) brought on from complications with COPD.

According to the Canadian Lung Association (2005), only ten per cent of physicians in New Brunswick had used spirometry to diagnose COPD (p. 27). The same number were comfortable interpreting spirometry results.

The New Brunswick Association of Respiratory Therapists believes that Registered Respiratory Therapists have the knowledge, skills and clinical judgment to complete spirometry testing, so long as there is a quality assurance program overseeing the testing and that the CTS guidelines are followed, and testing meets the ATS/ERS standards. Spirometry, which requires a physician referral, is available through regional health authorities at hospitals and health centres across the province.

5.7 Prince Edward Island

The Government of Prince Edward Island (2014) reported its COPD trends over a ten-year period from 2001-2011. The report found that, while consistently lower than the national average, the prevalence of Islanders diagnosed with COPD rose significantly between 2001 and 2011 (p. 7). There was a particularly sharp increase in 2008, which the report indicates could be due to new CTS guidelines in spirometry being released, pharmacies offered spirometry testing for a short time, and two physicians with a respiratory medicine specialty were recruited to

work in the province (p. 9). The province found that individuals with COPD visited a physician twice as much as those without the disease, and spent three times as many days in hospitals (p. 17).

Due to the significant health resources required, Health PEI introduced new measures in 2013 to address the increased burden. All primary care networks in the province recruited nurses specializing in COPD and certified in spirometry testing. Anyone suspected of COPD were referred to these teams, which also included respiratory therapists. They would complete a spirometry test, receiving confirmation of interpretation from physician specialists.

5.8 Northwest Territories

The Government of Northwest Territories provides spirometry testing through the hospital in Yellowknife. The department of respiratory therapy within the hospital is responsible for all spirometry testing in the Northwest Territories. The response to the researcher indicated that because a respirologist is not employed by the hospital, all spirometry testing and interpretation is done by the respiratory therapists on staff. While unable to formally diagnose the patient, the respiratory therapist does provide specific recommendations back to the primary care provider based on the result of the test. Generally, patients will wait up to ten weeks for testing, although the Government of the Northwest Territories intends to reduce the wait to approximately two to three weeks.

6. Findings

This section presents the brief findings from the Yukon data available. It also presents findings from the literature review, with a particular focus on the CTS spirometry guidelines and promising practices identified in the delivery of spirometry services. Finally, this section presents findings from the jurisdictional scan.

6.1 Yukon data

The Canadian Institute for Health Information (2021) reports the prevalence of COPD in Yukon at 4.7 per cent. While the literature suggests this number is likely under-representative of the true prevalence of COPD in the territory, it indicates that at least 2,000 Yukoners have the disease. As Yukon continues to have some of the highest smoking rates in Canada, it is plausible the incidence of COPD is significantly higher than reported. This strengthens the need for appropriate spirometry services in the territory. Using this conservative estimation provided by the Canadian Institute for Health Information, the Government of Yukon should aim to provide at least 2,000 spirometry tests per year, to ensure appropriate diagnosis of new cases, as well as to monitor the disease progression in individuals already diagnosed.

The Yukon Hospital Corporation reports that COPD treatment costs the hospital approximately $4 million per year, nearly seven per cent of their budget. COPD is also one of the leading causes of avoidable emergency department visits and admissions to the hospital. By improving diagnosis and management of COPD, along with other lung diseases, the health system will have fewer instances of acute visits. Accurate diagnosis and management through spirometry is an important step in reducing these costs.

Prior to 2016, the provision of spirometry tests in Yukon had been handled by technicians at the Whitehorse General Hospital laboratory. This includes testing for Whitehorse and community residents. For those outside Whitehorse, this meant travelling by car or by air to receive their test. The laboratory conducted the routine testing one clinic day per week, sending the results to the BC Lung Centre for interpretation by a respirologist (a physician with this specialty training). Approximately nine spirometry tests were scheduled each week, meaning 30-40 spirometry tests were completed every month. Depending on scheduling, some months saw only 15 tests conducted over that period (Government of Yukon, private communication, October 2016). With limited human resource capacity to provide testing, hundreds of patients would remain on a spirometry waitlist for several months.

Due to these delays, and the associated negative health consequences, the Yukon Hospital Corporation engaged with the Government of Yukon to determine other models for the delivery of spirometry services. For example, in 2016,

spirometry blitzes were undertaken in Whitehorse, where additional staff were made available for a short period of time to support testing. These focused testing periods reduced the waitlist by hundreds of patients. This approach, however, proved to be time-limited and the waitlist returned to levels seen before the blitzes.

In June 2017, the Government of Yukon entered a contract with TrueNorth Respiratory Services to provide spirometry testing in Whitehorse and communities, as referred by care providers. TrueNorth is a private business organization that provides Yukoners with respiratory health care, including sleep apnea and oxygen management, among other respiratory needs. The staff are Registered Respiratory Therapists with extensive experience in lung function testing, including spirometry.

The laboratory at Whitehorse General Hospital continued to provide inpatient and acute testing, with all other referrals directed to TrueNorth. The contract was initially in place for one year, and in April 2018 was extended for another year.

Under this new model of delivery from July to December 2017, over 450 spirometry tests were completed in Yukon. This averages to approximately 75 spirometry tests per month. Interpretation services continued to be provided by the BC Lung Health Centre.

Dr. Marciniuk, respirologist in Saskatchewan, has visited Yukon on multiple occasions to discuss his expertise in COPD and spirometry. At official meetings, he advised the Government of Yukon that organizations performing spirometry testing should endeavour to complete the process in approximately two weeks, from point of referral to having an interpreted result back in the hands of the referring practitioner (Aram, 2018). In 2017, the process would normally take 7-10 weeks, and historically would have wait times closer to twelve months.

In reviewing the documentation made available, there was no evidence that Yukon has yet adopted a specific guideline or standard to inform the delivery of spirometry services in a consistent manner.

6.2 Literature Review

The literature review provided concrete evidence for the framework of spirometry delivery in Yukon. The CTS spirometry guidelines provide a number of recommendations that directly answer some of the research questions asked in this report. The literature review also provided interesting insight for consideration in developing options for service delivery in Yukon. The researcher did, however, identify some gaps in the literature view. These topics are discussed in more detail below.

6.2.1 Canadian Thoracic Society spirometry guidelines

Three guidelines were identified through the literature review that speak directly to spirometry testing. While the Canadian Thoracic Society (CTS) guidelines were not referenced extensively in the literature, they are based on the 2005 ATS/ERS spirometry guidelines. As the ATS/ERS standards were referenced broadly in the literature, there is significant confidence that the CTS standards meet or exceed the promising practices identified.

There is added confidence that, as a Canadian institution, the CTS guidelines are most appropriate for the Canadian and northern context. The CTS acts as a national specialty society for respiratory health (Canadian Thoracic Society, 2018, para 1). Its function is to evaluate, develop and disseminate evidence-based clinical practices in respiratory sciences.

The CTS produced a position statement on spirometry in primary care, written by Coates et al. (2013). This position statement provides concrete advice on the delivery of spirometry services (including training and interpretation of testing) in primary care across Canada. The statement provides important answers to many of the research questions asked in this report.

The position statement was developed by a committee of experts in the development of spirometry guidelines, the use of spirometry for the diagnosis of COPD and asthma, the training of quality spirometry, and the evaluation of spirometers. The committee reviewed the literature and evidence available, establishing their position statement based on existing guidelines and accreditation standards. In particular, the CTS spirometry guidelines are based on the 2005 joint standards for lung function testing by the ATS and ERS (p. 13).

Coates et al. provide recommendations on several topics in spirometry. Those relevant to this project include:

i) individuals eligible to conduct a spirometry test
ii) training in spirometry testing
iii) individuals eligible to interpret a spirometry test
iv) appropriate reference values for interpretation
v) spirometer equipment and calibration
vi) quality assurance in testing

These factors are further examined below.

i) Individuals eligible to conduct a spirometry test

Spirometry is not controlled by federal regulations, and provincial and territorial guidelines vary, so no actual legal restrictions exist in Canada for who can conduct spirometry testing on patients. Coates et al. recommend, however, that trained and registered personnel conduct testing, particularly those with at least basic life-support training. They identify respiratory therapists and registered

cardiopulmonary function technologists as ideal candidates to provide spirometry testing services.

If respiratory therapists and registered cardiopulmonary function technologists are not available, the authors recommend that other healthcare professionals with formal studies in anatomy and physiology related to respiratory and cardio care provide spirometry testing. At a minimum, Coates et al. recommend that any healthcare provider conducting a spirometry test complete a recognized training course and be supervised over a one-month period in the performance of testing to confirm appropriate quality spirometry.

ii) Training in spirometry testing

Appropriate coaching of the individual being tested is imperative for a successful spirometry test. To support healthcare providers in their responsibilities and ensure they are confident and competent to conduct a spirometry test, appropriate training should be sought. The authors do not support a specific training regimen for spirometry, although the CTS has endorsed the SpiroTrec course offered by RESPTREC. SpiroTrec provides a basic understanding of performing quality spirometry. The course offers sixteen hours of learning and assignments, an eight-hour in-person workshop and a subsequent quality assurance review of 15-30 spirometry tests over a three-month period.

While CTS has endorsed SpiroTrec, Coates et al. reference evidence from another study conducted by Licskai, Sands, Paolatto, Nicoletti and Ferrone (2012) indicating acceptable spirometry results were maintained after enrollment in a four-hour course (p. 249). Regardless of the training regimen, the authors recommend short-term follow up and frequent supplementary training to maintain quality testing.

iii) individuals eligible to interpret a spirometry test

Legislation in Canada at the provincial and territorial level limits the interpretation of spirometry to physicians and nurse practitioners. Coates et al. indicate their displeasure for legislation that does not include specific interpretation qualifications, arguing that a physician or nurse practitioner interpreting spirometry should complete a formal training course, at minimum (p. 14). The authors reference respirologists as the ideal interpreters of spirometry, due to their training and knowledge.

iv) Appropriate reference values for interpretation

While the spirometry test measures an individual's lung function, the results must be compared to expected normal values to determine whether the findings are abnormal. Coates et al. explain that normal reference values have been generated by population studies of healthy, asymptomatic individuals (p. 17). Expected lung volume is variable based on height, age, gender and ethnicity. For example, males have a higher lung volume than females of the same age and

height. Caucasians have a lung volume approximately ten per cent higher than African Americans, and between two to eight per cent higher than Asians.

When interpreting results, healthcare providers are seeking abnormal results, which Coates et al. categorize as the lower limit of normal (LLN), the value that marks the lower five percent of the normal population. This equates to 1.64 standard deviations below the mean value. Individuals suffering from COPD or asthma are very likely to fall below this threshold in lung function, and the value will help determine the degree of obstruction that exists within the lungs.

Several studies have been conducted to identify appropriate reference values to be used. Coates et al. identify Quanjer et al. (2012) as the preferred source of reference values used in spirometry interpretation. These particular reference values are preferred due to the number of subjects studied and the age range included. They provide reference values for Caucasians, African Americans, Southeast Asians and Northeast Asians, and provide a formula for individuals that do not fall within the described ethnicities. Quanjer et al. acknowledge that this result should be used with caution until additional data is reviewed and appropriate reference values deduced for other ethnicities, citing Indian, Arabic, Polynesian, African and Latin American as areas for further study (p. 1324).

Canadian Indigenous populations do not yet have a set of reference values, as more data is needed to make any conclusions. Coates et al. suggest that Indigenous individuals have a statistically significant difference in lung volume to Caucasians, but without the appropriate data recommend using Caucasian reference values with some caution.

v) Spirometer equipment and calibration

The spirometer tool and the equipment associated with its use are integral to the return of a quality spirometry test. In 2005, the ATS/ERS released technical specifications for spirometers. The authors recommend that any spirometer used in Canada should meet this standard. For example, there are spirometers that measure exhalation only, but this would not meet the technical standard, which requires both inhalation and exhalation to be measured.

With improvements in technology, spirometers are now able to provide some basic analysis of each test, determining whether ATS/ERS requirements and repeatability are met. While this cannot be relied on fully, it does provide additional support to the technologist in their coaching of the patient during the test.

Due to the calculations required to differentiate normal and abnormal lung function, calibration of spirometry equipment is necessary for the valid diagnosis of lung illness. Aligning with the ATS/ERS standards, Coates et al. endorse the use of a three-litre syringe for daily calibration.

vi) Quality assurance in testing

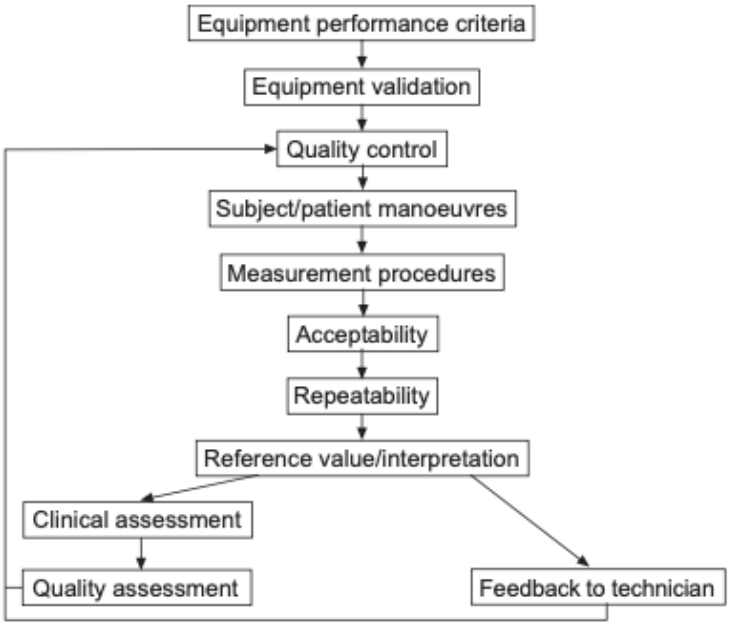
Because spirometry results provide diagnoses that can lead to important medication prescribing and care, Coates et al. believe it is imperative that testing is done to a very high standard (p. 18). Without adequate quality testing, the diagnosis and management of individuals with a respiratory illness or disease is negatively impacted. To ensure a high standard of testing, several quality assurance measures and procedures should be undertaken. These measures include:

- Daily spirometer calibration, with potential for calibration before each patient.
- All personnel doing testing and interpretation are qualified and appropriately educated and trained on the theoretical and practical aspects of spirometry, including techniques, measurements, calibrations, hygiene, and quality control.
- Infection control procedures are followed.
- A suitably trained physician or nurse practitioner oversees the spirometry program.
- All procedures comply with CTS guidelines.

Test quality grading is not recommended by Coates et al., who believe that tester comments should suffice (p. 17). Some researchers have recommended a scholastic grading system for spirometry, where an ‘A’ means standards were exceeded, ‘B’ means standards were met, ‘C’ and ‘D’ mean data is useable but falls short of standards, and ‘F’ means a test is not useable for interpretation. There is no specific ATS or ERS standard related to test quality grading, so there is some risk in its adoption, as not all testers or interpreters may be familiar with the grades. Also, while previous GOLD guidelines embraced the grading scheme, the updated 2017 guidelines no longer endorse test quality grading.

6.2.2 Spirometry standardization and training

It was clear from the literature that the standardization of spirometry services plays an important role in quality testing. Spirometry services are most successful when a standardized protocol is in place and when the individuals conducting the test are appropriately trained and given continuous quality feedback on their performance (Tan et al., 2014, p. 148). Appropriate equipment, quality control, proper coaching, proper feedback, appropriate reference values, and acceptable, repeatable results all play a role in the success of spirometry testing.



Source: Miller et al. (2005), p. 321

Figure 1: Steps to spirometry standardization

Simply having access to a spirometer does not mean that a healthcare provider will use the device. Saad, Sedeno, Metz and Bourbeau (2014) demonstrated that providing general practitioners with spirometers without appropriate training did not improve spirometry delivery (p. 4). They argued that implementing spirometry into primary care is not an easy process, and that the best results occurred when an individual is trained and dedicated to performing spirometry. Enright (2012) is of the same mind, claiming that rather than providing spirometers to general practitioners, the solution for quality, accurate spirometry delivery is to have respiratory therapists visit primary care providers in their community on a regular basis conduct the testing (p. 149).

Much of the research reviewed suggests the credentials of the individual conducting the spirometry test do not automatically return quality testing. Rather, it is the training and quality assurance that led to better results. Borg, Hartley, Fisher and Thompson (2010) studied the impacts of a 14-hour spirometry training course in the production of valid spirometry results. They found that individuals trained were unable to meet ATS acceptability criteria in the majority of the tests they performed after five months had passed since their training. Interestingly, they found that testing improved when feedback was provided regularly. They concluded that spirometry training alone would not guarantee quality spirometry testing, but appropriate training along with regular feedback did have a positive impact on acceptable spirometry tests.

Tan et al. (2014) concluded from their research that a single spirometry training session was inadequate for acceptable spirometry delivery. They found that consistent monitoring and feedback on the quality of tests, along with a continuous quality improvement program, would help sustain quality spirometry services (p. 149). There is also evidence of significant misdiagnosis when spirometry results are interpreted by individuals without specific training in interpretation (Saad et al., 2014, p. 5). Without proper training, there is a risk of improper diagnosis and pharmacotherapy treatment.

While several models of delivery were described, the main point of emphasis from the literature was that quality testing is imperative to the interpretation of a spirometry test, which means that the most accurate and reproducible test will determine an accurate diagnosis (Cawley and Warning, 2015).

6.2.3 Fixed ratio versus lower limit than normal

An important differentiation between spirometry guidelines published by ATS/ERS, CTS and GOLD is that the GOLD guidelines endorse the fixed ratio of FEV1/FVC < 0.70 for the diagnosis of COPD. The ATS/ERS and CTS guidelines endorse the use of lower limit of normal (LLN) values.

The GOLD guidelines explain that a fixed ratio is simpler and does not require additional research into appropriate reference values. It states that LLN values are too dependent on the appropriate choice of reference values. In recognition of diagnostic simplicity and consistency, it favours the fixed ration over the LLN (Global Initiative for Chronic Obstructive Lung Disease, 2017, p. 29).

The Guidelines and Protocols Advisory Committee of British Columbia (2017) acknowledges that there is some controversy regarding the use of a fixed ratio versus LLN values (p. 3). They argue a fixed ratio can lead to over-diagnosis in older populations and under-diagnosis in younger patients. Further, they conclude that using the lower limit of normal values, according to the unique height, age, gender and ethnicity of the patient, will lead to a more appropriate diagnosis.

Enright (2008b) also advocates for the use of the LLN. He argues that using the fixed ratio of FEV1/FVC below 0.7 incites an increase in false positive diagnoses of COPD due to the natural reduction in forced vital capacity as an individual ages, particularly those over the age of seventy (p. 239). The LLN is associated with the specific age, height and ethnicity of the individual, and is therefore more appropriate and precise for diagnosis.

6.2.4 Appropriate waiting period for a spirometry test

The literature review did not provide evidence of an appropriate waiting period for a spirometry test.

It is possible that since most spirometry research involves delivery in a physician's office, there is no record or need of a waitlist for services. Individuals may be waiting for spirometry, but no evidence is provided in the literature that describes what an appropriate wait for services would be. There is mention from some researchers about getting tested as early as possible, or as soon as necessary, but these terms are not defined.

6.3 Jurisdictional scan

Gershon et al. (2017) concluded that quality spirometry is associated with a decreased risk of admission to hospital due to better management of medications and symptoms (p. E530). While there is evidence that provinces and territories are working to provide appropriate spirometry services to their residents, there is no obvious consensus on the most appropriate model of spirometry delivery. The jurisdictional scan demonstrated that several different models are used within Canada.

For example, while British Columbia and Alberta are often used to model care in Yukon, both have very differing protocols of service delivery. In British Columbia, spirometry tests are only conducted in hospital or at the office of a specialist physician. Only physicians can administer and interpret spirometry tests. In contrast, Alberta does not mandate who must deliver a spirometry test if conducted in a physician's office. It also employs differing professionals in public and private lung health labs, depending on the level of the facility. Only physicians are eligible to interpret spirometry results. Other jurisdictions employ Nurse Practitioners with proper credentials to provide interpretive services.

Saskatchewan has made training available to healthcare providers for both spirometry testing and interpretation. As part of their COPD strategy, Saskatchewan has made funding available for the purchase of spirometers for organizations that have participated in their training program.

In Prince Edward Island, the province has focused on recruiting nurses specializing in COPD, with appropriate training certification in spirometry testing. These nurses are part of COPD response teams, and referrals for spirometry and follow-up care are directed at these specialized groups in the province. These teams include registered nurses and registered respiratory therapists. Spirometry interpretation is completed by specialized physicians in the province.

While there may not be consensus among provinces and territories on the ideal delivery model, lessons can be learned from the delivery and implementation decisions by these jurisdictions to inform the Government of Yukon's model. Where appropriate, key findings can be adapted to meet the distinct needs of the territory.

7. Discussion

The literature clearly indicates that spirometry is underutilized for the diagnosis of lung function diseases. This underutilization has harmful impacts on the individual suffering from undiagnosed or misdiagnosed illness. It also has harmful impacts on the healthcare system, leading to frequent acute care visits and hospitalizations or unnecessary pharmacological treatment. While underutilization is detrimental, so too is low-quality spirometry. Unwarranted therapies or undertreatment of disease are possible if spirometry is not delivered at an appropriate standard. As with many other issues, there is a dilemma between volume and quality.

The analysis of the current state of spirometry services in Yukon leads the researcher to conclude that more can be done to ensure spirometry tests are more readily available when they are needed. The jurisdictional scan provided further evidence that when spirometry services are only provided in hospitals or lab settings, individuals are put on waitlists for a longer period of time. Shorter wait times were associated with spirometry testing being available at community health centres or physician offices.

The literature made it clear that, while making spirometry more available in the primary care setting leads to more testing, it does not necessarily lead to quality testing over the long-term. Making spirometry available in physician offices does not mean that quality testing will take place.

Through rigorous analysis of the literature review and jurisdictional scan, the researcher has identified several key themes for a successful spirometry program. The CTS guidelines provide much of the framework for spirometry delivery in the Canadian context. Regardless of the delivery model used, any program administered by the Government of Yukon should include:

- appropriate credentials for testing
- appropriate credentials for interpretation
- proper training for staff
- proper quality control
- appropriate equipment
- standardized spirometry protocols

An important limitation noted in the literature is that CTS reference values do not yet exist for the Canadian Indigenous population. While there is some evidence that the Indigenous population has a larger lung volume than Caucasians, there is insufficient data to confirm this difference (Coates et al., 2013, p. 18). This is an obvious gap that must be addressed. Nearly a quarter of Yukon's population are Indigenous. This is a significant portion of the population that does not yet have accurate reference values, possibly impacting the diagnosis of asthma and COPD. Yukon can contribute data to research being conducted on this topic,

resulting in better data to ensure Indigenous Canadians receive the best care and diagnosis possible for lung disease.

8. Conclusion and Recommendations

Better management of lung disease leads to better health outcomes for patients and to a reduced impact on the health care system. The first step in management is a prompt, accurate diagnosis. This paper sought to determine what the Government of Yukon can do to ensure that quality spirometry testing is available when clinically appropriate. The impact of lung function disease can be reduced if it is diagnosed early and, particularly for COPD, flare-ups are prevented. There is no doubt that spirometry is the best tool to diagnose lung disease. The accuracy and reproducibility of testing is critical to accurate diagnosis.

It is possible that, as technology improves, spirometry testing will become “fool-proof”. The testing machine itself may be able to coach and ensure appropriate testing quality is achieved. The technology advances of the spirometer expected in the near- and long-term future was out of scope for this project; however, the current technology is not there yet. Proper spirometry still relies on trained technologists to support the individual being tested.

With this in mind, the problem seems to boil down to a dilemma of volume versus quality. While there is evidence that recruiting general practitioners to provide spirometry testing leads to an increase in testing available, the literature indicates that often this model goes underutilized or results in poor quality testing. There is strong support for a model that allows appropriately trained individuals to conduct the testing, freeing up important physician time to regular clinic duties. With fewer testers, there is also a better ability to conduct quality assurance.

It is interesting to note that, while the research project did not incorporate information beyond 2018, the COVID pandemic undoubtedly disrupted COPD and spirometry services. In fact, the researcher understands that all spirometry services were halted in the territory in March 2020. No routine spirometry services have been available since the early days of the pandemic. If urgent spirometry or other lung function testing was needed, patients required medical travel to British Columbia. There is a strong likelihood that this disruption in service has led to multiple individuals being undiagnosed and/or suffering symptoms that went untreated. It is now more important than ever to deliver consistent, quality spirometry services to ensure those that require the test are seen as soon as possible, and appropriate treatment can begin.

8.1 Options for service delivery

The CTS spirometry guidelines make it clear that spirometry is not controlled by any medical services regulations and there are no legal restrictions on who can perform spirometry testing. However, the CTS position is that spirometry should be *conducted* by trained and qualified personnel, preferably by a respiratory therapist or cardiopulmonary function technologist. Proper coaching during the test helps return a good and reliable result, which is why proper staff training is

so important to a successful spirometry program. There is currently no legal or regulatory requirement for physicians, respiratory therapists, nurse practitioners, or others, to have special qualifications or training before performing spirometry testing in the Yukon.

The CTS also recommends that *interpretation* of spirometry results should be completed by physicians or nurse practitioners who have specific training in spirometry interpretation. In some jurisdictions, legal or regulatory requirements are in place to limit the interpretation of spirometry results to those with a physician or nurse practitioner designation. Even so, there is no legal or regulatory requirement for these providers to have distinct qualifications or training in the interpretation of spirometry.

Quality control and standardization is essential for the proper use of spirometry. Evidence demonstrates that regular feedback (weekly to monthly) on the quality of tests performed will lead to consistent testing performance. Thus, a quality assurance program with frequent feedback to those providing spirometry tests is another key component of a spirometry program.

With these key considerations in mind, the researcher considered three possible models to be implemented in Yukon. While delivery by pharmacists was described in the literature, this model does not fit with the guidelines identified through the CTS and ATS/ERS. Therefore, it was not considered for implementation. A description of the three options follows.

8.1.1 Option 1: Spirometry at the Whitehorse General Hospital

Historically, the provision of spirometry tests has been handled by technicians at the Whitehorse General Hospital laboratory. Technologists, who had training in spirometry delivery but were not respiratory therapists, conducted the routine testing approximately one clinic day per week. Approximately nine spirometry tests were scheduled each week, excluding acute spirometry tests, meaning only 30-40 spirometry tests were completed each month. While this means that a predictable number of tests can be performed each year, the need exceeds the 500 tests per year this model allows. It would be very difficult to ensure that individuals have access to timely testing if the status quo is maintained. The limited testing available makes this model untenable.

8.1.2 Option 2: Spirometry through primary health care provider

In some jurisdictions in Canada, spirometry is performed in the private clinics of primary care providers. Physicians provide the service in-clinic, either performing the test themselves or by having clinic staff conduct the test. The physician then bills government as per the fee-for-service model. This would allow more access to spirometry for Yukoners; however, there is no guarantee that physician offices would invest in spirometers, or in appropriate staff training. The literature also

demonstrated that even if a service is provided widely, the quality of testing would not necessarily meet appropriate standards. Implementing this model would see a significant increase in individuals performing spirometry, which means quality assurance would be more difficult to maintain. Yet the literature supports the need for a strong quality assurance program; standards must be met and maintained, and this is difficult to enforce if more individuals become eligible to do the testing. As spirometry requires a significant amount of clinic time, there is also concern that physician offices might not see it as a good use of limited time resources, unless the fee was significant. Government also would have no direct control over the number or quality of tests performed.

8.1.3 Option 3: Spirometry by trained third-party provider

In many jurisdictions in Canada, patients are referred to lung health laboratories, clinics, or health centres that specialize in lung health services to receive spirometry as referred by their primary care provider. The literature supported models that had specially-trained staff providing spirometry services, rather than relying on generalists.

The Government of Yukon piloted this model in 2017, contracting with a third-party provider to deliver spirometry testing as referred by care providers in Yukon. Contracting with a private sector partner, led to more consistent spirometry service available to Yukoners. The number of tests performed per week nearly doubled, meaning patients were more likely to be properly diagnosed or monitored through their lung health journey than if they received the service through the Whitehorse General Hospital. Moving the services to a third-party provider has also allowed Whitehorse General laboratory staff to provide routine services during times they would otherwise be required to provide spirometry.

By having the same individuals consistently conducting spirometry tests, we can expect better quality testing. Appropriate training, quality assurance and feedback on performance will result in a higher rate of acceptable tests, all of which can be enforced through a contract between the Government of Yukon and the third-party provider.

It is important that clients in all communities receive spirometry in an equitable manner to Whitehorse. Itinerant spirometry service to the communities is not necessarily equitable access, particularly if wait times are longer in communities than they are in Whitehorse; however, the third-party provider could develop a schedule that ensures itinerant services are available within a reasonable timeframe.

8.2 Recommendations

To provide the best service to the most Yukoners possible, the researcher submits five recommendations for consideration. These recommendations have been prioritized based on timing of implementation.

Short-term action (within 1-3 months)

1.That the Government of Yukon standardize spirometry testing protocols by either adopting the CTS guidelines for spirometry or drafting territory-specific guidelines.

Standardization of spirometry is an important component of any delivery model. It is recommended that the Government of Yukon adopt the CTS guidelines to ensure all practitioners are consistently employing the same protocols across the territory. If unique procedures need to be reflected within the guidelines given the distinct challenges of the rural and remote nature of the territory, standard testing protocols could be drafted for the territory based on the CTS guidelines. Doing so reduces the risk of poor-quality testing, be it due to substandard equipment, training, coaching, or other aspects of spirometry delivery. To ensure appropriate knowledge and transparency of the expected standards of service, this recommendation is a high priority and should receive immediate action.

2. That the Government of Yukon turn to a company specializing in lung health services for the delivery of spirometry in the territory.

This recommendation aligns with the promising practice identified in the literature review and is employed by some provinces in Canada. It ensures that a distinct number of care providers are entrusted with spirometry delivery, allowing for appropriate management of the program, more consistent testing delivery, and an overall more standardized product. Given the time required to complete the government procurement process, action should be taken as soon as possible. The negative impact of the COVID-19 pandemic on testing (reduced testing and worsened wait times) further strengthens the need for immediate action.

Medium-term action (within 4-12 months)

3. That the Government of Yukon develop a quality assurance program to ensure that those performing spirometry continue to provide reliable testing results. It is strongly recommended that the quality assurance program include minimum educational requirements and training standards for those conducting a spirometry test.

Quality assurance is an important component of a spirometry delivery program, where it is imperative that quality testing can be measured and enforced. It is recommended that a quality assurance program be developed within twelve

months, to support the ongoing delivery of spirometry. Timing of implementation may be pushed back if a contract is considered, where the quality assurance metrics could be incorporated into the specifications of the agreement.

Training requirements should also be included in the quality assurance program. The CTS guidelines make recommendations related to educational requirements for spirometry testing, but the Government of Yukon should take this a step further by implementing a minimum training requirement through regulation. This will ensure consistent application if the delivery model is adapted in the future to better meet the needs of the population. As this will take time to implement, the contract should include stipulations related to minimum training requirements for those conducting the spirometry testing.

Long-term action (no timeline defined)

4. That the Government of Yukon implement regulations limiting spirometry interpretation to physicians or nurse practitioners who have completed an interpretation course.

Some jurisdictions have legislation or regulations in place to ensure spirometry interpretation is only conducted by qualified personnel. This is a step the Government of Yukon should consider for future action. At this time, all spirometry interpretation is conducted by specialist physicians in respirology in British Columbia. If interpretation were to be considered within Yukon in the future, it should only be implemented after appropriate legislation or regulations are in place.

5. That the Government of Yukon consider working with Yukon First Nations governments to understand how the lack of reference values for the Indigenous population affects the diagnosis of lung disease.

An important limitation noted in the literature is that expected lung volume reference values do not yet exist for the Canadian Indigenous population. It may be possible for governments in Yukon to conduct more research on this issue and to better understand how it affects the Indigenous population. By contributing to the research being done on this topic, an important gap in the academic literature could be addressed.

References

Aram, A. (2018, January 11). *Spirometry working group*. [Agenda and minutes from the working group meeting on spirometry]. Copy in possession of River Walton, who also attended the meeting.

Bednarek, M., Maciejewski, J., Wozniak, M., Kuca, P., and Zielinski, J. (2008). Prevalence, severity and underdiagnosis of COPD in the primary care setting. *Thorax, 63*(5), pp. 402-407.

Borg, B. M., Hartley, M. F., Fisher, M. T., and Thompson, B. R. (2010). Spirometry training does not guarantee valid results. *Respiratory Care*, 55(6), pp. 689-694.

Boulet, L., Bourbeau, J., Skomro, R., and Gupta, S. (2013). Major care gaps in asthma, sleep and chronic obstructive pulmonary disease: A road map for knowledge translation. *Canadian Respiratory Journal, 20*(4), pp. 265-269.

Bourbeau, J., Bhutani, M., Hernandez, P., Aaron, S. D., Balter, M., Beauchesne, M., D'Urzo, A., Goldstein, R., Kaplan, A., Maltais, F., Sin, D. D., and Marciniuk, D. D. (2019). Canadian thoracic society clinical practice guideline on pharmacotherapy in patients with COPD - 2019 update of evidence. *Canadian Journal of Respiratory, Critical Care, and Sleep Medicine, 3*(4), pp. 210-232.

Bryan, S., and Navaneelan, T. (2015). Deaths from chronic obstructive pulmonary disease in canada, 1950-2011. Health at a Glance, Statistics Canada, Catalogue no. 82-624X, pp. 1-8.

Canadian Institute for Health Information (2021). Your health system. Retrieved on October 5, 2021 from: https://yourhealthsystem.cihi.ca/hsp/indepth.

Canadian Lung Association. (2005). Chronic obstructive pulmonary disease (copd): A national report card. Retrieved from: https://www.researchgate.net/publication/272788628_Chronic_Obstructive_Pulmonary_Disease_COPD_a_National_Report_Card.

Canadian Thoracic Society. (2018). About us. Retrieved from: https://cts-sct.ca/about-us/.

Camp, P., and Levy, R. (2008). A snapshot of chronic obstructive pulmonary disease in British Columbia and Canada. *BC Medical Journal*, 50(2), pp. 80-84.

Cawley, M. J., and Warning, W. J. (2015). Pharmacists performing quality spirometry testing: An evidence based review. *International Journal of Clinical Pharmacy*, 37(5), pp. 726-733.

Coates, A. L., Graham, B. L., McFadden, R. G., McParland, C., Moosa, D., Provencher, S., and Road, J. (2013). Spirometry in primary care. *Canadian Respiratory Journal*, 20(1), pp. 13-22.

College of Physicians and Surgeons of Alberta. (2006). Spirometry and flow volume measurements: Standards & guidelines. Retrieved from: https://cpsa.ca/wp-content/uploads/2020/10/Spirometry_Flow_Volume_Measurement_Guidelines.pdf.

College of Physicians and Surgeons of British Columbia. (2018). Community spirometry. Retrieved from: https://www.cpsbc.ca/programs/dap/accreditation/community-spirometry.

Dang-Tan, T., Ismaila, A., Zhang, S., Zarotsky, V., and Bernauer, M. (2015). Clinical, humanistic, and economic burden of chronic obstructive pulmonary disease (COPD) in canada: A systematic review. *BMC Research Notes,* 8(1), pp. 464-488.

Derom, E., van Weel, C., Liistro, G., Buffels, J., Schermer, T., Lammers, E., Wouters, E., and Decramer, M. (2008). Primary care spirometry. *The European Respiratory Journal,* 31(1), pp. 197-203.

Desjardins, A., Boulay, M., Gagné, M., Simon, M., and Boulet, L. (2020). Family medicine physician teachers and residents' intentions to prescribe and interpret spirometry: A descriptive cross-sectional study. *The Journal of Asthma, 57*(2), pp. 149-159.

Enright, P. (2008a). Provide GPs with spirometry, not spirometers. *Thorax, 63*(5), pp. 387-388.

Enright, P. (2008b). The use and abuse of office spirometry. *Primary Care Respiratory Journal: Journal of the General Practice Airways Group, 17*(4), pp. 238-242.

Enright, P. (2012). Should we keep pushing for a spirometer in every doctor's office? *Respiratory Care, 57*(1), pp. 146-153.

Evans, J., Chen, Y., Camp, P. G., Bowie, D. M., and McRae, L. (2014). Estimating the prevalence of COPD in canada: Reported diagnosis versus measured airflow obstruction. *Health Reports*, 25(3), pp. 3-11.

Fraser, S. (2011). Yukon health services and programs - 2011: Department of health and social services. Office of the Auditor General of Canada.

Gershon, A. S., Hwee, J., Croxford, R., Aaron, S. D., and To, T. (2014). Patient and physician factors associated with pulmonary function testing for COPD: A population study. *CHEST*, 145(2), pp. 272-281.

Gershon, A., Mecredy, G., Croxford, R., To, T., Stanbrook, M. B., and Aaron, S. D. (2017). Outcomes of patients with chronic obstructive pulmonary disease diagnosed with or without pulmonary function testing. *CMAJ: Canadian Medical Association Journal*, 189(14), pp. E530-E538.

Gershon, A. S., Warner, L., Cascagnette, P., Victor, J. C., and To, T. (2011). Lifetime risk of developing chronic obstructive pulmonary disease: A longitudinal population study. *The Lancet, 378*(9795), pp. 991-996.

Global Initiative for Chronic Obstructive Lung Disease. (2017). Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease (2017 report). Retrieved from: http://goldcopd.org/gold-reports/.

Government of British Columbia (2004). A snapshot of COPD care in british columbia 2003/04. Retrieved from: http://www.health.gov.bc.ca/library/publications/year/2004/copd_snapshot_2004.pdf.

Government of Canada (2021). Canada's tobacco strategy. Retrieved from: https://www.canada.ca/en/health-canada/services/publications/healthy-living/canada-tobacco-strategy.html.

Government of Prince Edward Island (2014). Prince Edward island chronic obstructive pulmonary disease (COPD) trends: 2001-2011. Retrieved from: https://www.princeedwardisland.ca/sites/default/files/publications/copd_trends_2001_2011.pdf.

Guidelines and Protocols Advisory Committee (2017). Chronic obstructive pulmonary disease (COPD): Diagnosis and management. Retrieved from: https://www2.gov.bc.ca/assets/gov/health/practitioner-pro/bc-guidelines/copd_full_guideline.pdf.

Gupta, S., Moosa, D., MacPherson, A., Allen, C., and Tamari, I. E. (2016). Effects of a 12-month multi-faceted mentoring intervention on knowledge, quality, and usage of spirometry in primary care: A before-and-after study. *BMC Pulmonary Medicine, 16*(1), pp. 56-65.

Hill, K., Goldstein, R., Guyatt, G., Blouin, M., Tan, W., Davis, L., … and Stanbrook, M. (2010). Prevalence and underdiagnosis of chronic obstructive pulmonary disease among patients at risk in primary care. *CMAJ, 182*(7), pp. 673-678.

Johns, D., Wood- Baker, R., Walters, J., Hansen, E., Mudge, P., and Walters, E. (2005). Barriers to the use of spirometry in general practice. *Australian Family Physician, 34*(3), pp. 201-203.

Joo, M. J., Au, D. H., Fitzgibbon, M. L., McKell, J., and Lee, T. A. (2011). Determinants of spirometry use and accuracy of COPD diagnosis in primary care. *Journal of General Internal Medicine, 26*(11), pp. 1272-1277.

Kaplan, A., Levitz, S., and Petrasko, K. (2017). The role of spirometry in the management of obstructive airways disease: How pharmacists should get involved. *Canadian Pharmacists Journal, 150*(4), pp. 229-232.

Kilian, A., Nidumolu, A, and Lavis, J. (2016). Jurisdictional scan in policy making: A critical interpretive synthesis. Presented at the Emerging Health Policy Research Conference. Retrieved from: https://ses.library.usyd.edu.au/bitstream/2123/15695/1/bhsc_kilian_ehpr-presentation-2016-06-21final.pdf.

Kinnula, V. L., Vasankari, T., Kontula, E., Sovijarvi, A., Saynajakangas, O., and Pietinalho, A. (2011). The 10-year COPD programme in finland: Effects on quality of diagnosis, smoking, prevalence, hospital admissions and mortality. *Primary Care Respiratory Journal: Journal of the General Practice Airways Group,* 20(2), pp. 178-183.

Lareau, S.C., Fahy, B., Meek, P., and Wang, A. (2019). Chronic Obstructive Pulmonary Disease (COPD)." *American Journal of Respiratory and Critical Care Medicine*, 199(1), pp. P1-P2.

Lee, J. Y., Rhee, C. K., Jung, K. S., and Yoo, K. H. (2016). Strategies for management of the early chronic obstructive lung disease. *Korean Academy of Tuberculosis and Respiratory Diseases*, 79(3), pp. 121-126.

Licskai, C. J., Sands, T. W., Paolatto, L., Nicoletti, I., and Ferrone, M. (2012). Spirometry in primary care: An analysis of spirometry test quality in a regional primary care asthma program. *Canadian Respiratory Journal, 19*(4), pp. 249-254.

Manitoba Health, Seniors and Active Living. (2017). Annual statistics 2016-2017. Retrieved from: https://www.gov.mb.ca/health/annstats/as1617.pdf.

Mann, R., and Nichols, J. (2009). Management of chronic obstructive pulmonary disease. *American Journal of Lifestyle Medicine*, 3(6), pp. 458-465.

McLennan, B., Green, G., Marchildon, G., Strand, D., and Zelmer, J. (2020). Putting people first: The final report of the comprehensive review of Yukon's health and social programs and services. Retrieved from: https://yukon.ca/en/putting-people-first.

Mehta, V., Desai, N., and Patel, S. (2016). When pulmonary function test is available, should we wait for the COPD symptoms to develop? *Journal of Clinical and Diagnostic Research, 10*(10), pp. OE08-OE12.

Miller, M. R., Hankinson, J., Brusasco, V., Burgos, F., Casaburi, R., Coates, A., … and Sahlgrenska Academy. (2005). Standardisation of spirometry. *The European Respiratory Journal, 26*(2), pp. 319-338.

Moore, P. (2007). Practice management and chronic obstructive pulmonary disease in primary care. *The American Journal of Medicine, 120*(8), pp. S23-S27.

Qaseem, A., Wilt, T. J., Weinberger, S. E., Hanania, N. A., Criner, G., van der Molen, T., … and American College of Physicians, American Thoracic Society, American College of Chest Physicians, and European Respiratory Society. (2011). 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, 155*(3), pp. 179-192.

Quanjer, P. H., Stanojevic, S., Cole, T. J., Baur, X., Hall, G. L., Culver, … and Stocks, J. (2012). Multi-ethnic reference values for spirometry for the 3-95 year age range: The global lung function 2012 equations: Report of the global lung function initiative (GLI), ERS task force to establish improved lung function reference values. *The European Respiratory Journal,* 40(6), pp. 1324-1343.

Saad, N., Sedeno, M., Metz, K., and Bourbeau, J. (2014). Early COPD diagnosis in family medicine practice: How to implement spirometry? *International Journal of Family Medicine,* 2014, pp. 1-6.

Salinas, G. D., Williamson, J. C., Kalhan, R., Thomashow, B., Scheckermann, J. L., Walsh, J., Abdolrasulnia, M., and Foster, J. A. (2011). Barriers to adherence to chronic obstructive pulmonary disease guidelines by primary care physicians. *International Journal of Chronic Obstructive Pulmonary Disease,* 6, pp. 171-179.

Soriano, J. B., Zielinski, J., and Price, D. (2009). Screening for and early detection of chronic obstructive pulmonary disease. *The Lancet, 374*(9691), pp. 721-732.

Tan, W. C., Bourbeau, J., O'Donnell, D., Aaron, S., Maltais, F., Marciniuk, D., … and Fitzgerald, J.M. (2014). Quality assurance of spirometry in a population-based study -predictors of good outcome in spirometry testing. *COPD: Journal of Chronic Obstructive Pulmonary Disease*, 11(2), pp. 143-151.

To, T., Guan, J., Zhu, J., Lougheed, M. D., Kaplan, A., Tamari, I., … and Gershon, A. S. (2015). Quality of asthma care under different primary care models in canada: A population-based study. *BMC Family Practice,* 16(1), pp. 1-12.

Walters, J. A., Hansen, E. C., Johns, D. P., Blizzard, E. L., Walters, E. H., and Wood-Baker, R. (2008). A mixed methods study to compare models of spirometry delivery in primary care for patients at risk of COPD. *Thorax*, 63(5), pp. 408-414.

Weiss, G., Steinacher, I., Lamprecht, B., Schirnhofer, L., Kaiser, B., Sönnichsen, A., and Studnicka, M. (2014). Detection of chronic obstructive pulmonary disease in primary care in salzburg, austria: Findings from the real world. *Respiration,* 87(2), pp. 136-143.

Winnipeg Regional Health Authority. (2017a). Primary health care and regional respiratory therapy operational guideline: Spirometry testing – adult. Retrieved from: https://professionals.wrha.mb.ca/old/professionals/primary-care-providers/files/PCPG16SpirometryTesting.pdf.

Winnipeg Regional Health Authority. (2017b). Appendix C: Role of primary care clinics, regional respiratory therapy and the PHC program in spirometry testing and quality assurance. Retrieved from: http://www.wrha.mb.ca/staff/familyphysicians/files/APPENDIXCTheRole.pdf.

Yukon Bureau of Statistics. (2021). Yukon statistical review, 2020. Retrieved from: https://yukon.ca/en/yukon-statistical-review-2020.

Appendix A - Email to relevant jurisdictions

From: River.Walton@gov.yk.ca [mailto:River.Walton@gov.yk.ca]
Sent: January-05-18
To:
Cc: rmwalton@uvic.ca
Subject: Delivery of Spirometry Services - Request for Documentation

Hello,

My name is River Walton and I am a graduate student in the Master of Public Administration program at the University of Victoria. I am also a Policy Analyst with the Department of Health and Social Services, Government of Yukon.
As part of my graduate studies, I am conducting research on the delivery of spirometry within Canada. I am investigating whether jurisdictions differ in the models used for performing spirometry. Some of the questions I am considering include:

- How many spirometry tests are performed each year?
- What is the average wait time for a test?
- Are jurisdictions providing services through primary care, or are other models being used (such as providing the service through pharmacy, traveling nurses or private business)?
- Who is performing the test and interpretation? Is it Physicians, RNs, RTs, LPNs, MOAs, or other health professionals?

If you have any information about how spirometry services are delivered in your jurisdiction, I would appreciate receiving that documentation (reports, information notes, studies, etc.). Please be advised that any documents received may be referenced in the Master's project report. If confidential documents are shared (e.g. briefing notes), the report can be made confidential, meaning only myself, my client and my supervisory committee would have access. It would not be available to the public.

I am unable to speak directly to individuals, so any information you can share must be in the form of a document (email, report, briefing note, information note, study, etc.). If there is a specific contact that I can email with this request, please let me know.

Thanks so much for your help, and I look forward to hearing from you soon.

River Walton
Policy Analyst
Territorial Health Investment Fund – Chronic Disease Management
Department of Health and Social Services (H-22)
Government of Yukon
Phone: 867.455.2813 | Email: River.Walton@gov.yk.ca