May 2018

Validation of an Algorithm Allowing Identification of Primary Spontaneous Pneumothorax Cases from Administrative Databases

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Graduate Program in Epidemiology and Biostatistics

A thesis submitted in partial fulfillment of the requirements for the degree in Master of Science

Recommended Citation
https://ir.lib.uwo.ca/etd/5324
Abstract

Introduction: There is no differentiation between primary spontaneous pneumothorax (PSP) and secondary pneumothorax (SP) in the current version of the International Classification of Diseases (ICD-10). Objective: To validate the accuracy of an algorithm that identifies cases of PSP from administrative databases. Methods: The charts of 150 patients who attended the emergency room (ER) with a recorded main diagnosis of pneumothorax were reviewed. The corresponding hospital administrative data collected during previous hospitalizations and ER visits were processed through the proposed algorithm. The results were compared over two different age groups. Results: The results obtained from the PSP algorithm demonstrated a significantly higher sensitivity (97% vs. 81%, p=0.038) and positive predictive value (87% vs. 46%, p<0.001) in patients under 40 years of age compared to older patients. Conclusions: The proposed algorithm is adequate to identify cases of PSP from administrative databases in the age group classically associated to the disease.

Keywords

Epidemiology; Pneumothorax; Pleural Diseases; International Classification of Diseases; Validation Studies
Co-Authorship Statement

The validation study and the study protocol presented here were designed and undertaken by Eric Fréchette, whose tasks include but were not limited to the studies design, data collection, data analysis and manuscript production. This was made possible with the support and regular feedback from the supervisory committee and from the co-authors whose names appear below.

Dr. Richard A Malthaner was the primary supervisor and was involved in different aspects of this work.

The support and review of the co-authors of the publication below allowed to optimize the study protocol in order to obtain appropriate funding and finalize the manuscript which was accepted for publication in the Canadian Respiratory Journal on May 12, 2016.

Acknowledgments

Supervisory committee: I am thankful for the support provided by my supervisor Dr Richard A Malthaner throughout the steps of this work. He has been very supportive and encouraging and has been an excellent source of knowledge and inspiration. I want also to thank Dr Blayne Welk for providing an excellent support related to population-based studies, and Dr Yun-Hee Choi for her help regarding data analysis.

Surgical Investigators Group at ICES Western: I would like to thank the members of the group including Chris Bailey, Muriel Brackstone, Sumit Dave, Luc Dubois, Steve Latosinsky, Danielle MacNeil, Jacob McGee, Dave Nagpal, Stephen E. Pautler, and Kelly Vogt who served as scientific and clinical advisors for this work and who have facilitated the work with their support.

Colleagues from the Department of Surgery: I want to acknowledge the support of colleagues involved in research in the Department of Surgery of London Health Sciences Centre, more specifically Dr Keegan Guidolin, Dr Ayman Seyam, Mr J. Andrew McClure, and Mrs Jennifer Winick-Ng, for their involvement in data collection and their help with data analysis.

Funding support: This work has been made possible with the financial support of the Department of Surgery, (Schulich School of Medicine & Dentistry, Western University); I am deeply grateful for their provision of an Internal Research Fund Grant.

Division of Thoracic Surgery: This work and my recent epidemiology training would not have been possible without the everyday support from my colleagues and the staff of the Division, who were always available and helpful, providing a great working environment allowing time and resources to be used for education and research. To Dr Dalilah Fortin, Dr Richard Malthaner and Dr Richard Inculet: thank you! To Deb, Khrystyn, Linda H., Linda M, Raquel, Danielle, Maria, Nancy and Kendra: Thank you!

Family: For their constant understanding, trust and love, my wife Katharina and all my family members need to share a great part of the acknowledgments, always being present and supportive and always believing in our success.
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Chapter 1
1 Introduction

1.1 Background and Overview

Primary spontaneous pneumothorax (PSP) is one of the most common lung diseases treated by thoracic surgeons. It is a medical condition affecting generally young and healthy individuals who are presenting with sudden onset shortness of breath and shoulder pain. It results from the rupture of a lung bulla, a pocket of air located at the superior portion of the lung, leading to the accumulation of intrathoracic atmospheric air and collapsing the lung at some degree. Spontaneous pneumothorax can also occur in patients presenting different types of lung diseases such as lung emphysema or cystic fibrosis, which will impact the long-term management. While PSP is most commonly a benign condition that can sometimes simply be observed, it has the potential, if unrecognized, to progress to a catastrophic situation in which the heart and other intrathoracic organs are compressed by a high pressure tension pneumothorax potentially creating a hemodynamic instability, which if untreated can be fatal.

Depending on the size of the pneumothorax and its associated clinical presentation, the initial management may vary. It may include simple observation, needle aspiration, or chest drainage allowing an evacuation of the intrathoracic trapped air until the lung breach has healed. But sometimes, a persistent air leak from the lung originating from a “broncho-pleural fistula” will need to be addressed surgically. This is one of the indications to perform a surgical intervention for PSP in which the bullae of the lung are removed and the lung defect is being closed. It is normally associated to another procedure, named pleurodesis, that can be either mechanical or chemical and that aims to induce the formation of scar tissue within the chest cavity to permanently maintain the lung surface adherent against the inner portion of the chest wall, which will decrease the chance of another episode.

However, the main indication to perform surgery for PSP is to prevent recurrence. Many factors have been proposed to increase the risk of recurrence in patients following an
episode of PSP, but the most important is the number of prior PSP episodes. Most patients will be offered surgery after a second documented episode.

Unfortunately, the exact risk of recurrence following an episode of PSP is hard to predict, in part because only few studies with a limited number of patients have been conducted specifically on the subject. Some population-based studies are available but include both primary and secondary spontaneous pneumothorax which are often pooled under the same classification codes in hospital discharge summaries. This is problematic, as the recurrence risk, and the factors influencing recurrence, may be different among secondary pneumothorax. Large administrative data studies specifically on PSP are lacking.

Administrative hospital data are potentially powerful data sources, allowing epidemiological studies of diseases, but the accuracy of the data must be confirmed. The tenth edition of the International Classification of Diseases (ICD-10-CA) was introduced in Canada in 2000, and it includes codes allowing the identification of patients seeking medical treatment for pneumothorax. A subdivision of the code J93 further differentiates between spontaneous tension pneumothorax, other spontaneous pneumothorax, other pneumothorax, and pneumothorax (unspecified). Unfortunately, the classification does not clearly allow the identification of PSP, which would be necessary for the conduct of large population-based studies on PSP using administrative data from emergency room visits and hospital discharge summaries.

The clinical significance of this lack of knowledge on PSP is that it might be difficult for a physician to predict the risk of recurrence of a particular patient and therefore decide which treatment would be the most appropriate.

The objective of this work is to validate the accuracy of an administrative data algorithm designed to identify PSP cases from the recorded emergency room and hospital discharge summaries, in order to allow population-based research in this population.
2. Literature review

2.1 Definition and incidence of primary spontaneous pneumothorax

The accumulation of air into the pleural cavity, or pneumothorax, can happen suddenly in previously asymptomatic individuals. The term secondary pneumothorax (SP) has been used to define this condition when it is caused by an underlying medical condition, such as emphysema or trauma. It is different than primary spontaneous pneumothorax, which is occurring mainly in previously healthy patients.\(^1\) It is the result of the rupture of blebs or bullae located at the apex of the lung, or by the presence of pleural porosities in this area.\(^2\) Melton et al. reported 77 cases of PSP occurring over a 24-year period in Olmstead county, Minnesota and calculated an age-adjusted incidence rate of 7.4/100 000 persons per year in males and 1.2/100 000 persons per year in females (adjusted for the USA white population age distribution from 1960). The phenomenon was described as being 6.2 times more frequent in males than in females.\(^3\) Others have reported incidence rates varying between 18-28 cases/100 000 persons per year for males and between 1.2-6 cases/100 000 persons per year for females.\(^4\) The peak of incidence is believed to be between the age of 20 and 30 years-old.\(^5\) More recently, an analysis of a French database identified over a 4-years period, 42595 patients requiring hospitalization for either primary and secondary pneumothorax and calculated an annual incidence rate of 22.7 cases/100 000 persons.\(^6\)

2.2 Clinical presentation and management

Patients presenting an acute episode of pneumothorax will complain most commonly of dyspnea and severe chest pain irradiating to the shoulder. The physical examination will reveal decreased breath sounds on auscultation and hyperresonance at chest percussion of the involved side. A postero-anterior chest radiography will confirm the diagnosis and will allow an estimation of the pneumothorax size. (Figure 1.)
Figure 1. Postero-anterior chest radiograph documenting a complete right-sided pneumothorax with shifting of the mediastinum towards the left chest. The right lung is completely collapsed (arrow) creating a large intrapleural space filled with air in which the normal aspect of lung parenchyma and vasculature is no longer visible.
Depending on the severity of the clinical symptoms and the size of the pneumothorax, most patients will be treated by simple observation, needle aspiration or chest-tube insertion. Although the clinical course of most patients will be benign, PSP might have occasionally serious complications. In some cases a tension pneumothorax might develop. This is a life-threatening condition caused by the accumulation of air under pressure within the chest, from a one-way valve phenomenon at the site of the air leak. Increased thoracic pressure, shifted mediastinal structures and a compromised blood return to the right atrium may lead to hypoxia, hypotension and cardiovascular collapse.

Another reported complication from PSP is persistent air leakage from a broncho-pleural fistula, which may result in a prolonged hospital stay. In these cases the site of rupture at the apex of the lung will not heal for many days and the patient will require chest tube insertion to evacuate the air from the pleural cavity, a procedure usually associated with minimal complications, however pain or discomfort might be significant. Sometime, a larger broncho-pleural fistula will lead to air accumulating within the chest despite previous drainage and additional chest tube insertion, or suction chest drainage is necessary. A prolonged air leak will be an indication to address PSP by surgery. Although there is no consensus on the most appropriate length of time to wait until the leak stops before proceeding with a surgical intervention, most experts will recommend a waiting period of 5 days.

Surgical procedures for PSP are some of the most commonly performed interventions in thoracic surgery and are usually definitive. Through an open axillary approach or with the use of thoracoscopy, the procedure includes the removal of the apical blebs and bullae which are thought to be causal factors. In addition, in order to improve the surgical results and minimize the potential for recurrence, some type of pleurodesis will be performed to promote scarring at the apex of the lung, which will adhere to the inner surface of the thoracic cavity. Mechanical pleurodesis includes pleural abrasion or pleurectomy and can only be performed at the time of surgery. A chemical pleurodesis might be performed at the time of surgery, but also in the endoscopy unit during medical thoracoscopy, or even at the patient’s bedside by the injection of sclerosing agents through chest tubes. This latter approach was shown to be inferior to a surgical
approach, but can be a valid option in frail patients who aren’t candidates for a surgical intervention.\textsuperscript{11}

Figure 2. An incomplete re-expansion of the right lung can be seen on this chest radiograph following the insertion of a drainage catheter for a spontaneous pneumothorax (white arrow). A discrete amount of subcutaneous emphysema is also visible in the subcutaneous tissues around the site of chest tube insertion (black arrow).
Several products have been suggested as potential sclerosing agents to use in cases of PSP, the most effective being talc, which can be directly insufflated within the chest or injected as a suspension into the chest tube. Chemical pleurodesis is rarely used alone in patients with PSP in Canada and in the United States, but many European authors have suggested that this could represent an adequate alternative to surgery and that the resection of the causative ruptured blebs or bullae could be optional. \(^{12}\) Pain and talc toxicity (including acute pneumonitis, acute renal failure and myocardial infarction) have been described as potential adverse events of talc pleurodesis. \(^{13}\)

As previously mentioned, surgical intervention might be necessary in cases of prolonged air-leak. In those cases, the procedure will allow to stop the air-leakage and withdraw the drainage catheter, to eventually discharge the patient from the hospital. (Figure 3.) In those cases, the necessity of the procedure is obvious. Similarly, an intervention to prevent PSP recurrence is recommended in certain hazardous situations, such as when a patient is living far away from accessible medical care, working in pressurized environment (e.g. airplane pilot, divers) and when a pneumothorax recurrence can become a catastrophic situation. \(^{14}\)

Outside of those obvious conditions, surgery for pneumothorax is most commonly aimed at recurrence prevention. The problem is that this risk of recurrence in a specific patient is difficult to define. As detailed by Massard et al., the risk of recurrence increases after each new episode of pneumothorax, and patients presenting with recurring PSP, either ipsilateral or contralateral, should be offered surgery. \(^{8}\) This has become a generally well accepted concept, even considering the paucity of information on this subject in the medical literature. In a Delphi consensus statement on the management of pneumothorax by the American College of Chest Physicians, 85% of the expert panel members recommended surgery after the first recurrence of PSP. The number of previous episodes is the only predictor of recurrence commonly used in clinical practice. \(^{15}\)
Figure 3. Following surgery for primary spontaneous pneumothorax with persistent air leak, the expanded right lung occupies the totality of the ipsilateral pleural space. This chest radiograph documents the presence of a chest tube and close to its tip postoperative changes of the apex of the lung related to bullectomy.
2.3 Reported PSP recurrence rates

Because of the fact that recurrences seem to guide the treatment offered to patients suffering from PSP, one would expect to find in the medical literature a thorough description of this risk and of the different factors modelling it. But this is not the case: a wide variation in the recurrence rates have been described, ranging from 10 to 21% after a first episode, and rising as high as 50% to almost 80% after a second and third episode. The time interval during which the recurrences were captured varies from one study to the other, offering generally a short period of follow up, and reporting a wide variety of incidence of this late complication. In their article published in 1991, Lippert et al. were the first to report appropriately the results on a time-related basis. Their 5-year cumulative survival without pneumothorax in patients without lung disease was estimated to be 77% (95% confidence interval: 73-81%). Many authors cited the information published by Cran and Rumball reporting data collected on spontaneous pneumothorax in the British Royal Air Force between 1941 and 1962, on 994 men aged between 16 and 50 years-old. A global recurrence rate of 18.7% was described, with most recurrences occurring within one year (59.5%) or two years (81.0%) after the first episode. The proportion of spontaneous pneumothorax recurrences occurring after five years was minimal (3.2%). In a recent study from Korea, 232 patients were treated without surgery and underwent telephone follow up for 4 to 8 years following their episode of PSP. The number of PSP episodes was not included in the analysis, but a recurrence rate of 29% was noted in patients treated with observation. The patients who required chest drainage had a 54% recurrence rate, which is higher than what has been reported before.

2.4 Risk factors for pneumothorax

Many clinical elements have been described as potential risk factors for the development of a first episode of PSP. It is important to understand those characteristics as they could also cause recurrence. This was suggested in a review of 1491 patients who presented themselves in 14 medical centers in France over a period of 4 years, where no differences
in clinical factors could be identified between initial and recurrent cases.\textsuperscript{19} The most commonly cited patient-related risk factor is gender. Males are known to be more than three times more at risk than females to develop a pneumothorax, and this risk rises up to six times when the analysis is restricted to PSP.\textsuperscript{3,6} Age is also related to the risk of developing PSP. In a review from the General Practice Research Database (GPRD) including 5.6\% of the patients treated in England and Wales, Gupta et al. described a biphasic distribution of age in patients consulting for any pneumothorax. The first peak of incidence was thought to be mainly due to PSP and was corresponding to the 20-24y.o. age group in male and 30-34y.o. age group in female.\textsuperscript{5} Another risk factor for a spontaneous pneumothorax is smoking. In a population-based study in the county of Stockholm, Sweden, Bense et al. reported in 1987 a 9-fold and 22-fold risk increase of developing pneumothorax with tobacco smoking in women and men, respectively.\textsuperscript{20} Marijuana smoking has also been identified as detrimental for respiratory functions and it is suspected to increase even more the risk of developing bullous lung diseases and causing pneumothorax in individuals who are most commonly already smokers.\textsuperscript{21} Tall and thin individuals are known to be at higher risk for PSP. The effect of the height-weight ratio on the risk of recurrence has been confirmed by Nakamura to be independent from the effect of the level of tobacco consumption.\textsuperscript{22} Patients height seems to be a more important factor than weight for the occurrence of PSP, taller individuals being at higher risk.\textsuperscript{23} Rapid changes in the configuration of the upper chest occurring during adolescence was found to have an impact on the risk of developing PSP in a case-control study on 404 patients treated in Taiwan.\textsuperscript{24} The intensity of physical activity was initially suspected as being a significant etiological factor for PSP, but this has been refuted.\textsuperscript{4} Some psychological or emotional factors were once suspected to cause PSP. In an interesting cooperative work involving departments of psychiatry and emergency medicine, no clear relation could be identified between episodes of PSP and patients’ anger, anxiety or depression levels.\textsuperscript{25} Certain environmental factors, such as weather conditions, atmospheric pressure, level of air pollution, have been suggested to promote the occurrence of PSP.\textsuperscript{26-29} However, in the study of 638 pneumothorax patients admitted over a period of 4 years in a French urban area of 110 000 inhabitants, no relation could
be identified between the occurring of pneumothorax and atmospheric pressure, relative humidity, rainfall, wind speed or temperature.\textsuperscript{30}

### 2.5 Risk factors for PSP recurrence

It is unusual for patients to develop PSP recurrence following surgical treatment, unless an incomplete bullae resection is performed with an inadequate pleurodesis. (Figure 4.) Many reports in literature have defined the factors related to those unsuccessful interventions, however it was decided for this work not to include them and to limit the review to the natural history of PSP prior to any definitive treatment.

The presence of air trapping on tomodensitometry (CT-Scan), has been described as being a risk factor for PSP.\textsuperscript{31} In a study on 176 patients treated without surgery and followed for at least 12 months after an episode of PSP, the risk of recurrence increased from 6\% to 68\% in patients found to have blebs or bullae on high-resolution CT-scan.\textsuperscript{32} Similarly, in a retrospective study of 114 patients treated non-surgically for PSP, Young Choi et al. noted after a mean follow up of 43 months a recurrence rate higher (60\% vs 31\%) in patients documented to have blebs or bullae identified on high-resolution CT-scan. In a retrospective review of 153 patients treated for PSP, Sadikot et al. reported over a four-year period a 54.2\% rate of recurrence. Gender, height and smoking status were the only three independent factors for recurrence that could be found as significant.\textsuperscript{33} Similarly, in a study of 122 subjects treated for a first episode of spontaneous pneumothorax, Lippert et al. documented a higher risk of recurrence in patients with lower height-weight ratio, in smokers, in patients over 60 years of age and in patients presenting pulmonary fibrosis on chest X-Ray. This study however included patients who underwent surgical treatment for pneumothorax and possibly also cases of secondary pneumothorax, making the results from their analysis not applicable to non-surgical PSP cases.\textsuperscript{16}
Figure 4. Coronal view of the chest computed tomodensitometry performed in a patient presenting a left PSP recurrence 18 month following ipsilateral axillary thoracotomy for bullectomy with vibramycin pleurodesis. A residual bulla can be seen next to the stapler line (arrow). In this case, the absence of adhesion between the lung and the chest wall was suspected to be secondary to the weak efficacy of the antibiotic as agent for pleurodesis.
The patient BMI seems to be related to the risk of recurrence. In a retrospective analysis of a cohort of 273 patients aged less than 30 years and treated for a first episode of PSP, Tan et al. recorded 81 recurrences (30%). Sixty-four percent of their patients underwent surgery. They performed a Cox regression analysis and identified 3 factors associated to recurrence: a low body-mass index (BMI) (less than 18.5 kg/m$^2$), the absence of surgical treatment, and a large-size pneumothorax (more than 50% of the lung volume).\textsuperscript{34} In a similar study design including 553 patients treated surgically for PSP and analyzing the risk factor for contralateral recurrence, Chen et al. identified both low BMI and visible blebs/bullae on HDCT to be related to an additional episode of PSP.\textsuperscript{35} Another group from China (Chiu et al.), analyzing the results of 128 patients treated medically for a first episode of pneumothorax, identified the size of the pneumothorax to be associated to further episodes.\textsuperscript{36}

Other factors related to the type of treatment offered to patients with PSP have been related to the risk of recurrence. The decision to treat the patient initially with chest air aspiration through thoracentesis instead of chest tube insertion was found to have a higher incidence of recurrence during the first week of follow-up in two studies published in the mid-1990’s.\textsuperscript{37} This finding is however not surprising because multiple thoracentesis sessions may be necessary when this procedure, most commonly performed in Europe, is used when dealing with PSP.\textsuperscript{38} In a meta-analysis of randomized trials comparing the results of thoracentesis and chest drainage in the treatment of PSP, no significant difference could be identified in recurrence rates at one year.\textsuperscript{39} The performance of chemical pleurodesis through the chest-tube at the moment of initial treatment for PSP has been shown to be an effective way to reduce recurrences, and reports have detailed the benefits of using tetracycline, minocycline or talc suspension to obtain an effective sclerotherapy of the pleural space.\textsuperscript{40,41}

### 2.6 Pneumothorax in administrative data studies

Administrative hospital data are potentially powerful data sources, allowing epidemiological studies of diseases, but the accuracy of the data must be confirmed. The
The tenth edition of the International Classification of Diseases (ICD-10-CA) was introduced in Canada in 2000, and implemented in Ontario in 2002. It includes codes allowing the identification of patients seeking medical treatment for pneumothorax. A subdivision of the code J93 further differentiates between spontaneous tension pneumothorax, other spontaneous pneumothorax, other pneumothorax, and pneumothorax (unspecified). Unfortunately, the classification does not clearly allow the identification of PSP, which is necessary to conduct large population-based studies on the subject using administrative data from emergency room visits and hospital discharge summaries.

Gupta et al. published in 2000 their work on the epidemiology of pneumothorax in England. They identified from the General Practice Research Database and the Hospital Episode Statistics obtained from the Office for National Statistics over 20,000 consultations for pneumothorax between the years 1991 and 1995. The authors could not specifically target the patients presenting for PSP and included in their study patients treated for secondary pneumothorax and traumatic or iatrogenic pneumothorax. They were however able to demonstrate the impact of age on the incidence of pneumothorax, as both in males and females a biphasic distribution of cases of pneumothorax. The first peak of incidental cases occurred between ages 20-24 in males and between the ages 30-34 in female. It was suggested that these early age pneumothorax were representing mostly PSP cases.

In another population-based study, Bobbio et al, reported from the French database “Programme de Médicalisation des Systèmes d’Information” between 2008 and 2011, 59,637 hospitalizations of 42,595 patients for pneumothorax. Patients treated as outpatients were not included in the study. The authors calculated an annual incidence of 22.7 cases per 100,000 population for France. The mean hospital stay was 7 days, 24% of patients underwent surgery with thoracoscopic resection of blebs (76% or intervention) associated to mechanical pleurodesis in 52% and talc pleurodesis in 24%. The authors excluded traumatic pneumothorax and differentiated between secondary pneumothorax and what was termed “idiopathic pneumothorax”. The authors used the ICD classification for the diagnosis of pneumothorax and it is unclear how they differentiated between idiopathic and secondary pneumothorax. The risk of recurrence could not be calculated in this
study, however, a high proportion of the cases represented a re-hospitalization, (48% of the cases in females and 49% of the cases in males), and in those cases the patients were found to be significantly younger (35 vs 40 years when no previous pneumothorax could be documented), and underwent more often a surgical procedure. There was in this study a high proportion of idiopathic pneumothorax (85% of patients) even in the group of patients above 50 years old (65% of cases in males and 77% in females). This raises the question whether or not the idiopathic pneumothorax cases in this study represent cases of PSP.

There is to our knowledge no large population-based epidemiological study specifically on PSP and its risk factors of recurrence.
Chapter 3
3 Rationale, research question and hypothesis

3.1 Rationale

PSP is one of the most common chest pathologies treated by chest physicians. The main indication for surgery is the prevention of recurrence in high risk patients. There have been multiple publications reporting the experience of different medical centers, some of them having a significant experience. However, there are only a few rare population-based studies on the subject, and none adequately or specifically examine the epidemiology, risk factors and recurrence rates for PSP. This is in part a consequence of the absence of specific codes differentiating primary and secondary spontaneous pneumothorax in the International Codification of Disease. The consequence is a variability between the recommendations of the different thoracic societies, and an important non-adherence to national guidelines of treatments.\(^4,15,44\) We conducted this work with the hope to provide researchers with a tool to facilitate large population-based studies on PSP.

3.2 Research question and hypothesis

The objective of this study was to create and validate an administrative data algorithm which would allow the identification of PSP cases from the recorded emergency room and hospital administrative data. We hypothesized that we could build an algorithm identifying PSP cases with a sensitivity and positive predictive value of at least 80%, to be used in large population-based study.
Chapter 4
4 Methods

4.1 Study design

We performed a retrospective validation study to assess the accuracy of an algorithm designed to identify cases of PSP amongst patients presenting to the emergency room with a main diagnosis of pneumothorax. The results obtained from the proposed algorithm were compared to the reference standard obtained from manual chart review.

The research protocol was reviewed and approved by the Health Sciences Research Ethics Board at the University of Western Ontario (0000940-105409).

4.2 Creation of the algorithm

The development of the algorithm was based on the same concepts used clinically to differentiate between PSP and other types of pneumothorax. It was derived from clinical reasoning and designed following discussions amongst the research collaborators after a complete review of the ICD-10-CA codes to identify the different clinical entities that are recognized to be a cause of SP. Four main diagnostic codes of pneumothorax were chosen as algorithm inclusion criteria because they were potentially associated with patients presenting PSP. These codes were included the following:

- J93.0 Spontaneous tension pneumothorax
- J93.1 Other spontaneous pneumothorax
- J93.8 Other pneumothorax
- J93.9 Pneumothorax, unspecified

We decided not to include some additional diagnosis of pneumothorax found in the ICD-10-CA in our algorithm, as they likely represented cases of secondary, iatrogenic or traumatic pneumothorax. Those unused codes were:

- congenital or perinatal pneumothorax (P25.1)
- postprocedural pneumothorax (J95.811)
- traumatic pneumothorax (S27.0)
- tuberculous pneumothorax (A15)
- pyopneumothorax (J86)

The next step in the algorithm creation was the exclusion of all cases not believed to be related to PSP and representing potentially either an iatrogenic pneumothorax, a secondary pneumothorax consecutive to a chronic condition, or a pneumothorax related to an acute illness or event such as trauma, pneumonia, status asthmaticus, etc. Below are the details of the three steps of algorithmic exclusion:

1. Patients with a hospital admission record in Discharge Abstract Database (DAD) in the previous 30 days were excluded unless their main diagnosis was pneumothorax, as they could represent cases of iatrogenic pneumothorax from a procedure or an intervention having occurred during this hospitalization.

2. Patients with a chronic condition associated with SP were excluded. We identified these patients based on all diagnosis in DAD and National Ambulatory Care Reporting System (NACRS) databases recorded for 14 conditions present at the index emergency room visit date, or earlier. (Table 1.)
Table 1. Chronic conditions identified as potential cause of secondary pneumothorax with corresponding ICD-10-CA codes.

<table>
<thead>
<tr>
<th>Chronic conditions</th>
<th>ICD-10-CA codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic Obstructive Pulmonary Disease</td>
<td>J40, J410, J411, J418, J42, J431, J432, J438-J441, J961, J982</td>
</tr>
<tr>
<td>Thoracic endometriosis</td>
<td>N808</td>
</tr>
<tr>
<td>Pneumocystis</td>
<td>B59</td>
</tr>
<tr>
<td>Sarcoidosis</td>
<td>D860-J863, D868, D869</td>
</tr>
<tr>
<td>Tuberous sclerosis</td>
<td>Q851</td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td>M051-M053, M058-M060, M062-M064, M068, M069, M080</td>
</tr>
<tr>
<td>Ankylosing spondylitis</td>
<td>M081, M45</td>
</tr>
<tr>
<td>Scleroderma</td>
<td>L940-L941</td>
</tr>
<tr>
<td>Ehler-Danlos syndrome</td>
<td>Q796</td>
</tr>
<tr>
<td>Marfan syndrome</td>
<td>Q874</td>
</tr>
<tr>
<td>Langerhan's disease</td>
<td>D760, D763</td>
</tr>
<tr>
<td>Cystic fibrosis</td>
<td>E840, D841, D848, D849</td>
</tr>
<tr>
<td>Interstitial lung disease</td>
<td>J841, J848, J849</td>
</tr>
<tr>
<td>Lung neoplasm</td>
<td>C3400, C3401, C3409-C3411, C3419, C342, C3430, C3431, C3439, C3480, C3481, C3489, C3490, C3491, C3499, C780, C783, D022, D023, D024, D174, D143, D381</td>
</tr>
</tbody>
</table>

3. We also excluded the patients presenting with an acute condition potentially causing SP in the 30-days prior to the first visit for PSP. (Table 2.)

For each patient all information from index date and previous visits DAD and NACRS recorded locally were obtained. The information collected for the analysis included the admission and discharge dates and all ICD-10-CA diagnostic codes. The data from the different visits and databases were pooled for each individual and submitted to the algorithm.
Table 2. Acute conditions identified as potential cause of secondary pneumothorax with corresponding ICD-10-CA codes.

| Foreign bodies           | T173-T175, T178, T179, T181, T188, T189 |
| Status asthmaticus       | J4501, J4511, J4581, J4591 |
| Lung abscess             | J850-J852 |

4.3 Validation study cohort creation

The charts of the first 150 consecutive patients who presented at the LHSC Victoria Hospital from January 2003 to March 2010 with a main ICD-10-CA diagnosis of pneumothorax were considered for inclusion in the study. The sample size estimation is detailed at chapter 4.7. The patient’s charts where identified from the NACRS database information stored locally at the hospital’s Medical Records service. The NACRS database contains data for hospital-based ambulatory care and is mandatory in Ontario for all day surgery and emergency department visits. It includes the recording of the main diagnosis along with up to 25 additional ICD-10-CA diagnostic codes collected from trained abstractors. In this study, patient’s recruitment was limited to individuals aged at the time of consultation between 18 and 65 years, representing an age distribution that
would allow the recruitment of a sufficient number of both primary and secondary pneumothoraces while excluding the pediatric population. The cases of pneumothorax were identified from one of the NACRS main diagnosis codes: J930 (spontaneous tension pneumothorax), J931 (other spontaneous pneumothorax), J938 (other pneumothorax), or J939 (pneumothorax, unspecified), correlating to the inclusion criteria of the proposed algorithm. These codes included the complete range of disease severity.

For this study, it was decided to perform the validation from a group of patients having one of the ICD-10-CA codes of pneumothorax. It would have been difficult to recruit enough patients having a PSP from a wider inclusion characteristic such as the presence of shortness of breath or pleuritic chest pain at presentation. But because the goal of the algorithm was to differentiate PSP cases from other types of pneumothorax, and because of the high accuracy of the J93 code, the cohort was built from patients diagnosed at the emergency with a diagnosis of pneumothorax.

### 4.4 Reference standard

To define the validity of the propose algorithm, the results needed to be compared to a reference standard obtained by manual chart review. Patient charts were abstracted by two independent physicians, blinded to the recorded administrative data coding (KG, AS). The reviewers confirmed or rejected the diagnosis of pneumothorax from the documents contained in the charts, including the radiology reports and images if needed. All cases of pneumothorax were defined as PSP or SP. Where there was disagreement between reviewers, the diagnosis was obtained following a review by a third physician (EF).

### 4.5 Statistical methods

The results obtained from the algorithm and from the chart review were compared. The results were stratified over two age groups, patients under 40 years-old, and patients 40
years or older, this threshold representing the midpoint of the usual distribution peaks for PSP and SP.

The chart review results were considered as the gold standard reference for the validation of the proposed algorithm. Comparing the results from the chart review and administrative data algorithm, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated, including the 95% confidence interval. SAS software version 9.3 was used. Fisher’s exact test was used to compare categorical data of the two patients groups including sensitivity, specificity, PPV and NPV. The kappa statistic was calculated as a measure of agreement between reviewers’ results. Additional calculations of sensitivity and specificity were performed to evaluate the ability of the algorithm to define PSP when limiting the diagnosis to patients below different age thresholds set between 30 and 50 years of age.

In this study, sensitivity was defined as the proportion of PSP patients (identified from the reference standard) adequately having a positive result from the algorithm. Specificity as the proportion of patient without PSP from the reference standard and negative from the algorithm. PPV was the proportion of algorithm positive patients truly having PSP from the reference standard, and NPV was the proportion of algorithm negative patients not having a PSP from the reference standard.

4.6 Sample size calculation

To evaluate the diagnostic performance of the proposed algorithm to diagnose primary pneumothoraces, sensitivity and specificity was obtained from a comparison to the reference standard, taken from manual chart review. The necessary sample size has been calculated following the binomial exact approach for a dichotomous diagnostic test using the SAS 9.3 software (SAS Institute Inc., Cary (NC) USA). A significance level of 0.05 has been chosen to calculate the total number of patients necessary to reach a power of 90% in a non-inferiority trial, comparing the proposed algorithm binomial results to a standard reference obtained from manual chart review, using a one-sided exact test with expected sensitivity and specificity of 90% and minimal acceptable sensitivity and
specificity of 80%. As shown in Figure 5, because of the nature of the binomial distribution, a “saw-toothed” curve was acquired when power was expressed for different values of sample size. This phenomenon was expected as previously described. From a conservative analysis of this graph, it is noted that the power of the study to reject the null hypothesis was superior to 90% for any value of sample size superior to 130. Considering possible incomplete data and other challenges that might present during chart reviews, an additional 15% cases have been added to the number in order to reach a total sample size of 150 patients in this study.
Figure 5. Saw-tooth appearance of the graph reporting the calculated power of an exact test for binomial proportions in a non-inferiority study attempting to document a minimal acceptable sensitivity or specificity of 80% when a result of 90% is expected.
Chapter 5
5 Results

5.1 Manual chart review

Of the 150 patients included in this study, 95 were under the age of 40 years and 55 were aged 40 years and over. The chart review could not identify any evidence of pneumothorax in the charts of 6 patients, while 96% had a pneumothorax corresponding appropriately to the main diagnosis. These included 90 cases of PSP, representing 60% of patients. Eighty-two percent of these (74 cases) were found in patients under 40 years-old, while 18% were identified in older patients.

There was an agreement of 88% between the two reviewers; corresponding to a kappa statistics of 0.76 and a third review was necessary in 18 cases.

5.2 ICD-10-CA codes used as inclusion criteria

The review of the administrative data revealed that the code J939 (pneumothorax, unspecified) was the most commonly used to describe the main diagnosis, present in 85 of the 150 patients. However in younger patients, the code J931 (other spontaneous pneumothorax) was also commonly used and was identified in 48% of the 95 patients. The codes J930 (spontaneous tension pneumothorax) and J938 (other pneumothorax) were retrieved in only 4 patients for each of them.

5.3 Results from the algorithm

The reason to suspect a SP from the administrative data was most commonly related to an associated chronic condition which could be identify in 23 of the 39 patients not considered to have a PSP from the results of the algorithm. In some patients, more than one potential cause of secondary pneumothorax was identified. These results are detailed in Table 3.
Table 3. Distribution of patients with a main diagnosis code of pneumothorax according to age group.

<table>
<thead>
<tr>
<th>main diagnosis code</th>
<th>0 to 39 years</th>
<th>40 years and over</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>J930</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>J931</td>
<td>46</td>
<td>11</td>
<td>57</td>
</tr>
<tr>
<td>J938</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>J939</td>
<td>45</td>
<td>40</td>
<td>85</td>
</tr>
<tr>
<td>clinical review</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>primary spontaneous pneumothorax</td>
<td>74</td>
<td>16</td>
<td>90</td>
</tr>
<tr>
<td>secondary pneumothorax</td>
<td>17</td>
<td>37</td>
<td>54</td>
</tr>
<tr>
<td>absence of pneumothorax</td>
<td>4</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>administrative data algorithm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>primary spontaneous pneumothorax</td>
<td>83</td>
<td>28</td>
<td>111</td>
</tr>
<tr>
<td>secondary pneumothorax</td>
<td>12</td>
<td>27</td>
<td>39</td>
</tr>
<tr>
<td>suspected etiology:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>chronic condition</td>
<td>5</td>
<td>18</td>
<td>23</td>
</tr>
<tr>
<td>acute condition</td>
<td>7</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>iatrogenic</td>
<td>3</td>
<td>10</td>
<td>13</td>
</tr>
</tbody>
</table>

The ability of the proposed algorithm to identify cases of PSP is detailed in Table 4, which summarizes diagnostic accuracy. Overall, sensitivity of the algorithm for PSP was 94%, being higher in younger patients (97%) than in older patients (81%), p=0.0376. Similarly, a higher PPV was obtained when the algorithm was applied to the younger patients population, 87%, compared to 46% for the patients ages 40 years or more (p<0.0001). The overall specificity of the algorithm was 57%, and no significant difference was identified between the younger and older patient groups. Similarly, there was no significant difference between the two groups NPVs, the overall value estimated to 87%.
Table 4. Diagnostic performance of the administrative data algorithm for the identification of primary spontaneous pneumothorax cases (estimate and 95% confidence interval).

<table>
<thead>
<tr>
<th>Measure</th>
<th>Total</th>
<th>0 to 39 years</th>
<th>40 years and over</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>94 (88 - 98)</td>
<td>97 (91 - &gt;99)</td>
<td>81 (54 - 96)</td>
<td>.0376</td>
</tr>
<tr>
<td>Specificity</td>
<td>57 (43 - 69)</td>
<td>48 (26 - 70)</td>
<td>62 (45 - 77)</td>
<td>.4135</td>
</tr>
<tr>
<td>Positive predictive value</td>
<td>77 (68 - 84)</td>
<td>87 (78 - 93)</td>
<td>46 (28 - 66)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Negative predictive value</td>
<td>87 (73 - 96)</td>
<td>83 (52 - 98)</td>
<td>89 (71 - 98)</td>
<td>.6342</td>
</tr>
</tbody>
</table>

5.4 Age dichotomization cutting point

In order to evaluate the appropriateness of the 40-years threshold used in the study, we performed additional modifications on the algorithm for different age levels varying between 30 and 50 years. We calculated the sensitivity and specificity of the algorithm applied to the 150 patients when limiting the diagnosis of PSP to patients younger than each age point. Between the levels of 30 to 50 years, the sensitivity varied from 59% to 88% and the specificity from 82% to 63% (Figure 6).
Figure 6. Sensitivity and specificity of the algorithm’s modifications applied to the 150 patients and restricting the diagnosis of primary spontaneous pneumothorax to patients below the age level detailed on the axis.
Chapter 6
6 Discussion

6.1 Importance of differentiating PSP from SP

PSP is by definition a spontaneous and unprovoked event usually occurring in young and previously healthy individuals. It differs from SP, which represents a proportion of about half of all pneumothorax.\textsuperscript{3,46-48} All pneumothorax will require similar initial management; however, once urgent treatment is completed, the care given to patients presenting with either PSP or SP will differ.\textsuperscript{49,50} Treatment of the underlying cause of SP will be necessary and could include chest wall stabilization, optimization of the COPD or asthma medication, and antimicrobial treatment of pneumonia or lung abscess. For PSP, aside from smoking cessation and recommendation to avoid certain activities, most individuals will require no further treatment, but surgery could be offered to patients who are at a higher risk of recurrence or complications.\textsuperscript{4,8,15}

6.2 Need for epidemiological studies on PSP

There is a need for large epidemiological studies on the subject of PSP to help define predictors of recurrence and lead to treatment recommendation tailored to this otherwise healthy and potentially productive population. Population-based studies from United Kingdom and France have been published in the last few years and have produced significant knowledge on the subject; however, these included both primary and SP. Halifax and Rahman noted an unexpectedly low proportion of SP (14\%) in a report from the French national healthcare database, which has not been fully explained and suggests that a proportion of the cases might not be classified appropriately.\textsuperscript{6,51} In the present review, 54 patients presented with a SP, representing 38\% of cases.
6.3 Limitations of the ICD-10-CA classification

The 10th version of the ICD, used in Canada as in many other jurisdictions, does not include a sub-classification allowing the identification of the different types of spontaneous pneumothorax. This situation is problematic and limits the ability of researchers to target PSP specifically. In the United States, a different version of the ICD has been implemented in October 2015, ICD-10-CM (Clinical Modification), which includes a subdivision of the J931 code corresponding to PSP: J9311. However, it is difficult to anticipate the effect of this sub-classification on eventual epidemiological studies because of the presence of three other J93 codes which could be used for PSP. In our study, only 38% of patients were coded J931, the majority (57%) of the charts were labeled with the code J939 (pneumothorax, unspecified).

6.4 Validation of administrative data

Code-validation is necessary before conducting population-based studies to ensure adequacy of the patient cohorts. In Canada, the Institute for Clinical Evaluative Sciences (ICES) reported in 2006 that the pneumothorax code J93 is amongst the most accurately used (95%) of the main diagnosis codes, and this correlates to the results of this review which identified a miscode rate of only 4%. However, to our knowledge, this study represents the first attempt to differentiate between PSP and SP using hospital administrative data. Defining PSP by only the absence of associated codes for underlying lung disease was not considered sufficient in the design of this study and three exclusion criteria were created with the goal of obtaining a better case definition. Based on the results of the administrative data algorithm, these exclusion criteria identified a significant proportion of patients experiencing SP, particularly in younger patients for which the presence of a chronic condition was responsible for only 42% of cases defined as SP.
6.5 Study strengths and limitations

PSP is known to occur in a younger population than SP, and multiple studies have suggested that peak incidence occurs between 20 and 30 years of age. When creating the inclusion criteria for a population-based study oriented towards this age group, an option would be to use the patient’s age to minimize the number of misdiagnoses that would be associated with inclusion of older patients. This study’s dichotomization of younger versus older patients allowed observation of the effect of this strategy. The ability of the proposed algorithm to accurately identify cases of PSP cases was significantly better when limited to the younger group of patients. However, using this method would exclude cases of true PSP occurring in older patients (16 individuals in this study) and limit the participation to about 82% of potential patients. However, these individuals might also have a non-diagnosed underlying lung condition.

The proposed algorithm demonstrated a good diagnostic accuracy in defining PSP cases amongst patients under 40 years of age. The 97% sensitivity rate found in this age group suggests that almost all PSP cases can be identified with the use of administrative data. And, as demonstrated by the 87% PPV, the identification of a PSP case from the algorithm will be correct in a very high proportion of patients. These findings also suggest that limiting the diagnosis of PSP to the absence of recorded concurrent lung conditions might be insufficient and could be improved by the use of more restrictive exclusion criteria.

The limitations of the proposed algorithm are related to its lower than expected specificity. This is a direct consequence of a high number of patients falsely considered to have a PSP, particularly in the older population. This suggests either that the strict criteria used in this study for PSP definition might not be sufficient or more likely, that the recording of secondary diagnosis into NACRS and DAD databases is occasionally incomplete. Thus, it would be prudent to limit the use of the algorithm to the suggested target population of PSP, as its accuracy might be insufficient when attempting to build a cohort of patients with SP.
Choosing an appropriate reference standard is an important part of a validation study. The “golden” standard used in this study was based on the review of patients charts by two independent reviewers. Even if the patients were not directly evaluated by the reviewing physicians, the ability to proceed with a third chart review in cases of non-agreement is thought to have provided this study with a solid reference standard.

6.6 Future direction

The findings of this study support the use of the proposed algorithm as an appropriate method of PSP identification for the conduction of population-based epidemiological studies based on administrative data using ICD-10 codes. As a result, an ICES study proposal abstract has been written. It proposes the use of this study’s algorithm to evaluate in the population of Ontario the epidemiology of PSP and its recurrence factors (Appendix A). Because of the wide acceptance of the ICD-10 codification system, it is possible that the proposed algorithm could be exported to other provincial and national databases even if discharged summaries slightly different than DAD or NACRS could exist in other jurisdictions. Eventually, a clinical algorithm for the management of PSP might be created. In the development of such prognostic models, the process of derivation is different than the validation: it will allow the identification of prognostic factor according to a subset of patient from regression analysis. The prognostic model obtained needs then to be validated to ensure its external validity, often using a second subset of the studied population. Such clinical algorithms may have a significant impact on the clinical practice.

6.7 Conclusions

PSP is a clinical entity distinct from SP for which there is a paucity of epidemiological studies. The ICD-10 codes used in most countries do not allow its direct identification. An algorithm was created, which uses the information available in NACRS and DAD to overcome this deficiency. Of 150 patients presenting with a diagnosis of pneumothorax, we validated this algorithm to have a sensitivity of 97% and a PPV of 87% when used in a population of young patients known to be at higher risk of developing a PSP. These results support the use of administrative data to identify patients consulting for PSP and
give researchers the tools required to conduct epidemiological studies on large population-based data. Such studies are expected to improve the understanding of the disease, its treatment and related outcomes.
References


42. Juurlink DN, Institute for Clinical Evaluative Sciences in O. *Canadian Institute for Health Information discharge abstract database.* Toronto, Ont.: Institute for Clinical Evaluative Sciences; 2006.


Appendix A

Proposed ICES study abstract

Title: Risk of recurrence of primary spontaneous pneumothorax in Ontario: a retrospective population-based cohort study.

Short title: Recurrence of primary spontaneous pneumothorax

Investigators: Eric Fréchette, Ester Lau, Marcus Povitz, Yun-Hee Choi Blayne Welk, Richard Malthaner

Background:

Primary spontaneous pneumothorax (PSP) is a common thoracic disorder having a peak of occurrence present between the ages of 20 and 30 years and affecting previously healthy individuals.\(^1,2\) The definitive treatment is surgical and is directed at preventing recurrence in high-risk patients.\(^3\) Many risk factors for recurrence have been identified in case series, however, in part because of an inadequate coding in the international classification of disease (ICD-10), there is no large population-based study from administrative data directed specifically at the study of the recurrence after an episode of PSP.\(^4,5\) The result from this situation is that it is often difficult to predict adequately the risk of recurrence in these patients and to suggest the most appropriate treatment. This is depicted with the conflicting recommendations from different thoracic societies on PSP and the weak adherence of the caregivers to those recommendations.\(^6-8\) An algorithm allowing the identification of PSP cases from administrative data was recently developed and validated, but was never used to define the risk of PSP recurrence at the population level.\(^9\)
**Project objectives:**

1. To define the factors associated to PSP recurrence in patients presenting with a previous episode in Ontario;

2. To define the impact of PSP recurrence on the utilization of health services and on the associated cost for the healthcare system.

**Methods:**

A population-based, retrospective cohort study will be conducted from the databases stored at the Institute for Clinical Evaluative Sciences (ICES). Patients 18-39 years old presenting with a first episode of PSP between April 1, 2004 and March 31, 2014 will be included in the study. The PSP cases will be identified from the ICD-10 codes J930, J931, J938 and J939 recorded as main diagnosis of emergency room summary National Ambulatory Care Reporting System (NACRS). A look-back period extending to April 1, 1992 will be used to rule out any previous pneumothorax episodes and will include a two-year period of ICD-10 diagnosis codes collection from NACRS and Discharge Abstract Database (DAD) which will be processed by an algorithm previously described to exclude cases suspected to be secondary, iatrogenic or traumatic pneumothorax. The other exclusion criteria will include a missing age, sex, and patients residing outside Ontario at the time of index event. The maximum follow-up period will extend to March 31, 2016.
Health Insurance Plan Claims Database (OHIP), DAD, NACRS, and the following databases: SDS, ODB, IPDB, CENSUS, POP, PCCF, LHIN, INST, OMHRS, CCRS/NRS, OHCAS/HCD, and ADP. The main outcome will be the development of another episode of pneumothorax recorded as main diagnosis in NACRS or DAD. The patients will stay included in the cohort following an event of pneumothorax recurrence to allow the analysis of the impact of the number of previous episodes on the outcome. The exposure characteristics analysed in this study will include patient sex, age at time if index event, number of previous episodes, type of initial treatment (chest drainage, pleurodesis, surgery), need for hospitalization, duration of initial hospitalization, specialty of the physicians involved, type of institution initially visited and mean neighborhood income. The cost estimation will be obtained using the %GETCOST macro.

The risk of recurrence will be studied using time-to-event analysis. Recurrence rate at 2 and 5 years will be estimated using the Kaplan Meier technique. The influence of the different risk factors on recurrence will be calculated using multivariable Cox proportional hazard regression analysis for multiple events. As the patients could not be at risk of a second recurrence before having developed a first one, a conditional model “A” will be used; the time interval for the second recurrence will be measured from the time of occurrence of the first one.
**Expected cohort size and number of events:**

The ICES NACRS EDMAINPROBLEM data informed us that there were 27880 emergency room visits recorded in the NACRS database with a main diagnosis code J930, J931, J938 or J939 during the 10-year period starting in year 2004. From the information collected in our validation study, we expect that the algorithm will identify 55% of those cases as PSP occurring in individuals aged between 18 and 39 years old. This represents more than 15,000 cases of PSP. The expected proportion of recurrent events is thought to be about 30-40%.

**Relevance:**

This project has the potential to significantly improve health care delivery. It will be the first large population-based study on PSP and its recurrence. It will offer physicians and other health care providers an understanding of the risk of recurrence according to the number of previous episodes and other patients’ clinical characteristics. This study will define for the first time the impact of PSP recurrence in term of costs for the health care system. This information might help defining the indications for surgery or other treatments according the expected need for additional treatments and associated costs.
Abstract References:


Appendix B

Research Ethics

Western University Health Science Research Ethics Board
HSREB Delegated Initial Approval Notice

Principal Investigator: Dr. Eric Fredette
Department & Institution: Schulich School of Medicine and Dentistry/Surgery, London Health Sciences Centre

HSREB File Number: 10549
Study Title: Validation of an algorithm to identify patients treated for spontaneous primary pneumothorax from the ICD-10 diagnosis codification.
Sponsor:

HSREB Initial Approval Date: September 30, 2014
HSREB Expiry Date: November 30, 2014

Documents Approved and/or Received for Information:

<table>
<thead>
<tr>
<th>Document Name</th>
<th>Comments</th>
<th>Version Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Master log form</td>
<td>2014/06/02</td>
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<td>Data Collection Form/Case Report Form</td>
<td>ICD 10 data collection sheet</td>
<td>2014/06/02</td>
</tr>
<tr>
<td>Data Collection Form/Case Report Form</td>
<td>Reviewer collection sheet</td>
<td>2014/06/02</td>
</tr>
<tr>
<td>Instruments</td>
<td>ICD10 codes to be used for the identification of primary spontaneous pneumothorax</td>
<td>2014/06/02</td>
</tr>
<tr>
<td>Western University Protocol</td>
<td></td>
<td>2014/07/22</td>
</tr>
</tbody>
</table>

The Western University Health Science Research Ethics Board (HSREB) has reviewed and approved the above named study, as of the HSREB Initial Approval Date stated above.

HSREB approval for this study remains valid until the HSREB Expiry Date noted above, conditional to timely submission and acceptance of HSREB Continuing Ethics Review. If an Updated Approval Notice is required prior to the HSREB Expiry Date, the Principal Investigator is responsible for completing and submitting an HSREB Updated Approval Form in a timely fashion.

The Western University HSREB operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans (TCPS2), the International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH-GCP), the International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH-GCP), the International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH-GCP), the Ontario Personal Health Information Protection Act (PHIPA, 2004), Part 4 of the Natural Health Products Regulations, Health Canada Medical Device Regulations and Part C, Division 5, of the Food and Drug Regulations of Health Canada.

Members of the HSREB who are named as investigators in research studies do not participate in discussions related to, nor vote on such studies when they are presented to the REB.

The HSREB is registered with the U.S. Department of Health & Human Services under the IRR registration number IRB 01000010.
Appendix C

LAWSON FINAL APPROVAL NOTICE

LAWSON APPROVAL NUMBER: R-14-456

PROJECT TITLE: Validation of an algorithm to identify patients treated for spontaneous primary pneumothorax from the ICD-10 diagnosis codification

PRINCIPAL INVESTIGATOR: Dr. Eric Frechette

LAWSON APPROVAL DATE: October 21, 2014

Health Sciences REB#: 105409

Please be advised that the above project was reviewed by the Clinical Research Impact Committee and Lawson Administration and the project:

Was Approved

Please provide your Lawson Approval Number (R#) to the appropriate contact(s) in supporting departments (eg. Lab Services, Diagnostic Imaging, etc.) to inform them that your study is starting. The Lawson Approval Number must be provided each time services are requested.

Dr. David Hill
V.P. Research
Lawson Health Research Institute

All future correspondence concerning this study should include the Lawson Approval Number and should be directed to Sherry Paiva, Research Administration Officer, Lawson Approval, Lawson Health Research Institute,

cc: Administration
November 14, 2013

Dr. Dr. Eric Fréchette

Sent as PDF to:

Dear Dr. Fréchette,

Your SIRF research grant entitled: “Risk of recurrence of primary spontaneous pneumothorax: a population-based cohort study” was reviewed by the members of the Department of Surgery Research Committee. I am pleased to report that your grant was recommended for funding in the amount of $20,000 for the term January 1, 2014 to December 31, 2015. Please find enclosed a summary of the review comments for your grant for your consideration to assist you with this grant as you go forward. Please note that at the completion of your grant you are required to complete an IRF End of Study Form or an IRF One Year Extension Request that you must return to the Department of Surgery Office.

You will need to apply for a research grant account through Western promptly. Please go to: http://uwo.ca/research/rds/ROLAROLAFrameset.html and scroll down to the title “UWO internal Surgery”. Please note if you apply before December 31, 2013 you will need to click on the “New Rola” button to the right of “INTERNAL RESEARCH FUND-2013 OPEN FUNDING”. If you apply after December 31, 2013 you will need to click on the “New Rola” button to the right of “INTERNAL RESEARCH FUND-2014 OPEN FUNDING”. If you require assistance, please contact Janice Sutherland (extension 64304) in the Department of Surgery Office. Please note that all internal research grants have a two-year limited time on expenditure of the funds.

Congratulations!

Yours Sincerely,

Alp Senar, MD, PhD, FRCSC
Chair
Department of Surgery Research Committee
Department of Surgery
Western University

Encls.

Cc: Dr. J. Denstedt
Dr. Richard I. Inculet
Ms. D. Frank
Research Development & Services (Western)
Appendix E

Chart review collected results

(Legend: 1= primary spontaneous pneumothorax, 2= Secondary pneumothorax, 3= no pneumothorax, revres= review result for analysis)

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Curriculum Vitae

Name  Eric Fréchette

Degrees and Diplomas

2003 - 2005  Residency in Thoracic Surgery, Université de Montréal, Chirurgie, Postgraduate, Montreal, Quebec, Canada

1995 - 2000  Residency in General Surgery, Laval University, Chirurgie, Postgraduate, Sainte-Foy, Quebec, Canada

1990 - 1995  Doctor of Medicine, Université de Montréal, Médecine, Undergraduate, Montreal, Quebec, Canada

Research Training

2015 - 2017  Western University, Institute for Clinical Evaluative Sciences, ICES scholar program, Supervisor: Salimah Shariff

2012 - present  Western University, Epidemiology and Biostatistics, Clinical Epidemiology, Supervisor: Richard Malthaner

Specialized Training

2005  University of Pittsburgh Medical Center, Minimally Invasive Thoracic Surgery, Supervisor: James Luketich, Pittsburgh, Pennsylvania, United States

2005  Université de Montréal, Endoscopic Ultrasonography, Supervisor: Anand Sahai, Montreal, Quebec, Canada

2001 - 2003  Virginia Commonwealth University, Medical College of Virginia, Surgical Oncology, Supervisor: Harry D. Bear, Richmond, Virginia, United States

2000 - 2001  Ulm University Hospital of Surgery, Surgical Oncology, Supervisor: Hans G. Beger, Germany

Appointments

2017 - present  “Professeur d’Enseignement Clinique”, Department of Surgery, Université de Sherbrooke, QC.

Head, Thoracic Surgery division, CISSS Montérégie Centre, Charles-Lemoyne Hospital, Longueuil, QC.

2012 - 2017  Assistant Professor, Department of Surgery, Division of Thoracic Surgery, Schulich School of Medicine & Dentistry, The University of Western Ontario, ON.

Thoracic Surgeon, London Health Sciences Centre, Department of Surgery, Division of Thoracic Surgery, London, ON.

2006 - 2012  “Professeur d’Enseignement Clinique” & Head, University Thoracic Surgery Division, Department of Surgery, Université Laval, Quebec, QC

Thoracic Surgeon & Head of Hospital Thoracic Surgery Division, Institut Universitaire de Cardiologie et de Pneumologie de Québec, Quebec QC
Recent honours

2016  
Best Poster Presentation, 4th Global Conference on Perioperative Care of the Cancer Patient, Category: ‘PERIOPERATIVE CARE’, presented by Dr Ali Albargawi, Type: Research award, Research supervisor, International, United Kingdom

2014 - 2015  
University Student Council Teaching Honour Roll, Award of excellence, teaching in Surgery,

Recent Publications

Journal Article, peer reviewed


4. Eric Frechette, MD, MSc, Keegan Guidolin, BSc, MD, Ayman Seyam, MD,Yun-Hee Choi, PhD, Sarah Jones MD, PhD,Andrew McClure, MSc, Jennifer Winick-Ng, MSc, Blayne Welk, MD, MSc, Richard A Malthaner MD, MSc, for the Surgical Investigators Group at ICES Western. Identifying primary spontaneous pneumothorax from administrative databases: a validation study. Can Resp J, 2016 May 12; 2016 (10): 1155, Principal Author, DOI: 1690482.


Book Chapter

In Press