HOSPITAL CARE UTILIZATION TRENDS IN PATIENTS WITH COPD AND LUNG CANCER IN THE 6 MONTHS PRIOR TO DEATH

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ABSTRACT

Background: Hospital care utilization has been described as a key measurable indicator of care quality in patients with terminal respiratory diseases. Knowledge about patterns in service utilization for patients with advanced Chronic Obstructive Pulmonary Disease (COPD), however, is fairly limited. The goal of this study was to investigate health care utilization patterns in the last six months of life among patients who died with COPD compared with those who died of lung cancer, and also to examine variations in health care among individuals living with COPD between sex, age, comorbidity, and temporal trends.

Methods: We conducted a retrospective study using administrative health data in the province of Saskatchewan to identify indicators associated with greater hospital care utilization between 1997 and 2006. Those with either COPD or lung cancer as the underlying cause of death (UCOD) were included in this study. Characteristics examined in this study included socio-demographics, comorbidity, location of death, and use of institutional services. Multiple logistic regression was the primary method of analysis.

Results: Between 1997 and 2006, 7,114 persons covered by Saskatchewan Health were identified as having COPD (N=2,332) or lung cancer as the UCOD (N=4,782). Approximately 60% were males with an average age of 74.2 years (S.D. =10.1 years).
Half of the decedents were rural dwellers (47.0%), and were married or common law (51.6%). The majority had multiple comorbid conditions (60.3%), died in hospitals (73.5%), and had never received services from long-term supportive care institutions (74.3%). Compared with those who died from lung cancer, people dying from COPD were less likely to be admitted to hospitals (OR=0.71, 95%CI: 0.64-0.80 in the last six months of life; OR=0.81, 95%CI: 0.70-0.93 in the last month of life) and had shorter LOS for each admission (OR=0.78, 95%CI: 0.70-0.87 in the six months of life; OR=0.67, 95%CI: 0.60-0.75 in the last month of life). However,

persons with COPD were more likely to be managed in an intensive care settings (5.3% of COPD subjects vs. 1.7% of lung cancer subjects in the last six months of life; 4.3% of COPD subjects vs. 0.06% of lung cancer subjects in the last month of life) and had higher numbers of transfers between long-term care facilities (7.7% of COPD subjects vs. 3.2% of lung cancer subjects). Between 1997 and 2006, there was no significant change in the hospital utilization among patients who died of COPD or those who died of lung cancer.

Conclusions: Marked differences in terms of hospital service utilization in the last six months of life were observed between subjects dying with COPD and lung cancer. Our study results support previous work indicating that the nature of care management at the end of life for people who died of advanced COPD is different from those who died from lung cancer, which was reflected by reduced likelihood of hospital service usage, more ICU admissions, and frequent transfers between supportive care facilities. There is no significant change observed regarding the patterns of hospitalization over 10-year study period. We would suggest collecting more information on services managed in other care settings, such as emergency departments, out-patient settings, and clinics, etc. This would allow an in-depth examination regarding what types of institutional services influenced the usage of in-patient care. In addition, education of all health care professionals on the complex needs of patients living with respiratory illnesses is required.

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Chapter 1: INTRODUCTION & RATIONALE

1.1 Introduction

Based on estimates from Statistics Canada in 2008, chronic respiratory diseases, including lung cancer and Chronic Obstructive Pulmonary Disease (COPD), were the fourth leading causes of death among Canadians [1]. COPD is a common respiratory disease, characterized by increasing breathlessness, functional impairment, and steadily deteriorating quality of life. Recent literature indicated that women diagnosed with COPD tend to fare worse than men, with female patients being more likely to be hospitalized from COPD [2]. Unfortunately, for patients with advanced COPD, the large amount of variability in COPD progression makes accurate prognostication difficult.

As the number of COPD-related deaths is expected to increase in the future, there is an increasingly urgent need to understand key issues in this disease's trajectory at the end of life. There remained significant opportunities to improve the quality of care for the COPD population. In contrast to COPD, lung cancer received a great deal of attention and a number of indicators were developed that may serve as proxies for evaluating quality of care at the end of life including the number of hospitalizations and information around hospitalization such as time spent in ICU, emergency department visits, or medical ventilator usage.

1.2 Rationale

Trends in hospital care utilization have been described as an important measurable indicator of care quality in patients with terminal respiratory diseases; however, knowledge about trends in hospitalization for patients with advanced COPD remains limited. In addition, the impact of sex on hospitalization trends among the population with advanced COPD has received little attention in the past. Given the lack of focus on this variable in past studies, differences between the sexes should be a focal point in these analyses. To better understand these gaps in knowledge, this analysis seeks to evaluate the trends in hospitalization among those who died from COPD or lung cancer. In addition, the current study aimed to examine the association between sex, age and comorbidity with hospitalization.

1.3 Objectives and Research Questions

The overarching objective of this thesis was to investigate health care utilization patterns (i.e. hospitalizations) in the last six months of life among patients aged 50 years or above who died with COPD compared with those who died of lung cancer, and also to examine variations in health care utilization among individuals based in key personal characteristics.

More specifically, the research questions were:

1. How do indicators of hospitalization including the number of ICU and inpatient days in the six months prior to death compare between patients with a diagnosis of COPD and those with a diagnosis of lung cancer?

2 Is there an association between the following independent variables and hospitalization among the target population and do they modify the effect of diagnostic group?

(a) age

(b) comorbidity

(c) sex

3. Does the pattern of hospitalization change over a 10 year period and are the associations between hospitalization and diagnostic group, age, sex, and comorbidity consistent over the 10 year period?

Chapter 2: LITERATURE REVIEW

2.1 Selection of Articles for Inclusion in the Literature Review

The purpose of the study was to examine differences in hospitalization patterns and reasons for hospitalization among patients with COPD when compared to patients with lung cancer, to assess their association with sex, age and comorbidities, and to consider temporal changes in these trends. To aid in this purpose, this literature review describes the epidemiology of COPD and lung cancer, including morbidity and mortality rates globally and across Canada, as well as well-established indicators associated with health care utilization from studies of patients with lung cancer. Searches of the literature were conducted using PUBMED database and Google scholar. The search included articles from 1997 to 2014. Search terms or keywords included but were not limited to “COPD”, “Lung cancer”, “epidemiology”, “palliative care”, “hospitalization”, “time trends”, “mortality”, and “end-of-life”. The search was limited to adults aged 50 years and above who were diagnosed with COPD or lung cancer. These terms were searched separately and in combination.

From this search, 26 articles examined the patterns of hospitalization for the study population. Among those, eight articles described the trends in hospitalization among the COPD population during their last phase of life while eighteen papers examined the patterns among the lung cancer population. Eight articles were selected regarding the indicators associated with hospitalization. For the epidemiology (time trends on prevalence) of lung cancer and COPD, there were 135 papers. Twenty-four articles focused on COPD and 111 focused on lung cancer. With regard to trends on mortality among COPD and the lung cancer population, there were fourteen papers. Two papers examined the patterns of mortality in COPD populations, and twelve papers focused on the frequency and incidence in the lung cancer group.

2.2 COPD

COPD is a chronic lung disease, which is characterized by progressive airflow obstruction. COPD consists of chronic bronchitis and emphysema. The most common symptoms of COPD include chronic and progressive dyspnea, cough, and sputum production that can vary daily [3].

2.2.1 Recent trends in the prevalence and incidence of COPD

2.2.1.1 Global

COPD is recognized as a disease that leads to chronic impairment of health functions and causes significant mortality and morbidity among patients. COPD affects approximately 340 million people worldwide [4]. According to the Centers for Disease Control and Prevention, the prevalence of COPD in the United States remained steady between 1998 and 2009 with rates that were higher in women (6.1%) than in men (4.1%) [5]. During the period from 1997 to 2007, based on a report from the United Kingdom, the prevalence of physician-diagnosed COPD in women (1.8%) also exceeded that in men (1.5%) [6]. A study from the Netherlands suggested that there would be a 76% increase in the prevalence of COPD by 2015 compared with that in 1994[7].

2.2.1.2 Canada

COPD is recognized as a highly prevalent respiratory disorder among Canadians. A population-based cohort study suggested that the prevalence of COPD increased by 23.0% from 1980 to 1995 [8]. Based on a report from Statistics Canada, 4.8 percent of Canadian women had to cope with COPD compared with 3.9 percent of men [5]. According to estimates, in the year 2005, 425,300 Canadian women 35 years of age or older self-reported a diagnosis of chronic obstructive pulmonary disease compared with 329,500 Canadian men [9]. In comparison with other provinces, Saskatchewan had a relatively low COPD prevalence. In 2003, Saskatchewan prevalence estimates ranged from 4% to 5% of the population aged 45 years and older. These figures were far below the prevalence in the Maritime Provinces, which ranged from 8% to 10%

of the study population [10]. The observed lower prevalence in Saskatchewan may be due to smoking rates that are lower than that in the Maritime Provinces as cigarette smoking is considered as the primary risk factor or COPD [11]. The exclusion of high-risk populations such as First Nations people contributed to the low prevalence of COPD in the Saskatchewan population. Previous studies suggested that there was a steady growth in the prevalence of COPD in Saskatchewan, with the biggest rise seen in the Registered Indian population [13]. However, they were usually excluded from population health research or were not captured in the administrative data.

2.2.2 Mortality

2.2.2.1 Global

According to the World Health Organization (WHO), in 2002, COPD was ranked as the fifth most common cause of death and remained the only common cause of respiratory mortality that was increasing in incidence globally [9]. By the year 2020, experts predicted that COPD would become the third leading cause of death across the world [15]. Studies in North America also stated that the COPD-specific mortality was found to be increasing over the last decade [16, 17]. According to the COPD Disease Surveillance in the U.S., there was a fivefold increase in mortality rate due to COPD in women between 1971 and 2000[18]. Statistics estimated that Chronic Lower Respiratory Disease (CLRD), which consisted of both COPD and asthma, was the third leading cause of death in 2008 in United States [19]. In the UK, the male age standardized mortality rates from COPD were found to have progressively decreased over the last 30 years; while, in women, the report estimated a small but progressive increase over the last 20 years [20]. In addition, advanced COPD is also marked by slow deterioration with intermittent occasions of potentially fatal acute exacerbation. According to a Spanish study in 2002, the mortality rate for severe COPD was as high as 50% after admissions for an acute exacerbation [21].

2.2.2.2 Canada

In Canada, COPD was the fourth leading cause of death in 2010, with the highest mortality rate in the Northwest Territories [22]. Although the 5-year survival rate for patients living with COPD ranges from 30% to 40%, it falls to 23% with the severe cases [22]. Furthermore, an upward trend was observed in the number of deaths caused by COPD among Canadians between the years 1987 to 2014. According to Camp et al., the largest increase was witnessed in the population aged 75 years and above [10]. Additionally, there is evidence that women are more affected by COPD than men in terms of functional health, which is partly reflected as significant growth in terms of mortality. Statistics reported that COPD was the fourth-ranked cause of mortality among Canadian males aged 65 years and over between 1984 and 1993. Meanwhile, COPD was the seventh-ranked cause of death among women aged 65 years and over during the same period [1]. COPD mortality rates in men increased steadily since the early 1960s but since the mid-1980s stabilized and started to decline. In women the rates continued to increase unabated [6].

2.3 Lung cancer

Lung cancer is defined as an unregulated growth in the tissues of the lungs. The main types of lung cancer are small-cell lung carcinoma (SCLC) and non-small-cell lung carcinoma (NSCLC). The majority (85%) of lung cancer diagnoses are NSCLC, while SCLC consists of 15% [23]. The characteristic symptoms include cough, weight loss and shortness of breath [23].

2.3.1 Recent trends in the prevalence and incidence of lung cancer

2.3.1.1 Global

Cancer accounted for a substantial proportion of morbidity and mortality worldwide in the twenty-first century [1, 2, 9]. Experts predicted that the number of new cases of cancer would be more than 15 million by the year 2020, and the number of deaths was projected to be 12 million [1]. In addition, lung cancer was recognized as the most commonly diagnosed cancer globally in

2008 [2, 9]. According to the report of Global Cancer Statistics, the highest lung cancer incidence rates were found in North America (42.2 per 100,000 population per year), followed by Europe (33.4 per 100,000 population per year) and Australia (25.6 per 100,000 population per year) [24].

2.3.1.2 Canada

In Canada, lung cancer was one of the most three common cancers among both males and females. Similar to the patterns observed globally, the incidence of lung cancer in Canada was rising. In 2010, there were more than 24,000 Canadians who were diagnosed with lung cancer [25]. In 2007, among females, the number of new cases for lung cancer has tripled since 1976 [25]. In 2005, the incidence rates of lung cancer among women were reported to be more than half of those among men [25].

2.3.2 Mortality

2.3.2.1 Global

Despite advances in the early detection and treatment of cancer, according to the WHO, it was still reported as the leading cause of death worldwide, accounting for 13% of all deaths in 2008 [26]. Lung cancer was the leading cause of cancer death in males in 2008 globally. Among females, it was the second leading cause of cancer death [24]. In the United States, lung cancer caused the most cancer-related deaths from 1998 to 2009 [27]. In 2006, lung cancer made up approximately one quarter of all cancer deaths in the United States [28]. In Europe, lung cancer accounted for 20% of all cancer deaths [10]. In particular, lung cancer was recognized as the most common cancer leading to death in men and the second most common cancer in women in the UK [10].

2.3.2.2 Canada

In 2010, lung cancer accounted for nearly one third of all cancer-related deaths in Canada [29]. The total number of individuals who died of this disease was more than the number of deaths from prostate, breast and colorectal cancers combined [30]. Moreover, lung cancer remained the leading cause of cancer death in Canadian women in 2005, accounting for an estimated 8,300 deaths [30]. According to Canadian Cancer statistics, in 2012, lung cancer was the most common cause of cancer related deaths for both males and females in Saskatchewan [31].

2.3 Summary of findings for frequency and mortality for COPD and lung cancer

Lung cancer has been identified as the leading cause of cancer-related mortality for both sexes globally and across Canada [13, 29]. COPD also had an increasing burden worldwide, reported to be the fifth most common cause of death in 2007 [9], and projected to be the third by 2020 [15]. As suggested by earlier research, the mortality rate from COPD may be underestimated resulting from difficulty in distinguishing between various causes of deaths in clinical settings [32]. Where obstructive lung disease was mentioned but not the underlying cause of death, the other most common causes were heart disease and lung cancer. COPD was more likely to be reported as a contributing rather than underlying cause of death or morbidity, or might not be reported at all [94].

2.4 End-of-life Care

End-of-life care, a more humane and appropriate alternative to aggressive health-care intervention, is defined as “the active, total care of patients whose disease is not responsive to curative treatment” [34]. Thus, it aims for providing less aggressive, less expensive, more patient-centered holistic care for patients living with end-stage illnesses in order to achieve the best possible quality of life. According to the Canadian Hospice Palliative Care Association (CHPCA), the dramatically increasing demand for palliative care services in the next 40 years should be considered as a top priority [35]. The hospital is considered an important setting to deliver end-of-life care services since virtually all patients entering the final six months of life spend at least some time in a hospital, usually on multiple occasions [36]. Moreover, a growing body of literature suggested the consumption of palliative care services was associated with a significant improvement in quality of life and a notable reduction in the use of aggressive care services near the end of life. Unfortunately, based on a Canadian study in 2007, only one third of the decedents across Canada had ever received palliative care services. Furthermore, it was also observed that palliative care services across Canada were unevenly distributed. Rural dwellers, or those living with disabilities, had severely limited access to formal palliative care services [35].

2.4.1 The End-of-life Trajectory for People with COPD

According to the National Council for Palliative Care (NCPC), less than half of health facilities in the U.S. explicitly considered the needs and wishes of dying people [32]. As cited by Richardson, overlooking end of life care in major strategies would lead to costly fragmentation in care and support that failed to meet patients' needs [37]. Based on the evidence from the scientific literature, COPD patients at the end of life suffered neglect from health care professionals [38], leaving the growing need for a quality end-of-life care significantly more important and relevant.

Patients who died from COPD fared far worse, in terms of end-of-life care, than those who died from lung cancer [39]. They received fewer palliative care services, were more likely to receive invasive therapy, and were more frequently admitted to ICU, although both groups experienced heavy symptom loads near the end of life, including physical and psychological afflictions [39, 40]. Moreover, patients with end-stage COPD suffered from a poor quality of life in regards to higher degrees of social isolation, lower physical functioning, as well as higher levels of disability as indicated by an earlier UK report [18]. One possible explanation was the difficulties in making an accurate prognosis among patients living with advanced COPD. As indicated by previous report, almost half of the deceased subjects were not aware that they might die, even though they had had more than two hospitalizations [41]. In addition, such differences in care might also result from variations in patients' attitudes towards care services they've received, their preferences regarding end-of-life care, differences in physicians' preferences and attitudes, and some combination of these factors. Furthermore, it is well acknowledged that patient living with COPD, particularly those with poor prognosis, suffer from a significantly higher burden of depressive or anxious symptoms than those with lung cancer. The presence of depression or anxiety may influence the patient's ability to understand the impact of decisions that they make. Moreover, it may have an impact on physician's decision-making regarding end-of-life treatments.

Apart from the unpredictable disease prognosis, it was also difficult for the physicians to start the end-of-life discussions. An earlier American study on end-of-life communication found that, from July 1999 to June 2002, nearly three quarters of the patients would rather talk about staying alive than dying [41]. Previous work by Gore and colleagues also suggested that palliative care resources were not in place to meet the needs of individuals dying of COPD [42]. In marked contrast, when a diagnosis of lung cancer was made, the focus was not only on maximizing the survival possibility but also on quality of life with respect to physical and emotional wellbeing, as suggested by Claessens and colleagues [39].

With COPD diagnoses and deaths on the rise, patients with terminal COPD require quality palliative care to alleviate their suffering. Previous research that investigated the quality of life among COPD patients at the end of life suggested that a severe impact of the disease and the considerable needs of quality healthcare services were evident, and end-of-life care for patients living with advanced COPD merited more attention from clinicians, researchers, and policy-makers.

2.4.2 End-of-life care for lung cancer

Despite the rapid development of the technological and chemotherapeutic science, treatment options for lung cancer are still limited. Based on evidence from scientific literature, the 5-year survival rate in Canada was around 17% in this population [43], leaving lung cancer as the leading cause of cancer-related deaths nationally; therefore, end-of-life care for this population should be stressed as a top priority.

Compared with individuals who died of COPD, patients who died from lung cancer reported a relatively satisfactory experience during their last phase of life, including better symptom management, higher emotional status, more communication with health care professionals, and were more likely to die at home or in a hospice setting [44]. However, previous reports suggested an impaired quality of life among patients living with lung cancer. According to Price and colleagues in 2009, many patients with lung cancer continued to suffer not only from pain, but also from other symptoms related with physical and emotional discomfort in their final days [45].

According to a national survey, 1.2 million Americans with cancer were admitted to hospital in 2002. In addition, this figure was expected to increase as a result of a growing and aging cancer population [46]. These justified the call for the development of effective end-of-life care for patients with serious and complex illness, such as lung cancer. According to the Lung Cancer in Canada report in 2010, the aim of end-of-life cancer care was to improve the quality of life among terminally ill patients by relief of suffering, practical support need, open communication and effective management of concerns [29].

Death from chronic respiratory diseases follows a course of functional decline with acute exacerbation. Based on the work by Pot and colleagues in 2009, patients who died from COPD, when compared with those who died from lung cancer, unfortunately had relatively unsatisfactory care management, both physical and psychosocial, leaving the COPD population an important group to consider in end-of-life care research [47].

2.5 Potential Indicators

The use of indicators has been acknowledged as one approach for identifying key areas for improvement in end-of-life care. Additionally, administrative databases have been recognized as useful and economical tools from which to draw indicators that measure the quality of end-of-life cancer care.

Five quality indicators specific to cancer care were identified by Earle et al. based on administrative data in the U.S.: 1) hospital as place of death, 2) short interval between last chemotherapy dose and death, 3) frequent emergency department visit, 4) high number of hospital and intensive care unit (ICU) days near the end of life, 5) low proportion of patients enrolled in hospice and hospice enrolment very near death [30]. Building on the work of Earle and colleagues, Canadian studies were conducted utilizing administrative databases to determine quality indicators among terminal cancer patients [36]. Since COPD's disease trajectory is less predictable than that of cancer, it is more difficult to predict the optimal time to provide palliative care for those suffering from COPD.

2.5.1 Hospitalization

Building on previous studies, hospitalization was identified as a measurable indicator for investigating the quality of end-of-life cancer care. Although many of the patients with respiratory disorders were not hospitalized for their disease, hospitalization represented a major contribution to the socio-economic burden of chronic respiratory diseases. As a person approached the end of life, the consumption of acute hospital services increased, especially in the last thirty days of life. This was supported by a study from Teno and colleagues [48]. According to the literature, significant reductions in hospitalizations were associated with a significant improvement in relieving patients' financial stress [49, 50]. This was particularly important in systems lacking universal health coverage.

In addition, prolonged LOS in hospital was projected to increase the chance for readmission [34]. Longer stay in a hospital setting was also associated with a poorer quality of life as a result of a high degree of social isolation, poor disease prognosis, and emotional distress [43].

According to Anthonisen et al., in 2002, respiratory diseases accounted for three fourths of all hospitalizations in Canada [51]. In 2009, lung cancer was the third most common cause of cancer hospitalization among Canadians, placing an enormous economic burden on the health care system [45]. In Alberta, the cost associated with lung cancer hospitalization was $8.4 million [52].

With regard to hospitalization among the COPD population, the Northwest Territories had the highest hospitalization rate in Canada between 1996 and 1999, with 3,082 hospitalizations for COPD per 100,000 in the 55 years and older population [10]. In marked contrast, British Columbia had the lowest rate (555 hospitalizations per 100,000 population) [22]. The figure for patients living with COPD in the U.S. was 726,000 in 2000 [54]. An acute exacerbation was recognized as a primary cause of hospital readmission in the COPD population [44]. According to Camp et al., one out of ten COPD patients was re-hospitalized within 15 days after an acute exacerbation, leaving COPD the third most common cause for readmission in Canada in 2009 [10]. Individuals with COPD were also reported to have a longer hospital stay when compared with individuals with other diseases. However, previous research that evaluated the needs for healthcare services suggested deceased COPD patients received inadequate services from primary and secondary care in their last year of life [46].

2.5.2 Intensive Care Unit (ICU) Admission

Increased demand for health services from an aging population, coupled with an influx of new technologies, is placing increasing pressures on health care systems [53]. According to the Statement of the 5th International Consensus Conference in Critical Care, the goal of optimal care for patients dying in intensive care settings is to provide relief from distressing symptoms, to integrate the spiritual aspect when caring for patients, and to offer support to the patients as well as their families [54].

The ICU visit can be considered an indicator of poor quality of life among patients in their last phase of life, although the provision of critical care is primarily dependent upon the severity of illness. It was suggested that aggressive treatment should be stopped and supportive care services should be put in place when a person was close to death [55]. However, intensive care services were often allocated to those who entered the final stage of the dying process. Teno and colleagues found that, in the last thirty days of life, approximately one in three patients receiving hospice care were admitted to ICU in 2009 [48], which was consistent with an earlier study of patients with cancer [30]. Au and colleagues suggested that ICU use might be ineffective in patients with terminal illness in terms of financial cost, physical and emotional burden for patients, family members, and health-care providers [56].

According to Keenan et al., ICU admissions were found to directly translate to increased healthcare costs [53]. Additionally, the terminal ICU admission accounted for 80% of all terminal hospitalization costs [53]. Other findings suggested that in order to address the fiscal burden within the health care system, ample savings could be realized through the improvement in efficiency of high-cost services, such as ICU [55]. Frequent ICU attendance also placed strain on hospital bed availability, resulting in longer waiting times for other patients [55]. Nowadays, this issue became more pronounced in light of human resources in hospital settings, which provided another reason why ICU utilization was a subject of public concern [18]. Since ICU demanded special resources, for example, a low patient–nurse ratio was required for careful titration of intravenous medication to control dyspnea during ventilator withdrawal; increased ICU usage was believed to further contribute to a national shortage of nursing staff. Previous research suggested that the use of hospice care services help avoid unnecessary consumption of aggressive care services, leaving a decreased financial burden on the health care system. Earle and colleagues found that individuals residing in regions with greater access to hospice services had a reduced likelihood of being admitted to intensive care settings at the end of life [30]. On the other hand, some advanced techniques used in the intensive care settings may have harmful side effects or may reduce the quality of life for the patient, but they save lives. When a person is very close to death, the question of whether death itself is a harm and whether the harm caused by the treatment outweighs the improved quality of life from palliative care program needs to be considered.

A growing body of literature found that an increasing proportion of patients with terminal respiratory diseases received ICU services near the end of life [56-59]. A prospective study designed to identify the potential factors of prolonged length of stay (LOS) in ICU showed that patients living with critical respiratory diseases were more than twice as likely to have a prolonged stay and to consume large amounts of critical care resources [57]. Another Canadian study also demonstrated that subjects with lung cancer consumed a greater amount of care services in ICU compared with COPD participants in 2008 [58]. However, a study in the United States in 2006 demonstrated that COPD patients had approximately twice the odds of receiving ICU service, five times the odds of staying at ICU two weeks or longer compared with patients afflicted with lung cancer [56]. A study conducted by Sharma and colleagues in 2008 claimed that there were no significant differences in mean or median LOS in ICU among decedents living with severe respiratory diseases; however, among those suffering from a respiratory disorder, nearly forty percent of ICU users had three or more hospitalizations in the last six months of life compared to one quarter of non-ICU users [59].

2.5.3 Factors influencing Hospital and ICU usage

Based on evidence from the scientific literature, hospital and ICU utilization were associated with a number of patient characteristics, including age, sex, and comorbid conditions. Female patients were more likely to have a prolonged LOS in hospital, but reported less frequent ICU admissions [60, 61]. Age was confirmed as an important factor influencing hospital and ICU usage [18, 62]. In the last phase of life, the use of hospital services was predicted by younger age [63], whereas an aggressive end-of-life service was associated with advanced aging [42]. Individuals with more co-existing illness were high utilizers of health care services [53-57, 62-64]. The overall impacts from both age and comorbidity were found to be much higher than the effect of age alone [65]. Other factors also contributed to the increased consumption of hospitalization. For both lung cancer and COPD patients, those with high socioeconomic status reported higher accessibility to health care services, such as ICU care, than those with lower socioeconomic status [66]. More importantly, tobacco consumption was well-known as a strong predictor for developing lung diseases [29], having longer LOS in hospitals, and a higher likelihood of admitted to ICU settings among this population [67].

2.5.3.1 COPD

Sex

The role of sex in hospitalization and ICU use trends remained unclear and is the topic of a great deal of research. The trends of hospitalization in 1997, in a Danish study, were reported to correspond with mortality trends, decreasing in men and increasing in women [60]. Since more elderly females than males lived alone, this might contribute to a higher proportion of females being hospitalized [68]. Another possible explanation was suboptimal care management, which was shown in a study in cardiovascular disease [61]. Suboptimal management is described as a failure to provide appropriate and timely interventions to patients. According to Gan and colleagues, women with the same degree of lung disease did not receive as much aggressive care services as the male patients, which increased the likelihood of females being hospitalized in the later stage [61]. This type of bias could also exist in patients with COPD since it has historically been considered a disease of men. According to the CDC, from 1999 through 2007, COPD hospitalization rates declined for both men and women in the United States [5]. In Singapore, the hospitalization rate in 1994 for those aged 65 years and above was 93.0 per 10,000 [69]. COPD hospitalization rates in Singapore men were similar to rates in Canadian men, but for women, the rates in Canada were 2 to 8 times higher [69].

Based on evidence from the scientific literature, female patients living with COPD were more likely to report more severe disease symptoms. According to a Spanish study in 2005, female subjects had a higher degree of dyspnea than the males even though they suffered fewer comorbid illnesses and had better oxygenation [70]. In addition, there was no significant difference observed in terms of hospitalization rate between sexes. There were also studies that reported no significant differences between sexes in terms of hospitalization and ICU use [71, 95]. According to a Spanish study from Watson and colleagues in 2004, the variation between sexes in terms of the number of hospital admissions was not statistically significant [66]. Based on a Canadian study in 2005, Menec and colleagues suggested that ICU use did not differ significantly by sex [72]. However, based on the work by Prescott and colleagues, females had an increased risk of hospitalization for COPD compared with males [67]. The findings from Prescott and colleagues were also in agreement with a Canadian study where hospitalization was found to be associated with female sex [51]. In marked contrast, based on an earlier U.S. study in 2002, Wolff and colleagues found the opposite, suggesting that female patients have a decreased likelihood of being hospitalized [64]. Therefore, the discrepancies between sexes called for more attention from health care providers and scholars. Table 2.1 describes characteristics of studies that investigated the association between sex and hospital utilization in patients living with COPD.

Table 2.1 Characteristics of studies to investigate the association between sex and hospital usage in patients living with COPD

First author reference # (Year published) Location	Study design	Study population (Sample size)	Outcome & strength of association
de Torres JP [70] (2005) Spain	Case-control	N=106, 53 FEV_1-matched men and women with COPD attending clinic at Hospital Universitario Ntra Sra de Candelaria in Spain. Inclusion criteria: the subject had smoked ≥10 pack-years and had a postbrochodilator FEV_1/FVC of <0.7 after 400 µg of inhaled albuterol.	No statistically significant difference observed in the rates of hospitalization between sex (p=0.101).
Watson L [71] (2004) USA, Canada, France, Italy, Germany, The Netherlands, Spain and the UK	Cross sectional	N= 3,265 Source population: survey (hospitals and emergency room) Inclusion criteria: patients were at least 45 years old, with a reported physician diagnosis of COPD, chronic bronchitis or emphysema, or with symptoms of chronic bronchitis (defined as persistent cough with sputum from the chest for the last two years or more).	There were no differences in the risk of hospitalization between sexes (OR= 0.81, 95%CI: 0.64,1.03)

First author reference # (Year published) Location	Study design	Study population (Sample size)	Outcome & strength of association
Anthonisen NR [51] (2002) Manitoba Canada	Prospective cohort	N=5,887 Participants had annual clinic visits for 5 years that included questionnaires on smoking, use of prescription drugs, serious illness, hospitalizations, and physician visits.	Hospitalization was found to be associated with female sex
Menec VH [72] (2005) Manitoba, Canada	Cross sectional	N=7,678 Source population: Administrative data Inclusion criteria: adults 65 years or older and died in Manitoba, Canada.	There were no differences in the risk of hospitalization between sexes (OR=1.01, 95%CI: 0.92, 1.12 in the last 30 days of life; OR=1.01, 95%CI=0.91, 1.12 in the last 180 days of life)

Age

Age has been proven to be a significant determinant of hospital and ICU utilization. In Canada, statistics showed that, for the period from 1984 to 1993, COPD was the fourth-ranked cause of hospitalization among men aged greater than 65 years of age; and among women aged greater than 65 years, COPD was the sixth most frequent cause of hospitalization during the same period [5]. A previous Canadian study in 2002 claimed that COPD was a leading cause of hospitalization amongst adults, particularly in older populations [18]. According to a Canadian study from Lacasse and colleagues in 1999, the age-specific hospitalization rate increased among the elderly (aged 65 years and more), particularly in those aged 75 years and older [8]. Data also showed that the odds of lengthier in-hospital stay were associated with increasing age [8]. Wolff and colleagues, in 2002, also found an increased rate of hospitalizations with increasing age, rising from 21.3 per 1,000 beneficiaries between 65 and 69 years of age to 82.1 per 1,000 beneficiaries aged 85 years and older in the United States [64]. In marked contrast, some studies showed opposite findings in the relationship between age and hospitalization. In Amsterdam, according to Pot and colleagues, aging was a positive predictor of hospitalization in 2009 [47], which was in contrast to findings reported by Menec et al. [72].

When it comes to ICU use, previous studies reported inconsistent results in terms of the association between age and ICU admission. According to Seferian et al., in 2008, the number of ICU admissions was found to increase with age with the highest number in the very elderly in Minnesota [62]. However, building on the work of Menec and colleagues, in 2005, the odds of being admitted to intensive care settings decreased with patient's age in the province of Manitoba, Canada [72]. Table 2.2 describes characteristics of studies that investigated the association between age and hospital utilization in the COPD population.

Table 2.2 Characteristics of studies to investigate the association between age and hospital usage in patients living with COPD

First author reference # (Year published) Location	Study design	Study population (Sample size)	Outcome & strength of association

Pot AM [47] (2009) Amsterdam	Retrospective case-control	N=3,107 The sample was recruited in 1992 for the NESTOR-study on ling Arrangements and Social Networks of older adults. Inclusion criteria: adults aged 55 years or older.	Age was a positive predictor for hospitalizations (logistic regression coefficient=0.007, p<0.0001)
Menec VH [72] (2005) Manitoba, Canada	Cross sectional	N=7,678 Source population: Administrative data Inclusion criteria: adults 65 years or older and died in Manitoba, Canada	Individuals 85 years old or older had lower odds of being admitted to an ICU than did individuals 65–74 years old (OR=0.23 (0.18, 0.29) in the last 30 days, 0.24 (0.19, 0.30) in the last 180 days). Individuals 75-84 years old had increased odds of being hospitalized (1.20 (1.06, 1.37) in the last 30 days 1.22 (1.07, 1.40) in the last 180 days)but lower odds of being admitted to an ICU than did individuals 65-74 years old (0.74 (0.60, 0.90)in the last 30 days 0.71 (0.59, 0.85) in the last 180 days)
Seferian EG [62] (2006) Minnesota	Retrospective cohort	N=818 Source population: ICU Inclusion criteria: subjects aged 18 years or older.	An increasing proportion of those in the elderly age groups being admitted to the ICU for monitoring only, from 24% in the 65- to 74-yrs-old age group to 36.4% in those aged 85 years and older Residents greater than 85 years old were 3.75 times as likely (p < 0.001) to be admitted to the ICU

Comorbidity

Comorbidity is a common feature of the population with critical illness. Patients with COPD typically have comorbid conditions, such as muscle wasting, diabetes, renal failure, cardiovascular disease (CVD), depression, reduced fat-free mass, osteopenia, and chronic infections [73]. Among all the common chronic conditions, previous literature has confirmed that cardiovascular disease accounted for the highest proportion of comorbid conditions in individuals with severe COPD [73].

These comorbid conditions were recognized as contributors to hospitalization in patients with COPD residing in British Columbia, Canada in 2008 [67]. Furthermore, cardiovascular disease was recognized as a contributor of hospitalization of COPD patients, from 1980 to 1995, followed by accidental fall and stroke, as reported in an earlier Canadian study [8]. Based on the work by Wong and colleagues, in 2008, an increasing number of comorbidities increased the risk of hospital readmission in the province of British Columbia, Canada [67]. Similar results were also reported from a case control study conducted in Amsterdam in 2009; it confirmed that multiple comorbid conditions were positively associated with acute care utilization [47]. Moreover, comorbidity also influenced the types of care delivered and the frequency of ICU admissions [64]. According to Wolff and colleagues, in 2002, subjects with more than four comorbid conditions were found to be 99-times more likely to be admitted to hospital than those without any co-existing condition in the United States [64]. Not unexpectedly, patients with multiple comorbid conditions were high utilizers of medical care, as indicated by a U.S. study in 2004 [74]. Based on the study conducted in Minnesota from Seferian and colleagues, in 2006, subjects with one or more comorbid illnesses were more likely to receive ICU care in the last 6 months of life than subjects without any complications [62]. Data also showed that residents with 3 to 4 comorbid conditions were found to have 95-times higher rate of ICU visit compared with individuals without any comorbidity [62]. Table 2.3 describes characteristics of studies that investigated the association between comorbidity and hospital utilization in the COPD population.

Table 2.3 Characteristics of studies to investigate the association between comorbidity and hospital usage in patients living with COPD

First author reference # (Year published) Location	Study design	Study population (Sample size)	Outcome & strength of association
Pot AM [47] (2009) Amsterdam	Retrospective	N=3,107 The sample was recruited in 1992 for the NESTOR-study on ling Arrangements and Social Networks of older adults. Inclusion criteria: adults aged 55 years or older.	Increasing number of comorbid illness was a positive predictor for hospitalizations (logistic regression coefficient=0.151, p<0.0001)
Wong AW [67] (2008) British Columbia, Canada	Retrospective cohort	N= 109 admissions Source population: administrative data. Inclusion criteria: patients aged 35 years or older, had a diagnosis of COPD, with a FEV_1 of less than 70% of the predicted value, with a total lung capacity of greater than 80% of the predicted value Exclusion criteria: patients with a FEV_1 increased to 80% of the predicted value, or reported a use of inhaled bronchodilator product, or they had other diseases which was serious enough to influence their quality of life or clinical course (i.e. cancer, left ventricular failure, stroke, etc.)	Hospital readmission was associated with the number of comorbid conditions (OR= 1.47, 95%CI: 1.10,1.97)

First author reference # (Year published) Location	Study design	Study population (Sample size)	Outcome & strength of association
Seferian EG [62] (2006) Minnesota	Retrospective cohort	N=818 Source population: ICU Inclusion criteria: subjects aged 18 years or older.	Subjects with one or more comorbid illnesses were more likely to receive ICU care in the last 6 months of life than subjects without any complications. Data also showed that residents with 3 to 4 comorbid conditions were found to have 95-times higher rate of ICU visit compared with individuals without any comorbidity

2.5.3.2 Lung Cancer

Sex

Based on evidence from the scientific literature, sex played a significant role in determining the treatment decision among the lung cancer population. For example, a cross-sectional U.S. study, in 1999, showed that male patients were more likely to accept aggressive interventions in the hospitals than their female counterparts [75]. Women's past experience as a caregiver for their sick relatives might influence their attitudes towards aggressive care, such as aggressive interventions in the ICUs, resulting in a higher denial rate, which was also suggested by a Canadian study in 2007 examining sex-difference in the care delivery [68].

Regarding the use of hospital services, Fowler and colleagues observed that, among all the subjects admitted to hospitals, more women than men were observed. Furthermore, female patients also spent longer with each hospitalization than their male counterparts [68]. The higher risk of frequent hospitalizations in females was found to be associated with the deteriorating pulmonary functions. According to Prescott and colleagues, females were more susceptible than males to the effects of smoking with regard to development of lung diseases [67]. In marked contrast, Holmquist and colleagues, in 2008, found that the rate of lung cancer-related hospitalizations were highest in males 65 years and older in the United States [53].

Sex was also found to influence the provision of critical care services. An earlier Canadian report in 2007 suggested that fewer women than men were admitted to ICU even though they were significantly more likely to be admitted to hospitals [68]. Fowler et al. also reported a reduced likelihood of receiving mechanical ventilation in females in the ICU settings despite suffering the same degree of pulmonary deterioration at the time of ICU admission [68]. Moreover, women who received ICU services had a slightly shorter duration than men even though it was not statistically significant. This was also confirmed by Valentin et al. in Austria and Romo et al. in Belgium [76, 77]; males with lung cancer were more likely to seek health care resources and to undergo more invasive therapies than their female counterparts. However, according to a U.S. report from Sharma and colleagues, ICU use did not differ substantially by sex in 2008 [59]. Previous studies suggested that there were still considerable gaps in our knowledge about the factors, including sex, which may affect LOS in hospital or in ICU. Table 2.4 describes characteristics of studies that investigated the association between sex and hospital utilization in the lung cancer population.

Table 2.4 Characteristics of studies to investigate the association between sex and hospital usage in patients living with lung cancer

First author reference # (Year published) Location	Study design	Study population (Sample size)	Outcome & strength of association
Blackhall LJ [75] (1999) Los Angeles USA	Cross-sectional	N=800 Source population: survey. Inclusion criteria: individuals aged 65 years or greater and residing in Los Angeles County.	Male patients were more likely to accept aggressive interventions in the hospitals than their female counterparts (OR=0.5, 95%CI: 0.3, 0.7)

First author [reference #] (Year published) Location	Study design	Study population (Sample size)	Outcome & strength of association
Romo H [77] (2004) Belgium	Retrospective population-based cohort	N=4,420 Source population: ICU	The odds of critical care use declined with increasing age (OR=0.31, 95%CI: 0.31-0.32, comparing patients more than 90 years old with those 68-70 years old)
Sharma G [59] (2008) USA	Retrospective population-based cohort	N= 45,627 Source population: the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) registries. Inclusion criteria: individuals aged 65 years and above.	ICU use didn't differ substantially by sex (OR=0.965, 95%CI: 0.918–1.015)

Age

Increasing age was strongly associated with increasing rates of cancer as indicated by previous research [78]. Data showed that men and women aged 65 years or above had a risk eleven times greater than those aged less than 65 years [78]. In addition, aging was also associated with increased vulnerability to health problems and impaired physical functioning.

Elderly patients, however, were found to use not as much standard care services as their younger counterparts [74, 79-82]. According to a report conducted in Belgium from Berghmans and colleagues, in 2002, among patients living with non-small-cell lung cancer, one out of five patients aged 75 years or greater did not receive the standard treatment [82]. This finding was also in line with the work by Townsley and colleagues in 2005; they found that the odds of a patient 70 years of age or older receiving any cancer treatment were just half of that of a patient under age 70 years in the province of Ontario, Canada [80]. One possible explanation was the changes in the tolerance to the standard treatment, which influences the safety and effectiveness of therapy in this population. They also observed a decreased likelihood of having a clinical trial discussion with the cancer specialist among the elderly [80].

Age was also found to influence the provision of critical care services. Based on a U.S. study in 2008, the odds of critical care use declined substantially with increasing age [59]. According to Sharma and colleagues, ICU use was significantly associated with younger age while individuals less than 85 years old had the least use of intensive care services [59]. This result was also confirmed by work from Iwashyna and colleagues in 2004 who found that increasing age decreased the odds of ICU admission, with the lowest odds observed in the oldest age group (>90 years of age) in the United States [74]. However, these results were in marked contrast with the finding from Craig et al. in 2004, which showed a steadily increasing use of care services in ICUs among patients aged 65 years and above in the United States [81]. Iwashyna and colleagues also observed a lowest rate of ICU admission for the very old patients (aged 85 years and above) [74]. Age was also found to influence patterns of ICU demands and expenditures. Some studies made projections that ICU care consumption would increase in the next several decades as a result of an aging population [62]. This justified that further evidence was needed to better examine the relationship between age and hospitalization among lung cancer patients. Table 2.5 describes characteristics of studies that investigated the association between age and hospital utilization in the lung cancer population.

Table 2.5 Characteristics of studies to investigate the association between age and hospital usage in patients living with lung cancer

First author reference # (Year published) Location	Study design	Study population (Sample size)	Outcome & strength of association

First author reference # (Year published) Location	Study design	Study population (Sample size)	Outcome & strength of association
Townsley C[80] (2005) Ontario Canada	Retrospective Chart review	N=1,505 Source population: administrative data. Inclusion criteria: individuals over the age of 35 years with lung, breast, colorectal cancer.	The odds of a patient 70 years of age or greater receiving any cancer treatment were half of that of a patient aged less than 70 years (OR=0.50, 95%CI= 0.33-0.76)
Berghmans T[82] (2002) Belgium	Prospective cohort study	N=604 Source population: cancer hospital. Inclusion criteria: patients aged 75 years and above and diagnosed with lung cancer; had a normal white blood cell (>4,000/mm^3) and platelet (> 100,000/mm^3) counts. Exclusion criteria: recent myocardial infarction or cardiac arrhythmia requiring treatment, uncontrolled infectious disease, medical or psychological factors preventing adherence to the treatment schedule, prior treatments (i.e. chemotherapy, surgery or radiotherapy).	Among patients living with non-small-cell lung cancer, data showed that 20% of patients aged 75 years of age or greater didn't receive the standard treatment.

Comorbidity

Earlier reports suggested that comorbidity was highly prevalent in the lung cancer population and the majority of those with lung cancer have at least one comorbid condition [83]. According to a Spanish study, in 2002, nearly three quarters of them presented with one or more comorbidities; among those with multiple comorbid conditions, half of the subjects living with COPD. It also found that older patients showed a higher risk in developing comorbid illness [83]. This finding was in line with the work by Westert and colleagues in 2001; they also reported a higher prevalence observed in elderly women in the United Kingdom [84].

Moreover, comorbidity plays an important role in the delivery of hospital services. Based on evidence from the scientific literature, comorbidity was related with higher mortality and consumption of in-patient hospital and ICU resources [55, 59, 63, 74, 81]. According to two earlier Canadian reports, multiple comorbid conditions were found to be a positive predictor of ICU admission [55, 63]. This result was in line with the work by Iwashyna and colleagues, in 2004, where over half of the American medical beneficiaries being managed in the intensive care settings living with multiple chronic illnesses [74]. Furthermore, data also showed that patients living with comorbid illnesses were reported as repeated users for intensive care services [74]. Consistent result was also reported from a USA study in 2004, where the increasing number of comorbid conditions increased the odds of ICU admission by 1.14 times [81]. Table 2.6 describes characteristics of studies that investigated the association between comorbidity and hospital utilization in the lung cancer population.

Table 2.6 Characteristics of studies to investigate the association between comorbidity and hospital usage in patients living with lung cancer

First author reference # (Year published) Location	Study design	Study population (Sample size)	Outcome & strength of association

First author reference # (Year published) Location	Study design	Study population (Sample size)	Outcome & strength of association
Barbera L[55] (2006) Ontario Canada	Retrospective population-based cohort	N=21,323 Source population: administrative data.	Comorbidity significantly influenced the likelihood of being admitted to ICUs (adjusted OR=1.606, 95%CI: 1.394-1.853)
Sharma G [59] (2008) USA	Retrospective population-based cohort	N= 45,627 Source population: the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) registries. Inclusion criteria: individuals aged 65 years and above.	Subjects with more comorbid illnesses were more likely to receive ICU care in the last six months of life (OR=1.622, 95%CI: 1.525–1.7425)
Earle CC[81] (2004) Boston USA	Retrospective cohort	N=28,777 Source population: the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) registries and Centers for Medicare and Medicaid Services Medicare claims data. Inclusion criteria: individuals aged 65 years and above and died from lung, breast, colorectal, and other gastrointestinal cancers.	Increasing number of comorbid conditions increased the odds of ICU admission (adjusted OR=1.14, 95%CI: 1.06-1.23)

2.6 Summary

Chronic respiratory illnesses, such as COPD and lung cancer, represent an increasing burden in terms of morbidity and mortality across the world. However, the experience of those dying from these diseases was poorly understood, particularly for the population of COPD patients, who frequently attended aggressive care settings, died in hospitals, and had unmet personal preferences at the end of life. Many factors affecting the hospital utilizations in patients dying from COPD or lung cancer have been proposed, including personal characteristics and overall health status.

Chapter 3: METHODS

3.1 Study design

A retrospective study was conducted to compare the difference in hospitalization trends between decedents with COPD and decedents with lung cancer using administrative health data. Information on hospitalization in the six months prior to death for each person dying from COPD or lung cancer was collected from 1997 to 2006. We included three persons who died on January 1st, 2007, with those who died in 2006 for the analysis as their time contribution would be entirely from 2006. The primary outcome of interest was the hospitalization indicators, including LOS (total LOS in hospitals and average LOS per hospitalization) and total number of hospitalizations near the end of life.

3.2 Study population

The study sample consisted of all individuals who died of COPD or Lung cancer between 1997 and 2006 in Saskatchewan, Canada. Data in this study was obtained from Saskatchewan Health, which provided health care services coverage to approximately 99% of residents. Persons not covered included those covered by the federal government, namely, Royal Canadian Mounted Police, Canadian Forces members, and inmates of federal penitentiaries. In addition, Registered Indians were also excluded from this study because the federal government covered prescription drug costs for this group. We excluded individuals who were not covered under Saskatchewan Health at the time of the study. Finally, the study sample consisted of 7,114 people.

The end-of-life period referred to the last six months of life, and was measured by working backwards from date of the death recorded by Saskatchewan Health. The underlying cause of death (UCOD) was utilized to select individuals who died of COPD or lung cancer over the 10-year study period. The cause of death of all eligible subjects was obtained from the Vital Statistics Registry. The causes of death recorded on this form were keyed in electronically and an algorithm was applied to determine the underlying cause of death in accordance with WHO criteria.

3.3 Overview of Data Sources

Data in this study was obtained from Saskatchewan Health. There were a number of health databases maintained by Saskatchewan Health. Each insured individual had a unique identifier that could be used to link personal health records from each of the databases. Prior to receiving data from Saskatchewan Health, the unique identifier was de-identified and was replaced with a unique encrypted number. The databases we used from Saskatchewan Health included the population registry database, hospital service database, institutional supportive care database, and vital statistics database.

The population registry collected data on sex, year of birth, residence information, and dates of health care coverage. The hospital service file included dates of admission and discharge, diagnoses and diagnoses types, and procedures of interest undertaken during hospitalization. The vital statistics file contained information on the date of death, underlying cause of death (UCOD) and multiple cause of death (MCOD) as well as the location of death, such as in-hospital vs. out-of-hospital death. Finally, the institutional supportive care database had information on the type of supportive care services and number of hours for each type of service.

We used data that spanned a period of ten years. As such, the data was very comprehensive compared to studies that spanned fewer periods. The study population was also representative of residents of Saskatchewan who were covered under Saskatchewan Health given that it was nearly a complete sample.

3.4 Theoretical Framework

The behavioural model of health care utilization, developed by Andersen, Aday and others, was recognized as one of the most commonly used conceptual frameworks for examining factors associated with patient utilization of care [85].

This conceptual framework successfully integrates a wide range of variables (health policy, health hospitalization and characteristics of target population) associated with care-seeking decisions. By doing this, health care professionals and policy makers are able to identify the reasons for differences in utilization of care and establish programs and policies in appropriate care seeking. In addition, this conceptual framework could be used to guide research on health care utilization. It has been used by 19 studies to examine the accessibility to end-of-life care services among people with terminal illness. Figure 1 shows the relationship between the main components of the framework.

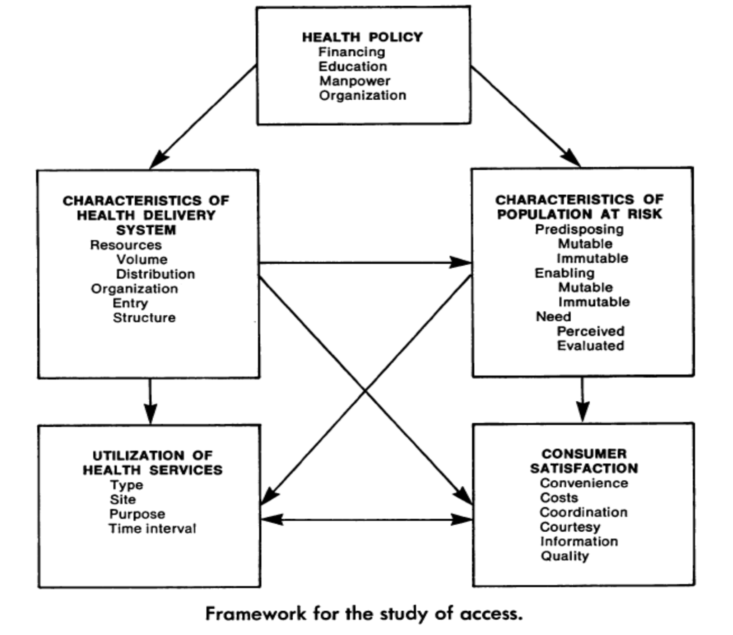

Figure 3. 1 Access to Medical Care

Health Policy: According to Aday and Andersen, health policy was described as the starting point of the access to health care resources, which included hospitals and ICUs [85]. As shown in this diagram, health policy consisted of financing, education, manpower and health care organization programs. In order to improve access to health care, especially among socially disadvantaged populations, policy-makers should establish policies suited to their financial and educational needs.

Characteristics of the Health Care Delivery System: The health care delivery system seeks to provide high quality patient health care in the treatment and prevention of human illness. There are two key components of health care delivery system--- resources and organization. Resources consist of the volume and the distribution of medical resources in an area; while organization is the structure of the system. In addition, the characteristics of the health care delivery system are interrelated and interact with each other. The resources component encompasses a wide range of health professionals, educational materials and medical equipment; while organization is described as the manner in which health care providers and institutions are properly coordinated and managed.

Characteristics of the Population at Risk: The characteristics of the population at risk encompass predisposing, enabling, and need components. The predisposing component includes factors that exist prior to the onset of the disease, such as age, sex, race, religion. The enabling component refers to a means that allows individuals to use health services. It includes such things as individual's income and his or her health care coverage. The need component is described as disease level. It decides directly whether the patient needs care and protection, and evaluates how much care should be provided to the patient.

Utilization of Health Services: The utilization of health services is described in terms of type, site, purpose, and the time interval involved. The type of utilization encompasses a wide range of services provided by a wide variety of health professionals, including physician, dentist, pharmacist, etc. The site of the utilization refers to the place where the health services were received: ICU, emergency room, inpatient department, etc. The purpose of utilization is described as preventive, illness-related, or custodial care. Preventive care is characterized as prevention of a disease before it begins, including immunization and screening. Illness-related care is described in terms of acute and chronic illnesses. Curative care has been provided to patients living with acute diseases, such as flu and fever. In regards to chronic illness, long-term care will be given to patients with irreversible illness (e.g. COPD and heart failure). The time interval required for a visit is described in terms of contact, volume, and continuity measures. Contact refers to whether a person uses the health care services in a given period of time. Volume refers to the number of visits by a person in a given period of time. Continuity is concerned with the quality of care a person received in a given period of time. It measures the degree of a patient's experience of a continuous caring relationship with the health care system.

Consumer Satisfaction: Consumer satisfaction refers to an individual's attitude towards the health care system. It also measures how efficiently the health services are managed and how promptly services are provided. It has been recognized as a key indicator within health care services.

By using this conceptual model, we are able to examine the factors predicting the probability of use and amount of use of hospital services among the COPD population. Additionally, by linking data from Saskatchewan Health's hospital service records, this study is able to explore the factors that influence the differences between sexes. For example, whether the disparity between sexes could be predominantly explained by the characteristics of the target population (such as age and sex) or the characteristics of the utilization of health services (for example, time spent in ICU). However, we are not able to investigate every aspect of the conceptual model due to the limited information from Saskatchewan Health, which results in a reduced internal validity of the study.

The variables that were analyzed in this study were presented in Figure 2 (Characteristics of Health Services Utilization) and Figure 3 (Individual Determinants of Health Hospitalization)

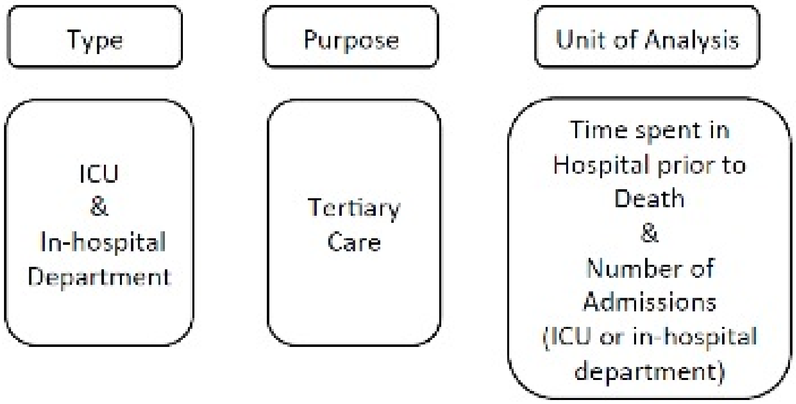

Figure 3. 2 Characteristics of Health Service Utilization

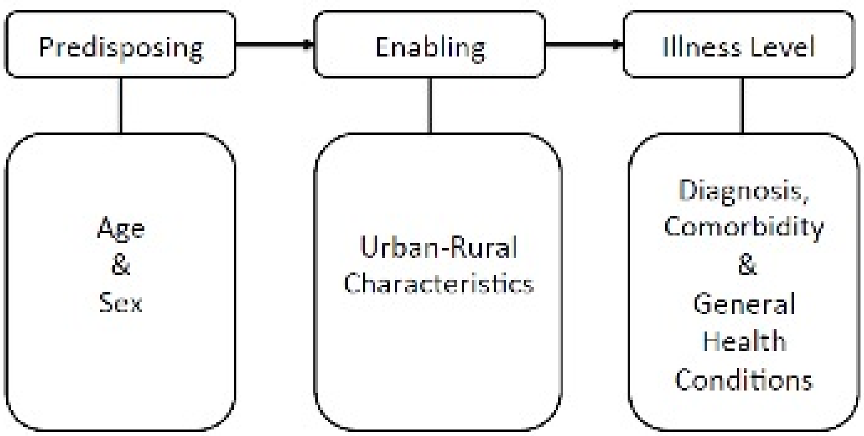

Figure 3. 3 Individual Determinants of Health Service Utilization

Characteristics of health hospitalization describe the type of health service provided to individuals, the purpose of the utilization, and the unit of analysis.

With respect to type of health service, we define it in this study as the place (ICU or in-hospital departments) where the service was received by an individual. In the current study, the purpose of service refers to tertiary care, which provides stabilization for long-term irreversible diseases, for example, COPD and lung cancer. Another characteristic that was studied is the unit of analysis. We defined this variable as:

1) Time spent in hospital prior to death

2) Number of admissions

In addition to the characteristics of the health service, we were also interested in the individual determinants of hospitalization that allows health professionals to determine the health care offered from the health facilities. The figure above describes a sequence of factors that contributes to decisions made to seek health care.

According to the model, the use of health service is based on:

1) The predisposition of the patient to seek service
2) The enabling conditions that allow a patient to seek health resources
3) The patient's illness level

In this analysis, the predisposing factors will be measured as age and sex. Although these characteristics are not directly related to the health utilization, previous literature suggested that female patients, particularly those of older age, were more likely to use health services.

With regards to the enabling factors, it will be characterized as the rural-urban nature of the community in which the individual lives. It will be measured as the percentage of the population that is urban or rural within the province of Saskatchewan. The enabling variable is important in this analysis because it links to how medicine is practiced in the community that influences the health seeking behaviour of the individuals living in the community.

Illness level is believed to be the most immediate cause of the utilization of care. Measures of illness level include:

1) Diagnosis of the disease (COPD and lung cancer)
2) Comorbidities

3.5 Operational Definitions

3.5.1 COPD and lung cancer

COPD and lung cancer were defined according to the International Classification of Diseases (ICD) coding following the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines, which was also consistent with that used in the US National Center for Health Statistics COPD Surveillance Summary 1971–2000 [55].

The information on COPD, lung cancer, and causes of death were coded and tabulated according to both the ninth and the tenth revision of the International Classification of Diseases [82] as the study period crossed the transition period between ICD-9 and 10 coding.

Table 3.1 shows the method of ICD coding.

DISEASE	ICD-9	ICD-10
COPD	491.x, 492.x, 493.2, 496.x	J44.x
Lung Cancer	162.x, 195.1, 165.x	C34.x

3.5.2 Hospitalization (includes any in-patient days) in the six months prior to death

Data was retrieved from the hospital service database; and the reason for hospitalization is identified by “primary diagnosis.” In order to avoid double counting from inter-hospital transfers, we counted a patient who was readmitted to another hospital on the same day of discharging from an existing hospital as having one transfer, and combined two hospitalizations rather than counting it as a second admission.

Hospitalization was considered as Total LOS in hospitals, Average LOS per hospitalization, and total number of hospitalizations in the six months prior to death for each disease group (COPD and lung cancer)

Since the assumptions of normality were not met, the number of hospitalizations were classified as ⩾2 visits or <2 visits during the last 6 months of life, and both of the total LOS in hospitals and average LOS per hospitalization were categorized as >7 days or ⩽7days as per a previous study [50].

3.5.3 Hospitalization in one month prior to death (includes any in-patient days)

Hospitalization in the past month referred to hospital stays in the 30 days prior to death. Most patients with chronic respiratory disease remain quite functional until approximately five to six months prior to their deaths [87]. During one to two months before their deaths, their health status tends to decline rapidly. In Teno's study in 2003, more than 50 percent of lung cancer patients reported that they had difficulty getting out of a bed or chair one month prior to death [88]. Previous literature also found a dramatic increase in the proportion of people admitted to ICU in the mother before they died over the last decade [89]. Thus, it was important to investigate the trends of hospitalization among patients with terminal respiratory disease one month prior to their deaths. This was considered as total LOS in hospitals and average LOS in hospitals in one month prior to death for each disease group (COPD and lung cancer).

3.5.5 Independent Variables of Interest

The independent variables of primary interest were disease status (COPD and lung cancer), age group (⩽59 years, 60-69 years, 70-79 years, 80-89 years and ⩾90 years), sex (male and female), and comorbid conditions (0-1 condition and ⩾2 conditions). Other variables that were also included in the analysis were residence (⩾300,000 population in their communities, 10,000-

299,999 population in their communities, and <10,000 population in their communities), location of death (in hospital and outside hospital), marital status (married/ common law, never married, separated/ divorced, and widowed), institutional supportive care services (yes and no), transfers between institutional supportive care facilities (yes and no), and number of transfers between institutional supportive care facilities.

3.6 Statistical analysis

All data analysis in this study were conducted using SPSS (19.0). All statistical tests were two tailed, and α was set at 0.05 to define statistical significance.

3.6.1 Baseline Characteristics

Throughout the analysis, the variable of primary interest was disease status (COPD vs. lung cancer). Initially, baseline characteristics of the study population were described and compared by disease group. Continuous variables were expressed as means and standard deviations (SD). Statistical comparison of the differences between disease groups was completed using the independent samples t-test. Descriptive analyses using categorical variables were presented as frequencies and proportions. For categorical variables, statistical comparisons between groups were completed using the chi-squared tests. Characteristics of patients with COPD or lung cancer were compared to determine whether differences existed in age distribution, sex, and co-morbidities.

3.6.2 Analysis for each Research Question

1: How do indicators of hospitalization in the six months prior to death compare between patients with a diagnosis of COPD and those with a diagnosis of lung cancer?

This analysis was primarily descriptive. The independent variable of primary interest was the disease status (COPD and lung cancer). The outcome was hospitalization, which was expressed as:

1) Total LOS in hospitals in the six months prior to death for each disease group (COPD and lung cancer);
2) Total LOS in hospitals in one month prior to death for each disease group (COPD and lung cancer);
3) Average LOS per hospitalization in the six months prior to death for each disease group (COPD and lung cancer);
4) Average LOS per hospitalization in one month prior to death for each disease group (COPD and lung cancer);
5) Number of hospitalizations in the six months prior to death for each disease group (COPD and lung cancer);
6) Number of hospitalizations in the one month prior to death for each disease group (COPD and lung cancer);

Statistical comparisons of the differences between COPD and lung cancer groups were completed using the independent samples t-tests if the assumptions were met and the Mann-Whitney test if the assumptions were not met.

2: Is there an association between the following independent variables and hospitalization among the target population and do they modify the effect of diagnostic group?

(a) age; (b) comorbidity; (c) sex

To investigate this research question, first, the chi square test was performed to determine the univariate association between age group, comorbidity, and sex with hospitalization. Following this the association was assessed using a univariate logistic regression model. Variable selection followed that of Hosmer [88]. Variables with $p<0.25$ in the univariate analysis were the candidate variables for a full multivariate model. Variables in the full multivariate model with $p<0.05$ were included in the reduced model. Following this, assessment of confounding took place. Variables in the full multivariate model with $p>0.05$ were added to the reduced model to evaluate the confounding. In order to assess the presence of confounding, the crude beta coefficient (without controlling for confounding) was compared with the beta coefficient adjusted for the potential confounder. If the beta coefficient had changed significantly (approximately 15% or more), then there was evidence of confounding and that variable was retained in the final main effect model. The strength of associations was presented by odds ratios and their 95% confidence intervals for categorical variables. Disease status remained in all models due to its role as a primary variable. Throughout the analysis, disease status, age, sex, and comorbid condition were included in the models.

In order to test whether sex was an effect modifier in the association between disease group and LOS, two methods were performed.

(1) Stratified analysis:

First, stratified analysis was performed. Stratification occurred by sex. The odds ratio (OR_{Male} and OR_{Female}) was calculated from the 2*2 tables shown below.

Stratum1 (Male)

	<7 days	>7 days
COPD	A_1	B_1
Lung Cancer	C_1	D_1

OR_{Male}=

Stratum2 (Female)

	<7 days	>7 days
COPD	A_2	B_2
Lung Cancer	C_2	D_2

OR_{Female}=

If $OR_{Male} \neq OR_{Female}$, it suggested that the association between disease status and hospitalization was dependant on sex, then an interaction between sex and disease status could be said to exist.

(2) Likelihood Ratio Test:

Second, I performed the likelihood ratio test to investigate this research question. An interaction term (sex*disease group) was added to the final main effect model containing all the main effects. If the interaction was statistically significant it would be retained in the final multivariate model. The final model included the main effects and significant interactions. The interaction effect was described through the linear combination of effects. The strength of associations was presented by odds ratios and their 95% confidence intervals.

Other interactions of interest to be tested were comorbidity*disease group and age*disease group. Assessments of interaction were the same as above.

3. Does the pattern of hospitalization change over a 10 year period and are the associations between hospitalization and diagnostic group, age, sex, and comorbidity consistent over the 10 year period?

The independent variables of primary interest were the disease status (COPD and lung cancer) and calendar year. The outcome was hospitalization and was considered as described above.

Initially, descriptive analyses examined hospitalization for each year (from 1997 to 2006) by disease group (COPD and lung cancer). Following this, multiple logistic regression was performed to consider the effect of year. For this analysis, calendar year was forced into the final model obtained from research question 2 as a main effect variable in order to investigate the trends of hospital service utilization (Total LOS in hospitals, Average LOS per hospitalization and number of hospitalizations) over the 10-year study period. Interaction between calendar year and disease group was assessed following the methods described above (stratified analysis and LR tests).

3.7 Sample Size and Statistical Power

3.7.1 Overall

Statistical power was calculated using G power 3.1 software. Throughout the power calculations, alpha was 0.05 and power (1-beta) was determined as 80%. All tests were two-sided.

3.7.2 Sample size for research question 1

In order to investigate Research Question 1, the Chi-square test was considered. Based on the study conducted by Goodridge et al. [58], 433 died of lung cancer while 602 died of COPD.

Therefore, ratio of lung cancer over COPD was 0.72. Regarding the proportion of hospitalization in each group, 40% of the COPD patients spent more than 7 days in hospitals, while there were 48.2% from those with lung cancer. Using the Chi-square test, we would require 722 people with lung cancer and 519 people with COPD.

3.7.3 Sample size for research question 2(a)

Sample size for Research Question 2(a) is based on logistic regression. Based on the report from the Division of Health Care Statistics [90], the hospitalization rate ranged from 45 per 10,000 in 1995 to 49 per 10,000 in 2004. The age associated odds ratio was 1.16 among lung cancer patients according to the report from McCarthy et al. [64]. Using logistic regression, we would require 1444 decedents in total.

3.7.4 Sample size for research question 2(b)

Sample size for Research Question 2(a) is based on logistic regression. Based on the report from the Division of Health Care Statistics [90], the hospitalization rate ranged from 45 per 10,000 in 1995 to 49 per 10,000 in 2004. The comorbidity associated odds ratio is 1.61 among lung cancer patients according to the report from Barbera et al. [91]. Using logistic regression, we would require 155 decedents in total.

3.7.5 Sample size for research question 2(c)

Sample size for Research Question 2(c) was based on logistic regression. Based on the report from the Division of Health Care Statistics [90], the hospitalization rate ranged from 45 per 10,000 in 1995 to 49 per 10,000 in 2004. The sex associated odds ratio was 1.15 among lung cancer patients according to the report from Huang et al. [75]. Using logistic regression, we would require 6436 decedents in total.

3.7.6 Sample size for research question 3

Sample size for Research Question 3 was based on logistic regression. Based on the report from the Baillargeon and colleagues, the calendar year associated odds ratio ranged from 0.74 to 0.84 between 1999 and 2007. Using logistic regression, we would require the total population to be between 2,389 and 6,821.

3.7.7 Summary of sample size

In the dataset, there were 2,332 subjects who died of COPD and 4,782 who died of lung cancer resulting in a total of 7,114 subjects included in the current study. Based on the above calculations, the largest required sample size in total was 6,821. Since the dataset (7,114) in the current study was larger than the largest required sample size, the sample size calculations showed that the study has an adequate sample size to achieve the desired statistical power of 80%.

Chapter 4: RESULTS

4.1 Research Question 1

How do indicators of hospitalization in the six months prior to death compare between patients with a diagnosis of COPD and those with a diagnosis of lung cancer?

Table 4.1 presents the personal characteristics for the study population (N=7,114) for each factor of interest including age, sex, residence, comorbid condition, location of death, marital status, institutional supportive care services, transfers between institutional supportive care facilities, and number of transfers between institutional supportive care facilities, comparing COPD (N_{COPD}= 2,332) and lung cancer ($N_{Lung\ cancer}$= 4,782) group. It was observed that between the COPD and lung cancer population, there were statistically significant differences in terms of all personal characteristics except for residence.

Table 4.1 Personal Characteristics of the study population overall and by disease group

	Overall N=7114 N (%)	Lung Cancer N=4782 N (%)	COPD N=2332 N (%)	P-value *
Age				
≤59 years	659 (9.3)	610 (12.8)	49 (2.1)	<0.0001
60-69 years	1427 (20.1)	1197 (25.0)	230 (14.2)	
70-79 years	2471 (34.7)	1717 (35.9)	754 (32.3)	
80-89 years	2430 (34.2)	1212 (25.3)	1218 (52.2)	
≥90 years	127 (1.8)	46 (1.0)	81 (3.5)	
Sex				
Female	2822 (39.7)	1948 (40.7)	874 (37.5)	0.008
Male	4292 (60.3)	2834 (59.3)	1458 (62.5)	
Residence				
≥300,000	2498 (35.1)	1679 (35.1)	819 (35.1)	0.20

(10,000- 299,999)	1270 (17.9)	828 (17.3)	442 (19.0)	
<10,000	3346 (47.0)	2275 (47.6)	1071 (45.9)	
Comorbid Condition				
0-1	2823 (39.7)	1974 (41.3)	849 (36.4)	<0.0001
≥2	4291 (60.3)	2808 (58.7)	1483 (63.6)	
Location of Death				
Hospital	5526 (73.5)	3553 (74.3)	1673 (71.7)	0.02
Outside Hospital	1882 (26.5)	1223 (25.6)	659 (28.3)	
Marital Status				
Married/ Common Law	3668 (51.6)	2655 (55.5)	1013 (43.4)	<0.0001
Never Married	617 (8.7)	402 (8.4)	215 (9.2)	
Separated/ Divorced	1663 (23.4)	1036 (21.7)	627 (26.9)	
Widowed	1166 (16.4)	689 (14.4)	477 (20.5)	
Institutional Service				
No (reference)	5285 (74.3)	3783 (79.1)	1502 (64.4)	<0.0001
Yes	1829 (25.7)	999 (20.9)	830 (35.6)	
Transfer within Institution				
No (reference)	6783 (95.3)	4630 (96.8)	2153 (92.3)	<0.0001
Yes	331(4.7)	152 (3.2)	179 (7.7)	
Number of Transfers within Institution among those receiving Institutional Services				
0 (reference)	1498 (21.1)	847 (17.7)	651 (17.9)	0.004
1	297 (4.2)	139 (2.9)	158 (6.8)	
2	27 (0.4)	11 (0.2)	16 (0.7)	
3	7 (0.1)	2 (0.04)	5 (0.2)	

*Comparing Lung Cancer with COPD group

The average age of death for the deceased COPD patient was 79.1 years (SD= 7.8 years) whereas the average age of death for the decedents with lung cancer was 71.9 years (SD= 10.2 years). Discrepancies between disease groups were observed for the age distribution, which was categorized into five groups: ≤59 years, 60-69 years, 70-79 years, 80-89 years and ≥90 years. It was observed that the proportion of COPD deaths increased with age except for ≥90 years. This pattern was not witnessed in the lung cancer group. Significant differences existed between sexes, with 59.3% of decedents with lung cancer being male, compared to 62.5% of decedents with COPD. Regarding the comorbidity, a higher proportion of decedents with COPD (63.6%) had multiple comorbid illnesses than those with lung cancer (59.3%). Decedents from COPD (71.7%) were less likely to die in hospital when compared with decedents from lung cancer (74.3%). Most of the study population were married or lived common law, with 55.5% observed in the lung cancer group and 43.4% in the COPD group. With regards to the difference in the distribution of institutional supportive care services, most of decedents (79.1%) from lung cancer did not receive it as compared to decedents from COPD (64.4%). The majority of decedents never had transfers between institutions. Among those receiving services in the supportive care institutions, a similar proportion of lung cancer (17.7%) and COPD (17.9%) subjects never had any transfers. A larger proportion of deceased COPD patients had one, two, and three transfers as compared with the decedents from lung cancer.

Information on the hospital care utilization, including total LOS in hospitals, average LOS per hospitalization, number of hospitalizations, and ICU admission, are illustrated in Table 4.2. In the last month of life, decedents with lung cancer spent more time in hospital (mean=13.5 days, SD=16.1 days of total LOS) than decedents with COPD (mean=10.3 days, SD=13.7 days of total LOS). Similarly, decedents with lung cancer had longer stay per hospitalization (mean=14.4, SD=14.4 days of average LOS) than decedents with COPD (11.5 days, SD=12.2 days of average LOS). A higher proportion of subjects dying of COPD were admitted to ICU (4.3%). However, this proportion was significantly less among subjects dying of lung cancer (0.06%).

Similar trends were also witnessed in the last six months prior to death. Decedents with COPD spent on average, 24.0 days (SD=26.2 days) in hospital, compared to 26.6 days (SD=25.5 days) among those in the lung cancer population. The lung cancer group had a longer average hospital stay per visit (14.3 days, SD=18.5 days) when compared with their COPD counterparts (13.4 days, SD=18.6 days). The proportion of ICU admission was higher for decedents from COPD (5.3%) than for decedents from lung cancer (2.9%).

Table 4.2 Hospitalization in patients with COPD and Lung Cancer by disease group and length of time prior to death

	1 Month			6 Month		
	Lung Cancer N=4782	COPD N=2332	Total N=7114	Lung Cancer N=4782	COPD N=2332	Total N=7114
In-patient Hospitalization						
Total LOS in Hospital						
Mean Total LOS ±S.D. (days)	13.5±16.1	10.3±13.7[‡]	12.4±15.4	26.6±25.5	24.0±26.2[‡]	25.7±25.8
Median Total LOS (Minimum, Maximum)	10 (0, 210)	7 (0, 210)	9 (0, 210)	20 (0, 183)	16 (0, 184)	18 (0, 184)
% with Total LOS ≤7 days	41.3	53.7[‡]	45.3	20.6	28.8[‡]	23.3
% with Total LOS >7 days	58.7	46.3[‡]	54.7	79.4	71.2[‡]	76.7
Average LOS per visit						
Mean Average LOS per visit ±S.D. (days)	14.4±14.4	11.5±12.2[‡]	13.5±13.8	14.3±18.5	13.4±18.6[†]	14.0±18.5
Median Average LOS (Minimum, Maximum)	7 (0, 180)	5 (0, 180)	6.5 (0, 180)	9 (0, 180)	8.5 (0, 180)	8.75 (0, 180)
% with Average LOS per visit ≤7 days	50.3	59.5[‡]	53.3	40.8	43.8[†]	41.8
% with Average LOS per visit >7 days	49.7	40.5[‡]	46.7	59.2	56.2[†]	58.2
Number of Hospitalizations						
% with 0 hospitalization	13.9	17.0[‡]	14.9	0.1	0.3	0.2
% with 1 hospitalization	64.8	67.5[‡]	65.7	35.1	47.2	39.0
% with ≥2 hospitalizations	21.2	15.5[‡]	19.4	64.8	62.6[‡]	60.8

ICU Admission						
% with an ICU Admission	0.06	4.3[‡]	1.5	1.7	5.3[‡]	2.9

* P<0.10 comparing the Lung Cancer with the COPD group

† P<0.05 comparing the Lung Cancer with the COPD group

‡ P<0.01 comparing the Lung Cancer with the COPD group

Table 4.3 presents sex-specific hospital utilization for lung cancer, COPD and the general population in both one month and six months prior to death. It was observed that decedents with lung cancer were more likely to consume greater hospital services (total LOS in hospitals, average LOS per hospitalization and number of hospitalizations) and have less ICU admissions than their COPD counterparts in each sex group.

Table 4.3 Hospitalization in patients with COPD and Lung Cancer by disease group and length of time prior to death stratified by sex

	1 Month			6 Months		
	Lung Cancer	COPD	Total	Lung Cancer	COPD	Total
Male						
In-patient Hospitalization						
Total LOS in Hospital						
Mean Total LOS ±S.D. (days)	13.3± 16.6	10.2± 11.7	12.2± 15.2	24.7± 23.6	23.5± 25.6	24.3± 24.3
% with Total LOS ≤7 days	41.7	52.4	43.5	21.8	28.7	24.1
% with Total LOS >7 days	58.3	47.6	54.7	78.2	71.3	75.9
Average LOS per visit						
Mean Average LOS per visit ±S.D. (days)	14.0± 15.0	11.4± 10.8	13.1± 13.8	13.1± 16.7	13.0± 18.3	13.0± 17.3
% with Average LOS per visit ≤7 days	50.6	58.4	53.2	43.2	43.6	43.3
% with Average LOS per visit >7 days	49.4	41.6	46.8	56.8	56.4	56.7

Number of Hospitalizations						
% with 0-1 hospitalization	77.3	84.3	79.7	35.3	47.1	39.3
% with ≥2 hospitalizations	22.7	15.7	20.3	64.7	52.9	60.7
ICU Admission						
% with an ICU Admission	2.2	3.9	2.2	2.0	4.7	2.9
Female						
In-patient Hospitalization						
Total LOS in Hospital						
Mean Total LOS ±S.D. (days)	13.7± 15.3	10.4± 16.5	12.7± 15.7	29.2± 27.8	24.9± 27.3	27.9± 27.7
% with Total LOS ≤7 days	40.6	55.8	45.3	18.8	28.9	22.0
% with Total LOS >7 days	59.4	44.2	54.7	81.2	71.1	78.0
Average LOS per visit						
Mean Average LOS per visit ±S.D. (days)	15.0± 13.6	11.7± 14.3	14.0± 13.9	16.2± 20.6	14.0± 19.2	15.5± 20.2
% with Average LOS per visit ≤7 days	49.8	61.2	53.4	37.4	44.3	39.5
% with Average LOS per visit >7 days	50.2	38.8	46.6	62.6	55.7	60.5
Number of Hospitalizations						
% with 0-1 hospitalization	80.9	85.0	82.1	35.1	48.1	39.1
% with ≥2 hospitalizations	19.1	15.0	17.9	64.9	51.9	60.9

ICU Admission						
% with an ICU Admission	0.6	5.0	2.0	2.3	6.4	2.9

Table 4.4 summarizes the hospital services consumption in each disease group (COPD and lung cancer) and the total study population stratified by comorbid conditions (0-1 and ⩾2 conditions). Overall, decedents with multiple comorbid conditions had greater usage than those with one or zero comorbid condition. In the last one month of life, there was not a significant difference in hospital stays between different comorbidity categories. Interestingly, patients with multiple comorbid conditions (Percentage of two or more hospitalizations: 16.3%) were less likely to visit hospitals twice or more when compared with those having one or zero comorbid condition (Percentage of two or more hospitalizations: 24.0%).

Table 4.4 Hospitalization in patients with COPD and Lung Cancer by disease group and length of time prior to death stratified by comorbid condition

		1 Month			6 Months	
	Lung Cancer	COPD	Total	Lung Cancer	COPD	Total
0-1 condition						
In-patient Hospitalization						
Total LOS in Hospital						
Mean Total LOS ±S.D. (days)	13.9± 18.2	10.2± 14.9	12.8± 17.3	25.6± 25.3	22.6± 24.8	24.7± 25.2

% with Total LOS ≤7 days	41.2	54.2	45.1	22.6	31.0	25.1
% with Total LOS >7 days	58.8	45.8	54.9	77.4	69.0	74.9
Average LOS per visit						
Mean Average LOS per visit ±S.D. (days)	14.5± 16.9	11.2± 13.4	13.5± 16.0	11.9± 17.2	9.7± 12.2	11.2± 15.9
% with Average LOS per visit ≤7 days	52.7	62.3	55.6	49.0	53.6	50.4
% with Average LOS per visit >7 days	47.3	37.7	44.4	51.0	46.4	49.6
Number of Hospitalizations						
% with 0-1 hospitalization	74.6	79.3	76.0	23.3	35.3	26.9
% with ≥2 hospitalizations	25.4	20.7	24.0	76.7	64.7	73.1
ICU Admission						
% with an ICU Admission	1.0	3.3	1.7	1.5	3.9	2.2
≥2 conditions						
In-patient Hospitalization						
Total LOS in Hospital						
Mean Total LOS ±S.D. (days)	13.3± 14.4	10.3± 12.9	12.2± 14.0	27.2± 25.6	24.8± 27.0	26.4± 26.1
% with Total LOS ≤7 days	41.3	53.4	45.5	19.2	27.5	22.0
% with Total LOS >7 days	58.7	46.6	54.5	80.8	72.5	78.0
Average LOS per visit						

Mean Average LOS per visit ±S.D. (days)	14.3± 12.5	11.8± 11.5	13.4± 12.2	16.1± 19.1	15.5± 21.2	15.9± 19.8
% with Average LOS per visit ≤7 days	48.6	57.9	51.8	35.0	38.2	36.1
% with Average LOS per visit >7 days	51.4	42.1	48.2	65.5	61.8	63.9
Number of Hospitalizations						
% with 0-1 hospitalization	81.7	87.6	83.7	43.5	54.3	47.3
% with ≥2 hospitalizations	18.3	12.4	16.3	56.5	45.7	52.7
ICU Admission						
% with an ICU Admission	1.0	4.9	2.4	1.9	6.1	3.4

Table 4.5 suggests that there are differences across age groups in the consumption of hospital services in both the last one month and six months of life. Usage of decedents aged 60 to 69 years was higher than that in any other age groups, while the oldest age group (≥ 90 years) consumed the least amount of hospital care services. Regarding the difference between disease groups in each age category, usage differed much more on the older age groups than in the younger age groups.

Table 4.5 Hospitalization in patients with COPD and Lung Cancer by disease group and length of time prior to death stratified by age

	1 Month			6 Months		
	Lung Cancer	COPD	Total	Lung Cancer	COPD	Total
≤59 years						
In-patient Hospitalization						
Total LOS in Hospital						
Mean Total LOS ±S.D. (days)	13.2± 16.4	14.0± 26.1	13.2± 17.3	26.2± 24.4	29.7± 39.4	26.5± 25.8
% with Total LOS ≤7 days	43.6	51.0	44.2	21.6	30.6	22.3
% with Total LOS >7 days	56.4	49.0	55.8	78.4	69.4	77.7
Average LOS per visit						
Mean Average LOS per visit ±S.D. (days)	13.6± 15.8	13.5± 26.8	13.6± 17.0	13.0± 15.6	14.4± 31.1	13.1± 17.2
% with Average LOS per visit ≤7 days	53.1	61.2	53.7	46.1	55.1	46.7
% with Average LOS per visit >7 days	46.9	38.8	46.3	53.9	44.9	53.3

Number of Hospitalizations						
% with 0-1 hospitalization	75.4	65.3	74.7	28.2	36.7	28.8
% with ≥2 hospitalizations	24.6	34.7	25.3	71.8	63.3	71.2
ICU Admission						
% with an ICU Admission	0.5	2.0	0.6	1.0	8.2	1.5
60-69 years						
In-patient Hospitalization						
Total LOS in Hospital						
Mean Total LOS ±S.D. (days)	14.1± 17.6	12.1± 20.4	13.7± 18.1	27.1± 26.2	29.4± 33.4	27.5± 27.5
% with Total LOS ≤7 days	39.6	51.3	41.5	19.9	25.7	20.8
% with Total LOS >7 days	60.4	48.7	58.5	80.1	74.3	79.2
Average LOS per visit						
Mean Average LOS per visit ±S.D. (days)	14.7± 14.9	11.8± 13.5	14.2± 14.7	14.3± 19.2	14.3± 24.4	14.3± 20.1
% with Average LOS per visit ≤7 days	50.5	60.9	52.1	42.3	45.7	42.8
% with Average LOS per visit >7 days	49.5	39.1	47.9	57.7	54.3	57.2
Number of Hospitalizations						
% with 0-1 hospitalization	77.4	77.0	77.3	31.9	35.7	32.5
% with ≥2 hospitalizations	22.6	23.0	22.7	68.1	64.3	67.5

ICU Admission						
% with an ICU Admission	0.9	7.8	2.0	1.7	9.1	2.9
70-79 years						
In-patient Hospitalization						
Total LOS in Hospital						
Mean Total LOS ±S.D. (days)	13.9± 15.3	11.1± 11.8	13.0± 14.4	27.6± 26.5	25.3± 26.8	26.9± 26.6
% with Total LOS ≤7 days	38.7	50.3	42.2	18.2	26.9	20.8
% with Total LOS >7 days	61.3	49.7	57.8	81.8	73.1	79.2
Average LOS per visit						
Mean Average LOS per visit ±S.D. (days)	14.6± 13.8	12.0± 10.0	13.8± 12.8	14.5± 19.0	14.1± 19.7	14.4± 19.2
% with Average LOS per visit ≤7 days	47.8	55.2	50.1	38.1	41.2	39.1
% with Average LOS per visit >7 days	52.2	44.8	49.9	61.9	58.8	60.9
Number of Hospitalizations						
% with 0-1 hospitalization	76.7	84.7	79.2	32.7	45.9	36.7
% with ≥2 hospitalizations	23.3	15.3	20.8	67.3	54.1	63.3
ICU Admission						
% with an ICU Admission	1.5	4.5	2.5	2.3	6.5	3.6
80-89 years						

In-patient Hospitalization						
Total LOS in Hospital						
Mean Total LOS ±S.D. (days)	12.5± 15.6	9.4± 11.7	11.0± 13.9	24.9± 23.9	22.4± 23.8	23.6± 23.9
% with Total LOS ≤7 days	45.0	55.3	50.1	23.8	30.1	27.0
% with Total LOS >7 days	55.0	44.7	49.9	76.2	69.9	73.0
Average LOS per visit						
Mean Average LOS per visit ±S.D. (days)	14.3± 14.3	11.1± 10.9	12.7± 12.8	14.8± 18.4	12.8± 16.2	13.8± 17.3
% with Average LOS per visit ≤7 days	51.9	60.8	56.4	40.5	44.3	42.4
% with Average LOS per visit >7 days	48.1	39.2	43.6	59.5	55.7	57.6
Number of Hospitalizations						
% with 0-1 hospitalization	84.2	86.5	85.3	44.7	50.4	47.6
% with ≥2 hospitalizations	15.8	13.5	14.7	55.3	49.6	52.4
ICU Admission						
% with an ICU Admission	0.7	3.7	2.2	1.3	4.1	2.7
≥90 years						
In-patient Hospitalization						
Total LOS in Hospital						
Mean Total LOS ±S.D. (days)	10.6± 10.8	7.9± 20.7	8.8± 17.8	22.8± 22.7	18.8± 19.7	20.3± 20.8

% with Total LOS ≤7 days	52.2	70.4	63.8	28.3	33.3	31.5
% with Total LOS >7 days	47.8	29.6	36.2	71.7	66.7	68.5
Average LOS per visit						
Mean Average LOS per visit ±S.D. (days)	13.2± 10.7	10.7± 24.5	11.7± 20.2	16.0± 17.8	11.5± 13.0	13.1± 15.0
% with Average LOS per visit ≤7 days	56.5	74.1	67.7	39.1	48.1	44.9
% with Average LOS per visit >7 days	43.5	25.9	32.3	60.9	51.9	55.1
Number of Hospitalizations						
% with 0-1 hospitalization	91.3	87.7	89.0	54.3	56.8	55.9
% with ≥2 hospitalizations	8.7	12.3	11.0	45.7	43.2	44.1
ICU Admission						
% with an ICU Admission	0	0	0	0	0	0

4.2 Research Question 2

Is there an association between the following independent variables and hospitalization among the target population and do they modify the effect of diagnostic group?

(a) age

(b) comorbidity

(c) sex

The main effect variables included in this analysis are disease status, age, sex, and comorbid condition. The univariate associations between hospital utilization, including total LOS in hospitals, average LOS per hospitalization and number of hospitalizations, and the covariates are presented in Tables 4.6 and 4.7.

According to Table 4.6, in the last six months of life, among nine factors, eight of them were significantly associated with the Total LOS > 7 days independently. The only exception was for institutional supportive care services. However, it was still included in all multivariate analyses as suggested by literature.

It was observed that having COPD as the UCOD decreased the likelihood of having a total LOS greater than 7 days (OR= 0.64, 95%CI= 0.57-0.72). Decedents aged 80 years or above were less likely to stay longer in hospital than those aged 59 years or below. Male subjects were observed to have reduced odds of staying in hospital longer than 7 days. Living in rural areas was 1.25 times more likely to have longer hospital stay as compared to residents in urban areas. The odds were increased by 1.19 times among decedents with multiple comorbid conditions. The odds however were observed to be reduced by 0.65 times among subjects who died outside of the hospital when compared with those died in hospital. With regards to marital status, being widowed decreased the odds of staying in hospital greater than 7 days. Number of transfers between institutional supportive care facilities doubled the likelihood of staying longer in hospital as compared to without transfers.

In the last month of life, seven out of nine independent variables were significantly associated with the Total LOS > 7days. Sex, comorbid condition, and marital status were not significantly associated with total LOS. However, they were included in all multivariate analyses since they were main effect factors of interest in this study and could be confounders in the analysis. Subjects who were died of COPD had a reduced probability of longer hospital stay (OR=0.61, 95%CI= 0.55-0.67). It was observed that rural residents were more likely to have longer hospital duration as compared to urban residents. Subjects who were at an age of 80 years and above, died out of hospital, had institutional supportive care services, and had transfers between institutional supportive care facilities had reduced likelihood of prolonged hospital stay.

In the last six months of life, all factors were significantly associated with the Average LOS per hospitalization > 7days at the univariate level. The odds were reduced by 0.88 times among decedents with COPD when compared with decedents from lung cancer (OR= 0.88, 95%CI= 0.80-0.98). Male subjects were observed to have reduced odds of greater average LOS per visit. Compared with those at an age of 59 years or below, individuals at an age of 70-79 years were more likely to spend more than seven days in hospitals. In addition, subjects with multiple comorbid illnesses, never married or separated/ divorced, had institutional supportive care services, and had transfers between supportive care institutions, had increased odds of longer LOS per hospitalization.

In the last month of life, sex was observed to have no statistically significant relationship with the Average LOS per visit > 7days at the univariate level. However, this factor was still included in all the multivariate analyses as it was of one of the primary interest. Decedents with COPD were observed to have reduced odds of longer average hospital stay (OR= 0.69, 95%CI= 0.62-0.76). Subjects with multiple comorbid conditions and never married were found to have prolonged hospital stay.

Regarding the number of hospitalizations, as indicated by Table 4.7, in the six months before death, sex was found to have no statistically significant relationship with ≥ 2 hospitalizations at the univariate level. However, sex was still included in all the multivariate analyses as it was one of the main effect factors of interest. COPD as UCOD was found to reduce the likelihood of ≥ 2 hospitalizations. Other factors that reduced hospital attendance included advancing age, multiple comorbid conditions, out-of-hospital death, unmarried status, and having institutional supportive care services. Rural residence was associated with an increased likelihood of frequent hospital attendance.

In the last month of life, all independent variables were significantly associated with ≥ 2 hospitalizations individually. Subjects who died of COPD had less probability of having frequent hospital attendance as compared with their lung cancer counterparts (OR= 0.68, 95%CI= 0.59-0.77). Male sex and rural residence increased the odds of two or more hospital admissions. However, aging, multiple comorbid conditions, out-of-hospital death, unmarried status, receiving long-term supportive care, and transfer between supportive care facilities were found to reduce the likelihood of frequent hospitalizations.

Table 4.6 Univariate Analysis examining associations with LOS in Hospital

	Total LOS > 7 days in Hospital in the 6 months prior to death		Total LOS > 7 days in Hospital in the 1 month prior to death		Average LOS per visit >7 days in the 6 months prior to death		Average LOS per visit >7 days in the 1 month prior to death	
	Unadjusted OR (95%CI)	P-value	Unadjusted OR (95%CI)	P-value	Unadjusted OR (95%CI)	P-value	Unadjusted OR (95%CI)	P-value
Disease status								
Lung Cancer	1.00		1.00		1.00		1.00	
COPD	0.64 (0.57, 0.72)	<0.0001	0.61 (0.55, 0.67)	<0.0001	0.88 (0.80, 0.98)	0.02	0.69 (0.62, 0.76)	<0.0001
Age								
≤59 years	1.00		1.00		1.00		1.00	
60-69 years	1.09 (0.87, 1.37)	0.44	1.12 (0.93, 1.34)	0.25	1.17 (0.97, 1.41)	0.09	1.07 (0.89, 1.28)	0.50
70-79 years	1.09 (0.89, 1.34)	0.41	1.08 (0.91, 1.29)	0.37	1.37 (1.15, 1.63)	<0.0001	1.16 (0.98, 1.38)	0.10
80-89 years	0.78 (0.63, 0.95)	0.02	0.79 (0.66, 0.94)	0.007	1.19 (1.00, 1.42)	0.05	0.90 (0.76, 1.07)	0.22
≥90 years	0.62 (0.41, 0.95)	0.03	0.45 (0.30, 0.67)	<0.0001	1.08 (0.74, 1.58)	0.70	0.55 (0.37, 0.83)	0.004
Sex								
Female	1.00		1.00		1.00		1.00	
Male	0.89 (0.79, 0.99)	0.04	1.00 (0.91, 1.10)	0.99	0.86 (0.78, 0.94)	0.002	1.01 (0.91, 1.11)	0.92
Residence								

≥300,000	1.00		1.00		1.00		1.00	
(10,000- 299,999)	0.95 (0.81, 1.11)	0.52	0.98 (0.85, 1.12)	0.73	1.07 (0.94, 1.23)	0.31	1.09 (0.95, 1.25)	0.20
<10,000	1.25 (1.11, 1.41)	<0.0001	1.15 (1.03, 1.27)	0.01	1.09 (0.98, 1.21)	0.11	1.11 (1.00, 1.23)	0.05
Comorbid Condition								
0-1	1.00		1.00		1.00		1.00	
≥2	1.19 (1.06, 1.33)	0.003	0.99 (0.90, 1.09)	0.78	1.80 (1.63, 1.98)	<0.0001	1.17 (1.06, 1.28)	0.002
Location of Death								
Hospital	1.00		1.00		1.00		1.00	
Outside Hospital	0.65 (0.57, 0.73)	<0.0001	0.24 (0.21, 0.27)	<0.0001	0.81 (0.73, 0.91)	<0.0001	0.29 (0.26, 0.33)	<0.0001
Marital Status								
Married/ Common Law	1.00		1.00		1.00		1.00	
Never Married	1.16 (0.94, 1.44)	0.16	1.13 (0.95, 1.34)	0.18	1.35 (1.14, 1.62)	0.001	1.22 (1.03, 1.45)	0.02
Separated/ Divorced	1.00 (0.87, 1.14)	0.97	0.96 (0.85, 1.07)	0.44	1.17 (1.04, 1.32)	0.009	1.06 (0.95, 1.20)	0.30
Widowed	0.85 (0.73, 0.99)	0.04	0.90 (0.79, 1.02)	0.10	1.11 (0.97, 1.27)	0.12	1.00 (0.88, 1.14)	0.97
Institutional supportive care services								
No	1.00		1.00		1.00		1.00	
Yes	1.04 (0.92, 1.19)	0.50	0.52 (0.46, 0.57)	<0.0001	1.44 (1.29, 1.61)	<0.0001	0.61 (0.55, 0.68)	<0.0001
Transfers between institutional supportive care facilities								

No	1.00		1.00		1.00		1.00	
Yes	2.00 (1.42, 2.80)	<0.0001	0.28 (0.21, 0.36)	<0.0001	2.77 (2.09, 3.67)	<0.0001	0.31 (0.24, 0.41)	<0.0001

Table 4.7 Univariate Analysis examining associations with Number of Hospitalizations

	N	≥ 2 hospitalizations in the 6 months prior to death		≥ 2 hospitalizations in the 1 month prior to death	
		Unadjusted OR (95%CI)	P-value	Unadjusted OR (95%CI)	P-value
Disease status					
Lung Cancer	4782	1.00		1.00	
COPD	2332	0.60 (0.54, 0.67)	<0.0001	0.68 (0.59, 0.77)	<0.0001
Age					
≤59 years	659	1.00		1.00	
60-69 years	1427	0.84 (0.69, 1.03)	0.09	0.87 (0.70, 1.07)	0.19
70-79 years	2471	0.70 (0.58, 0.84)	<0.0001	0.78 (0.64, 0.95)	0.01
80-89 years	2430	0.45 (0.37, 0.54)	<0.0001	0.51 (0.41, 0.62)	<0.0001
≥90 years	127	0.32 (0.22, 0.47)	<0.0001	0.37 (0.20, 0.65)	0.001
Sex					
Female	2822	1.00		1.00	
Male	4292	0.99 (0.90, 1.10)	0.88	1.17 (1.04, 1.32)	0.01
Residence					
≥300,000	2498	1.00		1.00	
(10,000- 299,999)	1270	0.94 (0.82, 1.07)	0.33	1.05 (0.88, 1.26)	0.56
<10,000	3346	1.22 (1.10, 1.36)	<0.0001	1.42 (1.24, 1.62)	<0.0001
Comorbid Condition					
0-1	2823	1.00		1.00	
≥2	4291	0.41 (0.37, 0.46)	<0.0001	0.62 (0.55, 0.69)	<0.0001
Location of Death					
Hospital	5226	1.00		1.00	
Outside Hospital	1882	0.55 (0.50, 0.62)	<0.0001	0.32 (0.27, 0.38)	<0.0001

Marital Status					
Married/ Common Law	3668	1.00		1.00	
Never Married	1617	0.63 (0.53, 0.75)	<0.0001	0.85 (0.68, 1.05)	0.13
Separated/ Divorced	1663	0.80 (0.71, 0.90)	<0.0001	0.79 (0.68, 0.92)	0.002
Widowed	1166	0.69 (0.61, 0.79)	<0.0001	0.74 (0.63, 0.89)	0.001
Institutional supportive care services					
No	5285	1.00		1.00	
Yes	1829	0.72 (0.65, 0.80)	<0.0001	0.50 (0.42, 0.58)	<0.0001
Transfers between institutional supportive care facilities					
No	6817	1.00		1.00	
Yes	297	0.83 (0.66, 1.05)	0.13	0.37 (0.25, 0.56)	<0.0001

As shown in Table 4.8, in the last six months of life, most factors were significantly associated with the Total LOS > 7 days in hospitals. Exceptions were age and marital status. Decedents with COPD were less likely to spend more than seven days in hospitals compared to their lung cancer counterparts (OR=0.64, 95%CI= 0.56-0.72). Male decedents had a reduced likelihood of prolonged hospital stay as compared with female decedents. The odds of longer hospital duration for rural residents were 1.32 times greater than that for urban residents. Subjects with multiple comorbid conditions were more likely to stay hospital longer than those with one or zero comorbid condition. Subjects who died out of hospital had a reduced probability by 0.55 times that of those who died in hospital for a longer hospital stay. The probability of having Total LOS >7 increased by 1.31 times among those receiving institutional supportive care services as compared to subjects without it. Subjects with transfers between supportive care institutions were 2.57 times more likely to have a longer stay in hospitals than those without transfers.

In the last month of life, sex, comorbid conditions and institutional supportive care services were not statistically associated with the Total LOS > 7 days in hospitals. Subjects who died of COPD had a reduced likelihood of a longer hospital stay (OR=0.61, 95%CI= 0.52-0.68). In addition, out-of-hospital death and transfers between supportive care institutions also decreased the probability of longer hospital stay. Subjects aged 60-69 and 70-79 years were 1.22 times and 1.13 times more likely to have longer hospital stay as compared to subjects aged 59 years or below. Residing in rural areas also increased the probability by 1.20 times as compared to those in urban areas. Those never married also increase the odds of having prolonged hospital stay by 1.29 times as compared to those married or common law.

Table 4.8 Multivariate Analysis examining associations with Total LOS in Hospital

	Total LOS > 7 days in Hospital in the 6 months prior to death		Total LOS > 7 days in Hospital in the 1 month prior to death	
	Adjusted OR (95%CI)	P-value	Adjusted OR (95%CI)	P-value
Disease status				
Lung Cancer	1.00		1.00	
COPD	0.64 (0.56, 0.72)	<0.0001	0.61 (0.52, 0.68)	<0.0001
Age				
≤59 years	1.00		1.00	
60-69 years	1.15 (0.92, 1.44)	0.23	1.22 (1.00, 1.48)	0.05
70-79 years	1.20 (0.97, 1.49)	0.10	1.31 (1.09, 1.57)	0.005
80-89 years	0.92 (0.74, 1.14)	0.44	1.16 (0.96, 1.41)	0.13
≥90 years	0.74 (0.48, 1.14)	0.17	0.73 (0.48, 1.12)	0.15
Sex				
Female	1.00		1.00	
Male	0.88 (0.78, 0.99)	0.04	0.99 (0.89, 1.10)	0.78
Residence				
≥300,000	1.00		1.00	
(10,000- 299,999)	1.01 (0.86, 1.18)	0.96	0.99 (0.86, 1.15)	0.94
<10,000	1.32 (1.16, 1.49)	<0.0001	1.20 (1.07, 1.34)	0.002
Comorbid Condition				
0-1	1.00		1.00	
≥2	1.23 (1.09, 1.38)	<0.0001	1.04 (0.94, 1.15)	0.44
Location of Death				
Hospital	1.00		1.00	
Outside Hospital	0.55 (0.48, 0.62)	<0.0001	0.23 (0.22, 0.28)	<0.0001

Marital Status				
Married/ Common Law	1.00		1.00	
Never Married	1.18 (0.95, 1.47)	0.13	1.29 (1.07, 1.55)	0.008
Separated/ Divorced	1.03 (0.89, 1.20)	0.67	1.11 (0.98, 1.26)	0.12
Widowed	0.90 (0.77, 1.06)	0.21	1.07 (0.92, 1.24)	0.39
Institutional supportive care services				
No	1.00		1.00	
Yes	1.31 (1.12, 1.52)	0.001	1.04 (0.91, 1.19)	0.57
Transfers between institutional supportive care facilities				
No	1.00		1.00	
Yes	2.57 (1.83, 3.62)	<0.0001	0.49 (0.37, 0.66)	<0.0001

Adjusted for all the variables in the table.

As shown in Table 4.9, in the six months prior to death, all factors were significantly associated with the Average LOS per visit > 7 days in hospitals. Subjects who died of COPD (OR=0.78, 95%CI= 0.70-0.87), being male, and died out of hospital had a reduced probability of a longer hospital stay. The odds of prolonged stay increased by 1.22 times and 1.40 times among subjects aged 60-69 and 70-79 respectively as compared to those aged 59 years and below. In addition, residing in rural areas, having multiple comorbid illnesses, having institutional supportive care services and having transfers were also associated with an increased risk of prolonged hospitalization.

In the last month of life, the risk of having an average LOS per visit > 7 days in hospital was found to be reduced among those who died of COPD (OR= 0.67, 95%CI= 0.60-0.75). Other factors that reduced the likelihood of prolonged hospital stay per visit included out-of-hospital death and having transfers between supportive care institutions. However, subjects who were at an age of 70-79 years, residing in rural areas, with two or more comorbid conditions, having institutional supportive care services were at an increased risk of longer hospital stay. The odds increased by 1.36 times and 1.20 times among those never married and separated / divorced respectively as compared to those married or in common law. Sex was observed to have no significant association with the Average LOS per visit > 7 days.

Table 4.9 Multivariate Analysis examining associations with Average LOS per Hospitalization

	Average LOS per visit >7 days in the 6 months prior to death		Average LOS per visit >7 days in the 1 month prior to death	
	Adjusted OR (95%CI)	P-value	Adjusted OR (95%CI)	P-value
Disease status				
Lung Cancer	1.00		1.00	
COPD	0.78 (0.70, 0.87)	<0.0001	0.67 (0.60, 0.75)	<0.0001
Age				
≤59 years	1.00		1.00	
60-69 years	1.22 (1.01, 1.48)	0.04	1.14 (0.94, 1.38)	0.18
70-79 years	1.40 (1.17, 1.67)	<0.0001	1.33 (1.11, 1.60)	0.002
80-89 years	1.17 (0.97, 1.42)	0.10	1.20 (0.99, 1.45)	0.07
≥90 years	0.96 (0.64, 1.43)	0.83	0.79 (0.52, 1.22)	0.29
Sex				
Female	1.00		1.00	
Male	0.86 (0.77, 0.95)	0.003	1.01 (0.91, 1.12)	0.83
Residence				
≥300,000	1.00		1.00	
(10,000- 299,999)	1.15 (1.00, 1.32)	0.06	1.13 (0.98, 1.30)	0.09
<10,000	1.17 (1.05, 1.31)	0.004	1.16 (1.04, 1.30)	0.007
Comorbid Condition				
0-1	1.00		1.00	
≥2	1.81 (1.64, 2.00)	<0.0001	1.23 (1.11, 1.36)	<0.0001
Location of Death				
Hospital	1.00		1.00	
Outside Hospital	0.62 (0.55, 0.70)	<0.0001	0.30 (0.26, 0.34)	<0.0001

Marital Status				
Married/ Common Law	1.00		1.00	
Never Married	1.34 (1.12, 1.61)	0.001	1.36 (1.13, 1.63)	0.001
Separated/ Divorced	1.11 (0.97, 1.25)	0.12	1.20 (1.06, 1.36)	0.005
Widowed	1.02 (0.89, 1.18)	0.75	1.14 (0.98, 1.32)	0.09
Institutional supportive care services				
No	1.00		1.00	
Yes	1.52 (1.33, 1.73)	<0.0001	1.10 (1.06, 1.26)	<0.0001
Transfers between institutional supportive care facilities				
No	1.00		1.00	
Yes	2.55 (1.91, 3.40)	<0.0001	0.47 (0.35, 0.63)	<0.0001

Adjusted for all the variables in the table.

As seen in Table 4.10, in the last six months of life, COPD as UCOD reduced the risk for having ≥ 2 hospitalizations (OR= 0.71, 95%CI= 0.64-0.80). Other protective factors were aging, multiple comorbid conditions, outside-hospital death and never married and widowed. The risk however increased among rural residents and with transfers between supportive care institutions by 1.16 times and 1.41 times respectively.

In the last month of life, decedents with COPD had reduced likelihood of having ≥ 2 hospitalizations (OR= 0.81, 95%CI= 0.70- 0.93). The risk also decreased with aging, multiple comorbid conditions, out-of-hospital death, and having institutional supportive care services. Being male and living in rural areas were risk factors of frequent hospital admissions.

Table 4.10 Multivariate Analysis examining associations with Number of Hospitalizations

	≥ 2 hospitalizations in the 6 months prior to death		≥ 2 hospitalizations in the 1 month prior to death	
	Adjusted OR (95%CI)	P-value	Adjusted OR (95%CI)	P-value
Disease status				
Lung Cancer	1.00		1.00	
COPD	0.71 (0.64, 0.80)	<0.0001	0.81 (0.70, 0.93)	0.003
Age				
≤59 years	1.00		1.00	
60-69 years	0.83 (0.67, 1.02)	0.08	0.86 (0.69, 1.08)	0.20
70-79 years	0.75 (0.62, 0.91)	0.004	0.83 (0.67, 1.02)	0.08
80-89 years	0.53 (0.43, 0.64)	<0.0001	0.62 (0.49, 0.78)	<0.0001
≥90 years	0.44 (0.29, 0.66)	<0.0001	0.52 (0.28, 0.95)	0.03
Sex				
Female	1.00		1.00	
Male	0.99 (0.90, 1.11)	0.98	1.18 (1.04, 1.34)	0.01
Residence				
≥300,000	1.00		1.00	
(10,000- 299,999)	0.93 (0.81, 1.07)	0.33	1.04 (0.87, 1.25)	0.66
<10,000	1.16 (1.04, 1.30)	0.01	1.41 (1.23, 1.62)	<0.0001
Comorbid Condition				
0-1	1.00		1.00	
≥2	0.41 (0.37, 0.46)	<0.0001	0.65 (0.57, 0.73)	<0.0001
Location of Death				
Hospital	1.00		1.00	
Outside Hospital	0.53 (0.47, 0.60)	<0.0001	0.36 (0.30, 0.43)	<0.0001

Marital Status				
Married/ Common Law	1.00		1.00	
Never Married	0.63 (0.53, 0.76)	<0.0001	0.88 (0.70, 1.10)	0.27
Separated/ Divorced	0.91 (0.80, 1.03)	0.14	0.97 (0.82, 1.13)	0.66
Widowed	0.86 (0.74, 1.00)	0.04	0.99 (0.82, 1.19)	0.90
Institutional supportive care services				
No	1.00		1.00	
Yes	1.10 (0.97, 1.26)	0.15	0.81 (0.68, 0.97)	0.02
Transfers between institutional supportive care facilities				
No	1.00		1.00	
Yes	1.41 (1.01, 1.81)	0.008	0.82 (0.53, 1.26)	0.36

Adjusted for all the variables in the table.

Disease status and sex, disease status and age, and disease status and comorbid condition were also tested for interaction in each model (Table 4.11, 4.12, 4.13). The overall Likelihood ratio test was used to confirm the inclusion of the interaction term in the model.

In the last six months of life, sex was an effect modifier in the association between disease status and total LOS in hospitals (P=0.045 with log-likelihood difference= 4.023 for 1 d.f.). The interaction between sex and disease status contributed significantly to the prediction of the probability of having total LOS greater than 7 days in hospitals in the last month of life (P=0.025 with log-likelihood difference= 5.032 for 1 d.f.). Stratified analysis showed that while those with COPD were less likely to have a long hospital stay than those with lung cancer, the protective effect was weaker among males than females.

In the six months prior to death, sex was an effect modifier in the association between disease status and average LOS per visit > 7 days in hospitals (P=0.001 with log-likelihood difference= 10.098 for 1 d.f.). However, in the last month of life, sex did not modify the relationship between disease status and average LOS in hospitals (P=0.072 with log-likelihood difference=3.246 for 1 d.f.). Stratified analysis showed that while decedents with COPD were less likely to have a longer hospital than decedents with lung cancer, the protective effect was weaker among males than females.

Age was an effect modifier in the relationship between disease status and number of hospitalizations in the six months prior to death (P=0.031 with log-likelihood difference=10.614 for 1 d.f.). The interaction between age and disease status contributed significantly to the prediction of the probability of having two or more hospital attendance in the last month of life (P=0.003 with log-likelihood difference=14.482 for 1 d.f.). Stratified analysis indicated that while those with COPD were less likely to have frequent hospital admissions than those with lung cancer, the protective effect was stronger among those aged 70-79 years than the others.

Table 4.11 Association between disease status and each outcome stratified by sex, comorbid condition or age with total LOS in hospital

	Total LOS >7 days in Hospital in the 6 months prior to death Adjusted OR (95% CI)	Total LOS >7 days in Hospital in the 1 month prior to death Adjusted OR (95% CI)
Sex		
Male		
Lung cancer	1.00	1.00
COPD	0.67 (0.57, 0.79) *	0.64 (0.55, 0.74) *
Female		
Lung cancer	1.00	1.00
COPD	0.57 (0.46, 0.70)	0.54 (0.45, 0.65)
Comorbid Condition		
0-1 condition		
Lung cancer	1.00	1.00
COPD	0.67 (0.55, 0.82)	0.61 (0.51, 0.73)
≥2 conditions		
Lung cancer	1.00	1.00
COPD	0.60 (0.51, 0.71)	0.60 (0.52, 0.69)
Age		
≤59 years		
Lung cancer	1.00	1.00
COPD	0.66 (0.34, 1.29)	0.65 (0.35, 1.19)
60-69 years		
Lung cancer	1.00	1.00
COPD	0.66 (0.47, 0.92)	0.53 (0.39, 0.72)
70-79 years		

Lung cancer	1.00	1.00
COPD	0.58 (0.47, 0.71)	0.56 (0.47, 0.68)
80-89 years		
Lung cancer	1.00	1.00
COPD	0.69 (0.57, 0.83)	0.68 (0.58, 0.81)
≥90 years		
Lung cancer	1.00	1.00
COPD	0.65 (0.26, 1.59)	0.53 (0.22, 1.28)

*P<0.05 based on Wald test for interaction

+P<0.10 based on Wald test for interaction

Adjusted for residence, marital status, location of death, institutional supportive care services and transfers between institutional supportive care facilities.

Overall Likelihood Ratio test with Total LOS in Hospital 6 months prior to death adding interaction term disease status*sex: P=0.045 (difference= 4.023 with df=1)

Overall Likelihood Ratio test with Total LOS in Hospital 1 month prior to death deaths adding interaction term disease status*sex: P=0.025 (difference= 5.032 with df=1)

Overall Likelihood Ratio test with Total LOS in Hospital 6 months prior to death adding interaction term disease status*age: P=0.562 (difference= 0.336 with df=1)

Overall Likelihood Ratio test with Total LOS in Hospital 1 month prior to death adding interaction term disease status*age: P=0.93 (difference= 0.080 with df=1)

Overall Likelihood Ratio test with Total LOS in Hospital 6 months prior to death adding interaction term disease status*comorbidity: P=0.733 (difference= 2.016 with df=4)

Overall Likelihood Ratio test with Total LOS in Hospital 1 month prior to death adding interaction term disease status*comorbidity: P=0.596 (difference= 2.776 with df=4)

Table 4.12 Association between disease status and each outcome stratified by sex, comorbid condition or age with average LOS per hospitalization

	Average LOS >7 days in Hospital in the 6 months prior to death	Average LOS >7 days in Hospital in the 1 month prior to death
	Adjusted OR (95% CI)	Adjusted OR (95% CI)
Sex		
Male		
Lung cancer	1.00	1.00
COPD	0.88 (0.77, 1.02) [*]	0.70 (0.61, 0.81) [+]
Female		
Lung cancer	1.00	1.00
COPD	0.63 (0.53, 0.75)	0.61 (0.51, 0.73)
Comorbid Condition		
0-1condition		
Lung cancer	1.00	1.00
COPD	0.78 (0.66, 0.93)	0.69 (0.58, 0.82)
≥2 conditions		
Lung cancer	1.00	1.00
COPD	0.77 (0.67, 0.89)	0.65 (0.57, 0.75)
Age		
≤59 years		
Lung cancer	1.00	1.00
COPD	0.68 (0.37, 1.24)	0.61 (0.33, 1.13)
60-69 years		
Lung cancer	1.00	1.00
COPD	0.80 (0.60, 1.08)	0.58 (0.43, 0.78)
70-79 years		

Lung cancer	1.00	1.00
COPD	0.82 (0.68, 0.98)	0.69 (0.57, 0.82)
80-89 years		
Lung cancer	1.00	1.00
COPD	0.78 (0.66, 0.92)	0.71 (0.60, 0.84)
≥90 years		
Lung cancer	1.00	1.00
COPD	0.62 (0.26, 1.47)	0.57 (0.24, 1.38)

[*]P<0.05 based on Wald test for interaction

[+]P<0.10 based on Wald test for interaction

Adjusted for residence, marital status, location of death, institutional supportive care services and transfers between institutional supportive care facilities.

Overall Likelihood Ratio test with Average LOS per Hospitalization 6 months prior to death adding interaction term disease status*sex: P=0.001 (difference= 10.098 with df=1)

Overall Likelihood Ratio test with Average LOS per Hospitalization 1 month prior to death adding interaction term disease status*sex: P=0.072 (difference= 3.246 with df=1)

Overall Likelihood Ratio test with Average LOS per Hospitalization 6 months prior to death adding interaction term disease status*comorbid condition: P=0.968 (difference= 0.002 with df=1)

Overall Likelihood Ratio test with Average LOS per Hospitalization 1 month prior to death adding interaction term disease status*comorbid condition: P=0.946 (difference= 0.005 with df=1)

Overall Likelihood Ratio test with Average LOS per Hospitalization 6 months prior to death adding interaction term disease status*age: P=0.860 (difference= 1.309 with df=4)

Overall Likelihood Ratio test with Average LOS per Hospitalization 1 month prior to death adding interaction term disease status*age: P=0.758 (difference= 1.882 with df=4)

Table 4.13 Association between disease status and each outcome stratified by sex, comorbid condition or age with Number of Hospitalizations

	>2 Hospitalizations in the 6 months prior to death Adjusted OR (95% CI)	>2 Hospitalizations in the 1 month prior to death Adjusted OR (95% CI)
Sex		
Male		
Lung cancer	1.00	1.00
COPD	0.71 (0.62, 0.82)	0.75 (0.63, 0.90)
Female		
Lung cancer	1.00	1.00
COPD	0.71 (0.59, 0.85)	0.92 (0.72, 1.16)
Comorbid Condition		
0-1condition		
Lung cancer	1.00	1.00
COPD	0.64 (0.53, 0.78)	0.92 (0.74, 1.13)
≥2 conditions		
Lung cancer	1.00	1.00
COPD	0.75 (0.66, 0.86)	0.72 (0.59, 0.87)
Age		
≤59 years		
Lung cancer	1.00	1.00
COPD	0.74 (0.39, 1.42)	1.69 (0.88, 3.25)
60-69 years		
Lung cancer	1.00	1.00
COPD	0.83 (0.61, 1.12)	1.03 (0.73, 1.45)
70-79 years		

Lung cancer	1.00	1.00
COPD	0.57 (0.48, 0.69) *	0.59 (0.47, 0.74) *
80-89 years		
Lung cancer	1.00	1.00
COPD	0.81 (0.68, 0.96) *	0.91 (0.72, 1.15) +
≥90 years		
Lung cancer	1.00	1.00
COPD	0.85 (0.38, 1.92)	1.36 (0.34, 5.43)

*P<0.05 based on Wald test for interaction

+P<0.10 based on Wald test for interaction

Adjusted for residence, marital status, location of death, institutional supportive care services and transfers between institutional supportive care facilities.

Overall Likelihood Ratio test with Number of Hospitalizations 6 months prior to death adding interaction term disease status*sex: P=0.701 (difference= 0.147 with df=1)

Overall Likelihood Ratio test with Number of Hospitalizations 1 month prior to death adding interaction term disease status*sex: P=0.274 (difference= 1.196 with df=1)

Overall Likelihood Ratio test with Number of Hospitalizations 6 months prior to death adding interaction term disease status*comorbid condition: P=0.204 (difference= 1.613 with df=1)

Overall Likelihood Ratio test with Number of Hospitalizations 1 month prior to death adding interaction term disease status*comorbid condition: P=0.153 (difference= 2.039 with df=1)

Overall Likelihood Ratio test with Number of Hospitalizations 6 months prior to death adding interaction term disease status*age: P=0.031 (difference= 10.614 with df=4)

Overall Likelihood Ratio test with Number of Hospitalizations 1 month prior to death adding interaction term disease status*age: P=0.003 (difference= 14.482 with df=4)

4.3 Research Question 3

Does the pattern of hospitalization change over a 10 year period and are the associations between hospitalization and diagnostic group, age, sex, and comorbidity consistent over the 10 year period?

Table 4.14 describes the annual proportion of decedents in each disease group with greater hospital usage (Total LOS > 7days, Average LOS > 7days per hospitalization, ⩾2 hospitalizations). In the last month of life, fewer decedents had larger consumption of hospital services (Total LOS > 7days) in 2002 (OR=0.71) and in 2005 (OR=0.71). In the last six months of life, there was no significant change over the study period witnessed in the proportion of decedents with greater hospital service use.

Over the ten-year study period, there was no significant change in the proportion of subjects with greater hospital use (Average LOS per hospitalization > 7 days) in either one month or six months prior to death.

Regarding the frequency of hospital admissions, fewer subjects had more than two hospitalizations in 2001 (OR=0.54) in the last month of life. In the last six months of life, the proportion of decedents with more than 2 admissions in 2002, 2003 and 2005 were approximately 70% of that in 1997 (OR_{2002}= 0.71, OR_{2003}= 0.72, OR_{2005}= 0.70).

Table 4.14 Proportion with Hospitalization category by disease group and length of time prior to death between 1997 and 2006

	1 month			6 months		
	Lung Cancer N(%)	COPD N(%)	OR (95% CI)	Lung Cancer N(%)	COPD N(%)	OR (95% CI)
Total LOS >7 days						
1997	256 (9.1)	100 (10.9)	1.00	340 (9.0)	170 (10.2)	1.00
1998	288 (10.3)	118 (10.9)	0.89 (0.66, 1.21)	373 (9.8)	169 (10.2)	0.91 (0.70, 1.17)
1999	325 (11.6)	121 (11.2)	0.81 (0.60, 1.09)	437 (11.5)	188 (11.3)	0.86 (0.67, 1.11)
2000	271 (9.6)	110 (10.2)	0.88 (0.65, 1.20)	366 (9.6)	168 (10.1)	0.92 (0.71, 1.19)
2001	282 (10.0)	111 (10.3)	0.85 (0.63, 1.16)	378 (10.0)	166 (10.0)	0.88 (0.68, 1.14)
2002	286 (10.2)	94 (8.7)	0.71 (0.52, 0.98)[†]	385 (10.1)	148 (8.9)	0.77 (0.59, 1.00)[*]
2003	284 (10.1)	104 (9.6)	0.79 (0.58, 1.09)	390 (10.3)	161 (9.7)	0.83 (0.64, 1.07)
2004	269 (9.6)	111 (10.3)	0.90 (0.66, 1.22)	362 (9.5)	162 (9.8)	0.90 (0.69, 1.16)
2005	280 (10.0)	92 (8.5)	0.71 (0.52, 0.98)[†]	387 (10.3)	153 (9.2)	0.79 (0.61, 1.03)[*]
2006	268 (9.5)	101 (9.4)	0.82 (0.60, 1.12)	380 (10.0)	176 (10.6)	0.93 (0.72, 1.20)

Average LOS per hospitalization > 7 days						
1997	229 (9.6)	103 (10.9)	1.00	263 (9.3)	129 (9.8)	1.00
1998	244 (10.3)	110 (11.6)	1.00(0.73, 1.39)	289 (10.2)	147 (11.2)	1.04 (0.78, 1.39)
1999	169 (11.3)	103 (10.9)	0.85 (0.62, 1.18)	319 (11.3)	151 (11.5)	0.97 (0.73, 1.29)
2000	226 (9.5)	94 (10.0)	0.93 (0.66, 1.29)	272 (9.6)	127 (9.7)	0.95 (0.71, 1.28)
2001	237 (10.0)	93 (9.8)	0.87 (0.63, 1.22)	271 (9.6)	138 (10.5)	1.04 (0.77, 1.39)
2002	249 (10.5)	82 (8.7)	0.73 (0.52, 1.03) *	292 (10.3)	113 (8.6)	0.79 (0.58, 1.07)
2003	230 (9.7)	87 (9.2)	0.84 (0.60, 1.18)	294 (10.4)	127 (9.7)	0.88 (0.66, 1.18)
2004	242 (10.2)	97 (10.3)	0.89 (0.64, 1.24)	267 (9.4)	130 (10.0)	0.99 (0.74, 1.34)
2005	232 (9.8)	87 (9.2)	0.83 (0.59, 1.17)	292 (10.3)	109 (8.3)	0.76 (0.56, 1.03)*
2006	220 (9.3)	89 (9.4)	0.90 (0.64, 1.26)	272 (9.6)	139 (10.6)	1.04 (0.78, 1.40)
>2 Hospitalizations						
1997	244 (7.9)	124 (10.1)	1.00	87 (8.6)	41 (11.4)	1.00
1998	305 (9.8)	118 (9.6)	0.78 (0.46, 1.34)	95 (9.4)	35 (9.7)	0.76 (0.56, 1.03)*
1999	369 (11.9)	142 (11.6)	0.59 (0.35, 1.01)*	119 (11.7)	33 (9.2)	0.76 (0.57, 1.01)*

2000	318 (10.3)	127 (10.4)	0.75 (0.45, 1.27)	107 (10.5)	38 (10.6)	0.79 (0.58, 1.06)
2001	314 (10.1)	118 (9.6)	0.54 (0.31, 0.94)†	110 (10.8)	28 (7.8)	0.74 (0.55, 1.00)*
2002	318 (10.3)	115 (9.4)	0.76 (0.44, 1.30)	95 (9.4)	34 (9.4)	0.71 (0.53, 0.96)†
2003	309 (10.0)	113 (9.2)	0.65 (0.38, 1.11)	108 (10.6)	33 (9.2)	0.72 (0.53, 0.98)†
2004	297 (9.6)	120 (9.8)	1.04 (0.63, 1.72)	104 (10.2)	51 (14.2)	0.80 (0.59, 1.08)
2005	321 (10.4)	114 (9.3)	0.73 (0.43, 1.25)	99 (9.7)	34 (9.4)	0.70 (0.52, 0.95)†
2006	305 (9.8)	135 (11.0)	0.76 (0.44, 1.31)	92 (9.1)	33 (9.2)	0.87 (0.65, 1.17)

* P<0.10

† P<0.05

‡ P<0.01

Calendar year was included in the logistic regression model as a main effect variable to investigate the trends of hospital service utilization (Total LOS in hospitals, Average LOS per hospitalization and number of hospitalizations) over the 10-year study period. In addition, calendar year was also included as a continuous variable in the model to examine the linear trends.

As shown in Table 4.15, there was no statistically significant relationship observed between calendar year and the total LOS > 7 days in hospitals, which was also consistent with the results obtained from multivariate regression models regarding calendar year as a continuous variable [P=0.16 with OR (95%CI) = 0.99 (0.97, 1.01) in the 6 months prior to death and P=0.25 with OR (95%CI) = 0.99 (0.97, 1.01) in the last month of life].

Table 4.15 Multivariate Analysis examining associations with total LOS in hospital

	Total LOS >7 days in Hospital in the 6 months prior to death		Total LOS >7 days in Hospital in the 1 month prior to death	
	Adjusted OR (95%CI)	P-value	Adjusted OR (95%CI)	P-value
Disease status				
Lung Cancer	1.00		1.00	
COPD	0.63 (0.56, 0.72)	<0.0001	0.61 (0.54, 0.68)	<0.0001
Calendar year				
1997	1.00		1.00	
1998	0.89 (0.68, 1.15)	0.39	0.95 (0.76, 1.19)	0.64
1999	0.99 (0.77, 1.29)	0.99	0.98 (0.79, 1.22)	0.86
2000	0.91 (0.70, 1.18)	0.47	0.92 (0.73, 1.15)	0.45
2001	0.81 (0.65, 1.09)	0.18	0.96 (0.76, 1.20)	0.71
2002	0.92 (0.71, 1.19)	0.52	0.99 (0.78, 1.24)	0.90
2003	0.82 (0.64, 1.06)	0.14	0.92 (0.73, 1.15)	0.47
2004	0.89 (0.68, 1.15)	0.37	1.07 (0.85, 1.35)	0.55
2005	0.87 (0.67, 1.13)	0.30	0.94 (0.75, 1.18)	0.58
2006	0.86 (0.66, 1.11)	0.24	0.80 (0.64, 1.00)	0.06
Age				
≤59 years	1.00		1.00	
60-69 years	1.15 (0.92, 1.44)	0.23	1.22 (1.01, 1.49)	0.04
70-79 years	1.20 (0.97, 1.49)	0.10	1.31 (1.09, 1.57)	0.005
80-89 years	0.92 (0.74, 1.15)	0.45	1.17 (0.96, 1.41)	0.12

≥90 years	0.76 (0.49, 1.18)	0.22	0.75 (0.49, 1.15)	0.19
Sex				
Female	1.00		1.00	
Male	0.88 (0.78, 0.99)	0.03	0.98 (0.88, 1.09)	0.74
Residence				
≥300,000	1.00		1.00	
(10,000- 299,999)	0.99 (0.86, 1.17)	0.98	0.99 (0.86, 1.15)	0.94
<10,000	1.31 (1.16, 1.49)	<0.0001	1.20 (1.07, 1.34)	0.002
Comorbid Condition				
0-1	1.00		1.00	
≥2	1.23 (1.10, 1.38)	<0.0001	1.04 (0.94, 1.16)	0.41
Location of Death				
Hospital	1.00		1.00	
Outside Hospital	0.55 (0.48, 0.62)	<0.0001	0.25 (0.22, 0.28)	<0.0001
Marital Status				
Married/ Common Law	1.00		1.00	
Never Married	1.18 (0.95, 1.46)	0.14	1.29 (1.07, 1.55)	0.008
Separated/ Divorced	1.03 (0.89, 1.19)	0.69	1.11 (0.97, 1.26)	0.12
Widowed	0.91 (0.77, 1.07)	0.25	1.08 (0.93, 1.25)	0.34
Institutional Services				
No	1.00		1.00	
Yes	1.31 (1.13, 1.53)	0.001	1.04 (0.91, 1.19)	0.57

Transfer within Institution				
No	1.00		1.00	
Yes	2.60 (1.85, 3.67)	<0.0001	0.50 (0.38, 0.66)	<0.0001

Adjusted for all the variables in the table.

Table 4.16 provides the multivariate analysis investigating associations with calendar year and the Average LOS per hospitalization. In the six months prior to death, reductions in the hospital usage were observed in 2003 (OR= 0.79, 95%CI= 0.64-0.99), 2005 (OR= 0.79, 95%CI= 0.64-0.99), 2006 (OR=0.76, 95%CI=0.61-0.95) as compared to that in 1997. The regression model examining the linear effect of calendar year also showed a reduced OR (OR= 0.97, 95%CI= 0.96-0.99) with P-value equals 0.001. In the last month of life, fewer decedents had longer hospital stay per visit in 2003 (OR=0.77, 95%CI=0.68-0.96) and in 2006 (OR=0.73, 95%CI= 0.58-0.91) when compared with that in 1997. However, the multivariate analysis regarding calendar year as a continuous variable presents a non-significant result [OR (95%CI) = 0.99 (0.97, 1.00) with P=0.11].

Table 4.16 Multivariate Analysis examining associations with average LOS per hospitalization

	Average LOS >7 days in Hospital in the 6 months prior to death		Average LOS >7 days in Hospital in the 1 month prior to death	
	Adjusted OR (95%CI)	P-value	Adjusted OR (95%CI)	P-value
Disease status				
Lung Cancer	1.00		1.00	
COPD	0.78 (0.70, 0.87)	<0.0001	0.67 (0.60, 0.75)	<0.0001
Calendar year				
1997	1.00		1.00	
1998	1.03 (0.82, 1.29)	0.80	0.92 (0.74, 1.15)	0.45
1999	0.90 (0.73, 1.12)	0.35	0.86 (0.69, 1.07)	0.17
2000	0.84 (0.67, 1.05)	0.12	0.82 (0.66, 1.02)	0.08
2001	0.82 (0.65, 1.02)	0.07	0.86 (0.67, 1.07)	0.17
2002	0.87 (0.69, 1.09)	0.22	0.94 (0.75, 1.18)	0.59
2003	0.79 (0.64, 0.99)	0.04	0.77 (0.68, 0.96)	0.02
2004	0.84 (0.67, 1.05)	0.13	1.06 (0.84, 1.33)	0.63
2005	0.79 (0.64, 0.99)	0.04	0.87 (0.69, 1.09)	0.22
2006	0.76 (0.61, 0.95)	0.02	0.73 (0.58, 0.91)	0.006
Age				
≤59 years	1.00		1.00	
60-69 years	1.22 (1.01, 1.47)	0.04	1.15 (0.95, 1.39)	0.16
70-79 years	1.39 (1.16, 1.66)	<0.0001	1.34 (1.11, 1.60)	0.002

80-89 years	1.17 (0.97, 1.41)	0.11	1.21 (1.00, 1.46)	0.05
≥90 years	1.02 (0.68, 1.54)	0.92	0.79 (0.51, 1.22)	0.30
Sex				
Female	1.00		1.00	
Male	0.85 (0.77, 0.94)	0.002	1.01 (0.91, 1.12)	0.91
Residence				
≥300,000	1.00		1.00	
(10,000- 299,999)	1.14 (0.99, 1.32)	0.06	1.13 (0.98, 1.30)	0.10
<10,000	1.17 (1.05, 1.30)	0.005	1.17 (1.04, 1.30)	0.007
Comorbid Condition				
0-1	1.00		1.00	
≥2	1.83 (1.66, 2.02)	<0.0001	1.23 (1.12, 1.37)	<0.0001
Location of Death				
Hospital	1.00		1.00	
Outside Hospital	0.63 (0.56, 0.71)	<0.0001	0.30 (0.26, 0.33)	<0.0001
Marital Status				
Married/ Common Law	1.00		1.00	
Never Married	1.33 (1.11, 1.59)	0.002	1.36 (1.13. 1.63)	0.001
Separated/ Divorced	1.10 (0.97, 1.25)	0.15	1.20 (1.06, 1.36)	0.005
Widowed	1.04 (0.90, 1.20)	0.64	1.15 (0.99, 1.33)	0.07
Institutional supportive care services				
No	1.00		1.00	

Yes	1.52 (1.33, 1.74)	<0.0001	1.11 (0.98, 1.26)	0.14
Transfers between institutional supportive care facilities				
No	1.00		1.00	
Yes	2.60 (1.95, 3.47)	<0.0001	0.48 (0.36, 0.64)	<0.0001

Adjusted for all the variables in the table.

Table 4.17 presents the result of the multivariate analysis investigating associations with calendar year and number of hospitalizations. In the six months prior to death, increased likelihood of frequent hospital admissions were observed in 1999 (OR=1.50, 95%CI=1.20-1.87), 2000 (OR=1.51, 95%CI=1.20-1.90), 2002 (OR=1.47, 95%CI= 1.16-1.83), 2004 (OR=1.37, 95%CI=1.09-1.72), 2005 (OR=1.41, 95%CI=1.12-1.77) and 2006 (OR=1.34, 95%CI=1.07-1.67) as compared with that in 1997. The multivariate analysis regarding calendar year as a continuous variable presents a non-significant result [OR (95%CI) = 1.02 (1.00, 1.04) with P=0.06]. In the last month of life, increased likelihood of frequent hospital admissions was observed in 2004 (OR=1.41, 95%CI= 1.07-1.85). Again, the multivariate analysis regarding calendar year as a continuous variable presents a non-significant result [OR (95%CI) =1.02 (0.99, 1.04) with P=0.16].

Table 4.17 Multivariate Analysis examining associations with Number of Hospitalizations

	≥ 2 hospitalizations in the 6 months prior to death		≥ 2 hospitalizations in the 1 month prior to death	
	Adjusted OR (95%CI)	P-value	Adjusted OR (95%CI)	P-value
Disease status				
Lung Cancer	1.00		1.00	
COPD	0.72 (0.64, 0.80)	<0.0001	0.81 (0.70, 0.93)	0.003
Calendar year				
1997	1.00		1.00	
1998	1.16 (0.92, 1.45)	0.21	0.89 (0.68, 1.18)	0.43
1999	1.50 (1.20, 1.87)	<0.0001	0.99 (0.77, 1.31)	0.99
2000	1.51 (1.20, 1.90)	<0.0001	1.15 (0.87, 1.50)	0.33
2001	1.23 (0.98, 1.54)	0.08	1.04 (0.79, 1.37)	0.80
2002	1.47 (1.16, 1.83)	0.001	1.04 (0.78, 1.37)	0.80
2003	1.23 (0.98, 1.54)	0.07	1.13 (0.86, 1.49)	0.37
2004	1.37 (1.09, 1.72)	0.008	1.41 (1.07, 1.85)	0.01
2005	1.41 (1.12, 1.77)	0.003	1.10 (0.83, 1.45)	0.52
2006	1.34 (1.07, 1.67)	0.01	0.94 (0.71, 1.24)	0.64
Age				
≤59 years	1.00		1.00	
60-69 years	0.84 (0.68, 1.03)	0.10	0.87 (0.70, 1.09)	0.23
70-79 years	0.75 (0.62, 0.92)	0.005	0.83 (0.68, 1.03)	0.09
80-89 years	0.53 (0.43, 0.65)	<0.0001	0.62 (0.50, 0.78)	<0.0001

≥90 years	0.42 (0.28, 0.64)	<0.0001	0.49 (0.27, 0.90)	0.02
Sex				
Female	1.00		1.00	
Male	1.01 (0.90, 1.12)	0.92	1.19 (1.04, 1.35)	0.01
Residence				
≥300,000	1.00		1.00	
(10,000- 299,999)	0.93 (0.81, 1.08)	0.35	1.05 (0.87, 1.26)	0.61
<10,000	1.16 (1.04, 1.30)	0.009	1.42 (1.24, 1.64)	<0.0001
Comorbid Condition				
0-1	1.00		1.00	
≥2	0.41 (0.37, 0.45)	<0.0001	0.64 (0.57, 0.72)	<0.0001
Location of Death				
Hospital	1.00		1.00	
Outside Hospital	0.53 (0.46, 0.59)	<0.0001	0.36 (0.30, 0.43)	<0.0001
Marital Status				
Married/ Common Law	1.00		1.00	
Never Married	0.64 (0.53, 0.76)	<0.0001	0.89 (0.71, 1.11)	0.31
Separated/ Divorced	0.91 (0.80, 1.04)	0.16	0.97 (0.83, 1.13)	0.68
Widowed	0.86 (0.74, 0.99)	0.04	0.98 (0.82, 1.19)	0.86
Institutional supportive care services				
No	1.00		1.00	
Yes	1.10 (0.96, 1.26)	0.16	0.81 (0.68, 0.97)	0.02

Transfers between institutional supportive care facilities				
No	1.00		1.00	
Yes	1.39 (1.08, 1.78)	0.01	0.81 (0.53, 1.26)	0.35

Adjusted for all the variables in the table.

Table 4.18, 4.19 and 4.20 present the results of the analysis stratified by disease status to investigate whether it is an effect modifier in the relationship between calendar year and the dependent variables (total LOS greater than 7 days, average LOS per visit greater than 7 days, and more than 2 hospitalizations).

The overall Likelihood Ratio test was used to confirm the inclusion of the interaction in the regression model. As shown in Table 4.18, disease status is not an effect modifier in the association between calendar year and Total LOS greater than 7 days in hospitals in the six months prior to death (P = 0.57 with log-likelihood difference=7.607 for 8 d.f.). Disease status does not significantly influence the relationship between calendar year and Total LOS greater than 7 days in hospitals in the last month of life (P=0.69 with log-likelihood difference= 6.477 for 9 d.f.).

As shown in Table 4.19, disease status is not an effect modifier in the association between calendar year and Average LOS per visit greater 7 days in the six months prior to death (P =0.09 with log-likelihood difference= 15.075 for 9 d.f.). Disease status does not significantly affect the relationship between calendar year and Average LOS per visit greater 7 days in the last one month of life (P=0.71 with log-likelihood difference= 6.302 for 9 d.f.).

As shown in Table 4.20, disease status modify the association between calendar year and number of hospitalizations in the six months prior to death (P=0.45 with log-likelihood difference= 8.865 for 9 d.f.). Disease status is not an effect modifier in the relationship between calendar year and number of hospitalizations in the last month of life (P =0.37 with log-likelihood difference= 9.805 for 9 d.f.).

Table 4.18 Association between disease status and total LOS in hospital stratified by disease status

	Total LOS >7 days in Hospital in the 6 months prior to death Adjusted OR (95%CI)		Total LOS >7 days in Hospital in the 1 month prior to death Adjusted OR (95%CI)	
Calendar Year	COPD	Lung Cancer	COPD	Lung Cancer
1998	0.98 (0.64, 1.50)	0.82 (0.59, 1.14)	1.02 (0.70, 1.50)	0.89 (0.67, 1.18)
1999	1.08 (0.71, 1.65)	0.95 (0.69, 1.32)	0.94 (0.65, 1.37)	0.99 (0.75, 1.30)
2000	0.81 (0.53, 1.23)	0.98 (0.70, 1.37)	0.80 (0.655, 1.17)	1.98 (0.73, 1.31)
2001	0.70 (0.47, 1.05)	0.93 (0.66, 1.29)	0.81 (0.56, 1.18)	1.04 (0.78, 1.38)
2002	0.82 (0.53, 1.23)	0.97 (0.70, 1.35)	0.89 (0.60, 1.32)	1.04 (0.78, 1.38)
2003	0.66 (0.44, 1.00)	0.93 (0.67, 1.29)	0.80 (0.55, 1.17)	0.98 (0.74, 1.30)
2004	0.78 (0.51, 1.19)	0.95 (0.68, 1.32)	1.02 (0.69, 1.50)	1.10 (0.83, 1.47)
2005	0.70 (0.46, 1.06)	0.98 (0.71, 1.37)	0.73 (0.49, 1.08)	1.06 (0.80, 1.40)
2006	0.74 (0.49, 1.11)	0.93 (0.67, 1.30)	0.68 (0.46, 1.00) *	0.86 (0.65, 1.15)

Adjusted for age, sex, residence, comorbid condition, marital status, location of death, institutional supportive care services and transfers between institutional supportive care facilities.

Table 4.19 Association between disease status and average LOS per hospitalization stratified by disease status

	Average LOS per visit >7 days in the 6 months prior to death Adjusted OR (95%CI)		Average LOS per visit > 7days in the 1 month prior to death Adjusted OR (95%CI)	
Calendar Year	COPD	Lung Cancer	COPD	Lung Cancer

1998	1.34 (0.91, 1.97) +	0.88 (0.67, 1.16)	1.14 (0.78, 1.67)	0.81 (0.61, 1.06)
1999	1.12 (0.77, 1.63)	0.80 (0.61, 1.04)	0.89 (0.61, 1.30)	0.83 (0.64, 1.08)
2000	0.78 (0.54, 1.14)	0.85 (0.64, 1.13)	0.77 (0.52, 1.13)	0.84 (0.63, 1.10)
2001	0.89 (0.62, 1.30)	0.75 (0.57, 0.99)	0.75 (0.51, 1.10)	0.90 (0.68, 1.18)
2002	0.80 (0.54, 1.19)	0.87 (0.66, 1.15)	0.89 (0.59, 1.32)	0.95 (0.73, 1.25)
2003	0.72 (0.50, 1.06)	0.81 (0.61, 1.07)	0.74 (0.50, 1.09)	0.78 (0.59, 1.02)
2004	0.90 (0.61, 1.32)	0.79 (0.60, 1.05)	1.01 (0.69, 1.50)	1.08 (0.82, 1.43)
2005	0.65 (0.44, 0.95)	0.85 (0.65, 1.12)	0.86 (0.58, 1.27)	0.86 (0.66, 1.13)
2006	0.80 (0.55, 1.17)	0.72 (0.55, 0.95)	0.71 (0.48, 1.04)	0.73 (0.55, 0.96)

Adjusted for age, sex, residence, comorbid condition, marital status, location of death, institutional supportive care services and transfers between institutional supportive care facilities.

Table 4.20 Association between disease status and number of hospitalizations stratified by disease status

	>2 Hospitalizations in the 6 months prior to death Adjusted OR (95%CI)		>2 Hospitalizations in the 1 month prior to death Adjusted OR (95%CI)	
Calendar Year	COPD	Lung Cancer	COPD	Lung Cancer
1998	0.96 (0.66, 1.41)	1.29 (0.98, 1.71)	0.79 (0.47, 1.31)	0.90 (0.54, 1.49)
1999	1.25 (0.85, 1.82)	1.68 (1.28, 2.21)	0.89 (0.54, 1.47)	0.74 (0.44, 1.24)
2000	1.10 (0.75, 1.61)	1.81 (1.36, 2.42) *	0.77 (0.46, 1.28)	0.94 (0.57, 1.55)
2001	0.87 (0.60, 1.27)	1.50 (1.13, 2.00) *	0.97 (0.59, 1.58)	1.67 (0.39, 1.14)
2002	1.18 (0.80, 1.75)	1.63 (1.23, 2.16)	0.64 (0.38, 1.09)	1.02 (0.61, 1.71)

2003	0.87 (0.59, 1.27)	1.49 (1.13, 1.97) *	0.99 (0.59, 1.65)	0.88 (0.52, 1.47) *
2004	1.01 (0.68, 1.48)	1.62 (1.22, 2.15) *	0.87 (0.52, 1.45)	1.45 (0.89, 2.35)
2005	0.96 (0.65, 1.41)	1.76 (1.33, 2.33) *	1.41 (0.88, 2.27)	0.90 (0.53, 1.51)
2006	1.10 (0.75, 1.61)	1.50 (1.13, 1.99)	0.86 (0.52, 1.44)	0.78 (0.46, 1.30)

Adjusted for age, sex, residence, comorbid condition, marital status, location of death, institutional supportive care services and transfers between institutional supportive care facilities.

4.4 Sensitivity analysis

Table 4.21 presents the result of sensitivity analysis regarding the association between all the variables included with hospitalization (total LOS>7days, average LOS>7days and number of hospitalizations) after re-categorizing the variables Institutional Services and Transfer within Institution into a new variable (no institutional care and no transfer, institutional care without transfer and institutional care with transfer) in the last six months of life. The result shows that, among the three models, the odds ratio for each variable included in the model does not change significantly compared to the original model

Table 4.21 Sensitivity analysis Multivariate Analysis examining associations with hospital service utilization

	Total LOS >7 days in Hospital in the 6 months prior to death		Average LOS>7 days per visit in the 6 months prior to death		≥ 2 hospitalizations in the 6 months prior to death	
	Adjusted OR (95%CI)	P-value	Adjusted OR (95%CI)	P-value	Adjusted OR (95%CI)	P-value
Disease status						
Lung Cancer	1.00		1.00		1.00	
COPD	0.63 (0.56,	<0.0001	0.78 (0.70,	<0.0001	0.72 (0.64,	<0.0001

	0.72)		0.87)		0.80)	
Calendar year						
1997	1.00		1.00		1.00	
1998	0.89 (0.67, 1.15)	0.36	1.03 (0.82, 1.29)	0.80	1.16 (0.92, 1.45)	0.21
1999	1.00 (0.77, 1.29)	0.99	0.90 (0.73, 1.12)	0.35	1.50 (1.20, 1.87)	<0.0001
2000	0.91 (0.70, 1.18)	0.47	0.84 (0.67, 1.05)	0.12	1.51 (1.20, 1.90)	<0.0001
2001	0.84 (0.65, 1.08)	0.18	0.82 (0.65, 1.02)	0.07	1.23 (0.98, 1.54)	0.08
2002	0.92 (0.71, 1.19)	0.52	0.87 (0.69, 1.09)	0.21	1.47 (1.16, 1.83)	0.001
2003	0.82 (0.64, 1.06)	0.14	0.79 (0.64, 0.99)	0.04	1.23 (0.98, 1.54)	0.07
2004	0.89 (0.68, 1.15)	0.37	0.84 (0.67, 1.05)	0.13	1.37 (1.09, 1.72)	0.008
2005	0.87 (0.67, 1.13)	0.30	0.79 (0.64, 0.99)	0.04	1.41 (1.12, 1.77)	0.003
2006	0.86 (0.66, 111)	0.24	0.76 (0.61, 0.95)	0.02	1.34 (1.07, 1.67)	0.01
Age						
≤59 years	1.00		1.00		1.00	
60-69 years	1.15 (0.92, 1.44)	0.23	1.22 (1.01, 1.47)	0.04	0.84 (0.68, 1.03)	0.10
70-79 years	1.20 (0.97,	0.10	1.39 (1.16,	<0.0001	0.75 (0.62,	0.005

	1.49)		1.66)		0.92)	
80-89 years	0.92 (0.74, 1.15)	0.45	1.17 (0.97, 1.41)	0.11	0.53 (0.43, 0.65)	<0.0001
≥90 years	0.76 (0.49, 1.18)	0.22	1.02 (0.68, 1.54)	0.92	0.42 (0.28, 0.64)	0.005
Sex						
Female	1.00		1.00		1.00	
Male	0.88 (0.77, 0.99)	0.03	0.85 (0.77, 0.94)	0.002	1.01 (0.90, 1.12)	0.90
Residence						
≥300,000	1.00		1.00		1.00	
(10,000- 299,999)	1.00 (0.86, 1.17)	0.98	1.14 (0.99, 1.32)	0.06	0.93 (0.81, 1.08)	0.61
<10,000	1.31 (1.16, 1.49)	<0.0001	1.17 (1.05, 1.30)	0.005	1.16 (1.04, 1.30)	0.008
Comorbid Condition						
0-1	1.00		1.00		1.00	
≥2	1.23 (1.10, 1.38)	<0.0001	1.83 (1.66, 2.02)	<0.0001	0.41 (0.37, 0.45)	<0.0001
Location of Death						
Hospital	1.00		1.00		1.00	
Outside Hospital	0.55 (0.48, 0.62)	<0.0001	0.63 (0.56, 0.71)	<0.0001	0.53 (0.46, 0.59)	<0.0001
Marital Status						
Married/ Common Law	1.00		1.00		1.00	

Never Married	1.18 (0.95, 1.46)	0.14	1.33 (1.11, 1.59)	0.002	0.64 (0.53, 0.76)	<0.0001
Separated/ Divorced	1.03 (0.89, 1.19)	0.69	1.10 (0.97, 1.25)	0.15	0.91 (0.80, 1.04)	0.16
Widowed	0.91 (0.77, 1.07)	0.26	1.04 (0.90, 1.20)	0.64	0.86 (0.74, 0.99)	0.04
Transfer within Institution						
No institutional care and no transfer	1.00		1.00		1.00	
Institutional care without transfer	1.31 (1.13, 1.53)	0.001	1.52 (1.33, 1.74)	<0.0001	1.10 (0.96, 1.26)	0.16
Institutional care with transfer	3.41 (2.43, 4.79)	<0.0001	3.96 (2.97, 5.27)	<0.0001	1.52 (1.19, 1.95)	<0.0001

Table 4.22 presents the result of sensitivity analysis regarding the association with total LOS in hospital in the last six months of life (total LOS>7 days, total LOS>3 days and total LOS>14 days). The result shows that, among the three models, the odds ratio for each variable included in the model does not change significantly.

Table 4.22 Sensitivity Analysis examining associations with total LOS in hospital

	Total LOS >7 days in Hospital in the 6 months prior to death		Total LOS >3 days in Hospital in the 6 months prior to death		Total LOS >14 days in Hospital in the 6 months prior to death	
	Adjusted OR (95%CI)	P-value	Adjusted OR (95%CI)	P-value	Adjusted OR (95%CI)	P-value
Disease status						

Lung Cancer	1.00		1.00		1.00	
COPD	0.63 (0.56, 0.72)	<0.0001	0.65 (0.55, 0.76)	<0.0001	0.67 (0.60, 0.75)	<0.0001
Calendar year						
1997	1.00		1.00		1.00	
1998	0.89 (0.68, 1.15)	0.39	1.11 (0.79, 1.55)	0.56	1.01 (0.81, 1.26)	0.95
1999	0.99 (0.77, 1.29)	0.99	1.02 (0.74, 1.41)	0.92	0.92 (0.74, 1.14)	0.45
2000	0.91 (0.70, 1.18)	0.47	1.01 (0.72, 1.42)	0.95	1.02 (0.82, 1.28)	0.85
2001	0.81 (0.65, 1.09)	0.18	0.95 (0.68, 1.31)	0.74	0.81 (0.65, 1.01)	0.07
2002	0.92 (0.71, 1.19)	0.52	1.09 (0.77, 1.53)	0.63	0.90 (0.72, 1.12)	0.35
2003	0.82 (0.64, 1.06)	0.14	0.93 (0.67, 1.29)	0.65	0.88 (0.71, 1.10)	0.26
2004	0.89 (0.68, 1.15)	0.37	1.07 (0.76, 1.50)	0.71	0.97 (0.77, 1.21)	0.77
2005	0.87 (0.67, 1.13)	0.30	0.99 (0.71, 1.38)	0.97	0.85 (0.68, 1.06)	0.16
2006	0.86 (0.66, 1.11)	0.24	0.87 (0.63, 1.20)	0.40	0.86 (0.69, 1.07)	0.19
Age						
≤59 years	1.00		1.00		1.00	
60-69 years	1.15 (0.92,	0.23	1.09 (0.80,	0.58	1.17 (0.97,	0.11

	1.44)		1.48)		1.42)	
70-79 years	1.20 (0.97, 1.49)	0.10	1.11 (0.83, 1.48)	0.48	1.15 (0.96, 1.38)	0.13
80-89 years	0.92 (0.74, 1.15)	0.45	0.84 (0.62, 1.12)	0.24	0.90 (0.74, 1.09)	0.27
≥90 years	0.76 (0.49, 1.18)	0.22	0.59 (0.34, 1.02)	0.06	0.62 (0.42, 0.94)	0.02
Sex						
Female	1.00		1.00		1.00	
Male	0.88 (0.78, 0.99)	0.03	0.84 (0.72, 0.99)	0.04	0.84 (0.75, 0.93)	<0.0001
Residence						
≥300,000	1.00		1.00		1.00	
(10,000- 299,999)	0.99 (0.86, 1.17)	0.98	1.11 (0.90, 1.36)	0.34	1.09 (0.95, 1.26)	0.22
<10,000	1.31 (1.16, 1.49)	<0.0001	1.40 (1.19, 1.66)	<0.0001	1.22 (1.10, 1.36)	<0.0001
Comorbid Condition						
0-1	1.00		1.00		1.00	
≥2	1.23 (1.10, 1.38)	<0.0001	1.60 (1.38, 1.85)	<0.0001	1.12 (1.01, 1.24)	0.03
Location of Death						
Hospital	1.00		1.00		1.00	
Outside Hospital	0.55 (0.48, 0.62)	<0.0001	0.52 (0.44, 0.61)	<0.0001	0.50 (0.44, 0.56)	<0.0001

Marital Status						
Married/ Common Law	1.00		1.00		1.00	
Never Married	1.18 (0.95, 1.46)	0.14	1.16 (0.87, 1.53)	0.31	1.20 (1.00, 1.43)	0.05
Separated/ Divorced	1.03 (0.89, 1.19)	0.69	1.12 (0.92, 1.36)	0.24	1.05 (0.93, 1.19)	0.46
Widowed	0.91 (0.77, 1.07)	0.25	0.96 (0.77, 1.18)	0.67	0.96 (0.83, 1.11)	0.57
Institutional Services						
No	1.00		1.00		1.00	
Yes	1.31 (1.13, 1.53)	0.001	1.29 (1.06, 1.57)	0.01	1.60 (1.40, 1.83)	<0.0001
Transfer within Institution						
No	1.00		1.00		1.00	
Yes	2.60 (1.85, 3.67)	<0.0001	2.45 (1.55, 3.86)	<0.0001	3.12 (2.34, 4.16)	<0.0001

Table 4.23 presents the result of sensitivity analysis regarding the association with average LOS per visit in the last six months of life (average LOS>7 days, average LOS>3 days and average LOS>14 days). Among the three models, the result shows that the odds ratio for each variable included in the model does not change significantly except for calendar year. A reduced odds ratio is observed in the logistic regression model examining associations with average LOS per hospitalization greater than 14 days.

Table 4.23 Sensitivity Analysis examining associations with Average LOS per hospitalization

	Average LOS >7 days in Hospital in the 6 months prior to death		Average LOS >3 days in Hospital in the 6 months prior to death		Average LOS >14 days in Hospital in the 6 months prior to death	
	Adjusted OR (95%CI)	P-value	Adjusted OR (95%CI)	P-value	Adjusted OR (95%CI)	P-value
Disease status						
Lung Cancer	1.00		1.00		1.00	
COPD	0.78 (0.70, 0.87)	<0.0001	0.82 (0.72, 0.95)	0.006	0.73 (0.65, 0.83)	<0.0001
Calendar year						
1997	1.00		1.00		1.00	
1998	1.03 (0.82, 1.29)	0.80	1.02 (0.76, 1.36)	0.89	0.92 (0.73, 1.16)	0.48
1999	0.90 (0.73, 1.12)	0.35	0.95 (0.72, 1.26)	0.74	0.77 (0.61, 0.97)	0.03
2000	0.84 (0.67, 1.05)	0.12	0.94 (0.71, 1.26)	0.69	0.72 (0.57, 0.91)	0.006
2001	0.82 (0.65, 1.02)	0.07	0.89 (0.67, 1.18)	0.41	0.60 (0.47, 0.77)	<0.0001
2002	0.87 (0.69, 1.09)	0.22	0.94 (0.71, 1.26)	0.69	0.62 (0.48, 0.78)	<0.0001
2003	0.79 (0.64, 0.99)	0.04	0.93 (0.70, 1.24)	0.61	0.70 (0.55, 0.88)	0.003
2004	0.84 (0.67, 1.05)	0.13	1.04 (0.78, 1.40)	0.78	0.66 (0.52, 0.84)	0.001
2005	0.79 (0.64,	0.04	0.87 (0.66,	0.35	0.70 (0.55,	0.003

	0.99)		1.16)		0.89)	
2006	0.76 (0.61, 0.95)	0.02	0.89 (0.67, 1.19)	0.44	0.69 (0.55, 0.88)	0.002
Age						
≤59 years	1.00		1.00		1.00	
60-69 years	1.22 (1.01, 1.47)	0.04	1.24 (0.98, 1.58)	0.08	1.13 (0.92, 1.39)	0.26
70-79 years	1.39 (1.16, 1.66)	<0.0001	1.30 (1.04, 1.64)	0.02	1.12 (0.92, 1.37)	0.26
80-89 years	1.17 (0.97, 1.41)	0.11	1.13 (0.89, 1.44)	0.31	0.98 (0.80, 1.21)	0.86
≥90 years	1.02 (0.68, 1.54)	0.92	0.82 (0.50, 1.34)	0.42	0.86 (0.55, 0.88)	0.51
Sex						
Female	1.00		1.00		1.00	
Male	0.85 (0.77, 0.94)	0.002	0.86 (0.75, 0.98)	<0.0001	0.78 (0.70, 0.87)	<0.0001
Residence						
≥300,000	1.00		1.00		1.00	
(10,000- 299,999)	1.14 (0.99, 1.32)	0.06	1.06 (0.89, 1.26)	0.53	1.11 (0.96, 1.30)	0.17
<10,000	1.17 (1.05, 1.30)	0.005	1.30 (1.13, 1.50)	<0.0001	1.06 (0.94, 1.19)	0.35
Comorbid Condition						
0-1	1.00		1.00		1.00	

≥2	1.83 (1.66, 2.02)	<0.0001	1.85 (1.63, 2.10)	<0.0001	1.85 (1.66, 2.07)	<0.0001
Location of Death						
Hospital	1.00		1.00		1.00	
Outside Hospital	0.63 (0.56, 0.71)	<0.0001	0.62 (0.53, 0.72)	<0.0001	0.63 (0.55, 0.72)	<0.0001
Marital Status						
Married/ Common Law	1.00		1.00		1.00	
Never Married	1.33 (1.11, 1.59)	0.002	1.33 (1.03, 1.70)	0.03	1.47 (1.22, 1.78)	<0.0001
Separated/ Divorced	1.10 (0.97, 1.25)	0.15	1.05 (0.89, 1.24)	0.55	1.16 (1.01, 1.33)	0.03
Widowed	1.04 (0.90, 1.20)	0.64	0.94 (0.78, 1.13)	0.50	1.21 (1.03, 1.41)	0.02
Institutional supportive care services						
No	1.00		1.00		1.00	
Yes	1.52 (1.33, 1.74)	<0.0001	1.36 (1.15, 1.62)	<0.0001	1.81 (1.57, 2.08)	<0.0001
Transfers between institutional supportive care facilities						
No	1.00		1.00		1.00	
Yes	2.60 (1.95, 3.47)	<0.0001	2.10 (1.41, 3.14)	<0.0001	2.65 (2.06, 3.40)	<0.0001

Chapter 5: DISCUSSION

In total, 7,114 subjects were included in this study using data from Saskatchewan Health, with 2,332 decedents from COPD and 4,782 decedents from lung cancer. Retrospective data collection was used in the current study due to the difficulty in identifying patients who were at high risk of dying within six months in a prospective study as well as in having the ability, through the use of Saskatchewan Health data, to identify those who died from the conditions of interest and being able to look back in time. Half of the decedents were rural dwellers, and were married or common law. The majority had multiple comorbid conditions, died in hospitals, and had never received services from long-term supportive care institutions.

5.1 Summary and interpretation of results

5.1.1 Disease Status

The results of the current study were similar to earlier reports where decedents from lung cancer were more likely to utilize hospital services, but less likely to receive ICU care than their COPD counterparts [47, 56, 58]. Many factors could provide an explanation for this difference between the disease groups. One potential reason could be the great variability in COPD progression, making the prognosis a great challenge for physicians. According to an UK study from Gardiner and colleagues in 2009, for those later found to be in their last week of life, their physicians had estimated a forty percent likelihood of six or more months of survival [92]. Apart from the unpredictable disease prognosis, physicians in the United States also found it difficult to start the end-of-life discussions with patients suffering from end-stage COPD as compared with those living with advanced lung cancer [41]. According to Knauft and colleagues, approximately three quarters of the patients would rather talk about staying alive than dying [41].

It was observed in this study that COPD patients were more likely to receive management in intensive care settings and have transfers between long-term care institutions, but were less likely to have frequent hospital admissions than their lung cancer counterparts. A possible interpretation was that the use of long-term care services was not mainly associated with the medical diagnostic category but was relevant to the functional status, such as impairment of daily functioning, which was previously shown in other studies in health care utilization [47, 93]. In addition, lack of adequate patient education and discussion about preferences regarding end-of-life care also made the COPD population more likely to be admitted to ICU due to exacerbations, which was supported by earlier research from Curtis and colleagues in the U.S. in 2002 [90].

Our finding that the COPD population was more likely to use ICU services compared to the lung cancer population in both six months and one month prior to death were consistent with a prior U.S. study in 2002 [56], although the overall use of ICU was relatively low for both groups. The observed differences in ICU usage could be a result from differences in severity of illness or the difficulty of prognostic accuracy; unfortunately, we were not able to assess these factors in administrative data. Furthermore, expansion in the use of hospice care might also contribute to the lower proportion of lung cancer patients using aggressive care services, such as ICU [59]. Earle and colleagues, in 2004, found that individuals residing in regions with greater access to hospice services had a reduced likelihood of being admitted to intensive care settings at the end of life in the U.S. [81]. Our data was in line with an earlier UK report in 2000 where the COPD population was a more disadvantaged group in terms of medical and social care when compared with the lung cancer group [42].

Given the expensive nature of ICU care, these results have large implications in terms of health care costs, especially considering the increased occurrence of COPD in the elderly population [94]. An earlier U.S. report in 2004 also suggested an improvement in the accessibility of palliative care services among the COPD population, which was a better alternative to unnecessary ICU use in terms of symptom relief and cost saving [81]. Improved accessibility of palliative service programs among the COPD population would increase the efficiency and value of services provided and would potentially be cost-saving. Importantly, improved access would lead to improved patients outcomes, both physical and psychosocial, and likely a reduction in avoidable ICU admission.

5.1.2 Age

As expected, the proportion of COPD deaths increased with age except for the oldest age group (Table 1). As cited by Mannino and colleagues, the prevalence of COPD would double per 10-year increase in age in the U.S. [18].

Our study, combined with earlier reports [2, 95], suggested that patients dying from lung cancer were on average younger than those dying from COPD. This observation could partially explain the finding that the COPD population was more likely to be managed in long-term care facilities as compared with their lung cancer counterparts since the supportive care services were more likely to be allocated to the elder population.

We also found an increased likelihood of a longer hospital stay with increasing age up to a certain point, which was previously shown in other studies [58, 62, 64, 68]. However, the opposite was true for patients aged ninety years and above in both disease groups, which was also in agreement with reports by Roos, Bickel and Menec et al. [33, 84]. Differences in terms of disease expression and therapy response might exist in different age groups, indicating a variation in the provision of hospital services in sub-groups. In addition, this inconsistency might be related to variations in decision-making among patients in different age groups, particularly in those with chronic disorders. For example, for the severely ill older patients, the long-term services were more likely to be allocated as compared with the younger generation due to their decreased ability to complete daily activities and the presence of multiple comorbid conditions, as indicated by a prior study conducted in Amsterdam in 2004 [96].

The most surprising finding in this study was that age had an inverse relationship with the number of hospitalizations; although it was hypothesized that advancing age would increase the likelihood of hospital service usage. This was an unexpected finding that poses some difficulty in its interpretation and therefore merits attention for further research. Patients' treatment refusal was one possible explanation for this inconsistency, especially among the elderly with poor health conditions, a hypothesis supported by the work of Berghmans and colleagues in 2002 [82]. This group found that patients aged seventy years and above were often reluctant to receive the standard cancer treatment in Belgium [82]. Some factors in the previous study associated with treatment avoidance included poor patient-physician communication, time constraints, physical discomfort, distrust of medical procedures, memories of unpleasant past experiences of self or others, as well as negative perceptions of the health care system provided for patients living with lung cancer. Two other studies in cancer also found that age was an inverse predictor of undergoing treatment [97, 98].

Townsley and colleagues, in 2005, also observed a change in decision-making over the course of life in the province of Ontario, Canada [80]. Older adults were more likely to reject a treatment plan if they thought the side-effects outweighed the potential increase in lifespan or other benefits from the intervention. The younger generation was less impacted by these factors, but more influenced by family responsibilities, leading to a lower refusal rate. In order to accurately assess the attitudes and perceptions among patients in different age groups, further research investigating these factors need to be conducted.

We also speculate that age significantly influences physicians' decisions on care planning, a hypothesis supported by Angus and colleagues in 2004, who reported an decreased likelihood of acute care hospitalization among adults aged eighty years and above at the end of life as compared to the younger generation of society in the U.S.[99]. This association was also reported in earlier reports with subjects living with different types of carcinoma [80, 97, 99, 100], indicating better understanding and communication with geriatric patients were needed so as to achieve optimal care management.

5.1.3 Sex

According to our descriptive analysis, significant differences existed between sexes, with a higher proportion of male decedents observed in both disease groups, which was consistent with another U.S. study in 2002 concluding that COPD and lung cancer were male diseases [101]. Regarding the sex differences in the provision of hospital care services, however, it was observed that female patients stayed longer in hospitals as compared with their male counterparts in the last six months of life. This finding was in line with prior reports focusing on sex differences [68, 75-77]. Factors contributing to the observed variations included levels of anxiety, perception of breathlessness, differences in disease progression and disease management in different sex groups [60, 71, 102]. Whether the female subjects experienced more severe symptoms than the males, or whether they had different treatments was not possible to investigate in this observational study. Additionally, gender role differences could be another interpretation. The fact that women usually look after their partners at home could explain much of the sex differences. Another possible explanation was suboptimal care management for women. This was initially shown in an UK study that examined cardiovascular diseases in 2000 [61]. According to Gan and colleagues, women with the same level of disease severity did not receive as aggressive care services as the male patients, which increased the likelihood of females being hospitalized in the later stages [61]. This type of bias could also exist in patients with COPD since it has been traditionally viewed as a male disease; physicians may fail to pay close attention to the females as compared with males in earlier stages.

However, there was no significant difference in terms of LOS in hospital in the one month prior to death between males and females. This result was reasonable and was reported in other works [67, 71]. We suggested that those with severely impaired health had an equal possibility of being hospitalized, which could explain much of this finding. As a person approached the end of life, the utilization of acute hospital services increased regardless of sex, especially in the last thirty days of life; this was also supported by Danish study from Teno and colleagues in 2011[48].

Sex was found to modify the association between disease status and LOS in hospitals, meaning that the inverse association with COPD was weaker among males than females. Given the fact that tobacco consumption plays a prominent role in the development of COPD [60], significantly higher smoking prevalence in males could be one possible explanation [103]. As indicated by work from Hunninghake and colleagues, ingredients in cigarettes caused an increase in the number of macrophages and neutrophils in the lower airways, leaving greater chance of developing lung disorders [104]. Second, female patients were more likely to receive advice from physicians. According to a prior UK report from Watson and colleagues in 2004, female patients showed better compliance in terms of smoking cessation than their male counterparts, suggesting a greater probability of decline in lung function in the male patients [71].

5.1.4 Rural-urban Differences

Almost half of the decedents were rural dwellers, suggesting that respiratory illnesses were an important burden on the health of rural residents. This was especially important given that approximately one-third of Saskatchewan residents live in rural areas [105]. An earlier Canadian report in 2006 also observed an upward pattern with increasing rurality in terms of mortality rates from respiratory diseases for both sexes [106].

According to the results of the multivariate analysis in this study, the difference existing between urban and rural residents with respect to LOS in the hospital and number of hospitalizations, was consistent with prior reports [59, 107, 108, 109]. Graverholt noted that, in 2014, hospital care utilization was not only influenced by patients' needs, but also dependent upon the availability of hospitals and nursing homes in the local area [110]. In 2001, results from the National Family Physician Workforce Survey suggested that rural dwellers had poorer access to long-term care services but greater access to acute hospital care than their urban counterparts [111].

Observed variations in the hospital care utilization may reflect limitations in access to health care for a large number of Saskatchewan residents, particularly those living in rural areas. Complex disease conditions often require lengthier hospital stays, especially when services are limited. Furthermore, long commutes to hospitals may discourage people from being discharged since re-admission might be needed as health conditions deteriorate. Improvements in end-of-life care services among rural patients should be expanded. For example, the use of telehealth technology could maximize the efficiency of treatment, particularly for those residing far from the nearest hospital.

Additional factors might also underlie the urban-rural differences. For example, home care resource availability would influence the utilization of hospital services, suggesting a greater dependence upon home support system by people living in rural regions [112].

5.1.5 Comorbid Conditions

Patients with either COPD or lung cancer experienced a significant number of comorbid illnesses, which was consistent with findings in other studies [83, 86]. Many factors contributed to the high risk of comorbidity, as cited by Fabbri and colleagues, such as decreased function in terms of physiology and immunity [113].

Patients with multiple comorbid conditions typically made high use of hospital services [78]. We found that individuals living with more than two comorbid illnesses were more likely to stay longer in hospital, which was also reported in prior studies [62, 64, 74, 114]. In 2003, Kinnunen and colleagues in Finland demonstrated the great effect of comorbidity on the duration of hospital stay, reporting an average LOS of 7.7 days without any comorbid condition compared with 10.5 days if any co-existing disease was present [114].

In marked contrast to other studies, however, our findings suggested that multiple comorbid conditions was a contributing factor of lower number of hospitalizations, which was inconsistent with traditional views [51]. As cited by Anthonisen and colleagues, in 2002, almost half of the hospitalizations were due to co-existing chronic conditions in patients living with respiratory illness in the U.S. We speculated that the greater use of other types of services, including hospice care, family physician visits, and nursing homes, might explain much of the inconsistencies. In addition, patients' reluctance of being hospitalized could be another interpretation [97, 98]. Patients living with COPD in the earlier stage were usually admitted to hospitals more frequently than those living with lung cancer, leaving the COPD population more averse towards acute care settings [98].

5.1.6 Location of Death

We found a similar proportion of patients dying in acute care hospitals with studies conducted in other provinces in Canada, where rates were reported to be seventy percent or above [46, 55, 115]. The majority of deaths occurred in hospital settings suggesting that opportunities may exist to facilitate desired home deaths at a national level, such as a palliative care tele-health network. Earlier research from Nova Scotia in 2012 studied contributing factors of location of death. They observed that urban dwellers were more likely to die out of hospitals [46]. In light of these earlier results, our finding that the majority of deaths occurred in the hospitals might be expected since nearly half of the study population was residing in rural areas and alternate care may not be available.

Patients with end-stage COPD were less likely to die in hospital when compared with patients living with lung cancer, which was inconsistent with findings of Edmonds and colleagues in 2001 [105]. Sudden death could partly explain the observation, which occurred more commonly in patients living with multiple comorbid conditions, such as cardiovascular comorbidity, a hypothesis supported by the work by McGarvey and colleagues in 2007 [116]. They noted that, in a total of 911 deaths, cardiovascular cause accounted for more than one quarter of the study population, with the most common cause being sudden death.

However, an earlier study in Nova Scotia in 2003 suggested that long-term supportive service was a predictor of out-of-hospital death [46]. In other words, when a person had greater consumption in supportive care institution, the likelihood of hospital death decreased. Our findings that the relatively fewer hospital-deaths observed in the COPD population seemed logical, because, the proportion of deceased COPD patients receiving supportive care was larger than that in the lung cancer group.

5.1.7 Marital Status

In the last six months of life, those who never married were more likely to have a longer hospital stay as compared with the married/ common law subjects. Our findings were consistent with other studies concluding that the use of hospital services were higher among never married than among married subjects [117, 118]. As suggested by work conducted in the U.S. from Gruneir and colleagues in 2007, marital status was an important indicator of social support, which reflected the quality of care provided in non-hospital settings [119]. We suggest that the hospital service usage might be reduced by home care from a spouse among the married decedents, or be increased by poorer physical and spiritual conditions observed among those living alone, which was in line with the work by Waite and colleagues in 2002 [117]. This group suggested that patients who lived alone were more susceptible to acute disease exacerbations, as compared to those with companions, since they had difficulty finding assistance to manage their diseases, such as taking medications, maintaining a healthy diet, and regularly attending pulmonary rehabilitation program [117].

Inconsistency occurred in the association between marital status and the number of hospital admissions. One possible interpretation could be the lower level of social support experienced by those who lived alone. Individuals living with severe illness usually need people responsible for transportation to the hospitals. Lack of social support might decrease the likelihood of seeking health care services, leading to a decreased number of admissions. Other factors might also contribute to a reduced number of hospitalizations, such as personality, educational level, and socio-economic status. Although previous study found that living alone was associated with a reduced physician visits, it did not affect the likelihood of hospitalizations [120].

5.1.8 Institutional Supportive Care Services

When compared to the existing literature on institutional supportive care services, our study's results supported the trend found by others that COPD patients were more likely to receive long-term institutional care services than their lung cancer counterparts in the six months prior to death [47, 58].

According to the results of our multivariate analysis, receiving institutional supportive care services increased the possibility of staying longer in the hospital in the six months prior to death, but it did not affect the number of hospital visits. One interpretation was that people with prolonged hospital stay were more likely to receive institutional supportive care after discharge, a hypothesis supported by a Singapore study of Saxena and colleagues in 2005; this group reported that patients with discharges to nursing home spent significantly longer time in hospital as compared with patients who were discharged directly to home [121]. This was also shown previously in other studies with cancer populations [122, 123]. Another potential reason for this observation was the increased waiting time experienced among patients to be placed in long-term care institutional settings, indicating an unnecessary cost and decreased hospital bed availability [123].

However, there was still inconsistency in the literature where a previous U.S. study conducted in 2003 reported an opposite relationship [75]. McCarthy and others suggested that higher utilization of institutional services decreased the likelihood of being hospitalized and having prolonged stay in hospitals [75].

5.1.9 Transfer between Institutional Supportive Care Facilities

As part of the current study, transfers between the supportive care institutions for both COPD and lung cancer patients were also examined. Among those receiving institutional supportive care, 4.7% were recorded as having at least one transfer.

Patients' safety has been identified as a priority within different care settings. Preventable adverse events, such as infection, falls and adverse drug events, from transfers were discussed previously in many studies [124, 125]. A prior U.S. report in 2005 also illustrated that repeated transfers could result in disastrous clinical outcomes [125].

A previous UK study pointed out that unnecessary transfers were frequently observed in patients in different disease categories, resulting in avoidable adverse events that outweigh the benefits of transfer, such as closer monitoring and better diagnostic equipment [126]. Consequences of unnecessary transfers were especially severe for terminally ill patients, which might lead to greater burden on health care utilization, indicating impaired quality of life [126].

The higher incidence of transfers observed in the COPD population when compared with the lung cancer group, had the potential to diminish quality of life in this population. More attention is needed from clinicians and policy makers to address this concern. Furthermore, more transfers may also reflect the great variability in predicting the disease progression, with episodes of acute exacerbations during stable deterioration. Unlike lung cancer patients, it is difficult for health care providers to identify the terminal phase of illness for COPD population, leaving a poor patient education and discussion regarding end-of-life care preferences, which in turn increases the likelihood of transfers during exacerbations. As cited by Elkington and colleagues, half of the subjects dying from COPD did not recognize their trajectory toward death in their last year of life [42].

Our findings suggest an increased risk of longer stay in hospitals in the transferred group within the last 6 months of life, which were also demonstrated in previous studies [127, 128]. However, the model revealed the hospital utilization (Total LOS, Average LOS and number of hospitalizations) to be significantly less in the transferred group of patients in the last one month of life, a finding that was somewhat unexpected. Some factors may explain this observation. First, an unpleasant past experience might decrease the likelihood of accepting further transfers plan [129]. Second, we only considered those transferred between long-term care institutions. If those brought directly to hospitals from long-term care settings were also included, the relationship might be changed because respiratory diseases were the second most common reason for a transfer between supportive care institutions and hospitals. Based on a study by Przybysz and colleagues, in 2009, one in five transferred patients were admitted to acute hospital care settings primarily associated with impaired respiratory function in Canada [128]. A limitation of the present study was a lack of information on the transfers between hospitals and supportive care institutions.

5.1.10 Calendar Year

Over the 10-year study period, there was no significant change in the utilization of hospital care services after adjustment for age, sex, disease status, residence, comorbid conditions, location of death, marital status, institutional supportive care services and transfers between supportive care institutions. This observation was inconsistent with other studies where a reduction in hospital bed use among respiratory patients was noted [75, 91]. A number of factors contributed to the disparities in results.

First, significant changes occurred in the Saskatchewan health care system in 1990's, resulting in a reduction in the number of hospital beds [130], which might have created an observed downward trend in hospital bed utilization in prior reports. This was also associated with time spent in hospital and was described in other Canadian reports [75, 131]. Most studies investigated the trends of hospitalization during the last year of life among terminally ill patients; however, we were focusing on the patterns during the last six months and one month of life. Given the fact that people's health condition deteriorates dramatically in the weeks prior to death, their possibility of being hospitalized may not change as much as those in their last year of life.

Second, the way we managed the data could, in part, explain the disparities. We combined two admissions into one event if a patient was readmitted to a hospital on the same day of discharging from another hospital, resulting in a slightly smaller number of hospital visits when compared with those who counted two admissions as two events. As a result, the total LOS in hospitals remained same, but the denominator became smaller, it was more likely to get a larger average LOS per visit.

Additional factors may have also influenced the patterns of hospital services utilization, such as the use of palliative care services, physician's decision on care planning, and patient's preference on the location of care, which was not possible to be assessed in the current study due to the limited information from administrative data.

5.2 Strengths and limitations

5.2.1 Strengths

Administrative data provides an efficient and economical tool in measuring the care utilization at the end of life among individuals who died from lung cancer and COPD. Since the data were continuously collected, and were population-based over the study period without intent for a specific research project, the risk of bias was decreased. An almost universal population within Saskatchewan was used. The use of Saskatchewan Health data also allows us to measure the trends for hospital utilization at the end of life through data linkage of existing files.

In addition, our method enabled us to report the LOS in hospitals as well as the number of admissions near the end of life among decedents with COPD and lung cancer, which was more informative than those only focusing on whether the patient died in hospital or not.

A group of decedents from lung cancer was used as a comparison group in this study. This has the advantage of using a comparison group that could control some external confounders that may account for the changes in hospitalizations. Additionally, without a comparison group (i.e. lung cancer patients), we would not be able to fully explain the seriousness of health conditions among the advanced COPD patients. Thus, this study could examine whether these patients living with COPD are relatively disadvantaged in terms of medical care when being compared with a group with terminal lung cancer.

A previous report illustrated the significant impact from double counting from inter-hospital transfers, and suggested that it should be considered or corrected when conducting and interpreting research [132]. In order to avoid transfer bias, we counted a patient who was readmitted to another hospital on the same day of discharging from an existing hospital as having one transfer, and combine two hospitalizations rather than counting it as a second admission. Various time frames for identifying a transfer were applied in previous studies [132, 133]; our decision was made to minimize the possibility of double counting.

5.2.2 Limitations

Our findings are subject to several limitations. The main purpose of this study was to measure the quality of care provided for patients near death, which is, ideally, measured by whether the right care is given to the right patient in the right way in the right amount and at the right time. However, we had no information on patients' preferences for end-of-life services or on patients' satisfaction with the care provided during hospitalization, for example, the effectiveness of pain control, or the emotional or physical support provided by the nursing staff.

Second, the administrative data provides information regarding the frequency of hospital attendance and duration for each hospitalization; however, it doesn't contain information on the improvement in patients' health, which has great clinical and political implication. Previous literature showed that terminal cancer patients were routinely given surgery or other treatments even though the treatments would bring them no benefit [91]. If the treatment intensity doesn't correspond to the improvement of patients' health or satisfaction, we would question the efficiency of the health care system. Thus, suboptimal care management among critically ill patients makes a strong case for more intensive research and analysis. Unfortunately, we cannot relate services provided in hospitals to health outcomes, thus, we are not able to reach conclusions regarding the efficiency of the current care system. Moreover, quality of life for both disease groups in terms of emotional wellbeing is not possible to be investigated in the current study, although it is considered as an important component in health evaluation [134].

Furthermore, this study investigated only in-patient hospitalizations. We did not consider hospitalizations that were managed in outpatient settings or in emergency departments, due to the lack of information on these topics available, suggesting a substantial underestimation of the hospital service consumption. In addition, information on time spent in ICU is missing. Some research suggested a significant relationship between transfer and ICU consumption. According to Golestanian and colleagues, in contrast to the non-transfer clients, the transferred group consumed greater resources in both regular in-patient and intensive care settings because of their severely impaired health condition [127]. Unfortunately, the data does not contain information on LOS in ICU, leaving much difficulty in measuring the effect from transfer. In addition, sex may also influence the number of days spent in ICU, which provides us an opportunity to examine the quality of end-of-life care for the study population between sexes. Thus, we were not able to examine this in administrative data.

First Nations people were excluded in the analysis due to the way residence is coded in the administrative database. However, First Nations people constitute about 9% of the Saskatchewan population. In addition, a higher percentage of COPD in both morbidity and mortality have been observed in this population in previous studies [13, 14]. This limitation could lead to an underestimation of the hospital service utilization and lack of generalizability to this group.

The results of this study represent only one Canadian province. It may be difficult to generalize the findings nationally due to the regional scope of the study. Additionally, we only observed patients who died from COPD or lung cancer, which may limit the relevance of the findings to patients who died from other respiratory diseases.

Although the number of cases of COPD has increased in the last 20 years, COPD has been infrequently mentioned as a contributing or underlying cause of death even in patients with severe diseases [15, 32], but more likely as a contributory cause of death [60, 136]. Some authors argued that this would result in underestimation of a true association. An earlier European study reported a substantial underestimate on the number of deaths to which obstructive lung disease makes a contribution. Where obstructive lung disease was mentioned but not the underlying cause of death, the other most common causes were heart disease and lung cancer. In North America, work in the USA [32] also suggested that using underlying cause of death as an indicator of the health burden from severe COPD might dramatically underestimate the impact of the disease, with non-respiratory causes accounting for 50% of the underlying causes of death in COPD patients in the USA. Thus, COPD is likely to be underreported on death certificates in our cohort study.

Given the nature of the retrospective study design and that we used administrative databases, it is certainly possible that some other confounding variables were missed or poorly documented. For instance, smoking history, material deprivation level, and home support is not available from administrative data. This could potentially lead to a biased estimate due to confounding.

Age is the independent variable of primary interest in this study. The descriptive analysis suggests that people who died of COPD are on average older than those who died of lung cancer. This might result in a biased result because the older adults are more likely to be managed in the long-term care facilities than the acute hospital settings, leaving patients with COPD a reduced risk of being hospitalized. None of the predefined indicators in the study, however, is a direct measure of the quality of end-of-life care. For instance, one person can die at home suffering great distress without any care, and another, can die in an intensive unit with good pain control and ample emotional support from the nursing staff. However, all variables included in this study were based on the recent literature.

5.4 Causal Inference in Epidemiology

Causality was also considered in this study as suggested by Hill's criteria [135]. First, although this was a case-control study in nature, temporality was established due to the way data was recorded in the administrative file. Second, the findings demonstrated strong and statistically significant associations between the main effect factors (age, sex, comorbidity and disease status) and hospital service utilization. Third, since the findings were consistent with some earlier research in given literature, consistency was achieved. Finally, some of the current findings were not plausible based on literature. For example, we found that age and comorbidity were negative predictors of frequent hospital admissions, which was also inconsistent with our hypothesis. Although there was some concern of misclassification bias suggested by current literature, this type of bias occurs were at random and would have had little effect on the true relationship between disease status and hospital service utilization.

5.3 Implications

Issues pertaining to advanced COPD affect millions of individuals around the world. Our study attempted to identify trends in hospital care utilization among terminally ill COPD patients with specific emphasis on how sex, age and comorbidity affected the trends. We expect the findings would provide the basis for establishing recommendations on how to improve the quality of end-of-life care among individual living with advanced COPD. Furthermore, we hope the findings would make a tangible contribution to the development of palliative care that allow for unique needs based on sex.

5.4 Recommendations

ICU has been acknowledged as an important component of acute hospital care services. Initially, we were interested in looking at the relationship between main effect factors and LOS in intensive care settings. However, due to the large amount of missing information for this variable, it could not be examined. Therefore, a study investigating the association between disease status and LOS in ICU is required in the future.

We also suggest that more information regarding the patient's attitudes towards advance care planning should be collected for further research as the primary objective is to investigate whether the optimal quality of life is achieved after receiving end-of-life services among those who are expected to live less than six months.

There were no significant trends observed in the current study regarding the hospital services utilization over a 10-year study period, which was inconsistent with prior reports. We would suggest collecting more information on services provided in other care settings, such as emergency room, out-patient settings and clinics, etc. This would allow an in-depth examination regarding what types of institutional services influenced the usage of in-patient care.

Advancing age and multiple comorbid conditions showed inverse associations with frequent hospital attendance. Even though these factors were consistent with some studies in given literature, more investigation was required to explore the reasons behind it. Confounding factors such as smoking history, communication between physician and patients, patients' preference on care planning and patient's disease severity, may affect the true relationship. Thus, they should be considered in the multivariate analysis in future studies for more persuading result.

Only one province of Canada was investigated in the current study, thus it was not possible to generalize the findings nationally. We would suggest further research at a national level.

5.5 Conclusions

Marked differences in terms of hospital service utilization in the last six months of life were observed between subjects dying with COPD and lung cancer. Our findings also suggested that the care utilization at the end of life could be attributed to factors in the health care utilization framework developed by Andersen, Aday and others [75]. Predisposing factors, such as younger age, significantly contributed to frequent hospital admissions, while older people were more likely to stay longer in each admission. A higher rurality predicted an increased likelihood of greater hospital service utilization, indicating that enabling factors, such as the rural-urban nature of the community in which the subjects live, played an important role in predicting the probability of hospital services use among those in their last phase of life. In addition, need variables, such as comorbid conditions, were also related with the care delivery. For example, a prolonged LOS in hospitals was clearly associated with a higher number of comorbid conditions.

In summary, the complex nature of chronic respiratory diseases presents a challenge for all care providers. Overall, patients dying from COPD were on average older than those who died from lung cancer. Furthermore, compared with those who died from lung cancer, people dying from COPD were less likely to be admitted to hospitals and had shorter LOS for each admission although their physical and psychosocial symptoms were as severe as their lung cancer counterparts; however, they were more frequently managed in the intensive care settings and had higher numbers of transfers between long-term care facilities. Education of all health care professionals on the complex needs of patients living with respiratory illnesses is required. Considering the variability of COPD progression, palliative care services should be available at the earlier stage instead of at the end stage. In addition, individual determinants of health service utilization, including the predisposing personal characteristics, the enabling factors, and factors that reflected the need of care, play an important role in predicting the hospital services usage among those towards the end of life. Policy makers should keep these factors in mind when establishing regulations in health service delivery.

REFERENCE

(1) Statistics Canada [http://www.statcan.gc.ca/start-debut-eng.html]. Leading causes of death; 2011 [updated 2011 November 1; cited 2012 July 11]. Available from: http://www.statcan.gc.ca/daily-quotidien/111101/dq111101b-eng.htm.

(2) Yohannes AM. Palliative care provision for patients with chronic obstructive pulmonary disease. Health Qual Life Outcomes 2007;5:17.

(3) Gerald LB, Bailey WC. Global initiative for chronic obstructive lung disease. Journal of Cardiopulmonary Rehabilitation and Prevention 2002;22(4):234-244.

(4) Aaron SD, Vandemheen KL, Fergusson D, et al.., for the Canadian Thoracic Society/Canadian Respiratory Clinical Research Consortium. Tiotropium in combination with placebo, salmeterol, or fluticasone-salmeterol for treatment of chronic obstructive pulmonary disease: a randomized trial. Ann Intern Med. 2007;146(8):545-555.

(5) Centers for Disease Control and Prevention [http://www.cdc.gov/] Chronic Obstructive Pulmonary Disease Among Adults Aged 18 and Over in the United States, 1998–2009; 2011[updated 2011 June 29; cited 2012 July 11]. Available from: http://www.cdc.gov/nchs/data/databriefs/db63.htm

(6) Soriano JB, Maier WC, Egger P, Visick G, Thakrar B, Sykes J, et al... Recent trends in physician diagnosed COPD in women and men in the UK. Thorax 2000;55(9):789-794.

(7) Feenstra T. The burden of asthma and chronic obstructive pulmonary disease: data from The Netherlands. Pharmacoeconomics 2001;19(S2):1-6.

(8) Lacasse Y, Brooks D, Goldstein RS. Trends in the epidemiology of COPD in Canada, 1980 to 1995. CHEST Journal 1999;116(2):306-313.

(9) Cruz AA. Global surveillance, prevention and control of chronic respiratory diseases: a comprehensive approach. : Who; 2007.

(10) Camp PG, Levy RD. A snapshot of chronic obstructive pulmonary disease in British Columbia and Canada. BRITISH COLUMBIA MEDICAL JOURNAL 2008;50(2):80.

(11) Pauwels RA, Buist AS, Calverley PM, Jenkins CR, Hurd SS. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease. American journal of respiratory and critical care medicine 2012;163(5).

(12) O'Donnell DE, Aaron S, Bourbeau J, Hernandez P, Marciniuk D, Balter M, et al. Canadian Thoracic Society recommendations for management of chronic obstructive pulmonary disease--2003. Can Respir J 2003 May-Jun;10 Suppl A:11A-65A.

(13) Senthilselvan A, Lawson J, Rennie DC, Dosman JA. Stabilization of an increasing trend in physician-diagnosed asthma prevalence in Saskatchewan, 1991 to 1998. CHEST Journal 2003;124(2):438-448.

(14) Primary Health Care Division. Alberta Health Primary Health Care- Community Profiles. 2013 02/2013:09/2013.

(15) University of Maryland Medical Center [http://www.umm.edu/].Chronic obstructive pulmonary disease – complications; 2011 [cited 2012 July 11]. Available from: http://www.umm.edu/patiented/articles/how_serious_chronic_obstructive_lung_disease_000070_5.htm#ixzz1yLnD8e79
(16) Jemal A, Ward E, Hao Y, Thun M. Trends in the leading causes of death in the United States, 1970-2002. JAMA: the journal of the American Medical Association 2005;294(10):1255-1259.
(17) Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. PLoS medicine 2006;3(11):e442.
(18) Mannino DM, Homa DM, Akinbami LJ, Ford ES, Redd SC. Chronic obstructive pulmonary disease surveillance-United States, 1971-2000. Respir Care 2002;47(10):1184-1199.
(19) Mimino AM. Deaths: preliminary data for 2008. : DIANE Publishing; 2011.
(20) Office for National Statistics. Health Statistics Quarterly. (8) winter 2000. London: HMSO; 2000.
(21) Soler-Cataluna JJ, Martinez-Garcia MA, Roman Sanchez P, Salcedo E, Navarro M, Ochando R. Severe acute exacerbations and mortality in patients with chronic obstructive pulmonary disease. Thorax 2005 Nov;60(11):925-931.
(22) Canadian Institute for Health Information, Canadian Lung Association, Health Canada, et al. Respiratory disease in Canada. Ottawa: Health Canada; 2001.
(23) Fauci AS. Harrison's principles of internal medicine. : McGraw-Hill Medical New York; 2008.
(24) Jemal A, Bray F, Center MM, Ferlay J, Ward E, Forman D. Global cancer statistics. CA: a cancer journal for clinicians 2011;61(2):69-90.
(25) Marrett L, Logan H, Mery L. Canadian Cancer Statistics 2007. Canadian Cancer Society/National Cancer Institute of Canada 2007.
(26)Cancer. January,2013; Available at: http://www.who.int/mediacentre/factsheets/fs297/en/, March, 2013.
(27) Centers for Disease Control and Prevention [http://www.cdc.gov/] Chronic Obstructive Pulmonary Disease Among Adults Aged 18 and Over in the United States, 1998–2009; 2011[updated 2011 June 29; cited 2012 July 11]. Available from: Cdc: http://www.cdc.gov/cancer/lung/

(28) Heron M, Tejada-Vera B. Deaths: leading causes for 2005. Natl Vital Stat Rep 2009 Dec 23;58(8):1-97.

(29) Statistics Canada: Leading causes of death in Canada, 2010. Ottawa, Canada; Statistics Canada,2010

(30) Earle CC, Park ER, Lai B, Weeks JC, Ayanian JZ, Block S. Identifying potential indicators of the quality of end-of-life cancer care from administrative data. Journal of Clinical Oncology 2003;21(6):1133-1138.

(31) Canadian Cancer Society. Canadian cancer statistics 2012. 2012; Available at: http://www.cancer.ca/~/media/cancer.ca/CW/cancer%20information/cancer%20101/Canadian%20cancer%20statistics/Canadian-Cancer-Statistics-2012---English.pdf. Accessed 05/16, 2013.

(32) Stephen Adams. Needs of dying overlooked by health reforms, claims charity. 22 Nov 2012; Available at: http://www.telegraph.co.uk/health/healthnews/9694529/Needs-of-dying-overlooked-by-health-reforms-claims-charity.html, 22 Dec 2013.

(33) Bickel H. The last year of life: a representative study of deceased patients. Living arrangement, place of death and utilization of health resources. Z Gerontol Geriatr 1998 Jun;31(3):193-204.

(34) Mapes DL, Lopes AA, Satayathum S, Mccullough KP, Goodkin DA, Locatelli F, et al. Health-related quality of life as a predictor of mortality and hospitalization: the Dialysis Outcomes and Practice Patterns Study (DOPPS). Kidney Int 2003;64(1):339-349.

(35) Increasing palliative care in Canada; 2011 [cited 2012 July 11]. Available from: http://www.living-lessons.org/main/hospice.asp.

(36) Grunfeld E, Lethbridge L, Dewar R, Lawson B, Paszat LF, Johnston G, et al... Towards using administrative databases to measure population-based indicators of quality of end-of-life care: testing the methodology. Palliat Med 2006;20(8):769-777.

(37) Needs of dying overlooked by reforms claims charity; 2012 [cited 2012 July 7] Available from: http://www.telegraph.co.uk/health/healthnews/9694529/Needs-of-dying-overlooked-by-reforms-claims-charity.html

(38) Chronic obstructive pulmonary disease - Complications. 2011; Available at: http://www.umm.edu/patiented/articles/how_serious_chronic_obstructive_lung_disease_000070_5.htm#ixzz1yLnD8e79. Accessed 7/11, 2012.

(39) Claessens MT, Lynn J, Zhong Z, Desbiens NA, Phillips RS, Wu AW, et al... Dying with lung cancer or chronic obstructive pulmonary disease: insights from SUPPORT. J Am Geriatr Soc 2000;48(5):146-153.

(40) Bruera E, Sweeney C, Russell N, Willey JS, Palmer JL. Place of death of Houston area residents with cancer over a two-year period. J Pain Symptom Manage 2003;26(1):637.

(41) Knauft E, Nielsen EL, Engelberg RA, Patrick DL, Curtis JR. Barriers and facilitators to end-of-life care communication for patients with COPD. CHEST Journal 2005;127(6):2188-2196.

(42) Gore J, Brophy C, Greenstone M. How well do we care for patients with end stage chronic obstructive pulmonary disease (COPD)? A comparison of palliative care and quality of life in COPD and lung cancer. Thorax 2000;55(12):1000-1006.

(43) Whitehouse JD, Friedman ND, Kirkland KB, Richardson WJ, Sexton DJ. The impact of surgical-site infections following orthopedic surgery at a community hospital and a university hospital: adverse quality of life, excess length of stay, and extra cost. Infect Control Hosp Epidemiol 2002 Apr;23(4):183-189.

(44) Rohde G, Wiethege A, Borg I, Kauth M, Bauer T, Gillissen A, et al. Respiratory viruses in exacerbations of chronic obstructive pulmonary disease requiring hospitalisation: a case-control study. Thorax 2003;58(1):37-42.

(45) Price RA, Stranges E, Elixhauser A. Cancer Hospitalizations for Adults, 2009. 2012.

(46) Burge F, Lawson B, Johnston G, Cummings I. Primary care continuity and location of death for those with cancer. J Palliat Med 2003;6(6):911-918.

(47) Pot AM, Portrait F, Visser G, Puts M, van Groenou MI, Deeg DJ. Utilization of acute and long-term care in the last year of life: comparison with survivors in a population-based study. BMC health services research 2009;9(1):139.

(48) Teno JM, Gozalo PL, Bynum JP, Leland NE, Miller SC, Morden NE, et al. Change in end-of-life care for Medicare beneficiaries: site of death, place of care, and health care transitions in 2000, 2005, and 2009. JAMA 2013;309(5):470-477.

(49) Bruera E, Sweeney C, Russell N, Willey JS, Palmer JL. Place of death of Houston area residents with cancer over a two-year period. J Pain Symptom Manage 2003;26(1):637.

(50) Schiøtz M, Price M, Frølich A, Søgaard J, Kristensen JK, Krasnik A, et al... Something is amiss in Denmark: A comparison of preventable hospitalisations and readmissions for chronic

medical conditions in the Danish Healthcare system and Kaiser Permanente. BMC health services research 2011;11(1):347.
(51) Anthonisen NR, Connett JE, Enright PL, Manfreda J. Hospitalizations and mortality in the Lung Health Study. American Journal of Respiratory and Critical Care Medicine 2002;166(3):333-339.
(52) Demeter SJ, Jacobs P, Chmielowiec C, Logus W, Hailey D, Fassbender K, et al. The cost of lung cancer in Alberta. Canadian respiratory journal: journal of the Canadian Thoracic Society 2007;14(2):81.
(53) Holmquist L, Russo CA, Elixhauser A. Hospital Stays for Lung Cancer, 2006. 2008.
(54) Thompson BT, Cox PN, Antonelli M, Carlet JM, Cassell J, Hill NS, et al. Challenges in end-of-life care in the ICU: Statement of the 5th International Consensus Conference in Critical Care: Brussels, Belgium, April 2003: Executive summary. Crit Care Med 2004;32(8):1781-1784.
(55) Barbera L, Paszat L, Chartier C. Indicators of poor quality end-of-life cancer care in Ontario. J Palliat Care 2006;22(1):12.
(56) Au DH, Udris EM, Fihn SD, McDonell MB, Curtis JR. Differences in health care utilization at the end of life among patients with chronic obstructive pulmonary disease and patients with lung cancer. Arch Intern Med 2006;166(3):326.
(57) Arabi Y, Venkatesh S, Haddad S, AL SHIMEMERI A, Al Malik S. A prospective study of prolonged stay in the intensive care unit: predictors and impact on resource utilization. International Journal for Quality in Health Care 2002;14(5):403-410.
(58) Goodridge D, Lawson J, Duggleby W, Marciniuk D, Rennie D, Stang MR. Health care utilization of patients with chronic obstructive pulmonary disease and lung cancer in the last 12 months of life. Respir Med 2008;102(6):885.
(59) Sharma G, Freeman J, Zhang D, Goodwin JS. Trends in end-of-life ICU use among older adults with advanced lung cancer. CHEST Journal 2008;133(1):72-78.
(60) Prescott E, Bjerg AM, Andersen PK, Lange P, Vestbo J. Gender difference in smoking effects on lung function and risk of hospitalization for COPD: results from a Danish longitudinal population study. European Respiratory Journal 1997;10(4):822-827.
(61) Gan SC, Beaver SK, Houck PM, MacLehose RF, Lawson HW, Chan L. Treatment of acute myocardial infarction and 30-day mortality among women and men. N Engl J Med 2000;343(1):8-15.

(62) Seferian EG, Afessa B. Demographic and clinical variation of adult intensive care unit utilization from a geographically defined population. Crit Care Med 2006 Aug;34(8):2113-2119.

(63) Ho TH, Barbera L, Saskin R, Lu H, Neville BA, Earle CC. Trends in the aggressiveness of end-of-life cancer care in the universal health care system of Ontario, Canada. Journal of Clinical Oncology 2011;29(12):1587-1591.

(64) Wolff JL, Starfield B, Anderson G. Prevalence, expenditures, and complications of multiple chronic conditions in the elderly. Arch Intern Med 2002;162(20):2269-2276.

(65) Blot F, Guiguet M, Nitenberg G, Leclercq B, Gachot B, Escudier B. Prognostic factors for neutropenic patients in an intensive care unit: respective roles of underlying malignancies and acute organ failures. European journal of cancer (Oxford, England: 1990) 1997;33(7):1031.

(66) Goodridge D, Lawson J, Rennie D, Marciniuk D. ORIGINAL RESEARCH. Rural/urban differences in health care utilization and place of death for persons with respiratory illness in the last year of life. Rural & Remote Health 2010;10(2).

(67) Wong AW, Gan WQ, Burns J, Sin DD, van Eeden SF. Acute exacerbation of chronic obstructive pulmonary disease: influence of social factors in determining length of hospital stay and readmission rates. Can Respir J 2008 Oct;15(7):361-364.

(68) Fowler RA, Sabur N, Li P, Juurlink DN, Pinto R, Hladunewich MA, et al. Sex-and age-based differences in the delivery and outcomes of critical care. CMAJ 2007 Dec 4;177(12):1513-1519.

(69) Wever-Hess J, Wever A. Asthma statistics in the Netherlands 1980–1994. Respir Med 1997;91(7):417-422.

(70) de Torres JP, Casanova C, Hernández C, Abreu J, Aguirre-Jaime A, Celli BR. Gender and COPD in patients attending a pulmonary clinic. CHEST Journal 2005;128(4):2012-2016.

(71) Watson L, Vestbo J, Postma DS, Decramer M, Rennard S, Kiri VA, et al. Gender differences in the management and experience of chronic obstructive pulmonary disease. Respir Med 2004;98(12):1207-1213.

(72) Menec VH, Lix L, Nowicki S, Ekuma O. Health care use at the end of life among older adults: does it vary by age? J Gerontol A Biol Sci Med Sci 2007 Apr;62(4):400-407.

(73) Sin DD, Anthonisen NR, Soriano JB, Agusti AG. Mortality in COPD: Role of comorbidities. Eur Respir J 2006 Dec;28(6):1245-1257.

(74) Iwashyna TJ. Critical care use during the course of serious illness. American journal of respiratory and critical care medicine 2004;170(9):981-986.
(75) Blackhall LJ, Frank G, Murphy ST, Michel V, Palmer JM, Azen SP. Ethnicity and attitudes towards life sustaining technology. Social Science & Medicine; Social Science & Medicine 1999.
(76) Valentin A, Jordan B, Lang T, Hiesmayr M, Metnitz PG. Gender-related differences in intensive care: a multiple-center cohort study of therapeutic interventions and outcome in critically ill patients. Crit Care Med 2003 Jul;31(7):1901-1907.
(77) Romo H, Amaral ACK, Vincent J. Effect of patient sex on intensive care unit survival. Arch Intern Med 2004;164(1):61-65.
(78) Yancik R. Cancer burden in the aged. Cancer 1997;80(7):1273-1283.
(79) Earle CC, Neumann PJ, Gelber RD, Weinstein MC, Weeks JC. Impact of referral patterns on the use of chemotherapy for lung cancer. J Clin Oncol 2002 Apr 1;20(7
(80) Townsley C, Pond GR, Peloza B, Kok J, Naidoo K, Dale D, et al... Analysis of treatment practices for elderly cancer patients in Ontario, Canada. Journal of clinical oncology 2005;23(16):3802-3810.
(81) Earle CC, Neville BA, Landrum MB, Ayanian JZ, Block SD, Weeks JC. Trends in the aggressiveness of cancer care near the end of life. Journal of Clinical Oncology 2004;22(2):315-321.
(82)Berghmans T, Tragas G, Sculier J. Age and treatment of non-small-cell lung cancer: a database analysis in elderly patients. Supportive care in cancer 2002;10(8):619-623.
(83) López-Encuentra A. Comorbidity in operable lung cancer: a multicenter descriptive study on 2992 patients. Lung Cancer 2002;35(3):263-269.
(84) Westert GP, Satariano WA, Schellevis FG, van den Bos GA. Patterns of comorbidity and the use of health services in the Dutch population. Eur J Public Health 2001 Dec;11(4):365-372.
(85) Aday LA, Andersen R. A framework for the study of access to medical care. Health Serv Res 1974;9(3):208.
(86) Rochon PA, Katz JN, Morrow LA, McGlinchey-Berroth R, Ahlquist MM, Sarkarati M, et al. Comorbid illness is associated with survival and length of hospital stay in patients with chronic disability: a prospective comparison of three comorbidity indices. Med Care 1996;34(11):1093-1101.

(87) Centers for Disease Control and Prevention [http://www.cdc.gov/] Classification of Diseases, Functioning, and Disability; 2012 [updated 2012 October 4; cited 2012 July 7]. Available from: http://www.cdc.gov/nchs/icd/icd10cm.htm

(88) Hosmer Jr DW, Lemeshow S, Sturdivant RX. Applied logistic regression. : Wiley. com; 2013.

(89) DeFrances CJ, Hall MJ, for the Division of Health Care Statistics.2005 National Hospital Discharge Survey. Hyattsville, MD: 2007.

(90) Curtis JR, Wenrich MD, Carline JD, Shannon SE, Ambrozy DM, Ramsey PG. Patients' Perspectives on Physician Skill in End-of-Life CareDifferences Between Patients With COPD, Cancer, and AIDS. CHEST Journal 2002;122(1):356-362.

(91) Baillargeon J, Kuo Y, Holmes H, Wang Y, Sharma G. Temporal Trends in Hospitalization Rates for Older Adults With Chronic Obstructive Pulmonary Disease. Chest 2012;142(4_MeetingAbstracts):694A-694A.

(92) Gardiner C, Gott M, Small N, Payne S, Seamark D, Barnes S, et al. Living with advanced chronic obstructive pulmonary disease: patients concerns regarding death and dying. Palliat Med 2009 Dec;23(8):691-697.

(93) World Health Organization. International classification of impairments, disabilities, and handicaps: a manual of classification relating to the consequences of disease, published in accordance with resolution WHA29. 35 of the Twenty-ninth World Health Assembly, May 1976. 1980.

(94) Centers for Disease Control and Prevention (CDC). Chronic obstructive pulmonary disease among adults. MMWR Morb Wkly Rep. 2012; 61 (46): 938-943.

(95) Edmonds P, Karlsen S, Khan S, Addington-Hall J. A comparison of the palliative care needs of patients dying from chronic respiratory diseases and lung cancer. Palliat Med 2001 Jul;15(4):287-295.

(96) Kriegsman DM, Deeg DJ, Stalman WA. Comorbidity of somatic chronic diseases and decline in physical functioning:: the Longitudinal Aging Study Amsterdam. J Clin Epidemiol 2004;57(1):55-65.

(97) Schwartz KL, Alibhai SM, Tomlinson G, Naglie G, Krahn MD. Continued undertreatment of older men with localized prostate cancer. Urology 2003;62(5):860-865.

(98) Alibhai SM, Krahn MD, Cohen MM, Fleshner NE, Tomlinson GA, Naglie G. Is there age bias in the treatment of localized prostate carcinoma? Cancer 2004;100(1):72-81.
(99) Angus DC, Barnato AE, Linde-Zwirble WT, Weissfeld LA, Watson RS, Rickert T, et al. Use of intensive care at the end of life in the United States: An epidemiologic study*. Crit Care Med 2004;32(3):638-643.
(100) Sharf BF, Stelljes LA, Gordon HS. ‘A little bitty spot and I'm a big man’: patients' perspectives on refusing diagnosis or treatment for lung cancer. Psycho‐Oncology 2005;14(8):636-646.
(101) National Statistics. Deaths by age, sex and underlying cause. 2003 registrations: health statistics quarterly 22, Report No.: HSQ22DT2. London: Office for National Statistics, 2004.
(102) Williams D, Kelly A, Feely J. Preferential prescribing of oral corticosteroids in Irish male asthmatic children. Br J Clin Pharmacol 2001;52(3):319-321.
(103) Guindon GE, Boisclair D. Past, current and future trends in tobacco use: HNP discussion paper. Washington: The World Bank; 2003. Available from: http://escholarship.org/uc/item/4q57d5vp [accessed 29 June 2014].
(105) Population, urban and rural, by province and territory (Saskatchewan). 2011; Available at: http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/demo62i-eng.htm. Accessed 06/24, 2014.
(106) DesMeules M. How Healthy are Rural Canadians?: An Assessment of Their Health Status and Health Determinants. : Canadian Institute for Health Information= Institut canadien d'information sur la santé; 2006.
(107) Wennberg JE, Fisher ES, Stukel TA, Skinner JS, Sharp SM, Bronner KK. Use of hospitals, physician visits, and hospice care during last six months of life among cohorts loyal to highly respected hospitals in the United States. BMJ 2004 Mar 13;328(7440):607.
(108) Laditka JN, Laditka SB, Probst JC. Health care access in rural areas: evidence that hospitalization for ambulatory care-sensitive conditions in the United States may increase with the level of rurality. Health Place 2009;15(3):761-770.
(110) Graverholt B. Acute hospital admissions from nursing homes. Rates and characteristics; unwarranted variation and effects of interventions to reduce them. 2014.

(111) College of Family Physicians of Canada. CFPC National Family Physician Workforce Survey [Part of the Janus Project: Family physicians meeting the needs of tomorrow's society]. Mississauga, Ont: College of Family Physicians of Canada 2001.
(112) Schlenker RE, Powell MC, Goodrich GK. Rural‐Urban Home Health Care Differences Before the Balanced Budget Act of 1997. The Journal of Rural Health 2002;18(2):359-372.
(113) Fabbri L, Luppi F, Beghe B, Rabe K. Complex chronic comorbidities of COPD. European Respiratory Journal 2008;31(1):204.
(114) Kinnunen T, Saynajakangas O, Tuuponen T, Keistinen T. Impact of comorbidities on the duration of COPD patients' hospital episodes. Respir Med 2003;97:143–146.
(115) Simmons C, Clemons M. Pattern of care at the end of life: does age make a difference? J Clin Oncol 2005 Apr 1;23(10):2441; author reply 2441-2.
(116) McGarvey LP, John M, Anderson JA, Zvarich M, Wise RA, TORCH Clinical Endpoint Committee. Ascertainment of cause-specific mortality in COPD: operations of the TORCH Clinical Endpoint Committee. Thorax 2007 May;62(5):411-415.
(117) Waite L, Gallagher M. The case for marriage: Why married people are happier, healthier and better off financially. : Random House LLC; 2002.
(118) Almagro P, Calbo E, de Echaguen AO, Barreiro B, Quintana S, Heredia JL, et al. Mortality after hospitalization for COPD. CHEST Journal 2002;121(5):1441-1448.
(119) Gruneir A, Mor V, Weitzen S, Truchil R, Teno J, Roy J. Where people die: a multilevel approach to understanding influences on site of death in America. Med Care Res Rev 2007 Aug;64(4):351-378.
(120) Stoller EP. Patterns of physician utilization by the elderly: A multivariate analysis. Med Care 1982:1080-1089.
(121)Saxena S, Ng T, Yong D, Fong N, Gerald K. Total direct cost, length of hospital stay, institutional discharges and their determinants from rehabilitation settings in stroke patients. Acta Neurol Scand 2006;114(5):307-314.
(122) Reville B, Miller MN, Toner RW, Reifsnyder J. End-of-life care for hospitalized patients with lung cancer: utilization of a palliative care service. J Palliat Med 2010;13(10):1261-1266.

(123)Rundek T, Mast H, Hartmann A, Boden-Albala B, Lennihan L, Lin IF, et al. Predictors of resource use after acute hospitalization: the Northern Manhattan Stroke Study. Neurology 2000 Oct 24;55(8):1180-1187.
(124) Horwitz LI, Krumholz HM, Green ML, Huot SJ. Transfers of patient care between house staff on internal medicine wards: a national survey. Arch Intern Med 2006;166(11):1173-1177.
(125) Gandhi TK. Fumbled handoffs: one dropped ball after another. Ann Intern Med 2005;142(5):352-358.
(126) Saliba D, Kington R, Buchanan J, Bell R, Wang M, Lee M, et al. Appropriateness of the decision to transfer nursing facility residents to the hospital. J Am Geriatr Soc 2000 Feb;48(2):154-163.
(127) Golestanian E, Scruggs JE, Gangnon RE, Mak RP, Wood KE. Effect of interhospital transfer on resource utilization and outcomes at a tertiary care referral center. Crit Care Med 2007 Jun;35(6):1470-1476.
(128) Przybysz R, Dawson H, Leeb K. Falls among top reasons for transfers from continuing care to acute care hospitals in Canada. Healthcare Quarterly 2009;12:62-66.
(129) Purdy W. Nursing Home to Emergency Room?: The Troubling Last Transfer. Hastings Cent Rep 2002;32(6):46-49.
(130) Canadian Institute for Health Information: Health Care in Canada: A First Annual Report. http://www.cihi.ca
(131) Wen SW, Liu S, Fowler D. Trends and variations in neonatal length of in-hospital stay in Canada. Can J Public Health 1998 Mar-Apr;89(2):115-119.
(132) Westfall JM, McGloin J. Impact of double counting and transfer bias on estimated rates and outcomes of acute myocardial infarction. Med Care 2001;39(5):459-468.
(133) Naylor CD, Chen E. Population-wide mortality trends among patients hospitalized for acute myocardial infarction: the Ontario experience, 1981 to 1991. J Am Coll Cardiol 1994;24(6):1431-1438.
(134) Callahan D. The WHO definition of 'health'. Stud Hastings Cent 1973;1(3):77-88.
(135) HILL AB. The Environment and Disease: Association Or Causation? Proc R Soc Med 1965 May;58:295-300.
(136) Statistics Canada, Health Statistics Division. Hospital Morbidity, 1992-1993; Ottawa: Ministry of Industry, 1995; Catalogue 82-216