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Temporal trends in the incidence and relative survival of non-small cell lung cancer in Canada: A population-based study

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ABSTRACT

Objectives: The objective of this study was to estimate trends in incidence and relative survival ratio in patients diagnosed with invasive lung cancer in Canada over the period of 1992–2007.
Materials and methods: We identified patients with primary invasive non-small cell lung cancers in the Canadian Cancer Registry (CCR) dataset. Patients younger than 18 years of age were excluded in this analysis. A flexible parametric model was used to estimate one- and five-year relative survival ratios and excess mortality rate.
Results: In total 182,417, patients from CCR dataset with invasive lung cancer were identified of which 57.2% (n = 106,197) were male and the mean age at diagnosis was 68.8 (SD = 11.0) years. The incidence rate of lung cancer decreased in men and increased in women. Although one-year relative survival ratio slightly improved over time for both genders and most age groups, five-year relative survival decreased for most of the groups.
Conclusions: Although the incidence rate of invasive lung cancer continued to decrease in men, it is increasing in women and the gap in incidence between men and women is narrowing. The one-year relative survival ratio gradually increased for most age groups over the study period, particularly for the younger age groups. Additionally, excess mortality rate is at its peak shortly after diagnosis and for the first 6 months and thereafter gradually decreases.

1. Introduction

Lung cancer is the most common non-skin cancer in Canada with 25,500 patients estimated to have been diagnosed with lung cancer in 2013 and 20,200 to die from this disease [1]. It is responsible for more deaths a year than cancers of breast, colon, and prostate combined. Based on the World Cancer Report 2008, lung cancer is the leading cause of cancer death in the world [2]. American Cancer Society estimated that cancers of lung and bronchus account for 13.8% of all new cases of cancers and 27.8% of all cancer deaths in the US [3]. Based on the Canadian Cancer Statistics, lung cancer is the 3rd most common cancer in men and the 2nd in women accounting for 13.7% and 13.3% of all new cancer cases in men and women, respectively [4].

Trends in incidence and survival of a cancer can portray the effectiveness of the public health strategies in fighting the disease and reducing its burden on the population [5]. However, literature is limited on the trends of incidence and survival of lung cancer in Canada.

In this article, we assess the trends in incidence and relative survival in patients diagnosed with invasive non-small cell lung cancer in Canada over the period of 1992–2008. In particular, we examine the long-term trends in relative survival and its association with demographic variables as temporal trends that can better elucidate significant associations.

2. Materials and methods

2.1. Data source

In this analysis, we used lung cancer data from the Canadian Cancer Registry (CCR) database. The CCR is a dynamic database of all Canadian residents from all provinces and territories who have been diagnosed with cancer since 1992. The CCR is a collabo-

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ration between the 13 Canadian provincial and territorial cancer registries (PTCRs) and the Health Statistics Division of Statistics Canada, where the data are maintained. The CCR is a patient-based system that records the type and number of primary cancers diagnosed for each person until death. The patient data is regularly linked to mortality data to optimize the accuracy of date, cause, and place of death fields in the CCR and to identify potential primary cancers not currently registered in the CCR. For each patient, the CCR describes both the individual and the tumor characteristics [6]. Stage and size of tumor were regularly collected from 2004.

Using the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10), we identified patients with primary invasive non-small cell lung cancer (NSCLC) with the codes of C34.0 (malignant neoplasm of main bronchus), C34.1 (malignant neoplasm upper lobe, bronchus or lung), C34.2 (malignant neoplasm of middle lobe, bronchus or lung), C34.3 (malignant neoplasm of lower lobe, bronchus or lung), C34.8 (overlapping malignant lesion of bronchus or lung), and C34.9 (malignant neoplasm bronchus or lung unspecified) in the CCR dataset. Then, using the International Classification of Diseases for Oncology (ICD-O-2 or ICD-O-3), we excluded from the analysis all small cell carcinoma, carcinoid tumor, adenoid cystic, fibromatous neoplasms, fibrous histiocytomal, mesenchymoma and cribriform carcinoma, and all tumous with ICD-O codes of 9050-9975 [7]. In addition, we excluded all patients diagnosed with benign borderline neoplasm of bronchus or lung. Patients were also excluded if the diagnosis was only based on the death certificate or autopsy. The analysis includes patients who were 18 years and over at diagnosis. The data from the province of Quebec were excluded from the CCR dataset because the death could not be confirmed by CCR.

Age at diagnosis was classified as <50, 50–59, 60–69, 70–79, and 80 and over. To summarize frequency of diagnosis based on period of diagnosis, year of diagnosis was categorized as 1992–1994, 1995–1999, 2000–2004, and 2004–2007.

2.2. Statistical analysis

Using CCR dataset and the population of Canada for each age group in different years, we calculated the age adjusted incidence rate of invasive lung cancer for the period of 1992–2008. Population of Canada for each age group in 2005 was used as the standard population. We also estimated incidence rate per age group over this period and used a simple linear regression to estimate the best linear fit between incidence rate and year of diagnosis for each age group (Fig. 2).

Relative survival analysis is used as the standard and preferred approach for population-based cancer registry datasets [8–10]. Relative survival ratio (or simply relative survival) is defined as the observed survival rate among cancer patients divided by the expected survival rate in the general population. It is interpreted as the survival probability in the absence of other causes where the cancer is the only cause of death [11–13]. Relative survival analysis was conducted on patients diagnosed with lung cancer from 1992 to 2007 with follow-up until the end of 2008. We used a flexible parametric (Royston–Parmar) model [14,15] to estimate relative survival ratio for each gender, age group, and year of diagnosis.

To estimate the relative survival, the background mortality rate for the general population which is usually available from the country's life-table is incorporated in the model. We retrieved the population size and background mortality rate for Canada from the Human Mortality Database [16].

We started fitting a model by incorporating age group, gender, and year of diagnosis into a multiple statistical model to find a final model for estimating the relative survival. We also included the interaction term between each two variables in the model. The likelihood ratio test was used to compare between different models to reach to a final model. Then, based on the final model, we estimated the one- and five-year relative survival ratios for each age group, gender, and year of diagnosis. We also estimated the excess mortality rate [17] which shows how much more the mortality is in the lung cancer patients compared with the general population of the same sex and age group.

The flexible parametric model was fitted using the freely available stpm2 software developed by Lambert and Royston [14] for the Stata package. Descriptive summary measures were estimated using Stata/SE 12.1 (Stata Corporation, College Station, TX).

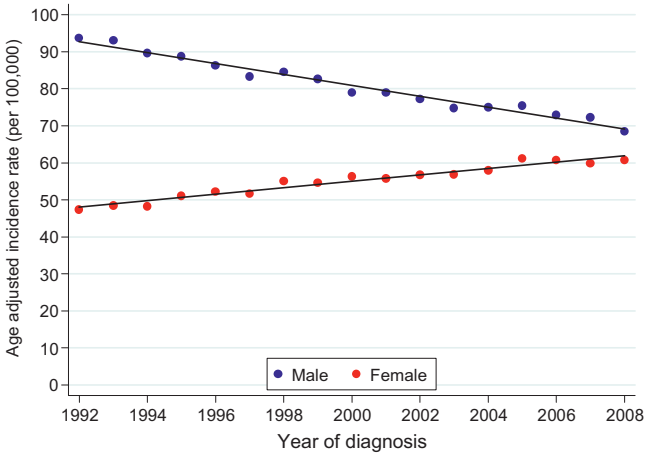

Fig. 1. Trends in the age adjusted incidence rate of lung cancer in Canada.

3. Results

In total 182,417, patients from CCR dataset with invasive NSCLC were identified of which 57.2% ($n = 106,197$) were male and the mean age at diagnosis was 68.8 (SD = 11.0) years. Table 1 presents frequency of diagnosis based on gender, age group, and period of diagnosis. Approximately, 80% of the patients were older than 60 years at the time of diagnosis. Proportion of the patients in the youngest age group decreased from 6.2% to 4.5% over time but it increased for oldest group from 12.9% to 19.7%. Same pattern has been observed for male and female groups separately. In other word, the data indicates that age of diagnosis increased over time. In addition, proportion of male patients decreased from 64.1% for the period of 1992–1994 to 58.2% for 2005–2007.

3.1. Incidence of lung cancer

Fig. 1 depicts trends in the age adjusted incidence rate (per 100,000 persons) in men and women over the period of 1992–2008. Further analysis showed that on average, the incidence rate in men decreased by 1.47 cases per 100,000 persons per year over this period ($p < 0.001$). On the other hand, incidence rate among women increased by 0.86 cases per 100,000 persons per year ($p < 0.001$). Fig. 2 shows trends in incidence rate for each age group for the same period. Based on this graph, incidence rate decreased in all age groups for men but increased for all women 60 years and over, although slightly decreased for women younger than 60 years. In contrast with men where the highest incidence rate observed for the older age group (80+), in women the highest incidence rate is observed in patients 70–79 years old.