Does Socioeconomic Status Affect Stage at Presentation for Larynx Cancer in Canada’s Universal Health Care System?

Diana Khalil, MD, FRCSC1, Martin J. Corsten, MD, FRCSC2, Margaret Holland3, Adele Balram3, James Ted McDonald, PhD4, and Stephanie Johnson-Obaseki, MD, FRCSC1

Abstract

Background

In 2013, there were an estimated 89,081 people living with laryngeal cancer in the United States. In 2016, there were an approximately 13,340 new cases in the United States and 3620 deaths from laryngeal cancer.1 These numbers are comparable per population with an estimated 1050 new cases and 400 deaths in Canada in 2016.2 Most people with laryngeal cancer present with hoarseness at an early stage in their disease.3 Early diagnosis of laryngeal cancer is dependent on patient and physician awareness that persistent hoarseness needs to be investigated as well as access to an otolaryngologist. Despite the early symptom of hoarseness, only 55.3% of laryngeal cancers are diagnosed at the local stage. Late diagnosis at more advanced stages has a direct effect on prognosis as the 5-year survival of localized laryngeal cancer is 76.3%, compared to 44.5% and 35.1% with regional and distant disease, respectively.1

Many cancers have a worsened survival in patients with lower socioeconomic status (SES).4 SES is a function of income, education, and occupation and is thought to be a marker of underlying physical and social factors that cause cancer and reduced survival.5 Such factors include stage at presentation, education, access to health care services, diet, environmental exposure, and differential levels of tobacco and alcohol consumption.6 There is an increasing debate regarding the ability to provide adequate health care access in the public system to citizens across varied SES classes.

No sponsorships or competing interests have been disclosed for this article.

Objective. Diagnosis of laryngeal cancer is dependent on awareness that persistent hoarseness needs to be investigated as well as access to an otolaryngologist. This study aimed to better classify and understand 3 factors that may lead to variability in stage at presentation of laryngeal cancer: (1) socioeconomic status (SES), (2) differences in access to health care by location of residence (rural vs urban or by province), and (3) access to an otolaryngologist (by otolaryngologists per capita).

Study Design. Registry-based multicenter cohort analysis.

Setting. This was a national study across Canada, a country with a single-payer, universal health care system.

Subjects. All persons 18 years or older who were diagnosed with laryngeal cancer from 2005 to 2013 inclusive were extracted from the Canadian Cancer Registry (CCR).

Methods. Ordered logistic regression was used to determine the effect of income, age, sex, province of residence, and rural vs urban residence on stage at presentation.

Results. A total of 1550 cases were included (1280 males and 265 females). The stage at presentation was earlier in the highest income quintile (quintile 5) compared to the lower income quintiles (quintiles 1-4) (odds ratio [OR], 0.68; \( P < .05 \)). There was a statistically significant difference in stage at presentation based on rural or urban residence within the highest income quintile (OR, 1.73; \( P < .005 \)).

Conclusion. There is a relationship between SES and stage at presentation for laryngeal cancer even in the Canadian universal health care system.

Keywords

laryngeal cancer; stage at diagnosis; socioeconomic status, rural residence, urban residence, income, age at diagnosis

1Department of Otolaryngology–Head and Neck Surgery, University of Ottawa, Ottawa, ON, Canada
2Department of Otolaryngology–Head and Neck Surgery, Methodist Dallas Medical Center, Dallas, Texas, USA
3New Brunswick Institute for Research, Data, and Training, University of New Brunswick, Fredericton, NB, Canada
4Department of Economics, University of New Brunswick, Fredericton, NB, Canada

This article was presented at the 2017 AAO-HNSF Annual Meeting and OTO Experience; September 10-13, 2017; Chicago, Illinois.

Corresponding Author:
Diana Khalil, MD, FRCSC, Department of Otolaryngology–Head and Neck Surgery, University of Ottawa, S3–501 Smyth Road, Ottawa, ON K1H 8L6, Canada.
Email: diana.khalil@medportal.ca
The universal health care system in Canada is often upheld as an ideal. This ideal was reinforced in 1984 with the Canada Health Act that made Canada a rigid 1-tier system, making health care “free” for all Canadians regardless of income or insurance status. Booth et al examined the effects of median household income on survival for a number of cancers in Ontario, Canada, including head and neck, and found a substantial gradient in survival between the highest and lowest income quintiles for all cancers studied. A national Canadian study was conducted by McDonald et al from 1999 to 2005, showing a statistically significant increase in survival for head and neck cancers across all income quintiles (InQs) and a survival benefit for individuals in the highest InQ compared to the lowest over the study period. In 1999, Nutting et al examined survival for laryngeal cancer in England and Wales and found that 5-year survival was 17% lower among men diagnosed in the most deprived group compared to those in the most affluent group. These past studies have shown that despite universal health care systems, there is a survival gradient that is driven by income quintile.

In 2009, the American Academy of Otolaryngology–Head and Neck Foundation (AAO-HNSF) published the first clinical practice guideline on hoarseness, which is used across North America—suggesting a 3-month window in which the larynx should be visualized if hoarseness persists. This requires both a referral source from a general practitioner as well as access to specialized care, particularly to otolaryngologists, as diagnosis is dependent on visualization of the larynx using flexible laryngoscopy. However, specialized care tends to be centralized, with a greater number of otolaryngologists in urban areas. In the United States and France, rural patients have been reported to have more advanced disease at the time of cancer diagnosis. Studies in the United States and Europe have shown that patients with poor access were more likely to present with disseminated disease for breast, colorectal, prostate, and lung cancers. They also have been found to be less likely to be referred to specialist centers or receive adjuvant therapy, suggesting that the problem is primarily one of distance from cancer centers.

What makes laryngeal cancer of specific interest is that diagnosis is dependent on 2 factors that may be related to SES and/or residence: (1) awareness that persistent hoarseness needs to be investigated and (2) access to an otolaryngologist. Our group sought to better classify and understand the relationship between SES, location of residence (rural vs urban), and province of residence and stage at presentation of laryngeal cancer from 2005 to 2013. To our knowledge, there has not been a Canadian study using nationwide Cancer Registry data to examine the relationship between stage of presentation of laryngeal cancer, SES, and geographic location in Canada. The goals of this study were 2-fold: (1) to confirm the relationship between SES and stage of presentation and (2) to investigate a potential relationship between rural vs urban residence and stage of presentation and whether there was a correlation between province of residence and the number of otolaryngologists per capita.

Methods

Data Collection

This study made use of data from the following sources: (1) the Canadian Cancer Registry (CCR); (2) the Postal Code Conversion File, version 6C (PCCF + 6C); and (3) the 2006 Canadian Census of population. Our data were accessed in the New Brunswick Research Data Centre (NB-RDC), located at the University of New Brunswick in Fredericton, Canada. The CCR contains tumor-specific and patient demographic data for each tumor reported to the provincial and territorial cancer registries. Cases of laryngeal cancer were identified using International Classification of Diseases, 10th Revision (ICD-10) codes C32.0 to C32.9. The CCR data set used by Statistics Canada Research Data Centre program provided ICD-10 codes that were consistently defined over the sample period from 2005 to 2013. From the CCR, we also obtained patient-level data on sex, age at diagnosis, year of diagnosis, and American Joint Committee on Cancer (AJCC) stage at diagnosis. Records missing any key data were excluded from our sample.

Data on SES information at the local level were drawn from the 2006 confidential Canadian Census of population and assigned using PCCF + 6C. PCF+6C is a SAS program that assigns a range of 2006 standard census geographies and other supplementary data using patient postal code, which is available in the CCR for each record of laryngeal cancer. The smallest level of disaggregation at which census information is available through the Research Data Centre is Dissemination Area (DA). DAs are relatively stable geographic units that cover the whole territory of Canada. Our key measure of interest was SES. We captured SES by controlling for adjusted average neighborhood-level (DA) income, which was defined as the average income per single person equivalent (IPPE) in the DA. In brief, IPPE is a household size-adjusted measure of household income that uses single-person equivalents and low-income cutoffs.

To control for important regional differences in prices and wages, average neighborhood IPPE was ranked into income quintiles relative to the other DAs within the corresponding Census Metropolitan Area (CMA), Census Agglomeration (CA), or provincial residual area not corresponding to any CMA or CA. CMAs and CAs are subprovincial regions that consist of 1 or more adjacent municipalities centered on a population center termed the core. A municipality is included within a CMA/CA if it had a high degree of integration with the core, where integration is defined by degree of commuting flows recorded in the 2006 Census of Population. A CMA consists of at least 100,000 people, with at least half (50,000 people) residing in the core. A CA must have a minimum of 10,000 people living in the core. There were 33 CMAs and 111 CAs in the 2006 Census of Population.
Our dependent variable was AJCC stage at diagnosis, which is an ordinal variable with 4 possible levels: stages I, II, III, and IV. Accordingly, our sample was restricted to cases of laryngeal cancer occurring in those provinces and territories that report on staging information for cases of laryngeal cancer (i.e., Alberta, Manitoba, Newfoundland, Northwest Territory, Nova Scotia, Prince Edward Island, and Saskatchewan). Our sample was further restricted to cases of cancer occurring in a province due to the small number of cases of laryngeal cancer in the Northwest Territory during the sample period. Cases of laryngeal cancer diagnosed in 2005 through 2009, inclusive, were staged in accordance to AJCC 6.\(^\footref{6}\)\(^\footref{19}\) Cases of laryngeal cancer diagnosed in 2010 through 2013, inclusive, were staged in accordance to AJCC 7.\(^\footref{7}\)\(^\footref{19}\)\(^\footref{20}\) For the purposes of this study, it was assumed that AJCC 6 staging criteria for laryngeal cancer were consistent with the criteria outlined in AJCC 7.\(^\footref{19}\)\(^\footref{20}\)

Research Ethics Board

This study complied with the University of New Brunswick’s Institutional Review Board policy, which does not necessitate an additional, internal institutional review for research projects using data accessed through the Statistics Canada Research Data Centre Program.

Statistical Analysis

Our statistical analysis employed ordinal logistic regressions to investigate changes in the relationship between stage at diagnosis and SES. The dependent variable was expressed as a function of SES and other personal characteristics (i.e., age at diagnosis, sex, province of residence, rural area resident, and year of diagnosis). Two different specifications for SES were used: (1) income quintile, measured as a set of 4 binary variables, and (2) a binary variable for where belonging to the highest income quintile takes on the value of 1 and 0 otherwise. This article reports the binary measures as they were the most important, but other results are available on request. To allow trends to vary by SES, we controlled for additional interactions between the income variables and residing in a rural area and male sex. Ordinal logistic regressions were first estimated for the entire sample using an indicator for sex and then separately for males and females. \(P\) values and 95% confidence intervals were computed based on clustered (Rogers) standard errors that are robust to the presence of heteroskedasticity.

Statistical analysis was conducted using SAS version 9.4 (SAS Institute, Cary, North Carolina) and Stata version 14 (StataCorp LP, College Station, Texas).

Results

Stage at Diagnosis by SES

SES, as measured by InQ, was strongly and significantly correlated with stage of laryngeal cancer at diagnosis. Individuals in the highest InQ (InQ 5) compared to the rest (InQs 1-4) were more likely to be diagnosed with an earlier stage of laryngeal cancer (Table 1). In earlier results not reported that included controls for all quintiles, there were no significant differences in stage at diagnosis among the lower 4 quintiles. After controlling for age, sex, and location of residence, the odds ratio (OR) for the highest InQ relative to the rest was 0.67 (95% confidence interval [CI], 0.47-0.97; \(P = .036\)). Disaggregating the sample by sex and estimating the model separately for men and women revealed that this protective association for highest InQ and earlier stage of diagnosis was seen to hold true for men (OR, 0.66; 95% CI, 0.45-0.98; \(P = .038\)) but not for women (95% CI, 0.96-1.03; \(P = .397\)). This shows that for the general Canadian population, and males in particular, those with lower SES are being diagnosed with more advanced cancer.

Stage at Diagnosis by Rural/Urban Residence

Table 2 demonstrates the results of our analysis of stage at diagnosis of laryngeal cancer by whether the individual resided in a rural area. Multivariate analysis showed no significant correlation between urban/rural residence and stage at diagnosis of laryngeal cancer when age, sex, and InQ were controlled for (95% CI, 0.47-0.97; \(P = .33\)). Further analysis to allow the effect of rural residence to vary by income quintile shows that when looking at people in the highest InQ, those living in rural locations will be diagnosed with a later stage of laryngeal cancer (OR, 1.73; 95% CI, 1.07-2.78; \(P = .02\)) relative to the significantly lower stage of laryngeal cancer for urban dwellers in the highest income quintile, offsetting the apparent advantage to highest income quintile individuals. The net effect is that the highest InQ advantage only applies in urban populations. Thus, it appears that both high income quintile and residence in an urban area are necessary for an advantage in terms of lower

Table 1. Socioeconomic Status and Stage at Diagnosis.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Everyone (n = 1550)</th>
<th>Male (n = 1280)</th>
<th>Female (n = 265)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR</td>
<td>(P) Value</td>
<td>95% CI</td>
</tr>
<tr>
<td>Age &gt;65 y</td>
<td>0.91</td>
<td>.351</td>
<td>0.74-1.11</td>
</tr>
<tr>
<td>Rural</td>
<td>1.08</td>
<td>.326</td>
<td>0.93-1.25</td>
</tr>
<tr>
<td>Highest income quintile</td>
<td>0.68</td>
<td>.036</td>
<td>0.47-0.97</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; OR, odds ratio.
stage at diagnosis. Therefore, those living in rural residence in both highest and lower InQs are being diagnosed with more advanced cancer compared to urban residents in DAs in the highest InQ.

**Stage at Diagnosis by Province of Residence**

Table 2 demonstrates the results of our analysis of stage at diagnosis of laryngeal cancer across Canada by province. Alberta was used as the reference province. Provinces included in the study had CCR data specific to stage of laryngeal cancer at presentation (Alberta, Manitoba, Newfoundland and Labrador, Nova Scotia, Prince Edward Island, and Saskatchewan). Significant variability across provinces was found for the general population with an increased odds ratio of later stage of laryngeal cancer at diagnosis for the eastern provinces of Prince Edward Island (1.18) and Nova Scotia (1.20), as well as an earlier stage of diagnosis being seen in Manitoba (0.64) and Newfoundland (0.78) (all \( P < .001 \)). Disaggregating the population by sex showed that these same associations, with an earlier stage of laryngeal cancer, held true for males in Newfoundland (0.65) and Manitoba (0.64), as well as females in Manitoba (0.65) and Saskatchewan (0.84) (all \( P < .001 \)). Males in Prince Edward Island (1.03) and Nova Scotia (1.06) were seen to have an increased odds ratio of later stage of laryngeal cancer (all \( P < .001 \)).

**Otolaryngologists per Capita and Stage at Presentation**

One possible reason for variation across provinces in stage at diagnosis is ease of access to an ear, nose, and throat (ENT) specialist. To investigate whether this is the case, we present the results of our regression analysis of stage at diagnosis of laryngeal cancer across Canada after including as a regressor the number of otolaryngologists per capita (Table 3). Again, Alberta was used as the reference province. The included provinces are listed in order of increasing number of otolaryngologists/100,000 population. There is no statistically significant result for stage at diagnosis of laryngeal cancer and the number of otolaryngologists per capita.

**Discussion**

Since the 1960s, Canada has prided itself on having a universal health care system covering all services provided by physicians and hospitals.\(^7\),\(^21\) This universal health care...
system has been held as the ideal, but with increasing demand, surging costs, and limited resources, its sustainability is in question.

Our study showed that even within Canada’s universal health care system, there does exist an income/health gradient for stage at diagnosis of laryngeal cancer. Although the gradient was not statistically significant across all the income quintiles, when comparing the highest InQ to the remainder (InQs 1-4), there was a significant odds ratio favoring the highest InQ for earlier stage at diagnosis. The highest InQ advantage was seen in the general population and in male patients but did not carry over to female patients. The poor prognostic impact on overall survival seen in male patients in lower SES has been seen across numerous cancers, including other head and neck malignancies.22 Most recently, Saini et al23 completed a nationwide population-based cohort study specific to laryngeal cancer in the United States and found that residing in a county with low median household income increased the odds of receiving surgical therapy (OR, 1.22; \( P < .001 \)). Although they did not show this was associated with a statistically significant difference in overall survival, this may speak to the later stage at presentation that precluded the use of laryngeal preservation treatments.

Groome et al5 completed a Canadian study to explain the SES effect in laryngeal cancer, looking specifically within the province of Ontario. They found that patients with glottic cancers living in the poorest areas were 15% less likely to be diagnosed with a T1 category tumor than those living the richest areas of the province. They also found a statistically significant association with SES for cause-specific survival (\( P = .02 \)) and locoregional failure (\( P = .01 \)), with the gradient in the expected direction. These studies and ours highlight that even within a universal health care system, disparities in access to health care and barriers to early diagnosis exist.

The second finding highlighted in our study was that when comparing stage of presentation within the highest InQ between urban and rural dwellers, there does exist an advantage for urban location of residence. People in the highest InQs with rural residence are diagnosed at a later stage (OR, 1.73; \( P = .02 \)). This finding speaks to differences in access to health care and is in agreement with other studies showing that specialist health care tends to be localized to city centers.11-14 Recently published American data showed that not only SES but also geographic location play a role in the treatment of laryngeal cancer. Mourad et al24 completed a retrospective analysis of the Surveillance, Epidemiology, and End Results (SEER) database and found a statistically significant difference in treatment received by region and state (\( P < .0001 \)). They concluded that geographic variability likely played a pivotal role in determining overall treatment trends due to referral patterns, as well as availability of qualified practitioners.

The final finding of our nationwide Canadian study is that there does exist variability in the stage of laryngeal cancer at presentation across the provinces included. Regression analysis allowed us to control for otolaryngologists per capita and did not reveal any statistically significant relationship. This suggests that there may be a more fundamental issue occurring at the provincial level—either a function of the system or individual practices in each province, warranting further investigation using provincial administrative data.

Our study had several limitations. First, we did not possess CCR data specific to stage at presentation for all provinces within our study period, excluding British Columbia, Ontario, and Quebec. We urge reporting authorities to increase the transmission of staging information into administrative data health systems so that the wider Canadian population can be studied. Second, we did not have access to individual-level income data and thus used DA-level information on household income as a substitute, which is less precise than individual-level information. Within Canada’s system, access to an otolaryngologist requires referral by a general practitioner. Within our current national databases, date of initial presentation and referral is not available, and therefore we were unable to estimate the effect of prolonged wait times.

What is needed in this time of limited resources and federal scrutiny of health care delivery is a comparator study of other health care systems. This may have a direct impact on health care structuring to improve patient access both across different socioeconomic groups as well as locations, including increased access to specialist care in rural settings.

Conclusions

Even within Canada’s universal health care system, there exists a significant variation in stage of presentation of laryngeal cancer, with earlier presentation being seen in males within the highest income quintile residing in urban locations.

Acknowledgment

RDC: The analysis presented in this article was conducted at the New Brunswick Research Data Centre (NB-RDC), which is part of the Canadian Research Data Centre Network (CRDCN). The services and activities provided by the NB-RDC are made possible by the financial or in-kind support of the Social Sciences and Humanities Research Council (SSHRC), Canadian Institutes of Health Research (CIHR), Canadian Foundation for Innovation (CFI), Statistics Canada, and the University of New Brunswick (UNB). The views expressed in this article do not necessarily represent those of the CRDCN or that of its partners.

MSSU/NB-IRDT: A.B. and M.H. were supported by the Maritime SPOR Support Unit (MSSU) and New Brunswick Institute for Research, Data, and Training (NB-IRDT), which receives financial support from the Canadian Institutes of Health Research (CIHR), the New Brunswick Department of Health (GNB DH), and the New Brunswick Health Research Foundation (NBHRF). The opinions, results, and conclusions reported in this article are those of the authors and are independent from the funding sources. No endorsement by the MSSU or the named funding partners is intended or should be inferred.

Author Contributions

Diana Khalil, interpretation of data, drafting the article and final approval, agreement to be accountable for all aspects of the work;
Martin J. Corsten, conception of study, drafting the article and final approval, agreement to be accountable for all aspects of the work; Margaret Holland, study design, acquisition, analysis and interpretation of data, drafting the article and final approval, agreement to be accountable for all aspects of the work; Adele Balram, study design, acquisition, analysis and interpretation of data, drafting the article and final approval, agreement to be accountable for all aspects of the work; James Ted McDonald, conception and design, acquisition of data, drafting the article and final approval, agreement to be accountable for all aspects of the work; Stephanie Johnson-Obaseki, conception of study, drafting the article and final approval, agreement to be accountable for all aspects of the work.

Disclosures
Competing interests: None.
Sponsorships: None.
Funding source: None.

References