Medical Research Archives

ESMED
European Society of Medicine

OPEN ACCESS

Published: July 31, 2023

Citation: Febbraro M, Juergens R, et al., 2023. Surgical Oncologists: Assessing Access to And Outcomes of Medical Oncology and Radiation Oncology Consultation in Non-Small Cell Lung Cancer Patients: A Population-Based Study Using Administrative Data, Medical Research Archives, [online] 11(7). https://doi.org/10.18103/mra.v11i7.2.4130

DOI
https://doi.org/10.18103/mra.v11i7.2.4130

ISSN: 2375-1924

RESEARCH ARTICLE

Assessing Access to And Outcomes of Medical Oncology and Radiation Oncology Consultation in Non-Small Cell Lung Cancer Patients: A Population-Based Study Using Administrative Data

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ABSTRACT

Background: Therapeutic advances in non-small cell lung cancer (NSCLC) have shifted treatment away from chemotherapy towards immunotherapy, monoclonal antibody, and tyrosine kinase inhibitor therapy. Most studies focusing on access to specialist care and lung cancer treatment were conducted before novel therapeutic strategies in NSCLC. This study aimed to better understand and inform referral practices for patients with NSCLC in Ontario.

Methods: A retrospective population-based study using linked administrative healthcare data was conducted between 2010 and 2019. The study cohort was defined as patients, aged 18 years of age or older, with a stage I to IV NSCLC diagnosis in Ontario. Primary outcome: medical oncology or radiation oncology consultation within 120 days of diagnosis. Prognostic factors for consultation and receipt of treatment were identified using logistic regression.

Results: 73,849 patients were diagnosed with NSCLC with 61.3% and 50.9% receiving a medical oncology or radiation oncology consultation respectively. The median time to consultation was 24 days (interquartile range [IQR] 13-49 days). As the stage increased, consultation was more likely (odds ratio [OR] 6.07, 95% CI 5.78-6.38). As the distance to the nearest cancer center increased consultation was less likely (OR 0.72, 95% CI 0.67-0.78). Stage III NSCLC and patients aged 40-44 years were more likely to receive treatment OR 4.09 (95%CI 3.82-4.38) and OR 3.28 (95% CI 2.51-4.28) respectively.

Conclusion: Even in a universal health care system, socioeconomic factors impact a patient's access to specialist care. Given newer, more effective therapeutic options for NSCLC, access to specialist care must be equitable.

Introduction

Approximately 75% of lung cancers are diagnosed at an advanced stage (stage III or stage IV) with non-small-cell lung cancer (NSCLC) accounting for 85% of diagnoses.[1,2] The 5-year survival for lung cancer in Canada is approximately 19%, with stage IA disease having a 5-year survival of 92% and stage IVB disease having a 5-year survival of 0%.[1] Significant therapeutic advances in NSCLC have been facilitated by an improved understanding of pathogenic genomic alterations leading to the development of NSCLC. [3] Therapeutic advances, including the use of immunotherapy (IO), monoclonal antibody and oral targeted tyrosine kinase inhibitor (TKI) therapy, have moved treatment beyond a chemotherapy strategy, improving lung cancer survival.[2,4]

The management of metastatic NSCLC has significantly changed since the introduction of IO in 2015.[5] Pembrolizumab, a monoclonal antibody directed against programmed death 1 (PD-1), demonstrated an improvement in overall survival (OS) of 13 months when compared to chemotherapy in the first-line treatment of advanced NSCLC.[6] IO has also shown benefits in the locally advanced space with the use of atezolizumab and durvalumab, monoclonal antibodies directed against programmed death-ligand 1 (PD-L1), for the treatment of resectable and unresectable locally advanced NSCLC respectively.[7,8] Given the success of IO in curative and advanced NSCLC treatment, the use of IO as a neoadjuvant treatment of NSCLC is becoming more common.[9]

Over the past decade, the identification of aberrant cell growth and survival signalling pathways has led to the discovery of TKI and monoclonal antibody therapies targeting driver mutation pathways.[5] The International Association for the Study of Lung Cancer (IASLC) recommends testing for several driver mutations. The identification of a mutation can confer a survival advantage with the use of TKI therapy in the first-line setting.[10] For example, mutations of epidermal growth factor receptor (EGFR) are found in 30% of patients with NSCLC without a smoking history.[11] Osimertinib is an oral TKI directed against EGFR. It is used as an adjuvant treatment in resected NSCLC and as a first-line treatment for advanced NSCLC harbouring certain EGFR mutations.[12]

With lung cancer treatment advances, and the ability to provide novel therapies instead of or in addition to chemotherapy, the decision to offer or withhold treatment is becoming increasingly complex. Access to specialist assessment is particularly important to ensure patients are properly informed of their treatment options. Patients seen by a cancer specialist are more likely to receive cancer-directed therapy.[13] In addition to receiving the proper care, having disease detected, diagnosed, and treated in a timely fashion is crucial to patient outcomes.[14]

Canada functions under a universal healthcare system with health care funded by the federal and provincial governments through taxation. Universal healthcare systems are often viewed as more equitable, however, these systems are criticized for having excessively long wait times and lack of access to new and beneficial therapies. Given the importance of timely care for patients with NSCLC and the rapidly increasing number of therapeutic options for patients, an understanding of the current management process in Canada for patients with NSCLC is crucial for optimizing their care. Unfortunately, most studies focusing on access to specialist care and lung cancer treatment were conducted decades ago before the evolution of IO and TKI as beneficial treatment options. Further, most studies were conducted in an international setting making these studies difficult to interpret in a Canadian healthcare context. This study was conducted to better understand and inform referral practices for patients with NSCLC in Canada.

Methods

Study Design and Population

A retrospective population-based study using linked administrative health care data in Ontario, Canada was conducted. Ontario is the largest and most populous Canadian province, with a population of approximately 14.9 million and accounting for almost 40% of all Canadians.[15] All patients aged 18 years of age or older, with a stage I to stage IV NSCLC diagnosis in Ontario between 2010 and 2019 were included in the study population. Patients with prior cancer, patients who were seen by medical oncology or radiation oncology before lung cancer diagnosis, and patients who had received systemic or radiation therapy before a confirmed diagnosis of cancer were excluded as they were believed likely to have different care pathways than patients with a de novo cancer diagnosis.

Data Sources and Covariates

Using encrypted health insurance card numbers, the following administrative databases (and

corresponding variables) were linked through ICES (formerly known as the Institute for Clinical and Evaluative Sciences): Cancer Activity Level Reporting (radiation and systemic therapy services); Discharge Abstract Database (clinical, demographic and administrative data for hospital admissions and day surgery); Ontario Health Insurance Plan (date of service, diagnostic code, claim fee code); National Ambulatory Care Reporting System (day surgery visits, outpatient clinic visits, emergency department visits); New Drug Funding Program (cancer drug funding); Ontario Cancer Registry (cancer type, diagnosis date, stage); and Registered Persons Database (patient demographics, Charlson score). The de-identified data were obtained following approval from the Hamilton Integrated Research Ethics Board and completion of the ICES data use agreement.

Each patient had a timeline constructed of Ontario Health Insurance Plan (OHIP) billing codes and associated service dates beginning with the date of a primary cancer diagnosis. A consultation was determined by the most up-to-date billing codes through the Ontario Schedule of Benefits for Physician Services. A patient's distance to the nearest cancer center and dependency quintile were derived using conversion software from Statistics Canada to match postal codes based on the neighbourhood to small geographical units (Census Tracts and Dissemination Area).

Table 1 – Baseline Information

Variable		**N** (%)
Year of Diagnosis:	2010	7227 (9.8)
	2011	7158 (9.7)
	2012	7510 (10.2)
	2013	7282 (9.9)
	2014	7478 (10.1)
	2015	7338 (9.9)
	2016	7400 (10.0)
	2017	7698 (10.4)
	2018	7707 (10.4)
	2019	7051 (9.5)
Sex	Male	37109 (50.3)
	Female	36740 (49.7)
Age Group in Years:	18-34	182 (< 1)
	35-39	170 (< 1)
	40-44	431 (1.0)
	45-49	1221 (1.7)
	50-54	3237 (4.4)
	55-59	6354 (8.6)
	60-64	9669 (13.1)
	65-69	11900 (16.1)
	70-74	12923 (17.5)
	75-79	11682 (15.8)
	≥ 80	16080 (21.8)
Distance to Nearest Cancer Centre*:	< 10km	26458 (35.9)
	10-49.9km	27654 (37.5)
	50-99.9km	14004 (19.0)
	≥ 100km	5652 (7.7)
Stage	I	12396 (16.8)
	II	5344 (7.2)
	III	13031 (17.6)
	IV	33668 (45.6)
	Unknown	9410 (12.7)
Consult – N (%)	Radiation Oncology	37573 (50.9)
	Medical Oncology	45233 (61.3)
	Both	52837 (71.6)
Treatment – N(%)	Radiation Therapy	34262 (46.4)
	Systemic Therapy**	35558 (48.1)
*Due to missing data the total population evaluated for this variable was 73768 ** Treatment was defined as patients having received systemic therapy (including NDFP) or radiation therapy		

Analysis

Descriptive statistics were used to summarize the demographic and treatment information of the patient population as well as outcomes. The primary outcome was medical oncology and/or radiation oncology consultation, defined as the first visit with a medical or radiation oncologist within 120 days of diagnosis of lung cancer using the OHIP consultation billing codes. Logistic regression was used to identify prognostic factors for medical oncology and radiation oncology consultation as well as receipt of radiation and/or systemic treatment. Treatment was defined as patients having received systemic therapy (including NDFP) or radiation therapy. Univariable and multivariable analyses were performed, with the multivariable model constructed using the full model, which includes all potential covariates in the model, given the large sample size. All tests were two-sided and statistical significance was defined at α=0.05 level. All analyses were conducted using SAS software.

Results

In Ontario, a total of 73,849 patients were diagnosed with stage I to stage IV NSCLC between 2010 and 2019. **Table 1** displays the baseline demographics of the cohort. Fifty percent of patients were male, while most patients were aged 60 years and over and 45.6% had stage IV disease. Overall, 61.3% of patients received a medical oncology consultation and 50.9% of patients received a radiation oncology consultation following their diagnosis with the median time to consultation being 24 days (interquartile range [IQR] 13-49 days). Outcomes are presented by stage of disease in **Table 2.** As the stage increased, the proportion of patients that had a thoracic surgery consultation decreased. For all stages, a thoracic surgery consultation was the first specialist consultation received for malignancy. As the stage increased, the proportion of patients receiving a medical oncology or radiation oncology consultation increased and the proportion of patients receiving systemic therapy and radiation therapy also increased. The median OS ranged from 50.9 months (IQR 49.5 to 52.4 months) for stage I cancer to 4.0 months (IQR 3.9 to 4.1 months) for stage IV NSCLC. Patients who were treated had improved OS for all stages.

Table 2 – Outcomes by Stage if NSCLC

Variable:	Stage I	Stage II	Stage III	Stage IV
Total Patients	12396	5344	13031	33668
Consult – N (%)				
Thoracic Surgery	9526 (76.9)	4057 (75.9)	8254 (63.3)	12086 (35.9)
Radiation Oncology	2953 (23.8)	3184 (59.6)	8806 (67.6)	19528 (58.0)
Medical Oncology	5384 (43.4)	2972 (55.6)	10785 (82.8)	23069 (68.5)
First specialist consult – N (%)				
Thoracic Surgery	8866 (71.5)	3651 (68.3)	7156 (54.9)	3388 (36.0)
Radiation Oncology	651 (5.3)	563 (10.5)	1653 (12.7)	1220 (13.0)
Medical Oncology	1666 (13.4)	720 (13.5)	3272 (25.1)	1206 (12.8)
Radiation Therapy – N (%)	4236 (34.2)	2113 (39.5)	9079 (69.7)	18834 (55.9)
Systemic Therapy* – N (%)	1339 (10.8)	3757 (70.3)	10113 (77.6)	20349 (60.4)
Overall Survival in months – Median (95% CI)				
All Patients	50.9 (49.5, 52.4)	29.6 (28.2, 31.5)	14.2 (13.9, 14.6)	4.0 (3.9, 4.1)
Treated Patients*	37.8 (36.2, 39.1)	31.5 (29.3, 32.9)	16.6 (16.2, 17.1)	6.4 (6.3, 6.5)
Untreated Patients	65.2 (63.1, 67.3)	26.6 (24.6, 29.4)	4.6 (4.2, 5.0)	1.3 (1.2, 1.3)
1-Year (95% CI) Overall Survival				
All Patients	87.3 (86.7, 88.0)	74.7 (73.5, 75.9)	55.4 (54.6, 56.3)	23.1 (22.6, 23.5)
Treated Patients*	85.5 (84.5, 86.5)	78.5 (77.1, 79.9)	61.4 (60.4, 62.3)	29.6 (29.0, 30.2)
Untreated Patients	89.1 (88.3, 89.7)	67.4 (65.1, 69.7)	31.9 (30.1, 33.7)	9.0 (8.5, 9.6)

CI = confidence interval

*Treatment was defined as patients having received systemic therapy (including NDFP) or radiation therapy

Prognostic factors for medical oncology or radiation oncology consultation using multivariable regression analysis are reported in **Table 3**. Stage and distance to the nearest cancer center were significantly associated with receiving a consultation (p-values < 0.05). As the stage of NSCLC increased, consultation was more likely (odds ratio [OR] 6.07, 95% CI 5.78-6.38). Distance to the nearest cancer center was inversely related to consultation, with a further distance from the nearest cancer center having lower odds (OR 0.72, 95% CI 0.67-0.78). The consultation was also less likely to occur if a prior thoracic surgery consultation was received (OR 0.61, 95% CI 0.59-0.64).

Table 3 – Multivariable Analysis of MORO Consultation

Variable	Comparison	Odds Ratio (95% CI)	p-value
Stage	I II III IV Unknown	Ref 1.45 (1.35,1.56) 4.29 (4.05, 4.54) 6.07 (5.78, 6.38) 1.44 (1.34, 1.54)	< 0.001
Year of Diagnosis	/ year	1.13 (1.13, 1.14)	< 0.001
Distance to Nearest Cancer Center	< 10km 10-49.9km 50-99.9km ≥ 100km	1.14 (1.06, 1.23) 0.95 (0.88, 1.02) 0.72 (0.67, 0.78) Ref	< 0.001
Age	18-34 35-39 40-44 45-49 50-54 55-59 60-64 65-69 70-74 75-79 ≥ 80	1.07 (0.76, 1.51) 1.46 (1.01, 2.10) 1.18 (0.94,1.48) 1.47 (1.27,1.69) 1.33 (1.21, 1.45) 1.37 (1.28, 1.47) 1.20 (1.13, 1.28) 1.17 (1.10, 1.24) 1.09 (1.03, 1.15) 1.09 (1.03, 1.15) Ref	< 0.001
Sex	Male vs Female	1.05 (1.01,1.08)	0.013
Dependency Quintile	1 2 3 4 5	1.07 (1.01, 1.14) 0.99 (0.94, 1.05) 1.05 (1.00, 1.11) 0.98 (0.93, 1.03) Ref	0.010
Prior Thoracic Surgery Consult	Yes vs No	0.61 (0.59, 0.64)	<0.001
CI = confidence interval			
Note: also adjusted for ethnicity quintile, instability quintile, disease histology, disease laterality and disease morphology (data not shown for simplicity).			

Prognostic factors for treatment using multivariable regression analysis are reported in **Table 4**. Stage, age, and specialist consultation were significantly associated with receiving treatment (p-values < 0.05). Stage III NSCLC had the highest odds of receiving treatment (OR 4.09, 95% CI 3.82-4.38). Patients aged 40-44 years also had the highest odds of receiving treatment (OR 3.28, 95%CI 2.51-4.28), while younger patients tended to have increased odds of receiving treatment though it was not a linear relationship. Patients who had a specialist consultation with medical oncology, radiation oncology or thoracic surgery had over ten times (OR 10.05, 95% CI 9.61-10.51) increased odds of receiving treatment.

Table 4 – Multivariable Analysis for Treatment

Variable	Comparison	Odds Ratio (95% CI)	p-value
Stage	I II III IV Unknown	Ref 3.65 (3.38, 3.95) 4.09 (3.82, 4.38) 2.25 (2.13, 2.39) 1.16 (1.07, 1.25)	< 0.001
Year of Diagnosis	/ year	1.04 (1.03, 1.05)	< 0.001
Distance to Nearest Cancer Center	< 10km 10-49.9km 50-99.9km ≥ 100km	1.06 (0.98, 1.16) 1.11 (1.02, 1.21) 1.23 (1.12, 1.34) Ref	< 0.001
Age	18-34 35-39 40-44 45-49 50-54 55-59 60-64 65-69 70-74 75-79 ≥ 80	1.64 (1.12, 2.40) 2.98 (1.95, 4.56) 3.28 (2.51, 4.28) 3.06 (2.58, 3.62) 2.55 (2.28, 2.84) 2.36 (2.17, 2.56) 2.27 (2.11, 2.44) 1.93 (1.81, 2.07) 1.74 (1.63, 1.85) 1.42 (1.33, 1.52) Ref	< 0.001
Sex	Male vs Female	1.05 (1.01, 1.09)	0.024
Dependency Quintile	1 2 3 4 5	0.94 (0.88, 1.01) 0.99 (0.93, 1.05) 0.98 (0.92, 1.04) 1.00 (0.95, 1.06) Ref	0.41
Medical Oncologist Consult*	Yes vs No	10.05 (9.61, 10.51)	<0.001
Radiation Oncologist Consult*	Yes vs No	1.87 (1.78, 1.96)	<0.001
Thoracic Surgeon Consult*	Yes vs No	1.36 (1.29, 1.42)	<0.001
CI = confidence interval			
* within120 days of diagnosis			
Note: also adjusted for income quintile, ethnicity quintile, instability quintile, disease histology, disease laterality and disease morphology (data not shown for simplicity).			

Discussion

This is the first study in Canada that assesses access to medical oncology or radiation oncology consultation related to lung cancer while also providing an overview of recent trends in outcomes of NSCLC in Ontario since the advent of IO and TKI therapies. It is also the largest population-based study assessing referral and treatment patterns in lung cancer (regardless of stage and type subtype). Using provincially linked administrative health care data, it was identified that 30% of patients with NSCLC do not receive a consultation with a medical oncologist or radiation oncologist following their diagnosis. Of the patients that received consultation, approximately half went on to receive treatment. Ultimately, despite access to a universal health care system, socioeconomic factors impact patient access to specialist care.

Disparities in access to lung cancer specialty services is a global issue with many countries facing long wait times, and inaccessibility to oncology specialists, in addition to the socio-economic factors that also impact care.[14,16,17] Regardless of country of origin, all patients diagnosed with lung cancer should have access to cancer care and modern cancer therapies. The reality, however, is the opposite. Despite the need to improve access, and disparities in current cancer care, therapeutic advances in the treatment of NSCLC continue. Since the time of this study, novel therapeutic strategies with the use of neoadjuvant immunotherapy and

adjuvant TKI therapy have made their way into practice, with further studies broadening care to follow suit.[18–21] The use of IO and oral TKI therapy have changed the way stage IV NSLC is treated, ultimately leading to improvements in OS.[22–24] Internationally, lung cancer screening initiatives are underway, increasing early-stage disease diagnosis.[25,26]

As advances continue, disparities in access to cancer specialty services will only increase making the barriers more challenging to overcome. Rates of medical oncology consultation and lung cancer treatment have gone largely unchanged since the early 2000s in Canada. On average half of the patients diagnosed with advanced lung cancer were seen by a medical oncologist with half of those patients having received systemic therapy. [27–31] Factors affecting medical oncology consultation, and receipt of systemic therapy were similar to those found in these studies. This study adds to the literature by providing an update on lung cancer care in the age of novel therapeutic strategies. It is disconcerting that the same problems regarding access and healthcare equity continue to exist. Access to specialist care must be equitable. The time has come to collaborate with organizations and develop/implement standardized and validated strategies to decrease barriers and increase global access.[32]

The solution to the care gap requires a multi-faceted approach which includes education, targeted initiatives for populations at risk, and advocacy.[33–36] At the healthcare system level, the provision of high-quality lung cancer care requires the use of diagnostic access programs, patient navigators, and outreach teams to increase accessibility. At the provider level, improved education to primary care providers is needed to disseminate knowledge on the treatment advances in lung cancer and the use of lung cancer screening. At the policy level, there needs to be a strategy for equitable implementation of screening programs, as well as coordinated efforts to improve access to specialist services. While not applicable to all countries, assessing medical coverage as part of access to screening and care should be mentioned. Health equity needs to be at the forefront of these initiatives with strategies to measure and evaluate progress toward achieving equity goals or the impact of actions undertaken.[37]

Limitations

Due to the confines of an administration dataset, information regarding race/ethnicity, first language, immigration or refugee status could not be obtained. Many characteristics such as marginalization, income and distance were based on the neighbourhood and not specifically on the individual household. To understand the populations experiencing disparate outcomes datasets need to be expanded to include the above characteristics in more detail. Despite this limitation, the population-based data used provides accurate data regarding referrals and treatments for lung cancer. In addition, this data within a global context, can be used as critical information to inform resource utilization policies.

Next Steps

This study explored a dataset that did not encompass the coronavirus pandemic. It is known that the pandemic led to increased use of telehealth services and the creation of broader artificial intelligence (AI) infrastructure in cancer care.[36,38] This project will now assess the pandemic's impact on access to care in lung cancer to determine whether changes in practice have changed outcomes.

Conclusion

A high proportion of patients diagnosed with NSCLC in Ontario receive medical oncology or radiation oncology consultation with a subset of these patients ultimately receiving treatment. As newer systemic therapeutic options and lung cancer screening become standard of care it will be important to improve access to lung cancer specialist services. This will require the movement from recommendations to action with a multi-faceted approach focusing on reducing care inequities while improving lung cancer outcomes.

Acknowledgements: None

Conflicts of Interest: The authors have no conflicts of interest to declare.

Funding Statement: This research received no specific grant from any funding agency.

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