Healthcare Utilization Associated with Management of Oral and Oropharyngeal Cancer in Alberta: Trends and Predictors

by

Masoud Mirimoghaddam

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

Master of Science

Medical Sciences-Dentistry

University of Alberta

Abstract

Background: The increasing incidence of oral cavity cancer (OCC) and oropharyngeal cancer (OPC), especially HPV-related OPC, is a concerning healthcare challenge. Statistics Canada's recent report indicates a substantial 13.9% increase in OPC incidence in 2020 compared to the average from 2015-2019. Managing these cancers is resource-intensive and complex, and patients often endure not only the challenges of cancer itself but also treatment complications, especially when diagnoses occur in late stages.

Effective and timely management of treatment complications is crucial, as improper handling can lead to acute care needs and treatment interruptions, such as emergency department (ED) visits and unplanned hospitalizations (UH), which have been associated with poorer oncologic outcomes. Considering the rising incidence and prevalence of these cancers, it becomes crucial to assess the healthcare utilization associated with delivering high-quality care for patients. Understanding and evaluating the patterns of healthcare utilization can provide valuable insights to enhance patient care, optimize resource allocation, and improve overall treatment outcomes.

Objectives: With this background, this study had three main objectives: 1) Investigate trends in hospitalization and visits of OCC and OPC patients in emergency department, outpatient clinic, and community offices 2) Identify predictors of acute care visits, including unplanned hospitalizations, 30-day hospital readmissions, and emergency department visits 3) Determine the primary diagnoses of patients admitted to hospitals, visited emergency departments, and outpatient clinics.

Methods: This retrospective, population-based cohort study utilized administrative data collected from all healthcare facilities in Alberta from 2010 to 2019. The study cohort consisted of adult patients (18 years old or older) diagnosed with a primary tumor of the OCC or OPC, identified through the Alberta Cancer Registry (ACR). To examine the cohort's healthcare utilization, the ACR cohort was linked with the Discharge Abstract database, National Ambulatory Care Reporting System, and Physician Claim dataset. The primary diagnosis of patients in each event was determined using diagnosis codes from each database. For data analysis, the study outcomes were assessed using statistical methods, including logistic and linear regression, as well as parametric and non-parametric tests, all conducted using SAS Enterprise Guide 7.1.

Results: The final cohort consisted of 1,721 patients, 72.4% were male and 57.9% were between 45-65 years of age. OPC patients were diagnosed at a significantly younger age, with a mean age of 59.4 years, compared to OCC patients who had a mean age of 62.4 years (P-value < 0.05). During the study, 34% (582 individuals) of the patients had at least one visit to the ED, and 72% (1,244 patients) had at least one hospitalization visit. UHs constituted 48.1% of the overall 2,228 hospitalizations. Notably, outpatient clinic and community office visits showed a significant increase during the study period, with visits rising from 475 to 1,101 (β=0.20, P=0.01) and from 1,653 to 2,629 (β=0.31, P=0.02), respectively. Concurrently, ED visits decreased from 0.65 to 0.49 visits per patient, and the rate of UHs per patient decreased from 0.69 to 0.54 visits.

The common diagnosis for UHs were palliative care and post-surgical recovery, while surgery-related complications were frequent causes of 30-day unplanned readmissions. In ED

visits diagnoses of dehydration, post-procedural infections, and nausea and vomiting were frequent. Predictors of UHs included cancer stage, material deprivation, and the chosen treatment modality, whereas cancer type and comorbidities emerged as key predictors for readmissions. Moreover, Predictors of ED visits included cancer stage, rural residence, high material deprivation scores, and treatments other than surgery or no treatment.

Conclusion: The study's findings revealed a decrease in ED visits and UHs among cancer patients diagnosed between 2010 and 2017, accompanied by increased utilization of outpatient clinics and community offices, indicating a shift towards primary care settings for cancer-related care. Implementing a primary care model may have contributed to better patient management, reducing acute care visits and hospitalizations. Predictors of acute care events highlighted the importance of improving access to care for underprivileged patients and those in rural areas. It also showed Patients not receiving oncologic treatments and those undergoing radiation therapy need for close monitoring and intervention. Preventive strategies and patient education could help reduce avoidable ED visits, while monitoring and managing procedure-related complications can prevent subsequent hospital events.

Preface

This thesis is an original work of Masoud MiriMoghaddam. The research project, of which this thesis is a part, received research ethics approval from the Health Research Ethics Board of Alberta (HREBA) – Cancer Committee under the project “Healthcare utilization and costs related to the management of oral cancer in Alberta”, HREBA.CC-20-0204, 14-Jun-2020.

Acknowledgement

I'm deeply grateful to Dr. Maryam Amin for her unwavering support and guidance during my graduate studies. She has been a constant source of inspiration, nurturing my personal growth, critical thinking, problem-solving skills, and teamwork. Her supervision was instrumental in completing this thesis successfully.

I also want to extend my appreciation to my committee members, Dr. Babak Bohlouli and Dr. Hollis Lai. Their profound knowledge, expertise, constructive criticism, and feedbacks significantly enhanced this research project. Their patience and unwavering support during the research process and thesis preparation are truly valued.

Lastly, I would like to express my gratitude to the administrative team at UofA, including Heather Good and Deniz Ozgan, for their unwavering and timely support.

Table of Contents

List of Tables

List of Figures

List of appendices

1. Chapter One: Introduction

In this chapter, I will start by providing an overview of oral cavity and oropharyngeal cancer. Following that, I will explore the global and Canadian epidemiology of the disease. I will then discuss the management strategies and best practices for oral and oropharyngeal cancer. Finally, I will state the problem and outline my research objectives.

1.1. Background:

1.1.1. Definitions of Oral and Oropharyngeal Cancer

Oral cancer (OC) is a broad term that encompasses two distinct subcategories: Oral Cavity Cancer (OCC) and Oropharyngeal Cancer (OPC). Over 90% of oral cancers are squamous cell carcinomas that originate from the epithelial cells of the mucous membrane lining the oral cavity (Bagan et al., 2010). The rest of the malignancies originate from salivary glands, lymphoid tissue, the odontogenic apparatus, bone, or are metastatic tumors (Warnakulasuriya & Greenspan, 2020). While oral cancers are often grouped together, it is important to recognize that OCC and OPC are separate diseases with specific boundaries and anatomical sites.

The oral cavity is anatomically defined as the region extending from the vermilion border of the lips to the circumvallate papillae of the tongue in its inferior aspect, and the junction of the hard and soft palate in its superior aspect (P. H. Montero & Patel, 2015). OCC encompasses various topographical regions including the lip, oral tongue, floor of mouth, buccal mucosa, upper and lower gum, retromolar trigone, and hard palate.

In terms of anatomical boundaries of oropharynx, it is bounded in the front by the oral cavity. the superior boundary lies at the superior plane above the soft palate. The inferior boundary is defined by the plane of the superior hyoid bone or the floor of the vallecula. The oropharynx is further divided into specific subsites, which include the soft palate, palatine tonsils, tonsillar pillars, base of the tongue (including the lingual tonsils located posterior to the circumvallate papillae), and the pharyngeal wall (Chapman & Yom, 2018; Chi et al., 2015).

These boundaries help delineate the anatomical extent of the oral cavity and oropharynx and are important for accurately diagnosing and classifying tumors within this region, as they have different pathogenesis, treatment, and prognosis (Deschler et al., 2014). In this study, oral cancer is defined based on the classification provided by the World Health Organization's International Classification of Diseases for Oncology, third edition. The specific topographical codes C00-C06, C09-C019 and C14 are utilized to encompass malignant neoplasms affecting the lip, oral cavity, and pharynx (World Health Organization, 2013).

1.1.2. Etiology of Oral and Oropharyngeal Cancer

The etiology of OCC and OPC is multifactorial and tobacco, alcohol, betel quid, and Human Papilloma Virus (HPV) are the established risk factors (Chi et al., 2015). It has been shown that the relative risks of OCC and OPC among tobacco smokers are 3.4 and 6.8 respectively, compared to non-smokers (Gandini et al., 2008). Moreover, it has been shown that heavy alcohol consumption can increase the risk of oral cancer up to 8.8 times, and among heavy users of both it could increase the risk more than 15 times (International Agency for Research on Cancer (IARC), 2010; Mello et al., 2019).

Despite the multifactorial nature of these cancers, they are categorized as one of the most preventable cancers. The Canadian Population Attributable Risk of Cancer (ComPARe) study has provided valuable insights into the modifiable risk factors associated with oral and pharyngeal cancers. The study's findings indicated that 66.2% of these cancers can be attributed to modifiable risk factors, such as tobacco smoking, alcohol consumption, as well as infections such as Epstein-Barr virus and Human papillomavirus (Poirier et al., 2019). Besides modifiable risk factors, studies have explored the association between OCC and OPC incidence and patient demographics and older men with lower socioeconomic status face the highest risk of developing these diseases (Warnakulasuriya & Greenspan, 2020).

1.1.3. Epidemiology of Oral and Oropharyngeal Cancer

1.1.3.1. Global

Reporting the epidemiology of OCC and OPC presents challenges due to variations in reporting among different institutes. While some institutions report oral cancer incidence, others report head and neck cancer or oral and pharyngeal cancer incidence. Therefor in this thesis, I have reported the epidemiology based on the reference articles. Head and neck cancers (HNC) represent a diverse group of cancers that includes malignancies of the paranasal sinuses, nasal cavity, oral cavity, pharynx, and larynx. According to the 2020 global cancer statistics HNCs collectively rank as the seventh most common cancer worldwide, constituting 3.5% of all cancer cases (Gormley et al., 2022). Annually, there were approximately 660,000 new cases of HNCs, resulting in 325,000 associated deaths. OCC and OPC contribute significantly to the overall burden of HNCs in terms of both incidence and mortality. Lip and OCC accounted for 377,000 cases, and OPC accounted for 98,000 cases. The mortality rates of these cancers were reported to

be 177,000 and 48,000 deaths, respectively (Sung et al., 2021). Previous studies have also documented the prominence of these cancers as the majority of HNC cases (Chi et al., 2015; Kawakita et al., 2022).

The incidence of OCC and OPC exhibits regional variations across the world. In terms of lip and OCC, Melanesia, South Central Asia, and Eastern Europe have been identified as regions with the highest age-standardized incidence rates per 100,000 population, with Melanesia at 16.7, followed by South Central Asia at 9, and Eastern Australia and New Zealand at 6.0. In contrast to the OCC, high income countries of Western Europe, Northern Europe, and Northern America had the highest age standard incidence rate of 2.8, 2.6, and 2.4 respectively, which was more than two-times higher than the world average of 1.1 (Sung et al., 2021). While the incidence of HNCs related to non-HPV factors has shown a stable or declining trend, primarily attributed to the successful control of tobacco smoking, there has been a significant increase in HNCs associated with HPV infection (Menezes et al., 2021).

1.1.3.2. North America

In 2020, the number of new cases of lip and OCCs reported in North America was approximately 27,469, making it the third highest region in terms of incidence. South Central Asia and Eastern Asia held the first and second positions, respectively. Regarding OPC, North America ranked second, with 14,026 new cases, following South Central Asia. In terms of gender distribution, the incidence of oral cancer was approximately two times higher in men than in women. Men accounted for approximately 18,500 new cases, while women had around 9,000 new cases. However, the gender disparity was even more significant for OPC. Men had an incidence rate

that was more than 4.5 times higher, with 11,500 new cases, compared to women who had 2,500 new cases (International Agency for Research on Cancer (IARC), 2020).

From 2015 to 2019, the oral cancer incidence rates in women experienced a slight annual increase of less than 1%, while the rates in men remained stable during this period. During the same period HPV-related OPCs, showed a consistent rise, with an annual increase of 1.3% in women and 2.8% in men (American Cancer Society, 2022).

It is projected that the incidence of oral and pharyngeal cancer in the United States will reach around 54,540 new cases and an estimated 11,580 individuals are expected to die to the disease, in 2023. Consistent with previous findings, there will be a notable gender disparity in the incidence of oral and pharyngeal cancer in the US. Men are more than twice as likely to be affected compared to women. These cancers constitute approximately 3.9% of male cancer cases and 1.6% of female cancer cases (American Cancer Society, 2022)

In the past, HNCs were commonly associated with older individuals who were heavy smokers and had high alcohol consumption. However, with initiatives aimed at reducing alcohol and tobacco use, the incidence of HNCs has been declining (Chi et al., 2015; Cohen et al., 2018; Mourad et al., 2017). Conversely, there has been an alarming increase in HPV-related OPC, particularly the HPV-16 strain, among younger individuals. This trend has been observed in various regions, notably in northern Europe and North America. The rise in HPV-related OPC has been linked to sexual behaviors, including oral sex (Chow, 2020). In the US, the percentage

of HPV-positive HNCs increased from 16.3% in 1980 to 72.7% in 2000 (Chaturvedi et al., 2011).

Similarly, the increasing trend of HPV-related OPC has been reported in Canadian studies (Habbous et al., 2017). According to the latest report from the Canadian Cancer Statistics in 2022, it is estimated that 7,500 Canadians will be diagnosed with HNC, and 2,100 individuals will lose their lives to the disease. Among these patients, males make up more than 70% of both the diagnosed cases and the resulting deaths (Canadian Cancer Statistics Advisory in collaboration with the Canadian Cancer Society, 2022). In 2019, 3,700 cases of oral cancer in males and 1,600 cases in females were diagnosed which represented for 3.3% of male cancers and 1.5% of female cancers (Canadian Cancer Statistics Advisory Committee, 2019).

The trend analysis revealed that from 1984 to 2003, the incidence rates for both sexes experienced an annual decrease of 2%. However, between 2003 and 2015, there was an observed annual increase of 1.2% (Canadian Cancer Statistics Advisory Committee, 2019). Similarly, the incidence of OPC increased by 13.5% in 2020 compared to the average incidence rates from 2015 to 2019(Statistics Canada, 2023).

1.1.4. Cancer Management

In addition to the increasing incidence of OPC and OCC, late-stage diagnosis is another significant concern, as it is associated with unfavorable prognosis and diminishes the quality of life of patients (Lauritzen et al., 2021; Lehew et al., 2010). Research conducted in Alberta revealed alarming statistics, indicating that 45.2% of oral cavity (OC) and 82.4% of oropharyngeal (OPC) cancer cases are diagnosed at stage IV, accompanied by a mortality rate of

47.9% (Badri et al., 2021). Late diagnosis of OPC can be attributed to its ability to grow unnoticed and its potential for metastasis. Typically, patients become aware of the condition when presenting with symptoms such as a neck mass, sore throat, or dysphagia (McIlwain et al., 2014).

Patients diagnosed with OCC and OPC often require complex and resource-intensive treatments due to late-stage diagnosis (Massa et al., 2019; Ribeiro-Rotta et al., 2022), as well as the involvement of various healthcare professionals. This complexity arises from the cancer's involvement in anatomically diverse areas such as soft tissue, bones, skin, glands, and organs. Additionally, the vital functions of breathing, chewing, swallowing, and speech are often affected by both the cancer itself and the treatment. Due to these factors, a multidisciplinary approach involving a team of experts is necessary to provide comprehensive care for individuals with HNC, and all diagnosed patients should be seen by a specialized HNC Multidisciplinary Team (Chen et al., 2023; Lo Nigro et al., 2017). The initial and ongoing phases of care centralized at a high-volume center with sufficient expertise and support to deliver the highest level of care. Subsequent follow-up care can be provided in low-volume facilities (Alberta Health Services, 2019, 2022a).

1.1.4.1. Treatment modalities

According to the National Comprehensive Cancer Network and Alberta Health Services guidelines, cancer stage is the main determinant of treatments. The primary treatment for most OCCs involves surgical removal with clear margins of 1 to 2 cm. If there is lymph node involvement or a high risk of regional metastasis, a neck dissection is typically performed. In cases of advanced cancers, a combination of surgery, radiation, and/or chemoradiation therapy is

often necessary as the primary treatment approach. For patients with stage 4 cancer, concurrent systemic treatments may also be required to target the disease at a systemic level (Karan & Laronde, 2014; National Comprehensive Cancer Network (NCCN), 2022; Omura, 2014).

Treatment of OPC is inherently more complex, primarily due to the disparities observed between HPV-positive and HPV-negative tumors (Perri et al., 2020). HPV-positive OPCs are more prevalent among younger and healthier patients and exhibit a significantly improved prognosis compared to HPV-negative tumors (Adelstein et al., 2019). In the early stages, treatment typically involves a single modality, either surgery or radiation therapy. However, for advanced stages, a multimodality treatment strategy combining surgery, radiotherapy, and chemotherapy becomes imperative (Alberta Health Services, 2019; National Comprehensive Cancer Network (NCCN), 2022).

The choice between surgery and radiation therapy depends on post-treatment deficits and patient preferences and is an actively researched area. Ongoing studies aim to better understand the advantages and drawbacks of each treatment approach (Palma et al., 2022). Moreover, Given the markedly better prognosis associated with HPV-positive tumors, there exist controversial opinions regarding treatment deintensification for these patients in order to reduce treatment toxicity, necessitating further research through clinical trials (Adelstein et al., 2019).

1.1.4.2. Treatment complications

Multidisciplinary approaches for treatment of OCC and OPC have significantly improved the management of OCC and OPC, resulting in notable advancements in patient survival rates (Pulte & Brenner, 2010). However, it is crucial to acknowledge that alongside the burden of cancer

itself, these treatments also carry a risk of toxicity, further impacting patients' overall quality of life (Allen-Ayodabo et al., 2019; Langendijk et al., 2008).

Among various cancer types, HNC patients bear a particularly high symptom burden (Bubis et al., 2018). Adequate management of symptoms in patients with OCC and OPC is crucial, since these symptoms can be severe and uncontrolled symptoms may necessitate emergency care (Miah et al., 2012). Patients with HNC exhibit a substantial rate of Emergency Department (ED) visits and Unplanned Hospitalizations (UH), as evidenced by multiple studies (Chaudhary et al., 2017; Eskander et al., 2018; Noel et al., 2020). These visits have been associated with potential disruptions in the treatment course, leading to adverse treatment outcomes (Bese et al., 2007; Quinn et al., 2020). An Ontario-based study reported that 28-55% of HNC patients experienced at least one ED visit or UH during their treatment (Eskander et al., 2018).

Given the substantial symptom burden experienced by patients with OCC and OPC resulting from treatment toxicities and cancer-related deficits, it becomes crucial to predict and effectively manage these conditions. The focus on prediction and control is of significant interest to researchers and policymakers aiming to reduce the acute care needs of these patients (Kansagara et al., 2011; Noel et al., 2022). A previous systematic review has investigated predictors of ED visits and UHs in HNC patients, categorizing these predictors into patient factors, cancer severity, and process factors (Noel et al., 2020).

Effective management of treatment complications and symptom control plays a vital role in not only improving patient outcomes, but also alleviating the financial burden of cancer care on patients and the healthcare system. In Canada, the financial cost of cancer care is substantial, with hospital expenses accounting for a significant portion of the overall cost. In 2021 alone, the total cost of cancer care exceeded 26 billion dollars. Despite the presence of universal healthcare in Canada, patients still shoulder 30% of the financial burden associated with cancer care (de Oliveira et al., 2018; Garaszczuk et al., 2022). Notably, individuals with lower incomes experience higher levels of financial toxicity, poorer health status, and lower rates of disease-free survival (Noel et al., 2023).

1.1.4.3. Cancer care models and survivorship care

In addition to the primary treatment phase, the growing number of cancer patients and survivors highlights the importance of long-term follow-up and survivorship care of cancer patients and several studies investigated and compared different models of care (Høeg et al., 2019; Vos et al., 2021). Ensuring the delivery of high-quality care during this phase has become a focus in Canada, with several models and initiatives implemented to address this need. These models include strategies such as direct discharge to primary care, establishing transition clinics at cancer centers to facilitate follow-up care, maintaining oncology-led care, and promoting shared-care between oncology and primary care providers. The most utilized model is the direct-to-primary care approach, where patients are discharged from their oncologist's care directly to their primary care provider (Romkey-Sinasac et al., 2021).

The Alberta cancer plan 2030, introduced in 2013, emphasizes engaging primary care providers in the delivery of care in primary care and community settings. In Alberta, a primary

care model is used for delivering the care for HNC patients (Alberta Health Services, 2022a; Government of Alberta, 2013).

In summary, managing treatment complications and effectively controlling symptoms in patients with OCC and OPC are of paramount importance. These cancers present significant challenges, requiring multidisciplinary approaches and comprehensive evaluations to determine optimal treatment strategies.

1.2. Statement of the problem

The increasing incidence of OCC and OPC, particularly those with HPV+ OPC, with high survival rate had resulted in the increased prevalence of cancer patients. Excessive healthcare utilization by oral cancer patients due to late-stage diagnoses and increased need for survivorship care, highlight the importance of evaluating healthcare resources required to deliver high quality care. The evaluation is essential for ensuring efficient and sustainable long-term care delivery, particularly in countries with publicly funded healthcare systems like Canada.

Existing research has primarily focused on HNC in general or specific treatment approaches, with a predominant emphasis on ED visits or hospitalizations. However, given the growing significance of primary care and community settings in newer cancer care models, it is crucial to gain a comprehensive understanding of visit trends across different care settings and explore their potential interplay. Therefore, the goal of this research is to investigate the trends and potential care transitions in various care settings, while identifying the predictors of acute care needs in patients.

1.3. Objectives

The overall goal of this research was to conduct a comprehensive analysis of visit trends among oral cancer patients across different healthcare facilities and ascertain the predictors of acute care needs in these patients. This objective was accomplished through a two-phase approach, wherein the first phase involved an extensive investigation of ED visits, outpatient clinic visits, and community office visits. Subsequently, in the second phase, particular attention was given to the hospitalization of patients, specifically focusing on unplanned hospitalizations and 30-day unplanned readmissions.

1.3.1. Specific Objectives:

1) To examine the trends of OCC and OPC patients' hospitalization and visits across the emergency department, outpatient clinic, and community office settings.
2) To identify the predictors associated with acute care visits, including unplanned hospitalizations, 30-day hospital readmissions, and emergency department visits.
3) To determine the main reason of patients admitted to hospitals, or visited emergency departments, and outpatient clinics.

2. Chapter Two: Healthcare Utilization of Oral and Oropharyngeal cancer patients in Emergency Department and Outpatients settings: an 8-year Population-based Study

2.1. Abstract:

Purpose: The increasing incidence of Oral Cavity Cancer (OCC) and Oropharyngeal Cancer (OPC) is a concern, particularly HPV-related OPC. This study aimed to determine trends in the healthcare utilization by OCC and OPC patients across Emergency Department (ED) and outpatient settings in Alberta and examine the predictors of ED visits.

Methods: This is a retrospective, population-based, cohort study using administrative data collected by all healthcare facilities in Alberta. Using the Alberta Cancer Registry (ACR), a cohort of adult patients 18 years and older diagnosed with a single primary OCC or OPC between January 2010 and December 2017 was identified and linked with the Ambulatory Care Reporting System (NACRS) and Physician Claims databases. The trend of visits in different facilities, patients' primary symptoms, and predictors of ED visits were analyzed.

Results: Of the 1,721 patients included in the study, 72.4% were male, 57.9% were between 45-65 years of age, and 34% had at least one cancer-related ED visit. Among the patient cohort, 1,311 patients (76%) had 5,684 outpatient clinic visits and 1,658 (96%) patients had 15,995 community office visits (4.3, and 9.6 visits per patient respectively) over eight years. Along with a 31% increase in the number of patients, outpatient clinic and community office visits increased significantly by 131% and 60%, respectively, while ED visits reduced from 0.65 to 0.49 visits per patient per year. Common diagnosis for ED visits included dehydration, infection after a

procedure, and nausea and vomiting. Cancer stage, rural residence, high material deprivation score, and treatments other than surgery or no treatment were found as predictors of ED visits. **Conclusion**: Enhanced symptom management plans and improved access to care for disadvantaged individuals and those living in rural areas may reduce avoidable ED visits, leading to a lower burden of disease on patients and alleviating strain on the healthcare system.

Keywords: Oral Cancer, Oropharyngeal Cancer, Delivery of Health Care

2.2. Introduction

Oral Cavity Cancer (OCC) and Oropharyngeal Cancer (OPC) collectively represent the 8th most common cancer globally, and the incidence of oral cancer has dramatically increased since 1990 (Ren et al., 2020; Warnakulasuriya & Greenspan, 2020) Recent studies have shown a larger rise in OPC incidence in high-income countries and North America (Cohen et al., 2018; Ganatra et al., 2022; Gormley et al., 2022; Warnakulasuriya & Greenspan, 2020) A recent report from Statistics Canada showed a 13.5% increase in the incidence of OPC in Canada (Statistics Canada, 2023). In Alberta, the mean number of new cases for both sexes is projected to rise by 76.1% between 2003-2007 and 2028-2032, making it the most substantial anticipated increase in a province (Canadian Cancer Society's Advisory & Statistics, 2015)

With the increasing number of cancer patients, it is crucial for the healthcare system to manage the disease effectively. Oral cancer treatment is resource-intensive and involves complex treatment modalities including surgical resection, radiation, and chemotherapy (Alberta Health Services, 2019; Massa et al., 2019; National Comprehensive Cancer Network (NCCN), 2022; Ribeiro-Rotta et al., 2022). Despite the therapeutic benefits of these treatments, they often come

with a high rate of morbidity that can negatively affect patients' quality of life (Allen-Ayodabo et al., 2019) Specifically, for patients with head and neck cancer (HNC), who experience a high symptom burden compared to other cancers (Bubis et al., 2018), uncontrolled symptoms such as dysphagia, dehydration, and fatigue may necessitate emergency care (Miah et al., 2012) Emergency departments (EDs) play a critical role in providing care to cancer patients.

Studies have shown that OPC patients have a higher rate of symptom burden compared to other cancers (Bubis et al., 2018) and HNC patients have a high rate of ED visits and unplanned hospitalizations (Chaudhary et al., 2017; Eskander et al., 2018; Noel et al., 2020) An Ontario-based study reported that 28-55% of HNC patients had at least one ED or unplanned hospitalization during their treatment (Eskander et al., 2018). These visits may interrupt patients' treatment course and result in poor treatment outcomes (Bese et al., 2007).

According to a US study, 53% of ED visits of cancer patients are preventable and related to symptoms that can be managed in an outpatient clinic (Smith & Carlson, 2021; Vaidya A, 2017). The Alberta Cancer Plan introduced in 2013 (Government of Alberta, 2013), highlights the importance of integrating primary healthcare providers into outpatient facilities in order to provide the necessary care for cancer patients, particularly with the increasing number of cancer patients and survivors (Vos et al., 2021). As a result, survivorship care has become an important healthcare concern, with community offices and outpatient clinics playing a significant role in providing essential services for these patients. This is particularly important in Alberta, where the majority of OCC and OPC patients are diagnosed in advanced stages, requiring a high amount of resources for treatment and post-treatment complications (Ganatra et al., 2022).

In Canada, there are various care models available for survivors of cancer (Romkey-Sinasac et al., 2021). In Alberta, a primary care model is utilized to deliver post-treatment care for cancer patients, in which family physicians and nurse practitioners play a crucial role in conducting follow-up visits for patients. They provide ongoing care, support to survivors, and make referrals to specialists or other healthcare professionals as necessary (Alberta Health Services, 2022b). Given the increasing emphasis on shifting care to primary care settings and their significant role in survivorship care, it is important to evaluate the overall healthcare utilization of cancer patients and the trends in transitioning care to these settings.

While several studies have focused on the acute care needs of head and neck cancer patients and predictors of hospitalization and ED visits, there has been limited attention paid to the healthcare utilization of OCC and OPC patients in primary care settings. To the best of our knowledge, this is the first study investigating the transition of care in OCC and OPC management and identifying factors that may predict patients' revisits to the ED. This study, therefore, aimed to determine: 1) trends of emergency department, outpatient clinic, and community office visits during the study period, 2) primary symptoms of patients who visited emergency departments and outpatient clinics, 3) impact of cancer stage on healthcare utilization, and 4) predictors of emergency departments visits.

2.3. Methods

This was a retrospective, population-based, cohort study using administrative data collected from all emergency departments and outpatient clinics and community offices in Alberta for those cohort extracted from Alberta Cancer Registry. The ethics approval was obtained from the

Health Research Ethics Board of the Alberta Cancer Committee (Ethics ID# HREBA.CC-20-0204).

2.3.1. Data sources

Alberta Cancer Registry (ACR) database was used to define the patient's cohort. Detailed information on demographics, geographic zone of diagnosis, cancer type, stage, and treatment were retrieved from the ACR database. The International Classification of Diseases for Oncology, Third Edition (ICD-O-3) was used to define the tumor cohort. For OCC, topographical codes included Lip Mucosa (C00.3-C00.9), Oral Tongue (C02.0-C02.3, C02.8, and C02.9), Gum (C03.0-C03.9), Floor of Mouth (C04.0-C04.9), Palate (C05.0-C05.9), and Other unspecified parts (C06.0-C06.9). For OPC, the topographical codes included Base of Tongue (C01.9), Lingual Tonsil (C02.4), Tonsil (C09.0-C09.9), Oropharynx (C10.0-C10.9), Pharynx not otherwise specified (C14.0) and Waldeyer Ring (C14.8).

In order to determine the healthcare utilization of the defined cohort, the ACR database was linked with the Ambulatory Care Reporting System (NACRS) and Physician Claims databases using unique encoded identifiers. The NACRS is a database managed by the Canadian Institute for Health Information (CIHI). It contains information about patient visits to emergency departments, outpatient clinics, and other ambulatory care settings across Canada. It includes data such as patients visit details (date and time), diagnoses, and treatments. In addition, the physician claim dataset is a comprehensive collection of information that provides detailed information about the services delivered by physicians including diagnoses, service, location of visits, and the corresponding fees associated with these services. To filter the visits for only cancer-related events, the diagnosis codes at each visit were used.

To assess the socio-economic status of the patients, we used the Pampalon deprivation index, which considers both material and social factors and is based on Canadian census data. However, for this study, we only used the material component since it is more relevant in the Alberta context. The index is divided into five categories, with Q1 representing the most privileged patients and Q5 representing the most disadvantaged individuals (Alberta Health Services, 2016).

2.3.2. Study design and cohort creation

A cohort of adult patients 18 years and older, who were diagnosed with primary OCC or OPC between January 2010 and December 2017, were identified. To control the effect of multiple cancer sites and the complexity of the interpretation of the results, patients with multiple primary tumors were excluded from the cohort. The analysis included all cancer-related visits from the time of cancer diagnosis to two years after the diagnosis. The two-year follow-up period was chosen based on treatment guidelines that suggest most treatments and follow-up visits occur within the first two years after the diagnosis (Alberta Health Services, 2019; National Comprehensive Cancer Network (NCCN), 2022).

The patient cohort in ACR was linked deterministically with the NACRS and physician claim data set using unique encoded identifiers to form the cohort of ED visits, outpatient clinic visits and community office visits of patients. In order to only capture the office-based physician visits in community office and prevent double counting of the visits in outpatient clinics, physician claim data was narrowed to the visits accruing in the community offices.

2.3.3. Outcome measurements

The National Ambulatory Care Reporting System (NACRS) was used to identify outpatient clinic and ED visits using visit type indicator. The first of the ten diagnostic ICD-10-CA codes (primary diagnoses) in the NACRS database was used to classify the diagnoses into major categories. Only the first visit of each day was captured to avoid counting more than one observation. NACRS emergency/urgency visits were used to identify ED visits. To gain a better understanding of the reasons and 30-day ED revisits rate, which serve as an indicator for assessing the quality of healthcare services, we stratified the ED visits into two categories: Index visits and revisits. Index visits refer to ED visits in which the patient did not have any other visits within 30 days before that particular visit, and revisits are ED visits that occur within 30 days of a previous visit.
For the analysis, visits with discharge dispositions of transfer, death, and left the ED, as well as those with missing discharge dates, were excluded from the dataset.

The Alberta Practitioner Claims dataset was also used to identify visits occurring in community medical clinics. Using ICD-9 codes, all primary diagnoses were classified into major categories. Only one visit per day was captured to avoid including the incorrect number of clinical conditions in the data.

Once the final cohort of ED and outpatient clinic visits were identified, the primary reason, length of stay, disposition status, travel time and travel distance of each visit were extracted. To understand the trends in visits and the transitions of care between different settings, the average number of visits per patient per year was calculated for further analysis.

2.3.4. Data Analysis

The characteristics of the patients at the time of diagnosis were described based on cancer type. Categorical variables were summarized with frequencies and percentages, while continuous variables were described using means and standard deviations or medians, as appropriate. The average age at time of cancer diagnosis was compared between OCC and OPC using an independent sample t-test. Patient sex, age category, cancer site, tumor stage, comorbidity index, material deprivation index, diagnosis zone, and treatment were compared among cancer types using the Chi-square test. Moreover, chi-square was used to compare disposition status among cancer types. To compare the number and length of stay in ED among cancer stages, a Kruskal-Wallis test was used.

In addition, to determine the predictors of ED visits multivariable logistic regressions was performed. The dependent variable for the ED predictors model was having at least one ED visit during the follow-up period as the outcome of interest. In the selection of independent variables for the model (age, sex, cancer stage, cancer type, comorbidity index, deprivation index, rurality, treatment), we incorporated a priori information obtained from the existing literature (Baskin et al., 2018; Eskander et al., 2018; Moore et al., 2019; Noel et al., 2020; O'Neill et al., 2015; Ryu et al., 2013). The model's fitness was assessed using the global null hypothesis test and Hosmer-Lemeshow test to ensure its fitness.

Furthermore, a simple linear regression was used to analyze the trend of visits to different facilities during the study period. All analyses were conducted using SAS Enterprise guide 7.1

for Windows, and results were judged statistically significant using p-values (less than 0.05) and a 95% confidence interval.

2.4. Results

2.4.1. Cohort description

In this study, a total of 1,721 patients were included, with OPC accounting for 54.2% of cases. The results of the univariate analysis revealed significant differences in the mean age, sex, age category, cancer stage, and treatment methods between OCC and OPC (P <0.05). The majority of patients were male (72.4%), with a significantly higher proportion of males among OPC patients (82.8%) compared to OCC patients (60%). Moreover, the mean age at diagnosis was significantly lower among OPC patients (59.4 years) compared to OCC patients (62.4 years) (P-value<0.05).

In addition, a higher percentage of OPC patients were diagnosed with advanced cancer stages, with 93.1% of OPC patients diagnosed at stages III or IV compared to 75.4% of OCC patients. Oral tongue was the most frequent cancer site for OCCs, whereas the tonsils and base of the tongue were the most common sites for OPCs. The primary treatments for OPC were concurrent chemoradiation, whereas only surgery was the primary treatment for OCC. Table 2.1 provides further details on patient demographics and characteristics at diagnosis, as well as the results of the univariable analysis comparing OCC and OPC patients.

Table 2-1 Patient's demographics and cancer characteristics by cancer type

No table of figures entries found.		Cancer Type			P. Value
		OCC (N=788) N (%)	OPC (N=933) N (%)	Total N (%)	
Age, Mean (SD)		62.4 (14.5)	59.4 (9.6)	60.8 (12.2)	<0.01
Sex	**Male**	473 (60.0)	773 (82.8)	1246 (72.4)	<0.01
	Female	315 (40.0)	160 (17.2)	475 (27.6)	
Age category (years)	**<45**	85 (10.8)	44 (4.7)	129 (7.5)	<0.01
	45-65	359 (45.6)	637 (68.3)	996 (57.9)	
	>65	344 (43.6)	252 (27.0)	596 (34.6)	
Comorbidity Index	**0**	631 (54.3)	770 (87.1)	1401 (85.8)	**0.16**
	1	67 (9.0)	72 (8.1)	139 (8.5)	
	+2	51 (6.8)	42 (4.8)	93 (5.7)	
Deprivation Index	**Q1**	152 (20.9)	181 (20.8)	333 (19.4)	0.61
	Q2	116 (16)	144 (16.5)	260 (15.1)	
	Q3	129 (17.7)	171 (19.6)	300 (17.5)	
	Q4	147 (20.2)	183 (21)	330 (19.2)	
	Q5	183 (25.2)	193 (22.1)	376 (21.9)	
	Unknown	60 (7.6)	59 (6.3)	119 (6.9)	
Residential	**Rural**	180 (22.84)	208 (22.29)	388 (22.6)	0.78
	Urban	608 (11.16)	725 (77.71)	1333 (77.4)	
Geographic Diagnosis zone	**South**	56 (7.1)	65 (7)	121 (7)	0.59
	Calgary	292 (37.1)	364 (39)	656 (38.1)	
	Central	102 (12.9)	103 (11)	205 (11.9)	
	Edmonton	259 (32.9)	294 (31.5)	553 (32.1)	
	North	79 (10)	107 (11.5)	186 (10.8)	
Cancer site	**Oral Tongue**	385 (48.9)	N/A	385 (22.4)	N/A
	Unspecified parts of mouth	135 (17.1)	N/A	135 (7.8)	
	Floor of Mouth	99 (12.6)	N/A	99 (5.8)	
	Gum	73 (9.3)	N/A	73 (4.2)	
	Palate	70 (8.9)	N/A	70 (4.1)	
	lip	26 (3.3)	N/A	26 (1.5)	
	Tonsil	N/A	445 (47.7)	445 (25.9)	
	base of tongue	N/A	364 (39.0)	364 (21.2)	
	Oropharynx	N/A	106 (11.4)	106 (6.2)	
	Pharynx NOS	N/A	12 (1.3))	12 (0.7)	

	Lingual Tonsil	N/A	6 (0.6)	6 (0.4)	
Tumor Stage	**I**	219 (27.8)	12 (1.3)	231 (13.4)	<0.01
	II	84 (10.7)	32 (3.4)	116 (6.7)	
	III	67 (8.5)	89 (9.5)	156 (9.1)	
	IV	361 (45.8)	780 (83.6)	1141 (66.3)	
	Unknown	57 (7.2)	20 (2.1)	77 (4.5)	
	Urban	608 (11.16)	725 (77.71)	1333 (77.4)	
Treatment method	**Surgery only**	390 (49.5)	61 (6.5)	451 (26.2)	<0.01
	Chemoradiation	23 (2.9)	414 (44.4)	437 (25.4)	
	Surgery - Radiotherapy	167 (21.2)	100 (10.7)	267 (15.5)	
	Surgery- Chemoradiation	73 (9.3)	148 (15.9)	221 (12.8)	
	Radiotherapy	48 (6.1)	97 (10.4)	145 (8.4)	
	None	83 (10.5)	59 (6.3)	142 (8.3)	
	Other	4 (0.5)	54 (5.8)	58 (3.4)	

2.4.2. Trends and characteristics of visits to different facilities

Table 2.2 presents the outcomes and information about emergency visits among the cohort of 1,721 patients. Among the entire patient population, 582 individuals (34%) had at least one cancer-related ED visit during the two-year follow-up period in this study, resulting in a total of 1,087 ED visits. From this total, 554 visits were utilized to calculate the 30-day ED revisit rate during the study period, and it was found that 108 revisits (19.5%) occurred. The median time for a revisit from the index visits discharge date was found to be 6 days. Additionally, 1,311 patients (76%) had outpatient visits, and recorded a total of 5,684 in outpatient settings. In addition to ED and outpatient visits, the study recorded a total of 15,995 Community office visits for 1658 patients over eight years.

Table 2-2 Emergency Department and outpatient clinic visits summary

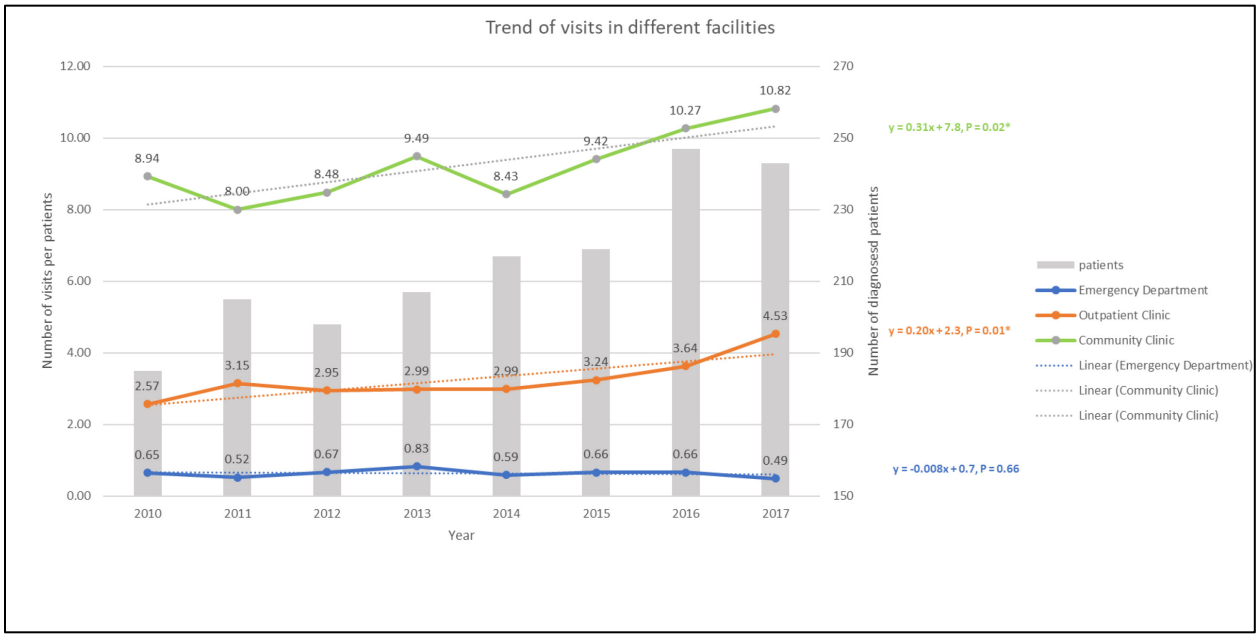
			Mean (Median) / Freq (%)
outpatient clinic visits (N=5681)	Travel Time (Minuts)		56 (70)
	Travel Distance (Km)		67 (107.5)
ED visits (N=1087)	Travel Time (Min)		31.3 (58.8)
	Travel Distance (Km)		35.6 (85.4)
	Length of stay (Hours)	Discharged	4.4 (3.2)
		Admitted	11.1 (8.6)
ED Disposition Type	discharged		585 (53.82)
	Admitted		428 (39.37)
	Transfer to other facility		33 (3.04)
	Other		25 (2.30)
	Left without seeing		13 (1.20)
	Death		3 (0.28)

The average travel time and distance required to reach an outpatient clinic were notably higher than that for an ED facility, with a mean of 33.1 minutes and 35.6 kilometers for ED and 56 minutes and 67 kilometers for OCs. Among the patients who visited the ED, more than half were discharged after receiving care, while almost 40% were admitted to the hospital. 3% of the

patients were transferred to another facility, 1.2% left the ED, and 0.28% died. Patients who were admitted to a hospital had a notably longer ED visit duration compared to those who were discharged. On average, admitted patients spent 11.1 hours in the ED, which is over 2.5 times longer than the average 4.4 hours spent by discharged patients.

In terms of healthcare utilization trends, between 2010 and 2017, the number of diagnosed patients increased from 185 to 243. Surprisingly, the number of visits to the ED remained almost the same, with 121 visits in 2010 and 120 visits in 2017 (β=0.008, P= 0.66). However, there was a significant increase in outpatient clinic and community office visits from 475 to 1,101 (β=0.20, P= 0.01) and 1,653 to 2,629 (β=0.31, P= 0.02), respectively, as shown in Figure 2.1.

Figure 2-1 Trend of Visits during the study period, simple linear regression



2.4.3. Primary diagnosis of patients at the Emergency department and outpatient clinics

The main reason for patients visiting both ED and outpatient clinics was malignant neoplasm, accounting for 29.8% and 46.2% of cases, respectively. However, for ED revisits specifically, the primary reason changed to factors influencing health status, which constituted 37.7% of the revisits. The most frequent non-neoplasm diagnoses for patients visiting the ED included dehydration, chemotherapy, infection following a procedure, and nausea and vomiting. These diagnoses were categorized under major groups such as clinical symptoms (19.1%), factors influencing health status (10.6%), and complications of surgical procedures (8.1%).

On the other hand, for outpatient clinic visits, dysphagia was identified as the most common diagnosis, followed by examination, counseling, and follow-up visits. Regarding revisits, the most frequent diagnoses were chemotherapy, dehydration, and palliative care. The main diagnosis major groups for these revisits comprised factors influencing health status (37%), malignant neoplasm (20.4%), and clinical symptoms (14.8%) (Table 2.3).

Table 2-3 The primary diagnosis of patients at ED and outpatient clinics

Setting	General category	N	(%)	Most Frequent Observations
ED visits (N=1087)	Malignant neoplasm	324	29.8	Tongue, Tonsils, and Pharynx cancer
	Clinical symptoms and signs	208	19.1	Nausea and Vomiting, Fever, and Dysphagia
	Factors influencing health. Status	115	10.6	Chemotherapy, Palliative care, and Prescription issues
	Metabolic disorders	88	8.1	Dehydration
	Complications of Surgical and medical care	71	6.5	Infection following a procedure, Hemorrhage and hematoma
	Other Categories	281	25.8	
	Total	1087	100	
ED Revisits (N=108)	Factors influencing health. status	40	37	Chemotherapy, Prescription issues
	Malignant neoplasm	22	20.4	Tongue, Tonsil, and Mouth
	Clinical symptoms and signs	16	14.8	Nausea and vomiting
	Metabolic disorders	14	13	Dehydration
	Other	16	14.8	
	Total	108	100	
outpatient clinic visits (N=5681)	Malignant neoplasm	2619	46.2	Tongue, nasopharynx, Malignant neoplasm head face & neck
	Clinical symptoms and signs	1533	26.8	Dysphagia
	Specific procedures and healthcare	1446	25.6	examinations, counselling, surgical follow-up care
	Other Categories	83	1.5	
	Total	5681	100	

2.4.4. Effect of stage on healthcare utilization

We also examined how the cancer stage - which determines treatment and indicates disease severity affected healthcare utilization by categorizing the average number of visits and length of stay in different healthcare facilities based on the cancer stage. The findings revealed that the average rate of ED and outpatient clinic visits varied significantly across different stages of cancer. For example, the average ED visits were more than four times higher in stage 4 cases compared to stage 1 (0.18 and 0.78 respectively), indicating that patients with advanced cancer required more urgent and intensive medical attention. Moreover, the length of stay in ED for patients at more advanced stages was significantly longer (P=0.01). We did not observe any difference in the rate of community office visits based on the cancer stage.

Table 2-4 Average number of Visits, and Length of stay of patients among different cancer stages, Kruskal-Wallis test

outcomes	Stages Settings	Mean (SD)				P. Value
		I	II	III	IV	
Visits	ED	0.18 (0.6)	0.43 (1)	0.49 (1.1)	0.78 (1.4)	< 0.01
	outpatient clinic	3 (3.9)	3.78 (4.7)	3.16 (4.2)	3.47 (4.3)	0.047
	community office	8.66 (4.7)	10.51 (7.6)	9.2 (6.3)	10 (8.7)	0.335
LOS	ED	5.5 (7.3)	7.8 (7.3)	8.3 (8.6)	9.7 (8.7)	< 0.01

2.4.5. Predictors of emergency department visits

The findings of the multiple logistic regression analysis to determine predictors of ED visits are presented in Tables 2.5. The model's fitness and significance were evaluated using the global null hypothesis test and the Hosmer-Lemeshow test. The global null hypothesis test produced a test statistic of 136.9 with 19 degrees of freedom ($p < 0.001$), indicating a strong level of statistical significance. Moreover, the Hosmer-Lemeshow test statistic was 2.87 with 8 degrees of freedom ($P= 0.94$), indicating a good fit of the model to the data. This implies that the model accurately represents the observed data and results are significant.

Of the included variables, sex, age at diagnosis, high comorbidity, and cancer type did not demonstrate a statistically significant effect on the risk of emergency visits. However, patients with higher cancer stages (II, III, IV) were more likely to make emergency visits compared to those with stage I. The odds of emergency visits significantly increased for stages II and III (OR 2.01, p-value 0.03) and stage IV (OR 3.12, $p< 0.001$). Additionally, patients in the highest deprived quintile and those living in rural areas had significantly higher odds of emergency visits (OR 2 for quintile 5 and OR 1.6 for rural residence, $p< 0.001$ for both). Most treatment modalities exhibited higher odds for emergency visits compared to only surgery (OR

2.6, 2, 1.68, and 2.09 for no treatment, only radiation, surgery-radiation, and surgery-chemoradiation, respectively, with a p-value of below 0.05 for all).

Table 2-5 Factors associated with ED visits, Multiple logistic regression

Predictors		Odds ratio	95% Confidence Limits		P. Value
Sex	Female		Reference		
	Male	1.01	0.76	1.33	0.96
Age at diagnosis		1.00	0.99	1.02	0.48
Stage	Stage I		Reference		
	stage II	2.01	1.05	3.82	0.03*
	stage III	2.01	1.07	3.80	0.03*
	stage IV	3.12	1.78	5.45	<0.001*
Cancer type	Oral cavity		Reference		
	Oropharyngeal	1.04	0.77	1.39	0.81
Comorbidity Index	0		Reference		
	1	1.42	0.95	2.11	0.09
	2+	1.46	0.9	2.36	0.13
Deprivation Index	1		Reference		
	2	1.20	0.81	1.78	0.36
	3	1.60	1.10	2.31	0.01*
	4	1.28	0.88	1.84	0.20
	5	2.00	1.41	2.85	0.001*
Residence	Urban		Reference		
	Rural	1.66	1.26	2.18	0.001*
Treatment	Only surgery		Reference		
	Only radiation	2.01	1.17	3.44	0.01*
	Chemoradiation	1.57	0.97	2.54	0.07
	Surgery- radiation	1.68	1.07	2.64	0.03*
	Surgery-chemoradiation	2.09	1.27	3.44	0.003*
	Other	1.66	0.79	3.49	0.18
	None	2.6	1.48	4.57	0.001*

2.5. Discussion

This study evaluated the correlation between clinical and demographic characteristics of patients diagnosed with OCC and OPC and their healthcare utilization in ED and primary care settings, and investigated the trends in Alberta, Canada, by analyzing three administrative databases from 2010-2019. With the increasing prevalence of OCC and OPC in Canada and the complexities of

HNC management, it is vital to evaluate healthcare utilization to enhance the quality of care and improve patient outcomes. Given the comprehensive analysis conducted, the findings provide valuable insights into critical OCC and OPC care management aspects, which helps in the coordination and design of best practices to reduce unplanned acute care needs (Handley et al., 2018).

With the growing number of cancer cases and the increased survival rates in Canada, more patients are entering the survivorship care phase. Several models exist for delivering care to cancer survivors, including general practitioner-led, nurse-led, and specialist-led models (Høeg et al., 2019). A systematic review by Vos et al. (Vos et al., 2021) found that primary care-based cancer survivorship care is equivalent to secondary care in terms of clinical and patient-reported outcomes and also less expensive.

The Alberta Cancer Plan (Government of Alberta, 2013) emphasized involving primary healthcare providers in delivering care for cancer patients, and Alberta employs the primary care model for patient follow-up. Our study's findings further support the effectiveness of this approach in providing care for OCC and OPC patients in Alberta. We observed an upward trend in the incidence of OCC and OPC, with OPC showing a more significant increase, which is consistent with previous reports indicating a significant rise in OPC cases in North America (Badri et al., 2021; Chaturvedi et al., 2011; Cohen et al., 2018; Ganatra et al., 2022; Gormley et al., 2022; Habbous et al., 2017).

Interestingly, despite this 31% increase in the total number of patients during the study period, the rate of ED visits per person per year reduced from almost 0.65 visits in 2010 to 0.49 visits in 2017. In contrast, there was a significant increase in the rate of outpatient clinic and community office visits from 2.57 and 8.94 to 4.5 and 10.8 respectively. Similarly, a review report on interventions to reduce ED visits among cancer patients showed that outpatient services provided by a nurse or physician in community office or hospital settings can effectively reduce the need for ED visits (Kirkland et al., 2020).

Our results showed that a considerable proportion (34%) of the patients in our cohort required ED visits during the follow-up period, and almost 40% of these visits resulted in inpatient admission. These findings are consistent with the rates reported by Eskander et al. (28-55%) (Eskander et al., 2018) and Reyes et al. (one-third of patients) (Reyes–Gibby et al., 2017)in their studies on HNC patients, and indicate the significant clinical burden of cancer on patients and healthcare system, which can negatively influence patient's outcomes. In terms of hospital admission following ED visits, a study study (Lash et al., 2017) reported 43% inpatient admission for oral cancer patients, which is comparable to our results; however, the result of Tang et al. (Tang et al., 2015) and Kligerman et al. (Kligerman et al., 2019) studies, reported 59.1% and 72.8% inpatient admission for HNC respectively, and 22.7% reported by Malik et al. (Malik et al., 2019). The variation in results could be due to regional differences in management strategies, cancer stage, and treatment methods.

The median time for admitted and discharged patients were 9.2 and 4.1 hours, which was comparable to 9.9 and 3.7 hours reported by Canadian Institute for Health Information (CIHI) for

Alberta (Canadian Institute for Health Information, 2022). This prolonged waiting time would place patients at risk of hospital-related infections and they might be examined by less cancer-related experienced staff, which is not favourable and would diminish expected treatment results (Gallaway et al., 2021; Vandyk et al., 2012). This information potentially indicates the need to prioritize cancer patients more during triage in EDs.

Our study showed that as the cancer stage advanced, the burden of the disease increased. The higher cost of treatment for advanced stages is well-documented in the literature (Ribeiro-Rotta et al., 2022). Patients in higher stages receive more aggressive treatments resulting in more toxicities and required more resource-intensive services in acute care settings. However, patients at all stages required almost equal outpatient clinic and community office visits for follow-ups.

We also found that dehydration was among the most common presentation at both ED and outpatient clinics, which was consistent with previous studies who reported dehydration and electrolyte disorders among the frequent complications of radiation and chemotherapy and the reasons for ED visits (Patel et al., 2023; Rivera et al., 2017) The result of Fredman et al. (Fredman et al., 2022) study showed regimented oral hydration significantly reduced the need for acute care. Moreover, we observed post-operative infection as a frequent reason for ED visits, which is a common condition for oral oncological surgeries (Haque et al., 2018). The observed symptoms in our study; however, were different from some studies who reported pain, respiratory distress, fatigue, and weakness as the chief complaints (Malik et al., 2019; Tang et al., 2015). These studies investigated HNC patients and the discrepancy may be due to differences in the types of cancers prevalent in different populations and therefore differences in

treatment modalities. Dysphagia, which is a common complication of oral cancer resection (Hasegawa et al., 2021), was found to be the most common diagnosis among patients visiting outpatient clinics. This suggests that patients are more likely to seek treatment at an outpatient clinicinstead of an ED for known complications, underscoring the effectiveness of managing certain conditions and patients' education.

I used a logistic regression analysis to determine the factors that increased the likelihood of ED visits for patients with OCC and OPC, which was very unique as other researchers mostly focused on hospital readmission predictors (Noel et al., 2020). The results showed that patients with more advanced cancer who received concurrent treatments compared to surgery alone, and those with low socioeconomic status who lived in rural areas had a higher likelihood of ED visits. Among all studied variables, patients who did not receive any treatments had the highest odds of ED visits (2.6) which signifies the importance of attention to this group of patients. In Eskandar et al study, comorbid conditions were found to be a significant predictor of ED and UH in addition to these factors. Results of a systematic review (Noel et al., 2020) also showed the presence of comorbid conditions and chemotherapy were frequently associated with ED use.

Our findings regarding the predictors of ED visits underscore the importance of focused follow-up care for patients with more severe conditions. They also draw attention to addressing the needs of patients living in rural areas with lower socioeconomic status. Our study revealed that the average travel time and distance required to reach an ED facility were nearly half that of an outpatient clinic, indicating restricted access to outpatient cancer clinics. This suggests that limited access to care may contribute to increased ED visits and that enhancing access to care could alleviate the strain on EDs.

Despite the strengths of the study, it is important to acknowledge the limitations of administrative data studies, such as the reliability and accuracy of the data. Furthermore, we were unable to include patients diagnosed with cancer after 2018 due to the changes in cancer staging. The new staging system is not comparable to the previous one, and including these patients in the study would have compromised the reliability of our findings. Additionally, we were unable to consider unmeasured confounders, such as habits and lifestyles.

In future studies, it would be valuable to analyze the effects of this transition of care toward more outpatient services on the patient outcomes. The results of this study can serve as a starting point for future research that incorporates both patient and healthcare provider perspectives. This would help identify the underlying reasons for the observed ED visits, leading to improvements in the patient experience and outcomes.

2.6. Conclusions

This study has the notable advantage of being population-based and using a substantial sample size acquired over 8 years. As a result, the study was able to identify trends in healthcare utilization and examine the underlying risk factors and presentations of patients at ED and outpatient clinics. We observed a shift in healthcare delivery to outpatient settings, resulting in increased outpatient clinic and community office visits and decreased ED utilization among oral cancer patients. Our analysis identified cancer stage, residence, deprivation, and treatment modality as factors influencing ED usage. By implementing improved symptom management plans based on these findings and prioritizing enhanced access to care for disadvantaged individuals and those living in rural areas, it is possible to reduce avoidable ED visits. This

approach would ultimately alleviate the disease burden on patients and lighten the strain on the healthcare system as a whole.

3. Chapter Three: Trends and Predictors of Unplanned Hospitalization among Oral and Oropharyngeal Cancer Patients

3.1. Abstract

Purpose: The incidence of oral cancers, particularly HPV-related oropharyngeal cancer, is steadily increasing worldwide, presenting a significant healthcare challenge. This study aims to investigate trends and predictors of unplanned hospitalizations for oral cavity cancer (OCC) and oropharyngeal cancer (OPC) patients in Alberta, Canada.

Methods: This retrospective, population-based, cohort study used administrative data collected from all hospitals in Alberta. Using the Alberta Cancer Registry (ACR), we identified a cohort of adult patients diagnosed with a single primary OCC or OPC between January 2010 and December 2017. Linking this cohort with the Discharge Abstract Database (DAD), we analyzed trends in hospitalizations, primary diagnoses, and predictors of unplanned hospitalization (UH) and 30-day unplanned readmission.

Results: Out of the 1,721 patients included, 1,244 patients recorded a total of 2,228 hospitalizations, with 48% being UH. Distribution of UH was significantly different among different sex, age group, comorbidity, cancer type, stages, and treatment modalities. UHs had a higher death rate of 18.5% as compared to 4.6% for planned. The rate of UH per patient decreased from 0.69 to 0.54 visits during the study period. Common diagnoses for UH were palliative care and post-surgical convalescence, while surgery-related complications such as infection and hemorrhage were frequent in 30-day unplanned readmissions. Predictors of UH included cancer stage, material deprivation, and treatment, while cancer type and comorbidity predicted readmissions.

Conclusion: The rate of UHs showed a noteworthy decline in our study, which could be a result of enhanced care coordination. Furthermore, identified primary diagnosis and predictors associated with UHs and readmissions, provide valuable insights for enhancing the quality of care for cancer patients.

Keywords: Oral Cancer, Oropharyngeal Cancer, Delivery of Health Care

3.2. Introduction

Oral cavity cancer (OCC) and oropharyngeal cancer (OPC) have become a growing global concern, ranking as the 8th most common cancer worldwide and accounting for 2.5% of all cancer cases (Warnakulasuriya & Greenspan, 2020). Studies have consistently reported an increasing incidence of oral and oropharyngeal cancers in North America, with a significant portion attributed to HPV-related oropharyngeal (Chaturvedi et al., 2011; Cohen et al., 2018; Gormley et al., 2022; Habbous et al., 2017). A recent report from Statistics Canada indicates a 13.9% increase in the incidence rate of oropharyngeal cancer in 2020 compared to the average incidence from 2015-2019 (Statistics Canada, 2023). Similarly, previous studies have shown a significant rise in oropharyngeal cancer cases in Alberta between 2005 and 2017 (Ganatra et al., 2022).

It is estimated that there will be 7,500 new cases of head and neck cancer in 2022, with oral and oropharyngeal cancer comprising the majority of these cases (Canadian Cancer Statistics Advisory in collaboration with the Canadian Cancer Society, 2022; Sturgis & Cinciripini, 2007).

Patients diagnosed with oral and oropharyngeal cancer often present at advanced stages, necessitating complex and resource-intensive treatments (Massa et al., 2019; Ribeiro-Rotta et al., 2022).

The management of these cancers requires a multidisciplinary approach, involving comprehensive evaluations to determine the most effective treatment strategies, which may involve surgical resection, concurrent radiotherapy, and chemotherapy (Alberta Health Services, 2019; Chow, 2020; National Comprehensive Cancer Network (NCCN), 2022). Although these treatment modalities have significantly improved patient survival in recent decades (Pulte & Brenner, 2010), they are accompanied by toxicities and complications. Compared to other cancers, patients with oropharyngeal cancer experience the highest symptom burden (Bubis et al., 2018)

Inadequate symptom management in patients with oral and oropharyngeal cancer can lead to treatment interruptions, which are associated with poorer oncologic outcomes (Bese et al., 2007; Su et al., 2021; Xiang et al., 2021). Uncontrolled symptoms can lead to emergency department visits and unplanned hospitalizations (UH), both have been identified as predictors of lower patient survival, and place additional strain on the healthcare system (O'Neill et al., 2015).

The cost associated with these services is significant, with cancer care expenses in Canada exceeding 26 billion dollars in 2021, and hospital expenses comprising the largest portion. Despite the universal healthcare system in Canada, 30% of the financial burden associated with cancer care is borne by patients (de Oliveira et al., 2018; Garaszczuk et al.,

2022). In fact, Canadians with an annual income below 30,000 CAD experience more severe financial toxicity, poorer overall health status, and lower rates of disease-free survival (Noel et al., 2023).

The number of patients receiving survivorship care is rising, specifically for HPV-related OPC, which is characterized by higher survival rates (Kimple & Harari, 2015). As a result, it is crucial to perform a thorough evaluation of the healthcare resources needed to guarantee the provision of excellent care for these individuals. The existing research in the field has predominantly concentrated on head and neck cancer or has focused on patients who underwent specific treatment modalities. However, to effectively address the challenges associated with OPC and OCC, it is essential to investigate deeper into these specific subtypes.

UHs have consistently been associated with poorer oncology outcomes and can significantly disrupt the treatment process (Chaudhary et al., 2017; Quinn et al., 2020) To mitigate these challenges, it is essential to develop effective strategies aimed at minimizing the occurrence of UHs and optimizing the allocation of healthcare resources. However, achieving these goals requires a comprehensive investigation to identify the necessary resources and best practices to enhance the delivery of high-quality care. Therefore, the objectives of this study were to investigate: 1) trends of unplanned hospitalization, 2) primary diagnoses at admission, and 3) predictors of unplanned hospitalization and hospital readmission in oral cancer patients.

3.3. Methods

3.3.1. Cohort description

This retrospective population-based cohort study was conducted using administrative data from all hospitals in Alberta after receiving an approval from the Health Research Ethics Board of the Alberta Cancer Committee (Ethics ID# HREBA.CC-20-0204). The study included adult patients aged 18 years and older diagnosed with primary OCC or OPC between January 2010 and December 2017, with the exclusion of patients having multiple primary tumors to mitigate the impact of multiple cancer sites in healthcare utilization. The analysis covered all cancer-related hospitalizations from date of diagnosis in cancer registry data until two years after diagnosis to follow the treatment guidelines, which recommend that most treatments and follow-up visits occur within this period.

3.3.2. Outcomes definition

The study utilized the Alberta Cancer Registry (ACR) database to identify the patient cohort and gathered detailed information on demographics, diagnosis zone, cancer type, stage, and treatment. The International Classification of Diseases for Oncology, Third Edition (ICD-O-3) was used to define the tumor cohort for both oral cavity cancer (OCC) and oropharyngeal cancer (OPC). For OCC, topographical codes included Lip Mucosa (C00.3-9), Oral Tongue (C02.0-3, C02.8, and C02.9), Gum (C03.0-C03.9), Floor of Mouth (C04.0-C04.9), Palate (C05.0-C05.9), and Other unspecified parts (C06.0-9). For OPC, the topographical codes included Base of Tongue (C01.9), Lingual Tonsil (C02.4), Tonsil (C09.0-C09.9), Oropharynx (C10.0-9), Pharynx not otherwise specified (C14.0), and Waldeyer Ring (C14.8).

To determine the healthcare utilization of the defined cohort in the hospital, the ACR cohort was linked with the Discharge Abstract Database (DAD) using unique encoded identifiers. Only visits for cancer-related events were included in the analysis, which was filtered by selecting hospitalizations with a cancer diagnosis mentioned in any of the 25 diagnosis codes in each observation of the DAD database. The study utilized the Pampalon deprivation index based on Canadian census data to evaluate the socio-economic status of patients, considering both material and social factors. However, for this study, only the material component of the index was used as it was deemed more relevant in the Alberta context. The index categorized patients into five categories, with Q1 indicating the most privileged patients and Q5 indicating the most disadvantaged individuals(Alberta Health Services, 2016).

After identifying the final cohort of visits, the study extracted the primary reason for hospitalizations and the length of stay for each visit. DAD includes an indicator defining admission categories, and the elective admissions were considered as planned and urgent admission as unplanned hospitalizations. Furthermore, we utilized the Alberta Health Services (AHS) indicator definition to identify 30-day unplanned readmissions, which were defined as unplanned or emergency admissions within 30 days of being discharged from a prior visit. To calculate the readmission rate, we excluded visits where patients were transferred to another acute care facility, deceased, or left the hospital from both the numerator and denominator(Alberta Health Services, 2012).

3.3.3. Data analysis

Univariate analysis was performed to describe and compare the characteristics of patients at the time of diagnosis based on their admission category. Categorical variables were presented using frequency and percentage distributions, while continuous variables were summarized using

means and standard deviations or medians and interquartile ranges. An independent sample t-test was used to compare the continuous variables between planned and unplanned visits. The Chi-square test was used to compare proportion differences between sex, age category, cancer site, tumor stage, comorbidity index, deprivation index, and treatments among admission categories. Moreover, disposition status was compared using the same test. The Mann-Whitney U test was used to compare the length of stay between planned and unplanned visits.

Two logistic regression models were employed to identify predictors of UH and unplanned hospital 30-day all-cause readmission, respectively. The outcome of interest for the unplanned predictors model was having at least one unplanned visit during the follow-up period, while the dependent variable for the readmission model was having at least one readmission visit during the same period. We used priori information from existing literature for selecting the independent variables for the UH model (Badr et al., 2019; Bur et al., 2016; Chaudhary et al., 2017; Eskander et al., 2018; Goel, Badran, et al., 2019; Hazelden et al., 2019; Luryi et al., 2016; Noel et al., 2020; O'Neill et al., 2015; Ryu et al., 2013). For the readmission model, given the limited number of observations for different variables, a hybrid variable selection approach was employed. Initially, the model was fitted using forward selection to identify significant variables. Then, additional important variables based on prior knowledge were incorporated, and the model's fitness was assessed using the global null hypothesis test and Hosmer-Lemeshow test to ensure its fitness. Furthermore, a linear regression analysis was conducted to assess the trend of unplanned in different healthcare facilities throughout the study period.

All statistical analyses were conducted using SAS Enterprise Guide 7.1 (SAS Institute, Cary, North Carolina). The alpha was set at $p < 0.05$, to determine statistical significance.

3.4. Results

3.4.1. Cohort description

The results of the univariate analysis of patient demographics categorized by their admission category are shown in Table 3.1. The study involved 1,721 patients, out of which 1,244 (72%) had a total of 2,228 hospitalizations, with 1,071 (48.1%) of them being categorized as unplanned. 71.4% of hospitalized patients were males, 57.5% were aged between 45-65 years and had no comorbidities. The proportion of hospitalizations for both OCC and OPC was nearly equal (49.6% and 50.4% respectively), and patients with tumors in the tonsil and base of tongue had the highest percentage of UHs (11.6% and 11.5% respectively). Patients in Stage IV had the greatest number of hospitalizations with 1,610 visits, and 55.2% of these hospitalizations were classified as unplanned. Patients who received chemoradiation therapy had the highest proportion of UHs (11.9%) and patients who only received radiation therapy had the greatest ratio of unplanned versus planned hospitalization (7.8% Vs. 1.7% respectively). Chi-square test results revealed a significant difference in the distribution of planned and UHs across all investigated variables.

Table 3-1 Patients' Clinical and Demographic Characteristics

Characteristics		Hospitalizations			p-value
		Unplanned	Planned	All	
		N (%)		N (Column %)	
Number of Individuals		612 (49.2)	632 (50.8)	1244 (100)	
Number of Visits		1071 (48.1)	1157 (51.9)	2228 (100)	
Sex	Male	798 (35.82)	793 (35.59)	1591 (71.4)	0.002
	Female	273 (12.25)	364 (16.34)	637 (28.6)	
Age Group	45-65	617 (27.69)	665 (29.85)	1282 (57.5)	0.001
	<45	53 (2.38)	108 (4.85)	161 (7.2)	
	>65	401 (18)	384 (17.24)	785 (35.2)	
Comorbidities (CCI)	0	782 (35.1)	942 (42.28)	1724 (83)	0.002
	1	102 (4.58)	90 (4.04)	192 (9.2)	
	+2	93 (4.17)	68 (3.05)	161(7.8)	
	Missing	94 (4.22)	57 (2.56)	151	
Cancer Type	OCC	416 (18.67)	690 (30.97)	1106 (49.6)	0.001
	OPC	655 (29.4)	467 (20.96)	1122 (50.4)	
Cancer Site	Base of tongue	255 (11.45)	167 (7.5)	422 (18.9)	0.001
	Floor of mouth	53 (2.38)	89 (3.99)	142 (6.4)	
	Gum	50 (2.24)	83 (3.73)	133 (6)	
	Lip	2 (0.09)	8 (0.36)	10 (0.4)	
	Lip, oral cavity and pharynx, other unspecified	13 (0.58)	7 (0.31)	20 (0.9)	
	Mouth, other and unspecified	80 (3.59)	122 (5.48)	202 (9.1)	
	Oropharynx	123 (5.52)	60 (2.69)	183 (8.2)	
	Palate	38 (1.71)	45 (2.02)	83 (3.7)	
	Tongue, other and unspecified	199 (8.93)	346 (15.53)	545 (24.5)	
	Tonsil	258 (11.58)	230 (10.32)	488 (21.9)	
Stage	I	35 (1.57)	195 (8.75)	230 (10.3)	0.001
	II	36 (1.62)	105 (4.71)	141 (6.3)	
	III	84 (3.77)	113 (5.07)	197 (8.8)	
	IV	889 (39.9)	721 (32.36)	1610 (72.3)	
	Missing/Unknown	27 (1.21)	23 (1.03)	50 (2.2)	
Treatment Modality	Surgery	114 (5.12)	431 (19.34)	545 (24.5)	0.001
	None	100 (4.49)	35 (1.57)	135 (6.1)	

Radiation	174 (7.81)	37 (1.66)	211 (9.5)
Other	43 (1.93)	21 (0.94)	64 (2.9)
Chemoradiation	265 (11.89)	122 (5.48)	387 (17.4)
Surgery with radiation	186 (8.35)	309 (13.87)	495 (22.2)
Surgery with chemoradiation	189 (8.48)	202 (9.07)	391 (17.5)

3.4.2. Trends of hospitalization and their outcomes

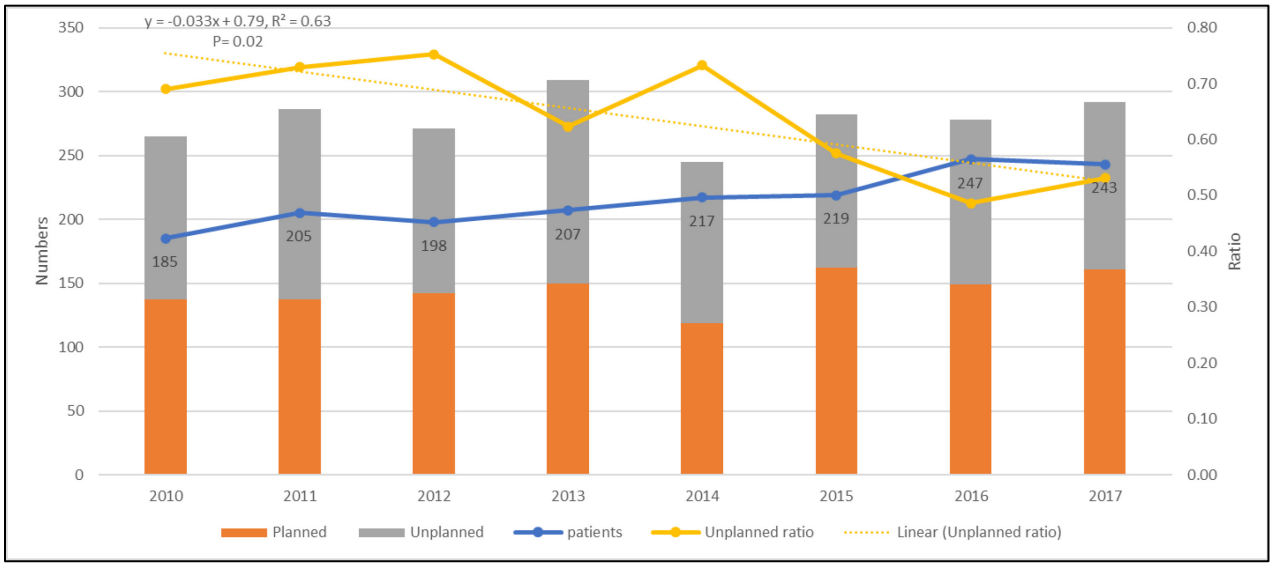
Of the 2,228 hospitalizations analyzed, there was a significant difference in discharge disposition between planned and unplanned hospitalizations (P= 0.001). While 88.4% of planned hospitalizations resulted in discharge, for the UHs, only 60% were discharged and the proportion of those who died in the hospital was four times higher at a rate of 18.5%. The median length of stay for planned hospitalizations was 9 days, compared to 8 days for unplanned visits. However, the mean length of stay for unplanned visits was longer at 14.7 days compared to 12.3 days for planned hospitalizations. Details of hospitalization outcomes are presented in Table 3.2.

Table 3-2 Hospitalization Outcomes and Length of Stay

	Unplanned	Planned	All	P. Value
Discharge Disposition				
Died	198 (18.5)	53 (4.6)	251 (11.3)	0.001
Discharged	639 (59.7)	1023 (88.4)	1662 (74.6)	
Left	17 (1.6)	9 (0.8)	26 (1.2)	
Transferred	217 (20.3)	72 (6.2)	289 (13)	
Length of Stay (Days)	14.7 (8)	12.3 (9)	13.5 (9)	0.09

During the study period, the number of individuals increased by 31%, from 185 in 2010 to 243 in 2017. Despite this increase, the number of hospitalizations only increased by 10%, which resulted in decreased ratio of hospitalization per patient by 16% from 1.43 hospitalization in 2010, to 1.2 in 2017.This decrease was more significant in UHs and the results of linear regression showed that the rate of UHs per patient decreased significantly by 22% from 0.69 to 0.54 (β=0.03, P= 0.02) (Figure 3.1).

Figure 3-1 Trend of hospitalizations during the study period, simple linear regression



3.4.3. Hospital readmission and primary reasons for hospitalization

Among patients who were discharged from the hospital, 109 (9.7%) were readmitted and there was a total of 128 readmission visits, resulting in an overall readmission rate of 7.7%. The primary diagnosis of events was analyzed based on the admission category. For planned hospitalizations, cancer diagnosis accounted for 84% of visits, followed by 9% for palliative care and convalescence following surgery. Among the unplanned visits, cancer diagnosis accounted for only 28.8%, palliative care and convalescence following surgery were more frequent with 22.6%, followed by clinical symptoms such as cachexia, dysphagia, and nausea accounted for 11.7%.

The top three single non-neoplasm diagnoses of UHs were palliative care, convalescence following surgery, and pneumonitis due to food and vomit. In terms of readmission visits, complications of surgical and medical care such as hemorrhage and post-surgical infection were the most common diagnosis group at 21.9%, followed by cancer diagnosis at 18% and clinical symptoms such as pain and cachexia at 18%. The top three single reasons for hospital readmission were pneumonitis due to food and vomit, Cachexia, and Hemorrhage and hematoma. Further details are presented in Table 3.3.

Table 3-3 Primary Diagnosis of Hospitalized Patients

Admit Category	Diagnosis Category	N (%)	Most Frequent Observations
Planned	Neoplasms	972 (84)	Malignant neoplasms of Tongue, Tonsil, Lymph nodes of face and neck
	Factors influencing health status	104 (9)	Palliative care, Convalescence following surgery
	Symptoms and signs	30 (2.6)	Cachexia, Dysphagia, Nausea and vomiting
	Other categories	51 (4.4)	Dehydration, Oral mucositis
Unplanned	Neoplasms	308 (28.8)	Malignant neoplasms of Tongue, Tonsil, Oropharynx
	Factors influencing health status	242 (22.6)	Palliative care, Convalescence following surgery, Pain management planning
	Symptoms and signs	125 (11.7)	Cachexia, Dysphagia, Nausea and vomiting, Pain
	Diseases of the respiratory system	86 (8)	Pneumonitis due to food and vomit, Pneumonia, Respiratory failure
	Complications of surgical and medical care	70 (6.5)	Infection following a procedure, Hemorrhage & hematoma complicating a procedure, Disruption of operation wound
	Diseases of the digestive system	57 (5.3)	Oral mucositis, stomatitis, post-procedural disorders of digestive system
	Endocrine, nutritional, and metabolic diseases	41 (3.8)	Dehydration, Disorders of calcium metabolism, Malnutrition
	Other categories	142 (13.3)	Neutropenia, Sepsis
Readmission	Complications of surgical and medical care	28 (21.9)	Hemorrhage, hematoma, and infection following a procedure, disruption of operation wound
	Neoplasms	23 (18)	Malignant neoplasms of Tongue, Tonsil, Oropharynx
	Symptoms and signs	23 (18)	Cachexia, Pain
	Factors influencing health status	17 (13.3)	Palliative care, Pain management planning
	Disease of respiratory system	15 (11.7)	Pneumonitis due to food and vomit
	Other categories	22 (17.2)	Dehydration, Oral mucositis

3.4.4. Predictors of Unplanned Hospitalization and hospital readmission

A logistic regression analysis was conducted to determine the predictors of UHs. we evaluated the overall significance of the logistic regression model by testing the global null hypothesis. The test yielded a test statistic of 308.4 with 20 degrees of freedom ($p < 0.001$), indicating that the

results are statistically significant. Moreover, the Hosmer-Lemeshow test was conducted to assess the goodness-of-fit of the model, resulting in a test statistic of 2.98 with 8 degrees of freedom (P= 0.94).

Based on these findings, we concluded that the model is well-fitted to the data, and the results obtained are both statistically significant and reliable. The results of the model revealed that several factors were significantly associated with increased risk of UHs, including advanced cancer stage, older age at diagnosis, and higher deprivation score. Specifically, patients at stages IV and III had 3.5 and 2.2 times higher odds of UHs compared to those at stage I. Additionally, patients who did not only undergo surgical procedures had a significantly higher odds of UHs. Table 3.4 provides a summary of the logistic regression analysis findings.

Table 3-4 Predictors of Unplanned Hospitalizations

Predictors		Odds ratio	95% Confidence Limits		P. Value
Sex	Female	Reference			
	Male	0.95	0.69	1.31	0.72
Stage	Stage I	Reference			
	Stage II	1.27	0.59	2.75	0.55
	Stage III	2.16	1.08	4.33	0.03
	Stage IV	3.51	1.89	6.54	<.0001
Age at diagnosis	<45	Reference			
	45-65	1.66	0.94	2.93	0.08
	>65	2.29	1.26	4.16	0.01
Deprivation Index	1	Reference			
	2	1.18	0.72	1.92	0.52
	3	1.08	0.68	1.70	0.75
	4	1.19	0.76	1.84	0.45
	5	1.78	1.16	2.74	0.01
Cancer type	OCC	Reference			
	OPC	1.11	0.79	1.56	0.50
Residence	Rural	Reference			
	Urban	1.05	0.74	1.49	0.79
Comorbidity index	0	Reference			
	1	1.33	0.81	2.18	0.27
	+2	1.85	1.00	3.44	0.05
Treatment	Surgery	Reference			
	Chemoradiation	4.99	2.89	8.62	<.001
	No procedure	10.81	4.96	23.55	<.001
	Other	7.64	2.75	21.27	<.001
	Surgery - Radiotherapy	1.50	0.94	2.40	0.09
	Radiotherapy	15.44	6.63	35.96	<.001
	Surgery - Chemo Radiotherapy	2.68	1.59	4.51	0.001

Furthermore, a multivariable logistic regression model developed to determine the predictors of 30-day hospital readmission. To overcome the issue with limited number of observations in early cancer stages, stage I and II were merged and considered as early stage and stage III and IV as late stage. Moreover, Other treatments and No treatment were merged as Other treatment. The model's fitness and significance were assessed using the same method as the UH model. The global null hypothesis test resulted in a test statistic of 26.5 with 9 degrees of freedom (P= 0.002), demonstrating that the findings are statistically significant. Furthermore, the Hosmer-Lemeshow test statistic was 1.8 with 8 degrees of freedom (P= 0.99), indicating that the model fits the data well.

The results showed that patients with oropharyngeal cancer and those with two or more comorbidities had a significantly higher risk of 30-day hospital readmission. Patients with oropharyngeal cancer had 1.9-fold increased risk of readmission compared to those with oral cavity cancer, and those with higher comorbidity scores had a 2.3-fold increased risk of readmission compared to those without any comorbidities. Interestingly, advanced stages of cancer, higher deprivation scores and treatment modality were not predictors of 30-day hospital readmission. These findings are presented in detail in Table 3.5.

Table 3-5 Predictors of 30-Day unplanned Hospital Readmission

Predictors		Odds ratio	95% Confidence Limits		P. Value
Stage	Early	Reference			
	Late	1.35	0.60	3.06	0.47
Cancer type	OCC	Reference			
	OPC	1.91	1.13	3.25	0.01
Comorbidity index	0	Reference			
	1	0.82	0.36	1.87	0.57
	+2	2.31	1.12	4.76	0.01
Treatment	Surgery	Reference			
	Chemoradiation	0.74	0.31	1.74	0.46
	Other	0.69	0.21	2.32	0.94
	Surgery - Radiotherapy	1.08	0.50	2.31	0.70
	Radiotherapy	1.87	0.71	4.94	0.25
	Surgery - Chemo Radiotherapy	1.63	0.75	3.53	0.33

3.5. Discussion

This study aimed to determine the trends of cancer-related hospitalization, specifically UH and predictors of UH and readmission, considering the significance of these indicators for patient care and the healthcare system. In our univariable analysis, we investigated the distribution of planned and unplanned hospitalizations in relation to patient demographics, cancer severity, and treatment modalities. We found significant differences in the distribution of these variables between planned and unplanned visits. The overall rate of all-cause hospitalization was 72%, with approximately 50% of hospitalized patients and 35% of the entire cohort experiencing UH during the follow-up period.

Our findings are consistent with previously reported rates of hospitalization, ranging from 15% to 38%, across different treatment modalities and follow-up periods (Han et al., 2020; Moore et al., 2019; Patel et al., 2023; Whitney et al., 2019). Specifically, our results closely align with the 38% rate reported by Whitney et al (Whitney et al., 2019), who conducted a study with

a one-year follow-up period. Furthermore, our findings are similar to those of Moore et al (Moore et al., 2019), who focused on patients undergoing radiotherapy and reported a higher rate of UH. In the two-year follow-up period of our study, we found a higher rate of UHs compared to previous studies with shorter follow-up terms. This indicates that patients may continue to require acute care over an extended duration, emphasizing the importance of implementing proactive measures to ensure appropriate support for patients in the long term.

Our results showed the in-hospital mortality of unplanned admissions at 18.5%, were more than 4 times higher than planned visits, which signifies the importance of prevention of unplanned visits and coordination of care and timely follow-up of patients. The mortality rate in our study was greater than previous reports of 15.6% for unplanned hospital mortality (Whitney et al., 2019). The higher mortality reported in our study could be due to the differences in cancer sites since these reports were for head and neck cancer. The majority of patients in this study had oropharyngeal cancers at advanced stages, which justifies the higher mortality rate. Moreover, the overall mortality rate of 11.3% of this study was comparable to previous studies 10.2% to 13% for different sex in Spain (Carazo-Casas et al., 2022).

In terms of patients' diagnosis, palliative care, convalescence following surgery, and pneumonitis due to food and vomiting were the leading diagnosis for UHs, and pneumonitis due to food and vomit, Cachexia, and Hemorrhage for readmissions. Similarly, various studies investigated the reasons for UH and readmission, the primary diagnosis varied based on the treatment patients received. For patients who underwent surgery, complications such as wound infection, bleeding and post-surgical pneumonia were frequent (Chaudhary et al., 2017; Goel,

Raghavan, et al., 2019; Offodile et al., 2015; Wu & Hall, 2018), and a systematic review determined wound complication as a risk factor for readmission. Among patients who underwent non-surgical treatment, gastrointestinal symptoms like nausea and vomiting, along with problems associated with reduced food intake such as dehydration, fatigue, and diminished well-being, were commonly reported (Allen-Ayodabo et al., 2019; Fahy et al., 2023; Givens et al., 2009; Hazelden et al., 2019; Moore et al., 2019; Patel et al., 2023). Implementing preventive strategies to address these complications could be beneficial in reducing the rate of unplanned visits and readmissions.

In our study, we conducted a logistic regression analysis to comprehensively examine the relationship between various predictors and UH and readmission. The analysis revealed that age at diagnosis, cancer stage, higher deprivation, and treatment modality were significant predictors of UH. These findings are consistent with a systematic review, in which predictors of UH and emergency department use among head and neck cancer patients were explored (Noel et al., 2020). Additional studies have also shown that age is a predictor of UH or readmission (Bur et al., 2016; Chaudhary et al., 2017; Moore et al., 2019). Furthermore, our findings revealed that patients from the most deprived socioeconomic groups had 81% higher odds of UH. This highlights the significant influence of socioeconomic status in determining the likelihood of UH among patients with oral and oropharyngeal cancer.

In a study, low income and lack of insurance were identified as risk factors for readmission, suggesting that socioeconomic factors can influence healthcare utilization (Noel et al., 2020). Another study in the US revealed that head and neck cancer patients without private

insurance had reduced odds of elective hospital admission and elective treatment in comparison to those with private insurance coverage (Allareddy & Konety, 2006). Similarly, a study conducted in Brazil, highlighted the importance of expanding primary dental care and increasing the number of dental care centers to improve access to care and reduced mortality rates of oral cavity cancer (OCC) and oropharyngeal cancer (OPC) (da Cunha et al., 2019). These findings suggest that improving access to comprehensive care may have a positive impact on the outcomes of patients with oral and oropharyngeal cancer. These findings highlight the importance of considering socioeconomic factors and access to care when developing strategies to reduce UHs and improve outcomes for these patients.

Our study has a notable strength in its population-based approach, as we included patients receiving various treatment modalities and compared them comprehensively. Unlike previous studies that often focused on specific treatment modalities, we examined the association between treatment modalities and UHs across all patients. Our results demonstrated that almost all treatment modalities had higher odds of UH compared to surgery. These findings align with the study from Ontario, which identified that patients who received radiation and surgery with radiation had the highest odds of emergency department (ED) visits or UH (Eskander et al., 2018). Similarly, we observed that patients who received radiotherapy had the highest odds of UH. Furthermore, we found that patients who did not receive any treatment had a significantly increased risk of hospitalization.

In our study, the rate of 30-days unplanned readmissions was 8.1%. Noel et al. reported a range of 2% to 37% for 30-day readmissions among head and neck cancer patients (Noel et al.,

2020). The variations in these rates can be attributed to differences in the studied population and the definition of readmission. Some studies focused on specific cancer sites or readmissions following specific procedures such as radiotherapy or surgery. Luryi et al. (Luryi et al., 2016) reported a 30-day readmission rate of 3.2% specifically for oral cavity cancer. The reported rates for oropharyngeal cancer were generally higher (Chaudhary et al., 2017; M. M. Chen et al., 2017; Goel, Raghavan, et al., 2019; Topf et al., 2017)

Our study revealed that patients with oropharyngeal cancer and those with comorbid conditions had a higher risk of hospital readmission. The impact of comorbidities on readmission risk has been extensively investigated (Noel et al., 2020). The increased risk of readmission among oropharyngeal cancer patients is not surprising, considering the late-stage diagnosis of the disease. More than 90% of these patients were diagnosed at stage III and IV and received concurrent treatments (Ganatra et al., 2022), which are associated with a high symptom burden. Additionally, OPC has been identified as a predictor of hospital readmission in other studies (Offodile et al., 2015). Similarly, Noel et al. reported that oral cavity cancer patients had a lower readmission rate compared to other sites within the head and neck cancer category (Noel et al., 2020).

Although this study has notable strengths, it is important to acknowledge the limitations it carries. Firstly, we were unable to gather information regarding well-known cancer risk factors such as tobacco and alcohol consumption, as well as the HPV status of the patients. Exploring the impact of these factors on the healthcare needs of patients would be a valuable focus for future research. Additionally, due to changes in the staging criteria for oral and oropharyngeal

cancer in 2018, we were unable to include the most recent patients in our analysis. Conducting a new study that specifically focuses on patients diagnosed after 2018 would help address this limitation and provide more up-to-date insights.

Currently, there are several models of care and initiatives for cancer survivors in Canada (Romkey-Sinasac et al., 2021). In 2012, the introduction of the Alberta Cancer Plan (Government of Alberta, 2013) emphasized the transition to outpatient settings and the integration of primary care professionals. In Alberta, a primary care model is utilized to provide the necessary care for head and neck cancer survivors (Alberta Health Services, 2022b). In this model, either a family physician or nurse practitioner conducts follow-up visits. Patients are educated about treatment side effects, and referrals to oncologists are made when necessary. The observed positive outcomes of this study could be attributed to the implementation of care models and improved patient management. Similarly, the transition from oncology-lead care to primary care reduced the number of hospitalizations for breast cancer patients in Ontario (Mittmann et al., 2018). Further investigation should examine patient outcomes trends and healthcare utilization patterns in outpatient facilities.

3.6. Conclusion

Considering the alarming increase in the incidence of oropharyngeal cancer (Statistics Canada, 2023) and the high survival rates associated with it (Song et al., 2020), efficient management of survivorship care is of utmost importance. Despite a notable rise in the patient population, our findings revealed a declining trend in the rate of UHs. This decrease could be attributed to the improved coordination of care. We also identified the primary diagnosis and predictors of unplanned and readmission hospitalizations. These findings provide valuable insights for

policymakers in terms of care coordination and reducing avoidable hospitalizations, ultimately reducing the burden of the disease on patients and the healthcare system and improving patient outcomes.

4. Chapter 4: Discussion and Conclusions

The objectives of this thesis were to:

1. Examine the trends of hospitalization and emergency department, outpatient clinic and community office visits among OCC and OPC in Alberta.
2. Identify the predictors associated with acute care visits, including unplanned hospitalizations, unplanned 30-day hospital readmissions, and emergency department visits.
3. Determine the primary diagnoses of patients admitted to hospitals, visited emergency departments, and outpatient clinics.

Due to the extensive volume of information contained within the four databases used in this study, it was not feasible to encompass all of them within a single manuscript. As a result, we implemented a two-phase approach to our research, enabling us to present a comprehensive report of the results. The initial phase focused on examining healthcare utilization, predictors, and trends specifically within the ED, outpatient clinic, and community offices. In the second phase, the study focused on patients' hospitalizations especially UHs, to effectively address the research objectives within that specific context.

The novelty of this research lies in its population-based approach, examining a substantial patient cohort. Moreover, while prior studies primarily centered around hospitalizations and emergency visits (Noel et al., 2020), our research extended beyond that scope. We delved into the patients' visits in outpatient clinics and community offices, exploring the interconnectedness between these different healthcare settings. By analyzing patients' visits

across these settings simultaneously over an 8-year period, we aimed to gain insights into how they could potentially influence each other. This aspect assumes particular significance, as it aligns with the emphasis on delivering care in primary care settings within newer models of care (Government of Alberta, 2013; Romkey-Sinasac et al., 2021).

The primary purpose of this chapter is to provide a comprehensive summary of the key findings derived from both phases of the study and interpret the results in the context of the literature. Moreover, it will also highlight the strengths and limitations of the study and discuss the implications of the findings, shedding light on their potential impact and suggesting prospective areas for further research in the field.

4.1. Summary of results

With the increasing number of cancer survivors and focus on shifting cancer care to primary care settings and recognizing their significant role in survivorship care (Government of Alberta, 2013; Song et al., 2020; Vos et al., 2021), it becomes crucial to evaluate the overall healthcare utilization trends of cancer patients and understand the transitioning care to these settings. While numerous studies have addressed the acute care needs of HNC patients (Noel et al., 2020), there has been limited attention given to the healthcare utilization of specifically OCC and OPC patients in primary care settings. In the phase one of the study, we aimed to investigate the trend of visits in primary care settings and EDs and identify factors that may predict ED visits.

Among the included patients in the study, males in older ages accounted for the majority of the cohort, and 34% had at least one cancer-related ED visit. Outpatient clinic visits were recorded for 76% of patients, while 96% had community office visits. Notably, there was a 31%

increase in the number of patients, and the number of outpatient clinic and community office visits increased significantly. Interestingly, ED visits showed a reduction from 0.65 to 0.49 visits per patient per year. The reducing ratio of ED visits per patient could potentially be associated with the transition of care toward outpatient facilities, which resulted in increases in outpatient clinic and community office visits.

Analyzing the ED visits, we found that almost half of the visits were resulted in discharge and 40% were admitted. Common diagnosis of patients included dehydration, post-procedure infections, and gastrointestinal disorders. Furthermore, we identified several predictors of ED visits. These predictors included cancer stage, rural residence, high deprivation score, and treatment modalities. Recognizing these predictors and frequent patients' diagnosis in visits can assist in identifying high-risk patients who may benefit from enhanced support and targeted intervention to further reduce avoidable ED visits and ultimately reducing the burden of the visits and improving patient outcomes.

In addition to ED, outpatient clinic, and community office visits, UHs have consistently been recognized as a significant challenge in oncology care, as they are associated with poorer outcomes and interrupt the treatment process (Chaudhary et al., 2017; Quinn et al., 2020). Moreover, they represent the most resource-intensive aspect of care for cancer patients (de Oliveira et al., 2018). To address these issues and mitigate the challenges posed by UHs, it is crucial to develop effective strategies that minimize their occurrence and optimize the allocation of healthcare resources. Therefore, in the second phase of the study, my focus shifted towards

analyzing the healthcare utilization patterns specifically related to hospitalizations among the patients.

Among the included cohort of patients, 72% experienced a total of 2,228 hospitalizations, with almost half of these hospitalizations classified as unplanned. In the patient level analysis, we found that almost one-third of the patients experienced UH, which was comparable to 15-38% reported by previous studies (Han et al., 2020; Moore et al., 2019; Patel et al., 2023; Whitney et al., 2019) The comparison between planned and unplanned hospitalizations revealed that UHs were associated with a four-times higher death rate compared to planned hospitalizations. This emphasizes the critical need to prevent and effectively manage UHs, as they are associated with increased risks and adverse outcomes for oral cancer patients.

Interestingly, we observed a noteworthy decline in the rate of hospitalizations per patient during the study period, which was more significant among UHs. In 2010, patients experienced an average of 0.69 UHs, which decreased to 0.54 UHs in 2017. This decline suggests that enhanced care coordination, may have played a role in reducing the occurrence of UHs among oral cancer patients.

Analyzing the primary diagnoses associated with UHs, we found that palliative care and post-surgical convalescence were the most common reasons for hospitalization. In contrast, among 30-days unplanned readmissions, surgery-related complications such as infection and hemorrhage were frequent causes of unplanned readmissions. These findings highlighted the importance of comprehensive post-operative care, including proactive monitoring and early

intervention, to prevent and manage such complications, ultimately reducing the likelihood of readmissions and UH.

The distribution of UHs exhibited significant variations across different factors such as sex, age group, comorbidity, cancer type, stages, and treatment modalities. These findings underscore the multifactorial nature of UHs, suggesting that specific patient characteristics and treatment-related factors may contribute to the likelihood of experiencing such events. To consider the cofounding impact of these factors we developed a logistic regression model. The model identified several predictors of UHs among oral cancer patients. Notable predictors included cancer stage, deprivation, and treatment modality. Patients with advanced cancer stages, those from deprived backgrounds, and those undergoing specific treatments were found to be at a higher risk of experiencing UHs. Additionally, cancer type and comorbidity emerged as predictors of hospital readmission. These predictive factors provide valuable insights for healthcare providers in identifying high-risk patients who may benefit from targeted interventions aimed at reducing the occurrence of UHs and readmissions.

To summarize, the results of my thesis sheds light on the transition of care in OCC and OPC management and highlighted the importance of primary care settings in cancer care. The observed trends towards increased outpatient clinic and community office visits and reduced ED and unplanned visits underscore the potential benefits of a more community-based approach to cancer care. To reduce avoidable acute care visits and alleviate strain on the healthcare system, efforts could be directed towards enhancing symptom management plans and improving access to care, particularly for disadvantaged individuals and those residing in rural areas. By

implementing these strategies, a more sustainable and patient-centric model of care can be created for patients, ultimately leading to improved patient outcomes and better resource allocation within the healthcare system.

4.2. Interpretation

Patients with HNC experience a high symptom burden and are at high risk of treatment related toxicities (Allen-Ayodabo et al., 2019; O'Neill et al., 2015). Improper and timely management of these symptoms during active treatment could result in ED visits and UHs, which have been shown to be associated with poor oncologic outcomes (Bese et al., 2007; Su et al., 2021). Due to the enduring impacts of treatment toxicities and cancer-related impairments, survivorship care plays a crucial role in addressing the ongoing needs of patients.

Our results showed the hospitalization and ED use were reduced during the study period, while patient's outpatient clinic and community office visits increased significantly at the same time. The reduction in acute care needs of patients could be attributed to an improved coordination and delivery of care in primary care settings which resulted in increase in the number of those kind of visits. In Alberta, a primary care model has been implemented to deliver survivorship care (Alberta Health Services, 2022b) and observed outcomes have demonstrated the effectiveness of this approach in meeting patient needs while reducing reliance on ED visits and UHs. Similarly, a review study examining interventions aimed at minimizing ED visits among cancer patients found that services delivered by nurses or physicians in oncology outpatient clinics can effectively decrease the ED visits (Kirkland et al., 2020). Another study conducted in the United States, demonstrated that improving outpatient transitions through

patient education, post-discharge nursing phone calls, and 5-day follow-up visits had the potential to decrease unplanned readmissions within the first 30 days after discharge of cancer patients, which highlights the significant role of primary care providers in delivering care(Montero et al., 2016).

In addition to reducing acute care needs, it is crucial to consider the perspectives of cancer patients on their experience. A Canadian qualitative study to investigate the insight of head and neck and breast cancer patients and primary care providers on cancer survivors care plan, patients, nurses and family physicians agreed on survivor's care plan facilitated the transition and continuity of care (Collie et al., 2014). Another study focusing on colorectal cancer patients demonstrated that individuals who received their follow-up care from primary care providers expressed positive evaluations regarding the transition and continuity of care (Sisler et al., 2012). These findings suggest that involving primary care providers in the follow-up care of cancer patients can contribute to a favorable patient experience and ensure ongoing and coordinated care throughout the survivorship journey.

The second objective of this thesis was to identify the factors that predict acute care needs of patients. The logistic regression model for predicting ED visits revealed that cancer stage, residing in rural areas, having a high deprivation score, and specific treatment modalities were significant predictors. Similarly, for UH, cancer stage, deprivation level, and treatment modalities were found to be significant predictors. When examining the predictors of 30-day hospital readmission, a high comorbidity index and the type of cancer were identified as

significant factors. A high similarity between findings of our study and previous studies was observed (Eskander et al., 2018; Noel et al., 2020; Patel et al., 2023).

The observed higher odds of ED visits and UHs among patients who are more deprived and live in rural areas is significant, as it suggests limited access to healthcare for these individuals. Our analysis revealed that the travel time and distance required to reach an outpatient facility was nearly twice as long compared to reaching an ED facility. Previous studies have also demonstrated that socioeconomic status and rurality are influential predictors of ED visits, UH, and hospital readmissions (Carey et al., 2018; M. M. Chen et al., 2017; Eskander et al., 2018; Goel, Raghavan, et al., 2019; Manning et al., 2018; Noel et al., 2020). This finding is significant because it highlights the modifiability of the situation. By implementing targeted policies and interventions that focus on enhancing access to healthcare for these patient groups, this issue can be effectively tackled.

The third objective of the thesis was to examine the primary diagnoses of patients across various healthcare facilities. Our analysis revealed that nausea, vomiting, fever, and dehydration were the most common diagnoses among ED visits, including revisits. Additionally, dysphagia emerged as the most frequent diagnosis associated with clinical symptoms. Studying the patients' diagnoses during their visits is crucial as it provides a foundation for policymaking and the development of preventive strategies to minimize unfavorable events. Understanding the prevalent diagnoses can aid in tailoring interventions and resources towards addressing specific healthcare needs effectively.

While various definitions exist for potentially preventable ED visits, it has been noted that a significant number of ED visits made by cancer patients could have been avoided (Alishahi Tabriz et al., 2023). Tabriz et al study reported that over 50% of the ED visits were preventable, with diagnoses such as dehydration, fever, and nausea being considered preventable. Although our study did not directly assess the proportion of preventable visits, we observed a high occurrence of visits with the primary diagnosis of the mentioned symptoms in our database.

This finding suggests that implementing improved preventive strategies to address the common symptoms could potentially lead to a further reduction in ED visits. By focusing on early intervention and better management of these symptoms, healthcare resources can be more effectively allocated to patients with more serious conditions. This interpretation is supported by the fact that a considerable proportion (54%) of the patients were discharged from the ED, suggesting that their conditions did not require further hospitalization. Among readmitted patients, surgery-related complications such as infection and hemorrhage were frequently observed, which highlights the importance of post-surgical follow-ups to mitigate these events.

4.3. Limitations

This thesis research possesses significant strengths due to its utilization of administrative databases, allowing for a population-based study to be conducted. Although the use of administrative databases can present limitations such as missing data and potential inaccuracies, the databases employed in this study demonstrated a high level of quality in terms of completeness, comparability, and reliability. Previous studies have not reported limitations regarding the data quality of these databases (Carrière et al., 2018; Zakaria et al., 2015). Despite

the strengths of this research, it is important to acknowledge and address limitations. Four main limitations were identified and should be taken into consideration:

- Given our utilization of administrative databases, we encountered limitations in accurately ascertaining the specific reasons behind hospitalizations and ED and outpatient clinic visits. Our interpretation of the events relied on primary diagnosis codes; however, it is important to acknowledge that the primary diagnosis may not always align with the patients' original intentions for seeking care. To address this limitation, future studies could incorporate a patient-centered perspective to gain insights into the true motivations behind healthcare visits. This approach would provide a more comprehensive understanding of healthcare utilization.
- In this study, we focused on identifying cancer-related hospitalizations and ED visits by filtering events based on the presence of cancer diagnosis codes. It is important to note that if a cancer diagnosis was not recorded for a particular visit or hospitalization, we may have missed that event. However, considering the overall high accuracy of the available data, the likelihood of missing such events is minimal.
- The study lacked information on well-known cancer risk factors such as tobacco and alcohol consumption, as well as the HPV status of the patients. Furthermore, we were unable to consider potential variations in technological advancements related to patient treatments and changes in treatment guidelines, which could have had a potential impact on patient treatments and, consequently, healthcare utilization. Future research should explore these factors to gain valuable insights, especially considering the increasing number of HPV-positive head and neck cancers.

- The study was unable to include patients diagnosed after the introduction of significant changes in cancer staging criteria (AJCC 8) in 2017(Lydiatt et al., 2017). However, as we conducted a two-year follow-up on patients, the analysis of their healthcare utilization extended up until the end of 2019. Considering the emergence of the Covid-19 pandemic, even if we had included patients diagnosed after 2018, the reliability of the findings regarding healthcare utilization would have been compromised. Conducting a study to explore the influence of the Covid-19 pandemic and the introduction of the new staging system on patients' healthcare utilization would yield valuable insights.

4.4. Implications

4.4.1. Policy and practice implication

While this study has provided valuable insights into the healthcare utilization patterns of oral cancer patients, it has also generated a series of new inquiries that should be explored in future research. Our findings underscore the significance of early cancer stage diagnosis in relation to healthcare resource needs and highlight the disparities in access to care for underprivileged patients residing in rural areas. Based on these findings, we propose the following recommendations to reduce the burden of disease on both patients and the healthcare system, ultimately leading to improved patient outcomes:

- Invest in the implementation of targeted screening programs specifically designed for the early diagnosis of OCC and OPC. Such programs have the potential to significantly decrease the healthcare resources required for delivering care while improving overall treatment outcomes.

- Address the observed disparities in access to care among less privileged patients and those living in rural areas. By improving access to care for these populations, unnecessary visits to ED and UH could be minimized, resulting in improved oncologic outcomes.
- Implement comprehensive follow-up care for patients who have undergone surgical procedures. This can help reduce hospital readmissions by effectively managing post-surgical symptoms and complications.
- Provide patient education on the potential symptoms of treatment and effective symptom management. By equipping patients with knowledge and strategies to better manage their symptoms, the need for acute care can be reduced. This, in turn, allows healthcare settings to focus on providing timely and appropriate care to patients with more serious conditions, considering the extended length of stay for patients admitted to the hospital.
- Prioritize the delivery of necessary care for patients who have not received any oncologic treatment or have undergone radiation therapy, as these groups exhibited high rates of ED visits and UH. Ensuring adequate and timely care for these patients is crucial for their overall well-being and treatment outcomes.
- Considering the vital significance of dental care both before and after oncologic treatments, it appears that the role of dentists has been undervalued in the formulation of patient care plans. Many complications arise within the oral cavity, highlighting the potential for dentists to play a pivotal role in patient care and improve access to necessary services. There may be a need to provide training to dentists in managing these complications, and policymakers should explore solutions to include such services in patient insurance coverage.

- Developing risk assessment tools to identify patients at an elevated risk of acute care needs is a crucial step. This could be achieved through the application of machine learning methods and multiclass analysis to identify the characteristics of patients who have utilized the highest volume of services. Subsequently, offering targeted support to these individuals, who stand to gain the most from this assistance, can significantly enhance healthcare outcomes.

4.4.2. Research implications and future direction

Given the substantial number of OCC and OPC patients with multiple primary tumors (Sawani, 2022), that were excluded in this study, there is a need for further exploration into the impact of this condition on healthcare utilization. Understanding how these patients navigate the healthcare system and the associated resource utilization can provide valuable insights for optimizing care delivery. Moreover, while our study primarily focused on analyzing trends and predictors of visits in various healthcare facilities, it is crucial to assess the implications of the observed transition of care on patient outcomes. Evaluating the changes in patient outcomes can guide the development of strategies to improve patient experiences and optimize healthcare outcomes. Additionally, it is crucial to incorporate the patient's perspective when studying the healthcare system. Conducting patient-centered studies, such as qualitative research, can provide more accurate and patient-centered information regarding their treatment experiences and the care they have received in different settings. The outcomes of these studies could yield valuable insights into improving the coordination of care, ultimately making it a better overall experience for patients.

4.5. Conclusion

Our findings indicate a decrease in the rate of emergency department (ED) visits and unplanned hospitalizations per patient per year among cancer patients diagnosed between 2010 and 2017. This decline coincided with a rise in the utilization of outpatient clinics and community offices, suggesting a shift towards primary care settings for cancer-related care delivery. The implementation of a primary care model may have contributed to better management of patients' needs in primary care settings, resulting in reduced acute care visits and hospitalizations. These findings highlight the potential benefits of a primary care-based approach in cancer care and the importance of effective care coordination in primary care settings.

Furthermore, we identified predictors of ED visits, UH, and 30-day hospital readmissions. Cancer stage, treatment modality, and high deprivation were associated with both ED visits and UH. Living in a rural area was also linked to a higher likelihood of ED visits. Based on these findings, we concluded that improving access to care for underprivileged patients and those living in rural areas could effectively reduce the need for acute care services.

Additionally, patients who did not receive oncologic treatments and those who underwent radiation therapy exhibited the highest odds of ED visits and UH. Prioritizing and closely monitoring these patients could help prevent adverse events and ensure timely intervention. Regarding patients' diagnoses, we observed that the most frequent diagnoses in the ED were potentially preventable conditions. This underscores the potential impact of preventive strategies and patient education in reducing the number of avoidable ED visits. Furthermore, among patients who were readmitted to the hospital within 30 days, complications related to procedures,

such as infections and hemorrhages, were frequently observed. This highlights the importance of monitoring and managing these symptoms to prevent adverse events and subsequent hospital readmissions.

References

Adelstein, D. J., Ismaila, N., Ku, J. A., Burtness, B., Swiecicki, P. L., Mell, L., Beitler, J. J., Gross, N., Jones, C. U., Kaufman, M., Le, Q. T., Semrad, T. J., Siu, L. L., & Ridge, J. A. (2019). Role of treatment deintensification in the management of p16+ oropharyngeal cancer: ASCO provisional clinical opinion. *Journal of Clinical Oncology*, *37*(18), 1578–1589. https://doi.org/10.1200/JCO.19.00441

Alberta Health Services. (2012). *Indicator Definition: 30 Day Unplanned Readmission Rate*. *Cdi*, 1–5. www.albertahealthservices.ca/publications/ahs-pub-pr-def-readmit.pdf

Alberta Health Services. (2016). *Pampalon Deprivation Index in Alberta*.

Alberta Health Services. (2019). *CLINICAL PRACTICE GUIDELINE HN-004 OROPHARYNGEAL CANCER TREATMENT*.

Alberta Health Services. (2022a). *The Organization and Delivery of Healthcare Services for Head and Neck Cancer Patients*. www.ahs.ca/guru

Alberta Health Services, G. R. U. (2022b). *Transfer of Care Patient Letter, Head and Neck cancer*. www.ahs.ca/709.asp.

Alishahi Tabriz, A., Turner, K., Hong, Y. R., Gheytasvand, S., Powers, B. D., & Elston Lafata, J. (2023). Trends and Characteristics of Potentially Preventable Emergency

Department Visits Among Patients With Cancer in the US. *JAMA Network Open*, *6*(1), e2250423–e2250423. https://doi.org/10.1001/JAMANETWORKOPEN.2022.50423

Allareddy, V., & Konety, B. R. (2006). Characteristics of patients and predictors of in-hospital mortality after hospitalization for head and neck cancers. *Cancer*, *106*(11), 2382–2388. https://doi.org/10.1002/CNCR.21899

Allen-Ayodabo, C. O., Eskander, A., Davis, L. E., Zhao, H., Mahar, A. L., Karam, I., Singh, S., Gupta, V., Bubis, L. D., Moody, L., Barbera, L., & Coburn, N. G. (2019). Symptom burden among head and neck cancer patients in the first year after diagnosis: Association with primary treatment modality. *Oral Oncology*, *99*(June), 104434. https://doi.org/10.1016/j.oraloncology.2019.09.026

American Cancer Society. (2022). *Cancer Facts & Figures 2022*.

Badr, H., Sobrero, M., Chen, J., Kotz, T., Genden, E., Sikora, A. G., & Miles, B. (2019). Associations between pre-, post-, and peri-operative variables and health resource use following surgery for head and neck cancer. *Oral Oncology*, *90*, 102–108. https://doi.org/10.1016/J.ORALONCOLOGY.2019.02.004

Badri, P., Ganatra, S., Baracos, V., Lai, H., & Amin, M. (2021). *Oral Cavity and Oropharyngeal Cancer Surveillance and Control in Alberta: A Scoping Review*. *C*, 1–16.

Bagan, J., Sarrion, G., & Jimenez, Y. (2010). Oral cancer: clinical features. *Oral Oncology*, *46*(6), 414–417. https://doi.org/10.1016/J.ORALONCOLOGY.2010.03.009

Baskin, R. M., Zhang, J., Dirain, C., Lipori, P., Fonseca, G., Sawhney, R., Boyce, B. J., Silver, N. L., & Dziegielewski, P. T. (2018). Predictors of returns to the emergency department after head and neck surgery. *Head & Neck*, *40*(3), 498–511. https://doi.org/10.1002/HED.25019

Bese, N. S., Hendry, J., & Jeremic, B. (2007). Effects of Prolongation of Overall Treatment Time Due To Unplanned Interruptions During Radiotherapy of Different Tumor Sites and Practical Methods for Compensation. *International Journal of Radiation Oncology*Biology*Physics*, *68*(3), 654–661. https://doi.org/10.1016/J.IJROBP.2007.03.010

Bubis, L. D., Davis, L., Mahar, A., Barbera, L., Li, Q., Moody, L., Karanicolas, P., Sutradhar, R., & Coburn, N. G. (2018). Symptom burden in the first year after cancer diagnosis: an analysis of patient-reported outcomes. *Journal of Clinical Oncology*, *36*(11), 1103–1111. https://doi.org/10.1200/JCO.2017.76.0876

Bur, A. M., Brant, J. A., Mulvey, C. L., Nicolli, E. A., Brody, R. M., Fischer, J. P., Cannady, S. B., & Newman, J. G. (2016). Association of Clinical Risk Factors and Postoperative Complications With Unplanned Hospital Readmission After Head and

Neck Cancer Surgery. *JAMA Otolaryngology–Head & Neck Surgery*, *142*(12), 1184–1190. https://doi.org/10.1001/JAMAOTO.2016.2807

Canadian Cancer Society's Advisory, & Statistics, C. on C. (2015). *Canadian Cancer Statistics 2015*.

Canadian Cancer Statistics Advisory Committee. (2019). *Canadian Cancer Statistics 2019*. http://cancer.ca/Canadian-Cancer-Statistics-2019-EN

Canadian Cancer Statistics Advisory in collaboration with the Canadian Cancer Society, S. C. and the P. H. A. of C. (2022). *Canadian Cancer Statistics: A 2022 special report on cancer prevalence*. cancer.ca/Canadian-Cancer-Statistics-2022-EN

Canadian Institute for Health Information. (2022). *NACRS Emergency Department Visits and Lengths of Stay by Province/Territory, 2021–2022 (Q1 to Q4)*.

Carazo-Casas, C., Gil-Prieto, R., Hernández-Barrera, V., & Gil de Miguel, Á. (2022). Trends in hospitalization and death rates among patients with head and neck cancer in Spain, 2009 to 2019. *Https://Doi.Org/10.1080/21645515.2022.2082192*, *18*(5). https://doi.org/10.1080/21645515.2022.2082192

Carey, R. M., Parasher, A. K., Workman, A. D., Yan, C. H., Glicksman, J. T., Chen, J., Palmer, J. N., Adappa, N. D., Newman, J. G., & Brant, J. A. (2018). Disparities in

sinonasal squamous cell carcinoma short- and long-term outcomes: Analysis from the national cancer database. *The Laryngoscope*, *128*(3), 560–567. https://doi.org/10.1002/LARY.26804

Carrière, G., Sanmartin, C., Murison, P., Trudeau, R., Trainor, C., Pelletier, C., Farrar, N., Snow, A., Bryan, S., & Newman, K. (2018). *Canadian Cancer Treatment Linkage Project* (Issue 11).

Chapman, C. H., & Yom, S. S. (2018). Oropharyngeal cancer. *Handbook of Evidence-Based Radiation Oncology*, 171–192. https://doi.org/10.1007/978-3-319-62642-0_7/FIGURES/2

Chaturvedi, A. K., Engels, E. A., Pfeiffer, R. M., Hernandez, B. Y., Xiao, W., Kim, E., Jiang, B., Goodman, M. T., Sibug-Saber, M., Cozen, W., Liu, L., Lynch, C. F., Wentzensen, N., Jordan, R. C., Altekruse, S., Anderson, W. F., Rosenberg, P. S., & Gillison, M. L. (2011). Human Papillomavirus and Rising Oropharyngeal Cancer Incidence in the United States. *Journal of Clinical Oncology*, *29*(32), 4294. https://doi.org/10.1200/JCO.2011.36.4596

Chaudhary, H., Stewart, C. M., Webster, K., Herbert, R. J., Frick, K. D., Eisele, D. W., & Gourin, C. G. (2017). Readmission following primary surgery for larynx and oropharynx cancer in the elderly. *The Laryngoscope*, *127*(3), 631–641. https://doi.org/10.1002/LARY.26311

Chen, H. M. N., Anzela, A., Hetherington, E., Buddle, N., Vignarajah, D., Hogan, D., Fowler, A., Forstner, D., Chua, B., Gowda, R., & Min, M. (2023). A proposed framework for the implementation of head and neck cancer treatment at a new cancer center from a radiation oncology perspective. *Asia-Pacific Journal of Clinical Oncology*. https://doi.org/10.1111/AJCO.13963

Chen, M. M., Orosco, R. K., Harris, J. P., Porter, J. B., Rosenthal, E. L., Hara, W., & Divi, V. (2017). Predictors of readmissions after head and neck cancer surgery: A national perspective. *Oral Oncology*, *71*, 106–112. https://doi.org/10.1016/J.ORALONCOLOGY.2017.06.010

Chi, A. C., Day, T. A., & Neville, B. W. (2015). Oral cavity and oropharyngeal squamous cell carcinoma—an update. *CA: A Cancer Journal for Clinicians*, *65*(5), 401–421. https://doi.org/10.3322/CAAC.21293

Chow, L. Q. M. (2020). Head and Neck Cancer. *New England Journal of Medicine*, *382*(1), 60–72. https://doi.org/10.1056/NEJMra1715715

Cohen, N., Fedewa, S., & Chen, A. Y. (2018). Epidemiology and Demographics of the Head and Neck Cancer Population. *Oral and Maxillofacial Surgery Clinics of North America*, *30*(4), 381–395. https://doi.org/10.1016/J.COMS.2018.06.001

Collie, K., McCormick, J., Waller, A., Railton, C., Shirt, L., Chobanuk, J., Taylor, A., Lau, H., Hao, D., Walley, B., Kapusta, B., Joy, A. A., Carlson, L. E., & Giese-Davis, J. (2014). Qualitative Evaluation of Care Plans for Canadian Breast and Head-and-Neck Cancer Survivors. *Current Oncology 2014, Vol. 21, Pages 18-28*, *21*(1), 18–28. https://doi.org/10.3747/CO.21.1698

da Cunha, A. R., Prass, T. S., & Hugo, F. N. (2019). Mortality from oral and oropharyngeal cancer in Brazil: impact of the National Oral Health Policy. *Cadernos de Saude Publica*, *35*(12). https://doi.org/10.1590/0102-311X00014319

de Oliveira, C., Weir, S., Rangrej, J., Krahn, M. D., Mittmann, N., Hoch, J. S., Chan, K. K. W., & Peacock, S. (2018). The economic burden of cancer care in Canada: a population-based cost study. *CMAJ Open*, *6*(1), E1–E10. https://doi.org/10.9778/cmajo.20170144

Deschler, D. G., Richmon, J. D., Khariwala, S. S., Ferris, R. L., & Wang, M. B. (2014). The "new" head and neck cancer patient-young, nonsmoker, nondrinker, and HPV positive: evaluation. *Otolaryngology--Head and Neck Surgery : Official Journal of American Academy of Otolaryngology-Head and Neck Surgery*, *151*(3), 375–380. https://doi.org/10.1177/0194599814538605

Eskander, A., Krzyzanowska, M. K., Fischer, H. D., Liu, N., Austin, P. C., Irish, J. C., Enepekides, D. J., Lee, J., Gutierrez, E., Lockhart, E., Raphael, M., & Singh, S. (2018).

Emergency department visits and unplanned hospitalizations in the treatment period for head and neck cancer patients treated with curative intent: A population-based analysis. *Oral Oncology*, *83*, 107–114. https://doi.org/10.1016/J.ORALONCOLOGY.2018.06.011

Fahy, E., Brooker, R. C., Fleming, J. C., & Patterson, J. M. (2023). A review of unplanned admissions in head and neck cancer patients undergoing oncological treatment. *Supportive Care in Cancer*, *31*(6), 1–6. https://doi.org/10.1007/S00520-023-07770-Y/TABLES/5

Fredman, E., Kharouta, M., Chen, E., Gross, A., Dorth, J., Patel, M., Padula, G., & Yao, M. (2022). Dehydration Reduction in Head and Neck Cancer (DRIHNC) Trial: Daily Oral Fluid and Electrolyte Maintenance to Prevent Acute Care Clinic and Emergency Department Visits for Patients Receiving Radiation for Head and Neck and Esophageal Cancer. *Advances in Radiation Oncology*, *7*(6), 101026. https://doi.org/10.1016/J.ADRO.2022.101026

Gallaway, M. S., Idaikkadar, N., Tai, E., Momin, B., Rohan, E. A., Townsend, J., Puckett, M., & Stewart, S. L. (2021). Emergency department visits among people with cancer: Frequency, symptoms, and characteristics. *Journal of the American College of Emergency Physicians Open*, *2*(3), 1–9. https://doi.org/10.1002/emp2.12438

Ganatra, S., Sawani, S., Badri, P., Pakseresht, M., & Amin, M. (2022). *Demographic and Clinicopathologic Distribution of Oral Cavity and Oropharyngeal Cancer in Alberta, Canada: A Comparative Analysis*.

Gandini, S., Botteri, E., Iodice, S., Boniol, M., Lowenfels, A. B., Maisonneuve, P., & Boyle, P. (2008). Tobacco smoking and cancer: a meta-analysis. *International Journal of Cancer*, *122*(1), 155–164. https://doi.org/10.1002/IJC.23033

Garaszczuk, R., Yong, J. H. E., Sun, Z., & de Oliveira, C. (2022). The Economic Burden of Cancer in Canada from a Societal Perspective. *Current Oncology (Toronto, Ont.)*, *29*(4), 2735–2748. https://doi.org/10.3390/CURRONCOL29040223

Givens, D. J., Karnell, L. H., Gupta, A. K., Clamon, G. H., Pagedar, N. A., Chang, K. E., Van Daele, D. J., & Funk, G. F. (2009). Adverse events associated with concurrent chemoradiation therapy in patients with head and neck cancer. *Archives of Otolaryngology - Head and Neck Surgery*, *135*(12), 1209–1217. https://doi.org/10.1001/archoto.2009.174

Goel, A. N., Badran, K. W., Mendelsohn, A. H., Chhetri, D. K., Sercarz, J. A., Blackwell, K. E., John, M. A. S., & Long, J. L. (2019). Readmission after surgery for oropharyngeal cancer: An analysis of rates, causes, and risk factors. *The Laryngoscope*, *129*(4), 910–918. https://doi.org/10.1002/LARY.27461

Goel, A. N., Raghavan, G., St John, M. A., & Long, J. L. (2019). Risk Factors, Causes, and Costs of Hospital Readmission after Head and Neck Cancer Surgery Reconstruction. *JAMA Facial Plastic Surgery*, *21*(2), 137–145. https://doi.org/10.1001/JAMAFACIAL.2018.1197

Gormley, M., Creaney, G., Schache, A., Ingarfield, K., & Conway, D. I. (2022). Reviewing the epidemiology of head and neck cancer: definitions, trends and risk factors. *British Dental Journal 2022 233:9*, *233*(9), 780–786. https://doi.org/10.1038/s41415-022-5166-x

Government of Alberta. (2013). *Changing our future: Alberta's cancer plan to 2030. February*, 53. http://www.health.alberta.ca/documents/Cancer-Plan-Alberta-2013.pdf

Habbous, S., Chu, K. P., Lau, H., Schorr, M., Belayneh, M., Ha, M. N., Murray, S., O'sullivan, B., Huang, S. H., Snow, S., Parliament, M., Hao, D., Cheung, W. Y., Xu, W., & Liu, G. (2017). Human papillomavirus in oropharyngeal cancer in Canada: Analysis of 5 comprehensive cancer centres using multiple imputation. *CMAJ*, *189*(32), E1030–E1040. https://doi.org/10.1503/CMAJ.161379/-/DC1

Han, H. R., Hermann, G. M., Ma, S. J., Iovoli, A. J., Wooten, K. E., Arshad, H., Gupta, V., McSpadden, R. P., Kuriakose, M. A., Markiewicz, M. R., Chan, J. M., Platek, M. E., Ray, A. D., Gu, F., Hicks, W. L., Repasky, E. A., & Singh, A. K. (2020). Matched pair analysis to evaluate the impact of hospitalization during radiation therapy as an early

marker of survival in head and neck cancer patients. *Oral Oncology*, *109*, 104854. https://doi.org/10.1016/J.ORALONCOLOGY.2020.104854

Handley, N. R., Schuchter, L. M., & Bekelman, J. E. (2018). Best Practices for Reducing Unplanned Acute Care for Patients With Cancer. *Journal of Oncology Practice*, *14*(5), 306–313. https://doi.org/10.1200/JOP.17.00081

Haque, M., McKimm, J., Godman, B., Abu Bakar, M., & Sartelli, M. (2018). Initiatives to reduce postoperative surgical site infections of the head and neck cancer surgery with a special emphasis on developing countries. https://doi.org/10.1080/14737140.2019.1544497

Hasegawa, T., Yatagai, N., Furukawa, T., Wakui, E., Saito, I., Takeda, D., Kakei, Y., Sakakibara, A., Nibu, K. ichi, & Akashi, M. (2021). The prospective evaluation and risk factors of dysphagia after surgery in patients with oral cancer. *Journal of Otolaryngology - Head and Neck Surgery*, *50*(1), 1–10. https://doi.org/10.1186/S40463-020-00479-6

Hazelden, L. A., Newman, M. J., Shuey, S., Waldfogel, J. M., & Brown, V. T. (2019). Evaluation of the head and neck cancer patient population and the incidence of hospitalization at an academic medical center. *Journal of Oncology Pharmacy Practice*, *25*(2), 333–338. https://doi.org/10.1177/1078155217735688

Høeg, B. L., Bidstrup, P. E., Karlsen, R. V., Friberg, A. S., Albieri, V., Dalton, S. O., Saltbæk, L., Andersen, K. K., Horsboel, T. A., & Johansen, C. (2019). Follow-up strategies following completion of primary cancer treatment in adult cancer survivors. In *Cochrane Database of Systematic Reviews* (Vol. 2019, Issue 11). John Wiley and Sons Ltd. https://doi.org/10.1002/14651858.CD012425.pub2

International Agency for Research on Cancer (IARC). (2010). *Section 2.2. Cancer of the oral cavity and pharynx*. " IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Alcohol Consumption and Ethyl Carbamate.

International Agency for Research on Cancer (IARC). (2020). *Oropharynx fact sheet; Global Cancer Observatory: Cancer Today*. https://gco.iarc.fr/today/data/factsheets/cancers/3-Oropharynx-fact-sheet.pdf

Kansagara, D., Englander, H., Salanitro, A., Kagen, D., Theobald, C., Freeman, M., & Kripalani, S. (2011). Risk Prediction Models for Hospital Readmission: A Systematic Review. *JAMA*, *306*(15), 1688–1698. https://doi.org/10.1001/JAMA.2011.1515

Karan, J., & Laronde, D. (2014). Treatment modalities of oral cancer. *Canadian Journal of Dental Hygiene*, *48*, 13–19.

Kawakita, D., Oze, I., Iwasaki, S., Matsuda, T., Matsuo, K., & Ito, H. (2022). Trends in the incidence of head and neck cancer by subsite between 1993 and 2015 in Japan. *Cancer Medicine*, *11*(6), 1553. https://doi.org/10.1002/CAM4.4539

Kimple, R. J., & Harari, P. M. (2015). The prognostic value of HPV in head and neck cancer patients undergoing postoperative chemoradiotherapy. *Annals of Translational Medicine*, *3*(Suppl 1), 14. https://doi.org/10.3978/J.ISSN.2305-5839.2015.01.37

Kirkland, S. W., Garrido-Clua, M., Junqueira, D. R., Campbell, S., & Rowe, B. H. (2020). Preventing emergency department visits among patients with cancer: a scoping review. *Supportive Care in Cancer*, *28*(9), 4077–4094. https://doi.org/10.1007/S00520-020-05490-1

Kligerman, M. P., Sethi, R. K. V., Kozin, E. D., Gray, S. T., & Shrime, M. G. (2019). Morbidity and mortality among patients with head and neck cancer in the emergency department: A national perspective. *Head & Neck*, *41*(4), 1007–1015. https://doi.org/10.1002/HED.25534

Langendijk, J. A., Doornaert, P., Verdonck-de Leeuw, I. M., Leemans, C. R., Aaronson, N. K., & Slotman, B. J. (2008). Impact of late treatment-related toxicity on quality of life among patients with head and neck cancer treated with radiotherapy. *Journal of Clinical Oncology*, *26*(22), 3770–3776. https://doi.org/10.1200/JCO.2007.14.6647

Lash, R. S., Bell, J. F., Bold, R. J., Joseph, J. G., Cress, R. D., Wun, T., Brunson, A. M., & Romano, P. S. (2017). Emergency department use by recently diagnosed cancer patients in California. *The Journal of Community and Supportive Oncology*, *15*(2), 95–102. https://doi.org/10.12788/JCSO.0334

Lauritzen, B. B., Jensen, J. S., Grønhøj, C., Wessel, I., & von Buchwald, C. (2021). Impact of delay in diagnosis and treatment-initiation on disease stage and survival in oral cavity cancer: a systematic review. *Acta Oncologica*, *60*(9), 1083–1090. https://doi.org/10.1080/0284186X.2021.1931712

Lehew, C. W., Epstein, J. B., Kaste, L. M., & Choi, Y. K. (2010). Assessing oral cancer early detection: clarifying dentists' practices. *Journal of Public Health Dentistry*, *70*(2), 93–100. https://doi.org/10.1111/J.1752-7325.2009.00148.X

Lo Nigro, C., Denaro, N., Merlotti, A., & Merlano, M. (2017). Head and neck cancer: improving outcomes with a multidisciplinary approach. *Cancer Management and Research*, *9*, 363. https://doi.org/10.2147/CMAR.S115761

Luryi, A. L., Chen, M. M., Mehra, S., Roman, S. A., Sosa, J. A., & Judson, B. L. (2016). Hospital readmission and 30-day mortality after surgery for oral cavity cancer: Analysis of 21,681 cases. *Head and Neck*, *38*, E221–E226. https://doi.org/10.1002/HED.23973

Lydiatt, W. M., Patel, S. G., O'Sullivan, B., Brandwein, M. S., Ridge, J. A., Migliacci, J. C., Loomis, A. M., & Shah, J. P. (2017). Head and Neck cancers-major changes in the American Joint Committee on cancer eighth edition cancer staging manual. *CA: A Cancer Journal for Clinicians*, *67*(2), 122–137. https://doi.org/10.3322/CAAC.21389

Malik, A., Sukumar, V., Pai, A., Mishra, A., Nair, S., Chaukar, D., & Chaturvedi, P. (2019). Emergency Department Visits by Head-and-Neck Cancer Patients. *Indian Journal of Palliative Care*, *25*(4), 535. https://doi.org/10.4103/IJPC.IJPC_57_19

Manning, A. M., Casper, K. A., Peter, K. S., Wilson, K. M., Mark, J. R., & Collar, R. M. (2018). Can Predictive Modeling Identify Head and Neck Oncology Patients at Risk for Readmission? *Otolaryngology–Head and Neck Surgery*, *159*(4), 669–674. https://doi.org/10.1177/0194599818775938

Massa, S. T., Osazuwa-Peters, N., Adjei Boakye, E., Walker, R. J., & Ward, G. M. (2019). Comparison of the Financial Burden of Survivors of Head and Neck Cancer with Other Cancer Survivors. *JAMA Otolaryngology - Head and Neck Surgery*, *145*(3), 239–249. https://doi.org/10.1001/jamaoto.2018.3982

McIlwain, W. R., Sood, A. J., Nguyen, S. A., & Day, T. A. (2014). Initial Symptoms in Patients With HPV-Positive and HPV-Negative Oropharyngeal Cancer. *JAMA Otolaryngology–Head & Neck Surgery*, *140*(5), 441–447. https://doi.org/10.1001/JAMAOTO.2014.141

Mello, F. W., Melo, G., Pasetto, J. J., Silva, C. A. B., Warnakulasuriya, S., & Rivero, E. R. C. (2019). The synergistic effect of tobacco and alcohol consumption on oral squamous cell carcinoma: a systematic review and meta-analysis. *Clinical Oral Investigations*, *23*(7), 2849–2859. https://doi.org/10.1007/S00784-019-02958-1

Menezes, F. dos S., Fernandes, G. A., Antunes, J. L. F., Villa, L. L., & Toporcov, T. N. (2021). Global incidence trends in head and neck cancer for HPV-related and - unrelated subsites: A systematic review of population-based studies. *Oral Oncology*, *115*, 105177. https://doi.org/10.1016/J.ORALONCOLOGY.2020.105177

Miah, A. B., Bhide, S. A., Guerrero-Urbano, M. T., Clark, C., Bidmead, A. M., St. Rose, S., Barbachano, Y., A'Hern, R., Tanay, M., Hickey, J., Nicol, R., Newbold, K. L., Harrington, K. J., & Nutting, C. M. (2012). Dose-Escalated Intensity-Modulated Radiotherapy Is Feasible and May Improve Locoregional Control and Laryngeal Preservation in Laryngo-Hypopharyngeal Cancers. *International Journal of Radiation Oncology*Biology*Physics*, *82*(2), 539–547. https://doi.org/10.1016/J.IJROBP.2010.09.055

Mittmann, N., Beglaryan, H., Liu, N., Seung, S. J., Rahman, F., Gilbert, J., Ross, J., Rossi, S. De, Earle, C., Grunfeld, E., & Sussman, J. (2018). Evaluating the impact of survivorship models on health system resources and costs. https://doi.org/10.1200/JCO.2018.36.7_SUPPL.1

Montero, A. J., Stevenson, J., Guthrie, A. E., Best, C., Goodman, L. M., Shrotriya, S., Azzouqa, A. G., Parala, A., Lagman, R., Bolwell, B. J., Kalaycio, M. E., & Khorana, A. A. (2016). Reducing unplanned medical oncology readmissions by improving outpatient care transitions: A process improvement project at the Cleveland Clinic. *Journal of Oncology Practice*, *12*(5), e594–e602. https://doi.org/10.1200/JOP.2015.007880

Montero, P. H., & Patel, S. G. (2015). CANCER OF THE ORAL CAVITY. *Surgical Oncology Clinics of North America*, *24*(3), 491. https://doi.org/10.1016/J.SOC.2015.03.006

Moore, Z. R., Pham, N. L., Shah, J. L., Nedzi, L., Sumer, B. D., Day, A. T., Khan, S. A., & Sher, D. J. (2019). Risk of Unplanned Hospital Encounters in Patients Treated With Radiotherapy for Head and Neck Squamous Cell Carcinoma. *Journal of Pain and Symptom Management*, *57*(4), 738-745.e3. https://doi.org/10.1016/J.JPAINSYMMAN.2018.12.337

Mourad, M., Jetmore, T., Jategaonkar, A. A., Moubayed, S., Moshier, E., & Urken, M. L. (2017). Epidemiological Trends of Head and Neck Cancer in the United States: A SEER Population Study. *Journal of Oral and Maxillofacial Surgery : Official Journal of the American Association of Oral and Maxillofacial Surgeons*, *75*(12), 2562. https://doi.org/10.1016/J.JOMS.2017.05.008

National Comprehensive Cancer Network (NCCN). (2022). *NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines®), Head and Neck Cancers, version 1.2023*. https://doi.org/10.1007/978-3-030-62120-9_20

Noel, C. W., Forner, D., Wu, V., Enepekides, D., Irish, J. C., Husain, Z., Chan, K. K. W., Hallet, J., Coburn, N., & Eskander, A. (2020). Predictors of surgical readmission, unplanned hospitalization and emergency department use in head and neck oncology: A systematic review. *Oral Oncology*, *111*(July), 105039. https://doi.org/10.1016/j.oraloncology.2020.105039

Noel, C. W., Hueniken, K., Forner, D., Liu, G., Eng, L., Hosni, A., Hahn, E., Irish, J. C., Gilbert, R., Yao, C. M. K. L., Monteiro, E., O'Sullivan, B., Waldron, J., Huang, S. H., Goldstein, D. P., & De Almeida, J. R. (2023). Association of Household Income at Diagnosis with Financial Toxicity, Health Utility, and Survival in Patients with Head and Neck Cancer. *JAMA Otolaryngology - Head and Neck Surgery*, *149*(1), 63–70. https://doi.org/10.1001/jamaoto.2022.3755

Noel, C. W., Sutradhar, R., Gotlib Conn, L., Forner, D., Chan, W. C., Fu, R., Hallet, J., Coburn, N. G., & Eskander, A. (2022). Development and Validation of a Machine Learning Algorithm Predicting Emergency Department Use and Unplanned Hospitalization in Patients With Head and Neck Cancer. *JAMA Otolaryngology–Head & Neck Surgery*, *148*(8), 764–772. https://doi.org/10.1001/JAMAOTO.2022.1629

Offodile, A. C., Pathak, A., Wenger, J., Orgill, D. P., & Guo, L. (2015). Prevalence and Patient-Level Risk Factors for 30-Day Readmissions Following Free Tissue Transfer for Head and Neck Cancer. *JAMA Otolaryngology–Head & Neck Surgery*, *141*(9), 783–789. https://doi.org/10.1001/JAMAOTO.2015.1323

Omura, K. (2014). Current status of oral cancer treatment strategies: Surgical treatments for oral squamous cell carcinoma. *International Journal of Clinical Oncology*, *19*(3), 423–430. https://doi.org/10.1007/S10147-014-0689-Z

O'Neill, C. B., Baxi, S. S., Atoria, C. L., O'Neill, J. P., Henman, M. C., Sherman, E. J., Lee, N. Y., Pfister, D. G., & Elkin, E. B. (2015). Treatment-related toxicities in older adults with head and neck cancer: A population-based analysis. *Cancer*, *121*(12), 2083–2089. https://doi.org/10.1002/CNCR.29262

Palma, D. A., Prisman, E., Berthelet, E., Tran, E., Hamilton, S., Wu, J., Eskander, A., Higgins, K., Karam, I., Poon, I., Husain, Z., Enepekides, D., Hier, M., Sultanem, K., Richardson, K., Mlynarek, A., Johnson-Obaseki, S., Odell, M., Bayley, A., Nichols, A. C. (2022). Assessment of Toxic Effects and Survival in Treatment Deescalation With Radiotherapy vs Transoral Surgery for HPV-Associated Oropharyngeal Squamous Cell Carcinoma: The ORATOR2 Phase 2 Randomized Clinical Trial. *JAMA Oncology*, *8*(6), 845–851. https://doi.org/10.1001/JAMAONCOL.2022.0615

Patel, S., Rich, B. J., Schumacher, L.-E. D., Sargi, Z. B., Masforroll, M., Washington, C., Kwon, D., Rueda-Lara, M. A., Freedman, L. M., Samuels, S. E., Abramowitz, M. C., Samuels, M. A., Carmona, R., & Azzam, G. A. (2023). ED visits, hospital admissions and treatment breaks in head/neck cancer patients undergoing radiotherapy. *Frontiers in Oncology*, *13*. https://doi.org/10.3389/FONC.2023.1147474

Perri, F., Longo, F., Caponigro, F., Sandomenico, F., Guida, A., Scarpati, G. D. V., Ottaiano, A., Muto, P., & Ionna, F. (2020). Management of HPV-Related Squamous Cell Carcinoma of the Head and Neck: Pitfalls and Caveat. *Cancers*, *12*(4), 975. https://doi.org/10.3390/CANCERS12040975

Poirier, A. E., Ruan, Y., Volesky, K. D., King, W. D., O'Sullivan, D. E., Gogna, P., Walter, S. D., Villeneuve, P. J., Friedenreich, C. M., & Brenner, D. R. (2019). The current and future burden of cancer attributable to modifiable risk factors in Canada: Summary of results. *Preventive Medicine*, *122*, 140–147. https://doi.org/10.1016/J.YPMED.2019.04.007

Pulte, D., & Brenner, H. (2010). Changes in Survival in Head and Neck Cancers in the Late 20th and Early 21st Century: A Period Analysis. *The Oncologist*, *15*(9), 994. https://doi.org/10.1634/THEONCOLOGIST.2009-0289

Quinn, Z. L., Vershvovsky, M., Xu, A., & Zibelli, A. M. (2020). Unplanned hospital admissions are a marker of decreased overall survival in patients with solid tumor malignancies. https://doi.org/10.1200/JCO.2020.38.15_SUPPL.E19118

Ren, Z. H., Hu, C. Y., He, H. R., Li, Y. J., & Lyu, J. (2020). Global and regional burdens of oral cancer from 1990 to 2017: Results from the global burden of disease study. *Cancer Communications*, *40*(2–3), 81–92. https://doi.org/10.1002/cac2.12009

Reyes–Gibby, C. C., Melkonian, S. C., Hanna, E. Y., Yeung, S. ching J., Lu, C., Chambers, M. S., Banala, S. R., Gunn, G. B., & Shete, S. S. (2017). Cohort Study of Oncologic Emergencies in Head and Neck Cancer Patients. *Head & Neck*, *39*(6), 1195. https://doi.org/10.1002/HED.24748

Ribeiro-Rotta, R. F., Rosa, E. A., Milani, V., Dias, N. R., Masterson, D., da Silva, E. N., & Zara, A. L. de S. A. (2022). The cost of oral cancer: A systematic review. *Plos One*, *17*(4), e0266346. https://doi.org/10.1371/journal.pone.0266346

Rivera, D. R., Gallicchio, L., Brown, J., Liu, B., Kyriacou, D. N., & Shelburne, N. (2017). Trends in Adult Cancer–Related Emergency Department Utilization: An Analysis of Data From the Nationwide Emergency Department Sample. *JAMA Oncology*, *3*(10), e172450–e172450. https://doi.org/10.1001/JAMAONCOL.2017.2450

Romkey-Sinasac, C., Saunders, S., & Galica, J. (2021). Canadian resources, programs, and models of care to support cancer survivors' transition beyond treatment: A scoping review. *Current Oncology*, *28*(3), 2134–2145. https://doi.org/10.3390/CURRONCOL28030198/S1

Ryu, C. H., Roh, J. L., Kim, S. B., Lee, S. W., Choi, S. H., Nam, S. Y., & Kim, S. Y. (2013). Risk factors for non-cancer health events in patients with head and neck squamous cell carcinoma. *Annals of Oncology*, *24*(4), 1049–1054. https://doi.org/10.1093/ANNONC/MDS540

Sawani, S. A. (2022). *Multiple Primary Tumors in Oral Cancer : Patient Characteristics and Survival Patterns*. https://doi.org/10.7939/R3-3R3C-GQ80

Sisler, J. J., Taylor-Brown, J., Nugent, Z., Bell, D., Khawaja, M., Czaykowski, P., Wirtzfeld, D., Park, J., & Ahmed, S. (2012). Continuity of care of colorectal cancer survivors at the end of treatment: the oncology-primary care interface. *Journal of Cancer Survivorship : Research and Practice*, *6*(4), 468–475. https://doi.org/10.1007/S11764-012-0235-9

Smith, M., & Carlson, J. (2021). Reducing ED Visits and Hospital Admissions after Chemotherapy with Predictive Modeling of Risk Factors. *New Pub: ACCC/Slack*, *36*(4), 40–44. https://doi.org/10.1080/10463356.2021.1927638

Song, J. S., Vallance, P., Biron, V., & Jeffery, C. C. (2020). Epidemiological trends of head and neck Cancer survivors in Alberta: towards improved understanding of the burden of disease. *Journal of Otolaryngology - Head & Neck Surgery*, *49*(1). https://doi.org/10.1186/S40463-020-00443-4

Statistics Canada. (2023). *Cancer incidence in Canada, 2020*. 8–10.

Sturgis, E. M., & Cinciripini, P. M. (2007). Trends in head and neck cancer incidence in relation to smoking prevalence. *Cancer*, *110*(7), 1429–1435. https://doi.org/10.1002/CNCR.22963

Su, W. W. Y., Lee, Y. H., Yen, A. M. F., Chen, S. L. S., Hsu, C. Y., Chiu, S. Y. H., Fann, J. C. Y., Lee, Y. C., Chiu, H. M., Hsiao, S. C., Hsu, T. H., & Chen, H. H. (2021). Impact of treatment delay on survival of oral/oropharyngeal cancers: Results of a nationwide screening program. *Head and Neck*, *43*(2), 473–484. https://doi.org/10.1002/hed.26504

Sung, H., Ferlay, J., Siegel, R. L., Laversanne, M., Soerjomataram, I., Jemal, A., & Bray, F. (2021). Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. *CA: A Cancer Journal for Clinicians*, *71*(3), 209–249. https://doi.org/10.3322/CAAC.21660

Tang, P. L., Cheng, J. S., Huang, W. C., Chang, H. S., & Chen, H. C. (2015). Why do head and neck cancer patients visit the emergency department? *American Journal of Emergency Medicine*, *33*(8), 1102–1105. https://doi.org/10.1016/j.ajem.2015.04.077

Topf, M. C., Vo, A., Tassone, P., Shumrick, C., Luginbuhl, A., Cognetti, D. M., & Curry, J. M. (2017). Unplanned readmission following transoral robotic surgery. *Oral Oncology*, *75*, 127–132. https://doi.org/10.1016/J.ORALONCOLOGY.2017.11.009

Vaidya A. (2017). *53% of cancer patients' ER visits can be avoided*. https://www.beckershospitalreview.com/patient-flow/53-of-cancer-patients-er-visits-can-be-avoided.html

Vandyk, A. D., Harrison, M. B., MacArtney, G., Ross-White, A., & Stacey, D. (2012). Emergency department visits for symptoms experienced by oncology patients: A systematic review. *Supportive Care in Cancer*, *20*(8), 1589–1599. https://doi.org/10.1007/S00520-012-1459-Y

Vos, J. A. M., Wieldraaijer, T., van Weert, H. C. P. M., & van Asselt, K. M. (2021). Survivorship care for cancer patients in primary versus secondary care: a systematic review. *Journal of Cancer Survivorship*, *15*(1), 66–76. https://doi.org/10.1007/S11764-020-00911-W

Warnakulasuriya, S., & Greenspan, J. S. (2020). *Textbook of Oral Cancer: Prevention, Diagnosis and Management*.

Whitney, R. L., Bell, J. F., Tancredi, D. J., Romano, P. S., Bold, R. J., Wun, T., & Joseph, J. G. (2019). Unplanned hospitalization among individuals with cancer in the year after diagnosis. *Journal of Oncology Practice*, *15*(1), E20–E29. https://doi.org/10.1200/JOP.18.00254

World Health Organization. (2013). *International classification of diseases for oncology (ICD-O)* (3rd ed.).

Wu, V., & Hall, S. F. (2018). Rates and causes of 30-day readmission and emergency room utilization following head and neck surgery. *Journal of Otolaryngology - Head and Neck Surgery*, *47*(1), 1–5. https://doi.org/10.1186/S40463-018-0283-X

Xiang, M., Gensheimer, M. F., Pollom, E. L., Holsinger, F. C., Colevas, A. D., Le, Q. T., & Beadle, B. M. (2021). Prolongation of definitive head and neck cancer radiotherapy: Survival impact and predisposing factors. *Radiotherapy and Oncology*, *156*, 201–208. https://doi.org/10.1016/j.radonc.2020.12.025

Zakaria, D., Trudeau, R., Sanmartin, C., Murison, P., Carrière, G., MacIntyre, M., Turner, D., Wagar, B., King, M. J., Vriends, K., Woods, R., Lockwood, G., & Louchini, R. (2015). Using personal health insurance numbers to link the Canadian cancer registry and the discharge abstract database. *Health Reports*, *26*(6), 3–11.

Appendices

Appendix 1 Ethics approval

HREBA Health Research Ethics Board of Alberta Cancer Committee

Health Research Ethics Board of Alberta
Cancer Committee
1500, 10104 - 103 Avenue NW
Edmonton, Alberta, T5J 0H8
Telephone: (780) 423-5727
Fax: (780) 429-3509
Email: cancer@hreba.ca

Modification of Ethics Approval

This is to acknowledge that the modification to the research indicated below has been reviewed and on behalf of the Health Research Ethics Board of Alberta (HREBA) – Cancer Committee (CC), I am pleased to advise that approval has been granted.

Ethics ID:	HREBA.CC-20-0204_MOD3
Principal Investigator:	Maryam Sharifzadeh-Amin
Co-Investigator(s):	Babak Bohlouli
Student Co-Investigator(s):	
Study Title:	Healthcare utilization and costs related to management of oral cancer in low income patients in Alberta
Sponsor:	

Effective: 9-Jun-2021 **Expires:** 8-Jun-2022

Modification reviewed by delegated review on 13 October 2021.

The following documents have been approved:

- Protocol_modification October 1, October 1, 2021

Appendix 2 Ethics renewal 1

HREBA Health Research Ethics Board of Alberta Cancer Committee

Health Research Ethics Board of Alberta
Cancer Committee
1500, 10104 - 103 Avenue NW
Edmonton, Alberta, T5J 0H8
Telephone: (780) 423-5727
Fax: (780) 429-3509
Email: cancer@hreba.ca

Certification of Ethics Approval - Renewal

This is to acknowledge that the renewal to the research indicated below has been reviewed and on behalf of the Health Research Ethics Board of Alberta (HREBA) – Cancer Committee (CC), I am pleased to advise that approval has been granted.

Ethics ID:	HREBA.CC-20-0204_REN1
Principal Investigator:	Maryam Sharifzadeh-Amin
Co-Investigator(s):	Babak Bohlouli
Student Co-Investigator(s):	
Study Title:	Healthcare utilization and costs related to management of oral cancer in low income patients in Alberta
Sponsor:	

Effective: 9-Jun-2021 **Expires:** 8-Jun-2022

Appendix 3 Ethics renewal 2

HREBA Health Research Ethics Board of Alberta Cancer Committee

Health Research Ethics Board of Alberta
Cancer Committee
1500, 10104 - 103 Avenue NW
Edmonton, Alberta, T5J 0H8
Telephone: (780) 423-5727
Fax: (780) 429-3509
Email: cancer@hreba.ca

Certification of Ethics Approval - Renewal

This is to acknowledge that the renewal to the research indicated below has been reviewed and on behalf of the Health Research Ethics Board of Alberta (HREBA) – Cancer Committee (CC), I am pleased to advise that approval has been granted.

Ethics ID:	HREBA.CC-20-0204_REN2
Principal Investigator:	Maryam Sharifzadeh-Amin
Co-Investigator(s):	Babak Bohlouli
Student Co-Investigator(s):	Masoud Mirimoghaddam
Study Title:	Healthcare utilization and costs related to management of oral cancer in low income patients in Alberta
Sponsor:	

Effective: 24-May-2022 **Expires:** 23-May-2023

Appendix 4 Ethics renewal 3

HREBA Health Research Ethics Board of Alberta Cancer Committee

Health Research Ethics Board of Alberta
Cancer Committee
1500, 10104 - 103 Avenue NW
Edmonton, Alberta, T5J 0H8
Telephone: (780) 423-5727
Fax: (780) 429-3509
Email: cancer@hreba.ca

Certification of Ethics Approval - Renewal

This is to acknowledge that the renewal to the research indicated below has been reviewed and on behalf of the Health Research Ethics Board of Alberta (HREBA) – Cancer Committee (CC), I am pleased to advise that approval has been granted.

Ethics ID:	HREBA.CC-20-0204_REN3
Principal Investigator:	Maryam Sharifzadeh-Amin
Co-Investigator(s):	Babak Bohlouli
Student Co-Investigator(s):	Masoud Mirimoghaddam
Study Title:	Healthcare utilization and costs related to management of oral cancer in low income patients in Alberta
Sponsor:	

Effective: 2-May-2023 **Expires:** 1-May-2024