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Original Research

Resource utilization and disaggregated cost analysis for initial treatment of melanoma☆

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ABSTRACT

Background: Emerging new treatments and indications for melanoma therapy lend uncertainty to changing costs. We present a contemporary real-world microcosting analysis of initial melanoma therapy over twelve years.

Methods: Patients with invasive cutaneous melanoma were identified retrospectively from the Ontario Cancer Registry (2003–2014) and deterministically linked with administrative databases through three separate algorithms. We identified comprehensively publicly funded resources utilized within a year of diagnosis, and costs related to various aspects of the healthcare continuum. Disaggregated, average-per-patient, and overall costs were presented, undiscounted, and from the perspective of the Canadian single-payer health system. Costs were ascribed to surgery, radiation, systemic therapy, physician billings, inpatient, and outpatient hospital sources.

Results: 28,708 patients with invasive melanoma were identified. Median age at diagnosis was 63 years and 54% were male. The most common cost contributor was ambulatory surgery (48–62% of patients diagnosed each year) with a mean per-patient cost of $1796 CAD. Rates of systemic therapy use have remained stable over time (6–9% of patients diagnosed each year). Mean cost per-patient has increased starting in 2012, reflecting use of new medications with a maximum cost of $24,348 CAD reached in 2013. The total burden of cost was a maximum of $46.6MCAD for 3083 patients diagnosed in 2014 with a mean overall cost per patient of $15,132 CAD.

Conclusion: Patterns of resource utilization and costs for initial treatment of melanoma are changing, particularly due to systemic therapy. Understanding these patterns and forecasting of future changes are critical for sustainable budgetary planning.

1. Introduction

Melanoma is the 7th most commonly diagnosed malignancy across Canada (5th most common in the United States) and its incidence is increasing annually [1–4]. Although it comprises only 4–5% of incident skin cancers, melanoma causes over 80% of skin cancer deaths and forms a substantial burden of medical costs and years of life lost [2]. Melanoma is traditionally a surgical disease treated with wide local excision, lymph node staging, and lymph node dissection as mainstays of curative therapy. Systemic therapy and radiation are the preferred modalities of metastatic disease treatment, although with limited efficacy until recently.

Assessing accurate direct healthcare costs in the treatment of cancer is an ongoing challenge. Population growth and ageing, in combination with new drugs and innovations, have created a rising trajectory for cancer-related expenditures in a society with struggling healthcare reserves. In a study examining the use and cost of initial cancer treatment in Ontario, substantial increases in cost over a 10-year period from 1997 to 2007 were seen, with hospital admissions being the main driver [5]. Similarly, it is projected that, by 2031, the financial burden of skin cancer in Canada will rise sharply to $922 million annually (from $532 million in 2004), with melanoma accounting for 75.5% of the cost [6].

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In Ontario, using 2009 population-based estimates, melanoma generated an incident annual economic burden of over 14 million dollars [7].

Melanoma occupies a fortunate place in the contemporary cancer domain with availability of several recent new drug classes with superior efficacy for the treatment of metastatic disease. Four approved drugs, vemurafenib, ipilimumab, dabrafenib and trametinib, in combination with additional drugs currently completing clinical trials (e.g. nivolumab, pembrolizumab), produce changes clinical efficacy, and add consequent complexity to the understanding of melanoma costs. The combination of these drugs, with each other and with local therapies, remains an exciting and evolving area of study for scientists, but with unpredictable repercussions for the healthcare system.

Identifying the provision of melanoma care, in conjunction with its underlying costs, is critically important to forecasting and budgeting for the future. Recent introduction of several costly drugs into the formulary for effective treatment of high-risk and metastatic melanoma also raises evolving concern for economic sustainability. At present, a comprehensive assessment of the economic burden of initial melanoma treatment in Ontario has not been completed. We present a contemporary cost analysis of initial melanoma treatment in Ontario. Correlating patterns of diagnosis and treatment with underlying healthcare utilization and costs will fuel initiatives to improve the quality and sustainability of melanoma management.

2. Methods

2.1. Study design

We conducted a retrospective cohort study identifying population-based patterns of care for patients diagnosed with their first primary invasive cutaneous melanoma (International Classification of Diseases (ICD) 172.0–172.9) between January 1, 2003 and December 31, 2014. Patients with mucosal melanomas, invalid provincial health insurance number, or ineligibility for provincial health insurance, were excluded. Patients were followed forward for one year from diagnosis to capture treatments received for the primary diagnosis. We then completed a descriptive microcosting analysis to identify direct, undiscounted, disaggregated costs of care, from a single-payer government perspective in Ontario, Canada.

2.2. Data sources

Ethical approval for this study was obtained from the Research Ethics Board of the Sunnybrook Health Sciences Centre. All datasets are housed and linked at the Institute for Clinical Evaluative Sciences (ICES), Toronto, Ontario.

The Ontario Cancer Registry (OCR) identified cases using ICD codes for melanoma. We linked cases from the OCR, using unique encoded patient identifiers, to administrative databases, to ascertain patient demographics and patterns of care: Registered Persons Database (RPDB) for demographic information, Ontario Health Insurance Plan Claims database (OHIP) for physician billing claims, Discharge Abstract Database (DAD) for inpatient hospital admissions, Same Day Surgery dataset (SDS) for ambulatory surgery, National Ambulatory Care Reporting System (NACRS) for ambulatory care claims including cancer clinic visits and radiation, Ontario Drug Benefit (ODB) claims database for prescription drugs received under the ODB program, Cancer Activity Level Reporting database (ALR) for chemotherapy and radiation visit information, New Drug Funding Program (NDFP) for provincially-funded chemotherapeutics, and Office of the Registrar General–Deaths dataset (ORG-D) for death. All treatments, biopsies and consultations with specialists were identified through OHIP using physician billing codes (Appendix). Radiation treatments were identified through NACRS using Canadian Classification of Health Interventions (CCI) codes. Drug treatments were identified through ODB, ALR, NDFP and OHIP (Appendix).

2.3. Patient demographics and definitions of treatment

We identified demographic variables including sex, age, rurality, income quintile based on location of residence, and anatomic location of melanoma. Stage data was not consistently available from OCR prior to 2007 and therefore is not included. We assessed patients' treatment using a one-year time window after diagnosis date. A 3-month look-back window was utilized when patients were categorized as having no treatment or inadequate treatment to ensure capture of all procedures.

Comorbidity was characterized using The Johns Hopkins Adjusted Clinical Groups (ACG) Case Mix System. This validated software uses diagnostic information for each patient in the two years prior to melanoma diagnosis (from databases DAD, SDS, NACRS, OHIP), to describe and predict health resource utilization. This study used resource utilization bands (RUBs) to describe concurrent resource use: 0–No utilization or invalid diagnoses, 1–Healthy Users, 2–Low Users, 3-Moderate Users, 4–High Users, 5–Very High Users [8].

Patient treatment was defined as 1) **Adequate** treatment of the primary melanoma, 2) **Inadequate** surgical treatment of the primary melanoma, or 3) **No treatment** beyond initial biopsy of the primary melanoma, based on previously published work [9].

Adequate treatment: Curative-intent patients had one of: curative surgery alone, surgery and interferon, surgery and radiation, or surgery, interferon and radiation. Curative surgical treatments included: wide local excision, skin/musculocutaneous flap, full/split thickness skin graft, amputation, sentinel lymph node biopsy (SLNB) (October 2010 and beyond), lymphoscintigraphy (used as proxy for SLNB prior to October 2010), and neck/axillary/groin dissection (Appendix). Surgical procedures were identified using both physician billings (OHIP) and hospital interventions (CCI codes) to ensure capture of the maximal extent of surgery. Patients treated adequately but with non-curative intent had one of: chemotherapy alone, chemotherapy and radiation, chemotherapy and surgery, chemotherapy and surgery and radiation, radiation alone, interferon alone, or interferon and radiation. Patients with a surgically inadequately treated primary melanoma but with a concurrent non-curative intent treatment (i.e. presumed to have distant metastases) were still ascribed to the *adequate treatment* category.

Inadequate Treatment: Patients who received inadequate surgical treatment were defined as receiving one of: minimal/simple excision, curettage, dessication, debridement, or cryotherapy only, WITHOUT concurrent receipt of chemotherapy/radiation within the year following diagnosis.

No Treatment: Patients had diagnostic biopsy alone.

2.4. Costs

A bottom-up approach was used to determine annual costs-per-capita and overall expenditures. Costs were generated from three separate methodologies at ICES: disaggregated health system costs (GETCOST) [10], and cancer-specific costing methodologies for chemotherapy (GETCHEMOCOST) and radiation (GETRADIATIONCOST).

GETCOST computes individual-level health care costs from resources utilized in DAD, SDS, NACRS, ODB, OHIP, inpatient rehabilitation, Complex Continuing Care and Long-Term Care, Home Care services, admissions to mental health beds, and the Assisted Device Program. Hospital-based encounters are considered short-term episodes, and costs are calculated by multiplying resource intensity weight (RIW) for the specific encounter by an annual cost-per-weighted-case to generate the total cost for an encounter [11]. RIWs are annual numerical index values calculated based on the relative costs of treatments for specific patient demographics. For longer-term episodes of care (e.g complex continuing care), costs are determined by weighted days. For claims/visit-based encounters, costs are determined at utilization.

GETCHEMOCOST determines drug-specific chemotherapy costs using patient visit and cost information from ODB, ALR and NDFP. Where cost information was not directly available, average wholesale