Calculating Costs of Oral Cancer Care from the Retrospective Oral Cancer Cohort (ROCC)

Objective: to estimate the treatment costs of people with oral cancer, based on a linked analysis of medical records. These estimates will reflect stage and treatment type, as used by the model.

- Treatment – Stage I (Surgery, Surgery + RT, Other)
- Treatment – Stage II (Surgery, Surgery + RT, Other)
- Treatment – Advanced (Surgery, Surgery + RT, Other)
- Treatment – Recurrence (Surgery, Nonsurgery, Palliative, No Treatment)
- Treatment – Second Recurrence
- Treatment – End of Life

Description of patient population

This analysis used the same retrospective cohort described in the Clinical History analysis (Retrospective Oral Cancer Cohort; ROCC). Briefly, 856 previously-diagnosed oral cancer patients in British Columbia were identified through the BC Cancer Registry, and their medical charts were reviewed by a researcher in order to identify critical clinical events (dates of diagnosis, recurrence, death).

Table 1 – Demographic characteristics of cohort

Variable (N = 856)		Mean	SD/Percent
Age at first treatment		65.6	14.0
Sex	Male	501	58.5%
	Female	355	41.5%
Smoking History	Never smoker	203	23.7%
	Ever smoker	587	68.6%
	Unknown	66	7.7%
Stage at diagnosis	I	319	37.3%
	II	300	35.0%
	III	106	12.4%
	IV	128	15.0%
	Unknown	3	0.4%

Description of linkage strategy

Anonymized records from the ROCC were sent by the principal investigator to the British Columbia Cancer Agency's (BCCA) Cancer Agency Information System (CAIS). The CAIS data stewards added data fields describing chemotherapy and radiotherapy resource utilization, as well as records of appointments and tests within the BCCA.

The linked dataset was then sent to PopData BC, where it was linked to resource utilization data from the following sources:

1. Canadian Institute of Health Information (CIHI) Discharge Abstract Database (DAD). This dataset contains information about resource utilization at hospitals, through the Resource Intensity Weight variables (inpatient, ambulatory RIWs).
2. BC's Medical Services Plan (MSP) billings. This dataset contains information about all provincially-insured fee-for-service (FFS) services received by members of the cohort. Importantly this dataset does not include services provided within the BCCA.
3. BC's PharmaNet billings. This dataset contains information about all provincially-insured medication prescriptions and their unit costs. This does not include chemotherapy or other supportive drugs (anti-emetics, analgesics, etc.) received within the BCCA.

The resulting linked dataset contained dates and resource records for the full cohort, from diagnosis to death or censoring.

Unit Costing – BCCA CAIS

Care at the BCCA is not delivered on a fee-for-service basis. As a result, it is not straightforward to derive unit costs for these services. An approach was taken that mirrors and improves upon efforts from previously-published exercises using CAIS data sources[1-3]. BCCA CAIS data contains three basic types of records: radiotherapy delivery, chemotherapy delivery, and appointments and tests.

Radiotherapy delivery

The radiotherapy records from CAIS were released summarized by course. Each course record included start and end dates, treatment intention, and the total number of fractions given. Double counting can easily occur from these records, as boost fractions (i.e., fractions delivered in addition to the guideline-prescribed number) may be coded separately from the guideline-prescribed fractions. To avoid this double counting, records were sorted using the following sequential steps:

1. Duplicate records with the same start/end date and number of fractions were removed
2. Duplicate records with the same start/end date and a lower number of fractions were removed
3. Duplicate records with the same end date were removed

Start date, rather than end date, was chosen as the resource utilization date. This choice was made to ensure that the maximum number of resources were included, rather than excluding those that sat on the 'border' of eligibility (i.e., those courses of RT starting before three months but ending after three months).

A unit cost of $325 was applied to each fraction, based on an internal BCCA costing exercise wherein the annual operating costs of the Vancouver Cancer Centre (VCC) were divided by the number of fractions of

RT delivered in that year. This is an admittedly crude measure, but is more up-to-date than amounts available in the published literature.

One of the biggest weaknesses of using this unit costing approach is that Head and Neck cancers tend to be more complex to treat than solid tumours in tissues like the breast. Moulds are needed to steady the head, and more complex pre-treatment planning is needed to ensure that sensitive tissues in the head and neck are not irradiated by mistake. This requires more resources and staff hours than average. As a result, it is likely that the unit costing approach used in this exercise underestimates the true cost of treatment.

Chemotherapy delivery

The data sharing agreement between the Ministry of Health and the BC Cancer Agency meant that we could not link direct drug costs from CAIS to the PopData file. Dispensed units are not reported consistently between hospitals, so it was not possible to use list prices as unit costs. The drug costs are provincially-negotiated, and as such are accessible to BCCA staff but cannot leave the Agency. In order to address this issue, the following steps were taken:

1. A file was obtained with agency ID, drug name, amount dispensed, protocol code, and billed amount for each systemic therapy record from each member of the ROCC cohort.

2. Prescriptions with protocol codes that were for other tumour types (i.e., non head-neck) were removed. Drugs with no protocol code were left in.

3. The total cost for each drug, for each cohort member, was calculated.

4. The 7 most frequently-prescribed drugs (representing 60% of the total number of prescriptions) were reviewed. An average per-prescription cost was calculated for each, in order to find a per-prescription cost that would most closely match the actual amount paid for each cohort member:

    - Cisplatin: averages were calculated by time period (before 2006, 2006-2010, after 2010)
    - Fluouracil: the mean of all prescriptions was used
    - Etoposide: means were calculated for records with a Head & Neck protocol code, and one for those without a protocol code
    - Methotrexate: the mean of all prescriptions was used
    - Carboplatin: means were calculated for records with a Head & Neck protocol code, and one for those without a protocol code
    - Leucovorin: the mean of all prescriptions was used

- Docetaxel: before 2005, the mean was used, after 2005 the average of head-neck codes was used.

The mean of all prescriptions was used for all remaining drugs.

5. The calculated per-prescription amounts were applied to the records in the linked PopData dataset, producing a unit cost for each record.

This process produced unit costs that are less accurate than what would be achievable if the billed amounts were available, but more accurate than what would have been produced if we had used list prices[1].

It should also be noted that the costs for chemotherapy do not include associated staff costs (nursing, administration, etc.).

Appointments and tests

Because appointments and tests at the BCCA are not delivered on a fee-for-service basis, there are no billing codes associated with the records retrieved from CAIS. These records contain the date of the service provided and codes generally describing the type, nature, and location of the service. The following steps were taken to apply unit costs to these records:

1. Records describing the following sources were excluded from the analysis, being deemed either redundant with other cost estimate sources (RT unit costs, CIHI DAD), or outside the scope of the analysis:
    - Hospitalizations
    - Memos, notes, referrals
    - Radiotherapy records (including mould room)
    - Chemotherapy dressings/equipment
    - Resources related to second primary cancers
2. Remaining records were classified according to type
3. Unit costs were estimated for each record type using MSP reimbursement rates for similar services. If MSP reimbursement was unavailable, literature sources and/or expert opinion were consulted.

[1] The phrase “list prices” is infuriatingly misleading. There is no centralized, generally-available list of drug prices, yet the official CADTH guidance for drug costing suggests the use of “list prices”. And the method used here was a methodological compromise based on the implications of a changed privacy law. If I had not been an employee of the BC Cancer Agency, I am sincerely not sure how I would have accomplished this analysis.

A full list of unit types, counts, and costs is presented in a Table at the end of this Appendix.

Unit Costing – CIHI DAD

All hospitalization records were eligible to be included in the analysis. Total RIW for each hospitalization record was multiplied by the cost per weighted case (CWC) for the hospital associated with that record, by hospital number. Hospital numbers were determined through a list published by CIHI[4]. Any record corresponding to a hospital number that was not included in the list was assigned the provincial average CWC. The product of the CWC and the RIW was taken to be the unit cost of the record.

Unit Costing – MSP Billings

All billings were eligible to be included in the analysis. Billed amounts ('paidamt') for each service are included within the datafile. The amount paid for each record was taken to be the unit cost of the record.

Unit Costing – PharmaNet Billings

All billings were eligible to be included in the analysis. Billed amounts ('paidamt') for each prescription are included within the datafile. The amount paid for each record was taken to be the unit cost of the record.

Results

Costs within three months from the event of interest are presented. Cohort members with fewer than 3 months of costs were excluded from the analysis, meaning that this figures under-represent those who are diagnosed with disease so severe that they experience another event (recurrence, death) within 3 months.

Primary treatment

Value		Mean	SD	95% CI		
Stage I						
	Surgery	$9,225	$10,676	$7,838	–	$10,612
	Surgery + RT	$27,895	$17,805	$18,407	–	$37,383
	Other	$7,889	$9,132	$5,237	–	$10,540
Stage II						
	Surgery	$19,454	$25,046	$15,056	–	$23,853
	Surgery + RT	$26,687	$19,000	$20,911	–	$32,464
	Other	$10,280	$8,660	$8,595	–	$11,964
Advanced Stage						
	Surgery	$37,800	$37,958	$26,528	–	$49,072
	Surgery + RT	$38,083	$23,453	$29,326	–	$46,841
	Other	$15,000	$16,088	$12,015	–	$17,986

Value	Mean	SD	95% CI
Total cost	$16,142	$20,210	$14,702 – $17,582
BCCA Appointments	$385	$653	$341 – $429
	6.53%	15.90%	5.40% – 7.66%
BCCA Tests	$14	$59	$10 – $19
	0.18%	1.01%	0.10% – 0.25%
Chemotherapy	$6	$41	$4 – $9
	0.16%	2.62%	-0.02% – 0.35%
Hospitalizations	$9,659	$17,472	$8,472 – $10,846
	47.81%	36.99%	45.18% – 50.45%
MSP	$2,112	$2,837	$1,920 – $2,305
	24.10%	26.85%	22.18% – 26.01%
Pharmanet	$208	$411	$180 – $236
	4.10%	10.84%	3.32% – 4.87%
Radiotherapy	$2,288	$4,098	$2,009 – $2,566
	17.13%	31.14%	14.91% – 19.34%

Recurrence Treatment

Value	Mean	SD	95% CI
Management Including Surgery	$29,262	$42,731	$13,306 – $45,218
Management not Including Surgery	$17,067	$20,315	$10,293 – $23,840
Palliative	$20,779	$31,106	$4,203 – $37,354
No Treatment	$11,120	$8,518	$543 – $21,696

Value	Mean	SD	95% CI
Total cost	$21,561	$31,384	$14,911 – $28,211
BCCA Appointments	$56	$308	$35 – $77
	8.48%	15.17%	5.26% – 11.69%
BCCA Tests	$6	$39	$3 – $8
	0.63%	2.07%	0.19% – 1.07%
Chemotherapy	$9	$205	-$5 – $23
	1.50%	8.02%	-0.20% – 3.20%
Hospitalizations	$1,786	$10,904	$1,046 – $2,527
	51.79%	37.56%	43.83% – 59.75%
MSP	$264	$1,261	$179 – $350
	26.19%	26.62%	20.55% – 31.83%
Pharmanet	$42	$218	$27 – $57
	5.04%	9.54%	3.02% – 7.06%
Radiotherapy	$109	$900	$48 – $170
	6.37%	18.46%	2.46% – 10.28%

Second Recurrence

Because of small sample size, proportional costs could not be reported. Mean treatment cost was $16,617 (SD: $27,428; 95% CI: $1428 – $31,806).

End of Life

Value	Mean	SD	95% CI
Total cost	$17,930	$21,977	$16,104 – $19,756
BCCA Appointments	$211	$525	$176 – $247
	3.85%	8.40%	3.16% – 4.55%
BCCA Tests	$18	$67	$14 – $23
	0.28%	1.05%	0.19% – 0.37%
Chemotherapy	$22	$264	$4 – $40
	0.34%	2.91%	0.10% – 0.58%
Hospitalizations	$9,890	$18,478	$8,635 – $11,145
	58.41%	38.97%	55.17% – 61.65%
MSP	$802	$1,308	$713 – $891
	19.48%	27.16%	17.22% – 21.74%
Pharmanet	$556	$1,301	$468 – $645
	13.82%	22.35%	11.96% – 15.68%
Radiotherapy	$504	$2,023	$366 – $641
	3.82%	13.14%	2.72% – 4.91%

1. Cromwell I, van der Hoek K, Melosky B, Peacock S: **Erlotinib or docetaxel for second-line treatment of non-small cell lung cancer: a real-world cost-effectiveness analysis**. *Journal of thoracic oncology : official publication of the International Association for the Study of Lung Cancer* 2011, **6**(12):2097-2103.
2. Cromwell I, van der Hoek K, Malfair Taylor SC, Melosky B, Peacock S: **Erlotinib or best supportive care for third-line treatment of advanced non-small-cell lung cancer: a real-world cost-effectiveness analysis**. *Lung Cancer* 2012, **76**(3):472-477.
3. Cromwell I, Ferreira Z, Smith L, van der Hoek K, Ogilvie G, Coldman A, Peacock SJ: **Cost and resource utilization in cervical cancer management: a real-world retrospective cost analysis**. *Curr Oncol* 2016, **23**(Suppl 1):S14-22.
4. **Your Health System** [https://yourhealthsystem.cihi.ca/hsp/indepth?lang=en#/theme/C9001/2/]

Unit costs of BCCA Appointments

Unit	Cost	Count	Source
Complex patient visit	89.71	1	MSP P33527
CT Scan	98.99	73	MSP 08693
Dental new patient	256.18	133	MSP 03770
Dental visit	59.81	5686	MSP 03785
Dermatology visit	52.69	2	MSP 00210
Doppler ultrasound	59.5	6	MSP 08664
ECG	100.7	7	MSP 08638
Fine needle biopsy	53.41	8	MSP S00844
Gastroscopy	50.75	2	MSP 10742
Genetic counselling	506	5	Personal communication - Gillian Mitchell
Hospital visit (orthopaedic)	30.35	199	MSP 51008
Hygiene	150	207	Personal communication - Denise Laronde
Mammogram	101	1	MSP 08610
Nutrition	100	3437	Personal communication - Angie Bowman
Occupational medicine visit	50.81	6	MSP 33907
Oncologist visit	80.67	5657	MSP 33512
Oncology consult	169.06	864	MSP 33510
Oncology follow-up	39.14	199	MSP 33508
Orthopedist new patient	104.17	31	MSP 51010
Patient + Family Counselling	50	470	Personal communication - Gina Mackenzie
Psychiatric consultation	126.17	53	MSP 00625
Psychiatrist (new pt)	237.95	16	MSP 00610
Psychology	50	412	Personal communication - Gina Mackenzie
Pulmonary function test	81.41	11	MSP S00945
Radiography	49.2	160	MSP 08602
Social Work	50	34	Personal communication - Gina Mackenzie
Speech Path	41	27	Personal communication - Cindy Reynolds
Symptom management	169.05	94	MSP 33510
Telephone call	24.05	1462	MSP G10003
Thoracentesis	99.83	1	MSP S00749
Tube Nutrition	337.5	62	Personal communication - Angie Bowman
Ultrasound (abdomen)	107.55	17	MSP 08648
Ultrasound (pelvic)	107.53	2	MSP 08653
Voiding study	19.27	1	MSP S00732