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Cost analysis of breast cancer diagnostic assessment programs

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ABSTRACT

Objectives Diagnostic assessment programs (DAPs) appear to improve the diagnosis of cancer, but evidence of their cost-effectiveness is lacking. Given that no earlier study used secondary financial data to estimate the cost of diagnostic tests in the province of Ontario, we explored how to use secondary financial data to retrieve the cost of key diagnostic test services in DAPs, and we tested the reliability of that cost-retrieving method with hospital-reported costs in preparation for future cost-effectiveness studies.

Methods We powered our sample at an alpha of 0.05, a power of 80%, and a margin of error of ±5%, and randomly selected a sample of eligible patients referred to a DAP for suspected breast cancer during 1 January–31 December 2012. Confirmatory diagnostic tests received by each patient were identified in medical records. Canadian Classification of Health Intervention procedure codes were used to search the secondary financial data Web portal at the Ontario Case Costing Initiative for an estimate of the direct, indirect, and total costs of each test. The hospital-reported cost of each test received was obtained from the host-hospital's finance department. Descriptive statistics were used to calculate the cost of individual or group confirmatory diagnostic tests, and the Wilcoxon signed-rank test or the paired t-test was used to compare the Ontario Case Costing Initiative and hospital-reported costs.

Results For the 191 identified patients with suspected breast cancer, the estimated total cost of $72,195.50 was not significantly different from the hospital-reported total cost of $72,035.52 ($p = 0.24$). Costs differed significantly when multiple tests to confirm the diagnosis were completed during one patient visit and when confirmatory tests reported in hospital data and in medical records were discrepant. The additional estimated cost for non-salaried physicians delivering diagnostic services was $28,387.50.

Conclusions It was feasible to use secondary financial data to retrieve the cost of key diagnostic tests in a breast cancer DAP and to compare the reliability of the costs obtained by that estimation method with hospital-reported costs. We identified the strengths and challenges of each approach. Lessons learned from this study have to be taken into consideration in future cost-effectiveness studies.

Key Words Breast cancer, diagnosis, diagnostic assessment programs, cost analyses

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INTRODUCTION

Diagnosis is a crucial component in the spectrum of cancer management. Linkage between primary and secondary care, and coordination of multiple procedures and health professionals, is essential to achieve a timely diagnosis, which can potentially be associated with improved cancer outcomes[1,2]. Various factors can delay diagnosis and contribute to poor clinical outcomes and a poor patient experience. Those factors include limited access to diagnostic tests; problems identifying, communicating with, and referring to specialists; and limited availability of human and technical resources[3,4]. Centralized diagnostic assessment programs (DAPs) appear to overcome those challenges and minimize diagnostic delays by improving access to specialist care[5–7]. A DAP can lessen the time from first referral to specialist visit and the time to first treatment, and can improve patient satisfaction with services and personal care received[8,9].

Guidelines for implementing DAPs are available[9], and DAPs of various types have emerged to coordinate and expedite cancer diagnostic services[5–7]. Some ensure

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that patients are seen concurrently or consecutively by a multidisciplinary team of specialists, and others include navigators to coordinate the patient's diagnostic process and to provide information and support to patients[5,6]. Others—identified as rapid access clinics or one-stop units—include multidisciplinary assessment and patient navigation, and establish a diagnosis in a single visit[7].

The DAP model that represents the optimal way to organize services is currently unclear. Systematic reviews have examined the cost-effectiveness of multidisciplinary team meetings[10] and the centralization of services for decision-making about treatment[11]. Little evidence is available for structures or processes that optimize the diagnostic task. One randomized controlled trial examined the costs and benefits of services for breast cancer diagnosis, concluding that one-stop clinics might not be justified, because anxiety was not reduced at 3 weeks or 3 months after diagnosis for their patients compared with patients seen in a multidisciplinary breast clinic[12].

Further research into the cost-effectiveness of various DAP models is needed to provide policymakers and health system leaders with knowledge that can support decisions related to the organization and delivery of diagnostic services. The present study is part of a larger study exploring whether and how DAP characteristics influence diagnostic service delivery measures such as wait time from referral to confirmed diagnosis and number of visits[13]. We are equally interested in exploring whether DAPs are cost-effective.

To prepare for a cost-effectiveness study comparing various DAP models, the preliminary research must

- identify reliable sources of data for services and costs, and ascertain how costs for those services should be calculated; and
- establish for the DAPs a set of clear and explicit outputs that are not measured in monetary terms, such as lives saved, illnesses prevented, or life–years gained from the health care perspective, and out-of-pocket expenses or patient satisfaction from the public perspective.

At this point, we thought that a cost-effectiveness analysis is not possible—primarily because it is perhaps premature to gather reliable data for the health care system outputs (that is, lives saved or life–years gained). Also, we are dealing with retrospective data, and hence we could not capture the public perspective outputs (that is, out-of-pocket expenses and satisfaction).

Important, too, is using a reliable data source for costs. There are two avenues to obtain cost data: use financial data from institutions or use secondary data. Given that DAP programs are hospital-based, and given that not all hospitals collect financial data similar to those used in our institution, reliance on hospital data itself presents a limitation for conducting a provincial cost-effectiveness analysis. Alternatively, use of the Ontario Case Costing Initiative (OCCI) database as a source of secondary data for estimating the cost of breast cancer diagnostic tests has never been done before.

The purpose of the present study was therefore to explore how to use secondary financial data from the OCCI to retrieve the costs of the key diagnostic test services in a breast cancer DAP so that the method can be replicated for conducting future cost-effectiveness analyses for DAP programs. Further, to test the reliability of this method of retrieving costs, we compare the OCCI-based financial data with hospital-reported costs.

METHODS

Study Design and Setting

The present study is part of a comprehensive study looking at how multiple DAP programs with differing characteristics enable multidisciplinary teamwork, whether and how multidisciplinary teamwork influences the delivery of diagnostic services, and what the challenges and enablers of multidisciplinary teamwork in diagnostic assessment centres are. For our costing analysis, we used as a case example the breast cancer DAP services situated in a teaching hospital in Ontario, where the health system is publicly funded. A health system perspective was used. Although this study is not a formal type of economic analysis, its conduct and reporting were informed by the Consolidated Health Economic Evaluation Reporting Standards criteria[14,15]. The study was approved by the research ethics board of the teaching hospital.

Study Population and Sampling

Patients were eligible if they were 18 years of age and older and had been referred for assessment, confirmation, or follow-up of primary breast cancer during 1 January–31 December 2012. The total population of patients referred in 2012 to the study DAP site was 836. A representative sample of 80 patients was needed for an alpha of 0.05 and a power of 80%. However, to account for a margin of error of ±5% and for unanticipated attrition, we opted to overpower our sample by using a computer-generated list of random numbers to randomly select 200 patients referred for breast cancer diagnosis. Patients were excluded if hospital-reported data lacked costs for procedures received[1] and if the particular procedure was performed for fewer than 3 patients[8]. The final sample included 191 breast cancer patients.

Data Collection

Medical Records

Diagnostic tests received by each patient were identified in medical records. Each eligible patient was assigned a unique encrypted record number. From July to August 2013, data were collected by a trained abstractor. The data included patient demographic characteristics (date of birth, sex), type of procedure that confirmed the diagnostic result (imaging only: one or more of mammography, ultrasonography, and magnetic resonance imaging; biopsy after one or more imaging procedures: fine-needle aspiration, core, or open), diagnosis date (date when the finding was recorded in patient record), and results (negative, positive, requires follow-up). Figure 1 shows the typical diagnostic trajectory of patients with suspected breast cancer at the host hospital.

Cost Data

Cost data came from two sources. The OCCI was the main source of secondary financial data, and hospital-reported

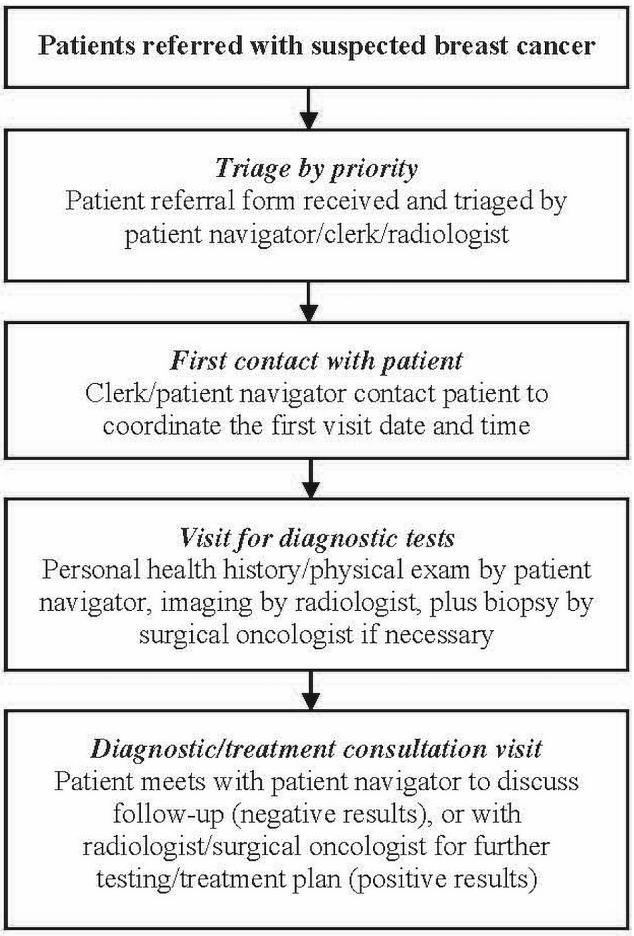

FIGURE 1 Diagnostic trajectory for patients with suspected breast cancer.

procedure costs were obtained from the host-hospital financial department (for comparison).

Each fiscal year, OCCI collects the costs of acute inpatient, day surgery, and ambulatory procedures from 37 hospitals, including the hospital in which the DAP studied here is situated, to generate mean direct (diagnostic imaging equipment, supplies, and medications; salaries for nurses, technicians, and physicians paid by the hospital), indirect (salaries for administrative, human resource, medical record, information system, housekeeping and other personnel), and total costs for each test performed in a hospital, including breast cancer diagnostic tests.

A cost for each confirmatory diagnostic test was obtained from the OCCI Web site. Those costs pertained to the fiscal year 2010–2011 (the most recent data available at the time of this study)[16] and were inflation-adjusted to 2012 (the year during which the eligible patients were diagnosed), based on the Bank of Canada Consumer Price Index[17]. The search at the OCCI Web portal used the Canadian Classification of Health Interventions[18] (CCHI) code by procedure and hospital department. Costs for confirmatory diagnostic tests not reported by OCCI (breast fine-needle aspiration and core biopsy) were obtained from the Ontario Ministry of Health and Long-Term Care's Health Data Branch. Table I shows the published cost of diagnostic tests.

We used the cost of each diagnostic test from the OCCI or the Ontario Ministry of Health and Long-Term Care to estimate the direct, indirect, and total costs associated with confirmatory diagnostic tests for each patient. We calculated the cost of ultrasound-guided core biopsy as the sum of the costs of core biopsy and of ultrasonography used in ultrasound-guided core biopsy, and the cost of stereotactic core biopsy as the sum of the costs of core biopsy and of imaging used in stereotactic core biopsy.

The hospital-reported cost of the confirmatory diagnostic test for each patient was obtained from the finance department. Patients were identified by unique encrypted record number and confirmatory diagnostic test date. Data collected included the department doing the billing, CCHI procedure code, and hospital-reported cost per patient (direct, indirect, and total costs). Some patients underwent multiple tests—for example, mammography and ultrasonography, as well as an ultrasound-guided core biopsy, all performed during one visit and billed together.

Compensation for consultation visits to non-salaried fee-for-service physicians were not included in the hospital-reported data. Those costs were acquired from the Ontario Health Insurance Plan *Schedule of Benefits* for fiscal year 2012–2013[19]. Table II shows the published unit costs for non-salaried health care personnel.

Data Analysis

Patients were categorized into 7 groups, based on having received the same confirmatory test or combination of confirmatory tests. For each group, the direct, indirect, and total costs derived from OCCI data were obtained. Descriptive statistics are used to report the demographic characteristics of the sample; the proportion of patients receiving the various confirmatory diagnostic tests; and the direct, indirect, and total costs of the tests. The hospital-reported direct, indirect, and total costs of the same confirmatory diagnostic tests were also calculated. The hospital cost data for the breast cancer diagnostic groups other than mammography, ultrasonography, and fine-needle aspiration biopsy were not normally distributed.

To explore the reliability of the OCCI data, we tested the cost estimates based on OCCI and hospital-reported data to determine whether they were statistically significantly different. The Wilcoxon signed-ranked test was used to compare the median of non-normally distributed costs, and a paired t-test was used to compare the mean of normally distributed costs. For 26 breast cancer patients, the confirmatory diagnostic tests reported in medical records and in hospital billing records differed. A unique variable was applied to identify those cases, and a sub-analysis was conducted to compare costs stratified by discrepancy status. An alpha of 0.05 was considered to indicate significance.

The cost of consultation visits with non-salaried physicians was separately calculated. The total consultation visits identified in medical records for each type of specialist was multiplied by the corresponding unit cost for specialist visits acquired from the Ontario Health Insurance Plan (Table II) to generate the specialty-specific and overall costs of consultation visits for diagnostic services.

TABLE I Cost estimates for breast cancer diagnostic procedures

Procedure	CCHI code	Cost source			Cost (CA$)[a]		
		Ontario Case Costing Initiative		MOHLTC	Direct (mean)	Indirect (mean)	TOTAL
		By procedure	By department				
Mammography	3.YM.10	—	3.YM.30.DA	—	102.18	28.44	129.60
Ultrasonography (US) of the breast	3.YM.30	—	3.YM.30.DA	—	59.00	16.90	75.90
US in US-guided core biopsy	3.YM.30.DA	3.YM.30.DA	—	—	206.50	69.53	276.00
Imaging used in stereotactic core biopsy	3.YM.94.ZC	—	1.YM.87.LA	—	230.70	57.90	288.60
		—	1.YM.87.UT	—			
Core biopsy	2.YM.71.LA	—		+	117.70	40.90	158.60
Fine-needle aspiration biopsy	2.YM.71.HA	—		+	149.80	40.52	190.30

[a] Inflation-adjusted to 2012 if necessary.
CCHI = Canadian Classification of Health Interventions; MOHLTC = Ministry of Health and Long Term Care.

TABLE II Human resource costs for breast cancer diagnostic procedures

Service	Provider	Data source	Billing code	Unit cost (CA$)
Various	Clerk	Indirect[a]	—	—
Various	Patient navigator		—	—
Various	Registered nurse		—	—
Various	Imaging technologist	Direct[a]	—	—
Various	Pathology technologist		—	—
Various	Pathologist		—	—
Mammography	Radiologist		X185	27.00
Ultrasonography	Radiologist		J127	16.40
Magnetic resonance imaging	Radiologist		X446, X447	100.00
Fine-needle aspiration biopsy	Radiologist or surgical oncologist	OHIP Schedule of Benefits[35]	Z141	37.20
Core biopsy	Radiologist or surgical oncologist		J149	36.90
Consultation	Surgical oncologist		A035	90.30
	Radiology oncologist		A345	152.40
	Medical oncologist		A135	157.00
	General physician oncologist		A911	144.70

[a] Hospital-reported or published.
OHIP = Ontario Health Insurance Plan.

All analyses were performed using the IBM SPSS Statistics software application (version 21: IBM, Armonk, NY, U.S.A.).

RESULTS

Patient Demographic Characteristics

Table III summarizes the demographic characteristics of eligible patients. The mean age of patients referred for a breast cancer assessment was 54.4 years. Of those patients, 189 (99.0%) were women, and 76 (39.8%) were diagnosed with breast cancer.

Comparison of Hospital-Reported and Estimated Costs

Table IV compares the direct, indirect, and total costs by confirmatory diagnostic test group for patients with suspected breast cancer. For most patients, a diagnosis was established with ultrasound-guided core biopsy after ultrasonography and mammography imaging (n = 66, 34.6%). For that group, the estimated total cost ($28,683.60) was not significantly different from the hospital-reported total cost ($27,986.50, $p < 0.35$). Costs differed significantly for patients undergoing multiple tests during the same visit to confirm the diagnosis and for patients whose confirmatory tests as reported in hospital data and medical records were discrepant. For example, for patients who underwent core biopsy, ultrasound-guided fine-needle aspiration, ultrasonography, and mammography all in one visit, the overall cost based on hospital data was $22,842.30 compared with $13,907.20 based on OCCI data ($p < 0.01$). Among those patients, 23 showed discrepancies between the medical record and the hospital-reported data; their

TABLE III Participant demographic characteristics and diagnostic results

Characteristic	Value
Participants (*n*)	191
Age group [*n* (%)]	
23–40 Years	28 (14.7)
41–50 Years	47 (24.6)
51–60 Years	57 (29.8)
61–70 Years	35 (18.3)
≥71 Years	24 (12.6)
Mean age (years)	54.4
Sex [*n* (%)]	
Women	189 (99.0)
Men	2 (1.0)
Diagnostic results	
Malignant	76 (39.8)
Benign	53 (27.7)
Follow-up required	62 (32.5)

total cost based on hospital data was $7,642.50, which was significantly lower than the estimate of $9,995.80 based on OCCI data ($p < 0.01$). However, of all patients with suspected breast cancer, the estimated total cost ($72,195.50) was not significantly different from the hospital-reported total cost ($72,035.52, $p = 0.24$).

Cost of Non-salaried Staff

Table v reports the cost of non-salaried staff—including radiologists and surgical, medical, radiation, and general physician oncologists—who delivered diagnostic services as $28,387.50.

DISCUSSION

In the present study, we showed that, in a publicly funded system such as that in Canada, having a secondary financial data source such as the OCCI that regularly captures data from a variety of organizations to provide cost estimates for specific procedures is feasible. This resource is particularly important for health care organizations that lack finance departments to report on the direct, indirect, and total cost for their services. However, using the OCCI data is not without its challenges.

We found that coding by physicians for diagnostic tests were consistently reported using the CCHI coding procedure, which facilitated derivation of the confirmatory diagnostic test from the medical record. Cost estimates generated by using CCHI codes to search the easy-to-access OCCI Web portal for the relevant tests was simple. Alternatively, we found that not all key diagnostic tests were reported by the OCCI. As mentioned earlier, we had to use an additional data source—the Ontario Ministry of Health and Long-Term Care's Health Data Branch—to complete the cost estimates. Further, not all diagnostic tests were listed by procedure; some were derived from within departments. For example, the estimated cost of ultrasonography in an ultrasound-guided core biopsy was obtained using the CCHI code 3.YM.30.DA and was located as a procedure. In contrast, the mammography estimate was derived from the hospital department, which produced a list of tests, including the diagnostic test being sought (Table I). Most importantly, we found discrepancies between the diagnostic tests reported in hospital data and in medical records, which translated into a significant difference between the hospital cost and the estimated cost based on the OCCI data. Further, for some patients who underwent multiple tests during one visit to confirm the diagnosis, the hospital financial data differed significantly from the OCCI estimates.

To our knowledge, the present study is the first to use secondary financial data to generate cost estimates for DAP services for patients with suspected breast cancer. Our ultimate goal is to conduct a comprehensive cost-effectiveness analysis examining the costs of various DAP service models on patient outcomes. Currently, most DAPs in Ontario are dedicated clinics for specific cancer types. Evidence indicates that, compared with usual care for melanoma patients, the cost of diagnosis and treatment in a dedicated clinic is $1,600 less per patient[20]. Our next step is to compare, for patients with suspected breast, lung, and colorectal cancer, the cost of diagnosis and treatment in a dedicated DAP clinic compared with usual care. Many of the DAPs in Ontario have navigators who assist patients throughout their cancer diagnosis journey. Our intention is also to investigate the cost-effectiveness of a navigator DAP compared with a non-navigator DAP, taking into consideration the patient perspective.

There are limitations to our study. We used data for patients referred to a single DAP at a single institution. A similar costing exercise is warranted for patients in a larger number of DAPs and with other types of cancer. Further, future studies might also examine costs from a patient perspective rather than from a health system perspective.

CONCLUSIONS

The output of the present study—deriving diagnostic tests from medical records and using secondary financial data to estimate their costs—represents a successful exploration. Future cost-effectiveness studies can consider using the OCCI as a data source; however, careful evaluation of the billing pattern for multiple tests performed during one visit at the organization level and of the level of consistency between the medical report and the financial billing first have to be clarified to increase the reliability of the findings.

CONFLICT OF INTEREST DISCLOSURES

We have read and understood *Current Oncology*'s policy on disclosing conflicts of interest, and we declare that we have none.

AUTHOR AFFILIATIONS

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TABLE IV Comparison of the hospital-reported and estimated cost of confirmatory diagnostic procedures in patients with suspected breast cancer

Procedure group	Participants [*n* (%)]	Cost (CA$)								
		Direct			Indirect			Total		
		Hospital	Estimate	*p* Value[a]	Hospital	Estimate	*p* Value[a]	Hospital	Estimate	*p* Value[a]
Mammography (MMG)[b]	10 (5.20)	704.00	1,021.80	0.03	232.70	284.40	0.24	933.70	1,296.00	0.05
Breast ultrasonography (US)[c]										
Overall	26 (13.60)	1,665.70	1,534.00	0.33	549.50	439.40	0.02	2,215.20	1,897.50	0.19
Non-discrepant	24 (12.60)	1,431.40	1,416.00	0.80	471.60	405.60	<0.01	1,903.00	1,821.60	0.32
Discrepant	2 (1.00)	234.30	118.00	0.50	77.90	33.80	0.45	312.20	151.80	0.51
MMG plus US[b]	30 (15.70)	4,120.20	4,835.40	0.05	1,354.50	1,360.20	0.96	5,474.70	6,165.00	0.16
Fine-needle aspiration biopsy (FNAB)[b], plus US, plus MMG										
Overall	8 (4.20)	1,821.60	1,198,40	<0.01	591.70	324.16	<0.01	2,413.30	1,52240	<0.01
Non-discrepant	7 (3.60)	1,666.92	1,048.60	<0.01	543.70	283.60	<0.01	2,210.70	1,332.10	<0.01
Discrepant	1 (0.60)	154.70	149.80	—	48.00	40.50	—		202.60	190.30
Core biopsy, US-guided[c], plus US, plus MMG										
Overall	66 (34.60)	21,074.80	21,397.20	0.41	6,911.80	7,288.40	0.12	27,986.50	28,683.60	0.35
Non-discrepant	43 (22.50)	15,318.10	13,940.60	0.16	5,026.10	4,748.50	0.50	20,344.10	18,687.80	0.19
Discrepant	23 (12.10)	5,756.80	7,456.60	<0.01	1,885.70	2,539.90	<0.01	7,642.50	9,995.80	<0.01
Core biopsy, US-guided[c], plus FNAB, plus US, plus MMG	32 (16.8)	17,290.60	10,374.40	<0.01	5,551.70	3,533.80	<0.01	22,842.30	13,907.20	<0.01
Core biopsy, stereotactic[c], plus FNAB, plus US, plus MMG	19 (9.9)	7,660.10	6,619.60	0.07	2,509.70	1,877.20	<0.01	10,169.80	8,496.80	0.02
TOTAL										
Overall	191 (100.0)	54,337.10	54,955.00	0.11	17,701.60	17,311.40	0.97	72,035.52	72,195.50	0.24
Non-discrepant	165 (86.0)	48,191.30	47,230.60	0.68	15,690.10	14,697.20	0.13	63,878.30	61,857.60	0.91
Discrepant	26 (14.0)	6,145.80	7,724.40	<0.01	2,011,50	2,614.20	<0.01	8,157.20	10,337.90	<0.01

[a] Not available for single discrepant cases.
[b] Mean hospital-reported and estimated costs, compared by t-test.
[c] Median hospital-reported and estimated costs, compared by Wilcoxon signed rank test.

TABLE V Cost of non-salaried physicians associated with the delivery of confirmatory diagnostic procedures for patients with suspected breast cancer

Service	Provider	Patients (*n*)	Cost (CA$)	
			Unit cost	Total
Mammography	Radiologist	90	27.00	2,430.00
Ultrasound	Radiologist	164	16.40	2,689.60
Magnetic resonance imaging	Radiologist	—	100.00	—
Fine-needle aspiration biopsy	Radiologist or surgical oncologist	41	37.20	1,525.20
Core biopsy	Radiologist or surgical oncologist	117	36.90	4,317.30
Consultation	Surgical oncologist	127	90.30	11,468.10
	Radiology oncologist	—	152.40	—
	Medical oncologist	2	157.00	314.00
	General physician oncologist	39	144.70	5,643.30
TOTAL				28,387.50

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