


Original Investigation

Specialized Surveillance for Individuals at High Risk for Melanoma

A Cost Analysis of a High-Risk Clinic

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IMPORTANCE Regular surveillance of individuals at high risk for cutaneous melanoma improves early detection and reduces unnecessary excisions; however, a cost analysis of this specialized service has not been undertaken.

OBJECTIVE To determine the mean cost per patient of surveillance in a high-risk clinic from the health service and societal perspectives.

DESIGN, SETTING, AND PARTICIPANTS We used a bottom-up microcosting method to measure resource use in a consecutive sample of 102 patients treated in a high-risk hospital-based clinic in Australia during a 12-month period.

EXPOSURE Surveillance and treatment of melanoma.

MAIN OUTCOMES AND MEASURES All surveillance and treatment procedures were identified through direct observation, review of medical records, and interviews with staff and were valued using scheduled fees from the Australian government. Societal costs included transportation and loss of productivity.

RESULTS The mean number of clinic visits per year was 2.7 (95% CI, 2.5-2.8) for surveillance and 3.8 (95% CI, 3.4-4.1) for patients requiring surgical excisions. The mean annual cost per patient to the health system was A \$882 (95% CI, A \$783-\$982) (US \$599 [95% CI, US \$532-\$665]); the cost discounted across 20 years was A \$11 546 (95% CI, A \$10 263-\$12 829) (US \$7839 [95% CI, US \$6969-\$8710]). The mean annual societal cost per patient (excluding health system costs) was A \$972 (95% CI, A \$899-\$1045) (US \$660 [95% CI, US \$611-\$710]); the cost discounted across 20 years was A \$12 721 (95% CI, A \$12 554-\$14 463) (US \$8637 [95% CI, US \$8523-\$9820]). Diagnosis of melanoma or nonmelanoma skin cancer and frequent excisions for benign lesions in a relatively small number of patients was responsible for positively skewed health system costs.

CONCLUSIONS AND RELEVANCE Microcosting techniques provide an accurate cost estimate for the provision of a specialized service. The high societal cost reflects the time that patients are willing to invest to attend the high-risk clinic. This alternative model of care for a high-risk population has relevance for decision making about health policy.

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Australia has the highest incidence of melanoma in the world.¹ Despite this statistic and the known risk factors for melanoma, screening in the general population is not recommended at present. Selected studies have shown that screening among men older than 50 years as a one-time intervention² or at 5-year intervals using primary care physicians³ may be cost-effective. The regular surveillance of individuals at high risk for melanoma in a specialized clinic has demonstrated improvements in early detection of lesions⁴ and a reduction in unnecessary excisions⁵; however, to our knowledge no studies have examined whether monitoring people at very high risk for developing melanoma for a long period is cost-effective. A specialized high-risk clinic (HRC) for individuals with an elevated risk for melanoma was established within a hospital outpatient clinic at the Sydney Melanoma Diagnostic Centre, Royal Prince Alfred Hospital, Sydney, Australia, in 2006, and this model of care is currently being evaluated and expanded in 3 more centers. Early detection underpins the rationale for surveillance of individuals at high risk for melanoma because the stage at diagnosis affects prognosis⁶ and the cost of subsequent treatment is lower when melanoma is detected at an early compared with an advanced stage.^{7,8}

The aim of our microcosting study was to measure (1) the cost of providing this specialized skin surveillance service to individuals at very high risk for melanoma and (2) the factors influencing variation in resource use. We aimed to calculate the direct costs of the HRC, that is, costs to the health care system, and the indirect costs not generated directly by the clinic but as a result of attending the clinic. These costs included out-of-pocket costs (eg, travel to the clinic) and the opportunity costs of time forgone in attending the clinic. Microcosting is the reference standard technique⁹ for calculating the cost of a new service when no published estimates are available.¹⁰ Microcosting techniques are preferred for interventions that contain a large component of labor costs and in which interpatient variation in costs is likely, making a mean cost difficult to predict.¹¹ The treatment of patients at high risk for melanoma in a specialized surveillance clinic has been evaluated in only a few countries,¹²⁻¹⁵ and, to our knowledge, no studies have reviewed or evaluated the costs of the health care service or the societal costs.

Methods

Study Design

We used a cohort study design. We obtained human research ethics committee approval from the institutional review board of the Royal Prince Alfred Hospital. All participants gave oral consent for one of us (C.G.W.) to attend and observe the HRC consultations. Patients had previously given informed consent for participation in the study.

Study Sample

All patients attending the HRC met at least 1 of the following eligibility criteria: (1) dysplastic nevus syndrome and at least 1 primary invasive melanoma, (2) diagnosis of 2 or more pri-

mary invasive melanomas, (3) strong family history of melanoma (≥ 3 first-degree relatives with melanoma) and 1 or more personal primary invasive melanomas, or (4) presence of the *CDKN2A* mutation with no requirement for a history of melanoma.¹⁶ The strategy used for surveillance in the Sydney HRC has been described previously.¹² In brief, this strategy involves regular extended-length consultations once every 6 months, which include a full-body skin examination augmented with dermoscopy and the use of total body photography plus dermoscopy when indicated. When a suspected lesion is identified, the lesion is excised or sequential digital dermoscopic imaging¹⁷ of the lesion is commenced and the patient returns for nevus monitoring in 3 months. An additional part of the program is that patients receive instruction in skin self-examination, which they are encouraged to perform using their total body photographs between appointments. A pilot study of this clinic involving 311 patients followed up for a median of 3.5 years showed effective early detection of primary melanoma and a ratio of benign to malignant lesion excision of 1.6:1 for all lesions excised.¹²

Microcosting Approach

We used a bottom-up microcosting approach to estimate the total costs of HRC care for 12 months. All costs associated with skin surveillance and management of newly identified lesions were included. Procedures related to testing for recurrence of a previously diagnosed cutaneous melanoma, such as chest radiography, were not included because these costs did not apply to HRC surveillance costs. All identifiable direct and indirect costs were included in the analysis and adjusted to 2013 Australian dollars.¹⁸ A 20-year time horizon was used to estimate the lifetime costs of surveillance based on the median age of the HRC participants. We applied the Australian standard discount rate of 5%¹⁹ to all future costs. The methods followed published guidance on microcosting.¹⁰ Additional information is included in the eMethods in the Supplement.

Direct Observation

Through direct observation of the HRC from December 10, 2012, through May 14, 2013, we recorded information about each patient's type and length of consultation (using a stopwatch) and all resource items used. Additional information regarding the mode of transport to the clinic, patient employment status, employment leave type, and requirement of a medical certificate were noted if discussed during the consultation. For employed patients, the occupational group was graded according to the Australian Bureau of Statistics classifications²⁰ to determine the median wage. The presence of accompanying family members or informal caregivers was also recorded.

Staff were interviewed about their roles, the time they spent on various tasks, and their use of consumables. Information about fixed costs and capital and equipment costs was obtained from the HRC records, and prices were checked with equipment suppliers when current receipts were not available. We calculated costs for software licenses, technology maintenance and support, and overhead costs for clinic space.

A mean cost per patient for staff in the HRC was derived using salary scales from the Public Health System Awards of New South Wales Health (the state health department).²¹ Staff costs, including payroll taxes and superannuation, were estimated as an additional 20% to their base salary.²²

Review of Medical Records

Sociodemographic data were obtained from the patients' medical records, and the return travel distance by road from the patient's home to the clinic was calculated using residential addresses and publicly available software (Whereis; <http://www.whereis.com>). All documented melanoma surveillance consultations and procedures, whether conducted in the HRC or by other services (eg, primary care), were recorded from the medical records. This information included all diagnostic tests and medication use during the preceding 12 months.

Health System Costs

Use of health system resources was calculated for all patients, including surveillance and treatment provided as a result of attending the HRC during the previous 12 months. Resource use items were valued according to the dollar amount subsidized by the Australian government through the Medicare Benefits Schedule.²³ The scheduled fees are set annually by the Australian government and provide a value for services against which all residents in Australia can claim a rebate of 100% for primary care services (if the service was billed in bulk) and 85% for non-primary care services. Fees for melanoma surveillance that were reimbursed by the Medicare Benefits Schedule²³ were deducted from the hospital salary costs of the dermatology resident to avoid double counting. We allocated a primary care level B (standard-length) or C (extended-length) service, depending on the duration of the consultation. Services provided by primary care physicians in the community were counted as level B consultations. All excised lesions were sent for a pathological examination, with costs varying according to the size and site of the lesion, the number of lesions excised during a consultation, and the complexity of the biopsy material being examined. If a patient was admitted to hospital for an excision, we assigned a health system cost based on the relevant Australian refined diagnosis related groups code.²⁴

A total annual health system cost was calculated for salaries and for overhead and capital costs. A mean cost per consultation was calculated by dividing this total cost by the total number of HRC consultations in 1 year (based on the mean number during the previous 6 years). This figure was used to calculate the mean annual cost per patient.

Societal Costs

Patient Travel Costs

For patients who reported their mode of travel, we calculated a mean annual travel cost. Based on the reported mode of transport, the number of trips made to the HRC, and the number of surveillance-related consultations documented in the patient's history, we calculated a total travel cost per patient across 12 months. For air travel, a standard

online ticket price was calculated. Hotel accommodation was based on the standard overnight rate for a midrange hotel located within a 5-km radius of the hospital. If individuals had consulted their local primary care physician in the community during the past 12 months for an excision or for removal of sutures related to surveillance at the HRC, a standard return travel distance of 9.6 km (6 miles) was allocated to each primary care visit.²⁵

Out-of-Pocket Costs for Medical Treatment

Documentation in the patient's medical record was used to calculate the mean out-of-pocket cost for medical treatment related to HRC surveillance in the previous 12 months but not fully rebatable through the Medicare Benefits Schedule²³ or the Pharmaceutical Benefits Scheme.²⁶ All patients required an initial set of total body photographs, which were used at each visit for monitoring lesions. At the present time, patients attending the HRC do not pay for these photographs, but this cost likely will be borne by patients in the future. A set of photographs usually lasts 7 years (E.C., personal communication, May 2013); therefore, a mean cost for 7 years was calculated per patient. Mean costs borne by patients for medicines and lotions²⁶ and out-of-pocket costs for specialist services were calculated based on the standard reimbursement through the Medicare Benefits Schedule²³ or the Pharmaceutical Benefits Scheme.²⁶

Opportunity Costs

The value of each patient's time to attend the HRC or to receive other related medical care during the previous 12 months was calculated using the market price of labor (ie, wages or the aged pension).²⁷ Based on our observation, an HRC visit for surveillance or a related procedure required 4 hours or half a day taken from work. For patients who lived more than 100 km (62 miles) away, a full day or 8 hours was required to attend the clinic. For employed patients, we calculated the opportunity cost of time not at work based on an estimated median of full-time weekly total cash earnings by occupation group.²⁸ For patients of working age whose occupation was unknown, we estimated the opportunity cost of lost personal time per visit based on a median of full-time weekly total cash earnings for all Australian employees.²⁸ For patients older than 65 years who were assumed to be retired, a proportion of the weekly single pension was used.²⁹ All wages were adjusted from 2012 to 2013 wage levels by 4.9%, which was the percentage change in full-time mean earnings provided by the Australian Bureau of Statistics.²⁰

Results

Study Population

All 102 consecutive patients attending the HRC on Mondays from December 10, 2012, through May 14, 2013, were included in the study (eFigure in the Supplement). Of these, 87 were continuing (prevalent) patients and 15 were new (incident) patients attending for the first time. The characteristics of the study population are summarized in **Table 1**.

Labor in the HRC (ie, staff salaries) was the main component of operational expenses and accounted for 50% of health system costs. Surveillance and procedures accounted for 46% of health system costs; of this group, 235 of 271 consultations (86.7%), excluding specialist consultations, were to the HRC (Table 2). The mean consultation time for a new patient was 40 minutes. All 87 prevalent patients had 2 extended-length consultations during the 12-month period, and these consultations took a mean of 31 (95% CI, 28-34) minutes. Within this group, an additional 66 consultations for nevus monitoring were performed (mean time, 11 [95% CI, 7-15] minutes). Almost half the study group (39 of 87 [45%]) commenced short-term monitoring during the 12-month period, with 1 to 6 lesions identified for short-term monitoring. Seven patients in this group had additional lesions identified for monitoring within the study period. Thirty of the 87 patients (34%) required an excision of a suspected lesion during the 12-month study period; of these, 16 (53%) had 1 lesion excised and 4 (13%) had a range of 4 to 8 excisions. The mean number of HRC visits per year was 2.7 (95% CI, 2.5-2.8) for surveillance and 3.8 (95% CI, 3.4-4.1) for patients requiring surgical excisions.

Three melanomas and 8 keratinocyte carcinomas were detected during the study period (Table 2). Patients had 12 visits to a primary care physician in the community for excision of lesions and 22 visits for removal of excision sutures. Only 1 hospital admission was documented during the study period. Costs per patient were heavily skewed to the right, with a few patients generating costs several times the mean (Figure). The higher health care costs resulted from more excisions of benign lesions with suspected melanoma features and surgical removal of melanoma and nonmelanoma skin cancers.

Mean annual societal costs were very similar to direct health care costs at A \$972 (95% CI, A \$899-\$1045) (US \$660 [95% CI, US \$611-\$710])³⁰ per patient (Table 3). The greatest proportion of these costs was related to the patient's time spent on surveillance or related activities and travel costs (Table 4). The opportunity cost of time not at work or spent on lost personal time was a mean of A \$502 (95% CI, A \$425-\$579) (US \$341 [95% CI, US \$290-\$388])³⁰ per person during the 12 months. This equates to a cost of A \$147 (US \$100) each time an individual engages with the health system by attending the HRC or for a related procedure. An opportunity cost for visiting a local primary care physician for removal of sutures was not calculated because we believed the time required would not cause the same disruption to one's daily schedule. The mean annual out-of-pocket cost for travel was A \$117 (US \$79) for a consultation or a procedure-related visit, and a wide variation existed in the distance patients traveled to the clinic (Table 4). The annual mean cost for travel and accommodation combined was A \$407 (95% CI, A \$183-\$631) (US \$276 [95% CI, US \$124-\$428])³⁰ per person; the mean cost of traveling by car was 79% of these costs. The mean total number of consultations was less when estimating societal costs because travel time was counted only once when an excision occurred on the same day as a clinic visit. When patients had traveled

Table 1. Characteristics of 102 Patients Included in the Study

Characteristic	Data ^a
Age, median (IQR), y	59 (49-64)
Sex	
Male	65 (63.7)
Female	37 (36.3)
High-risk group characteristics ^b	
Dysplastic nevus syndrome and previous melanoma	66 (64.7)
Multiple primary melanoma	96 (94.1)
Strong family history	11 (10.8)
CDKN2A mutation	4 (3.9)
Health insurance status	
Private	70 (68.6)
Public only (Medicare)	22 (21.6)
Unknown	10 (9.8)
Employment status ^c	
Employed	42 (55.3)
Full time	30 (71.4)
Part time	8 (19.0)
Unknown	4 (9.5)
Not employed	4 (5.3)
Retired	17 (22.4)
Unknown	13 (17.1)
Occupational type for employed group ^d	
Manager/professional	14 (33.3)
Technician, community, and trade workers	17 (40.5)
Clerical, administrative, and sales workers	8 (19.0)
Unknown	3 (7.1)
Leave type for employed group to attend clinic visit ^d	
Time in lieu	19 (45.2)
Annual leave/rostered day off	15 (35.7)
Sick leave	4 (9.5)
Unknown	4 (9.5)
Mode of transport to clinic ^e	
Car	34 (44.7)
Train, bus, taxi	13 (17.1)
Airplane	2 (2.6)
Unknown	27 (35.5)
Distance from patient's home to clinic and return, km	
Mean	248
Median (IQR)	56 (27-187)

Abbreviation: IQR, interquartile range.

^a Unless otherwise indicated, data are expressed as number (percentage) of patients. Percentages have been rounded and may not total 100.

^b Patients can be in more than 1 high-risk characteristic group.

^c Includes 76 patients who provided information about employment status.

^d Includes 42 patients who reported employment.

^e Includes 76 patients who provided information about mode of transport.

long distances and an excision was determined at the HRC to be necessary, an attempt was made to organize the surgery on the same day. In our study sample this occurred 6 times.

The out-of-pocket costs for medical treatment were a small component (6%) of patient costs, because only a few visits to

Table 2. Health System Costs for Patients Attending the HRC During a 12-Month Period

Description	Procedure Code ^a	Cost per Item, A \$ (a)	No. in 12 mo (b)	Total		Mean Cost per Patient per Year ^b	
				Cost, A \$ (c) ^{c,d}	Cost, US \$ (c) ^{c,d}	A \$ (d) ^e	US \$ (d) ^e
Medical Consultation Type							
Standard-length consultation ≤20 min (level B)	MBS 00023	36.30	95	3449	2342	NA	NA
Extended-length consultation >20 min (level C)	MBS 00036	70.30	176	12 373	8401	NA	NA
Dermatologic or surgical specialist^f							
Initial consultation	MBS 00104	85.55	6	513	348	NA	NA
Subsequent consultation	MBS 00105	43.00	10	430	292	NA	NA
Total consultation				16 765	11 383	NA	NA
Procedures for Excisions of Skin							
Diagnostic biopsy of skin ^g	MBS 30071	52.20	7	314	213	NA	NA
Diagnostic excision of skin							
<10 mm ^c	MBS 31205	95.45	39	2930	2528	NA	NA
10 to <20 mm	MBS 31210	123.10	2	246	167	NA	NA
Nose, ear, eyelid, or digit	MBS 31230	168.05	1	168	114	NA	NA
Face, neck, or lower leg ^c	MBS 31235	143.55	2	215	146	NA	NA
Therapeutic excision on skin							
Nose, ear, or eyelid, <10-mm SCC or BCC	MBS 31255	221.35	1	221	150	NA	NA
Face, neck, or lower leg, <10-mm SCC or BCC	MBS 31265	184.50	1	185	125	NA	NA
Reexcision on face, neck, or lower leg, <10-mm SCC or BCC	MBS 31266	184.50	1	185	125	NA	NA
Excision of skin from other site, <10-mm SCC or BCC	MBS 31280	155.85	4	623	423	NA	NA
Reexcision of skin from other site, <10-mm SCC or BCC	MBS 31282	156.40	1	156	106	NA	NA
Excision of skin, <10-mm melanoma							
Face, neck, or lower leg	MBS 31310	378.65	2	757	514	NA	NA
Other site	MBS 31325	270.55	1	271	184	NA	NA
Total skin excisions				6271	4795	NA	NA
Monitoring							
Sequential digital dermoscopy imaging							
1-3 Lesions		65.00	43	2795	1898	NA	NA
>3 Lesions		75.00	3	225	153	NA	NA
Total monitoring				3020	2051	NA	NA
Other Procedures^f							
Single-stage local flap repair	MBS 45203	406.05	1	406	276	NA	NA
Vermilionectomy	MBS 45669	326.05	1	326	221	NA	NA
Diagnostic biopsy of lymph gland (by specialist)	MBS 30075	149.75	1	150	102	NA	NA
Ultrasonography of the groin	MBS 55816	109.10	1	109	74	NA	NA
Inpatient stay in standard ward (mean length of stay, 1.23 d)	DRG 11Z ^g	NA	NA	2043	1387	NA	NA
Pathological examination^h							
Level 3	MBS 72816	86.35	22	1899	1290	NA	NA
Level 4	MBS 72823	97.13	39	3788	2572	NA	NA
Level 5	MBS 72830	274.15	3	822	558	NA	NA
Immunohistochemistry	MBS 72846	59.60	1	60	40	NA	NA
Cytology fine-needle aspiration	MBS 73049	68.15	1	68	46	NA	NA
Total other procedures				9671	6566	NA	NA
Total medical procedures (consultations, excisions, monitoring, and other)	NA	NA	NA	35 727	24 259	411	278

(continued)

Table 2. Health System Costs for Patients Attending the HRC During a 12-Month Period (continued)

Description	Procedure Code ^a	Cost per Item, A \$ (a)	No. in 12 mo (b)	Total		Mean Cost per Patient per Year ^b	
				Cost, A \$ (c) ^{c,d}	Cost, US \$ (c) ^{c,d}	A \$ (d) ^e	US \$ (d) ^e
Overheads and Capital^l							
Office equipment: computers, printers, software and licenses	NA	NA	NA	3785	2570	NA	NA
Medical equipment: monitoring, photographic equipment, dermatoscope, lamp, nitrous oxide canister ^j	NA	NA	NA	1298	881	NA	NA
Consumables, DVDs, gel, stationery, printer toner, gloves, paper rolls, shavers, tissues	NA	NA	NA	877	559	NA	NA
Hospital floor space costs	NA	NA	NA	2135	1450	NA	NA
Total overhead	NA	NA	NA	8095	5496	31	21
Salaries ^{l,k}	NA	NA	NA	113 605	77 133	440	299
Estimated total medical procedure costs^l				105 949	71 935	411	279
Estimated total health system costs	NA	NA	NA	227 649	154 564	882	599

Abbreviations: BCC, basal cell carcinoma; DRG, diagnosis related group; HRC, high-risk clinic; NA, not applicable; SCC, squamous cell carcinoma.

^a Unless otherwise indicated, coded as Medicare Benefits Schedule item number for services subsidized by the Australian government.²³

^b The mean cost per patient was calculated for medical procedures (n=87) based on the microcosting study. The mean capital and salary costs were based on the mean number of patients attending the HRC in a year (n=258).

^c Total amount may be less because Medicare Benefits Schedule multiple service rule was applied.²³

^d Calculated as $a \times b$.

^e Calculated as c/n .

^f Indicates consultation occurring outside the HRC.

^g Australian refined diagnosis-related group classification category.

^h Levels vary according to complexity level of biopsy material being examined, including tissue dissection, preparation, processing, and additional professional opinion(s) that may be sought.

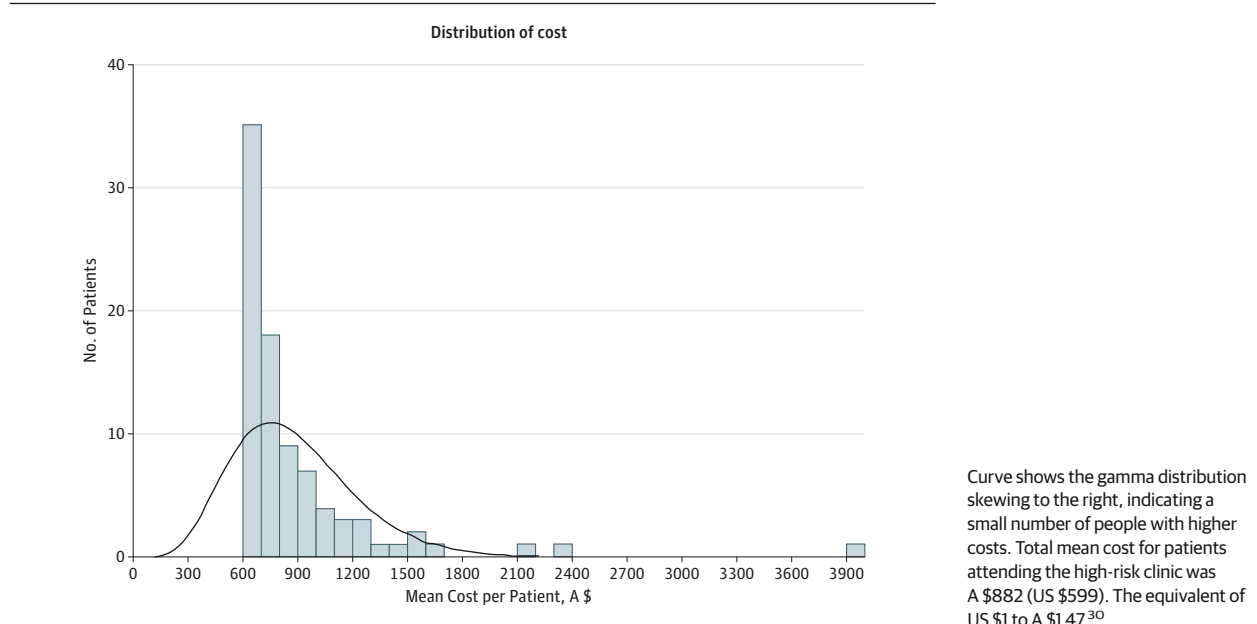
ⁱ Includes 102 patients.

^j Monitoring includes costs for recording and storage of lesion images for sequential digital dermoscopy imaging.

^k Include salaries for the dermatology resident (20 h/wk), administration (17.5 h/wk), research scientist (20 h/wk), clinical supervision (head of department for second opinion and training; 1 h/wk), and information technology support (25 h/y). Salaries have been adjusted to account for Medicare Benefits Schedule fee reimbursement for melanoma surveillance.²³

^l Based on extrapolation of medical procedure costs for 87 patients to the estimated 258 patients treated annually at the HRC.

Figure. Distribution of the Cost per Patient Cost to the Health Care System for 12 Months of Surveillance at the High-Risk Clinic



specialists outside the HRC were recorded and topical ointments and lotions were infrequently prescribed (Table 4). Visits for specialist procedures related to the location of the excision or pa-

tient preference. Two adverse events (wound infections) were noted in the medical records, and both responded to antibiotics. The mean annual and lifetime costs are summarized in Table 3.

Table 3. Summary of Health System and Societal Costs

Description	Mean Health System Cost per Patient per Year (95% CI) ^a		Mean Societal Cost per Patient per Year ^b	
	A \$ (95% CI)	US \$ (95% CI)	A \$ (95% CI)	US \$ (95% CI)
Mean cost per patient per year	882 (783-982)	599 (532-665)	972 (899-1045)	660 (611-710)
Mean discounted health system cost per patient for 20 y ^c	11 546 (10 263-12 829)	7839 (6969-8710)	12 721 (12 554-14 463)	8637 (8523-9820)

^a The mean cost per patient was calculated for medical procedures (n = 87) based on the microcosting study. The mean capital and salary costs were based on the mean number of patients attending the high-risk clinic in a year (n = 258).

^b Mean based on 3.4 visits per person per year because some surveillance and treatment occurs on the same day.

^c Australian standard discount rate of 5% has been applied to all future costs.

Table 4. Out-of-Pocket Costs for Patients Attending the HRC

Description	Cost per Item, A \$ (a)	No. of Visits in 12 Months (b)	Total		Allocated Cost per Person	
			Cost, A \$ (c) ^a	Cost, US \$ (c) ^a	A \$ (d) ^b	US \$ (d) ^b
Medical Costs^c						
Specialist						
Dermatology consultations	147	2	294	200	2	1
Dermatology follow-up	83	5	415	282	5	3
Surgical consultations	167	4	668	453	8	6
Surgical follow-up	88	5	440	299	5	3
Theater	50	5	250	170	3	2
Pharmacy, mean (range)	6 (13-61)	12	501	340	6	4
Set of total body photographs, annual cost per patient ^d	34	NA	2920	1982	34	24
Total cost	NA	NA	5488	3726	63	43
Travel Costs, Return Trip^e						
Car, mean (range)	162 (9-812) ^c	116	12 503	8490	321	218
Bus, train, or taxi, mean (range)	19 (5-44) ^c	33	551	374	14	9
Airplane	248	4	992	674	25	17
Accommodation in Sydney	140	13	1820	1236	47	32
Total cost	NA	NA	15 868	10 774	407	276
Total patient travel cost^f	NA	NA	35 398	24 034	407	276
Opportunity Cost of Time Not at Work or Lost Personal Time^c						
Opportunity cost per visit, mean (range)	148 (75-324) ^c	295	43 695	29 667	502	341
Total cost	NA	NA	84 581	57 427	972	660

Abbreviations: HRC, high-risk clinic; NA, not applicable.

^a Calculated as $a \times b$.

^b Calculated as c/n .

^c Includes 87 continuing (prevalent) patients.

^d Photographs were obtained once every 7 years.

^e Includes the 39 patients who described the mode of transport to clinic.

^f Based on extrapolation of travel costs for 39 patients to group of 87 patients.

Discussion

The key contributors to the costs of an HRC are labor costs, representing the intensive nature of surveillance, the number of consultations, and the length of time required per patient. The opportunity cost of patients' time away from work and other activities and the cost of travel are the main drivers for indirect costs.

Recommendations regarding optimal screening (before the diagnosis of melanoma) and surveillance (after the diagnosis) vary within international clinical practice guidelines.^{31,32} Although population screening is currently not recommended in most countries, some evidence supports follow-up of high-risk groups using an intensive surveillance strategy.^{33,34} Surveillance of high-risk groups is recommended to continue for lon-

ger periods because primary melanomas arise at a higher probability than for the general population during these patients' lifetimes.³⁴ During the 12-month study period, 34% of the group required an excision of a suspected melanoma lesion and 3 cutaneous melanomas were detected, reflecting the requirement for surveillance.

A systematic review reported significant productivity losses due to the morbidity and premature mortality associated with melanoma.³⁵ Although progress in the treatment of advanced disease has been made, the mean years of life lost owing to metastatic melanoma are greater compared with other cancers (20.4 vs 16.2 years).³⁶ This study quantifies the costs of long-term specialized surveillance in a group with a high probability of future melanoma. The 20-year cost of this model is less than that of other well-established surveillance practices for other cancers^{37,38} and compares favorably with surveillance costs in

the United States for early-stage melanoma⁸ (eTable in the Supplement). In addition, a substantial cost advantage is gained if melanoma is treated at an early stage. A study of total health care and societal costs across 5 years based on 2008 Medicare reimbursements in the mid-Atlantic states estimated the cost of managing an in situ melanoma at US \$5044 compared with the cost of managing a T4b melanoma at US \$110 150.⁸

The model of care assessed in this study uses specialized expertise to maximize the accuracy of melanoma detection at an early stage and to avoid unnecessary excision of benign lesions. However, costs may be lower using other models of care for high-risk individuals, such as primary care practitioners working in general practice or in skin cancer clinics. Barriers for a general practice setting, such as inadequate time to perform full-body skin examinations³⁹ and training in the use of dermoscopy,⁴⁰ would need to be addressed. Research identifying which groups would benefit most from this specialized screening strategy^{41,42} will also improve service efficiency.

A small number of patients had more than 4 excisions within 12 months and some had surgery requiring recovery time, which influences health system and out-of-pocket costs. Hospital admissions would affect health system costs; in our study, however, admission was required for only 1% of patients.

A number of limitations of this study have been identified. Only 1 clinic was observed, and other clinics in different locations may vary in their resource use. Although total costs may differ slightly across clinics for patient management and surveillance, the same protocol recommendations for frequency of skin examination, total body photography, and sequential digital dermoscopic imaging apply to all HRCs in the state; the key contributors to costs we identified would also be applicable in other clinics. Similar principles may be applicable internationally. We did not obtain information from all patients; however, our sample captured consecutive patients whom we believe to be typical of patients attending the clinic. The HRC staff attempted to follow up all reports of excisions performed outside the HRC (eg, by primary care physicians in the community), and these excisions were documented in the medical record. However, a small chance exists that some events may not have been captured. Not all pathologic examination reports were cited; where this occurred, we estimated costs based on the summary reports in the patients' medical records and therefore may have missed costs for additional his-

tologic stains or expert second opinions that would have been detailed in an original report. In this case, we would be more likely to underestimate rather than overestimate the cost of the pathological examination.

We did not calculate the opportunity cost for 4 accompanying adults in this sample because we could not ascertain whether they attended all consultations during the 12-month study period. Finally, we did not calculate lost work days in terms of lost productivity (business cost) because only 1 person in our study had more than 3 consecutive days off work, and this time off was not considered to have a material effect on the overall results. Further research into valuing patient time⁴³ should be considered.

Conclusions

Our study shows that the costs of surveillance for a group of individuals at high risk for melanoma in a specialized HRC can be estimated using microcosting methods. From a health system perspective, the costs of surveillance are driven by the labor costs of the clinic staff and the number of follow-up extended-length surveillance consultations required by these patients. Patients who require more intensive treatment have a greater effect on the overall cost of the program. However, high-risk patients in surveillance programs have been shown to have melanomas detected at an earlier stage compared with high-risk individuals not in a surveillance program.⁴ Costs for their treatment are therefore likely to have been lower than they would have been in standard care. Treatment at an earlier stage also has advantages in terms of decreased morbidity and cost to the community. Calculating costs using a societal perspective further informs the social cost of surveillance in an HRC. In particular, the costs of opportunity forgone and travel reflect the disease burden and the willingness of patients to travel and give up their own time to attend surveillance, indicating the patient's perceived acknowledgment of the benefits of attending the HRC. Results from this study will be used in an economic evaluation of the cost-effectiveness of the specialized HRC model of care for individuals at high risk for melanoma compared with standard care in the community. This study will help to inform health policy for melanoma skin screening and follow-up in Australia.

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