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The effects of a multidisciplinary high-throughput skin clinic on healthcare costs of organ transplant recipients

Running head: Effects of a skin clinic on healthcare costs

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Abstract

Background: A long-term complication among organ transplant recipients (OTRs) is skin malignancies which are associated with level and duration of immunosuppressive treatment, sun exposure and age. Dermatological surveillance is recommended for OTRs at high risk of skin malignancies, but evidence is lacking on the benefits of such services.

Objective: To examine the economic impact on patients and on the hospital service of a multidisciplinary high-throughput skin cancer Clinic in Brisbane, Australia, dedicated to dermatological and surgical care of high-risk OTRs.

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Methods: In a pre-post design, hospital admission and cost data were obtained for 101 consecutively-enrolled study participants from 12 months prior to the introduction of the Clinic (to February 2016), the 3-month 'run-in' period (March to May 2016), and 12 months subsequent (to June 2017). Differences between pre- and post-Clinic hospital costs were tested using non-parametric bootstrapping and interrupted time series analysis. A survey of patient out-of-pocket costs and perceived financial burden was also undertaken during the Clinic.

Results: Overall hospital costs were higher after the Clinic but 3-monthly hospital costs for skin procedures trended downwards. Despite 3-monthly mean hospital visits increasing from 85 to 314, mean 3-monthly costs reduced by AU\$1,491 ($p < 0.001$) indicating greater cost-efficiency. Total patient out-of-pocket costs were AU\$18,377 over 3 months.

Conclusion: Clinical costing data revealed higher, more rapid throughput, and significantly lower per patient costs pre- and post- establishment of a multidisciplinary skin cancer Clinic for OTRs.

Key words: organ transplant, hospital costs, out-of-pocket expenses, financial well-being, cost-analysis

Introduction

Major advances in organ transplantation have seen growing numbers of organ recipients worldwide (1). In the US, there were 34,771 solid organ transplantations performed in 2017 an increase of 23% over the previous decade (2). In Australia, over 10,000 individuals have received organ transplants since 2009, with increasing rates of transplantation due to Australia's program to encourage organ and tissue donations (3). However after transplantation patients require regular, life-long follow-up with extensive use of medical services and resources to address ongoing health needs and maintain improved quality of life (4).

Management of OTRs after the early post-transplant period varies among countries and institutions with aftercare performed by physicians, surgeons and/or general practitioners (4). Clinical practice guidelines recommend outpatient surveillance of OTRs should occur at least every 3-4 months (4). Since the after-effects of transplantation span many health aspects from metabolic disturbances, skin conditions, to cardiovascular conditions, care is ideally multi-disciplinary.

A key long-term complication among OTRs is skin malignancy whose incidence is an order of magnitude higher than in the general population (5). Skin cancers are associated with level and duration of immunosuppressive treatment, sun exposure and age. In Australia, with its high ambient ultraviolet (UV) environment and its population of largely European ancestry, high lifetime UV exposure results in very high keratinocyte cancer risk such that dermatological surveillance and sun protection advice are essential (5) (6). However dermatological care is not integrated into routine follow-up care of OTRs in Australia as it is in other countries (6, 7). This

means that OTRs must follow the usual referral pathways, appointment bookings and waiting times in order to access a hospital dermatologist. The OTR would typically face multiple visits, lengthy delays and inconvenience.

To address this lack, the Princess Alexandra Hospital Transplant Skin Clinic (hereafter 'the Clinic') was established in Queensland, Australia, in March 2016 to provide expert dermatology and surgical care and expedite skin cancer treatments for very high-risk OTRs in the state (8, 9). As part of a broader Clinic evaluation (8, 9), the purpose of this study was to quantify: 1) the financial burden incurred by OTRs for their ongoing related healthcare, and 2) hospital costs related to skin cancer management before and after establishment of the Clinic.

Methods

Study population

All adult OTRs, or those with organ failure, lymphoproliferative diseases and/ or under immunosuppressive treatment who were referred to the Clinic by a specialist (nephrologist, transplant physician and/or dermatologist from the Princess Alexandra Hospital) during the enrolment period December 2016 to May 2017 (Figure1) were eligible to take part (8, 9). Patients were required to comprehend the study requirements and give informed consent. The study was approved by the QIMR Berghofer Human Research Ethics Committee (P2257) and the Metro South Human Research Ethics Committee (HREC/16/QPAH/703).

Transplant skin clinic

The weekly Clinic provides “on the spot” high-throughput treatment of skin cancers for referred patients (9). It is staffed by: 1) a dermatology team (one consultant, multiple specialist trainees); 2) a surgical team (senior surgeon who determines optimal excision procedure, several surgical trainees, and junior doctors assisting); and 3) a transplant team, many of whom cross-participate in the surgical team (10). Plastic surgeons, radiation oncologists, kidney and liver physicians are on call. An average of eight patients are treated per Clinic (10), with any additional complex surgeries booked elsewhere in the hospital .

Study Design

The study used a single group, pre- and post-intervention design for analysis of the administrative hospital admissions and costing data. Hospital data were obtained for all study participants from 12 months prior to the introduction of the Clinic (March 2015 to March 2016), the 3-month ‘run-in’ period when the clinic started (March 2016 to May 2016) and 12 months afterward (June 2016 to June 2017) (Table 1). The study also included a self-administered survey about patients’ personal details, quality of life and out-of-pocket expenses over the previous 3 months (from study enrolment). The personal burden of managing skin cancer was intended to be a snapshot and not a comparative analysis of pre- and post-Clinic time points.

Data Collection

Administrative hospital admission, procedures, and costs: Hospital data were available only from the Princess Alexandra Hospital and no other hospitals patients may have attended. Nor did we collect data on health system costs in private settings. Data were extracted from routine administrative clinical costing datasets and included: hospital admission start and end dates, type of attendance (outpatient, inpatient, emergency), same day admission flag, major diagnostic category, admission ward, principal diagnosis (International Classification of Diseases (ICD)-10 code type and code), morphology (ICD-code), procedures, procedure dates, Australian-Refined Diagnosis Related Groups (AR-DRG) code, actual cost, direct cost, overhead cost, cost centre. The AR-DRG cost 'buckets' for inpatient episodes of care account for doctors' and nurses' time, other health professionals' time, all consumables used in procedures and hospital overheads (See relevant codes, Appendix 1). Specialist consultations in the Clinic were initially voluntary but the dermatologists are now remunerated for their clinic time in the outpatient setting. These costs were not part of this analysis.

Patient self-report: At enrolment, participants completed a self-administered questionnaire covering personal details (age, sex, marital status, occupation, education level, country of birth, ancestry, and general health rating) and medical history, skin type and sun exposure/ protection habits, out-of-pocket costs for skin care (travel, accommodation, treatment costs for skin cancer, sun protection items). Financial well-being was measured using the 11-item validated COmprehensive Score for financial Toxicity (COST)-Functional Assessment of Chronic Illness Therapy (FACIT) or COST-FACIT questionnaire that includes items on financial concerns (eg worry about financial problems, being able to meet monthly expenses,

feeling financially stressed), with Likert responses ranging from 'not at all' to 'very much'.

Analyses

Frequencies and percentages were used to describe categorical variables, and means and standard deviation, for continuous variables. Hospital costs were aggregated and presented by mean per person and mean per admission. As healthcare costs are typically right-skewed, with a few patients having extreme costs, we presented median, minimum and maximum values. Costs were presented in 2016/2017 Australian dollars for inpatient (or admitted patient), outpatient (or non-admitted patient) and total costs. Patients categorised as 'inpatients' undergo formal admission procedures by the hospital, but this is unrelated to the time spent in hospital, hence patients can be admitted and discharged on the same day.

Individual-level pre- and post-Clinic hospital admission and cost data were aggregated into 3-monthly blocks to align with the expected frequency of post-Clinic visits. The resources used for the cost analysis were those for skin lesion/cancer-related services only (Appendix 1). To test the differences between pre- and post-Clinic mean costs and account for skewness ($= 5.07$), 95% confidence intervals (bootstrap percentile interval) were computed using non-parametric bootstrapping analyses with 10,000 replacements (11). Bootstrap analysis was also used to estimate the probability that total post-Clinic costs were lower than pre-Clinic costs.

To further assess the effect of Clinic establishment on total costs we performed a gamma segmented regression analysis using a step and slope change model (12) to account for interaction between time and total post-clinic monthly cost. Personal expenses were aggregated for the total sample and covered the previous 3-month

period from the survey. COST-FACIT scores were calculated according to the scoring algorithm ranging from 0 to 44 with higher scores representing more favorable financial well-being. Analyses were performed using R (13).

Results

Participation rate and description of participants

Of 111 Clinic attendees invited to participate, 101 agreed (91% participation). Most participants were men (78, 77%) with a mean age of 63 years (sd 10), 77 (76%) had British or Irish heritage, 89 were OTRs (79 kidney, 8 liver, 1 lung and 1 heart) and the remaining 12 were awaiting transplantation or had a history of many skin cancers. (14, 15) On average, OTRs were 14 years from their initial transplant and 49 (49%) were on triple immunosuppressive therapy. Non-participants tended to be male (9, 91%) and younger (mean age 55) than participants (Table 2). A large proportion (41%) of OTR participants were considered low income (defined as <AU\$30,000 annual household income), 34 (34%) were in paid work and 56 (56%) had not completed high school. Around half had skin with a tendency to burn on acute sun exposure, nearly one-third had outdoor occupations during their lives and 42 (42%) had outdoor leisure activities.

Personal costs and financial strain

During a 3-month follow-up period, the participants visited the Clinic a median of 2 times (interquartile range 1-3) per person and 224 times in total. The median traveling distance was 40 km (range 5 - 1200). Most traveled by car to the Clinic and

67% incurring parking fees (total for group AU\$1189). Twelve OTRs incurred accommodation fees. Some 28% of employed participants required time off work to attend the Clinic (251 total hours) and 8% of carers required time off work. In total, the out-of-pocket costs for 101 OTRs were \$18,377 for 3 months. These included: a) skin cancer-related services; general practitioner and specialist visits outside the Clinic, excisions, creams, tests, radiation, and medications (AU\$7,074); and b) purchasing sun protection items: sunscreen, broad-brimmed hats, clothing like arm protectors, and sunglasses (AU\$11,303). The mean psychological burden of financial costs measured on the COST-FACIT was 29.6 (SD 9.3). Low-scoring items on the COST-FACIT indicated that patients were most concerned about the future, being unable to contribute at work and concerns about keeping their job and income.

Hospital costs

Both total inpatient and outpatient visits increased in the post-Clinic compared with pre-Clinic period (Table 3). Total costs for skin-related hospital visits showed AU\$220,419 pre-Clinic for 85 visits, AU\$113,083 immediately after the Clinic was established for 54 visits and, AU\$346,196 post-Clinic for 314 visits (Table 3, Fig. 1). Overall cost increases were driven by extreme high-costs of a few plastic surgeries and skin debridement (Table 3, Fig. 2). However, 3-monthly mean and median costs for *inpatient* visits per patient decreased from mean AU\$2,523; median AU\$1,920 before the Clinic to mean AU\$1,654 and median AU\$223 post-Clinic. Similarly, mean and median costs for *outpatient* visits per patient decreased from mean AU\$3,696; median AU\$3,696 before the Clinic to mean AU\$325 and median AU\$286 post-Clinic, despite there being only two pre-Clinic outpatient visits on average (Table 2)

(the Clinic was not then operating formally on an outpatient basis and so patients were admitted for all procedures). Mean 3-monthly costs after the Clinic was established, reduced significantly by AU\$1,491 (95%CI: AU\$1,024, AU\$1,966), $p < 0.001$. Correlation between hospital cost over time (pre- and post-Clinic) was not statistically significant ($p = 0.48$) but post-Clinic cost tended to decrease (Fig. 3).

Discussion

Our study shows economic savings accruing from a dedicated multidisciplinary transplant skin Clinic at a large metropolitan hospital in Australia. Before the Clinic, the estimated annual hospital cost burden for treating skin cancers in OTRs was AU\$220,419. As expected, immediately on inception the Clinic experienced high volumes of all skin-related attendances that then settled to reduced 3-monthly costs consistent with the more rapid throughput, as well as significantly lower per patient costs in the 12 months after the Clinic was established. Total hospital costs for skin procedures were higher overall in the 12 months after the Clinic was established but were trending downwards (June 2016-May 2017) and showed greater cost efficiency than the 12 months before the Clinic started. Higher overall costs were attributed to the additional capacity of Clinic staff to manage many more patients than managing these same patients within usual routine dermatology care. Cost efficiencies were likely driven by the high-throughput nature of the Clinic and the switch to low-cost outpatient care, avoiding the time and resources needed for processing inpatient admissions. We believe the high costs in the or establishment period occurred because patients had not yet attended the transplant skin clinic and were still undergoing slower and more expensive inpatient appointments, given that the new

clinic was at capacity with the influx of first-time patients. With a longer follow-up period, it is possible the costs would continue to decline with less inpatient care. With collaborative care, frequent follow-up will potentially prevent advanced skin cancer disease as it will potentially be caught earlier, further lowering costs.

The clinical benefits of the Clinic have been previously reported (8, 10).

Establishment of the Clinic led directly to more skin cancers being detected and treated consistent with the principle that a dermatology and surgery clinic for OTRs facilitates prompt treatment of skin malignancies and ultimately, should lower skin cancer metastases and fatalities. For the large investment in transplantation to be realised in OTRs' longevity and to minimize patient burden, it is important that they be managed promptly and that their care incorporates sun protection advice (8), early detection and intervention of skin cancers (16).

Our findings indicate that the out-of-pocket costs incurred by patients were substantial in the short-term. This is important since many Clinic patients were on low incomes or not in paid employment. The Clinic offers a 'one-stop shop' for patients that significantly eased the financial burden and delay in skin cancer treatment including when patients previously received this care by their primary care physician or in a private dermatology clinic. During patient interactions with the researchers in the Clinic, patients were very satisfied with the performance of the Clinic and liked attending because they received all their skin cancer treatment at a single visit and could avoid worry while they waited for surgery.(9) One-third of OTRs had their skin cancers surgically treated on the same day and the remaining patients were treated promptly: 50% of patients treated within seven days(9). Some patients

returned for skin treatment in separate visits due to, for example, being unwell, having numerous cancers or because they required more complicated plastic surgery.(9)

Out-of-pocket medical costs are a serious burden for many patients (17, 18), in particular for cancer populations(19, 20) and among those with chronic diseases (14, 15). Similar to our findings, costs for medications and medical services constitute a significant proportion of these personal costs (20) and financial strain has adverse impacts on quality of life (21). Inability to pay for medicines can lead to non-adherence (22) and disengagement with healthy behaviours (23), both of which are essential for optimal self-management in OTRs. While the Clinic offered some relief to patient medical costs via fewer hospital visits, these could be further reduced by providing free sunscreen to patients at the Clinic to encourage and sustain good sun protective practice. An important new insight arising from this study was the concern reported by OTRs for their employment or ability to continue working. This is consistent with other studies of OTRs where the circumstances and clinical demands of living with a graft hinder ability to work and maintain an income, creating a high degree of distress and financial hardship in some cases (24).

Our study is limited by the single-group pre-post design with relatively small numbers of participants. The lack of a control group and a non-randomised approach means confounding cannot be ruled out. However, in our study we enrolled a routine group of OTRs who were very similar to those from a large study of nearly 500 high-risk OTRs attending the Princess Alexandra Hospital.(5) We therefore propose that the findings are reasonably representative of OTRs attending a large metropolitan

specialist centre. There were also no changes to the way administrative data were collected or measured during our study, there were no other interventions that could affect our findings and regression to the mean was minimised with multiple counts of admissions over the period. Costs incurred by other private or public hospitals that patients were likely to use prior to the Clinic were outside the scope of this study and not collected. Therefore, our findings underestimate the full health system burden for managing skin conditions in participating OTRs and would likely exaggerate the cost reductions found post-Clinic. Strengths of this study were the use of administrative data to confirm hospital activities and billings over two years and the use of survey data that collectively provide a broad view of resource use by the hospital and patients respectively. A full economic evaluation would be beneficial to inform decision-makers on whether this service demonstrates cost-effective healthcare and is worthy of broader adoption. This would require comparison of a Clinic and non-Clinic group, and a larger study with longer follow-up, and a sample powered to measure clinical benefits.

Conclusion

The establishment of a proactive multidisciplinary dermatology and surgery skin clinic for OTRs offered patient-centered care and appeared to alleviate the economic and health burden for patients while potentially improving cost-efficiencies in a large public hospital. Further evidence on cost-effectiveness is required to support these findings.

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Table 1: Time periods of data collections

3-month period	Hospital cost data	Patient out-of-pocket data
Mar/May 2015	12 months Pre-Clinic	
Jun/Aug 2015		
Sept/Nov 2015		
Dec/Feb 2016		
Mar/May 2016	Clinic established	
Jun/Aug 2016	12 months Post-Clinic	
Sept/Nov 2016		
Dec/Feb 2017		Baseline survey ¹
Mar/May 2017		

1. The study recruitment period was also the baseline survey period.

Table 2: Participant characteristics and out-of-pocket expenses and financial burden at baseline

	(n=101)
Age (years)	
Mean (sd)	63 (10)
Gender (male)	78 (77%)
Highest level of education	
Did not complete high school	56 (56%)
Completed high school	15 (15%)
Completed trade/technical qualification	20 (20%)
Completed university/college degree	9 (9%)
Travelling distance (home to Hospital) kms	
Mean (sd)	133 (256)
Median (min, max)	40 (5-1200)
Usual mode of transport (n, %)	
Car	68 (67.3%)
Public transport	21 (20.8%)
Both car/public transport or other	12 (11.8%)
Total parking fees	\$1,189
Total public transport fares	\$1,834
Accommodation required (n, %)	
Yes	12 (11.9%)
No	89 (88.1%)
Total accommodation payments	\$760
Financial support (n, %) ¹	
No	78 (77.2%)
Yes: travel subsidy/other	23 (22.8%)
Total financial support	\$1,372
Time off work required?	
No	73 (72.3%)
Yes	28 (27.7%)
Total time off work taken (hours)	251
Partner/carer - Time off work required?	
No	93 (92.1%)
Yes	8 (7.9%)
Partner/carer - Total time off work taken (hours)	124
Costs for skin cancer treatments:	
General practitioner / specialist visits	\$2,495
Removal of skin lesion	\$2,110
Creams	\$1,024
Medical tests or imaging	\$389
Medications	\$856
Radiation or laser	\$0
Other treatment	\$200
Total	\$7,074
Costs for sun protection items	
Yes	68 (67.3%)
Sunscreen	\$1,643
Broad-brimmed hat	\$1,805
Clothing (rashie, arm protector)	\$1,915
Sunglasses	\$4,865
Other	\$1,075
Total	\$11,303
Financial well-being mean score (see below)	
Mean (sd) score	29.64 (9.25)

1. Excludes Government support pensions, aged pension etc.

Table 3: Number and type of hospital visits and costs (\$AU) for skin lesions or cancers, pre-Clinic, Clinic-establishment and post-Clinic (n=101¹)

	Inpatient ²	Outpatient	Total
Pre-Clinic			
3-monthly			
Mean costs (sd)	\$2,523 (\$1,777)	\$3,696 (\$4,871)	\$2,549 (\$1,797)
Median costs (min, max)	\$1,920 (\$941, \$8,760)	\$3,696 (\$252, \$7,141)	\$1,952 (\$252, \$8,760)
Total period (12 months)			
No. visits	83	2	85
Total costs	\$213,026	\$7,393	\$220,419
Clinic-establishment or 'run-in' period			
3-monthly			
Mean costs (sd)	\$2,004 (\$2,377)	\$2,291 (\$7,686)	\$2,094 (\$4,657)
Median costs (min, max)	\$1,672 (\$21, \$9,823)	\$518 (\$65, \$32,110)	\$532 (\$21, \$32,110)
Total period (3 months)			
No. visits	37	17	54
Total costs	\$74,136	\$38,947	\$113,083
Post-Clinic			
3-monthly			
Mean costs (sd)	\$1,654 (\$2,951)	\$325 (\$626)	\$1,129 (\$2,269)
Median costs (min, max)	\$223 (\$37, \$24,959)	\$286 (\$25, \$7,154)	\$278 (\$36, \$13,921)
Total period (12 months)			
No. visits	182	131	314
Total costs	\$302,849	\$42,701	\$346,196

1. The costs of the 12 non-OTRs were no different to the OTRs in the study with respect to direct costs: non-OTRs- median \$357 (min: AU\$ 19 ; max: AU\$14,284) vs OTRs: \$322 (min: AU\$16 ; max: \$28,403), and indirect costs: non-OTRs- median \$50 (min: AU\$6 max : AU\$2,245) vs OTRs: \$50 (min: AU\$1 max : AU\$3,707).
2. Many are same day admissions

Figure 1: Skin lesion/cancer procedures and mean costs pre-Clinic, Clinic establishment and post-Clinic



Figure 2: Cost per patient admission for skin cancer procedures, pre-Clinic, Clinic establishment and post-Clinic (n=101)

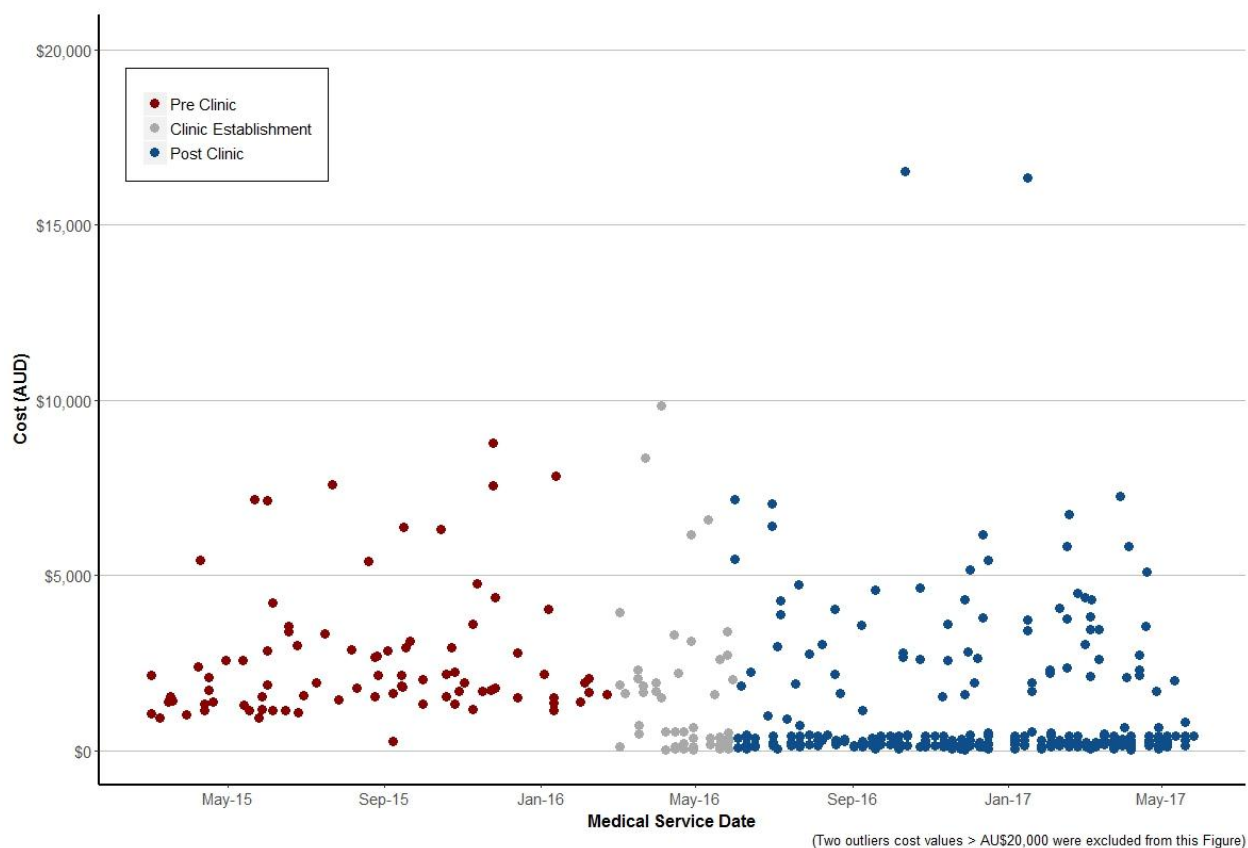
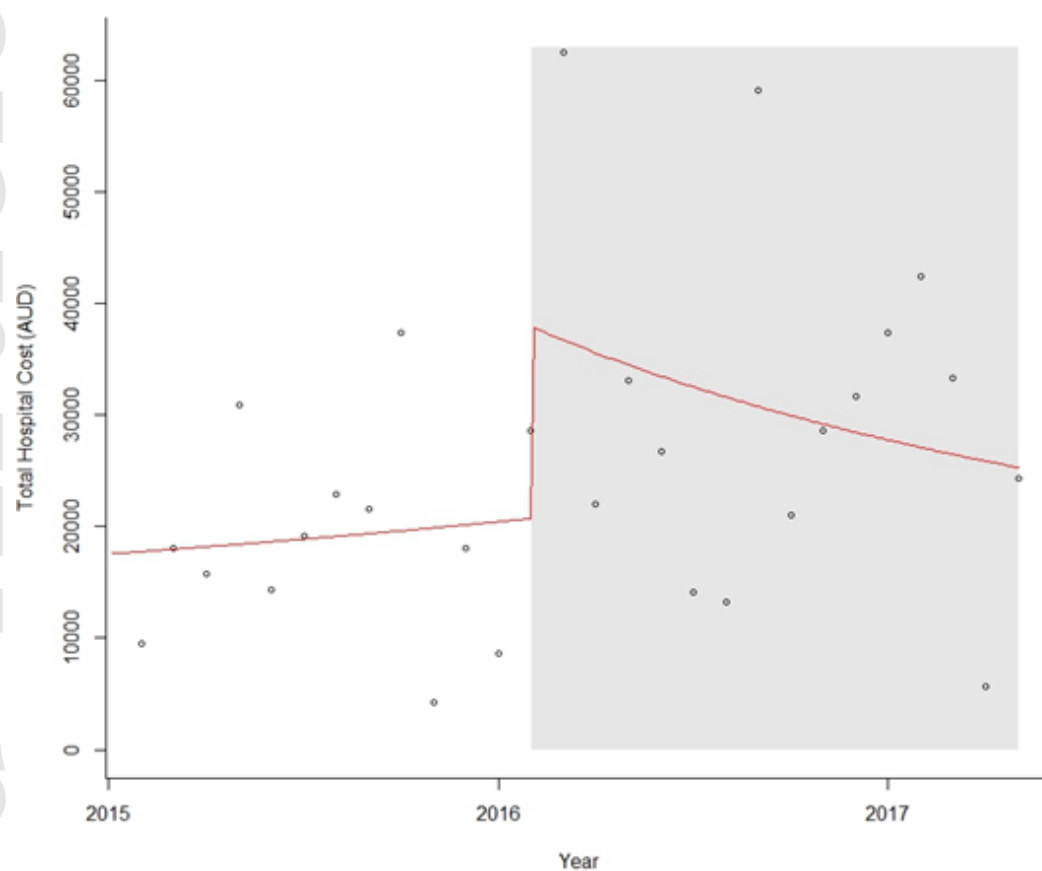


Figure 3: Total hospital cost for skin cancer procedures, pre-Clinic and post-Clinic (n=101)



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Appendix 1: Skin cancer diagnosis and procedure codes included in the analysis

Skin Cancer Diagnosis	
ICD-10 Code	Description
C44.0	Malignant neoplasm of skin of lip
C44.1	Malignant neoplasm of skin of eyelid, including canthus
C44.1	Skin of eyelid, including canthus
C44.2	Malignant neoplasm of skin of ear and external auricular canal
C44.3	Malignant neoplasm of skin of other and unspecified parts of face
C44.4	Malignant neoplasm of skin of scalp and neck
C44.5	Malignant neoplasm of skin of trunk
C44.6	Malignant neoplasm of skin of upper limb, including shoulder
C44.7	Malignant neoplasm of skin of lower limb, including hip
D03.6	Melanoma in situ of upper limb, including shoulder
D04.0	Carcinoma in situ of skin of lip
D04.1	Carcinoma in situ of skin of eyelid, including canthus
D04.2	Carcinoma in situ of skin of ear and external auricular canal
D04.3	Carcinoma in situ of skin of other and unspecified parts of face
D04.4	Carcinoma in situ of skin of scalp and neck
D04.5	Carcinoma in situ of skin of trunk
D04.6	Carcinoma in situ of skin of upper limb, including shoulder
D04.7	Carcinoma in situ of skin of lower limb, including hip
D22.2	Melanocytic naevi of ear and external auricular canal
D22.4	Melanocytic naevi of scalp and neck
D22.5	Melanocytic naevi of trunk
D22.5	Melanocytic naevi of trunk
D22.6	Melanocytic naevi of upper limb, including shoulder
D22.6	Melanocytic naevi of upper limb, including shoulder
D48.5	Neoplasm of uncertain or unknown behaviour of skin
Skin Cancer Procedures	
MBS Code	Description
30023-00	Excisional debridement of soft tissue
30026-00	Repair of wound of skin and subcutaneous tissue of other site, superficial
30071-00	Biopsy of skin and subcutaneous tissue

30189-01	Removal of other wart
30216-02	Other aspiration of skin and subcutaneous tissue
31205-00*	Excision of lesion(s) of skin and subcutaneous tissue of other site
31230-01*	Excision of lesion(s) of skin and subcutaneous tissue of nose
31230-02*	Excision of lesion of skin and subcutaneous tissue of ear
31230-03*	Excision of lesion of skin and subcutaneous tissue of lip
31230-04*	Excision of lesion(s) of skin and subcutaneous tissue of finger
31235-00*	Excision of lesion(s) of skin and subcutaneous tissue of other site of head
31235-01*	Excision of lesion of skin and subcutaneous tissue of neck
31235-02*	Excision of lesion(s) of skin and subcutaneous tissue of hand
31235-03*	Excision of lesion(s) of skin and subcutaneous tissue of leg
31235-04*	Excision of lesion(s) of skin and subcutaneous tissue of foot
45206-03	Local skin flap of ear
45439-00	Small split skin graft of other site
45451-24	Full thickness skin graft of other areas of face
45515-00	Revision of scar of other site <= 7 cm in length
45665-00	Full thickness wedge excision of lip
45665-01	Full thickness wedge excision of eyelid
45665-02	Full thickness wedge excision of ear
46516-01	Removal of fingernail
90665-00	Excisional debridement of skin and subcutaneous tissue
90686-01	Nonexcisional debridement of skin and subcutaneous tissue

Items "*" marked are not listed in the current MBS database:

<http://www.mbsonline.gov.au/internet/mbsonline/publishing.nsf/Content/news-2016-11-01-latest-news-Nov>