

# **The Costs of Skin Cancer to New Zealand**

A report to

The Cancer Society of New Zealand

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By

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# **The Costs of Skin Cancer to New Zealand**

## **Executive Summary**

This report to the Cancer Society of New Zealand has two tasks –

- To estimate the costs of Skin Cancer to New Zealand for the year 2006, updating a report written in 2000 which estimated costs for the year 1998.
- To show how such cost information might be used to carry out cost-effectiveness analyses of proposed interventions to reduce the burden of skin cancer

### Part I The Costs of Skin Cancer

- Skin cancer is by far the most common cancer affecting New Zealanders. There were 18,610 new cancer registrations in 2005. Of these 2,017 were ‘Malignant melanoma of skin’; 10.8 percent of all cancer registrations. Non-melanoma skin cancers are not registered. If, however, an estimated<sup>1</sup> 67,000 new non-melanoma skin cancers per year are added, new skin cancer cases each year total about 69,000; and all new cancers about 86,000. That is skin cancers account for just over 80 percent of all new cancers each year.
- New Zealand melanoma registration rates are of similar magnitude to those experienced in Australia, averaged over all Australian states<sup>2</sup>. Estimated rates for non-Māori New Zealanders are higher still, with New Zealand male rates about equal to all-Australia male rates, and New Zealand female rates higher than Australian female rates.
- Although mortality rates for non-melanoma skin cancers are very low, the large number of cases imposes a significant burden on the health system.
- In 2005 there were 269 deaths from melanoma, and 102 from non-melanoma skin cancers. Together these amounted to 4.7 percent of total cancer deaths of 7,970 in that year. Mortality rates for both melanoma and non-melanoma skin cancers are higher than the corresponding Australian rates.
- These deaths are the most important cost of skin cancer. It is calculated in this report that were it not for skin cancer New Zealanders would have lived an additional 4,741 life-years in 2006.
- In addition these persons if alive would have made an economic contribution through employment of an estimated additional NZ\$66 mn in 2006 (in 2007/08 dollars).

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<sup>1</sup> The reasoning underlying this estimate is given later in this report.

<sup>2</sup> There is considerable variation in rates between Australian states.

- Most skin cancer cases occur among the more elderly. But melanoma has a significantly lower average age of incidence, and mortality, than non-melanoma skin cancers. In 2005 11.9 percent of melanoma deaths were of persons aged under 45, compared with none for non-melanoma skin cancer, and 4.6 percent for all cancer deaths.
- Female skin cancer incidence rates are considerably lower than those of males, and female mortality rates about half those of males.
- The health-care costs of skin cancer and related neoplasms to New Zealand are estimated in this report at NZ\$57 mn for the year 2006, measured in 2007/08 prices, excluding GST. For comparison the estimated annual health-care costs in 1998, including related neoplasms, were \$33.4 million in 1998/99 prices, (O’Dea, 2000).
- These health-care cost estimates should not be regarded as very precise. They are more likely on the conservative side than otherwise. Good statistics are available for in-hospital care, but not for other components of health-care, particularly specialist health-care provided by dermatologists, plastic surgeons, and hospital oncology departments. The NZ Ministry of Health has been working on filling some of these information gaps, and it is desirable that this work be continued and extended. It would be of help also to have more comprehensive information on Lab Test results for suspect skin lesions. This report has relied on relatively old (1998) data-sets for one region (Bay of Plenty) for parts of the estimates.
- Also use has been made of Australian work in this field in calculating the New Zealand estimates. While helpful, is not ideal to use extrapolations from Australian data for calculations of New Zealand costs.
- The following table summarises the estimates –

**Summary Table**  
**Costs of Skin Cancer and Related Conditions to New Zealand**  
**2006.**

NZ\$ in 2007/08 prices.

	<b>Melanoma</b>	<b>Non-melanoma (incl. related neoplasms)</b>	<b>Total</b>
Lost life-years	3,811	930	4,741
Health-care Costs (NZ \$mn; excl GST)	\$5.7 mn	\$51.4 mn	\$57.1 mn
‘Lost Production’ (NZ \$mn)	\$59.3 mn	\$ 6.7 mn	\$66.0 mn

Note that Health-care Costs include \$11.6 million for ‘related neoplasms’.

- The annual economic costs to New Zealand of skin cancer amount therefore in 2006 to NZ\$123.1 million, in 2007/08 prices. The magnitude of these costs, and of the deaths and ill-health caused by skin cancer, show the importance of maintaining and improving preventive, early diagnosis, and treatment measures.
- To the amounts in the table could also be added ‘preventive’ expenditures. These include outlays of over \$2 million annually on community preventive measures, by organisations and agencies such as the Cancer Society and the Health Sponsorship Council. Additionally there are many millions spent annually by New Zealand households on sun protection measures, such as sunscreen, sunhats and other protective clothing<sup>3</sup>. Sunscreen purchases are substantial. Data supplied to the Cancer Society by AC Nielsen Ltd show supermarket sales of sunscreen for the six months to 22<sup>nd</sup> March 2009 to have been \$10.6 million, and \$9.7 million for the same period a year earlier (sales in remaining months are minimal). Some of these outlays would be, however, to avoid the unpleasantness of sunburn rather than, or as well as, consciously reducing skin cancer risk.

## Part II Cost-effectiveness analyses, and an appropriate template

- In this part of the report the criteria for a well-carried-out economic evaluation are discussed, and a template provided.
- The cost information derived in Part I could be used in such a template, with appropriate tabulation of unit costs by age-group and gender.

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<sup>3</sup> Purchases of protective clothing can be regarded, however, as substituting for normal clothing purchases.



## **The Costs of Skin Cancer to New Zealand**

### **1. Purposes of this report**

This report has two parts:

- Part One demonstrates the importance of skin cancer as a condition affecting large numbers of New Zealanders, and requiring substantial health-care resources.
- Part Two develops a template for use in assessing the cost-effectiveness of proposed preventive programs.

The first objective requires the construction of so-called ‘cost of illness’, or ‘burden of disease’, estimates for skin cancer. This is done in this report for the year 2006, updating estimates for the year 1998 in an earlier report by the same author (O’Dea, 2000).

The second objective goes a stage further. Suppose we have a proposed intervention that is expected to either reduce the incidence of skin cancer, or lead to its earlier detection and treatment. The objective of the proposed template is to illustrate how the cost estimates given in this report might be used in combination with estimates of the effectiveness of the proposed intervention to calculate its expected cost-effectiveness, and hence to give guidance on the best use of resources for such purposes.

Useful guidance on this second objective is provided by Sophy Shih’s recent (2008) technical report on economic evaluation of the Australian SunSmart programmes. A general economic evaluation protocol is given in the ACE-Prevention paper by Vos et al (2007).

## **Part One: The Costs of Skin Cancer**

### **2. Background**

Skin cancers are not, apart from melanoma, commonly regarded as being among the more serious cancers. They are, however, by far the most common cancer, accounting for three quarters or more of all cancers. For this reason the treatment costs for skin cancers are greater in magnitude than might generally be expected. Australian analyses have identified non-melanoma skin cancers as, in 2000-01, having the highest treatment costs of all cancers, ahead of colorectal and prostate cancer (AIHW 2005. Table 3.2. Page 27.).

Skin cancers are classified into –

- Melanoma (ICD-10 code C43);
- Non-Melanoma (ICD-10 code C44); of which by far the two most common types are
  - Basal Cell Carcinoma (BCC)
  - Squamous Cell Carcinoma (SCC)

Since the Cancer Registry Act 1993 came into force from 1 July 1994, new cases of melanoma are required to be reported to the Cancer Registry, along with almost all other cancers. Prior to that, melanoma cases were seriously under-registered, as, unlike other cancers, most melanoma cases are not admitted to hospital, removing this source of notification. (Ministry of Health, 2002. Page 233; Sneyd and Cox, 2006).

Registration is not required, however, for non-melanoma skin cancers. This leads to differences in approach in the statistical analyses below for melanoma and non-melanoma skin cancers.

Melanomas are much less frequent than non-melanoma skin cancers, but have a significantly higher mortality rate. Non-melanoma skin cancer is by far the most common of all cancers, although with a very low mortality rate. Australian estimates (Mathers et. al., 1998b, page 9) are that over three quarters of all new cancer cases in that country each year are non-melanoma skin cancers; whereas only about 2 percent are melanomas. That is, nearly four out of every 5 new cancers diagnosed is skin cancer. A similar proportion is shown below to hold for New Zealand.

Although non-melanoma skin cancer is the most common cancer, the relative simplicity of treatment in most cases means that its prevalence and treatment are poorly covered in the standard health sector statistical sources in New Zealand.

### 3. Skin Cancer Incidence, Mortality and Hospitalisation.

#### 3.1 Incidence

This section examines incidence data (registrations for melanoma; other sources for non-melanoma skin cancers). This is done first for melanoma, followed by a comparison of Australian and New Zealand melanoma rates. Then estimates are derived for non-melanoma skin cancers, and again compared with Australian estimates.

##### *Melanoma incidence*

Information on new melanoma registrations is given in Table 3.1. Registrations have recently numbered around 2,000 per year. Note that earlier numbers up to 1994 (not shown here) are under-counts. After adjusting for this, Ministry of Health analysts (2002) estimated that by 1996 the male incidence age-standardised rate had increased more than seven-fold since 1956, and the female rate four-fold. Around half of the increase in numbers of cases over this period were accounted for by these increases in incidence rates. Demographic trends – an ageing population primarily – accounted for a further similarly-sized increase in numbers of cases.

The rates given are age-standardised. Age-standardisation has switched in recent years from use of Segi's world population to the WHO world standard population model instead. Because of their different age structure results on the two methods are not comparable.

**Table 3.1 Melanoma Registrations. New Zealand. Numbers and age-standardised rates.**

Year	<u>Male</u>		<u>Female</u>		<u>Total</u>	
	Number	Rate	Number	Rate	Number	Rate
2000	818		842		1,660	
2001	869		888		1,757	
2002	933		909		1,842	
2003	962	40.3	892	35.1	1,854	37.4
2004	949	38.8	947	36.0	1,896	37.1
2005	1,107	44.3	910	34.3	2,017	38.8
2006 (prov.)	1,057	44.3	925	35.2	1,982	39.2

Notes: Rates are per 100,000 population. Starting with its 2005 publication NZHIS has age-standardised rates to the WHO World standard population (2000) model. Population denominators are Estimated NZ Resident Population as at 31 December of each year.

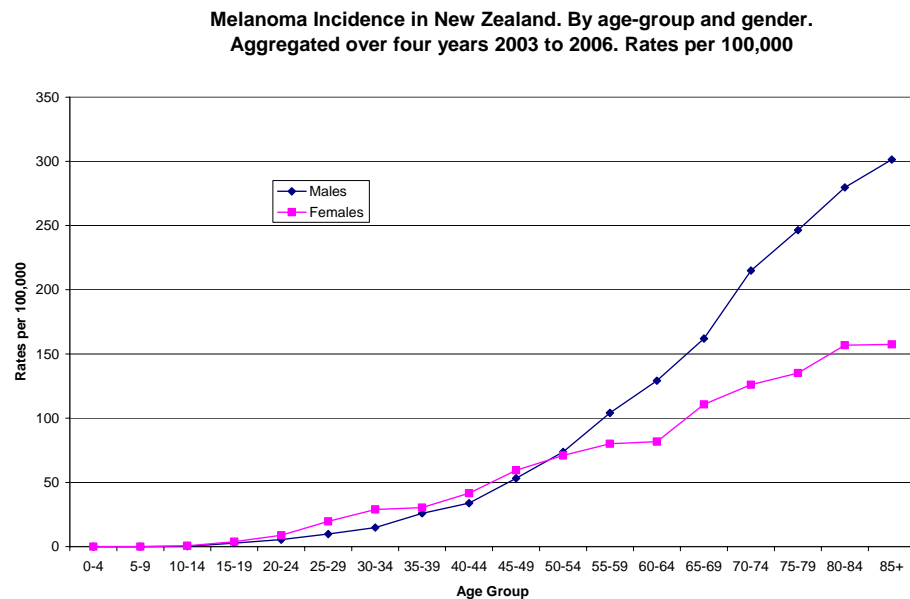
Source: *Cancer: New Registrations and Deaths*. NZHIS.

### *Melanoma incidence rates by age and gender*

Table A.1 in Appendix A gives incidence rates by age-group and gender, aggregated over the four-year period 2003 to 2006. The table is the source for Figure 3.1 here which displays the rates by gender and age-group. Points of interest in the chart are that –

- Incidence increases with age for both genders
- Rates for men and women are similar until 50-54 years old, after which they diverge with markedly higher incidence for males, so that by the 85+ age-group male rates are double female rates.
- The ratio of incidence in younger compared to older people is greater in melanoma than non-melanoma skin cancer (and than many other cancers also, as will become apparent from the corresponding figures for non-melanoma skin cancers below. Melanoma registrations occur from age-group 10-14 and older.
- The crude incidence rate (2003-2006) for all ages and sexes combined, is 47.2 per 100,000. The crude rate for men is 50.6, and the crude rate for women is 43.8, per 100,000. Corresponding age-standardised rates are given in Table 3.2.

**Figure 3.1. Melanoma Incidence in New Zealand by Age-Group and Gender.**



Source: Appendix A, Table A.1. From NZHIS Cancer publications.

*International comparisons – Melanoma incidence.*

New Zealand and Australia have the unwelcome distinction of possessing by far the highest melanoma incidence rates in the world, around triple or more the rates in other countries, including Europe and the Americas<sup>4</sup>. Table 3.2 gives annual age-standardised incidence rates per 100,000.

**Table 3.2 Melanoma incidence rates. Australia and New Zealand**  
Per 100,000, age-standardised to World Population

	<u>Males</u>	<u>Females</u>	<u>Both</u>
Australia 2003	44.2	31.0	37.1
New Zealand 2003-06	41.2	34.4	37.4

*Sources:* Australian rates AIHW 2007. Tables 2.1 plus.  
New Zealand rates NZHIS publications, plus author’s age-standardisation calculations.

On these numbers Australia had the world’s highest rate for males, and New Zealand for females. The difference for the genders combined is not statistically significant.

*Trends in New Zealand’s melanoma incidence rates over time*

The chart below uses age-standardised melanoma incidence rates for New Zealand calculated in the recent paper by Richardson et al. 2008. The age-standardisation is to the WHO world population. The initial two years of the series, 1994 and 1995, should be treated with caution: 1994 because compulsory registration of melanomas applied only from July of that year; and 1995 because there is reason for believing that some of the registrations in that year were ‘catch-ups’ from earlier years. 95% confidence intervals calculated in recent years by Richardson et al are approximately  $\pm 1.7$ . That is, for the 2004 value of 37.2 per 100,000, the 95% confidence interval is from 35.5 to 38.9 per 100,000.

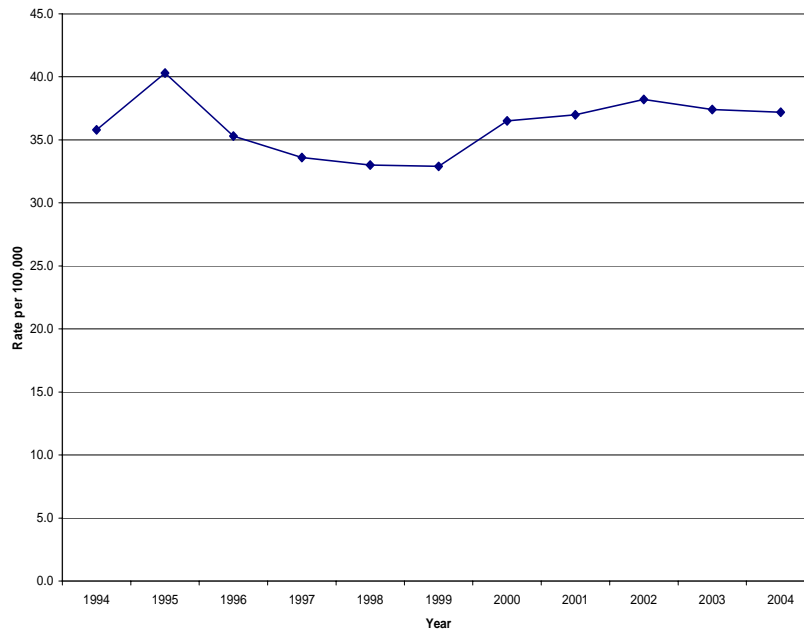
The increase over the period 1996 to 2004 appears statistically significant<sup>5</sup> for the series as a whole. The rate increased from 35.3 in 1996 to 37.2 in 2004; or by over 5 percent. Most of the increase occurred in the year 2000.

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<sup>4</sup> Heal et al. 2008, cite age-standardized incidence rates per 100 000 for cutaneous melanoma (CM) of 40.5, 13.3 and 6.1 for men, and 31.8, 9.4 and 7.7 for women in Australia, the U.S.A. and the U.K., respectively.

<sup>5</sup> Fitting a simple linear trend equation to the rates from 1996 to 2004 gives a statistically significant upwards trend (p-value of 0.02)

**Figure 3.2** Age-standardised melanoma registration rates. New Zealand. 1994-2004



### *Non-melanoma skin cancers (NMSC) incidence*

Non-melanoma skin cancers are not required to be registered. Information about the incidence of NMSC is therefore much more limited than for other cancers. What follows draws on results from earlier work (O’Dea 2000) on laboratory test results in 1998 for the Bay of Plenty in New Zealand. Two strong assumptions are made: that the Bay of Plenty is reasonably representative of New Zealand as a whole; and that rates based on 1998 data still hold good.

Non-melanoma skin cancers, or skin lesions suspected of being such, if limited in extent, may often be treated immediately by a general practitioner, typically by excision. Or the patient might be referred immediately to a dermatologist. Probably in most cases the excised lesion is sent to a community laboratory for histological testing. It is this laboratory test which confirms whether or not the lesion is a non-melanoma skin cancer.

For the earlier report on skin cancer costs by this author (O’Dea, 2000), use was made of a tabulation of the results of such tests conducted by MedLab Bay of Plenty in 1998. The advantage of this tabulation was that the results were for the one laboratory covering an entire well-defined region, with no ‘interloping’ by competing community laboratories. A similar but more up-to-date tabulation was obtained for the Bay of Plenty plus Lakes DHBs as this report was being completed, but analyses have still to be carried out, and will be reported separately. In default the age-gender rates from the earlier report have been assumed to still hold reasonably accurately, and have been applied to the current population<sup>6</sup>. A further point to note is that the Bay of Plenty population has a higher than average proportion Māori. The possible effect of the ethnic composition of New Zealand’s population on skin cancer rates is discussed below.

The detail of the calculations using these 1998 numbers is given in Appendix B, with only summary numbers discussed below. Note that a proportion of the patients in the Bay of Plenty data-base had more than one lesion tested, and both the number of patients (for measuring incidence) and the number of laboratory tests (for measuring costs) are relevant.

As part justification for applying skin cancer rates for one region to the whole of New Zealand, it was found that the melanoma incidence rates from the 1998 Bay of Plenty tabulations, when applied to the New Zealand population at that time, gave results matching closely to the 1998 total of New Zealand-wide melanoma registrations.

Table 3.3 gives the results of the calculations from applying Bay of Plenty 1998 rates for Basal Cell Carcinoma (BCC) and Squamous Cell Carcinoma (SCC) to the 2006

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<sup>6</sup> The Australian reviewer of a draft of this report points out that “the assumption of the 1998 Bay of Plenty NMSC rates adequately representing for all New Zealand in 2006 is questionable due to a considerable time gap.” In Australia NMSC incidence rates are still increasing over time, even in Victoria with a comprehensive SunSmart program.

Estimated Resident New Zealand population. Substantial numbers of non-malignant keratoses were also diagnosed, and are also included here<sup>7</sup>.

**Table 3.3: Estimated numbers of NMSCs and keratoses.  
New Zealand 2006. Based on Bay of Plenty data.**

**Estimated annual skin cancers diagnosed in NZ in 2006  
using Bay of Plenty 1998 rates**

<b>(a) Positive Test results</b>				<b>Ratio</b>
	<b>Male</b>	<b>Female</b>	<b>Total</b>	<b>Tests:Persons</b>
Basal Cell Carcinoma	32,804	21,689	54,706	1.25
Squamous Cell Carcinoma	14,759	10,349	25,214	1.09
Keratoses	12,895	14,366	27,275	1.10
<b>(b) Persons diagnosed</b>	<b>Male</b>	<b>Female</b>	<b>Total</b>	
Basal Cell Carcinoma	25,909	17,841	43,911	
Squamous Cell Carcinoma	13,536	9,476	23,117	
Keratoses	11,610	13,260	24,894	

Source: Bay of Plenty 1998 gender age-group rates applied to estimated resident 2006 mid-year NZ population. See Appendix B.

Notes: Total includes around 300 cases where gender not recorded 'In situ' carcinomas not included.

The number of positive biopsies on these calculations exceeds the number of persons diagnosed; by about 25 percent for BCC and nearly 10 percent for SCC and keratoses. A proportion of patients are having two or more lesions tested.

In summary, when one applies the Bay of Plenty 1998 incidence rates to New Zealand as a whole, the following numbers of people were expected to be diagnosed with BCC, SCC, or keratoses, in 2006<sup>8</sup>.

- 43,900 cases of Basal Cell Carcinoma
- 23,100 cases of Squamous Cell Carcinoma
- making a total of 67,000 new cases of non-melanoma skin cancer each year;

<sup>7</sup> Though a NZ reviewer comments that "They should not be included. There are many sorts of keratoses, and only 1 is associated with sun damage." Also, "In situ" carcinomas are not included in the following table, and keratoses are not even "in situ".

<sup>8</sup> Some persons could have both SCC and BCC. Re-excisions and recurrences will also be included.



- plus about 25,000 actinic Keratoses and pre-cancerous Solar Keratoses each year.

(The corresponding numbers of lab biopsies are 55,000 and 25,000, totaling 80,000 positive tests for NMSC, and 27,000 keratoses.)

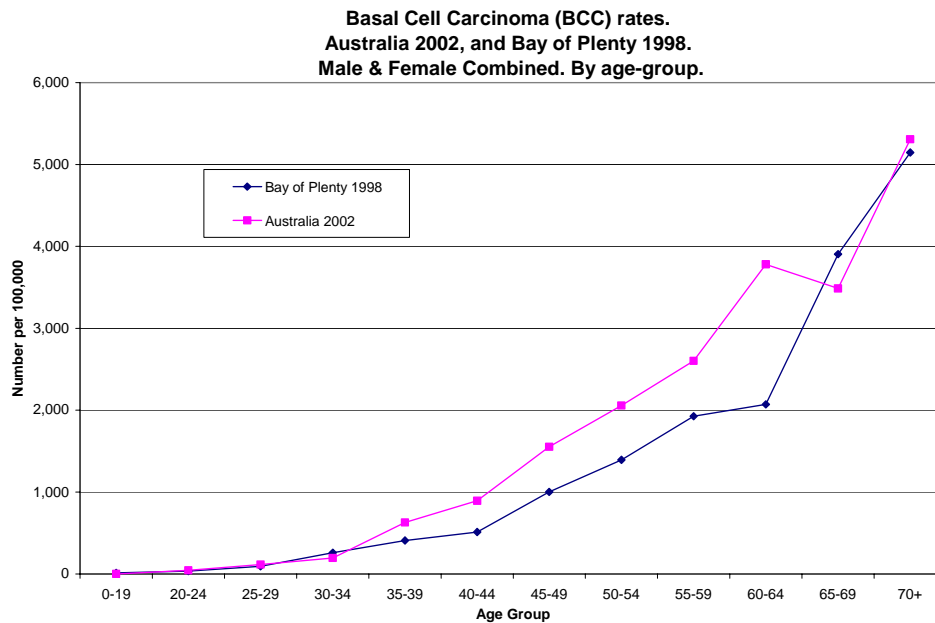
In addition, from routinely collected cancer registration data for the whole of New Zealand, approximately 2,000 persons were diagnosed as having skin melanoma.

***NMSC incidence comparisons – Australia and New Zealand***

An estimated 374,000 new cases of NMSC were treated in Australia in 2002. (AIHW, 2008. Table 1.1) Dividing by 5, the approximate ratio of total populations, this would equate with a number of 75,000 cases in New Zealand, compared with the estimate of 67,000 given above. The agreement is reasonable.

Figures 3.3 and 3.4, from Table B.3 in Appendix B, compare the estimated New Zealand NMSC age-group rates for Basal Cell Carcinoma and Squamous Cell Carcinoma, genders combined, with the published Australian rates. For both BCC and SCC the age-specific incidence curves rise more steeply than for melanoma. Australian rates are higher than the Bay of Plenty rates, except in the oldest age-groups from 65-69 onwards.

**Figure 3.3. Comparison of Australian and Bay of Plenty age-specific incidence rates for Basal Cell Carcinoma.**



**Figure 3.4. Comparison of Australian and Bay of Plenty age-specific incidence rates for Squamous Cell Carcinoma.**

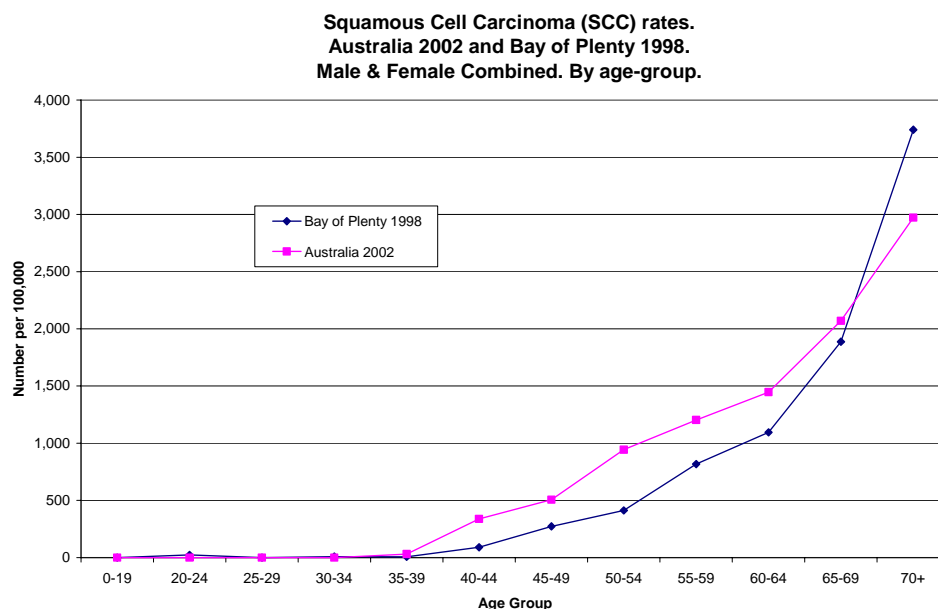


Table 3.4 provides a comparison of age-standardised Australian and Bay of Plenty rates. The rates are universally higher for males than for females, as was the case for melanoma also. Australian rates of incidence for BCC are about 25 percent higher than for the Bay of Plenty, and about 15 percent higher for SCC. For non-melanoma skin cancers overall the Australian rate is 22 percent higher<sup>9</sup>.

**Table 3.4 Age-standardised incidence rates for NMSC for Australia and Bay of Plenty.**

Per 100,000, age-standardised to World Population

	<u>Males</u>	<u>Females</u>	<u>Both</u>
<b><i>Basal Cell carcinoma (BCC)</i></b>			
Australia 2002	1,151	825	977
Bay of Plenty NZ 1998	974	612	781
<b><i>Squamous Cell Carcinoma (SCC)</i></b>			
Australia 2002	561	323	432
Bay of Plenty NZ 1998	492	278	377
<b><i>Total non-melanoma skin cancers (NMSCs)</i></b>			
Australia 2002	1,712	1,148	1,409
Bay of Plenty NZ 1998	1,466	890	1,158

*Sources:* Australia AIHW 2008. Table 1.1. Page 3.  
NZ Bay of Plenty tabulations 1998;  
plus author's age-standardisation calculations.

<sup>9</sup> An Australian reviewer of a draft of this report comments that "There are variations in Australia ... NMSC incidence in Queensland is about two times higher than the incidence in Victoria."

### 3.2 Mortality

Table 3.5 provides mortality data for recent years.

**Table 3.5. Number of deaths from melanoma and non-melanoma skin cancers in New Zealand.**

**2000 - 2005**

Number.

<b>Year</b>	<i>Melanoma</i>		<b>Total</b>
	<b>Males</b>	<b>Females</b>	
2000	155	98	253
2001	156	88	244
2002	149	86	235
2003	174	111	285
2004	152	97	249
2005 <sup>10</sup>	156	113	269

<b>Year</b>	<i>Non-Melanoma Skin Cancers</i>		<b>Total</b>
	<b>Males</b>	<b>Females</b>	
2000	51	35	86
2001	62	34	96
2002	71	40	111
2003	85	30	115
2004	48	37	85
2005 <sup>11</sup>	68	34	102

Sources: NZHIS annual reports. *Cancer: New Registrations and Deaths*; and *Mortality and Demographic Data*.

Since 2000, deaths have numbered about 250 per year from melanoma, and about 100 per year from non-melanoma skin cancers. New Zealand age-group by gender average annual mortality rates for melanoma and NMSC are tabulated in Appendix A for 2002-04.

Summary age-standardised rates for New Zealand are compared in Table 3.6 with corresponding Australian rates.

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<sup>10</sup> Provisional.

<sup>11</sup> Provisional.

**Table 3.6 Skin Cancer age-standardised mortality rates. Australia and New Zealand compared.**

Per 100,000, age-standardised to World Population

<i>Melanoma</i>			
	<u>Males</u>	<u>Females</u>	<u>Both</u>
Australia 2003	5.8	2.5	4.0
New Zealand 2002-04	6.5	3.2	4.7
<i>Non-melanoma skin cancer NMSC</i>			
	<u>Males</u>	<u>Females</u>	<u>Both</u>
Australia 2003	1.9	0.6	1.1
New Zealand 2002-04	2.6	0.9	1.6

*Sources:* Australian rates AIHW 2007. Tables 2.1 plus.  
New Zealand rates NZHIS publications, plus author's age-standardisation calculations.

It is noteworthy that New Zealand's mortality rates are consistently higher than those of Australia.

### 3.3 Influence of ethnic composition on Australia-New Zealand comparisons

The influence of the ethnic composition of New Zealand's population is of interest, both as it relates to trends over time in skin cancer incidence, and to comparisons of New Zealand rates with Australian rates. The issue has recently had some debate in *The New Zealand Medical Journal* (Richardson et al 2008; Shaw 2008; and a response on behalf of the authors of the first paper, Sneyd et al., 2008). It is apparent from that discussion that it is important to be precise about definitions of 'ethnicity'.

New Zealand Māori (inclusive or 'prioritised' definition) were 14.9 percent of the population in 2006 (another seven percent are of Pacific Island descent, but here we focus entirely on Māori). Skin cancer is rare among Māori, though not totally unknown (see following section). Incidence and mortality rates calculated for the entire population will, therefore, be under-estimates for the non- Māori population.

Table 3.7 gives estimated non- Māori age-standardised rates<sup>12</sup>. Because the Māori population is on average considerably younger than the non-Māori population the calculations are not simply a matter of reducing the denominator population by 14.9 percent (and increasing rates by 17.5 percent). Instead age-group rates have to be adjusted individually for each age-group, before age standardisation. That has been done for the estimates here. The population data are the Estimated Resident

<sup>12</sup> Non- Māori here include all persons other than those defining themselves as Māori.

Population numbers as at June of each year, published by Statistics NZ for years since 1991.

**Table 3.7 Estimates of New Zealand non-Māori age-standardised incidence rates.**

		<b>Per 100,000 population</b>		
		<b>Males</b>	<b>Females</b>	<b>Both</b>
<b>Melanoma incidence</b>				
2003-06	Total NZ	41.2	34.4	37.4
	Non- Māori	44.8	38.3	41.1
	% change	+8.9%	+11.2%	+10.1%
<b>Melanoma mortality</b>				
2002-04	Total NZ	6.5	3.2	4.7
	Non- Māori	7.0	3.5	5.1
	% change	+7.6%	+8.6%	+8.2%
<b>NMSC mortality</b>				
2002-04	Total NZ	2.6	0.9	1.6
	Non- Māori	2.8	0.9	1.7
	% change	+4.6%	+4.5%	+4.9%

The effect of the ethnic adjustments is to increase melanoma incidence rates by around 10 percent, melanoma mortality rates by around 8 percent, and NMSC mortality rates by around 5 percent.

On this basis the age-standardised melanoma incidence rate for non- Māori males is approximately equal to that of all Australian males (Table 3.2); and the non- Māori female rate further in excess of the all Australian female rate.

These calculations, and conclusions, should be treated with caution. The implicit assumptions are that, for New Zealand, Māori do not suffer any skin cancer<sup>13</sup>, and the Asian and Pacific ethnic groups experience the same rates as the ‘European’ (non-Māori, non-Pacific, non-Asian) population. And that the ethnic composition of the Australian population can be equated with that of New Zealand non- Māori. All these assumptions would be interesting to explore further.

For future research it would also be of value to obtain information on patients’ skin colour, (either from the Cancer Registry or, more practically, from specific surveys) in addition to data on ethnicity. Such information would be useful for analyses of the relationship of skin cancer incidence to skin colour. It could be useful also for investigating possible links of skin colour to the incidence of other cancers, perhaps connected with Vitamin D levels. There is evidence that higher Vitamin D levels are associated with ‘lighter’ skin colours as well as with increased sun exposure. Also

<sup>13</sup> To the extent they do, Māori cases should also be excluded from numerators.

there has been considerable recent discussion on possible inverse associations between Vitamin D levels and the incidence of certain cancers, particularly colorectal cancer<sup>14</sup>. There is an interesting discussion on this and other matters relating to ‘skin colour’ in New Zealand in Callister (2008).

### 3.4 Potential Years of Life Lost

Average age at death from melanoma ranged from 66 years to 69 years for the three years 2002 to 2004, with the female average being a little higher. There was of course wide variation about this average, with a significant number of melanoma deaths being in the younger adult age-groups. (As would be expected, average age at registration was lower than average age at death, around 60 years, but now with the female average lower than the male average). For non-melanoma skin cancer the average age at death was higher, around 78 years.

One approach to measuring the ‘mortality burden’ of skin cancers is to use these mortality data to estimate the Potential Years of Life Lost (PYLL) on average per death. The latest comprehensive New Zealand 2000-2002 Life tables have been used to construct the estimates in Table 3.8 below. These show the years which persons dying of skin cancer would otherwise have lived, assuming average life expectancies. Non- Māori life expectancies have been used on this occasion, for two reasons. First because the Māori incidence of skin cancer is very low<sup>15</sup>, and therefore non- Māori expectancies are more appropriate for measuring mortality burden. The second reason, of broader ethical relevance, is that non- Māori expectancies better represent the potential achievable by all ethnic groups combined when inequalities in life expectancies are eliminated to the fullest possible extent. (No adjustment has been made to life expectancies for the effect of removing skin cancer as a cause of death. Life expectancies would be increased slightly by the deletion of this cause of death, but the effect would be tiny.)

In the 2000 report it was estimated that an average overall of 17.4 years were lost per skin cancer death. The later numbers tabulated here show a reduction, of the order of two years per death. The reduction, part of which will reflect an aging population, would be larger still if it were not for the switch from Total population in the earlier report to Non- Māori life tables in this report.

It is worth noting that skin cancer prevention programs have more impact on the younger age groups. This is apparent in the Australian numbers discussed by Shih (2008). Older people will benefit less, because their exposure to risk has largely already occurred. Thus, for cost-effectiveness calculation purposes, gains in life-years saved per death prevented could well be higher than the averages given in the table.

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<sup>14</sup> These matters are discussed in Scragg (2007), and IARC (2008).

<sup>15</sup> There were 22 Māori cases of melanoma registered in 2005, 12 males and 10 females; and six melanoma deaths recorded, four males and two female. That is, about one percent of melanoma registrations, and 2 percent of melanoma deaths. The Māori population (all those reporting some Māori ethnicity) in 2006 was 15 percent of total population. *Cancer. New Registrations and Deaths. 2005*; NZHIS 2008. Page 41.

**Table 3.8. Potential Years of Life Lost per Skin Cancer Death.  
New Zealand. 2002 to 2004**

	Average Years lost per Death		
	2002	2003	2004
<i>Melanoma</i>			
Male	17.9	16.0	17.0
Female	20.0	18.3	18.1
Total	18.7	16.9	17.4
<i>Other skin cancers</i>			
Male	9.6	9.9	9.7
Female	9.7	8.5	10.0
Total	9.6	9.5	9.9
<i>All skin cancers</i>			
Male	15.2	14.0	15.2
Female	16.7	16.2	15.9
Total	15.8	14.8	15.5

Sources: NZHIS mortality data, and 2000-02 NZ Life Tables, non- Māori

### **3.5 Estimated current ‘prematurely dead population’ caused by past skin cancer deaths.**

For ‘cost of illness’ estimates of ‘Lost Production’ caused by premature mortality it is convenient to work in terms of the population that has died, but would still be alive if there had been no skin cancers.

Details of the calculation of this ‘prematurely dead population’ or ‘missing population’ are given in Appendix C. Table 3.9 summarises the results. Note that the calculations assume that current mortality rates would also have applied in past decades. In fact historic rates appear to have been lower, which would lead to some over-statement in the estimates below. However the concentration of skin cancer deaths in the older age-groups means the effect is unlikely to be too significant.

**Table 3.9 Estimated ‘prematurely dead population’ in 2006, because of skin cancer.**

	Males	Females	Total
<i>From Melanoma</i>	2,301	1,510	3,811
<i>From other skin cancers</i>	622	307	930
<b>All</b>	2,923	1,817	4,741
Percent	61.7	38.3	100.0

Source: Appendix C calculations

In other words an additional 4,741 people on average would have been alive in 2006 were it not for skin cancer. Equivalently, the results mean that 4,741 life-years were lost to society in 2006 because of the existence of skin cancer in years prior to and including 2006.

This human loss is the major cost of skin cancer. It is possible to put a \$ value on each life-year. A conceivable range would be from around a very conservative estimate of \$20,000 per life-year, which would be a reasonably acceptable value in the eyes of Pharmac; to between \$100,000 and \$150,000 per life-year, based on Transit NZ calculations of the value of a ‘statistical life’ – currently about NZ\$3 million – and a discount rate of the order of 3.5 percent. Higher discount rates would require higher values still.

The estimates in Table 3.9 also allow calculation of ‘lost production’ – that is the extra productive contribution that would have been made to society by the ‘missing population’. This is elaborated on in the subsequent section on non-Health-care costs.

### 3.6 Hospital skin cancer discharges

Table 3.10 gives counts for publicly-funded hospital discharges for skin cancers and related conditions for the four years 2004 to 2007 as extracted from a data-set supplied by NZHIS, with 2007 being the latest year for which the data were available. For convenience the related conditions are included in this and following tables, though they are not in general malignant.

**Table 3.10 Number of publicly funded skin cancer and related conditions hospital discharges. New Zealand. 2004 to 2007.**

ICD code	Number of Publicly Funded Hospital Discharges. Skin cancers and related conditions.	2004	2005	2006	2007
C43	Malignant melanoma of skin	1317	1254	1233	1186
C44	Other malignant neoplasms of skin	8161	7967	7810	8290
C79.2	Secondary malignant neoplasm of skin	114	107	120	136
D03	Melanoma in situ	431	484	463	462
D04	Carcinoma in situ of skin	570	527	467	532
D22	Melanocytic naevi	1052	991	1039	824
D23	Other benign neoplasms of skin	515	462	487	506



D48.5	Neoplasm of uncertain or unknown behaviour of skin	120	117	104	127
	<b>Total</b>	<b>12,280</b>	<b>11,909</b>	<b>11,723</b>	<b>12,063</b>

Source: Data-sets provided by NZHIS

The total discharges recorded in the table equalled 47,975, just under 12,000 per year.. Of this total melanomas (C43) and non-melanoma skin cancers (C44) accounted for 37,218; or 9,135 per year, of which melanomas were 13.4 percent and non-melanoma skin cancers 86.6 percent. That is, non-melanoma skin cancer hospital discharges outnumbered melanomas by 6.5 to 1.

Just under 20 percent of skin cancer discharges (C43 and C44) in 2003/04 (9085 cases in total, from NZHIS publication) were inpatient cases and the remaining 80 percent day-cases (NZHIS 2007b).

Privately-funded hospital discharges are not included in the table. They are a relatively small proportion of total hospital discharges. The latest available data are for 2003 (NZHIS 2007a). In that year, total privately-funded discharges for melanoma cases numbered 136, and for non-melanoma skin cancers numbered 753. These numbers are 10.3 percent and 9.2 percent respectively of the 2004 numbers in Table 3.10 of publicly-funded discharges for melanomas and non-melanoma skin cancers respectively. Combined, the privately-funded discharges were 9.4 percent of publicly-funded.

An approximate but reasonable adjustment to allow for privately-funded hospital treatment is therefore to add an additional 10 percent on to publicly-funded numbers and total costs.

#### Cost-weights

Hospital discharges, both in-patient and day-patient, are attributed a 'cost weight'. Individual cases are classified to a Diagnosis Related Group (DRG), which groups together cases requiring similar treatment procedures and which are of similar complexity. Average treatment costs are calculated for each DRG, making use of the AN-DRG framework (Australian-based calculations). The 'cost weight' is than the cost per case in a particular DRG, relative to the average treatment cost across all discharges. This overall average cost is the 'cost-weight multiplier'. Values for it are given later in this report.

The following tables give the sum of the 'cost weights' for the listed skin cancers and related conditions, and then the average cost-weight per case (this latter of interest rather than for use in later calculations).

**Table 3.11 Publicly funded skin cancer and related conditions hospital discharges. Sum of cost-weights. 2004 to 2007**

**Publicly Funded Hospital Discharges. 2004 - 2007.**

ICD-10		Sum of Cost Weights			
		2004	2005	2006	2007
C43	Malignant melanoma of skin	1,223.9	909.4	905.3	777.1
C44	Other malignant neoplasms of skin	5,223.9	5,054.5	4,721.2	4,931.0
C79.2	Secondary malignant neoplasm of skin	102.4	87.5	94.8	96.2
D03	Melanoma in situ	223.6	252.5	275.2	241.5
D04	Carcinoma in situ of skin	324.2	297.4	270.7	305.1
D22	Melanocytic naevi	495.3	461.8	478.9	374.2
D23	Other benign neoplasms of skin	247.4	215.0	229.1	208.4
D48.5	Neoplasm of uncertain or unknown behaviour of skin	66.3	63.2	57.0	82.5
	<b>Total</b>	<b>7,907.0</b>	<b>7,341.3</b>	<b>7,032.3</b>	<b>7,016.1</b>

**Table 3.12 Publicly funded skin cancer and related conditions hospital discharges. Average cost-weights. 2004 to 2007**

		Average Cost Weight per Discharge			
		2004	2005	2006	2007
C43	Malignant melanoma of skin	0.929	0.725	0.734	0.655
C44	Other malignant neoplasms of skin	0.640	0.634	0.605	0.595
C79.2	Secondary malignant neoplasm of skin	0.898	0.818	0.790	0.708
D03	Melanoma in situ	0.519	0.522	0.594	0.523
D04	Carcinoma in situ of skin	0.569	0.564	0.580	0.574
D22	Melanocytic naevi	0.471	0.466	0.461	0.454
D23	Other benign neoplasms of skin	0.480	0.465	0.470	0.412
D48.5	Neoplasm of uncertain or unknown behaviour of skin	0.552	0.540	0.548	0.649
<b>Total</b>		<b>0.644</b>	<b>0.616</b>	<b>0.600</b>	<b>0.582</b>

The cost-weight averages are reasonably low, indicating the relative lack of complexity of treatment of most cases of skin cancer and related conditions. As noted earlier about 80 percent of skin cancer discharges in 2003-04 were day cases, and the remaining 20 percent were in-patient cases.

## 4. Categories for Costs, and ‘Cost Of Illness’ Studies

### 4.1 Cost Categories

The cost estimates derived in following sections are classified as follows –

#### Health-system costs (Section 5)

Made up of

Hospital costs

Non-hospital costs

Plus

Expenditure on preventive education, research and evaluation

#### Non-health-system costs (Section 6)

Made up of

Years of Life lost

Lost production

i. because of premature mortality

ii. because of time spent in treatment

Plus

Personal expenditure on preventive measures (sun-screen, sun-hats, etc)

The earlier report focused primarily on narrowly defined health-system costs. Given the possible use of material in this report for economic evaluation of proposed future intervention measures, its scope has been expanded.

### 4.2 Categorisation of ‘Cost of Illness’ studies

‘Cost of illness’ studies, such as this, are commonly classified<sup>16</sup> as either –

‘Prevalence’ studies. That is estimates are made of the costs in the current year which are the consequence of past and current cases of skin cancer. In effect the current situation is compared with a hypothetical situation in which skin cancer is non-existent.

or -

‘Incidence’ studies. Estimates are computed of the current and future costs of skin cancer resulting from skin cancer occurring in the current year. Such studies include discounting of future costs to the current date.

Prevalence-based estimates are easier to calculate, and do not require specification of a discount rate, which can be a controversial matter. Incidence-based estimates are the more useful, however, for economic evaluation of proposed interventions. However, a prevalence study that provides a breakdown of costs by age-group, does provide useful information for carrying out an economic evaluation. A ‘current year’ population, or a population cohort, can be aged into the future and appropriate age-group rates applied.

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<sup>16</sup> For discussion of the prevalence and incidence approaches see Byford et al 2000.

## 5. Estimates of Health System Costs

### 5.1 Hospital Costs

The estimates of hospital costs in this section are based on the 'cost-weight' totals given in the earlier Table 3.11, for in-patients and day-patients combined. A standard 'Cost weight multiplier' is derived each year by the Ministry of Health for determining total publicly-funded hospital funding and its geographical allocation. Its value for recent years is given in Appendix D.

The 'Cost weight multiplier' for 2007/08 is \$3,740.38, excluding GST. Note there has been a very substantial increase in this multiplier for 2007/08, perhaps recognizing a failure in recent years to keep up with general health sector cost inflation.

Table 5.1 gives the results of applying this multiplier to the 'cost-weight' totals in the earlier Table 3.11.

**Table 5.1 Estimated Publicly-Funded Hospital Costs of Skin Cancers and Related Conditions.  
2004 to 2007**

**Annual Cost Totals, using 2007/08 Cost-Multiplier of \$3,740.38**

\$ mn, excl GST					
ICD-10		2004	2005	2006	2007
C43	Malignant melanoma of skin	4.58	3.40	3.39	2.91
C44	Other malignant neoplasms of skin	19.54	18.91	17.66	18.44
C79.2	Secondary malignant neoplasm of skin	0.38	0.33	0.35	0.36
D03	Melanoma in situ	0.84	0.94	1.03	0.90
D04	Carcinoma in situ of skin	1.21	1.11	1.01	1.14
D22	Melanocytic naevi	1.85	1.73	1.79	1.40
D23	Other benign neoplasms of skin	0.93	0.80	0.86	0.78
D48.5	Neoplasm of uncertain or unknown behaviour of skin	0.25	0.24	0.21	0.31
<b>Total</b>		<b>29.58</b>	<b>27.46</b>	<b>26.30</b>	<b>26.24</b>

Altogether \$26.24 million dollars, in 2007/08 dollars, was spent on hospital care in 2007, the latest year for which full data were available. The amount is almost identical to that in 2006, our base year. This compares with the estimate in the 2000 report of

\$14.3 million in 1998/99 dollars. Note that the numbers include the additional ‘related conditions’ ICD-10 diagnoses listed in the table, in addition to melanomas (C43) and non-melanoma skin cancers (C44)<sup>17</sup>.

## 5.2 Non-hospital health-care costs

Non-hospital costs<sup>18</sup> include GP consultations, lab tests, specialist (dermatologists and plastic surgeons) consultations and procedures carried out in their surgeries or at public out-patient clinics, pharmaceuticals, and, finally, residential and hospice care.

The estimation of these costs has been the most difficult part of this report. There is considerable uncertainty about the accuracy of the results. The description of the estimation process is complex. To avoid being buried in excessive detail at this point in the report, the full detail on the approaches used and the results has been relegated to Appendix E. Summary points are given below.

Two approaches are followed. The first might be called ‘top-down’, drawing on Australian estimates of cancer costs (AIHW 2005) and using the estimated Australian ratio of ‘non-hospital’ to ‘hospital’ costs.

The second approach, ‘bottom-up’, consists in trying to construct for New Zealand direct estimates of each major component of costs apart from hospital discharges.

## 5.3 Using Australian ratios to estimate out-of-hospital medical costs

Applying these ratios, after adjustments to some components of the Australian aggregates, gives the results in Table 5.2.

**Table 5.2 Total NZ skin cancer and related conditions health-care costs, if extrapolated from NZ hospital costs using Australian ratios. 2006**

NZ \$mn (excl. GST) in 2007/08 prices

	<b>Publicly-funded hospital costs</b> \$mn	<b>Privately- funded</b> \$mn	<b>Sum</b> \$mn	<b>Scaling factor</b> x	<b>Estimated Total</b> \$mn
Melanoma	3.4	0.3	3.7	1.53	5.7
Non-melanoma	17.7	1.8	19.4	2.05	39.8
Other neoplasms	5.3	0.5	5.8	2.00	11.6
<b>Total</b> (including other neoplasms)	<b>26.3</b>	<b>2.6</b>	<b>28.9</b>		<b>57.1</b>

<sup>17</sup> One reviewer remarks that C79.2, D23, and D48.5, have no known relationship with UV exposure. D22 probably does, but it is not a form of skin cancer.

<sup>18</sup> More accurately ‘non-admitted patient costs’, to use the Australian terminology. Inpatients and day-patients are ‘admitted’ patients, whereas out-patients are not.

Source: Appendix E

On this basis overall health costs at NZ \$57.1 million would exceed ‘admitted patient’ hospital costs of NZ\$28.9 mn by NZ\$28.2 mn.

#### **5.4 Cost of skin cancer-related laboratory tests and GP consultations in New Zealand.**

The ‘bottom-up’ approach, constructing direct estimates of components of non-hospital costs for skin cancer in New Zealand, starts first with Lab tests and GP consultations relating to skin cancer.

The standard lab test for suspect skin excisions is the C50 histology test. The schedule fee for this in recent years has been as follows<sup>19</sup> –

2006/07	\$59.90	excl GST.
2007/08	\$61.83	excl GST.
2008/09	\$63.19	excl. GST.

The 2007/08 value is applied to the estimated number of tests NZ-wide, applying rates found for the Bay of Plenty in 1998. Thus Lab test costs, for estimated test numbers in 2006, at the average fee of \$61.83 in 2007/08, are –

$$\begin{aligned} 109,000 & \times \$61.83 & = & \$6.7 \text{ million, excluding GST.} \\ \text{Of which melanoma associated costs are } & 2000 \times \$61.83 & = & \$123,660. \end{aligned}$$

An average GP consultation fee of \$70, before subsidy deductions, is assumed. Deducting GST gives a cost per consultation of \$62.22, excluding GST. From Australian data on average 2.2 GP consultations are required per confirmed laboratory test diagnosis of skin cancer. On this basis, GP consultation costs amount to –

$$\begin{aligned} 151,800 & \times \$62.22 & = & \$9.4 \text{ million, excluding GST.} \\ \text{Of which melanoma associated costs are } & 2000 \times 2 \times \$62.22 & = & \$248,880 \end{aligned}$$

Thus initial lab tests and consultation costs for all skin cancers, or suspect lesions, amount to NZ\$16.1 million.

#### **5.5 Remainder of costs, apart from ‘admitted hospital patient costs’.**

Remaining New Zealand skin cancer costs can now be estimated as the residual between the Australian-based ‘top-down’ estimates, and the New Zealand-based ‘bottom-up’ estimates. The resulting estimates are given in Table 5.3. It should be noted, however, that the estimates are probably on the low side, particularly given recent Ministry of Health estimates of the cost of hospital oncology departments’ out-patient consultation and treatment costs.

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<sup>19</sup> From a combination of data for localities applying the schedule fee, and those where community lab services are provided under bulk contract. (Pers. Comm. Chris Lewis, NZHIS).

**Table 5.3 Estimated Total Skin Cancer and Related Conditions health-care costs for New Zealand. 2006**

NZ \$mn (excl. GST) in 2007/08 prices

	<b><u>Hospital Costs – Admitted Patients</u></b>			<b>Other health-care</b>	<b>Total</b>
	<b>Publicly-funded</b>	<b>Privately funded</b>	<b>Total Hospital</b>		
	<b>\$mn</b>	<b>\$mn</b>	<b>\$mn</b>	<b>\$mn</b>	<b>\$mn</b>
Melanoma	3.4	0.3	3.7	2.0	5.7
Non-melanoma (including other neoplasms)	23.0	2.3	25.3	26.1	51.4
Total	26.3	2.6	28.9	28.2	57.1
(Of which: 'other neoplasms')	5.3	0.5	5.8	5.8	11.6 )

A substantial error margin should be assumed for the given total of NZ\$57.1 mn; perhaps of the order of  $\pm 10$  percent. Should these estimates be used in cost-effectiveness analyses, it would be necessary to subject the results to sensitivity testing of the effects of higher or lower costs.



## 6. Non-health system costs

From a broader perspective than that of 'health-care funding' there are three other costs to take into account.

The first is that of 'personal sun-avoidance expenditure'. Consumers buy sunscreen and also protective clothing. Changes in these expenditures need to be incorporated where relevant in carrying out cost-effectiveness analyses of sun avoidance interventions, as is noted in the Australian work by Carter and Shih. The amounts can be surprisingly substantial. The Australian practice is not to include protective clothing as this generally serves 'clothing' purposes as well as 'sun-protection' purposes. Expenditure on sunscreen can however be expected to change as a result of campaigns like SunSmart. The Australian estimate is that the average person would consume one extra tube of sunscreen a year, at a cost of approximately \$3. I.e. for New Zealand a total of the order of \$12 million. This is, however, undoubtedly too large an amount in the case of New Zealand. Data supplied to the Cancer Society by AC Nielsen Ltd show supermarket sales of sunscreen for the six months to 22<sup>nd</sup> March 2009 to have been \$10.6 million, and \$9.7 million for the same period a year earlier (sales in remaining months are minimal). A large proportion of these outlays would be, however, to avoid the unpleasantness of sunburn rather than, or as well as, consciously reducing skin cancer risk.

The second 'cost' is the community preventive expenditure undertaken by governments, either directly or through agencies such as the Health Sponsorship Council, and by non-government organisations such as, in particular, the Cancer Society (we leave aside private enterprise promotional expenditure for items such as sun-screen ointment, etc.)

These community preventive expenditures are discussed in Appendix F. Outlays by the Health Sponsorship Council and the NZ Cancer Society amount to over \$1 million annually by each.

The third, and largest, is 'lost production', namely the lost contribution to society, or, more narrowly, to GDP, resulting from premature mortality and time lost in treatment.

We estimate here simply that component caused by premature mortality. Also the valuation is in terms of contribution to GDP only. That is in terms of lost income from loss of time at work.

For this we draw on the estimates of the 'prematurely dead population' given earlier in Section 3. This missing population was estimated to total 4,741 in 2006. Equivalently this number of potential life-years was lost in 2006. A break-down of this number by age-group and gender has been constructed (see Appendix C), and average incomes derived from the annual June quarter Income Survey applied to these<sup>20</sup>. The results are shown in Table 6.1

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<sup>20</sup> The income averages by gender and age-group were derived from the June quarter 2007 Incomes survey. They were then adjusted upwards for inflation to the June year 2007/08, using the increase of 1.8 percent in the CPI over this half-year period.



**Table 6.1 Total Lost Yearly Production resulting from skin cancer mortality  
New Zealand 2006, \$mn in 2007/08 dollars**

Age/Group	Melanomas			Non-melanoma skin cancers		
	Males	Females	Total	Males	Females	Total
15-19	0.0	0.0	0.0	0.0	0.0	0.0
20-24	0.1	0.0	0.1	0.0	0.0	0.0
25-29	0.3	0.1	0.4	0.0	0.0	0.0
30-34	0.9	0.4	1.3	0.0	0.0	0.0
35-39	2.0	0.6	2.6	0.0	0.0	0.0
40-44	3.3	1.1	4.4	0.0	0.0	0.0
45-49	4.8	1.9	6.7	0.2	0.0	0.2
50-54	6.8	2.5	9.3	0.5	0.1	0.6
55-59	9.1	2.9	12.0	0.7	0.1	0.9
60-64	8.3	2.5	10.8	0.8	0.1	1.0
65+	8.6	3.1	11.8	3.2	0.9	4.0
Sum	44.2	15.2	59.3	5.4	1.3	6.7

The total loss is NZ\$66.0 mn; NZ\$59.3 mn for melanoma, and NZ\$6.7 mn for non-melanoma skin cancers. Most of the loss occurs for melanoma because of its higher mortality, and also because deaths occur at younger ages, with more years lost and a higher proportion of those for ages where people are more likely to be working.

## 7 Summary of Costs of Skin Cancer to New Zealand

Bringing together the main components of costs from the previous sections we have the following –

**Table 7.1**                      **Costs of Skin Cancer and Related Conditions to New Zealand 2006.**

\$ values in 2007/08 prices.

	<b>Melanoma</b>	<b>Non-melanoma (incl. related neoplasms)</b>	<b>Total</b>
Lost life-years	3,811	930	4,741
Health-care Costs (NZ \$mn; excl GST)	\$5.7 mn	\$51.4 mn	\$57.1 mn
‘Lost Production’ (NZ \$mn)	\$59.3 mn	\$ 6.7 mn	\$66.0 mn

plus Preventive Expenditures

Personal e.g. sunscreen                      Unknown but many millions.  
NGO and government e.g. Cancer Society    Approx. \$ 2 mn.

Of these the non-economic ‘cost’ of Lost Life-years is the most important, especially for melanoma. There is a wide range of \$ values which might be put on a life-year, but even if as low as NZ\$20,000, which is definitely too low, this would imply a loss of approaching NZ\$95 mn in \$ terms.

## 8 Information Gaps

The information available for the computations in this report of deaths resulting from skin cancer is reasonably complete<sup>21</sup>, and virtually so for skin cancer hospital discharges, allowing for a degree of approximation for privately-funded hospital discharges.

The information is also relatively complete for the number of new cases of skin cancer each year, to the extent, that is, that one can assume the 1998 Bay of Plenty rates adequately represent all New Zealand. The same source provides estimated numbers of laboratory tests for skin cancer.

<sup>21</sup> Though one reviewer has doubts. “Probably reasonable for melanoma deaths but probably not for NMSC. I expect NMSC is not high in the minds of doctors completing death certificates.”

The principal information gaps are for –

- the number of new cases of non-melanoma skin cancers each year. The estimates in this report are derived from laboratory test data for the Bay of Plenty in 1998, assuming those rates can be applied to the present-day population for New Zealand in total.
- numbers, and costs, of GP and specialist non-hospital consultations per skin cancer diagnosis.
- numbers, and costs, of non-hospital procedures for treatment of skin cancer cases.
- Numbers, and costs, of hospital non-admitted consultations and procedures. E.g. out-patient oncology department consultations, radiotherapy, chemotherapy, etc.

The assumptions made to bridge these gaps have been discussed in various earlier parts of this report. It would be helpful, however, for future monitoring of skin cancer incidence and costs, to be able to rely on more precise data, and fewer assumptions.

Possibilities for filling the information gaps include

- a) Population surveys at regular intervals to identify how many people report having had skin cancer. Such a survey might be linked to the National Health Surveys carried out every few years.
- b) Collation of results of laboratory tests carried out by community laboratories.
- c) Surveys, perhaps *ad hoc*, of GP and specialist consultations and procedures and costs. A model might be the work by Wilkinson et al for Skin Clinics in Australia.
- d) Collation of data on hospital outpatient consultations and treatment for skin cancers. The Ministry of Health has recently carried out some work in this area, linking to initial melanoma registrations on the Cancer Register.

A further information gap, relevant particularly to cost-effectiveness analysis of sun protection interventions is of information on household expenditure on sun protection, for instance sunscreen.; and on how responsive such expenditure is to sun protection promotion campaigns, Some data on this is probably available in Statistics NZ's regular Household Economic Survey, and could be purchased.

Perfect information is never available, and the benefits of getting better information need to be weighed against the costs of getting it. Nevertheless, it would be helpful for measuring the cost of skin cancer, and for evaluating interventions to reduce its incidence, to improve current data collections on the lines suggested here.

## **Part Two: Criteria and Template for carrying out an economic evaluation of interventions to reduce the burden of skin cancer**

The estimates of the ‘cost’, or ‘burden’, of skin cancer in the first part of this report have two main purposes:

- ❑ To show the total magnitude and importance of the burden that skin cancer places on New Zealand’s health system and society;
- ❑ To provide the data needed to carry out an economic evaluation of proposed interventions to reduce the burden of skin cancer.

This part of the report deals with the second objective. It discusses first the criteria for a well-carried-out economic evaluation. Various points in the reports by Shih and Carter<sup>22</sup> on their economic evaluation of a national SunSmart program in Australia are used to illustrate the discussion. (The most recent of these reports is Shih 2008; the Ace-Prevention Technical Report. It is this which is mainly drawn on in what follows.) Following this a template in the form of an Excel spreadsheet is given, showing how data would be used to carry out a similar economic evaluation for New Zealand.

Valuable references for the discussion below are Drummond et al. 3<sup>rd</sup> edition. 2005. *Methods for the economic evaluation of health care programmes*. OUP; and Pharmac’s 2007 *Prescription for pharmaco-economic analysis*; [www.pharmac.govt.nz](http://www.pharmac.govt.nz) .

Interventions broadly fall into four categories –

- ❑ Health promotion campaigns, such as SunSmart, intended to persuade people to reduce harmful sun exposure, thereby reducing skin cancer incidence
- ❑ Population screening programmes for detection of skin cancers<sup>23</sup>
- ❑ Targeted screening or surveillance of high risk groups
- ❑ Other measures to encourage earlier detection of skin cancer, particularly melanoma, thereby reducing subsequent morbidity and mortality.
- ❑ New measures for earlier and better medical and surgical treatment of skin cancer.

The points made in this section generally apply to all five categories, but the emphasis is on the first, in order to tie the general discussion to the specific example of SunSmart interventions in Australia.

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<sup>22</sup> Carter et. al. 1999. Shih and Carter, 2008. Shih 2008.

<sup>23</sup> Very unlikely to be cost-effective .

## II.1 Criteria for a well-carried-out economic evaluation.

A set of criteria widely used by health economists is the list of 10 criteria provided in Drummond et al (3<sup>rd</sup> edition; 2005). These are set out and commented on below.

### 1. Was a well-defined question posed in answerable form?

i) In particular does it address both the costs and consequences (positive or negative) of the proposed intervention?

For example – Suppose spending on sun protection programs in New Zealand is increased by NZ\$1 million per year over currently projected levels for the next 20 years. The economic evaluation would include assessment of the ‘net costs’ of the intervention (programme costs less savings in healthcare costs etc.); and of the ‘consequences’ (reduced morbidity and mortality, potential ‘production gains’ etc.).

Note that we have in New Zealand already a national sun protection program, which has been running since the early 1990s. An economic evaluation in this area of public health will focus therefore on the costs and consequences of either increasing current expenditure levels, or on reducing them, rather than on setting up a new program from scratch.

The costs and consequences included in the economic evaluation will depend on the ‘viewpoint’ or ‘perspective’ of the analysis? One possibility could be the “funder’s” or “Vote:Health” perspective, assessing the effects of the intervention on health-care expenditure, as set against the ‘health gains’ potentially resulting from the intervention. Health gains include reductions in mortality, and gains in Life-years or Quality-adjusted life-years (QALYs), or alternatively reductions in Disability-adjusted life-years (DALYs)<sup>24</sup>. A broader perspective is the “societal” viewpoint, taking account also of the effects on patient (and family) time and expenditure, and potential ‘production gains’. Production gains are the additional contributions able to be made to society as a result of reduced mortality and morbidity. It is good practice to try and identify all possible costs and consequences initially, later discarding those not relevant for the purpose of the evaluation, or not expected to be of significant magnitude.

### 2. Was a comprehensive description of the competing alternatives given?

Here the competing alternative, or comparator, would be continuation of current expenditure levels without significant increase or decrease.

### 3. Was the effectiveness of the programmes or services established?

This is the most difficult task in the specific case of sun protection programmes. Clearly RCTs are not possible in this context. The original Australian work (Carter et al., 1998) based its estimates of effectiveness on a model linking surveyed reductions in sunburn to eventual reductions in skin cancer. The

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<sup>24</sup> For discussion of QALYs see Drummond et al. 2005 (Page 15), or Gold et al. 1996; or other health economics texts. For DALYs the Ministry of Health’s *Our Health, Our Future* (1999) has extended discussion.

estimated reduction attributable to SunSmart was approximately 30 percent in both melanoma and NMSC. A 5 year time lag was assumed to the realisation of the reduced melanoma incidence, and a 15 year time lag to the reduction in NMSC incidence. An assumed 20 years of life was assumed saved per premature death prevented for melanoma (average age of incidence of 63, to life expectancy of 83), and 10 years of life for NMSC (average age of incidence 75 to life expectancy 85).

It has become apparent subsequently that the link from sunburn incidence to skin cancer incidence is less robust than originally thought. In place of that 1998 model Carter & Shih in their recent work have used regression relationships at state level from sun prevention campaign expenditures per head to reductions in melanoma incidence (Shih 2008). For NMSC, incidence in household surveys in the 1980s have been extrapolated and compared with more recent rates. For BCC this gave an overall reduction over 10 years of 20 percent for persons aged under 50, with higher reductions for those in the younger age-groups. For SCC it was assumed that there is a 5 percent reduction for those aged under 50. No reduction is assumed for those aged 50+.

In the case of New Zealand we have nothing equivalent to Australian state-level data for comparisons, nor household surveys of the prevalence of skin cancers. The data on melanoma incidence do not point to any significant reduction in incidence in the last decade. There are no solid data on trends in NMSC incidence. Analyses of New Zealand interventions must necessarily rely on parameters established for Australia.

These uncertainties require any modelling of the effectiveness of SunSmart-type programs to be subject to stringent sensitivity testing.

4. Were all the important and relevant costs and consequences identified?

Assuming a broad 'societal' perspective, these would include –

Costs:

- The ongoing costs of national sun protection programs, plus any significant changes in costs caused by changes in the scope and magnitude of such programs..
- Changes in consumer purchases of sun-screen and other protective clothing and accessories, e.g. sun-hats (though in the Australian work it is judged that protective clothing can be excluded because the predominant use is as clothing rather than sun protection).

Consequences: (All these consequences, of course, happen after some lag.)

- Reduction in health-care costs. These include hospital 'admitted patient' (inpatient and day-patient) costs, hospital non-admitted patient costs (e.g. oncology department consultations, radiotherapy, chemotherapy, etc), primary health-care consultations and minor procedures, laboratory histology testing, specialist (dermatologist and plastic surgeon) consultations and procedures. They should also ideally include costs of tests for suspect lesions which turn out to be



benign, and GP consultations where the lesion is treated on the spot, without confirming that it is malignant.

- Reduction in new cases.
- Reduction in hospital admissions
- Reduction in mortality
- Gain in life-years (or QALYs, or a reduction in DALYs)
- Reduction in sickness or invalid benefits, for those unable to work because of skin cancer.<sup>25</sup>

- Reduction in patients' time cost and travel costs for diagnosis and treatment.

- Gain in contribution to society from those not now prematurely deceased, or not making a reduced contribution while receiving treatment. There is debate on how this should be measured. In this report the view taken is that 'contribution' is best measured in terms of lost income from employment. That is, only that contribution which would be included as part of a nation's GDP (Gross Domestic Product) is counted.<sup>26</sup>

- A further consequence is the increase in health-care costs, for those persons who would otherwise have died from skin cancer, for their additional years of life. This is a controversial item, with no agreement in the literature on whether it should be taken into account or not (Gold, et al. 1996). It is assumed here that it would not normally be included.

Not all of the above costs and consequences need necessarily be included in subsequent analyses. Some might be assessed as relatively unimportant, and if difficult to quantify, not worth the extra work. It is good practice, however, to identify and discuss all possibilities.

### **Sun Protection, sun exposure and vitamin D**

Another possible consequence which needs considering in a cost-effectiveness analysis is the effect of increased sun protection on Vitamin D intake. Since the time when the original Costs of Skin Cancer to New Zealand report was written (O'Dea, 2000), a greater emphasis has been placed on the beneficial effects of human exposure to ultraviolet radiation (UVR), in particular the role played by vitamin D (Scragg 2007).

At the individual behavioural level, a balance is required between skin cancer risk reduction by avoiding excessive sun exposure and the adequate sun exposure required for maintaining healthy vitamin D levels (Cancer Society of New

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<sup>25</sup> The inclusion of this item depends on the viewpoint adopted. From a societal perspective, it would not be included, as being a 'transfer' item, rather than a true 'economic cost'. From a fiscal budget perspective it might be, as also might be changes in income tax receipts and pension payments. In general it is desirable to not attempt estimates of such items, as they add considerably to the complexity of any analyses. Also the purpose of health-care spending is to achieve 'health gain' at reasonable cost, rather than to improve the government's fiscal balance.

<sup>26</sup> Others, however, extend this item to include assessments of the 'market value' of 'non-market' contributions, as e.g. housekeeping, caring for grandchildren, etc. A drawback is that such valuations are subject to dispute. Also there is some risk of double-counting, if a dollar-value is also put on 'life-years saved' or 'QALYs gained'.

Zealand, 2008). The present report, to which this is a supplement, focuses on estimating the costs of skin cancer alone. For a cost-effectiveness analysis, however, should there be firm evidence that the avoidance of excessive and harmful levels of sun exposure is necessarily associated with inadequate levels of vitamin D for some people, this effect needs to be taken into account.

A 2008 report, *Vitamin D and Cancer*, from the International Agency for Research on Cancer advises that there is no evidence to suggest a need for any change to current sun protection advice during high UVR periods. However, there is evidence to suggest that some groups may be changing their sun protective behaviours because of concerns about insufficient vitamin D levels. Research commissioned by Auckland's Skin Institute found that 27% of New Zealanders used arguments about the need for Vitamin D in order to justify increased sun exposure during the 07/08 summer (Skin Institute, July 2008). See also Scully et al (2008) for Australian media surveys<sup>27</sup>. Any reduction in sun protective behaviour is likely to lead to future increases in skin cancer and associated costs.

5. Were costs and consequences measured accurately in appropriate physical units?

There is little difficulty with estimating program costs. The main difficulties arise for consequences, because of poor data availability on health-care encounters, apart from hospital admissions. Mortality data, are normally assumed robust, and probably are so for melanoma, but perhaps less so for non-melanoma skin cancers.

6. Were costs and consequences valued credibly?

For costs there are few difficulties. It is important, however, to be precise about whether any cost estimates exclude or include GST (Goods and Services Tax). GST is a value added tax, applied in New Zealand, at a uniform rate of 12.5 percent since 1989, to almost all goods and services, including healthcare provision. In fact, all estimates used in cost-effectiveness analyses should specifically exclude GST, as being a 'transfer payment'. Where the position on GST is not made clear (as is too often the case), there results an immediate uncertainty of 12.5 percent (one eighth) in the presentation of cost-effectiveness, cost-utility, and cost-benefit ratios.

For consequences, among the more important valuation questions are the proper values (excluding GST) to assign specified consultations and procedures. For New Zealand there is relatively good data on hospital costs (using cost-weights associated with DRGs, Diagnosis-related groups), and also in general for laboratory tests from fee-schedules, except when tests are provided under bulk contract. For consultations, the general switch in primary health-care in recent years towards a capitation-based payment system, combined with substantial subsidy increases, makes it more difficult than formerly to estimate GP consultation costs, though the requirement on practices to display a fee-list

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<sup>27</sup> Also, Australian research shows that of the 60% of Victorian adults who had ever seen/heard news reports about getting Vitamin D from sunlight, 16% agreed that it made them think they needed to go out in the sun more (Victorian component of the National Sun Survey conducted in summer 2006/07, communication with J. Makin at The Cancer Council Victoria, 3/6/08).

provides some help. Specialist consultation fees are not currently published, and it is of course illegal under the Commerce Act for specialist associations to set 'standard' fees. This situation contrasts with the Australian system with its availability of the very detailed Medical Benefits Schedule.

It is not necessary to put a dollar value on all consequences. For instance, for deaths prevented, life-years gained, or QALYs gained, it is often sufficient, and preferable, to express the results of the analysis simply in terms of \$ per death averted, or \$ per life-year gained, or \$ per QALY gained.

Sometimes, however, it is thought useful to place a \$ value on such outcomes. For example, the transport sector's estimate of the 'Value of Statistical Life' (VoSL), based on 'willingness-to-pay' surveys, as being currently about NZ\$3 million, could be used to value deaths prevented. Preferably one should go further and try to estimate, using the VoSL as a starting point, the value of a life-year or QALY. In practice, Pharmac in its decisions on which new drugs can qualify for subsidy, implicitly seems to value a QALY at around NZ\$30,000, which is rather lower than similar implicit valuations in other countries. This would in any case, because of Pharmac's budget constraint, be a 'lower bound' estimate. Alternatively, calculations linking VoSL and the currently approved semi-official discount rate of 3.5 percent and current life expectancies, suggest a value in excess of \$100,000 for a life-year or QALY. It is not possible to get much precision in this matter<sup>28</sup>.

Finally valuations need to be all in prices of the same year. That is they should be adjusted to the one base year, using appropriate measures of inflation. Thus Carter & Shih adjusted their estimates to a 'Reference year' of 2003. In the earlier part of this report the estimates of the cost of skin cancer are for the year 2006, but valued in 2007/08 dollars.

#### 7. Were costs and consequences adjusted for differential timing?

That is what real discount rate is applied to future values to give their 'present value'? The discounting factor for an item  $n$  years in the future at a discount rate of  $d$  percent per annum is  $1 / (1+d)^n$ .

Carter & Shih used a discount rate of 5 percent per annum.

The currently recommended (Pharmac, 2007) discount rate for health sector economic evaluations in New Zealand is 3.5 percent per annum. Alternatives should be also used as part of sensitivity analysis - normally the international 'gold standard' of 3 percent recommended by Gold et al (1996), and also a rate of 5 percent, and perhaps 6 or 7 percent, for comparison with countries using these rates as their preferred discount rate. Note that New Zealand practice as is generally the case elsewhere is to apply the same discount rate to 'health gains', such as QALYs gained, as to financial costs and benefits.

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<sup>28</sup> It can be noted, however, that Abelson (2003) proposed, for Australia, in 2002 prices, a constant Value of Life Year (VOLY) of A\$108,000, independent of age.

8. Was an incremental analysis of alternatives performed?

Only two alternatives would be compared in the case envisaged here. The incremental analysis compares costs and consequences with and without the proposed intervention.

9. Was allowance made for uncertainty in the estimates of costs and consequences?

Sensitivity analyses need to be carried out on the base case estimates, varying costs and, in particular, the assumed effectiveness of the sun protection program. This tests the sensitivity of the results to changes in the various parameters. Thus Shih (2008) varied the assumed proportion of the reduction in melanoma incidence due to the SunSmart program to assess the sensitivity of her results to this parameter.

A variant approach is to carry out a 'threshold analysis'. A desired threshold value is specified for the cost-effectiveness ratio – for example it could be specified that the cost per QALY gained should be less than NZ\$50,000. Then the level of health gain required to achieve this threshold is calculated, and the plausibility of achieving that level evaluated. Estimated program costs can be treated in the same fashion.

10. Presentation and discussion on other issues of concern to users.

Including such issues as generalizability of the results, and whether other important factors relevant to the decision under consideration, for example the distribution of costs and consequences (i.e. 'equity' concerns), and relevant ethical issues, are alluded to in the discussion of results. For skin cancer this would include consideration of the fact that it is a condition unlike most health conditions in that its prevention and treatment is of most benefit to those of European ancestry, and of higher socio-economic status.

Issues of implementation are also important, including the impact of possible financial or other (e.g. workforce) constraints on the feasibility of adopting the proposed change, and whether resources are freed for redeployment to other worthwhile programmes.

## II.2 A template for cost-effectiveness analysis of skin cancer interventions

The terms of reference for this project specified that this report include a template for cost-effectiveness analysis of future proposed interventions. Specifically –

“To develop a ‘cost and consequences’ template, based on Shih and Carter (2008), showing how the cost-effectiveness of current or proposed preventive or early detection programs might be assessed, for given assumptions about the magnitude of relevant parameters. For example, if a proposed education campaign costing \$x million is expected to reduce skin cancer mortality by y%, and to reduce other health system costs proportionally, the ‘cost per life year saved’ can be estimated, and comparisons made with the cost-effectiveness of other proposed health interventions. Shih and Carter (2008) have carried out this sort of exercise for Australia.”

A template table is set out on the following page. It is assumed the template would be constructed as an Excel spreadsheet.

The template takes the current or ‘base-year’ population. This is projected year by year the required number of years into the future. Carter and Shih use a 20-year time horizon, but a 30-year or more time horizon is perhaps better, for inclusion of long-term benefits, and given the use nowadays of a relatively low discount rate of 3.5 percent in New Zealand. Population projections are available from Statistics New Zealand.

The various parameters are then applied to the projected populations, and changes in costs and gains as a result of the intervention calculated. For illustrative purposes here it is assumed that the intervention requires an increase in spending, and that the changes in programme spending start in Year 1. The first impact of these spending changes is then assumed felt in Year 10, continuing through to Year 30. These impacts are shown in the final three columns of the table – namely ‘Averted Costs’, Production Gains, and ‘Health Gain’ outcomes. Again, and purely for illustrative purposes, these are shown as constant over years 10 to 30. In practice they would vary with population size, and population composition.

The assumed time-lag before the spending changes start to have an impact is, of course, easily altered. Other changes are also possible, for example a gradual phase-in of the impact.

On the Costs side of the template, the incremental cost per year for the new program would be tabulated, perhaps on the basis of expenditure of, for example, 25 cents (NZ) per capita each year on the new program. There could also be included a column tabulating increased household spending on sun-screen, sun-hats etc. For simplicity this is not included in the template, but the extension is easily made. All these costs would be expressed in ‘base-year’ dollars, that is dollars of 2008 or thereabouts. The incremental costs in future years would then be discounted back to the present – the base-year or Year Zero – and summed, to give the Present Value of future costs over the full period to the time horizon. The bottom two rows display the sums, of undiscounted and discounted annual values.

<u>Year</u>	<u>Change in Program Costs</u>	<u>Resulting 'Averted Costs'</u>	<u>Production gains.</u>	<u>Changes in 'health gain' outcomes.</u>
	Health Sector	Health Sector. Reduced hospital care, & out-of-hospital care	Extra income from increased work-force participation	Cases & deaths prevented. Life-years or QALYs gained.
	\$ excl GST	\$ excl GST	\$	Number
0				
1	\$x mn	0	0	0
2	\$x mn	0	0	0
....				
9	\$x mn	0	0	0
10	\$x mn	-\$y mn	-\$z mn	+ Gain
11	\$x mn	-\$y mn	-\$z mn	+ Gain
....				
29	\$x mn	-\$y mn	-\$z mn	+ Gain
L = 30 Time Horizon.	\$x mn	-\$y mn	-\$z mn	+ Gain
<b>Sum</b>	$\Sigma$	$\Sigma$	$\Sigma$	$\Sigma$
<b>Sum of discounted amounts</b>	$\Sigma PV$	$\Sigma PV$	$\Sigma PV$	$\Sigma PV$ Life-years & QALYs

On the 'Consequences' side (the remaining three columns in the template) there would be separate blocks for melanoma and non-melanoma skin cancer (NMSC). Also the detailed calculations would be carried out in age-group by gender detail on supplementary spreadsheets.

The Production Gains total for each year would be calculated by first estimating the change in 'prematurely dead population' as a result of the intervention, and applying appropriate values for 'lost contribution' to this change in population. A separate component here could be an estimate of 'production gain' from reduced time in treatment.

## Sensitivity Testing

Sensitivity tests are readily carried out by variation of the parameters underlying the table calculations. At a more sophisticated level, Monte Carlo simulation methods might be used to give a picture of the ‘scatter’ of possible outcomes.

## Summary Measures

Finally the results need to be put in summary form for the guidance of decision-makers. The steps would be –

- a) Calculate the Net Present Value of cost changes for the health sector.

$$\text{NPV} = \text{PV (Changes in program costs)} \text{ less } \text{PV (changes in health-care costs)}$$

If this NPV is negative (for a proposed increase in program spending), the proposed intervention should be proceeded with. It is said to be ‘dominant’. Eventual savings outweigh initial costs. A \$1 investment gives a return of better than \$1, after discounting.

- b) It is, however, rare for a proposed intervention to be dominant. At this stage one might further deduct the PV of Production Gains (in column 4). If the result is now negative, then the intervention might be said to be dominant from a broader ‘societal’ perspective.
- c) It is probable, however, that from whatever perspective, there is an increase in net costs from proceeding with the proposed intervention. The question is now whether the expected ‘health gains’ are sufficient to justify the extra cost.

Cost-effectiveness ratios will help in answering this question. These take the form of ratios such as –

- \$ cost per case prevented
- \$ cost per death prevented
- \$ cost per life-year saved
- \$ cost per Quality-adjusted life-year (QALY) saved

Any or all of these ratios might be calculated, depending on which are thought to give useful guidance. The \$/QALY ratio (often called the cost-utility ratio) is the most general and useful for comparing interventions right across the health sector.

A further step would be to put a \$ value on life-years or QALYs, giving a cost-benefit ratio solely in \$ terms. This can be useful for comparing with potential investments in sectors other than health.

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## Appendices

### The Cost of Skin Cancer to New Zealand

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## **Appendix A**

### **Supplementary Statistical Tables**

This appendix contains source data for charts in the main body of the report, and other supplementary statistical information not included in the main report.

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| Table A.1 | Melanoma Incidence rates, New Zealand. By age and gender. 2003-2006 aggregated.. |
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**Table A.1 Melanoma Incidence in New Zealand. 2003-2006 aggregated.**

Age/Group	Rates per 100,000		
	Males	Females	Total
0-4	0	0	0
5-9	0	0	0
10-14	0.3	0.7	0.5
15-19	2.8	3.8	3.3
20-24	5.4	8.8	7.1
25-29	9.8	19.6	14.9
30-34	14.8	29.0	22.2
35-39	25.9	30.4	28.2
40-44	33.9	41.6	37.9
45-49	53.3	59.5	56.5
50-54	73.7	70.9	72.3
55-59	104.2	80.1	92.0
60-64	129.3	81.7	105.2
65-69	162.0	110.8	135.7
70-74	215.0	126.1	168.5
75-79	246.4	135.2	185.6
80-84	279.7	156.8	205.4
85+	301.4	157.5	201.5
All Ages	50.6	43.8	47.2

**Table A.2: NZ Deaths – Melanoma and non-Melanoma Skin Cancers  
1990 – 2005**

**Melanoma**

<b>Year</b>	<b><u>Males</u></b>		<b><u>Females</u></b>		<b><u>Total</u></b>
	Number	Rate	Number	Rate	Number
1990	115	5.9	73	3.0	188
1991	109	5.4	71	3.1	180
1992	99	4.8	83	3.4	182
1993	112	5.2	82	3.1	194
1994	114	5.3	79	3.0	193
1995	126	5.8	71	2.9	197
1996	107	4.7	87	3.3	194
1997	121		80		201
1998	143		105		248
1999	146		85		231
2000	155		98		253
2001	156		88		244
2002	149		86		235
2003	174		111		285
2004	152		97		249
2005 (prov.)	156		113		269

**Non-Melanoma Skin Cancers**

<b>Year</b>	<b><u>Males</u></b>	<b><u>Females</u></b>	<b><u>Total</u></b>
1995	45	21	66
1996	43	20	63
1997	27	23	50
1998	40	26	66
1999	53	22	75
2000	51	35	86
2001	62	34	96
2002	71	40	111
2003	85	30	115
2004	48	37	85
2005 (prov.)	68	34	102

Rates are per 100,000; for earlier years age-standardised to Segi's world population.

Sources: *Cancer: New Registrations and Deaths*; and *Mortality and Demographic Data*. NZHIS annual reports.

**Table A.3 New Zealand Skin Cancer Mortality Rates by Age-group and Gender  
2002 – 2004**

**New Zealand Melanoma and NMSC Mortality rates by Age-Group.  
Rates per 100,000 2002 - 2004**

Age/Group	Melanoma			Non-melanoma skin cancer		
	Males	Females	Total	Males	Females	Total
0-4	0	0	0	0	0	0
5-9	0	0	0	0	0	0
10-14	0	0	0	0	0	0
15-19	0	0	0	0	0	0
20-24	0.7	0.5	0.6	0	0	0
25-29	0.5	1.0	0.8	0	0	0
30-34	2.6	0.9	1.7	0	0	0
35-39	3.2	1.3	2.2	0	0	0
40-44	2.6	2.7	2.6	0.2	0.0	0.1
45-49	5.6	4.7	5.1	0.5	0.2	0.4
50-54	8.9	4.0	6.4	1.4	0.5	0.9
55-59	14.1	5.9	10.0	0.9	0.3	0.6
60-64	18.0	9.5	13.7	3.5	0.8	2.1
65-69	29.7	12.4	20.8	12.6	2.9	7.6
70-74	35.4	18.0	26.3	16.8	6.3	11.3
75-79	46.5	21.8	32.9	28.5	6.7	16.4
80-84	75.3	26.4	45.3	47.2	18.4	29.5
85+	95.5	52.2	65.2	116.7	44.8	66.5
All Ages	8.0	4.8	6.4	3.4	1.7	2.6
ASR WHO	6.5	3.2	4.7	2.6	0.9	1.6



## **Appendix B**

### **Non-melanoma skin cancer incidence estimates**

#### **B.1 New Zealand estimates, using Bay of Plenty data**

For the earlier report on skin cancer costs by this author (O’Dea, 2000), use was made of a tabulation of the results of laboratory tests conducted by MedLab Bay of Plenty in 1998. The advantage of this tabulation was that the results were for the one laboratory covering an entire well-defined region, with no ‘interloping’ by competing community laboratories. In default of a more up-to-date tabulation the age-gender rates from the earlier report have been assumed to still hold reasonably accurately, and have been applied to the current population.

As part justification for applying skin cancer rates for one region to the whole of New Zealand, it was found that the melanoma incidence rates from the 1998 Bay of Plenty tabulations, when applied to the New Zealand population at that time, gave results matching closely to the 1998 total of New Zealand-wide melanoma registrations.

Table B.1 (from Appendix to O’Dea 2000) shows the Bay of Plenty 1998 incidence rates per 100,000 by age and gender for Basal Cell Carcinoma and Squamous Cell Carcinoma. Keratoses, as a possible precursor to skin cancers, are also included.

Table B.2 gives the results of applying the rates in Table B.1 to the estimated resident NZ population as at mid-year 2006, by age-group and gender.

**Table B.1 Persons diagnosed with skin cancers per 100,000 population**

**Bay of Plenty 1998**

**Basal Cell Carcinoma**

Age	0-4	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54
Male	14.7	33.8	46.3	39.3	145.7	287.5	496.6	1121.2	1371.3
Female	0.0	0.0	24.6	143.6	361.8	523.2	512.0	860.8	1411.3
Total	7.6	17.3	35.8	93.8	259.3	409.3	512.8	1000.9	1391.8
Age		55-59	60-64	65-69	70-74	75-79	80-84	85+	All Ages
Male		2365.9	2783.8	5394.7	6333.3	7570.1	9166.7	7567.6	1367.3
Female		1521.3	1366.0	2402.1	2997.1	4058.0	3591.2	3284.7	875.9
Total		1925.3	2071.2	3905.6	4638.1	5591.8	5814.0	4786.7	1120.4

**Squamous Cell Carcinoma**

Age		15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54
Male		0.0	46.3	0.0	18.2	16.0	34.2	379.7	527.4
Female		0.0	0.0	0.0	0.0	0.0	144.0	164.8	302.4
Total		0.0	23.9	0.0	8.6	7.7	91.0	273.0	412.4
Age		55-59	60-64	65-69	70-74	75-79	80-84	85+	All Ages
Male		1048.8	1459.5	2473.7	3454.5	4719.6	7250.0	6756.8	714.3
Female		604.0	747.4	1279.4	2276.7	2608.7	3922.7	3722.6	480.3
Total		816.8	1095.0	1887.3	2865.6	3551.0	5282.4	4786.7	597.6

**Keratoses**

Age	0-4	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54
Male	0.0	0.0	0.0	78.6	91.1	159.7	308.2	524.4	843.9
Female	15.7	35.2	73.9	125.7	65.8	209.3	336.0	622.7	947.6
Total	7.6	17.3	35.8	103.2	77.8	185.3	322.6	573.2	896.9
Age		55-59	60-64	65-69	70-74	75-79	80-84	85+	All Ages
Male		1292.7	1513.5	2026.3	2242.4	3364.5	3333.3	2297.3	597.8
Female		1454.1	1366.0	1906.0	2132.6	2971.0	2541.4	2408.8	655.5
Total		1376.9	1438.0	1979.0	2200.9	3142.9	2857.1	2369.7	628.3

Source: O'Dea 2000.

**Table B.2: Estimated numbers of NMSCs and keratoses.  
New Zealand 2006**

**Estimated annual skin cancers diagnosed in NZ in 2006  
using 1998 Bay of Plenty data**

<b>(a) Positive Test results</b>				<b>Ratio</b>
	<b>Male</b>	<b>Female</b>	<b>Total</b>	<b>Tests:Persons</b>
Basal Cell Carcinoma	32,804	21,689	54,706	1.25
Squamous Cell Carcinoma	14,759	10,349	25,214	1.09
Keratoses	12,895	14,366	27,275	1.10
<b>(b) Persons diagnosed</b>	<b>Male</b>	<b>Female</b>	<b>Total</b>	
Basal Cell Carcinoma	25,909	17,841	43,911	
Squamous Cell Carcinoma	13,536	9,476	23,117	
Keratoses	11,610	13,260	24,894	

Source: Bay of Plenty 1998 gender age-group rates applied to estimated resident 2006 mid-year NZ pop'n

Notes: Total includes around 300 cases where gender not recorded  
'In situ' carcinomas not included.

The number of tests producing a positive diagnosis on these calculations exceeds the number of persons diagnosed; by about 25 percent for BCC and nearly 10 percent for SCC and keratoses. More than one sample is taken for testing for some patients.

Summing up, applying the Bay of Plenty 1998 incidence rates to New Zealand as a whole, the following numbers of individual diagnoses were to be expected in 2006.

- 43,900 cases of Basal Cell Carcinoma
- 23,100 cases of Squamous Cell Carcinoma
- making a total of 67,000 new cases of non-melanoma skin cancer each year;
- plus about 25,000 pre-cancerous Keratoses and Solar Keratoses each year.

## B.2 Comparisons with Australian Estimates: Based on national household survey

It is of interest to see how Australian estimates compare with those described above. The Australian estimates are based on a national household survey, in this case one taken in 2002.

As a first overall check, an estimated 374,000 new cases of NMSC were treated in Australia in 2002. The Australian population is just over five times the size of the New Zealand population, and age structures are similar. Dividing by five the Australian number would equate with a number of 75,000 cases in New Zealand. On this basis the total of 67,000 given above from Table B.2 is certainly plausible.

Checking in rather more detail, Table B.3 gives Australian age-specific incidence rates for 2002.

**Table B.3. Incidence rates of BCC and SCC. Australia 2002.**

Age	BCC			SCC			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	Total
0-19	0	0	0	0	0	0	0	0	0
20-24	89	0	43	0	0	0	89	0	43
25-29	83	141	114	0	0	0	83	141	114
30-34	150	231	195	0	0	0	150	231	195
35-39	491	742	629	0	57	31	491	800	661
40-44	688	1,058	893	482	223	339	1170	1281	1231
45-49	1,493	1,602	1,553	597	431	506	2090	2033	2059
50-54	1,987	2,113	2,055	1,104	808	943	3090	2921	2999
55-59	3,293	2,014	2,602	1,857	647	1,204	5150	2661	3806
60-64	5,496	2,224	3,780	1,963	979	1,447	7458	3203	5226
65-69	4,165	2,849	3,486	2,251	1,900	2,070	6416	4749	5556
70+	7,051	3,880	5,308	3,979	2,146	2,972	11030	6027	8280
ASR (A)	1,538	1,068	1,286	771	441	592	2309	1510	1878
ASR (W)	1,151	825	977	561	323	432	1712	1148	1409

Source: AIHW 2008. Table 1.1. Cited as derived from NCCI 2003.  
ASR (A) Age-standardised to 2001 Australian Population  
ASR (W) Age-standardised to 2000 WHO World Population

Table B.4 for New Zealand is a condensed version of Table B.1 above, using the same age-groups as in Table B.3. Age-standardised rates, to the 2000 WHO World Population basis, have been added.

**Table B.4 NMSC Incidence Rates. Bay of Plenty 1998.**

**Incidence rates BCC and SCC. Bay of Plenty 1998.**

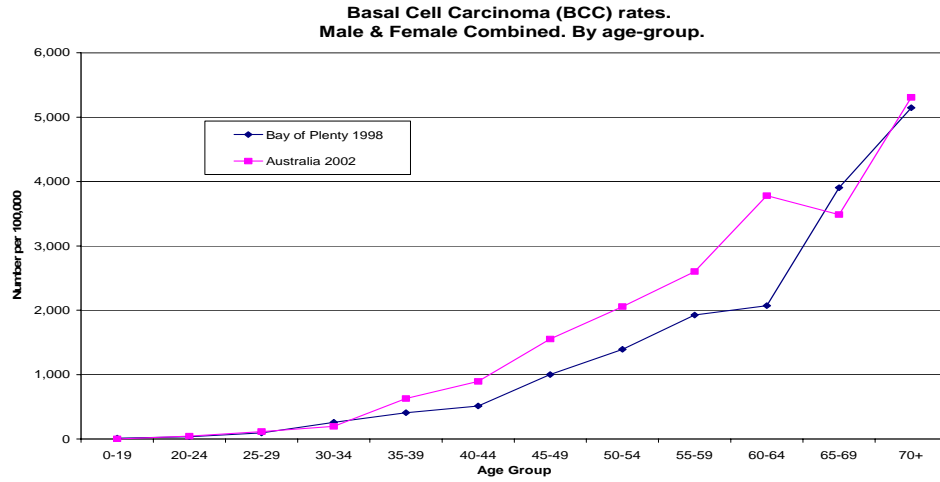
Age	BCC			SCC			Total		
	Males	Females	Total	Males	Females	Total	Males	Females	Total
0-19	24	0	12	0	0	0	24	0	12
20-24	46	25	36	46	0	24	93	25	60
25-29	39	144	94	0	0	0	39	144	94
30-34	146	362	259	18	0	9	164	362	268
35-39	288	523	409	16	0	8	304	523	417
40-44	497	512	513	34	144	91	531	656	604
45-49	1,121	861	1,001	380	165	273	1,501	1,026	1,274
50-54	1,371	1,411	1,392	527	302	412	1,899	1,714	1,804
55-59	2,366	1,521	1,925	1,049	604	817	3,415	2,125	2,742
60-64	2,784	1,366	2,071	1,459	747	1,095	4,243	2,113	3,166
65-69	5,395	2,402	3,906	2,474	1,279	1,887	7,868	3,681	5,793
70+	7,276	3,464	5,146	4,770	2,901	3,740	12,046	6,366	8,886
Crude Rate	1,367	876	1,120	598	655	628	1,965	1,531	1,749
ASR (W)	974	612	781	492	278	377	1,466	890	1,158

Source: BoP 1998 labs data  
 Crude Rate Per 100,000 Bay of Plenty Population, 1998  
 ASR (W) Age-standardised to 2000 WHO World Population. Author's calculation

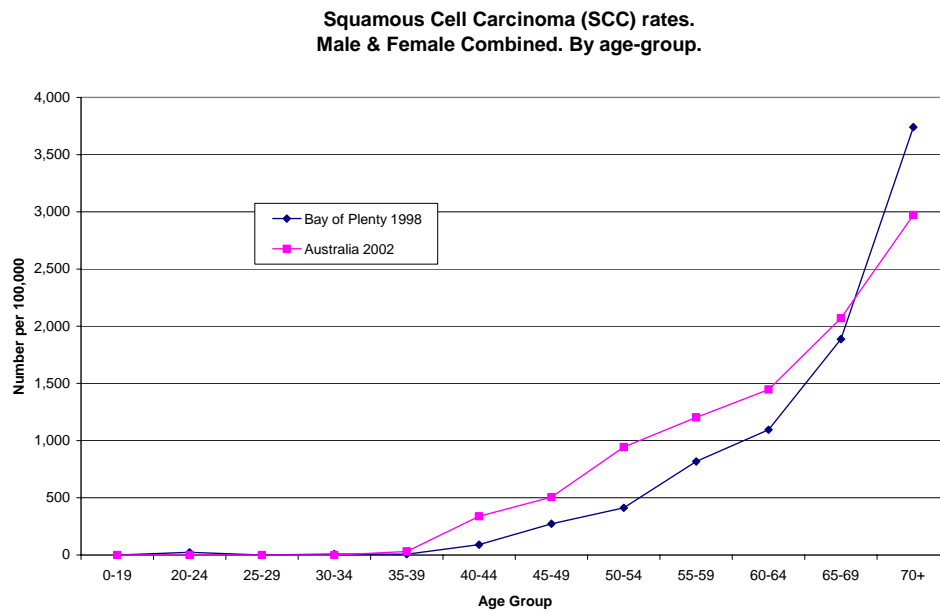
Charts B.1 and B.2 compare Bay of Plenty and Australian age-specific rates for Basal Cell Carcinoma and Squamous Cell Carcinoma respectively. The rates are for males and females combined.

It can be seen that Australian rates are higher than Bay of Plenty rates for most age-groups, except, rather puzzlingly, for the older age-groups.

**Chart B.1 Comparison of BCC incidence rates: Australia and Bay of Plenty.**



**Chart B.2 Comparison of SCC incidence rates: Australia and Bay of Plenty.**



**Table B.5 Comparison of Australian 2002 and Bay of Plenty 1998 NMSC Rates**

**Comparison of Australian and Bay of Plenty Non-Melanoma Skin Cancer Rates**

Actual Population and Age-Standardised to 2000 WHO World Population

Rates per 100,000 population

	BCC			SCC			Total		Total
	Males	Females	Total	Males	Females	Total	Males	Females	
<b>Actual Population</b>									
BoP 1998	1,367	876	1,120	598	655	628	1,965	1,531	1,749
Aust ASR (A)	1,538	1,068	1,286	771	441	592	2,309	1,510	1,878
<b>Age-standardised Population</b>									
BoP 1998 (W)	974	612	781	492	278	377	1,466	890	1,158
Aust ASR (W)	1,151	825	977	561	323	432	1,712	1,148	1,409
Ratio Aust: BoP	1.18	1.35	1.25	1.14	1.16	1.15	1.17	1.29	1.22

Table B.5 compares overall Australian and Bay of Plenty incidence rates. Age-adjusted to the WHO World Population basis, BCC Rates for Australia exceed Bay of Plenty rates by about 25 percent, and SCC rates by about 15 percent. These numbers appear plausible, given the generally greater solar exposure to be expected in Australia as compared with New Zealand.

A complicating issue is ethnicity (Shaw 2008). Māori and Pacific peoples' skin cancer incidence rates are not zero, but are certainly much lower than for 'European/Pakeha' or 'Non-Māori/non-Pacific' ethnic groupings. For New Zealand as a whole, Māori and Pacific ethnicities, using the 'inclusive' definitions, amount to approximately 20 percent of the total population, about 15 percent Māori and 5 percent Pacific. For the Bay of Plenty, the proportion Māori is higher, but Pacific lower.

The incidence rates for non-Māori non-Pacific would accordingly be higher than in the table above relative to the Australian population with its higher proportion 'Caucasian'. Offsetting this is the younger average age of Māori and Pacific populations.

## Appendix C

### Estimates of the current ‘prematurely dead population’ caused by past skin cancer deaths

That is, the ‘additional population’ or ‘missing population’ who would currently be alive were it not for the deaths caused in the past by skin cancers.

This involves the following steps –

- Applying current mortality rates for skin cancers (as in table A.3 in Appendix A) to past populations to estimate past deaths.
- Calculating the proportion of those past deaths who would subsequently have died anyway from normal causes during the intervening period from then to now.
- Summing the remainder to get the estimated additional population who would currently be alive were it not for skin cancer. (Note in accordance with standard practice, no attempt is made to quantify the births which did not take place because of lives lost through skin cancer. Collins and Lapsley, 2002, page 84. This of course is unlikely to be a significant number in the case of skin cancers)

For this report past deaths have been calculated back to 1951, applying the mortality rates derived separately for melanoma and NMSC for the 2002-2004 period. This has been done at 5-yearly intervals, 1951, 1956, etc., to 2001. Estimates for intervening years have been calculated by straight-line interpolation, within each 5-year age-gender group. Finally the proportion of those dying from skin cancers who would otherwise have died of normal causes is calculated using ‘survivorship factors’ derived from the 2000-2002 New Zealand Life Tables published by Statistics New Zealand.

The aggregated results of these calculations are summarised in table C.1 below. Note that only half the deaths are included for the ‘current’ year, 2006; assuming these die on average halfway through the year.

The total additional population in 2006 would have been 4,741. Put another way, 4,741 life-years were lost in 2006 as a result of skin cancers.



**Table C.1 NZ ‘prematurely dead population’ in 2006 as a result of past skin cancer deaths**

**Missing NZ Populations in 2006 as result of skin cancers**

<b>Melanomas</b>			<b>Non-melanoma skin cancers</b>		
<b>Age/Group</b>	<b>Males Number</b>	<b>Females Number</b>	<b>Age/Group</b>	<b>Males Number</b>	<b>Females Number</b>
15-19	0.0	0.0	15-19	0.0	0
20-24	2.6	1.8	20-24	0.0	0
25-29	6.3	6.5	25-29	0.0	0
30-34	17.2	13.4	30-34	0.0	0
35-39	38.5	22.6	35-39	0.0	0
40-44	60.9	38.3	40-44	0.8	0
45-49	87.9	64.1	45-49	3.4	0.9
50-54	124.9	85.1	50-54	8.9	3.3
55-59	184.4	108.0	55-59	15.0	5.6
60-64	221.9	124.3	60-64	21.8	6.8
65+	1556.4	1045.8	65+	572.4	290.8
Sum	2301.1	1509.9	Sum	622.2	307.4

Assumptions underlying the estimates

Some simplifying assumptions were required in deriving these estimates. These include –

- That the mortality experience of those dying as a result of skin cancers would otherwise have been identical to that of the rest of the population.
- That mortality rates summarised in the New Zealand Life tables for 2000-2002 are applicable to earlier periods. In fact mortality rates were higher in earlier years, and the numbers otherwise surviving to the current period will be somewhat overstated.
- That the mortality experience of emigrants and immigrants was identical to that of the rest of the population.
- That the age-structure, by gender, of the population prior to 1991, back to 1951, was identical to that observed in 1991. This was required by the lack of readily available information on the age-structure in those earlier years. (Note also that total populations prior to 1991 were scaled up by a factor of 2 percent, to make the earlier totals correspond to the ‘Estimated Resident’ population definition used by Statistics NZ from 1991 onwards.)
- That skin cancer mortality rates were the same in earlier years as in 2002-2004.

Of these assumptions that most likely to lead to significant error is the last. Although there seems to have been little change in melanoma incidence since 1996, it seems also that age-adjusted rates were lower in earlier decades, and presumably therefore mortality rates. It could therefore be therefore that the estimates given here are somewhat over-stated.

## Appendix D

### Inflation measures for health-system costs

The estimates in the 2000 report on the New Zealand costs of skin cancer were for the year 1998 in 1998/99 prices. For the current report the estimates are for the calendar year 2006, but June year 2007/08 prices are being used. This is in part to make use of the latest available Cost-Weight Multiplier, of \$3,740.38 (excl. GST) for 2007/08, used to calculate hospital inpatient (including day-patient) expenditures.

For general information the table below gives Cost-Weight Multipliers for June years from 1998/99. Overall its value increased by 53.7 percent over the nine-year period, or 4.9 percent per annum. It is to be noted, however, that this includes an 18.7 percent increase in the latest period from 2006/07 to 2007/08. Excluding this last year the average annual increase from 1998/99 to 2006/07 was only 2.9 percent per annum. Possibly the substantial increase in the latest year 2007/08 was to take account of higher than average increases in health work-force incomes in recent years. There are also complexities concerning the inclusion or exclusion of 'Blood' services in the cost-weight calculations which have influenced the values for some years.

Table D.1

#### Cost-Weight Multipliers. Financial Years 1998/99 to 2007/08 \$ excl GST

Financial Year	Medical/Surgical Inpatient	Neonatal Inpatient
Jul98-Jun99	\$2,433.62	None
Jul99-Jun00	\$2,399.22	\$2,761.48
Jul00-Jun01	\$2,487.16	\$2,732.47
Jul01-Jun02	\$2,479.01	\$2,677.23
Jul02-Jun03	\$2,617.72	\$2,827.03
Jul03-Jun04	\$2,728.55	\$2,946.72
Jul04-Jun05	\$2,854.88	\$3,124.17
Jul05-Jun06	\$2,949.09	\$3,124.17
Jul06-Jun07	\$3,151.01	No longer used
Jul07-Jul08	\$3,740.38	
<b>% change</b>		
	98/99 to 06/07	29.5%
	98/99 to 07/08	53.7%

Source: NZ Health Information Service

It can be convenient to have a number for the amount by which the estimates in 1998/99 prices should be scaled up to allow for subsequent inflation. We have the following numbers, for price inflation and wage inflation<sup>1</sup>.

CPI All Groups consumer prices. 1998 to 2007 Calendar years.	+ 22.6%
Average total weekly (FTEs) earnings. March quarter 1998 to 2007.	+ 34.9%

The CPI is the most commonly used deflator for health expenditure time series data. For example in the *Health Expenditure Trends* publications by the Ministry of Health. That is the earlier estimates for 1998 would be increased by about 22.6 percent to results comparable with those in this report (not forgetting, however, that other factors such as an aging population will also affect the latest numbers in this report).

It is, however, more reasonable on the whole (assuming negligible increased productivity) to use average earnings as a measure of health sector inflation, rather than consumer prices. That is, an increase of 34.9 percent might be applied to the earlier 1998 estimates. Though this still leaves quite a gap between the 34.9 percent increase for economy-wide weekly earnings, and the 53.7 percent increase in the official Cost-Weight Multiplier, even allowing for health sector increases exceeding the economy average. There is no simple resolution of these complexities, though development of cost and price indexes specifically for the health sector would do the job.

#### Adjusting 'lost production' estimates to 2007/08 prices.

One further minor detail is that these estimates for 2006 are calculated initially from incomes data for the June quarter 2007. To bring them to 2007/08 terms, they are further adjusted by the increase in the CPI from 2007 calendar year to June year 2007/08 – an increase of 1.8 percent.

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<sup>1</sup> Another possible measure of 'earnings inflation' is the average weekly income per person 15+ obtained from the June quarter Income Surveys linked to the Household Labour Force Survey in that quarter. This measure (excluding investment income) is used elsewhere in this report to calculate 'Lost Production' for the population lost from skin cancer deaths. This average increased 46.6 percent from 1998 to 2007. However it is not an appropriate 'index measure' for wage inflation as it includes all the adult population and hence will have increased in part because of the fall in unemployment over the past decade.

## Appendix E

### Details of estimates of ‘non-hospital’ health-care skin cancer and related conditions costs for New Zealand

A summary of the material in this Appendix is given in Section 5 of the main report.

#### E.1 Non-hospital healthcare costs<sup>2</sup>

As already mentioned the main information gap in measuring skin cancer costs concerns non-hospital costs. These include GP consultations, lab tests, specialist (dermatologists and plastic surgeons) consultations and procedures carried out in their surgeries or at public out-patient clinics, pharmaceuticals, and, finally, residential and hospice care. From data such as that available for 1998 from the Bay of Plenty dataset on Lab tests it is possible to estimate approximately the number and cost of Lab tests and GP consultations for the country as a whole. This still leaves, however, the problem of estimating specialist treatment costs, hospital and non-hospital.

Two approaches are followed here. The first might be called ‘top-down’, drawing on Australian estimates of cancer costs (AIHW 2005) and using the estimated Australian ratio of ‘non-hospital’ to ‘hospital’ costs. The rationale is that, although unit costs differ between the two countries, the differences will mainly be a result of the exchange rate and of differences in average income levels. Procedures will be similar, and cost ratios between different parts of each country’s health system should also be similar. Using Australian data is obviously not ideal, and is done only for lack of comprehensive New Zealand data.

The second approach, ‘bottom-up’, consists in trying to construct for New Zealand direct estimates of each major component of costs apart from hospital discharges. That is done in subsequent sections of this Appendix. Here we try initially the first approach.

#### E.2 Using Australian ratios to estimate out-of-hospital medical costs

Table E.1 provides a broad breakdown from the most recent Australian study of the costs<sup>3</sup> of ‘cancer and other neoplasm’ in that country in 2000-01.

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<sup>2</sup> More accurately ‘non-admitted patient costs’, to use the Australian terminology. Inpatients and day-patients are ‘admitted’ patients, whereas out-patients are not.

<sup>3</sup> Note that, unlike in New Zealand, Goods and Services Tax (GST) is not imposed on health-care services in Australia.

**Table E.1. Health System Expenditures on Skin Cancer.  
Australia. 2000-01**

A\$mn

<b>Condition</b>	<b>Admitted Patients</b>	<b>Out-of-Hospital Medical</b>	<b>Pharms Requiring prescription</b>	<b>Other</b>	<b>Total</b>
Melanoma	18	6	1	5	30
Non-melanoma skin cancer	119	84	1	60	264
Total	137	90	2	65	294

Source: AIHW 2005. Table 2.2

‘Out-of-hospital medical’ includes general practitioner, imaging, pathology, and other medical services (AIHW 2005. Page 11.) Later in the publication it is said that it ‘Includes un-referred attendances, imaging, pathology and specialist consultations.’ (Page 55).

‘Other’ category. This category includes the following. The expenditure totals are for all “cancers and other neoplasms”.

Research	A\$215 mn
Community & public health (cancer screening)	A\$130 mn
Dental & other professional	A\$ 22 mn
Non-admitted patient services hospitals	A\$272 mn
Over-the-counter medications	A\$ 16 mn
Aged care homes	A\$ 37 mn
Total	A\$692 mn

Source: Pers. Comm. John Goss AIHW 10/11/2008

The question is the allocation of these to melanoma and, particularly, NMSC. ‘Research’ costs are allocated to the different cancers in proportion to non-research costs. This would seem likely to exaggerate research spending on NMSC. Another point is that research costs are unlikely to vary with changes in cancer incidence, at least within the range of probably achievable changes. Therefore spending on research need not be taken into account for cost-effectiveness analyses of possible interventions such as SunSmart.

Of the other items in ‘Other’, the only one likely to be of any significance is ‘Non-admitted patient services hospitals’.

All this suggests a modification of Table E.1, removing Research costs (estimated approximately as Melanoma A\$2.4 mn; and NMSC as A\$19.7 mn) from ‘Other’, and labeling the residual as ‘Non-admitted patient hospital services’. Table E.2 is the result. The table should not be attributed to AIHW.

**Table E.2. Health System Expenditures on Skin Cancer. Australia. 2000-01 Modified to remove Research Expenditures**

Condition	A\$mn				Total
	Admitted Patients	Out-of-Hospital Medical	Pharms Requiring prescription	Non-admitted Hospital	
Melanoma	18	6	1	2.6	27.6
Non-melanoma skin cancer	119	84	1	40.3	244.3
Total	137	90	2	43	272

Source: Author’s modifications of Table E.1

For the Australian data in Table E.2, the ratio of ‘Total’ expenditure to ‘Admitted Patients’ expenditure is 1.53 for Melanoma, and for non-melanoma skin cancer 2.05.

Applying these ratios to the 2006 totals for hospital costs in New Zealand from Table 5.1, after scaling up 10 percent to include privately-funded hospital treatment, gives the following results in Table E.3. For ‘other neoplasms’ a ratio of 2 is assumed.

**Table E.3 Total NZ Health-care costs, if extrapolated from NZ hospital costs using Australian ratios. 2006**

	NZ\$mn (excl.GST) 2007/08 prices				Estimated Total \$mn
	Publicly-funded hospital costs \$mn	Privately-funded \$mn	Sum \$mn	Scaling factor x	
Melanoma	3.4	0.3	3.7	1.53	5.7
Non-melanoma	17.7	1.8	19.4	2.05	39.8
Other neoplasms	5.3	0.5	5.8	2.00	11.6
Total (including other neoplasms)	26.3	2.6	28.9		57.1

On this basis overall health costs at NZ \$52.9 million would exceed ‘admitted patient’ hospital costs of NZ\$28.9 mn by NZ\$28.2 mn.

### E.3 Cost of laboratory tests

We turn now to the ‘bottom-up’ approach, constructing direct estimates of components of non-hospital costs for skin cancer in New Zealand, starting with Lab tests.

The standard lab test for suspect skin excisions is the C50 histology test. The schedule fee for this in recent years has been as follows<sup>4</sup> –

2006/07	\$59.90	excl GST.
2007/08	\$61.83	excl GST.
2008/09	\$63.19	excl. GST.

In the earlier appendix the number of positive tests for non-melanoma skin cancer were calculated by applying Bay of Plenty 1998 rates to the resident New Zealand population in 2006. The resulting numbers were 55,000 for Basal Cell Carcinoma, 25,000 for Squamous Cell Carcinoma, and 27,000 for non-malignant keratoses; for a total of 107,000 tests New Zealand-wide. To this should be added the number of new melanomas diagnosed – approximately 2,000 annually – for a total of 109,000.

There were also of course tests ordered which gave a negative result. This number is not that easily estimated<sup>5</sup>. Strictly these tests should be included - they would not be required if there was no such condition as skin cancer – but no attempt is made here to estimate their number and cost. The totals from this section are therefore likely to be on the conservative side.

Thus Lab test costs, for estimated test numbers in 2006, at the average fee of \$61.83 in 2007/08, are –

$$\begin{aligned} 109,000 \times \$61.83 &= \$6.7 \text{ million, excl. GST.} \\ \text{Of which melanoma associated costs are } 2000 \times \$61.83 &= \$123,660. \end{aligned}$$

### E.4 Cost of skin cancer related GP consultations.

Associated with these Lab tests are initial GP consultations, and follow-up consultations as required. Working now in terms of the number of persons having one or more skin tests, rather than the number of tests, the estimated number of persons tested New Zealand-wide who test positively for malignant skin cancer is 43,900 for BCC, 23,100 for SCC, and 2000 for melanoma, for a total of 69,000. (For total New Zealand GP numbers of approximately 3,000 this equates to an average 22.3 malignant skin cancers annually.) These are assumed to require two GP consultations

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<sup>4</sup> From a combination of data for localities applying the schedule fee, and those where community lab services are provided under bulk contract. (Pers. Comm. Chris Lewis, NZHIS).

<sup>5</sup> Heal et al. 2008., report on the accuracy of clinical diagnosis of skin lesions, based on a sample of skin excisions in 8694 patients in Townsville / Thuringowa, Australia from December 1996 to October 1999, using the histological diagnosis as the ‘gold standard’.

Dr Marius Rademaker (*pers. comm.* 4/12/2008) also mentions this issue. “This doesn’t include the number of tests that were negative (ie lesions that were removed and tested because the referring doctor thought they were a skin cancer, but was not.” He adds “Estimates vary but on average Dermatologists will excise 4 lesions/Histologically proven melanoma and GPs 30 lesions/melanoma.”

on average<sup>6</sup>. For persons diagnosed as having keratoses, numbering around 25,000, it is assumed there will be no follow-up consultation<sup>7</sup>. Again GP consultations for persons whose tests are negative are not included in these counts.

Thus GP consultations are estimated to number

	69,000	x	2	=	138,000
plus	25,000	x	1	=	25,000
			Total	=	163,000

This equates to a ratio of GP consultations per diagnosis of skin cancer of 2.36. This could, however, overstate GP encounter numbers, as a lesion excised by the GP on first encounter might give a positive result, but having already been treated not require a second consultation. Australian data are of assistance here. From the recent AIHW report (2008, Tables 1.2, 1.3 and 2.1) it can be calculated that the ratio of GP encounters to new NMSC cases averaged about 2.2 in both the periods 2000-02 and 2005-07. Given this is based on actual survey data, this ratio is adopted in preference to the results of the calculation above.

Thus the number of GP encounters is taken as  $69,000 \times 2.2 = 151,800$

An average GP consultation fee of \$70, before subsidy deductions, is assumed (from a Government funding perspective the subsidy cost per consultation following the increases in subsidy in recent years would average of the order of \$45). Deducting GST gives a cost per consultation of \$62.22, excluding GST.

Thus total GP consultation costs amount to –

$151,800 \times \$62.22 = \$9.4 \text{ million, excluding GST.}$

Of which melanoma associated costs are  $2000 \times 2 \times \$62.22 = \$248,880$

Table E.4 summarises these cost totals.

**Table E.4 Skin Cancer associated GP consultation and Lab Test costs.  
New Zealand 2006**

NZ\$m, excl GST. Approx. 2007/08 prices

	Melanoma	Non-melanoma	Total
GP consultations	0.25	9.1	9.4
Lab Tests	0.12	6.6	6.7
	-----	-----	-----
Total	0.4	15.7	16.1

<sup>6</sup> Dr Rademaker comments “This will be underreporting because of the treatment of skin cancers with non-surgical techniques (cryotherapy, 5-fluorouracil, imiquimod, etc).” Further “It would be very unusual for a GP/specialist to excise a skin cancer at the first visit. Most will be booked for surgery. Most will probably also come back after surgery for suture removal/wound check/ discussion of results, so I think the numbers are underestimated.”

<sup>7</sup> Dr Rademaker notes “Most patients with solar keratosis will have them treated several times per year, as new lesions continue to appear regularly.”



The total of GP consultation fees plus Lab Test costs amounts to \$16.1 million, excl GST.

#### **E.5 Remainder of costs, apart from ‘admitted hospital patient costs’.**

From the earlier table E.3, extrapolated using Australian ratios, some NZ\$28.2 million might be expected to be spent on skin cancers outside of in-patient and day-patient treatment in the hospital system, of which NZ\$2.0 mn would be spent on melanoma, NZ\$20.4 mn on NMSCs, and NZ\$5.8 mn on ‘other neoplasms’. Deducting the amounts in Table E.4 for GP consultations and Lab tests leaves approximately NZ\$1.6 mn for melanomas, and NZ\$10.5 mn for NMSCs and ‘other neoplasms’ together.

For melanomas this means about NZ\$800 per new melanoma case (2,000 per year), and about NZ\$152 per NMSC (69,000 per year).

Are these reasonable numbers? One check is to look at the average lifetime Australian costs per case. For melanoma this is stated to have been A\$3,341 per case in 2000-01 and per NMSC A\$700. (Shih, 2008. Page 12; drawing on AIHW 2005). Suppose for comparison with these Australian numbers we divide the totals in Table E.3 by the number of cases (again combining NMSC and ‘other neoplasm’ expenditures). This gives for New Zealand in 2007 an average per melanoma case of NZ\$2,850, and per NMSC of NZ\$745. These are cross-sectional rather than life-time costs, but probably a reasonable approximation.

These numbers, at least for NMSC, appear not too unreasonable when compared with the Australian numbers, though the latter would need adjustment upwards for increases in costs subsequent to 2000-01<sup>89</sup>. For this report therefore the numbers in Table E.5 are taken as being adequate estimates of the costs of skin cancer in New Zealand. It does seem likely, however, that these numbers are on the conservative side, and the true costs are somewhat higher than estimated here. In support of this, recent work at the New Zealand Ministry of Health, collating melanoma registrations with out-patient procedures for melanoma, such as oncology department consultations and radiotherapy and chemotherapy, gives an estimated NZ\$4.7 mn per annum on specialist outpatient services for malignant melanoma. This is certainly in excess of the amount implied from the above calculation.

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<sup>8</sup> Also relevant in such comparisons is the exchange rate. In November 2008 NZ\$1.00 equalled approximately A\$0.85

<sup>9</sup> Further information of relevance provided by Dr Rademaker is as follows. “It is difficult to determine the cost of surgery outside of Public Hospital practice, but I’ve asked around: a median price for mole/NMSC removal is in the order of \$125-250 by GPs, \$400-800 by dermatologists, and \$600-1200 by plastic surgeons. These figures include theatre fees, which GPs rarely charge as they use lower end facilities.”

**Table E.5 Estimated Total Skin Cancer and Related Conditions Health-care costs for New Zealand.**

	<b>2006</b>				
	NZ\$m (excl. GST) in 2007/08 prices				
	<b><u>Hospital Costs – Admitted Patients</u></b>			<b>Other</b>	<b>Total</b>
	<b>Publicly-funded</b>	<b>Privately funded</b>	<b>Total Hospital</b>	<b>health-care</b>	
	\$mn	\$mn	\$mn	\$mn	\$mn
Melanoma	3.4	0.3	3.7	2.0	5.7
Non-melanoma (including other neoplasms)	23.0	2.3	25.3	26.1	51.4
Total	26.3	2.6	28.9	28.2	57.1
(Of which: 'other neoplasms')	5.3	0.5	5.8	5.8	11.6)

If these estimates are used in cost-effectiveness analyses, it will be necessary to subject the results to sensitivity testing of the effects of varying substantially these cost estimates.

## Appendix F

### Skin Cancer Preventive Expenditures in New Zealand

The two organisations primarily responsible for expenditure on the promotion of measures to reduce sun exposure and skin cancer incidence in New Zealand are –

- The Cancer Society is funded by bequests and donations. Spending on skin cancer is of course only a part of the Society's total expenditure. The Cancer Society's decentralised structure makes it difficult to get precise estimates of spending by it on sun-awareness and skin cancer prevention, and a proportion of the Society's work is undertaken by volunteers. It is possible that total resources devoted by the Society to skin cancer amount to about \$1 million annually.
- The New Zealand Health Sponsorship Council, whose work is financed by government contracts. Again spending on skin cancer prevention is a part only of the HSC's work, which also includes tobacco control measures, and general promotion of a healthy life-style.

Other sources of expenditure include personal expenditures on sunscreen, sun-hats, etc; and promotion of such products by their manufacturers. Data supplied by AC Nielsen Ltd show that all supermarket sales of sunscreen for the six months to 22<sup>nd</sup> March 2009 to have been \$10.6 million, and \$9.7 million for the same period a year earlier (sales in remaining months are minimal). A large proportion of these outlays would be, however, to avoid the unpleasantness of sunburn rather than, or as well as, consciously reducing skin cancer risk.

#### Cancer Society of New Zealand Outlays

(From information compiled by Dr Judith Galtry; November 2008)

**Table F.1**  
**Average annual skin cancer prevention & early detection costs**

National Office	Approx.	\$265,000
Divisions:	Approx.	\$906,449
Total (conservative estimate)		\$1,171,449

#### Health Sponsorship Council Outlays.

(Information supplied by Dr Iain Potter and Wayne Beckman; HSC, October 2008)

Outlays commenced in 1993/94. Preventive expenditures by the New Zealand Health Sponsorship Council on the Sun Safety program in recent years have been as follows:

**Table F.2**  
**NZ Health Sponsorship Council expenditure on Sun Safety program.**  
**2005/06 to 2007/2008**

NZ\$, including overheads, but excluding GST

2005/06	\$1,195,566	
2006/07	\$ 951,732	
2007/08	\$1,150,000	Not yet audited.
2008/09	\$1,053,000	Budgeted.

Source: Health Sponsorship Council.

These expenditures amount to about NZ 25 cents per head per year, for a New Zealand resident population of over 4 million, fairly close to what Shih labels as ‘optimal’ in the Australian case (Shih 2008).

An approximate break-down of these outlays over the two years 2007/08 and 2008/09 is as follows –

Research and Evaluation	Approximately 12%
e.g. three-yearly Sun Safety Survey, consumer research, etc	
Media	
Paid media	“ 25 – 33%
Other communications	“ 11%
e.g. PR, Met Service UVI information	
Resources for education	“ 6 – 8%
Posters, brochures, merchandise	
Projects	“ 6 – 10%
e.g. ongoing work with TLAs, web-based tool for assessing school environment and exposure to sun.	
Support community based health promotion activities	“ 2.5 – 4%
Sponsorships e.g. surf life-saving	“ 5%
Overheads, staff, travel, etc	“ 20 – 23%

Source: Discussion with Health Sponsorship Council (Iain Potter).

**Summary:**

These two organisations between them spend over \$2 million per year on skin cancer prevention and early detection.