Introduction
Where they have been recorded, incidence and mortality rates for melanoma have been rising steadily (although with some variation between countries) during the 20th century. Although there may be some breakthroughs with novel treatment on the horizon (as highlighted in this issue), at present surgical excision is the mainstay for cure of this disease. There is little doubt that detection and excision of the tumor in an early stage have contributed most to the decreasing case fatality rates seen in recent decades.

Early detection of melanoma is an approach to control that, if used effectively, can have a relatively rapid impact on decreasing population mortality rates. It focuses on people who either have melanoma or will develop it in the very near future. It is the first approach taken by most countries when implementing a public health control program for melanoma.

In the presence of a continuing increase in the incidence rate of melanoma, another approach considered by many cancer control programs is primary prevention. In this case, a cause for the disease (sunlight exposure) is highlighted, and programs are developed to reduce exposure to this environmental risk factor. It is a long-term approach.

Because there is a considerable time lag from exposure to sufficient sunlight to induce and then promote melanoma and the onset of the clinically apparent tumor, it is likely that decades must pass before a detectable reduction in the onset of new tumors occurs as a result of reduced exposure to sunlight following a melanoma primary prevention program.

Nevertheless, primary prevention and early detection (secondary prevention) are the two major public health approaches now being considered or undertaken on a population basis in many countries. This article considers both approaches. It outlines briefly the data and assumptions on which the approaches are based and gives some examples of program development, delivery, and measurement of outcome.

Epidemiologic and behavioral research underpin the process in both primary prevention and early detection programs. They provide data on the need, the cause, the susceptible population, the targets for change, and assessment of effect of the public health approach to melanoma control.

Early Detection as an Approach to Melanoma Control
DATA, ASSUMPTIONS, AND PRACTICAL DETAILS
To influence mortality due to a cancer, the tumor must be detectable in its primary tissue at a stage when it can be easily treated before secondary dissemination is
likely to be lethal within the affected individual’s expected lifetime. There are data now available which show that survival from invasive cutaneous melanoma can be influenced by excision when the tumor is thin. Using Breslow’s microscopic measurements (the thickness of the melanoma in millimeters from the granular layer of the epidermis to the deepest portion vertically below), it is possible to predict the likelihood of metastatic disease and subsequent mortality.\(^1\) Combined with other prognostic variables (e.g., sex, site, ulceration, Clark’s level of invasion, and others), a reasonably accurate risk of metastasis can be calculated.\(^2\)

Using thickness alone, it has been shown that tumors less than 0.75 mm in thickness are likely to be lethal in less than five percent of patients. Tumors that are 4 mm or more in thickness at primary excision have developed the capacity to metastasize and be lethal in more than 50 percent of patients.\(^2\)

The success of the public health approach to early detection relies on an ability to detect thin, early tumors. This in turn requires that early melanoma has characteristics that highlight the fact that it is abnormal. These characteristics must develop at a rate that allows them to be noticed and treated before the tumor has developed sufficiently to be potentially lethal. Thus, there is a need to have the melanoma seen (the public) and removed (the health professional).

There are very few data available that give a clear indication of the natural history of clinically apparent melanomas. Nevertheless, anecdotal data suggest that many tumors grow relatively slowly over months to a year or more in a thin stage (lateral growth phase), before becoming deeply invasive (the vertical growth phase).\(^3\) These tumors include the superficial spreading melanomas and the lentigo maligna melanomas.

Lentigo maligna melanomas may grow very slowly for many years on sunlight-exposed areas, such as the face, before becoming deeply invasive. Both lentigo maligna melanoma and superficial spreading melanomas develop clinical characteristics that suggest a need for attention. These can be remembered by thinking of ABCD: A (asymmetry); B (border irregularity); C (color variegation); and D (diameter enlarging) (Table 1).\(^4\) More recently, MacKie\(^5\) has published a seven-point checklist for medical practitioners refining the clinical characteristics to major signs and minor signs. A study of the original seven points suggested that of the various signs, border irregularity is the most powerful predictor of a melanoma.\(^6\) However, this simple sign still only had a positive predictive value of 13 percent.

Superficial spreading and lentigo maligna melanomas are most suitable for the public health approach to melanoma control. Nodular melanoma, on the other

| Table 1 |
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| **Clinical Signs of Early Melanoma** |
| **A** | - Asymmetrical lesion |
| **B** | - Border irregularity |
| **C** | - Color variegation within the lesion |
| **D** | - Diameter enlarging |

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Prevention and control of Melanoma

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hand, appears as a rapidly growing tumor in the vertical growth phase from an early stage. Nodular melanomas may not show all the typical characteristics of melanoma described above and thus are difficult tumors to detect in an early curable phase. They make up 10 to 20 percent of melanomas treated in most series reported. Unfortunately, they tend to have a higher case fatality rate due to detection at a thicker stage than superficial spreading melanoma or lentigo maligna melanoma. Therefore, they contribute proportionally more to mortality data than the other types.

In designing early detection programs, it is desirable to be able to concentrate on populations at high risk of developing the tumors (Table 2). From the data on risk factors for melanoma, it is clear that the most important risk factor is skin color. Melanoma is very rare in black people. Among people who are not black, the major risk factor is number of melanocytic nevi (moles), both common acquired and dysplastic or atypical. Risk gradients have been calculated for numbers of nevi, with greater than 200 nevi considered high risk (relative risk greater than 20 in some series). Other risk factors include tendency to freckle, unprotected skin response to strong sunlight (burn/tan response), family history of melanoma, family history of atypical nevi, past history of excessive sunlight (burns), and country of childhood. As in most cancers, age itself is a risk factor. It is difficult epidemiologically to separate age from exposure to sunlight.

People with a family history of melanoma and dysplastic nevi who have a large number of nevi themselves are at very high risk of developing a melanoma over a lifetime. In some series this cumulative lifetime risk approaches 100 percent. Thus, there is a case for placing such individuals under surveillance and regular follow-up. The use of clinical photography to record baseline lesions and detect change over time is a useful technique. Early tumors have been detected in follow-up of these patients in specialized clinics. Interestingly, it is the clinicians using the photographs who have detected the vast majority of melanomas, rather than the patients themselves.

Apart from this very high-risk group, the role of screening as a population-based approach to melanoma control is controversial. Although the risk factors mentioned above do help pinpoint which particular people are at increased risk, in most populations they account for only around 30 to 50 percent of people who develop lethal tumors. As yet, there are no data on population-
based mass screening of asymptomatic people demonstrating a reduction in mortality rate.  

On the other hand, a reduction in mortality rate has been reported in some populations following public education programs. These programs have relied on members of the public inspecting their own skin (or that of a friend or partner) and then visiting a health professional for subsequent management (Fig. 1). This is primary screening by skin self-examination. There have been a variety of techniques recommended for skin self-examination, but as yet there have been no studies that demonstrate with any certainty the efficacy of any particular method. A recent paper by Berwick et al suggests that skin self-examination may be of some value, but this is very early work, and as the authors themselves state, more research is necessary before strategies are promoted to increase the practice of any particular skin-examination technique. There are no studies to suggest the frequency with which skin self-examination should be performed.  

There are data published suggesting that members of the public do examine their own skin. A study of 1,344 people in New South Wales, Australia, recorded that 12 percent had noticed one or more signs suggestive of abnormality on the ABCD classification in the previous year. The study found that the positive predictive value of the classification is around 4.2 percent. Another study indicated that members of the public may be able to determine if they are at high risk using freckles and moles as risk factors. A group of dermatology patients without melanoma were able to show a sensitivity of 88 percent for number of freckles on the right forearm, 63 percent for one or more palpable nevi on the arm, and 68 percent for detection of nevi larger than 5 mm in diameter on any part of the body. Corresponding specificities ranged from 83 to 100 percent, depending on the type of lesion and number being classified.  

At the moment, simply describing the abnormal signs to look for has been the mainstay of education programs that have demonstrated any degree of success. Inducing people to visit a health professional for further management relies on the ability of the professional to be able to recognize abnormalities and to know the correct procedure to deal with them. An imperative of any public health program that relies on professional services to provide diagnosis and management of abnormalities detected by the public, therefore, is to train professionals first, prior to the public education program.  

In a hospital-based skin cancer clinic, skin cancer specialists were reported to
have an overall sensitivity of 81 percent, specificity of 99 percent, and positive predictive value of 73 percent for detection of melanoma in the years 1955 to 1982.\textsuperscript{16} In contrast, for skin cancer fairs run by the American Academy of Dermatology, positive predictive value for inspection by dermatologists was about 35 to 40 percent.\textsuperscript{17} These are data for specialists. Those not trained specifically in melanoma diagnosis have rates substantially lower than that.

Using photographs as a study instrument, Cassileth et al\textsuperscript{18} showed that only 38 percent of nondermatologists correctly diagnosed four or more of six melanomas compared with 92 percent of dermatologists. They showed also that only 42 percent of nondermatologists could identify dysplastic nevi compared with 96 percent of dermatologists. There are a variety of studies confirming the difference in reliability of diagnosis of melanoma and other pigmented lesions between specialists and others less well trained.\textsuperscript{19,20}

In some countries, specialized pigmented-lesion clinics staffed by experts in melanoma have been established. In other countries, members of the public can seek attention from a specialist, such as a dermatologist, as the first point of contact. This is the case in the United States, although changes in the provision of health care funding may lead to the primary care physician being appointed first contact in the future. This is already the case in Australia, where there are very few pigmented lesions clinics available. In these cases, education programs need to be directed at the doctor of first contact.

Data from most countries with relatively high mortality rates for melanoma are showing that it continues to rise in the elderly at a higher rate than younger people. This is particularly the case in men aged 65 years or older.\textsuperscript{21} In the elderly, lethal tumors occur with increasing frequency on exposed areas of the skin. Ironically, elderly patients also frequently visit medical practitioners for other medical problems (e.g., supply of antihypertensives or antiarthritic medication). There may be good reasons why the elderly are not seeking early attention for a tumor that should be plainly seen. These may include failing eyesight, many other benign skin lesions making it difficult to detect an early malignant lesion, other health priorities, and a lack of a partner to observe a change or cajole the individual to seek medical attention.

With this knowledge, there is a case for concentrating on training primary care physicians and encouraging opportunistic screening (case finding) among their older patients. This is taking the opportunity to thoroughly examine the skin of patients when they present for another condition or a supply of medication. There are data suggesting that 20 percent or more of melanomas in some series are detected by a doctor rather than a patient-initiated action.\textsuperscript{22}

The use of skin cancer fairs with dermatologists for screening, as occurs in the United States as a combined effort of the American Academy of Dermatology and the American Cancer Society, does provide an opportunity to educate the public to be aware of abnormalities and seek attention from a health professional. On the other hand, it is unrealistic to expect that these fairs provide a cost-effective way of screening for melanoma on a population basis. Although large numbers of the public have been seen and many melanomas detected, there has been no way of assessing the impact of these activities on long-term morbidity or mortality.
from melanoma in the United States. There may be a case for training skilled observers such as nurses to act as initial screeners in populations where prevalence of melanoma is likely to be high. As yet this concept has not been subjected to formal evaluation.

Finally, screening and detection for melanoma at present relies almost entirely on visual inspection. In an attempt to improve the diagnostic acumen, the dermatoscope (epiluminescence microscopy) has been promoted and used widely in a number of countries. This instrument is an illuminated magnification tool which uses oil on the skin to reduce the air/skin interface and allow inspection of the subcorneal epidermis and dermis. The use of this instrument is still in an early stage. Diagnostic accuracy actually dropped when this instrument was initially used by dermatologists who were not specially trained in its use. Diagnostic accuracy improved to slightly better than visual inspection when dermatologists who trained in its use. For those with limited exposure to many people with melanoma or other pigmented tumors, its value is questionable at present. Its main role may well lie in improving diagnosis of benign pigmented lesions, thus excluding malignancy, rather than in detection of melanoma.

Computerized visual imaging of pigmented lesions is also under study in a number of centers. There have been difficulties in establishing the validity of this approach in a single exposure to pigmented lesions. Nevertheless, as our understanding and technology improve, there may be a case for such an instrument in early detection of pigmented lesions. This is particularly likely to be when using the instrument for detection of change within the same pigmented lesion over time.

**Evaluation of Early Detection Control Programs**

The aim of early detection of melanoma is to reduce the mortality rate due to the tumor. A secondary benefit of early detection is a reduction in the management required and all its consequences. Evaluation of programs can take account of each of the steps along the pathway from attendance by the public for assessment and then removal of tumors to subsequent morbidity and mortality related to melanoma (Table 3).
The first phase of early detection programs involves education and motivation of the target population and the health professionals required to respond to them. Change in medical practitioners’ knowledge, attitudes, and skills following education programs would be a short-term measure of effect.

Similarly, change in attendance for advice following an education program would be a short-term measure of effect of a program directed toward the public. As there are several steps required in the likelihood of attendance, assessment of change in knowledge, attitudes, and beliefs about melanoma and its treatment would be an important component of an outcome measure looking at the public. A lack of attendance could be related to not only lack of knowledge, but also concern about the consequences of having a melanoma detected.

The thickness of tumors removed before and after education programs is a short-term measure of outcome frequently published in the literature. An increase in the proportion of tumors removed in the very thin categories is often cited as evidence of a successful response. However, there have been suggestions that education programs can result in detection of tumors that may not have progressed to a lethal stage. Thus, their detection may bias the assessment of success.

It is a reduction in mortality due to very thick tumors that is the primary aim of these programs. Thus, it is the absolute numbers of these tumors that are detected on a continuing basis that determines the true success in the long term. A reduction in absolute numbers of thick tumors (not just the proportion) for a given population over time is the outcome desired. In the short term, there may be an initial rise in the numbers of people with thick tumors detected as a result of the campaign. But following this, there should be a decrease as more people have their tumors detected early and less have them develop into thick and lethal lesions.

A population-based tumor registry is important in monitoring the effect of a program on the whole community. If the program induces only those people with early tumors to present for treatment, the registry will show that there has been no effect on the numbers of people still presenting elsewhere with thick tumors. In many countries, the inability to completely register all tumors (not just lethal ones) is a hindrance to complete evaluation of a melanoma control program.

Eventually, a reduction in mortality rate is the final monitor of success. Because of lead time bias with removal of thin tumors, it is essential to use long-term survival rates such as 10-year survival data as the monitor of success, rather than five-year survival data. Once again, adequate registration, analysis, and release of these data is imperative to monitor the outcome and subsequent direction of these programs.

Cost-benefit analysis of early detection programs may be expressed in a number of ways, including cost of a life saved, person-years of life saved, or lost time and cost of extensive management and subsequent terminal care avoided.

Primary Prevention as an Approach to Melanoma Control

Primary prevention of melanoma assumes a knowledge of the cause. Despite a large number of possible causative factors being investigated, to date exposure to sunlight by people constitutionally at risk of melanoma is the only environmental factor consistently linked to melanoma in most studies. The constitutional risk factors (or predisposition) were mentioned in the previous section. The exact relationship of sunlight exposure to risk of melanoma is not entirely clear. Epidemiologic studies suggest it is episodic high exposures sufficient to cause sun-
burn, particularly in childhood, that are important.\textsuperscript{27} There are also studies showing differences in risk between indoor and outdoor workers and within different socioeconomic levels.\textsuperscript{28,29} These are studies on adults which suggest that it is not only childhood exposure that is important. Nevertheless, migration studies clearly indicate that high exposure to sunlight during childhood sets the scene for high rates of melanoma as an adult.\textsuperscript{30} History of sunburns as a child is a risk factor, although it is not clear whether this is a global indication of very large exposures at that age or a peculiar sensitivity of childhood skin to excessive sunlight.

There is no satisfactory animal model for determining the exact wavelengths of sunlight that cause melanoma. It has been presumed to be in the UVB (290 to 320 nm) range of ultraviolet radiation because of this range’s ability to cause erythema (sunburn). More recently it has been suggested from studies on users of sunbeds that the UVA (320 to 400 nm) range may contribute as well.\textsuperscript{31} Although these studies are important, it cannot be forgotten that it is exposure to the whole of sunlight that has created the high incidence rate occurring now. Thus, protection should be from the whole of sunlight until we are a little clearer in our understanding of the relationship of the various components of sunlight to the etiology of this tumor. There may be inherent risks in suggesting strategies that reduce only a proportion of some wavelengths while allowing large exposures to others.

Recent concern about stratospheric ozone depletion has added a new dimension to the urgency that many people feel about the need for primary prevention programs. Predictions have been made of increased incidence and mortality rates as a result of increased terrestrial UVB levels caused by ozone depletion.\textsuperscript{32,33} In general, they have tended to be rather simplistic and may well have overestimated the likely outcome. Despite this, most people agree that environmental degradation should be avoided, including ozone depletion. Part of the approach to primary prevention is to not only change behaviors that lead to excessive exposure, but also try to prevent an increase in the strength or amount of the sunlight to which we are exposed.

As yet, we have no very clear-cut marker of individuals likely to develop melanoma if exposed to sufficient sunlight in the right amount at the right age. Genetic screening is becoming increasingly sophisticated. Future work may indicate a specific subgroup of the population to whom primary prevention programs could be targeted. Until then, fair skin populations who live or take vacations in hot sunny climates are the primary target group.

With the lack of clear-cut data on a dose-response curve for melanoma in individuals, the public health message becomes the simple one of suggesting an overall reduction in exposure to sunlight. Initially, this might concentrate on telling people how to reduce the risk of sunburn when outdoors (Figs. 2-4).

Research data suggest that there are some leisure activities during which the risk of sunburn is higher than others. Water sports have the highest proportion of people burning when at leisure outdoors.\textsuperscript{34} This could be due to the combi-
nation of reflected ultraviolet radiation (UVR) from disturbed water and the cooling effect of water, which might produce a false sense of security. A similar effect is seen on cloudy days. Clouds reduce the infrared component of sunlight and thus reduce its warmth. On the other hand, they may have little or no effect on UVR. Thus the common misconception that the erythema following exposure on a cloudy day is “windburn” rather than sunburn.

Risk of sunburn during outdoor activities correlates well with ambient UVR levels. There is a more complex relationship of sunburn to ambient temperature. When temperatures are low and high, sunburn levels are lowest. When temperatures are intermediate, sunburn levels are highest (Fig. 5). In cold weather, people cover up or remain indoors to keep warm. In hot weather, people are more likely to think of sun protection. In intermediate temperatures, including light cloud cover, they are most likely to get burned.

Behavioral research data show a clear correlation of risk of sunburn with desire for a suntan. Thus, an entry point for education programs might be to decrease the desire and the status of a suntan. Although there has been some pessimism on whether this can be achieved, in Australia, where primary prevention programs have been going on the longest, there have been substantial changes in attitudes toward and desire for suntans. An example of the extent to which this has occurred has been reflected in a decrease in the use of suntanned models for advertising products, not only swimwear, in women’s fashion magazines. Advertising agencies love to claim that they reflect community attitudes rather than changing them, particularly in advertising tobacco products.

Sunburn frequency also correlates with age and sex. It is higher in adolescents and young adults than older adults and higher in men than women. Behavioral approaches to sun protection also differ with age and sex. Sunscreens are more likely to be used by women than men and by younger people than older people. On the other hand, hats are more likely to be used by men than women and by older people than younger people. Each of the points mentioned so far is derived from behavioral research. They are useful in determining targets and entry points for developing subsequent education programs.

There are a number of ways in which sunlight exposure can be reduced apart from staying indoors. Various combinations of avoiding sun around the middle of the day, wearing hats and clothing, seeking shade while outdoors, and applying sunscreens can all lead to substantial
reductions in exposure. Natural protection is recommended as the best protection. Sunscreens should be promoted as an adjunct to natural protection, not a substitute for it.

Around 60 percent of total UVB is received in the two hours either side of midday (10:00 am to 2:00 pm, or 11:00 am to 3:00 pm during daylight saving time) (Fig. 6). Shade produced by trees and other canopies can substantially reduce sunlight, including UVR. The higher the canopy off the ground, the more opportunity there is for scattered UVR to reach the people under the shelter. Reflected UVR varies with different surfaces, being high for sand, white concrete, and snow. Although reflectance off still water may be low when the UVR source is vertically above (three to 10 percent), water is frequently disturbed. This can lead to high angles of incidence for the sun and greatly increase reflectance. This point is frequently missed when reflectance amounts from different surfaces and materials are quoted.

Hats with broad brims can provide substantial protection (Fig. 7). A brim size of 10 cm can lead to a reduction of 70 percent in UVR exposure to the head and neck. The density of weave of clothing is more important than the fiber type. Densely woven material provides a reflective barrier to UVR. Because it may also block heat loss, a careful design that allows clothing to be loose but densely woven is necessary to make it comfortable. For loosely woven material, the color and moisture content of the cloth can alter penetration by UVR. Darker colors absorb more UVR and thus allow less penetration than lighter colors, which scatter radiation through a lightly woven garment. Wetting a lightly woven garment may also allow more penetration.

There have been efforts in a number of countries to adopt standards for testing and rating the UVR absorption of clothing. A simple test of efficacy is to hold the material up to strong light and see whether it casts a dense shadow or whether it is easy to distinguish objects through it. A recent article on testing clothing demonstrated that a large proportion of commonly available shirts, not designed specifically for solar protection, had a UVR protection rating of around 20 or more.41

Sunscreens are rated for their UVR absorption under laboratory conditions. A sun protection factor (SPF) rating is determined by measuring the proportional increase in the dose of UVB required to cause minimal cutaneous erythema in humans using the test product compared with the dose required when the skin is unprotected.42 Thus a product requiring four times the dose of UVB is rated SPF4. At present, there is difficulty developing a satisfactory in vivo measure of sunscreen efficacy in the UVA range.

Figure 8 shows the percentage reduction of UVB achieved with increasing SPF numbers. It is an exponential response with relatively little absolute reduction in UVR achieved for relatively big increases in SPF after a level of around SPF16. In practice, most health authorities recommend use of a product that is broad spectrum (filters UVA to some extent) and that is rated at least 15.
Whether products with a much higher SPF rating are necessary is debatable. This author believes that with their relatively second-line role in solar protection, it is hard to justify the increased cost and other potential problems related to regular application of very high SPF products.

The SPF rating is a laboratory-derived classification of efficacy under ideal conditions. There are dangers inherent in translating it directly to a sunscreen’s effect in real-life use (e.g., for estimating sunburn times). An individual’s burn time on any particular day is dependent on many variables. These include body site, degree of normal skin color, amount of suntan, thickness of the epidermis (including stratum corneum), time of day, time of year, cloud cover, ozone levels, reflection and scatter from surrounding objects, and so on. It would require chaos theory to calculate an individual’s burn time at any particular time, and thus using SPF numbers to calculate safe time outdoors before burning is best avoided.

Similarly, the increasing number of electronic UV patches, badges, meters, and other gadgets designed to estimate safe exposure times are to be avoided for the same reason. Behavioral theory states that it is best to promote habitual behaviors to reduce risk from overexposure to sunlight. In practice that means using regular sun-protection methods rather than adjusting up or down on a day-to-day basis according to some faulty calculation. Similarly, it would be wrong to suggest that people should use seat belts in a car only when they believe there will be a lot of traffic and be at greater risk of having an accident.

There are data which show that inadequate application of sunscreens, both in the amount applied and the area covered, is a major problem with the use of these products. More is likely to be achieved by teaching people to apply sunscreens adequately, at the correct time and in reapplication, than would be
achieved by concentrating on seeking higher SPF numbers.

Using the data above, it is possible to see where there are particular target populations and behaviors that might be the subject of both public and professional education programs. But education programs alone are not the only component of the public health approach to melanoma control. They go hand in hand with structural change.

Structural change can be defined as a change to the social, political, or economic structure of a community that may lead to changes in behavior or other outcomes desired in a cancer control program. Structural change can be implemented independently of education programs, but frequently they go together. In tobacco control, classic examples of structural change include legislation banning advertising or taxing tobacco products to make them more expensive and thus more difficult for children to purchase. Examples of structural change in melanoma control are shown in Table 4.

In targeting certain populations, there are many networks that can be used to deliver primary prevention education messages. Professional groups include primary care physicians, pediatricians, maternal and child health nurses, child

Fig. 6. The midsummer and midwinter total UVR and UVB levels by time of day, showing that at least 60 percent of UVB occurs in the two hours either side of midday. Data from the Australian Radiation Laboratory.
care workers, and others who provide professional advice and guidance for children and parents.

Local government authorities are frequently responsible for amenities provided for outdoor use. These include municipal swimming pools, foreshores at beaches, child care centers, parks, and other areas where people may receive large exposure to sunlight. Change can be created by directing efforts through networks like these.

There are many other direct and indirect channels through which both educational messages and structural changes can be implemented. The degree and extent to which individual programs will be developed are dictated by the frequency of melanoma in a particular population and the nature of the surroundings and activities that put that population at risk. For example, in the northern United States or northern Europe, attention might be given to avoiding excessive sunlight exposure during summer or trips to southern climates. In countries closer to the Equator where susceptible populations live year round in the sunlight (e.g., South Africa, Israel, New Zealand, and Australia), more widespread programs might be initiated to try to change the population’s behaviors on a habitual basis in a large number of different situations throughout the year.

In the early 1970s, a program titled Slip! (on a shirt) Slop! (on a sunscreen) Slap! (on a hat) was produced in Australia. This program of cartoon characters appeared on posters, brochures, TV and radio ads, and other resources and exemplifies the very positive approach that can be taken to a primary prevention program. In contrast to tobacco control programs, where the message is clearly to cease exposure totally, the sun protection programs can tell people that being outdoors or going on sunny holidays is fun and healthy. But they can concentrate also on telling people how to enjoy the outdoor activities without substantially increasing the risk of melanoma. Sun-Smart activities can be portrayed in a

Fig. 7. Reduction in erythemal UVB (sunburn units) to the head and neck with increasing brim size on hats. Data from Dr. W. Ryman, Skin & Cancer Foundation, Sydney.
very positive and attractive manner that is more likely to have them noticed and accepted by the various target populations than a program that merely tells people not to do something all the time and takes away what might be seen as a pleasurable or healthy activity.

EVALUATION OF PRIMARY PREVENTION CONTROL PROGRAMS

As stated previously, the lead time between sufficient sunlight exposure to develop a melanoma and its clinical appearance may be many decades. Thus, evaluation of primary prevention programs needs to include measures of outcome that can be used to assess results within the relatively short term (Table 5). Short-term outcome measures predominantly include behavioral variables that indicate activities which put the population at risk. These include knowledge, attitudes, and beliefs about the relationship of sunlight and melanoma, as well as those about tanning and sun protection. Proportions of people in various categories of these behavioral variables can be used as quantitative rather than just qualitative measures.

Data derived from behavioral research used to determine the nature and extent of these variables for development of education programs also can be used to monitor the outcome. Examples include a reduction in the proportion of people with pro-tan beliefs over time, an increase in the proportion of people with knowledge of melanoma and its consequences, and an increase in the proportion of individuals who believe that they are personally at risk. All of these are important in the process that results in a change in behavior. The study of suntanned models in women’s fashion magazines mentioned above is an example of an indirect measurement of an effect of such programs.

Behavioral measures that can be used to assess early outcome of programs include the proportion of people using hats and clothing, the proportion applying sunscreens and particular types used, the proportion avoiding the sun around
the middle of the day, and the proportion using shade. They can be assessed in a variety of ways varying from self-report to observational studies (Fig. 9). Observational studies look at behavior of individuals while they are unaware that they are under surveillance.

The association of melanoma with sunlight exposure sufficient to cause sunburn points to another relatively short-term measure that can be used, that is, sunburn frequencies in populations at risk. Sunburn is a person-specific measure of the degree to which target tissue (i.e., the melanocyte) has been exposed to biologically active UVR. Measurement of the proportion of the population that develops sunburn during leisure activities over summer or on holidays can be determined. It is necessary to correct for weather conditions and UVR levels when making comparisons between sunburn frequency in populations at different times.34

Behavioral theory states that it is easier to change behavior in the short term (interrupt a habit) than to maintain long-term behavior change (change a habit).45 The latter is more complicated with determinants of trial behavior being

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**Table 4**

**Structural Changes Possible for Primary Prevention of Melanoma**

| Short Term | Medium Term | Long Term |
|------------|-------------|-----------|
| Increase in knowledge, attitudes, and beliefs about melanoma and sun protection | Increased use of hats, clothing, shade, and sunscreens | Decrease in incidence of sunburn |
| Decreased desire for suntan | Decreased frequency of sunburn | Decrease in mortality rate of melanoma |

**Table 5**

**Evaluation of Primary Prevention Programs**

| Short Term | Medium Term | Long Term |
|------------|-------------|-----------|
| Increase in knowledge, attitudes, and beliefs about melanoma and sun protection | Increased use of hats, clothing, shade, and sunscreens | Decrease in incidence of melanoma (including level I) |
| Decreased desire for suntan | Decreased frequency of sunburn | Decrease in mortality rate of melanoma |
different to those of habitual behaviors. Positive reinforcement is an important component of the latter. Thus, measures of change in behavior must be continued over time to ensure that they have become habitual and that they don’t merely represent trial behavior in the short term.

The long-term measure of success is, of course, a reduction in mortality as a direct consequence of a reduction in the incidence rate of melanoma. The value of adequate registration, analysis, and release of melanoma incidence data cannot be underestimated in confirming the success. The registration data should include not only invasive melanoma but in situ (level I) melanoma as well. If there is no drop in level I melanoma accompanying the reduced incidence of invasive tumors, then this could indicate success of an early detection program rather than a primary prevention effect. Good-quality incidence data will also allow birth cohort analysis to demonstrate, for example, a reduction in the incidence rate in the younger birth cohorts before the onset of a reduction in the overall age-adjusted incidence rate for the whole population.

**Conclusion**

The public health approach to disease control is now being looked at with increasing interest for many diseases. Melanoma represents an exemplary model of a disease whose impact can potentially be influenced substantially by this approach. With the knowledge available today about both the cause of melanoma and its appearance in those at risk, the two classical approaches of primary prevention and early detection seem possible. However, there are still gaps in our knowledge, and therefore, care is required in the development, delivery, and assessment of outcome of these programs.

Melanoma control programs need to be underpinned by research data to determine the need; select the population at risk; develop, test, and deliver education
programs; and measure their effect in both the short and long term. Lack or neglect of data may cause expensive and time-consuming programs to become ineffective or possibly countereffective at times.

Nevertheless, with a scientific basis underlying them, there is reason to believe that both early detection and primary prevention have the potential to be successful. In countries where melanoma incidence and mortality rates are reaching public health proportions, there is justification for embarking carefully on the public health approach to melanoma control.

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