The Effect of Skin Examination Surveys on the Incidence of Basal Cell Carcinoma in a Queensland Community Sample: A 10-Year Longitudinal Study

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Skin cancers pose a significant public health problem in high-risk populations. We have prospectively monitored basal cell carcinoma (BCC) and squamous cell carcinoma (SCC) incidence in a Queensland community over a 10-y period by recording newly treated lesions, supplemented by skin examination surveys. Age-standardized incidence rates of people with new histologically confirmed BCC were 2787 per 100,000 person-years at risk (pyar) among men and 1567 per 100,000 pyar among women, and corresponding tumor rates were 5821 per 100,000 pyar and 2733 per 100,000 pyar, respectively. Incidence rates for men with new SCC were 944 per 100,000 pyar and for women 675 per 100,000 pyar; tumor rates were 1754 per 100,000 pyar and 846 per 100,000 pyar, respectively. Incidence rates of BCC tumors but not SCC tumors varied noticeably according to method of surveillance, with BCC incidence rates based on skin examination surveys around three times higher than background treatment rates. This was mostly due to an increase in diagnosis of new BCC on sites other than the head and neck, arms, and hands associated with skin examination surveys and little to do with advancing the time of diagnosis of BCC on these sites as seen by a return to background rates following the examination surveys. We conclude that BCC that might otherwise go unreported are detected during skin examination surveys and thus that such skin cancer screening can influence the apparent burden of skin cancer.

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The incidence of skin cancer has risen around the world over the past few decades (Staples *et al*, 1998; Karagas *et al*, 1999; Harris *et al*, 2001; Diepgen and Mahler, 2002; Geller *et al*, 2002). Basal cell carcinoma (BCC) is the most common skin cancer occurring in Caucasian populations living in sunny places in Australia or parts of the United States (Carter *et al*, 1999; Staples *et al*, 1998; Karagas *et al*, 1999; Harris *et al*, 2001; Diepgen and Mahler, 2002; Geller *et al*, 2002). Together with squamous cell carcinoma (SCC) and melanoma, they impose a significant public health burden in these populations. Because skin cancers are unsuitable for routine cancer registration, monitoring the burden of skin cancer and the success of skin cancer control strategies must rely on ad hoc community or population surveys (Staples *et al*, 1998).

As part of ongoing studies of the causes and prevention of skin cancer (Green *et al*, 1988, 1996, 1999), we have been documenting the occurrence of skin cancer in a community sample in Queensland, Australia. Incidence rates of clinically and histologically diagnosed BCC and SCC in the period 1986 to 1992 have been reported previously (Green *et al*, 1996). In the course of monitoring incidence of BCC and SCC over the subsequent 10-y period to 2001 in this sample, we have noted a pattern of increased incidence of histologically confirmed BCC, not seen for SCC, coinciding with screening for incident skin cancer by skin examination surveys. We report here that skin examination surveys appeared to temporarily increase the observed incidence rates of BCC but not SCC.

Abbreviations: BCC, basal cell carcinoma; pyar, person-years at risk; SCC, squamous cell carcinoma

Results

Study population Treatment allocation was unrelated to baseline characteristics in the 1621 subjects who enrolled in the trial in 1992, including age, sex, skin type, and sun exposure (Green *et al*, 1999). Of 809 participants not randomized to the daily sunscreen intervention, 416 were given beta-carotene supplements and 393 were given placebo treatment. The mean age was 49 y with a higher proportion of women (56%). Most subjects (68%) had a skin type that burned and then tanned after acute sun exposure, whereas 21% said their skins always burned and 11% said they just tanned. About half the subjects (54%) had fair skin, 39% had medium skin color, and the remainder had olive skin. For 44% of participants occupation was mainly indoors and for 39% it was mixed indoor and outdoor, and 17% reported mainly outdoors occupations.

Person-based incidence During the 10-y surveillance period, 185 people were newly affected by histologically confirmed, invasive skin cancers: 149 by BCC and 70 by SCC. Age-standardized incidence rates of BCC were estimated to be 1567 per 100,000 pyar among women and 2787 per 100,000 pyar among men. Corresponding rates for SCC were 675 per 100,000 pyar and 944 per 100,000 pyar, respectively.

Tumor-based incidence There was a total of 649 skin cancers clinically diagnosed in the 10-y period, of which 535 (82%) were histologically confirmed and included in this analysis. Of these 535 lesions, 179 were SCC or BCC excised as a direct consequence of the examination survey. During the surveys a total of 306 lesions were excised, which included lesions provisionally diagnosed as benign, for example, solar keratosis and dermatofibromas, but where the diagnosis of skin cancer needed to be excluded. Age-standardized tumor-based incidence rates of skin cancers for this 10-y period were estimated to be 7575 per 100,000 pyar among men and 3579 per 100,000 pyar among women. BCC tumor rates were 5821 per 100,000 among men and 2733 per 100,000 pyar among women, and SCC tumor rates were 1754 per 100,000 pyar and 846 per 100,000 pyar, respectively.

When this 10-y period was divided into the trial and follow-up periods, for BCC (Fig 1) the tumor incidence rate was nearly three times as high during the trial (6079 per 100,000 pyar) as during the follow-up period (2247 per 100,000 pyar). The increase in BCC incidence during the trial was largely due to an increase of tumors diagnosed on sites other than the head and neck, forearms, and hands, sites that are not easily visible (Fig 1). The increase occurred mostly as a result of the 1992, 1994, and 1996 examination surveys by dermatology specialists. There was also a small peak in BCC tumor incidence on less visible sites in 2000 when 44% of the study sample participated in a skin examination survey by a dermatology specialist trainee (Fig 1). In contrast, for SCC tumors (Fig 2), rates did not vary appreciably between the trial period including the skin examination surveys and the follow-up period (respectively 1326 per 100,000 pyar and 1277 per 100,000 pyar). SCC occurred mostly on the head, neck, lower arms, and hands across the 10-y study period.

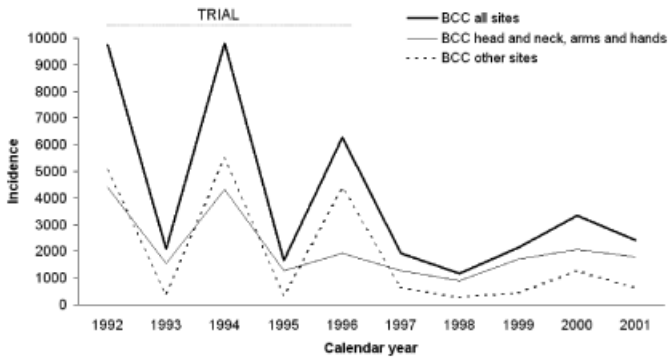

Figure 1
Tumor incidence rates of BCC by calendar year: overall and by site (standardized incidence rates per 100,000).

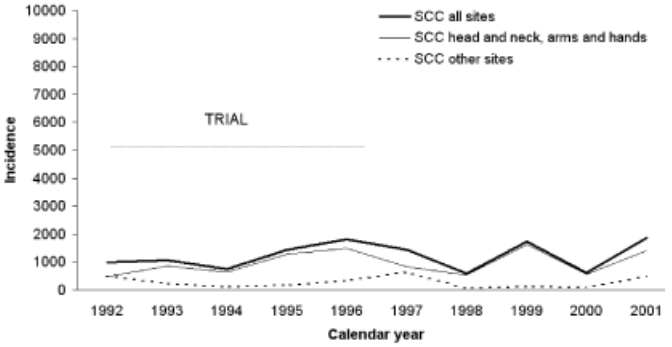

Figure 2
Tumor incidence rates of SCC by calendar year: overall and by site (standardized incidence rates per 100,000).

Discussion

By prospectively monitoring BCC and SCC incidence in a sample of a Queensland community, we have shown that the apparent incidence of BCC tumors but not SCC tumors can vary greatly according to method of surveillance. Skin examination surveys resulted in an increase of BCC on sites other than the head, neck, forearms, and hands. Some of the increase may have been explained by the earlier diagnosis during skin surveys of slow-growing BCC or diagnosis earlier in their development. Nevertheless, BCC tumor incidence rates on sites other than the head, neck, forearms, and hands did not climb back to a higher level with subsequent follow-up of all treated BCC after the skin examination surveys. This raises the possibility that some of the BCC on sites like the upper trunk that are detectable by intensive skin examination surveillance may otherwise never have come to the patient's attention. In comparison, rates of SCC are not substantially affected by intensive skin examination surveys because SCC mainly occur on easily visible sites.

Our study of the incidence of SCC tumors was limited by the exclusion of Bowen's disease from the monitored skin cancer rates. Also the community participation rates in the Nambour Trial (77%), the loss-to-follow-up between 1992 and 2001, and the relatively small study sample overall may limit the ability to apply our findings to other populations. Nevertheless, these limitations cannot explain the marked differences in BCC tumor incidence rates resulting from skin examination surveys compared with incidence rates based on monitoring treated BCC nor the marked increase in the proportion of BCC on less visible sites that occurred largely in association with screening for skin cancer by full skin examination by dermatology specialists.

Although we did not collect comprehensive data on morphologic types of BCC diagnosed in the study sample over the 10-y period, several other studies have shown that BCC arising on different sites of the body are likely to be of differing histologic subtypes (McCormack *et al*, 1997; Bastiaens *et al*, 1998; Puavilai and Sirapan, 2002). In particular, superficial BCC tend to occur more often on the upper trunk than other BCC types. Bastiaens *et al* (1998) investigating site and subtype of all BCC diagnosed at a University Medical Center in the Netherlands found a proportional increase in BCC on the trunk over an 11-y

period. They argued that this increase was partly due to an increased public awareness of skin cancers, resulting in diagnosis of BCC at an earlier stage of development and a proportional increase of BCC on often-obscured sites.

We conclude that the incidence rates of BCC tumors but not SCC tumors over time can vary greatly with the frequency of close surveillance by full skin examination in a population at moderate to high incidence of skin cancer. This may be because close screening of skin that is normally covered identifies a "reservoir" (Kaplan, 2002) of BCC tumors that might otherwise go undetected and untreated over a long period of time. This would have implications for health services if they were linked to skin cancer screening programs and also for choice of methods for following and analyzing BCC trends in the long term.

Materials and Methods

The source of the study population was a random sample of 3000 adult residents of Nambour, a Queensland township. The sample was drawn from the electoral roll (registration is compulsory by law) in 1986 for the purposes of a skin cancer prevalence survey, and 2095 (70%) took part (Green *et al*, 1988). Follow-up of a random subsample of nonattenders showed that they were not significantly different from the survey participants in terms of risk factors for skin cancer (e.g., skin type, previous history of skin cancer) (Green *et al*, 1988). Of the 2095 participants, 1621 (77%) attended the baseline survey for a skin cancer prevention trial, and they were examined by dermatologists and randomized to one of four treatment groups. The Nambour Trial, designed as a two-by-two factorial, aimed to determine the effectiveness of daily sunscreen application and/or beta-carotene supplementation for the prevention of BCC and SCC (Green *et al*, 1999). Those in the trial were similar in their profile of skin cancer risk to those who did not participate (Green *et al*, 1994). In particular there were no differences in skin type and although a history of skin cancer was more common in trial participants than in the original sample, the difference was small (26 and 22%, respectively). The Nambour Trial ran from February 1992 to August 1996 and follow-up of skin cancers diagnosed in the trial participants has continued subsequently.

Skin cancer surveillance 1992 to 2001 was mostly carried out by monitoring treated skin cancers. During the trial 1992 to 1996, this monitoring was more intense. Study participants carried wallet-sized treatment cards on which they asked their local doctor to record clinically diagnosed skin cancer at time of treatment and, every 3 mo at study clinics, they were asked about any skin cancer treated since last contact. Since 1996, study participants have reported the treatment of any skin lesions via questionnaires sent to them twice a year with response rates ranging from 92 to 99%. All self-reported BCC or SCC have been confirmed by reviewing the treating doctors' records. In addition, all relevant pathology laboratories in the region independently provided reports of all skin lesions diagnosed among the study cohort between 1992 and 2001. Here we examine all histologically confirmed BCC and SCC.

In addition to the monitoring of their treated skin cancers, all study participants underwent at least two full-body skin examinations by a consultant dermatologist during three scheduled examination surveys. In 1992, 100% of study participants had their skin examined; in 1994, 78% were examined, and in 1996, 80% were examined. As well, in 2000, all ongoing study participants were offered a full skin examination by a dermatologically trained physician, with a 44% uptake. All skin cancers diagnosed clinically during skin examination surveys were biopsied for histologic confirmation.

Scrutiny of the data collected over the 10-y period showed that skin cancers reported at initial diagnosis were often reported again if they were reexcised. We therefore cross-checked all apparently multiple BCC or SCC diagnosed less than 6 mo apart in the same person and on the same anatomical site in medical records and pathology reports to ensure that all duplicate reports were removed.

In the present report, analysis has been restricted to 809 participants who were not randomized to the daily sunscreen intervention (beta-carotene did not affect skin cancer incidence (Green *et al*, 1999)). Of the 809, 673 (83% of the original 809) continued to participate in the trial of whom 650 have had complete follow-up until 2001, and 23 had complete follow-up until date of death. Thus we have virtually 100% ascertainment of all histologically confirmed BCC and SCC in these 673 participants from 1992 to 2001.

Person-based incidence rates and tumor-based incidence rates of histologically confirmed BCC and SCC have been calculated over the 10-y period 1992 through 2001, overall and according to anatomical site: head and neck, arms, and hands versus other sites. Statistical analyses were conducted using SPSS statistical software package (version 11.0) and SAS 8.02. All histologically confirmed invasive skin cancers, that is, cutaneous BCC and SCC of the skin (excluding Bowen's disease and solar keratosis), diagnosed between February 1992 and December 2001 have been included. Incidence of skin cancer (person-based) was calculated as the number of people treated for first new histologically confirmed BCC or SCC, divided by the person-years at risk for the study period (person-years counted until the first diagnosis of each type of lesion, or date of death, or date of withdrawal from the study, whichever came first) and expressed per 100,000 person-years at risk (pyar). Age- and sex-specific tumor incidence rates were calculated as the total number of histologically confirmed BCC or SCC diagnosed, divided by the person-years at risk (person-years counted until date of death or date of withdrawal from the study, whichever came first) for the study period and expressed per 100,000 pyar. Age-standardized rates were calculated using the world standard population (Breslow and Day, 1987).

The study was approved by the Queensland Institute of Medical Research ethics committee and abided by the Declaration of Helsinki on research on human subjects.

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