Counseling to Prevent Skin Cancer: A Summary of the Evidence

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Introduction

Epidemiology

In 1996, the U.S. Preventive Services Task Force (USPSTF) found insufficient evidence to recommend for or against either routine screening for skin cancer by primary care providers or counseling patients to perform periodic skin self-examinations.[1] They also found insufficient evidence to recommend for or against the use of sunscreen to prevent skin cancer. While acknowledging that the effectiveness of counseling had not been well established, the 1996 Task Force recommended counseling patients at increased risk for skin cancer to avoid excess sun exposure.*

To help the Task Force update their recommendations about sunscreen use and counseling by primary care clinicians, the Oregon Health & Science University (OHSU) Evidence-based Practice Center (EPC) conducted a preliminary review of the literature. Based on the results of the preliminary review, the Task Force requested that the OHSU EPC prepare this brief summary of key systematic reviews and randomized controlled trials on selected topics relevant to sunscreen use and skin cancer counseling.

* The Task Force published updated recommendations for skin cancer screening in 2001.[2] The new skin cancer screening recommendations, and an accompanying systematic evidence review, are available at http://www.preventiveservices.ahrq.gov.

Burden of Illness

The 3 major types of skin cancer are melanoma, basal cell carcinoma, and squamous cell carcinoma. Melanoma is the deadliest form of skin cancer, causing more than 75% of all skin cancer deaths. About 53,600 people in the United States were diagnosed with a melanoma skin cancer in 2002, and approximately 7,400 died.[3] Melanoma accounts for 1.3% of all cancer deaths in the United States. The lifetime risk of dying of melanoma is 0.36% in white men and 0.21% in white women. Between 1973 and 1995, the incidence of melanoma in the United States increased about 4% per year, from 5.7 per 100,000 people in 1973 to 13.3 per 100,000 people in 1995, according to data from the Surveillance, Epidemiology, and End Results program (SEER) of the National Cancer Institute.[4]

Basal cell carcinoma is the most common form of skin cancer. In the United States, age-standardized basal cell cancer rates range from 175 to 1,073 per 100,000 in non-Hispanic white men and from 124 to 415 per 100,000 in non-Hispanic white women.

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Reprints of the USPSTF recommendation based on this evidence review can be found in "Counseling to Prevent Skin Cancer: Recommendations and Rationale," available on the AHRQ Web site and in the *Guide to Clinical Preventive Services, Third Edition: Periodic Updates.*

Squamous cell cancer rates range from 63 to 214 per 100,000 non-Hispanic white men and from 22 to 50 per 100,000 non-Hispanic white women.[5–7] Squamous cell cancers usually occur in chronically sun-exposed areas of the skin, especially on the face, ears, or backs of the hands. Squamous cell cancer has the potential to metastasize and may account for up to 20% of deaths from skin cancer. A large primary tumor (> 2 cm) is associated with an increased risk of metastasis. Patients who have been exposed to PUVA (Psoralen plus ultraviolet-A) radiation for psoriasis may constitute a substantial proportion of all patients who die of metastatic squamous cell cancer.[8] Very elderly men are also over-represented among patients who die of squamous cell cancer.

Rationale for Behavioral Counseling

Sun exposure is a strong risk factor for skin cancer. Experts in cancer control and in health promotion have hypothesized that sun exposure should be more easily modifiable through behavioral intervention than many other cancer risk factors and that changes in behavior should have a large impact on cancer incidence.[9]

Sun-related behaviors that have been subjects of behavioral interventions are listed in Table 1. There is no gold standard for assessing these behaviors. Methods used in published evaluation studies to measure sun protection behaviors include self-report, diaries, changes in skin tone, and direct observation of sun protection behavior by a trained research staff person.

Table 1. Behaviors to reduce the incidence of skin cancer

- Avoidance of sun between the hours of 10 AM and 4 PM
- Use of protective clothing when outdoors
- Use of sunscreen that blocks both Ultraviolet-A (UV-A) and Ultraviolet-B (UV-B) rays
- Avoidance of sunlamps and tanning equipment
- Practice of skin self-examination

Over the past 2 decades, knowledge about the risks of sun exposure, attitudes about the cosmetic value of a tan, and use of sunscreen have improved.[10–12] Nevertheless, there is a persistent gap between knowledge and behavior.[13] At least 50% of children[14–16] and adults,[17–19] including those who engage in activities that put them at high risk for skin cancer,[20–22] do not protect themselves adequately from exposure to sunlight. A cross-sectional survey of 10,000 teenagers found that 40% of girls and 26% of boys used sunscreen.[23] Eighty-three percent of respondents had at least 1 sunburn during the previous summer, and 36% had 3 or more sunburns. One in 20 girls aged 12–14 and 1 in 4 girls aged 15–18 had used a tanning bed. As in previous surveys, the preference for tanned skin, having many friends who were tanned, and belief in the worth of burning to get a tan were associated with sporadic sunscreen use, more frequent sunburns, and increased use of tanning beds. Another risk factor was parental use; 30% of the youth whose caregivers used indoor tanning sunlamps also did so themselves.[24]

Studies of Skin Cancer Protection Behavior

A large body of behavioral science literature is available to support the design of effective interventions to change sun exposure practices. This literature has examined social and behavioral predictors of sun exposure; barriers to changing or modifying sun-related behaviors; and the effectiveness of interventions to change these behaviors.

Several dozen cross-sectional studies[22,25–34] and a few longitudinal studies[35,36] have examined associations between skin protection behavior and personal characteristics, attitudes, and knowledge, especially among adolescents. A consistent finding across studies is that a high level of knowledge of the dangers of excessive sun exposure and the need for sun protection often does not translate into sun protection behavior.[37]

The Appendix lists some well-known school- and community-based intervention programs for skin cancer prevention and counseling. These interventions

can be classified by their theoretical foundations, target populations, and settings.[38]

Theoretical Foundations. Some efforts to understand and change behavior related to skin cancer risk are based on standard cognitive-behavioral theories. In a review of the effects of 24 sun protection programs that targeted children under age 14, the most frequently cited theories were none (16), Social Cognitive Theory (5), Piaget's Theory of Cognitive Development (1), Language Expectancy Theory (1), the Health Belief Model (1), Self-Efficacy Theory (1), Protection Motivation Theory (1), Social Learning Theory (1), and the Transtheoretical Model (1).[38] The Theory of Reasoned Action and Planned Behavior, which emphasizes the importance of communicating risk to motivate and direct behavior change, has been applied in cross-sectional surveys to explain the relationships among attitudes, knowledge, and self-reported behavior among children.[39] Interventions based on this theory have not yet reported results.

In adults, many behavioral interventions are based on Social Learning Theory or the Transtheoretical Model. Social Learning Theory emphasizes the need for behavioral skills training and ongoing environmental and social supports for skill maintenance. The transtheoretical model emphasizes the importance of targeting interventions to an individual's particular stage of readiness to adopt a new behavior.[20,40]

Target Populations. Interventions may target the general population or groups at increased risk for skin cancer (eg, people who spend time at the beach). Interventions that target children's behavior may be aimed at children directly, at their parents and caregivers, or both.

Settings. Most interventions have been delivered either at schools or at outdoor recreational sites. Programs aimed at the general population have used multiple avenues to reach subjects, such as mass media, community-based organizations, health care environments such as hospitals, home visits, telephone calls, or mailed material.

In general, the school-based and community-based interventions have led to short-term changes in knowledge and attitudes, and to modest improvements in self-reported behaviors in children and parents.[37,41] Previous reviews and commentaries on behavioral counseling interventions for skin cancer prevention have emphasized that multi-component interventions may be more effective than single-component ones.[9,38,40,42] They have also noted deficiencies in the evaluation studies themselves. Most studies used observational (pre-/post-) designs and most used unreliable methods to assess preventive behaviors.

Counseling in Current Primary Care Practice

In a survey from 1997, 60% of pediatricians said they usually or always counsel patients about sun protection.[43] In current practice, advice to use sunscreen is given about twice as frequently as advice about wearing protective clothing or avoiding the midday sun. In another survey, which compared pediatricians to family practitioners, pediatricians were more likely to have educational materials in the waiting room (70.4% vs. 34%) and to have sunscreen samples available in the office (62.4% vs. 15.4%), and were somewhat more likely to counsel often or always at well care visits (56.2% vs. 43.8%).[44]

Studies of barriers to sun protection counseling in office practice support the concept that "small steps," such as using simple reminder systems for clinicians and office staff and making instructional materials and sunscreen samples more available, can improve integration of sun protection counseling in primary care practices. In a survey in Massachusetts, almost 70% of pediatricians reported that they recommended safe sun practices to more than 50% of their patients and their parents during the summer months.[45] Four variables were independently associated with a practitioner's providing safe sun recommendations to more than 50% of parents and children: (1) being a practitioner in a private setting or health maintenance organization as opposed to being an academic physician, (2) high ranking of patients' safe sun knowledge, (3) sun protection counseling and parental knowledge of safe sun practices being high priorities for both parents and physicians relative to other recommendations, and (4) pediatrician interest in receiving instructional

materials. Only a few pediatricians cited inadequate training or poor reimbursement as barriers to improved counseling.

Scope of This Review

In February 2000, USPSTF members and project staff from the OHSU EPC discussed the scope of the review. At that meeting, the USPSTF, the OHSU EPC, and Agency for Healthcare Research and Quality (AHRQ) staff agreed to limit the review to interventions done in a health care setting by a primary care provider (physician, nurse, or physician's assistant). To further define the scope of the review, the OHSU EPC presented the results of 5 preliminary MEDLINE® searches for use in this discussion. These searches addressed: (1) risk factors and risk assessment for skin cancer, (2) counseling and health education studies, (3) studies of the relation between sun exposure and sun avoidance to skin cancer, (4) studies of the efficacy of sunscreen, and (5) studies of skin cancer self-examination.

The preliminary MEDLINE searches suggested that only 1 behavioral intervention trial included counseling in the primary care setting. It also suggested that there was controversy in the literature regarding the relationship between sun exposure and melanoma as well as new evidence regarding the efficacy of sunscreen and skin self-examination to prevent skin cancer.

Based on this information, the Task Force and AHRQ staff requested that the OHSU EPC conduct a brief, limited review of important new evidence published since 1996 addressing the following key questions:

1. Is reducing sun exposure effective in reducing melanoma?
2. Does the use of sunlamps and tanning beds increase risk for melanoma?
3. Is the use of sunscreen effective in preventing nonmelanoma skin cancer and melanoma?
4. Do sun protection behaviors have significant adverse effects?
5. Is skin self-examination effective in reducing the incidence of melanoma?
6. Does counseling by a primary care clinician increase sun protective behaviors?

Methods

Search Strategy

For questions 1 to 4, we searched MEDLINE combining the MeSH term "melanoma" (with the subheadings "prevention & control," "epidemiology," "etiology," or "genetics") together with the terms "sun exposure," "sunscreening agents" (subheadings: "adverse effect," "therapeutic use," and "toxicity"), or "tanning." This combination of terms was then limited to human studies published in English. This search identified 172 citations. In addition, to identify systematic reviews related to questions 1 to 4, we searched Database of Abstracts of Reviews of Effects (DARE), the Cochrane Database of Systematic Reviews, and ACP Journal Club using the terms "skin cancer," "melanoma," "basal cell carcinoma," and "squamous cell carcinoma." This search returned 70 citations. We identified additional citations from the preliminary searches mentioned above and from the reference lists of review articles.

For question 5, a previous search conducted for a systematic review of skin cancer screening[46] identified 1 case-control study. A supplemental search (1996 to August 2002) using the text word "self-examination" and the MeSH term "skin neoplasms" revealed several studies about the accuracy of skin self-examination and the prevalence of its use, but yielded no additional studies about its efficacy.

To find controlled trials of counseling (question 6), we searched MEDLINE using the terms "skin neoplasms" or "sunburn" (both with the subheading "prevention & control") and combined this set with "counseling" or "health education" or "behavior therapy" or any term beginning with "counsel." This combination of terms was then limited to human studies published in English. This search (1966 to August 2002) returned 367 citations. Of these, 10 were reports of randomized trials.[44,47–56] All but 1[44,50]

of these trials were excluded because they did not involve primary care providers.

Synthesis

For questions 1 and 2, we summarized the results of the major recent systematic reviews and meta-analyses, highlighting investigations (case-control and other epidemiologic studies) that are particularly important or not included in previous reviews. For questions 3 and 4, we reviewed controlled trials of sunscreen as well as systematic reviews of observational studies of the effect of sunscreen on the risk for skin cancer. For questions 5 and 6, we rated the quality of each controlled study and summarized its main findings in the text. For all the systematic reviews and original scientific articles included in this report, we used the methods developed by the USPSTF to rate study quality.[57] We summarized the results of randomized controlled trials (questions 3 and 6) in an Evidence Table (see page 10).

Role of Funder

AHRQ staff edited an earlier draft of this manuscript and suggested changes. The first author made all final decisions regarding these changes. A list of the changes suggested by AHRQ staff is available from the first author.

Results

1. Is reducing sun exposure effective in reducing melanoma?

Avoiding direct sunlight by staying indoors or in the shade or by wearing protective clothing is the most effective measure for reducing exposure to ultraviolet light and avoiding sunburn. The *Guide to Clinical Preventive Services*, 2nd edition, stated: "Avoiding sun exposure is likely to decrease the risk of malignant melanoma and nonmelanoma skin cancer, since both types of cancer have been associated with sun exposure in numerous cohort and case-control studies."[1] The most recent references cited for this statement were from 1993. With respect to nonmelanoma skin cancer, no evidence published since 1993 conflicts with this statement.

With respect to malignant melanoma, several good-quality systematic reviews have sought to integrate the conflicting information from case-control studies. In a meta-analysis of 25 case-control studies of sun exposure and melanoma published in 1995, intermittent sun exposure was a risk factor for melanoma (pooled odds ratio [OR], 1.57; 95% confidence interval [CI], 1.29 to 1.91), and chronic sun exposure was protective (pooled OR, 0.73; 95% CI, 0.60 to 0.89).[58] A more recent systematic review and meta-analysis of 50 case-control studies (1997) confirmed the finding that intermittent exposure was a risk factor (pooled OR, 1.71).[59] Heavy occupational exposure was a statistically significant protective factor (pooled OR, 0.86), while total exposure was associated with a small, marginally significant increased risk for melanoma (OR, 1.18).

A more recent good-quality, population-based case-control study from Ottawa, Canada, supported the hypothesis that intermittent sun exposure, rather than chronic exposure, increases the risk for melanoma.[60] In that study, chronic outdoor exposure to sunlight was a protective factor against melanoma, especially if the exposure occurred during adolescence (adjusted OR, 0.67; 95% CI, 0.52 to 0.85). This effect was significant across the various types and locations of melanoma and age groups.

An individual's skin type may be another factor mediating the effect of sun exposure on melanoma incidence. The older studies reviewed in the second *Guide* reported that a tendency to burn or inability to tan were risk factors for melanoma.[1] The interaction of skin type and exposure is demonstrated in a good, population-based case-control study of 338 female melanoma patients and 872 matched control subjects.[61–64] Overall, childhood sun exposure was a strong risk factor for melanoma in women who burned and then tanned (relative risk [RR], 3.1; 95% CI, 1.5 to 6.4), but not in women who burned without tanning (RR, 1.9; 95% CI, 0.9 to 3.8 for sunburn in childhood; RR, 1.3; 95% CI, 0.56 to 3.0 for sunburn in high school). Results for women who tanned without burning or burned with light tan were intermediate.

2. Does the use of sunlamps and tanning beds increase risk for melanoma?

The second *Guide* stated: "Use of tanning facilities has not been directly linked to cancer risk, but skin damage after use is common."[1] Since then, case-control studies have had mixed results.[65] Of 19 case-control studies, 6 found a positive association between sunlamp use and melanoma. Most of these studies did not adjust for recreational sun exposure or for the dosage and timing of sunlamp exposure. In the subset of these studies that examined the duration, frequency, or timing of sunlamp exposure, 4 of 9 studies found a positive association, particularly if the dose of exposure was high and if it caused burning.[66,67] In 1 of these studies, there was a significant association only in those who had at least 10 hours of exposure before 1980 (Adjusted Odds Ratio [AOR], 2.12; 95% CI, 0.84 to 5.37), particularly if the sunlamp use induced a sunburn (AOR, 7.35; 95% CI, 1.67 to 32.3).[67]

3. Is the use of sunscreen effective in preventing nonmelanoma skin cancer and melanoma?

Skin cancer is largely related to high levels of exposure to ultraviolet (UV) radiation. The two most important types of UV radiation, UV-A and UV-B radiation, are linked to development of skin cancer. UV-A rays are not absorbed by the ozone layer, penetrate deeply into the skin, and cause premature aging. UV-B rays, which are partially absorbed by the ozone layer, tan and sometimes burn the skin. Total UV exposure depends on the intensity of the light, duration of skin exposure, and whether the skin was protected by sun-protective clothing and sunscreen. Only physical sunblocks (eg, zinc oxide, talc, etc.) block all solar rays, and only some currently available sunscreens block both UV-A and UV-B rays.

Randomized, controlled trials have demonstrated that sunscreen use reduces the incidence of solar keratosis[68, 69] and of squamous cell cancer.[70] Only 1 trial has reported the effect of sunscreen on the incidence of squamous cell cancer. In this trial, 1,621 residents of Nambour, located in southeast Queensland, Australia, were randomly assigned to apply sunscreen daily to the head, neck, arms and hands, or to use sunscreen at their own discretion (primarily for recreational sun exposure). Participants were also randomly assigned to receive beta-carotene or placebo. At 4.5 years of follow-up, 1,383 subjects had undergone an examination by a dermatologist. Analyzed by intention-to-treat, the overall incidence of squamous-cell carcinoma was significantly lower in the daily sunscreen group than in the discretionary-use sunscreen group (rate ratio 0.61; 95% CI, 0.46 to 0.81; Number Needed to Treat [NNT], 140; 95% CI, 101 to 287). There was a small, statistically insignificant difference between groups in the number of first squamous-cell carcinomas (876 vs. 996 per 100,000 people; rate ratio, 0.88; 95% CI, 0.50 to 1.56; NNT, 833). Sunscreen had no effect on the risk for developing a first new basal cell cancer (rate ratio, 1.04; 95% CI, 0.73 to 1.27) or total number of basal cell cancers (rate ratio, 1.05; 95% CI, 0.82 to 1.34).

There are no similar data about the effect of sunscreen on melanoma incidence. There is evidence from a fair-quality, unblinded randomized trial that high-risk children who used sunscreen developed fewer nevi.[71] However, in several epidemiologic studies, the risk of melanoma is significantly higher in users of sunscreens than in non-users.[72–74] A recent meta-analysis of 9,067 patients from 11 case-control studies found no association between sunscreen use and the risk for malignant melanoma (summary RR, 1.01).[75]

Several potential explanations for the mixed results of studies of sunscreen and melanoma risk have been proposed. One hypothesis is that sunscreen might increase the risk for melanoma because it inhibits cutaneous vitamin D synthesis.[76] There is little evidence for or against this hypothesis.

Another possible explanation is that, as one editorial stated, "by conferring a false sense of security, sunscreen use may encourage longer stays in the sun."[77] In support of this hypothesis, a randomized trial found that individuals who used a sunscreen with a high sun protection factor (SPF)

stayed in the sun longer.[78] In that trial, young adults who used sunscreen with SPF 30 spent 72.6 hours in the sun over 1 summer, versus 58.2 hours for the group who used SPF 10 sunscreen (P=0.011). There was no difference in sunburn experience between the 2 groups. A subsequent trial by the same investigators confirmed this finding but also noted that only daily UV-B exposure was increased in the high-SPF group. Daily UV-A exposure and the combined total of UV-A and UV-B accumulated over all sunbathing sessions were not increased in the high-SPF group.[79]

There is also concern that in public health messages, prominent advice to use sunscreen may overshadow the message of sun avoidance. This concern arises because surveys as well as evaluations of health promotion campaigns consistently show that sunscreen is used much more commonly than sun avoidance or protective clothing among children and adults who recall getting advice about sun protection.[27, 80]

4. Do sun protection behaviors have significant adverse effects?

Sunscreen

There is no evidence from cohort studies or randomized trials that use of sunscreen with a recommended sun protection factor of 15 results in clinically significant vitamin D deficiency.[81] A recent case report suggested that, while living in England, an Asian child with borderline vitamin D intake developed rickets because of sunscreen use.[82] In 1 randomized, controlled trial in people over 40 years of age, sunscreen use over the summer had no effect on 25-hydroxyvitamin D3 levels (see Evidence Table on page 10).[83] Patients who used sunscreen had a smaller increase in 1,25-dihydroxyvitamin D3 levels than patients taking placebo, but no individual developed a level below the lower limit of the reference range.

Sun Avoidance

There have been no studies of potential adverse effects of reducing sun exposure. A recent article in the *British Medical Journal* questioned whether the cardiovascular and mental health benefits of sun exposure might outweigh its harmful effects.[84] The authors hypothesized that seasonal patterns in cardiovascular mortality and in cardiovascular risk factors may be related to sun exposure. They also noted that avoidance of sun might exacerbate seasonal affective disorder and, more generally, have a negative effect on mental health.

5. Is skin self-examination effective in reducing the incidence of melanoma?

The best evidence for the effectiveness of skin self-examination comes from a good case-control study that was reviewed in detail in the systematic evidence review on skin cancer screening.[85] In this study, 650 incident cases of melanoma in 1987–1989 were identified through the Connecticut Tumor Registry and compared with randomly selected, age- and sex-matched controls. After 5 years of followup, cases were classified as "lethal" if the individual died or had distant metastases. A structured questionnaire was used to assess skin self-examination attitudes and behavior. The definition of skin self-examination used in this study was: "...did you ever (in your life) carefully examine your own skin? By this I mean actually check surfaces of your skin deliberately and purposely?" Based on participant responses to these and related questions, 13% of the cases and 17.5% of control subjects were classified as careful or rigorous examiners, and an additional 57.4% of cases and 66.7% of controls were classified as casual examiners.

The investigators performed 2 multivariate analyses: 1 for primary prevention and 1 for secondary prevention. In the first analysis, after adjustment for sun exposure, skin color, the number of nevi, and other risk factors, skin self-examination was negatively associated with incidence of melanoma (OR, 0.66; 95% CI, 0.44 to 0.99).

In the second analysis, after adjustment for confounding risk factors, skin self-examination was associated with a reduced risk of lethal melanoma (OR, 0.37; 95% CI, 0.16 to 0.84).

Survival analysis comparing patients who practiced skin self-examination with those who did not suggested that, after an average of 5.4 years, self-examination was associated with a lower probability of lethal melanoma. The authors noted that the shape of the survival curves—the curve for the self-examination group plateaued after 3 years, while survival continued to decrease up to 5 years in the patients who did not practice self-examination—offers some reassurance that the observed benefit is due to actual improvement in survival rather than to lead-time bias.

As noted by the authors, this case-control study provides suggestive, rather than definitive, evidence for the effectiveness of skin self-examination. While the study indicates that patients who practiced self-examination had undergone more biopsies than those who had not, it does not report the frequency of these intermediate steps, or whether their frequency was different enough from that of other patients to explain the observed differences in outcome.

6. Does counseling by a primary care clinician increase sun protective behaviors?

A randomized trial of a community-based intervention, which included office-based counseling by physicians as a component, is the best evidence that counseling by a clinician is effective in the context of a multimodal promotion program.[44, 86] In this study, 10 towns in New Hampshire were randomly assigned to the SunSafe intervention or to usual care. Components of the SunSafe intervention were delivered in schools, day care centers, beaches, and primary care offices (see Table 2 for components of the SunSafe intervention). The intervention also included a public information component. The initial intervention was delivered between March and May 1996, and a brief followup contact was provided to schools, day care centers, beaches, and primary care offices 1 year later.

A total of 86 clinicians, including 15 of 21 practices in intervention towns, participated in an intervention to facilitate the delivery of sun protection advice in the primary care setting.

Observations were made on 2,344 children overall. In intervention towns, the proportion of children with some sun protection increased from 78% to 87% in the summer of the intervention, while in controls the proportion fell from 85% to 80% (P=0.029). The proportion using full protection increased from 53% to 74% in intervention towns versus 66% to 72% in controls (P=0.18).

The effect persisted after 2 years of followup.[50] After 2 years in intervention towns, the proportion of children using some form of protection increased by 15% (from 58% to 73%), while in control towns there was an increase of 3% (P=0.033). This increase was due to more use of sunscreen, but not to more use of protective clothing or shade. The study also found that 62% of caregivers in the intervention towns had received information about sun protection from physicians, health plans, or schools in the previous year, versus 33% in the control towns.

The study was not designed to determine the contribution of the primary care component to the overall effect. Nevertheless, the study convincingly

Table 2. Components of the SunSafe intervention*

Setting	Content
Schools	Age- and grade-specific curriculum promoting sun protection plus training for school principals and teachers.
Beaches	Poster display, free sunscreen, and educational pamphlets.
Primary care offices	Single 60-minute visit by study personnel to each office to provide free patient materials and sunscreen samples.

* Information in this table is from reference 86.

demonstrated that the intervention could be accomplished with minimal disruption and acceptable cost in "real-life" primary care practices, and that the effect persisted 2 years after the original intervention.

Summary

The evidence on the efficacy of sun avoidance and use of protective clothing for the prevention of melanoma is complex, but overall supports the hypothesis that intermittent sunburn in childhood is a preventable risk factor. There are no data from randomized trials linking sun avoidance and use of protective clothing to a reduced cancer incidence. Evidence to support avoiding artificial tanning devices is still weak.

There is good evidence from 1 trial[70] for a modest benefit of sunscreen in preventing squamous cell cancer. Based on this randomized trial, 140 people would need to use daily sunscreen for 4.5 years to prevent 1 squamous cell cancer. In another trial,[71] sunscreen use led to the development of fewer nevi, but the study had substantial flaws and the users still had many new nevi, making the clinical significance of this finding unclear. In a meta-analysis[75] of population-based case-control studies, sunscreen use was not associated with an increased risk for melanoma, and in one randomized trial, use of sunscreen with a high SPF was associated with an increased incidence of sunburn because users were overconfident about the degree of protection.

There is good evidence from 1 trial[44,50,86] for the effectiveness of counseling by a physician in the context of a broader, community-based educational intervention. The specific contribution of the office-based component to the overall effectiveness of the intervention was not described.

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Evidence Table—selected randomized trials of skin cancer prevention and counseling

Subjects	Topic	Design
Sunscreen trials:		
Children in Vancouver, B.C.[71]	Efficacy of sunscreen vs. no sunscreen in preventing nevi.	458 randomized; treated group (*n*=222) given sunscreen and instructions to use it; controls (*n*=236) were not given any. 309 children completed 3 years of followup.
Residents of Nambour, Australia[70]	Efficacy of sunscreen vs. placebo in preventing NMSC.	1,621 randomized; 1,383 completed 4.5 years of followup. Outcome measure: new skin cancers. Analysis: intention-to-treat.
Residents of Maryborough, Australia, over 40 with solar keratoses[68,69]	Effect of sunscreen plus moisturizer vs. moisturizer alone on solar keratoses.	588 began study; 431 completed it; 417 (71%) had complete data. Outcome measure: ratio of numbers of solar keratoses at end of study and beginning of study.
Residents of Maryborough, Australia, over 40 with solar keratoses[83]	Effect of sunscreen plus moisturizer vs. moisturizer alone on vitamin D levels.	Substudy of Thompson, 1993 study.[68] 153 began the substudy; 113 completed one summer of followup. Outcome measures: 25-hydroxyvitamin D3 levels and 1,25-dihydroxyvitamin D3.
French and Swiss paid volunteers 18–24 years of age who had a history of sunburn and who were regular sunscreen users (2 trials)[78,79]	Effect of sunscreen with high sun protection factor (SPF 30) vs. low (SPF 10) on sun avoidance behavior.	86 of 87 completed one summer of followup. Outcome measures: cumulative sun exposure, sunburn episodes.
Community-based intervention including a primary care counseling component:		
Children in 10 New Hampshire low-income towns with populations between 5,000 and 15,000[44,50]	Community-based promotion (5 towns) of SunSafe message vs. controls (5 towns) in day care, schools, beach areas, and physicians' offices.	Children 2 to 9 years of age who visited beaches between 10 AM and 3 PM were measured before and after the intervention (summer 1995 vs. summer 1996). Outcome measures: use of protective clothing, sunscreen, shade, hats with brim.
Children in 10 New Hampshire low-income towns with populations between 5,000 and 15,000[86]	Practice meeting and materials to help practices in establishing an office system to promote sun protection advice to children.	86 clinicians, including 15 of 21 intervention-town practices.

Evidence Table—selected randomized trials of skin cancer prevention and counseling *(continued)*

Quality	Results
Fair-poor: baseline differences in groups; not blinded; did not use intention-to-treat analysis	At baseline, grade 1 students had 41 nevi (median) and grade 4 students had 68 nevi. By the end of the study, children in the treated group developed a median of 24 new nevi vs. 28 new nevi in the control group (*P*=.048).
Good	No difference in the incidence of first cancers. Sunscreen reduced the total incidence of squamous cell cancers but not basal cell cancers. The number needed to treat (NNT) to prevent one squamous cell cancer was 140.
Good	1.6 new lesions per subject in the sunscreen group, vs. 2.3 in the moisturizer group (adjusted relative risk [ARR], 0.72; CI, .15-1.28). Remission of base-line lesions, 2.2 vs. 1.4 per subject (ARR, .814).
Good	Sunscreen: 25-hydroxyvitamin D3 levels rose by a similar amount in both groups. 1,25-dihydroxyvitamin D3 increased significantly in the placebo group only (placebo, +10.8 pmol/L; sunscreen, +1.3 pmol/L; *P*=.0009), but no individual developed a level below the lower limit of the reference range.
Fair	The SPF 30 group spent 72.6 hours in the sun, vs. 58.2 hours for the SPF 10 group (*P*=.011). There was no difference in sunburn experience between the two groups, but the incidences of sunburn (45%) and skin-reddening episodes (81%) were high.
Good	Sunscreen use, but not clothing or shade use, increased significantly in intervention towns. In intervention towns, the proportion of children with *some* sun protection increased from 78% to 87%, while in controls the proportion fell from 85% to 80% (*P*=.029). In the first summer, the proportion using *full* protection increased from 53% to 74% in intervention towns vs. 66% to 72% in controls (*P*=.18). The difference persisted after 2 years of followup.
Good	Before the intervention, 25% of parents reported that they had received sun protection information from a clinician. Afterward, 34% of parents in intervention towns vs. 27% in control towns reported this.

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Appendix

Selected sun protection behavioral interventions in school and community settings

- Slip! Slop! Slap![87]
- SunSmart (Hawaii)[88]
- SunSmart (Rhode Island)[89]
- SunSmart (Australia)[87]
- SunWise[90]
- Sunny Days, Healthy Ways[47,91]
- Block the sun, not the fun[48]
- Falmouth Safe Skin, Falmouth New Moms Project[92,93]
- SunWise[94]
- SunSafe[95]

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