

CLINICAL REVIEW

Sunscreen and Melanoma: Is Our Prevention Message Correct?

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Many primary care providers advise patients to use sunscreen as a means to reduce their risk for skin cancer, especially cutaneous malignant melanoma (CMM). Despite the availability and promotion of sunscreen for decades, the incidence of CMM continues to increase in the U.S. at a rate of 3% per year. There currently is little evidence that sunscreens are protective against CMM. A number of studies suggest that the use of sunscreen does not significantly decrease the risk CMM, and may actually increase the risk of CMM and sunburns. This paper discusses current information regarding the relationship between sunscreen use and CMM, and how providers may need to alter their advice regarding sunscreen use for CMM prevention. (J Am Board Fam Med 2011;24:735–739.)

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For years, primary care providers have advised patients to use sunscreen as a means to reduce their risk of skin cancer, especially cutaneous malignant melanoma (CMM). However, between 1973 and 2003, the incidence of CMM increased by 81% and continues to increase at a rate of 3% per year.¹ According to a 2006 US Environmental Protection Agency publication, “there is no evidence that sunscreens protect you from malignant melanoma.”² A number of studies suggest that the use of sunscreen either does not significantly decrease the risk or may actually increase the risk of CMM.^{3–7} Other studies indicate that sunscreen users, when compared with nonusers, may actually be more likely to develop sunburns, thereby possibly increasing their risk of CMM.^{7–9} These studies, as well as the continued increase in rates of CMM, call into question whether our current advice regarding sunscreen use is truly beneficial in preventing CMM or if it may actually be detrimental in the fight against CMM.

How Sunscreen Can Contribute to Increased Melanoma Incidence

Ultraviolet (UV) radiation is a known carcinogen.¹⁰ Both UVA and UVB radiation is emitted by the sun, but because UVB was thought to be the primary causative agent of all skin cancers by direct damage to DNA, initial sunscreens were developed that blocked UVB with little or no protective effects against UVA. The sun protection factor (SPF) label on sunscreen relates to protection against UVB radiation and is not at all related to UVA radiation protection.

Recent studies suggest that UVA radiation plays a role in the development of melanoma, not necessarily through direct DNA damage but through oxidative stress, free radical generation, and the degradation of vitamin D.^{11–16} The higher ratio of UVA to UVB given off by sunlamps and tanning beds compared with natural sunlight may contribute to greater melanoma risk among tanning bed users.^{11,17–19} Sunscreens that contain benzophenones (such as oxybenzone and sulisobenzene), avobenzone (Parsol 1789), ecamsule (Mexoryl, La Roche-Posay, France), titanium dioxide, or zinc oxide may provide some UVA protection. However, in one in vitro analysis of sunscreen ingredients used to block UVA, the most effective filter, titanium dioxide, blocked only 25% of UVA radiation.²⁰

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Though a number of studies show that the use of sunscreen can reduce the risk of squamous cell carcinoma, sunscreen use was found to be less effective in reducing the risk of basal cell carcinoma.^{21–23} Furthermore, there is no convincing evidence that sunscreen use protects against CMM. Several studies show either no difference in CMM rates between sunscreen users and nonusers or a slight increased risk of CMM in sunscreen users among certain populations.^{3–7}

Although there is convincing evidence that non-melanoma skin cancer is related to cumulative sun exposure,^{6,23} there is less evidence of that association with CMM. If CMM were related to cumulative sun exposure, one would expect that outdoor workers would have a greater incidence of CMM than indoor workers. However, that is not the case.⁶ The incidence of CMM is actually increasing among indoor workers who receive three to nine times less solar UV radiation than outdoor workers.¹⁶ Furthermore, there is a higher incidence of CMM among whites living in northern states such as Delaware, Vermont, and New Hampshire (>30 per 100,000), which enjoy less year-round sunlight and UV radiation than southern states such as Texas, Florida, Arizona, and New Mexico (<25 per 100,000).²⁴ In California, whites living in San Francisco had a CMM incidence of 30.5 per 100,000, whereas those living in Los Angeles had an incidence of 24.9 per 100,000.²⁴

There are a few studies that suggest that chronic, low-grade exposure to sunlight may be protective against CMM. In one Austrian study, those with chronic sun exposure without sunburn had a reduced incidence of CMM compared with those with recreational sun exposure.⁴ In Germany, outdoor activities during childhood, in the absence of sunburn, were associated with a lower risk of melanoma.²⁵ Chronic, repeated sun exposure may allow the skin to accommodate to UV radiation by increasing melanin production, thereby reducing the risk of sunburn.²⁶ An English study published in 2011 showed that regular weekend sun exposure had a protective effect against CMM, and the researchers postulated that this may be mediated by photo-adaptation or higher vitamin D levels.²⁷

Another point suggested by these studies is that sunburns, and not cumulative sun exposure, lead to increased risk for CMM. In an analysis of 15 case-control studies, Chang et al²⁸ concluded that sunburn is a strong predictor of melanoma at all lati-

tudes, whereas cumulative sun exposure affects melanoma risk only at low latitudes, defined as between 34° north/south and 20° north/south. Most of the United States lies north of 34° latitude. If cumulative sun exposure does not affect melanoma risk at countries at higher latitudes, such as the United States, and if chronic, low-grade exposure to sunlight is protective against CMM in these countries, then perhaps our emphasis on counseling patients in the United States should focus on sunburn, not sunlight, avoidance.

When used improperly, sunscreen can potentially increase the risk for CMM by conferring a false sense of protection against sunburn. This false sense of protection can lead to more time spent in the sun, paradoxically causing a greater incidence of sunburns. In two European studies, sunbathers who used SPF 30 sunscreen sunbathed 19% to 25% longer than those using SPF 10.⁸ In a Danish study, 66% of sunburned people had used sunscreen to prolong time spent in the sun.⁹ In addition, those most likely to use sunscreen were those with the skin type most likely to burn.⁷ A number of studies have shown a correlation between the use of sunscreen and increased incidence of sunburn.^{7,9}

With the advent of sunscreens of SPF 50 and higher, this false sense of security may be amplified, and sun exposure time may be prolonged. Because of this, the incidence of sunburns may be increased in the population most at risk for sunburns, thereby continuing the upward trend of melanoma incidence. This false sense of security may be experienced not only by sunbathers, but by parents of small children as well. In a Swedish study, children aged 2 to 7 whose parents had applied sunscreen on them were more likely to experience sunburn than those who received little or no sunscreen.⁷ Sunburns during childhood significantly increase the risk for CMM more than sunburns later in life.⁷ We may need to rethink how we educate our patients about the proper use of sunscreen on themselves and on their children.

What About the Australian Study?

Most of the studies indicating no protective benefit against or even increased risk of CMM with sunscreen use were performed using sunscreen that blocked only UVB radiation. Broad-spectrum UVA/UVB sunscreens now available may provide more protection against sunburns and subsequent

melanoma. In a randomized, controlled, prospective study conducted by Green et al²⁹ in Australia, consistent daily application of both UVA and UVB-filtering broad-spectrum sunscreen resulted in a decreased incidence of melanoma compared with control. What should be noted about the study is that the control group was allowed to use sunscreen as well, but was not guided as to type of sunscreen used or the frequency of application. Therefore, in this study, only daily, consistent use of broad-spectrum sunscreen, but not intermittent use of sunscreen, was associated with decreased risk of CMM. There is still no evidence that the intermittent use of sunscreen, as is more commonly practiced among the US population, reduces the incidence of CMM.

Furthermore, the financial feasibility of this intervention needs to be considered. Daily, rather than intermittent, use of sunscreen incurs a higher cost. A cost-benefit analysis of this intervention is yet to be done. In the Green et al²⁹ study, unlimited, free, broad-spectrum sunscreen was supplied to the intervention group but not the control group. Part of the reason the control group applied sunscreen less frequently may possibly have to do with cost. The cost to the individual for this intervention may hamper compliance.

Though those living in Australia may be highly motivated to reduce their skin cancer risk, compliance with this regimen may be problematic in the US population, who currently exhibits poor sun-protective behavior, even those at increased risk.^{30,31} Applying this intervention in the United States would require convincing populations in higher risk northern states²⁴ to continue to apply sunscreen daily in the middle of winter.

Finally, the Green et al²⁹ study was performed in the low-latitude township of Nambour, situated at 26° south latitude, where cumulative sun exposure affects melanoma risk.²⁸ The United States is not a low-latitude country, and studies do not indicate that cumulative sun exposure affects melanoma risk outside of low latitudes.²⁸ So, it is unclear whether this protective benefit of daily sunscreen use is applicable to the US population.

Because of ethical issues, a randomized, controlled, prospective study examining intermittent sunscreen use versus no use will likely never be done. But future case-control and cohort studies may show benefit with the newer broad-spectrum sunscreens now available. Until those studies are

conducted, the protective benefits of sunscreen use against CMM in the US population remain unproven and controversial.

In July 2011, the *Journal of the American Medical Association* published a commentary by Robinson and Bigby,³² who suggested that the data from Green et al's²⁹ study supports advocating regular sunscreen use in high-risk individuals for the primary prevention of CMM. The authors did not discuss any measures to overcome the limitations of the Green study as discussed above. Also, although the authors offered good advice about counseling high-risk individuals on the proper use of sunscreen, the authors did not mention specifically counseling against sunburn, which is a strong predictor of melanoma risk.²⁸ Sunscreen, when used properly, can be highly effective in reducing the risk of sunburn; however, the lack of specifically counseling against sunburn, may possibly lead to the misuse of sunscreen and may increase the risk of sunburn and resultant CMM.⁷⁻⁹

Discussion

Based on currently available information, the "harm" related to sunscreen use is probably not intrinsic to sunscreens³³; it is more likely related to the improper use of sunscreen, resulting in more sunburns.⁷⁻⁹ Primary care providers who encourage the use of sunscreen should also instruct patients about the proper use of sunscreen to avoid sunburns. Primary care providers need to alter their patients' current perception that using sunscreen allows them unrestricted latitude in the amount of time spent in the sun. If we counsel patients against the abuse of sunscreen and alter their behavior patterns with respect to sunburns, it is possible that future sunscreen studies may confirm the benefit of sunscreen use against CMM. Because there is still insufficient evidence that shows that the use of sunscreen reduces CMM risk in the US population, for now we should not be advising patients that using sunscreen will protect them from CMM. Instead, we should advise them that the proper use of sunscreen is one way to prevent sunburn and that the best way to reduce their risk of CMM, with respect to natural solar radiation, is to prevent sunburn. With that in mind, some suggested points for counseling include:

1. Sunscreen should not be used to prolong the amount of time spent in the sun. When used for

that purpose, there is a greater risk of becoming sunburned.^{8,9}

2. If the skin becomes uncomfortable or red at any time during solar radiation exposure, whether intentional or unintentional, with or without sunscreen, and regardless of length of time spent in the sun, the patient should cover up or seek shade immediately. Simply reapplying sunscreen and failing to seek shelter may increase the risk of sunburn and subsequent CMM.^{8,9,34}
3. Clothing, hats, and sunglasses provide protection against the damaging effects of solar UV radiation. Some studies suggest a negative correlation between clothing and sunburn.^{9,35} However, not all textiles provide equal UV protection.^{35,36} Therefore, a combination of clothing and sunscreen would probably provide the best protection against solar UV radiation. Patients should be advised that sunscreen should be used as an adjunct to, not a substitute for, clothing and hats.
4. Because UVA radiation may also play a role in the formation of skin cancer,^{11–15} patients should use sunscreen that provides protection against both UVA and UVB radiation.
5. Those at high risk of CMM may possibly benefit from consistent, daily use of broad-spectrum sunscreen.^{29,32}

References

1. Ries LAG, Harkins D, Krapcho M, et al (eds). SEER cancer statistics review, 1975–2003. Available at: http://seer.cancer.gov/csr/1975_2003/. Accessed 24 September 2011.
2. United States Environmental Protection Agency. Sunscreen: The Burning Facts. Available at: <http://www.epa.gov/sunwise/doc/sunscreen.pdf>. Accessed 24 September 2011.
3. Huncharek M, Kupelnick B. Use of topical sunscreens and the risk of malignant melanoma: a meta-analysis of 9067 patients from 11 case-control studies. *Am J Public Health* 2002;92(7):1173–7.
4. Wolf P, Quehenberger F, Müllegger R, Stranz B, Kerl H. Phenotypic markers, sunlight-related factors and sunscreen use in patients with cutaneous melanoma: an Austrian case-control study. *Melanoma Res* 1998;8(4):370–8.
5. Gorham ED, Mohr SB, Garland CF, Chaplin G, Garland FC. Do sunscreens increase risk of melanoma in populations residing at higher latitudes? *Ann Epidemiol* 2007;17(12):956–63.
6. Radespiel-Tröger M, Meyer M, Pfahlberg A, Lausen B, Uter W, Gefeller O. Outdoor work and skin cancer incidence: a registry-based study in Bavaria. *Int Arch Occup Environ Health* 2009;82(3):357–63.
7. Rodvall YE, Wahlgren CF, Ullén HT, Wiklund KE. Factors related to being sunburnt in 7-year-old children in Sweden. *Eur J Cancer* 2010;46(3):566–72.
8. Autier P, Boniol M, Doré JF. Sunscreen use and increased duration of intentional sun exposure: still a burning issue. *Int J Cancer* 2007;121(1):1–5.
9. Køster B, Thorgaard C, Philip A, Clemmensen IH. Prevalence of sunburn and sun-related behaviour in the Danish population: a cross-sectional study. *Scand J Public Health* 2010;38(5):548–52.
10. U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program. Report on carcinogens, 12th edition. Available at: <http://ntp.niehs.nih.gov/ntp/roc/twelfth/roc12.pdf>. Accessed 24 September 2011.
11. Garland CF, Garland FC, Gorham ED. Epidemiologic evidence for different roles of ultraviolet A and B radiation in melanoma mortality rates. *Ann Epidemiol* 2003;13(6):395–404.
12. Berking C. [The role of ultraviolet irradiation in malignant melanoma.] *Hautarzt* 2005;56(7):687–96, quiz 697.
13. Situm M, Buljan M, Bulić SO, Simić D. The mechanisms of UV radiation in the development of malignant melanoma. *Coll Antropol* 2007;31(Suppl 1):13–6.
14. Garland CF, Garland FC, Gorham ED. Rising trends in melanoma. An hypothesis concerning sunscreen effectiveness. *Ann Epidemiol* 2007;3(1):103–10.
15. Wischermann K, Popp S, Moshir S, et al. UVA radiation causes DNA strand breaks, chromosomal aberrations and tumorigenic transformation in HaCaT skin keratinocytes. *Oncogene* 2008;17;27(31):4269–80.
16. Godar DE, Landry RJ, Lucas AD. Increased UVA exposures and decreased cutaneous Vitamin D(3) levels may be responsible for the increasing incidence of melanoma. *Med Hypotheses* 2009;72(4):434–43.
17. Lazovich D, Vogel RI, Berwick M, Weinstock MA, Anderson KE, Warshaw EM. Indoor tanning and risk of melanoma: a case-control study in a highly exposed population. *Cancer Epidemiol Biomarkers Prev* 2010;19(6):1557–68.
18. International Agency for Research on Cancer Working Group on artificial ultraviolet (UV) light and skin cancer. The association of use of sunbeds with cutaneous malignant melanoma and other skin cancers: a systematic review. *Int J Cancer* 2007;120(5):1116–22.
19. Gerber B, Mathys P, Moser M, Bressoud D, Braun-Fahrlander C. Ultraviolet emission spectra of sunbeds. *Photochem Photobiol* 2002;76(6):664–8.
20. Couteau C, El-Boury S, Paparis E, Sébille-Rivain V,

- Coiffard LJ. In vitro UV-A protection factor (PF-UVA) of organic and inorganic sunscreens. *Pharm Dev Technol* 2009;14(4):369–72.
21. Green A, Williams G, Neale R, et al. Daily sunscreen application and betacarotene supplementation in prevention of basal-cell and squamous-cell carcinomas of the skin: a randomised controlled trial. *Lancet* 1999;354(9180):723–9.
22. Ulrich C, Jürgensen JS, Degen A, et al. Prevention of non-melanoma skin cancer in organ transplant patients by regular use of a sunscreen: a 24 months, prospective, case-control study. *Br J Dermatol* 2009;161(Suppl 3):78–84.
23. Kütting B, Drexler H. UV-induced skin cancer at workplace and evidence-based prevention. *Int Arch Occup Environ Health* 2010;83:843–54.
24. Centers for Disease Control and Prevention, National Program of Cancer Registries. United States Cancer Statistics. 2003–2007 Melanomas of the skin, United States. Available at: <http://apps.nccd.cdc.gov/uscs/cancersbystateandregion.aspx>. Accessed 24 September 2011.
25. Kaskel P, Sander S, Kron M, Kind P, Peter RU, Krähn G. Outdoor activities in childhood: a protective factor for cutaneous melanoma? Results of a case-control study in 271 matched pairs. *Br J Dermatol* 2001;145(4):602–9.
26. Moan J, Dahlback A, Setlow RB. Epidemiological support for an hypothesis for melanoma induction indicating a role for UVA radiation. *Photochem Photobiol* 1999;70(2):243–7.
27. Newton-Bishop JA, Chang YM, Elliott F, et al. Relationship between sun exposure and melanoma risk for tumours in different body sites in a large case-control study in a temperate climate. *Eur J Cancer* 2011;47(5):732–41.
28. Chang YM, Barrett JH, Bishop DT, et al. Sun exposure and melanoma risk at different latitudes: a pooled analysis of 5700 cases and 7216 controls. *Int J Epidemiol* 2009;38(3):814–30.
29. Green AC, Williams GM, Logan V, Strutton GM. Reduced melanoma after regular sunscreen use: randomized trial follow-up. *J Clin Oncol* 2011;29(3):257–63.
30. Spradlin K, Bass M, Hyman W, Keathley R. Skin cancer: knowledge, behaviors, and attitudes of college students. *South Med J* 2010;103(10):999–1003.
31. Geller AC, Brooks DR, Colditz GA, Koh HK, Frazier AL. Sun protection practices among offspring of women with personal or family history of skin cancer. *Pediatrics* 2006;117(4):e688–94.
32. Robinson JK, Bigby M. Prevention of melanoma with regular sunscreen use. *JAMA* 2011;306(3):302–3.
33. Burnett ME, Wang SQ. Current sunscreen controversies: a critical review. *Photodermatol Photoimmunol Photomed* 2011;27(2):58–67.
34. Bränström R, Kasparian NA, Chang YM, et al. Predictors of sun protection behaviors and severe sunburn in an international online study. *Cancer Epidemiol Biomarkers Prev* 2010;19(9):2199–210.
35. Gambichler T, Altmeyer P, Hoffmann K. Role of clothes in sun protection. *Recent Results Cancer Res* 2002;160:15–25.
36. Wolska A, Owczarek G, Bartkowiak G. UV protective textile clothing for workers exposed to natural and artificial UV radiation. *Conf Proc IEEE Eng Med Biol Soc* 2010;2010:6260–3.