Dangers of the Sun

Introduction

Skin cancer is the most rapidly increasing form of cancer in the United States.[1] Recent studies indicate that the incidence of skin cancer is increasing at an alarming rate[2], with 600,000 new cases of skin cancer are reported every year.[3] One in five Americans will develop skin cancer in their lifetime 1 and according to the Skin Cancer Foundation, by the year 2010, more than 1 million new reports of skin cancer could be reported each year,[3] Although skin cancer diagnosed in the early stages has almost a 100% cure rate [3], sun exposure can cause both acute and chronic injury to the skin. It is well documented that long-term sun exposure, with or without sunburn, can cause harmful effects [4], [5] including premature aging of the skin, malignant changes in the skin, development of lip carcinoma, and corneal opacities. [5]

Skin Cancer

There are 3 different types of skin cancer: basal cell carcinoma, squamous cell carcinoma, and malignant melanoma.[3] Basal cell carcinoma is the most common form of skin cancer. [3] It presents as a clear spot or small bump that usually occurs on the head, neck, or hand. [3] Squamous cell carcinoma may start as nodules or as a red, patchy area, which often occurs on the lips, face, or tops of the ears. [3] Nonmelanoma skin cancers, especially squamous cell, have been associated with cumulative sun exposure, while melanomas have been more closely associated with brief, intense sun exposure or blistering sunburns. [6, 7] Malignant melanoma is the least common skin cancer, but it is also the most fatal. [3] Risk factors for melanoma includes the following: light skin color, family history of melanoma, personal history of melanoma, large number of moles, presence of freckles (indicator of sun sensitivity and sun damage), and history of severe sunburns in the early stages of life. [3]

Ultraviolet Radiation

The UV radiation spectrum can be divided into three bands: UVA, UVB, and UVC.[8] Little UVC radiation reaches the earth because it is filtered out by the ozone layer.[8] UVC does not cause a person to tan; however, it may cause some erythema of the skin. [8] UVB penetrates superficially into the epidermis and is the principal cause of sunburn reactions.[4, 7] UVB is the wavelength that is mostly

associated with inducing skin cancer. [8] UVB has been reported to be responsible for causing more than 90 percent of basal and squamous cell cancers. [4, 7, 9]

In contrast to the effects caused by UVB, UVA is responsible for causing a slow natural tan to develop. [8] UVA radiation penetrate more deeply to the dermis of the skin, which can alter the fibers of the skin. [3] UVA may also contribute to the cancer-causing potential of UVB radiation. [3] Sunscreen lotions are more effective in protecting against shorter ultraviolet wavelengths (UVB) than against longer wavelengths (UVA). [10]

Sunscreens

Sunscreens contain active chemical ingredients that provide protection from the sun through absorption, reflection, and scattering of UV radiation.[4] They are usually divided into two categories: physical and chemical. [4] Physical sunscreens are thick, opaque substances that prevent UV radiation from reaching the skin by scattering the sunlight.[4] They contain titanium dioxide, zinc oxide, or talc as their active ingredients. [4, 5, 6] These sunscreens are very effective in blocking both UVA and UVB radiation; however, they are messy and usually cosmetically unappealing. [4, 5, 6]

Chemical sunscreens are the most commonly used and are available in a variety of formulations. [4] They contain one or more of the UV absorbing chemicals. [4] Some of the most widely used chemical groups that block UVB radiation are PABA (p-aminobenzoic acid), PABA esters (padimate O), cinnamates (cinoxate, ethylhexyl-p-methoxycinnamate), salicylates (octylsalicylate, homosalate), and anthranilates (methyl anthranilate). [4, 11] While these all block UVB radiation, the chemical group known as benzophenone (oxybenzone and dioxybenzone) provides protection against both UVA and UVB. [4]

Sun Protection Factor (SPF)

Sunscreens have been assigned Sun Protection Factor (SPF) values by the U.S. Food and Drug Administration (FDA) since 1978.[12] SPF is a number that refers to the sunscreen product's ability to block UVB radiation.[3] This number does not show the blockade against ultraviolet UVA radiation. Sunscreen products with SPFs of 2 to 50 are currently available.4 A sunscreen product with a SPF of 15 will protect your skin 15 times longer from UVB than if you did not have sunscreen applied. The exact amount of time will vary from person to person,

the altitude, and proximity to the equator.[3] SPF 15 will block 95% of the UVB wavelengths. SPF 30 does not work twice as well however, it will provide another 3% of protection.[3]

The efficacy of a product is related not only to its SPF but also to its substantivity.[8] Substantivity is the ability of a sunscreen to remain effective under the stress of prolonged exercise, sweating, and swimming.[8] The following three labeling recommendations have been suggested to help clarify substantivity:

- **Sweat-resistant:** protects up to 30 minutes of continuous heavy perspiration;
- **Water-resistant:** protects up to 40 minutes of continuous water exposure; and
- **Waterproof:** protects for up to 80 minutes of continuous water exposure.[4,8,10] PABA and its esters demonstrate more resistance to sweating and/or water immersion than do other chemical sunscreens.[11]

It is recommended that sunscreens be reapplied after swimming or perspiring. However, reapplication of a sunscreen does not further the period of protection.[4]

Recommendations

The American Academy of Dermatology, the American Academy of Pediatrics, and the Skin Cancer Foundation recommend that protection from excessive sun exposure be initiated early. [2] Regular use of an SPF-15 product starting after 6 months of age and continuing through 18 years can decrease the incidence of skin cancer over a lifetime by as much as 78%.[8] Recommendations for sunscreen use are as follows:

- Radiation from the sun is most damaging between the hours of 10 a.m. and 2 p.m.[8] Sun exposure should be avoided during this time whenever possible.
- On an overcast or cloudy day, sunscreen use is still necessary. The clouds filter a small amount of ultraviolet radiation. Most of the UV radiation (60-80%) will not be filtered by the clouds and will be allowed to pass through. [8]
- Use a sunscreen product with a SPF of at least 15.1
- Sunscreen products should be applied 20 to 30 minutes before sun exposure. [3]

- Avoid artificial sources of UV radiation, including tanning beds and sun lamps. [1]
- Wear a broad-brimmed hat, long-sleeved shirt, long pants, and sunglasses to decrease sun exposure, especially during the hours of 10 a.m. and 2 p.m. [1] Tightly woven clothing provides the best protection. [8]
- Sun exposure during childhood (up to 18 years old) is about 80% of an average person's lifetime exposure to the sun. [1] Sun protection should begin at a young age and may start as early as 6 months of age.
- Surfaces such as sand, snow, concrete, and water can reflect up to 85% of the UV radiation. [8] Extra precautions should be taken when around these surfaces.

Selection of the Appropriate Sunscreen Product

The individual's skin type is an important factor that must be considered when attempting to choose a sunscreen with the appropriate SPF. [4] In general, very fair-skinned individuals or those with previously sun-damaged skin may benefit from high SPF products. [4] None of the available sunscreen products are recommended by the FDA for use on children under six months of age.[8] In addition, products with an SPF of four or less are not recommended for use on children under two years of age because they will not provide adequate sun exposure protection.[8]

Sunscreen Application

Sunscreen should be applied 20 to 30 minutes before sun exposure so the product has a chance to bond with the skin.[3] Products containing PABA and PABA-like chemicals, however, may need to be applied up to two hours in advance of sun exposure in order to achieve their maximal effect.[5, 8]

Most individuals do not apply enough sunscreen to achieve adequate protection. The SPF is tested at an applied thickness of 2mg/cm2.[13] To cover the average 1.73m2 adult, approximately 35ml of sunscreen is required. The teaspoon rule of applying sunscreen is as follows: Apply slightly more than ½ teaspoon (~3ml) to each arm, to the face and neck. 13 On each leg, the chest and back, apply slightly more than a teaspoon (~6ml). 13 Using an adequate amount of sunscreen (2mg/cm2) provides greater sun protection than using an inadequate amount of a sunscreen with a higher SPF rating. [13]

Topical Toxicology

The FDA report on the over-the-counter (OTC) sunscreen products suggests that human skin under the age of six months may have different absorptive characteristics than that of adults. [2] It also suggests that the biological systems that metabolize and excrete drugs absorbed through the skin may not be fully developed in these children. [2] Although it is recognized that chemicals absorbed percutaneously result in higher blood concentrations in children than in adults, this is probably due to their greater ratio of body surface area to body weight rather than more absorption through the child's skin. [11, 14]

The FDA recommends that sunscreens containing aminobenzoic acid should be avoided in children younger than six months of age, even though a review of the oral use of aminobenzoic acid in large doses has shown it to be quite safe, even in young children. [2, 6] To provide an added margin of safety, the FDA also recommends that no sunscreens be used on children during the first six months of life. [2, 4]

Sunscreens that contain aminobenzoic acid and its esters (PABA), cinnamates, and oxybenzone can cause contact dermatitis or photosensitivity reactions. [4] There have also been reports of allergic contact photodermatitis with aminobenzoic acid. [8] but allergic sensitivity with PABA-containing sunscreens is uncommon. [14]

Aminobenzoic acid is chemically similar to other drugs that cause photosensitivity reactions in susceptible individuals including thiazides, sulfonamides, sulfonylureas, furosemide, and carbonic anhydrase inhibitors. [8] Cross-reactivity may also occur with benzocaine and paraphenylenediamine. [14] Individuals who have had photosensitivity reactions while taking any of these drugs should not use a sunscreen containing aminobenzoic acid or one of its derivatives (aminobenzoate, menthyl anthranilate, or padimate A or O). [8] A sunscreen containing oxybenzone or cinoxate should be recommended for these individuals instead. [8] Miscellaneous compounds, such as fragrances, lanolin, alcohol, and preservatives may also cause skin and eye irritation or sensitization. [4]

In May 1988, a new nitrosamine known as NPABAO was found in certain sunscreens containing padimate-O as the active ingredient. [15] Nitrosamines themselves can be carcinogenic; however, at this time it is uncertain whether this nitrosamine is present in sufficient quantities in sunscreens to be of concern. [7, 15]

Oral Toxicology

Zinc oxide, an ingredient often found in physical sunscreens, can cause gastrointestinal irritation if swallowed. Nausea, vomiting, and diarrhea may occur primarily due to the zinc. The most common symptoms are nausea and vomiting. [16]

Human overdose data on PABA or its esters are rare. Most toxicology data are derived from animal experimentation or chronic, large dose therapeutic use. Nausea, vomiting, and abdominal cramps as well as metallic taste are often seen with oral therapy. Ingestions of more than 10 grams per day for days have been necessary to induce symptoms other than local gastrointestinal irritation. Symptoms are unlikely with normal childhood exposure, and since PABA sunscreens contain 50% or more ethanol, ethanol toxicity may be the greater risk. [16]

Many sunscreen products contain a form of salicylate as their active ingredient. For example, homomenthyl salicylate (homosalate) is a sunscreen products. Half of the ingested dose of®agent found in many Coppertone homosalate could be hydrolyzed in vivo to free salicyclic acid and homomenthol. Theoretically, homosalate-containing sunscreens ingested in substantial amounts may cause salicylate poisoning; however, there are no such reported cases of salicylate intoxication. [16]

Conclusion

The risks of sun exposure and its relationship to skin cancer have been well documented. Regular sunscreen use seems to help limit these harmful effects. The risks of using sunscreen products appear to be minimal. Therefore routine sunscreen use should be recommended in all individuals, especially children, exposed to the sun.

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