Photoprotection

Part I. Photoprotection by naturally occurring, physical, and systemic agents

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Learning Objectives
After completing this learning activity, participants should be able to provide an overview of natural, physical, and systemic photoprotective agents.

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The acute and chronic consequences of ultraviolet radiation on human skin are reviewed. An awareness of variations in naturally occurring photoprotective agents and the use of glass, sunglasses, and fabric can lead to effective protection from the deleterious effects of ultraviolet radiation. New systemic agents, including *Polypodium leucotomos*, afamelanotide, and antioxidants have potential as photoprotective agents. (J Am Acad Dermatol 2013;69:853.e1-12.)

Key words: afamelanotide; antioxidants; glass; photoprotection; photoprotective agents; physical systemic photoprotective agents; ultraviolet radiation.

Effective protection from the harmful effects of ultraviolet radiation (UVR) requires the regular practice of photoprotective strategies, which include seeking shade, the use of clothing, wide-brimmed hats, sunglasses, and the application of sunscreens. Geographic and environmental variations affecting UVR transmission, protective cutaneous chromophores, glass, sunglasses, and fabric will be discussed in this article, along with the multiple systemic agents that show potential as photoprotective agents. Part II of our review will focus on sunscreen development, efficacy, and controversies.

CAPSULE SUMMARY

- Ultraviolet radiation exposure leads to harmful acute and chronic effects on human skin.
- Variations in naturally occurring photoprotective agents affect the degree of ultraviolet radiation exposure.
- Physical photoprotective agents, especially glass, are often underused in photoprotection strategies.
- Limitations of topical photoprotection have driven the search for systemic alternatives.

ULTRAVIOLET RADIATION

Key points

- **Acute effects of UVR include erythema, pigment darkening, delayed tanning, epidermal hyperplasia, free radical formation, and vitamin D synthesis.**
- **Chronic effects of UVR include photoaging, immunosuppression, photocarcinogenesis, and exacerbation of photodermatoses.**

Acute effects of ultraviolet radiation exposure on human skin

The sun emits UVR with wavelengths shorter than visible light (VL; 400-760 nm) but longer than x-rays. As agreed in the Second International Congress on Light in August 1932, UVR is divided into ultraviolet C (UVC; 270-290 nm), ultraviolet B (UVB; 290-315 nm), and ultraviolet A (UVA; 315-400 nm) wavelengths.[1] More recently, because of the recognition that the biologic effects of shorter spectrum UVA are close to that of UVB, UVA is further subdivided into UVA2 (315-340 nm) and UVA1 (340-400 nm). Because ozone in the stratosphere filters UVC radiation, the cutaneous effects of UVR exposure are attributed to UVA and UVB.

The initial response of human skin exposure to UVR includes erythema, immediate pigment darkening (IPD), persistent pigment darkening (PPD), delayed tanning, epidermal hyperplasia, free radical formation, and vitamin D synthesis.[2,3]

Erythema. Sunburn, primarily caused by UVB exposure (and to a lesser extent UVA2 exposure), is the best recognized acute effect of ultraviolet (UV) light exposure on human skin. UVB-induced erythema reaches its peak between 6 and 24 hours after exposure. An immediate erythema reaction, which lasts for 48 to 72 hours after exposure, characterizes skin reaction to high-dose UVA.

Immediate and persistent pigment darkening. Exposure to UVR also results in pigmentary alteration. IPD, predominantly caused by UVA light, is often gray in color. It develops within minutes of irradiation and fades within hours. At UVA

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