A Multidisciplinary Approach Challenging Current Thinking on UV and Glare

CONSENSUS FROM THE UV AND GLARE ROUNDTABLE

CONTRIBUTORS

Stephen Brunton, MD
Kenji Hamada, OD
Adelaide Hebert, MD
Richard Judelsohn, MD
Steven J. Lichtenstein, MD
Paula Newsome, OD
Knut Stamnes, PhD
Susan Stenson, MD

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INTRODUCTION

Ultraviolet radiation (UVR) is a significant health hazard that can cause skin cancer, a variety of serious eye diseases, and blindness. While these hazards are well documented, and simple and inexpensive preventive measures are readily available, it is clear that throughout the world, people generally ignore the hazards and fail to protect themselves sufficiently.

Seeking insight into both the health impacts of UVR and the causes of such widespread inattention to the dangers, Transitions Optical, Inc., convened the UV and Glare Roundtable on August 23, 2003 at Keswick Hall, Charlottesville, Virginia. Roundtable participants included a physicist, two ophthalmologists, two optometrists, a dermatologist, a family physician, and a pediatrician.

Each participant gave a half-hour presentation about UVR as it pertains to the participant's own discipline and professional experience. The result was a group synthesis of key insights and ideas that could provide a basis for a recommendation on implementing UV-protection programs in the United States.

Key Points

The participants found all of the presentations to be valuable and educational, giving them an excellent opportunity to learn about the dangers of UV radiation and the means of protection in a comprehensive and enjoyable way.

The participants were in consensus with the following major points:

1. ***An Important Issue***
   The participants were unanimous in their belief that the dangers of UV radiation are significant, and that the need for many different forms of protection is important in safeguarding the health of patients and the public. This issue is worthy of the continuing efforts of participants, of health care professionals, and of society.

2. ***Public Policy***
   The public simply does not understand the magnitude of the threat that UV exposure presents. Education efforts to date have not been sufficient. Thus, significant public policy initiatives are needed to increase the awareness of children, families, and educators about the dangers of UV radiation and the steps needed to protect themselves. Although the awareness programs initiated in Australia may be a good model for the US, they need to be modified to include greater awareness of the need for vision protection.

3. ***Interdisciplinary Education***
   The participants agreed that health care practitioners in every field could benefit enormously from this interdisciplinary discussion. A significant discovery that emerged from the discussion was that the medical professionals are aware of the potential hazards and the health impacts of UVR pertaining to their own specialty, but not outside of their own specialty. Those focusing on vision health did not have a thorough understanding of the hazards to the skin, and vice versa. Thus, the participants also recognize the need for complementary patient referral between and among vision and skin specialists – dermatologists, ophthalmologists, and optometrists.

4. ***Recommended Protection***
   - Skin protection includes UV protective clothing, hat with a minimum 3" brim, and consistent use of sunscreen. As a precaution, any new or changing moles should be checked promptly by a qualified physician.
   - Eye protection includes UV-protective lenses and filters for all outdoor use. Larger lenses that sit close to the eyes are preferred because they provide better protection. Photochromic lenses can be very effective and convenient as well. Ophthalmic or optometric visits should be scheduled regularly for preventive care.
   - People should avoid excessive sun exposure between the hours of 10 AM and 2 PM, when UV radiation peaks, and they should be attentive to light reflected from snow, water, sand, and pavement.

LATITUDE AND ALTITUDE, ATTITUDE, AND AWARENESS—SIGNIFICANT FACTORS IN SUN EXPOSURE

What Is UVR?

UVR is an invisible part of the light spectrum occupying a range of wavelengths from 100-380 nanometers (nm), whereas visible light is that part of the spectrum with wavelengths of about 380-780 nm (Figure 1). UVR from 280-upwards accounts for most of the detrimental biological effects of sunlight—primarily its effects on skin and vision (Table 1). UVB is partially absorbed by the ozone layer, whereas UVA is not. Notably, the ozone layer, which filters a portion of UVR, is diminishing at the rate of 12% per decade globally. It is estimated that for every 1% decrease of ozone layer, there is a 4% increase in skin cancer and a 0.6% - 0.8% increase in the incidence of cataracts.

Fig. 1. The spectrum of UV radiation and visible light

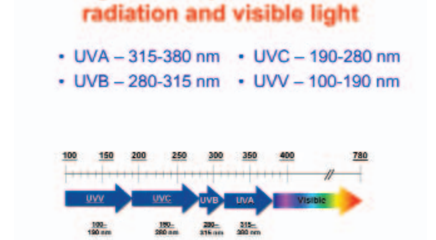


Table 1. The Light Spectrum

UVA—The band of UV radiation (wavelength: 315-380 nm) that induces sun tanning
UVB—The band of UV radiation (wavelength: 280-315 nm) that causes sunburns, blistering, and skin cancer
UVC—The band of solar radiation (wavelength: 190-280 nm) that does not penetrate to the earth's surface
UVV—The band of UV radiation (wavelength: 100-190 nm) that exists in a vacuum
Visible Light—Electromagnetic radiation that has a wavelength that ranges from about 380 nm (violet) to about 780 nm (red) and may be perceived by the normal unaided human eye.

Geography

The degree of exposure to solar radiation varies with the time of day, sky condition, season, and latitude (Figures 2 and 3) as can be seen by variations in the UV index. The effects of latitude on solar radiation are exemplified by the high levels of ambient UVR experienced in Australia.[1,2] During its summer, Australia is closer to the sun than the northern hemisphere. This, combined with clearer atmospheric conditions and more significant ozone depletion over the Antarctic (Figure 4), leads to an ambient UVR intensity that may be 12% to 15% higher in the southern hemisphere than the northern hemisphere.[3,4]

UVR intensity increases with altitude by 5% for every 1000 feet of elevation and with the degree of reflectivity of the local surface (Table 2). The UV index is highest on cloudless days; but up to 80% of UVR can pass through clouds, permitting sunburn and damage to the eyes.[5,6]

Attitude and Awareness

As a result of the high level of exposure to UVR, Australia has the highest skin cancer rates, including melanoma, in the world.[7,8] This has prompted the creation of a national policy and program for sun protection among Australian citizens, particularly the young.

A recent study indicates that the Australian population still does not focus on, or take steps to practice UV protection for the eyes. The study, done in Australia in 2003, found that 91% of those surveyed were aware of the dangers of UVR to the skin, yet only 12% of them were aware of its effects on the eyes.[12] A similar study in the US found that 79% of those surveyed were aware that UV leads to skin cancer, but only 6% were aware of the damage it caused the eyes.[37]

Fig. 2. Winter UV radiation

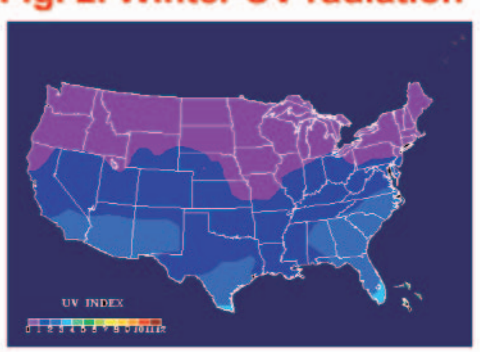
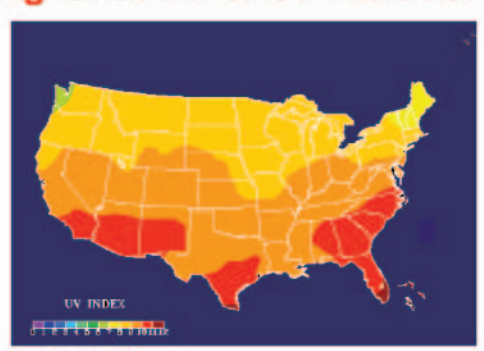


Fig. 3. Summer UV radiation



THE UV INDEX

The UV index (UVI) has been set as an international standard to represent the intensity of solar UV radiation at the earth's surface on any given day. The index ranges from zero upward, with higher values indicating a greater potential for UV damage to the skin and eyes, and a shorter exposure time for damage to occur. Sun exposure behaviors comprise the most significant individual risk factors for UVR damage. Therefore, the UVI is a significant educational tool that can be used to encourage people to reduce their exposure to UVR, and to implement effective protective measures on any given day. The UVI can be incorporated into educational programs on UV protection, and can be used as a guide to change attitudes and behaviors regarding UVR exposure. UVI dangers should remind people that exposure in everyday life needs to be monitored, and appropriate UV protection of the eyes and skin needs to be implemented. If the weather report is used to know when one should wear a raincoat or warmer clothing, then the UVI should be consulted to determine the degree of UV protection needed on any given day. This will require cooperation of the media in reporting the UVI, and an increase in public awareness and understanding of the UVI, and a willingness to use the information contained in it. {World Health Organization. Global Solar UV Index—A Practical Guide. A joint recommendation of: World Health Organization, World Meteorological Organization, United Nations Environment Programme International Commission on Non-Ionizing Radiation Protection. As an aid in using the UVI and in understanding its implications, the US Environmental Protection Agency (EPA) has created a website that gives the UVI by ZIP code, and describes what protective steps are appropriate for that given UVI.[32]

Table 2. Reflectivity of Various Surfaces

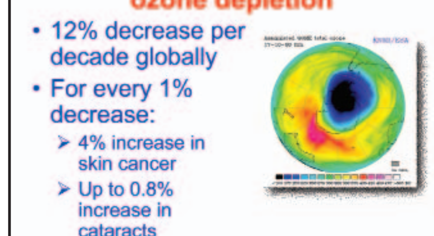
Surface	Reflection of UVR (%)
Grass	3
Water	5
Asphalt	8
Concrete	12
White Sand	20
Old Snow	50
New Snow	>90

Table 3. Frequency of Sunscreen Use by High School Student in the US Hall

	N[3]	Never %	Rarely %	Sometimes %	Most of the Time or Always %
Total	15,349	35.9	29.3	21.4	13.3
Age (years)					
≤ 14	1,308	30.5	26.1	25.9	17.5
15	3,378	35.2	29.1	22.1	13.7
16	3,988	35.3	29.8	21.2	13.7
17	4,013	36.6	30.4	21.1	11.9
≥ 18	2,631	41.0	29.0	18.3	11.6
Sex					
Female	7,828	29.8	28.4	23.8	18.1
Male	7,445	42.0	30.3	19.1	8.6
Race or Ethnicity					
White	5,407	25.0	32.5	26.0	16.5
Black	4,283	74.1	13.7	7.4	4.8
Hispanic or Latino	4,106	43.2	28.4	17.6	10.8
Grade					
9	3,786	37.0	27.5	21.0	14.6
10	3,787	34.2	29.5	22.8	13.6
11	3,885	35.8	30.1	21.7	12.5
12	3,823	36.6	30.7	20.3	12.4

Attitudes about participating in effective sun-protection behavior rest on an awareness of the dangers of UVR and the procedures needed to avoid them. Mounting evidence shows an appallingly low level of awareness concerning the hazards of UVR—particularly with regard to eye health and well being.

Fig. 4. UV radiation and ozone depletion



For example, in 1998, The American Cancer Society (ACS) conducted the first nationwide study of the sun exposure and sun protection habits of people 11-18 years of age.[13] The survey found a dangerous degree of sun exposure, despite the use of sunscreens. About 72% of the youths surveyed stated that they got sunburned during the summer despite the use of sunscreen.

A study of sunscreen use by over 15,000 US high school students in the US[14] showed that only 13.3% of students used sunscreen on a regular basis (always or most of the time) (Table 3). In yet another study[15] of 10,000 children and adolescents in the US, it was revealed that only 40% of girls and 26% of boys used sunscreen. Appallingly, a third of the girls and a quarter of the boys thought that it was a good idea to burn when getting a good tan.

Although these studies did not focus on eye protection, it can probably be assumed that, given these young people's attitudes about the dangers of the sun and UVR in general, they do not use significant UV eye protection. The results of these studies take on added weight considering that 80% of lifetime exposure to the sun occurs by age 18.[16]

HAZARDS OF SUNLIGHT EXPOSURE

Absorption by the Eye

Visible light penetrates the cornea and lens to impinge on the retina (Figure 5). Some UVB is absorbed by the cornea. The remainder of the UVB and UVA is absorbed by the adult human lens. Little, if any UVA reaches the retina. However, the very young human lens transmits a small window of UVA light to the retina.[17]

UV Damage to the Eye

It must be borne in mind that both UVA and UVB have the potential to damage ocular structures, and that the effects are cumulative over a lifetime.

Eyelids

Both UVA and UVB will cause sunburn of the eyelids. The lids are also susceptible to the development of skin cancers as a result of over-exposure to UVB. Ten percent of all skin cancers occur on the eyelids, with basal cell carcinomas accounting for about 80% of these. Squamous cell carcinoma and melanoma also occur in the ocular adnexa.

Conjunctiva

UVB damage leads to the formation of pterygium and pinguecula of the conjunctiva. Pterygia occur frequently in low latitudes, such as the southern US, and the tropics, and is common among dark-skinned people—which points to the universal need for UV protection regardless of race or ethnicity.

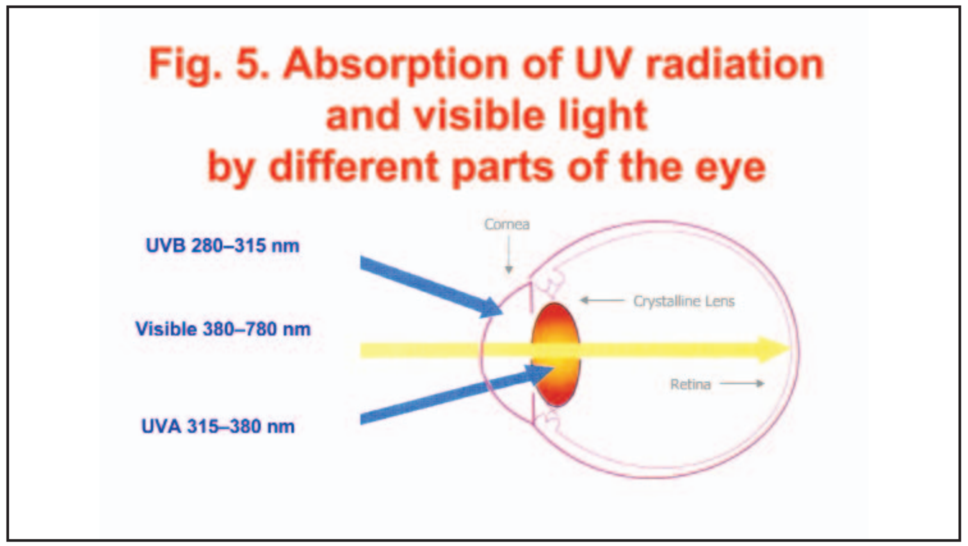


Fig. 5. Absorption of UV radiation and visible light by different parts of the eye

Cornea

The cornea can develop photokeratitis—essentially a corneal sunburn—as a result of acute exposure to UVB. The highly regenerative capacity of the cornea, however, usually repairs this painful condition very rapidly. More degenerative corneal changes resulting from chronic, cumulative UV exposure—as experienced by people who work outdoors—manifest as climatic droplet keratopathy or spheroidal degeneration.

The Lens and Retina

Chronic exposure to UVR increases the risk of developing age-related cataracts. The more insidious, chronic consequence, however, is AMD. Again, it should be noted that 75% of UVR passes through the crystalline lens in children under the age of 10—a time in life when sun exposure is apt to be significant—and even a low level of UVA reaching the retina will result in damage over time.[18,19]

These long-term effects have been confirmed by retrospective studies on human exposure to the sun. These studies revealed that, based on time spent outdoors during adult life, there was a slight increase in AMD and cataract.[20-23] However, a review of the degree of exposure that occurred earlier in the life of the same population—during teenage years (from 13-18) and in early adulthood (from 30-39 years)—revealed a higher incidence and greater correlation between sun exposure and both cataract and AMD.

HAZARDS OF SUNLIGHT EXPOSURE

Glare

Glare is a significant factor in visual acuity and its effects can range from mild discomfort to virtually blinding an individual experiencing it. Fundamentally, glare is the loss in visual performance or visibility, or the annoyance or discomfort produced by luminance in the visual field that is greater than the luminance to which the eyes are adapted. Simply put, this means that one will experience the effects of glare to the unaided eye when going from indoors, for instance, where the illuminance is about 400 lumens, to the outdoors where the illuminance may range from 1,000 to 3,500 lumens (the comfort limit). Glare can also be produced by highly reflective surfaces, or by looking directly at the sun, or into the headlights of an oncoming car. There are several types of glare—distracting, discomforting, disabling, and blinding. All can be caused by direct or reflected light. Distracting glare causes minor annoyance from reflections from the lens surface or from within the lenses. Discomforting glare starts at around 3,000 lumens and can reach levels that are disabling. Low-level discomforting glare induces squinting, leads to fatigue, and can occur even on overcast days. As luminance increases, discomforting glare results in pupillary constriction and head turning. With age, the tolerability to glare decreases and the onset of discomfort tends to occur at lower levels of luminance. When light intensity approaches 10,000 lumens, it effectively blocks vision and disabling glare ensues. Glare diminishes the apparent contrast of objects. When reflected light causes blinding glare, such as from a car windshield or hood, the light can be blinding to the point of dangerously obscuring sight behind the glare. This can have dire consequences, such as when blinding glare from a car windshield obscures a pedestrian's vision of oncoming traffic, or it temporarily blinds a construction worker performing a hazardous task. In the final analysis, glare results in eyestrain, headache, and diminished vision, where there is a reduction in depth perception and contrast sensitivity.

Absorption by the Skin

UVA and UVB penetrate the skin to different depths (Figure 7). UVB does not go much below the epidermis. UVA, however, penetrates into the dermis and subcutaneous layers. Because it is a much larger portion of the skin, the dermis is subject to considerable UV damage and subsequent photo-aging. UVB radiation varies over the day, and is strongest between 10 AM and 2 PM, but the variation in UVA is much less pronounced. Another difference between UVA and UVB is that a sunburn from UVB is noticeable on the first day, whereas a UVA sunburn may take up to 72 hours to become evident.

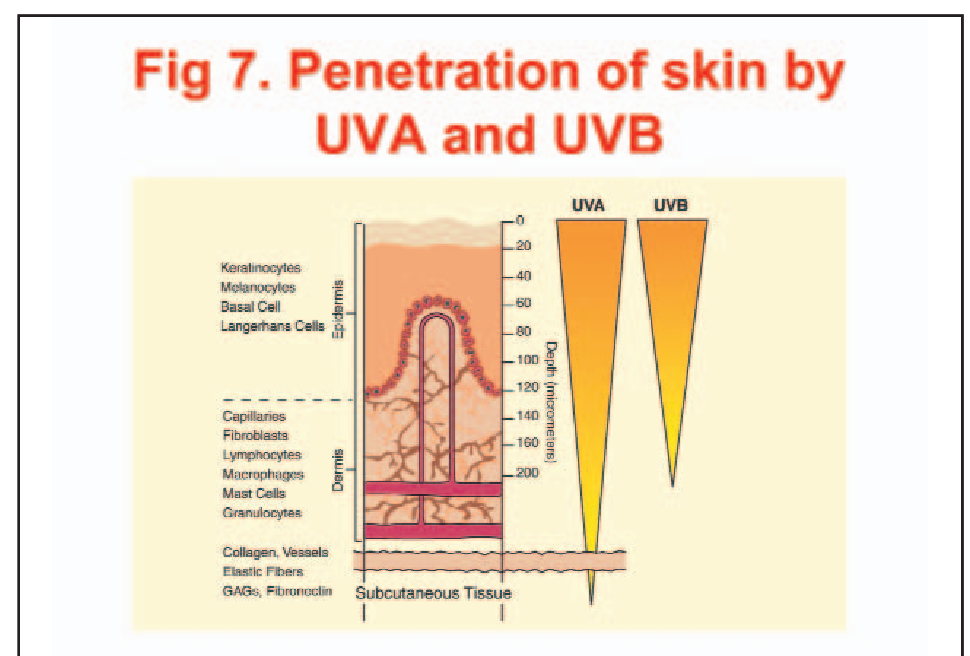


Fig 7. Penetration of skin by UVA and UVB

UV Damage to the Skin

Today, skin cancer is the most common form of cancer in the United States, and it causes 7,000 deaths annually. Of the three forms of skin cancer—basal cell carcinoma, melanoma, and squamous cell carcinoma—melanoma is the most dangerous. Its occurrence has more than doubled in the past 25 years, with an incidence rate of 14.3/100,000 in 1998, and the annual death rate has increased by 44%, from 1.6 to 2.3 per 100,000. Basal cell carcinoma is the most common form of skin cancer, with about 750,000 cases occurring each year. As noted earlier, UV-induced skin cancers on the adnexa of the eye are an important dermatological problem.

Acute and Chronic Effects of UVA and UVB

The two main acute skin reactions to UVR—sunburn and tanning—are harbingers of long-term skin and eye damage. The chronic reactions are photo-aging and skin cancer. In terms of skin health, UVB is the most mutagenic and cytotoxic band of the solar spectrum. It is the most damaging radiation, leading to pre-cancerous and cancerous lesions. By comparison, the phototoxic effects of UVA are much lower, although it penetrates much deeper into the skin and definitely contributes to photo-aging. Photo-aging of the skin manifests as fine wrinkling, texture and color change, sagging and scarring.

THE DYNAMICS OF PHOTO-AGING TO THE SKIN

Alteration of DNA

When sunlight enters the skin, it may alter nuclear components, including DNA. Although DNA is not a chromophore for UVA radiation, it can be damaged by photosensitization reactions that are initiated through absorption of UVA by unidentified chromophores.

UVB radiation primarily affects DNA through the formation of dimeric photoproducts between adjacent pyrimidine bases on the same DNA strand. There are extensive DNA repair mechanisms in human skin. However, the production of dimeric photoproducts may exceed the ability of the body to metabolize and neutralize them. In addition, reactive oxygen species may also lead to DNA damage—which provides a rationale for using antioxidants topically and as oral supplements.

Genetic Predisposition

Mutations on the genetic marker p53 seem to be an early event in UV-induced skin carcinogenesis, since p53 mutation is found in nearly 50% of actinic keratosis (AK), a premalignant stage of squamous cell carcinoma (SCC).

THE DYNAMICS OF UVR DAMAGE TO THE EYE

The potential for eye damage from UVR depends on several factors: intensity, wavelength, site of damage, oxygen tension, chromophores, and defense systems.

Intensity

Apart from the spectral distribution of light that enters the eye, the potential for damage increases with the intensity of the light. An acute exposure to high intensity UVR is exemplified by skiing on sunny days, especially at high altitudes, fishing, boating, or spending hours on the beach when the UV-Index is high. Exposure to high intensity UVR can result in photokeratitis or solar retinopathy—a macular burn.

Wavelength

Wavelength, which has already been discussed, is significant because it determines the depth of penetration of light into the eye and the skin (Figure 6). Shorter wavelengths possess higher energy, and thus a higher potential for biological damage, but do not penetrate tissue as deeply as longer wavelengths. Most UVR is absorbed by the lens and cornea, but in young children, the lens transmits a small band of UVA (around 320 nm). Before age 10, 75% of UV is transmitted through the lens, compared to about 10% transmitted at age 30.[17,34]

Site of Damage

Cornea and Uveal Tract

The epithelial and endothelial cells of the cornea are susceptible to damage from intense UVA and UVB light, which cause keratitis. However, these cells have an excellent repair mechanism, so that damage is rarely permanent.[17]
In contrast, the iris pigmented epithelial cells of the iris and the melanocytes of the uveal tract (which are highly pigmented), are significantly protected against damage, unless there is long-term exposure or aging of the cells.

The Lens

The epithelial layer of the lens is in contact with the aqueous and receives UVR directly, thus becoming susceptible to phototoxic effects. Phototoxicity in the inner layers of the lens involves changes in DNA and certain amino acids, as a result of damage to lipids and/or the main intrinsic membrane protein. These processes are all cataractogenic.[16]

The Retina

The small amount of UVR radiation that is not filtered by the cornea and lens can cause damage to occur in retinal pigment epithelial cells, the choroid, and the outer segments of the rods and cones. If phototoxic damage is extensive, permanent blindness can occur—possibly as a result of AMD, which can be a result of UV damage that accumulates each day over a lifetime.

Factors Effecting Degree of Damage

Oxygen Tension

The more highly oxygenated a tissue is, the more susceptible it is to oxidative and photooxidative damage. The eye, and its structures have a high oxygen tension. The cornea is oxygenated through direct contact with the air and the aqueous. The retina has a very complex network of vessels that provide a rich blood supply and therefore a high degree of oxygen tension. Although the lens has no direct blood supply it is still sufficiently oxygenated to be damaged by photooxidation.

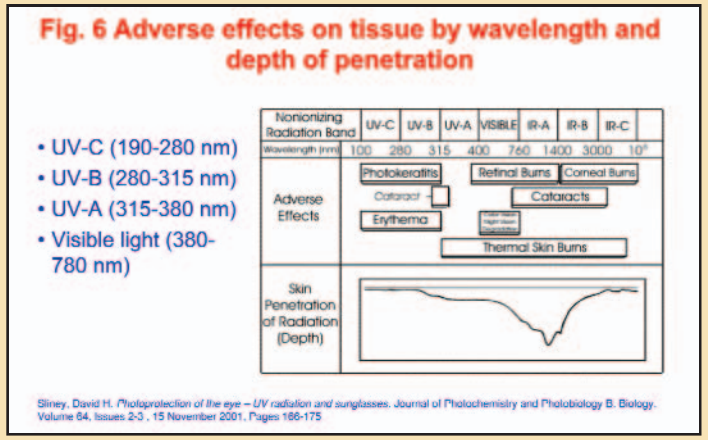


Fig. 6 Adverse effects on tissue by wavelength and depth of penetration

Chromophores

Both exogenous and endogenous chromophores absorb light energy and convert it to an impulse that is transmitted to the brain, where it is interpreted as an image. Ordinarily, both the endogenous and exogenous chromophores absorb UVR and prevent it from reaching the retina. Thus, they are protective against photooxidation. But with age, certain of these chromophores (yellow) are converted to xanthurenic acid, which leads to the production of reactive oxygen species that damage lens proteins.[17] As the lens has no reparative mechanisms, this damage is cumulative and culminates in age-related cataracts. The retina itself has a number of protective chromophores—(rhodopsin, opsin, melanin, A2E). With age, these are converted to lipofuscin that may promote photooxidative reactions, as well.

Defense Mechanisms

Finally, there are a number of defense mechanisms that are available to the eye that protect against photo-oxidation. These include antioxidant enzymes—such as superoxide dysmutase and catalase—and the antioxidants including vitamins E and C, lutein, zeaxanthin, lycopene, glutathione, and melanin. Again, these, too, diminish with age, but, fortunately, can be replaced by supplementation.

IMPACT OF UVR ON PATIENTS WITH SPECIAL NEEDS

UVR affects everyone—regardless of age, or ethnicity. The degree of risk may be greater in certain groups, including young children, people with sun-reactive skin types, people taking photosensitizing medications, people who work or play outdoors, or people who reside at high altitudes. People with existing eye diseases or conditions are at great risk of UV eye damage.

In addition, there is a common misconception that dark-skinned people need less protection from the sun. Yet, they are as susceptible to UV eye damage as are lighter-skinned people. In fact, the Intersun Project of the World Health Organization (WHO) clearly states that, "darker skin provides no protection against UV effects on the eye and immune system!"[24]

Moreover melanoma is highly virulent when it occurs in dark-skinned people. This points, again, to the need for all people to practice adequate UV protection.

Children

There are increased risks of high degree of exposure to UVR during childhood. Children have immature skin cells that are still developing; thus they are more susceptible to UV damage. They also tend to have a greater percentage of exposed body surface area. These risks, although ubiquitous to children, are compounded by geographic location, obviously becoming greater in the Sunbelt and anywhere with increased exposure to highly reflective surfaces such as sand, water, snow, and even pavement. Keep in mind that young eyes have less capability to filter UVR than adult eyes, and thus, eyes demand greater protection at the earliest possible age.[17]

Diabetics

Diabetics may be particularly susceptible to UV damage. Due to an accumulation of sorbitol and fructose in the lens, diabetics are at higher risk of developing cataracts at an earlier age than nondiabetics.[25]

Patients Taking Certain Medications

Certain medications may induce photosensitivity in various body sites, which is an increased absorption of UV (Table 4). In these phototoxic reactions, the drug is bound to skin tissue and absorbs energy from UV light. The drug releases energy into the skin, causing cell damage or death.[25] The propensity of these agents to induce visual damage depends on their chemical structure, absorption spectra, ability to cross blood-ocular barriers, and binding to ocular tissue. When these compounds deposit in the lens or retina, the tissues become more vulnerable to light damage.[17,27]

People Who Spend Extended Time Outdoors

People with outdoor jobs, or people who get continuous or extensive UV exposure, such as farmers, construction workers, and sports enthusiasts, have an increased risk for UV damage to the skin and eyes.

In the final analysis, everyone is at risk, especially before age 18. The highest level of exposure, occurring during adolescence, is compounded by young people's tendency for lack of caution and unprotected sun exposure behavior.

In addition, young people get eye care perhaps as little as 20%-30%. Unless there is an evident eye problem, examinations are usually limited to visual acuity testing by the primary care physician or pediatrician. Of those who do wear prescription glasses, very few in the US use protective eye wear for more than just glare protection. This is probably due to a lack of awareness concerning the deleterious effects of UVR on the eye. Ironically, parents, who wear sunglasses or photochromic lenses, do not usually consider sun protection for their children.[28]

Table 4. Photosensitizing Medications That Increase the Absorption of UVR[25,31]

- **Retinoids**
- **Tetracycline**
- **Accutane (Tx: acne)**
- **Thiazides and other diuretics (anti-hypertensive)**
- **Oral contraceptives**
- **Phenothiazines (tranquilizers)**
- **Psoralens (Tx: psoriasis)**
- **NSAIDs**
- **Herbs, such as St. John's Wort (hypericum)**

CONSENSUS RECOMMENDATIONS

To help organize and consolidate the opinions of the UV-Glare Roundtable participants regarding a consensus statement, the moderator divided the panelists into two multidisciplinary groups and asked them to address the following questions:
1. What do your colleagues need to know about UV and glare?
2. What do your patients need to know about UV and glare?
3. What are the most important points around which there is general agreement or consensus?
4. What are the most important points around which there is disagreement?

The opinions and conclusions reached by the panelists were presented by a spokesperson for each group. A summary of these panel discussions (held after the formal presentations) provided the information about UV and glare cited above.

Interestingly, Drs. Hebert and Judelsohn, reporting for each group, both said that there was very little disagreement among the panelists on the major issues. They pointed to the panelists' agreement that:

> "The increasing incidence of UV-related eye and skin diseases, and the public's inadequate sun-protection behavior comprise a mandate for comprehensive programs that will increase public awareness about the dangers of UVR and foster better UV-protection practices."

In addressing the first question, the UV and Glare Roundtable participants unanimously agreed that the UV-eye disease connection is not well recognized among non-eye care health professionals, including family practice (FP) and general practice (GP) clinicians, dermatologists, and pediatricians. In this regard, Dr. Hebert suggested to the panel that the dermatologist's assessment of the relationship between eye disease and UVR may need to be updated. In contrast, eye care professionals are aware of the association between UV exposure and damage to vision, but they may not be automatically delivering a strong or consistent message to their patients about the need for UV eye protection. The panelists stressed that education needs to begin with these health professionals so that they gain a better understanding about the dynamics of UV-induced eye damage and are equipped with the tools necessary to educate their patients. Moreover, the participants emphasized that education of all healthcare professionals, as well as the public, should be a multidisciplinary effort, with the initiative being spearheaded by the ophthalmic community regarding UV-eye protection, and by dermatologists concerning UV-skin protection. Dr. Stenson pointed out that one reason for a multidisciplinary approach is that eye care professionals do not get to see most of the people who use some form of UV protective eye wear, because most of it is obtained over the counter. Therefore, there is little chance for counseling by an eye care specialist. The panelists were also in agreement that ophthalmologists and optometrists need to provide eye care that goes "beyond 20/20" and addresses quality-of-life issues affected by glare and UV exposure.

Educating Healthcare Professionals

The UV and Glare Roundtable participants recommended that dermatologists need to learn more about the type of eye wear necessary to provide a high level of UV protection. Especially important, the ophthalmologists on the panel proposed that when patients present with one or more apparently sun-induced skin lesions, the dermatologist should consider overexposure of the skin as a potential overexposure of the eyes. The panelists suggested that this situation should prompt a referral of the patient to an eye care specialist to uncover any UV-related eye damage. Such multidisciplinary referrals, as Dr. Hamada noted, provide the opportunity for optimum vision care for all patients. However, an education and awareness campaign is needed for dermatologists to implement these protocols, so that they approach patients with a concern for UV protection of the eyes as well as the skin. The panel emphasized that such an educational program should be provided by the ophthalmology, optometry, and dermatology associations, in order to promote UV protection as a true multidisciplinary effort.

Educational programs about UVR and eye health are equally as important for primary care clinicians—including pediatricians, GPs, and FPs—who are likely to be the young patient's main healthcare provider for many years. Such programs can be implemented through continuing medical education (CME) efforts directed at physicians, optometrists, nurses, physician's assistants, and nurse practitioners.

The UV and Glare Roundtable panelists agree that educational initiatives should not stop with clinicians, but should be extended to school administrators, nurses, teachers, coaches, counselors, summer camp and youth organizations—in short, any professionals who work with the young—through their respective professional organizations. These programs should emphasize the need for early implementation of preventive eye and skin care to minimize the cumulative effects of UVR.

Educating Patients

In addressing the second question, the UV and Glare Roundtable discussion highlighted the need for healthcare providers to offer patient education on UV protection during infancy, starting with the parents. In this context, Dr. Brunton said that, "This enlisting of the parents is a real opportunity because they will often do something for their children that they won't do for themselves. And if we can stress the role that parents can have in terms of preserving the sight of their children into old age, that certainly will have an impact on long-term eye health."

Direct education of the patient may begin at about age 4, as part of routine examinations. Dr. Judelsohn urged that education on UV protection, which at present is primarily focused on the skin, has to move beyond just the skin. He added that this effort should be accompanied by specific and concrete suggestions about sun exposure habits and sun protection, for both eyes and skin with perhaps a more intense effort by geographical location, particularly, the Sunbelt. The panel called attention to reinforcing the message about the dangers of UV and good sun-protection practices to adolescents, a group whose sun exposure habits and attitudes put them at great risk for UV damage of vision and skin. On this point, Dr. Newsome noted that pediatrician's offices usually have patient information flyers and booklets on a wide variety of medical subjects, but very little on UV protection for the eyes. As a solution to this lack of critical eye care information, the panelists recommended that efforts at patient education need to be reinforced by patient information materials developed as a single or as a multidisciplinary initiative by various professional organizations including:

- The American Academy of Pediatrics (AAP)
- The American Academy of Dermatology (AAD)
- The American Academy of Ophthalmology (AAO)
- The American Academy of Family Physicians (AAFP)
- The American Optometric Association (AOA)
- The National Eye Institute (NEI)

In addition to these US-based professional healthcare associations, a number of international organizations have been instrumental in providing educational programs on UV protection for the eyes and skin. In many of these programs, including those in the US, the major emphasis is on skin protection; therefore, education on eye protection needs to be amplified.

Creating Public Advocacy

The initiative for promoting public policy on UV protection for the eyes may have to begin with the ophthalmic community—both ophthalmologists and optometrists—through their respective associations. However, other medical and healthcare associations, national, state, and local governments, public and private educational institutions, labor unions, and sports organizations need to adopt a uniform set of goals addressing sun protection polices that relate to sun exposure schedules and physical environments, personal protective clothing, and eye wear that protects against UV and glare, use of sunscreens, family outreach programs, resource allocation, and evaluation of program implementation.

Public policy should involve environmental management and urban planning that provide UV protection (including shade structures) and set sun exposure schedules in a variety of settings including:

- School playgrounds
- Recreational facilities
- Public parks and gardens
- Outdoor work areas

In particular, children's outdoor activities should be conducted in shaded areas, and the use of eye protection—eye wear that filters UVR and eliminates glare, and the use of wide-brimmed hats—should be encouraged.

Eye Wear Recommendations

Eye care specialists have to be educated that "20/20 is not enough." New approaches to eye care must emphasize total quality-of-life issues including:

- UV protection
- Elimination of glare that compromises vision, especially in older people
- Improved visual quality, as well as quantity of vision, (ie, better contrast sensitivity)
- Comfort and convenience that will increase compliance with UV-protective eye wear guidelines

The UV and Glare Roundtable participants noted that there are several methods of eye protection: UV protective eye wear (spectacles), contact lenses, and eyelid protection. Some contact lenses do not have UV filtration, so manufacturers must be educated and encouraged to incorporate UV filtration into these lenses. Even with UV filtration, the range of diameters of most contact lenses does not allow them to cover the entire cornea. In addition, they obviously do not cover the eye the way spectacles do, thus leaving the adnexa of the eye exposed to UVR. So, UV filtering contact lenses provide only partial protection of the cornea, and no protection of the conjuctiva or eyelids. Therefore, the panelists strongly recommended that for contact lens wearers to have optimal eye protection, they must complement contact lenses with UV-protective eye wear.

In contrast, spectacles can cover the eye and eyelids, offering greater UV protection. A range of lens materials, some high tech, that now block all UVA and UVB radiation (Table 6). Note that those who wear prescription glasses would benefit from the convenience of not having to change from prescription glasses to other forms of UV-protective eyewear with changing light conditions. In discussing the issue of convenience for enhancing the use of UV-protective eye wear, the panelists concurred that photochromic lenses are ideal to meet prescription, glare, and UV protection requirements in one pair of eyeglasses. Their discussion pointed to a number of benefits inherent in these lenses.

Photochromic lenses reversibly change color and rapidly darken in response to the intensity of UVR through a chemical reaction. In the absence of the radiation source, usually the sun, they become clear. Perhaps the most important feature of a photochromic lens is that they provide the convenience of a single pair of glasses for a variety of light conditions. Photochromic lenses provide optimum light transmission in response to ambient illuminance—essentially full-time UVR and on-demand sunlight (glare) protection. By allowing as much light transmission as is possible under the given conditions, photochromic lenses minimize the negative effects on color, contrast acuity, and contrast sensitivity. Taken together, the properties of photochromic lenses allow them to provide optimum visual comfort by minimizing or eliminating glare, to protect against UVR, to offer adjustment from indoor to outdoor lighting conditions, normal color vision, and contrast sensitivity.

This high degree of versatility afforded by photochromic lenses make them well suited to protect the eyes of children (those under age 18). Additionally,

CURRENT UV–EDUCATION PROGRAMS

In the US

In 1998, the Skin Protection Federation was formed in the US as a coalition of nonprofit organizations, including the American Cancer Society (ACS), government agencies, and corporations to inform the public about protecting themselves from the sun. The Federation adopted the Slip! Slop! Slap! message used in Australia.[34]

The American Cancer Society began a Sun Safe Community initiative in December of 2000 to help prevent skin cancer. This program consists of community-based prevention programs at schools, childcare centers, primary care offices, and beach and recreation areas. In 2002, Vero Beach, Florida implemented the ACS Sun Safe Program with a modified message: Slip, Slop, Slap, and Wrap (wrap on a pair of sunglasses).[35]

In Australia

An example of a successful public UVR-education campaign, known as Slip, Slop, and Slap-Slip on a T-shirt, Slop on some sunscreen or sunblock, and Slap on a hat—has been used in Australia. This program, which began in 1980, eventually became the SunSmart campaign and has been successful in promoting the message to school children. It is, in fact, mandatory for these children to wear protective clothing and hats to school, and to put on sunscreen before being allowed to participate in outdoor activities. In the early years of this program, however, the use of UV eye protection had been underemphasized.[10]

After twenty years, more Australians are practicing sun protective behaviors, and are also detecting skin cancers earlier and having them treated. Due to these efforts, there is a 50% reduction in sunburn rates, as well as a decrease in nonmelanoma skin cancer rates in those under age.[29] The current program also recognizes the need for eye protection.[11] It has become a model for other programs now beginning to be implemented throughout the world.

GLOBAL UV-PROTECTION PROGRAMS IN THE PUBLIC AND PRIVATE SECTOR—RESOURCES ONLINE

The potential detrimental consequences of overexposure to UVR are experienced globally, and thus numerous public and private organizations around the world have initiated sun-protection programs and/or produced educational literature on the subject. Some of these are presented here as a resource and guide for putting UV-protection campaigns into practice.

Canadian Ophthalmologic Society—
http://www.eyesite.ca/english/program-and-services/policy-statements-guidelines/UV-radiation-eye.htm

National Oceanic and Atmospheric Administration—
http://www.srrb.noaa.gov/UV/resources/uveyes_final.pdf

InterSun. The Global UV Project—
http://www.who.int/peh-uv/

Federal Provincial Territorial Radiation Protection Committee - Canada 1998—
http://www.labour.gov.sk.ca/safety/radiation/ultraviolet/printpage.htm

Cancer Research UK: SunSmart—
http://www.cancerresearchuk.org/sunsmart/forprofessionals/uvradiation/

The Cancer Council Victoria: SunSmart—
http://www.sunsmart.com.au/
Global Solar UV Index—
www.who.int/peh-uv/Solar_UV_Index_Guide_Final.pdf

Environmental Protection Agency: Sunscreen the Burning Facts
http://www.epa.gov/sunwise/doc/sunscreen.pdf.

US EPA Sunwise School Program
http://www.epa.gov/sunwise/

because of their active indoor–outdoor lifestyles, in combination with their general dislike of having to wear prescription glasses, a single pair of photochromic lenses would enable children to remain compliant with UV eye-protection guidelines. In addition, participation in sports or other outdoor activities may limit the full-time use of standard UV-protective eyewear that does not change its degree of darkness to accommodate ambient light conditions. Photochromic lenses would eliminate the need to change glasses in step with the rapid change of environments demanded by children's activities.

To address distracting glare, eye care providers should consider recommending anti-reflective (AR) coatings on eyeglasses. With AR coatings, indoor light transmission is increased by about 5-6%, providing almost total transmission of visible light.

The UV and Glare Roundtable panelists emphasized that the issue of UV protection should not be ignored with regard to individuals who have had intraocular lens (IOL) implants. Although most IOLs filter UV, and thus protect the retina, patients should be cautioned that the eyelids, conjuctiva, and cornea are still at risk for serious UV damage. These patients should be encouraged to use UV-protective eye wear, either as sunglasses or prescription eyeglasses, if needed.

To maximize eye protection and filter out a greater part of the UVR that can impinge on the eye, the panelists urged that large diameter lenses should be used. Dr. Stenson explained that larger lenses offer protection for a greater surface area of the eye, and that the closer the lens is to the eye, that is, a short vertex distance, the greater the protection achieved. It was noted that tint is not indicative of UV protection, and provides only visual comfort. The panelists also suggested that there should be a sticker on the eyewear stating that the lenses block 100% of UVA and UVB radiation. In addition, they agreed that eye care professionals should be encouraged to provide pamphlets or other literature describing what to look for in sunglasses. A caveat is that people expect UV-protective eyewear to be comfortable and convenient, so that they are more likely to wear them. It has been noted that a large proportion of the population recognizes the dangers of UVR to the skin compared with the segment that associates UVR with damage to their eyes. Consequently, gaining compliance with the use of UV-protective eye wear for more than cosmetic purposes presents a significant obstacle, which may be more of a factor for children and teenagers than for adults. The panelists also discussed that because we live in a cosmetic-conscious society that the use of sunscreen may be motivated more by the desire to avoid cosmetic damage (ie, wrinkles) to the skin than by the threat of skin diseases. Similarly, the use of UV-protective eye wear may be encouraged by campaigns that depict them as being "cool" and that enlist sports and entertainment figures who advocate them. Therefore, eye care and other health professionals need to promote the SunSmart theme of Slip, Slop, Slap…and Wrap.

CONCLUSIONS

The incidence of UV-induced skin and eye diseases is increasing alarmingly. According to the InterSun Project of the World Health Organization, there are 2-3 million cases of nonmelanoma skin cancer and 132,000 cases of melanoma occurring annually throughout the world. Of the 16 million cases of blindness that are due to cataracts, about 3 million are probably caused by overexposure to UVR.[28] It is predicted that a 10% decrease in the ozone layer over time will result in an additional 1.6-1.75 million cataract cases, 300,000 nonmelanoma skin conditions, and 4,500 melanoma skin cancers.[24] Yet the InterSun Project also estimates that there would be a 70% reduction in the frequency of skin cancer with regular use of sunscreen (SPF 15+) by individuals under the age of 18.[30]

Furthermore, if UV-eye-protection practices were widely followed, there would be a decrease in the risk of conditions such as UV-induced age-related cataract. According to statistics provided by Dr. Lichtenstein, estimations suggest that a 10-year delay in the onset of age-related eye diseases would reduce the cataracts in elderly by half, sparing up to 18 million individuals. A 20-year delay would reduce the number to one-sixth of current projections.[31]

The existing educational programs in the US and abroad, while commendable, are small and scattered, and thus, need to be expanded. They are models for national programs that can and should be implemented on a wide scale in the near future. A multi-disciplinary approach would be the best way to reach health care professionals and the general public, but to gain greater compliance with current recommendations, the message may need to be one of cosmetics and being "cool," in addition to one of eye safety.

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