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Ocular Hazards of UV Exposure

Please note: This paper supersedes 09MEDBL06 - Ocular Hazards of UV Exposure

INTRODUCTION

The range of wavelengths of visible light is from approximately 400 nanometers (nm) to 700nm. The wavelength of UV radiation is below that of visible light, ranging from 100nm to 400 nm. Since UV radiation has more energy than visible light it may cause damage to the ocular lens of the eye causing cataracts. It is believed to play a role in the pathophysiology of macular degeneration.

Ultraviolet radiation is divided into 3 major component bands: UV-A, UV-B, and UV-C.

- **UV-A** radiation comprises longer wavelength radiation, close to blue in the visible spectrum. It is usually responsible for skin tanning and browning in addition to premature aging of the skin with prolonged exposure.

- **UV-B** radiation comprises shorter wavelength radiation. It can cause blistering sunburn and is believed to be associated with skin cancer.

- **UV-C** radiation is absorbed by the atmosphere and is neither detected at sea level nor at typical flight levels.

If adequate eye protection is not worn; excessive exposure to intense sunlight and/or to any artificial source of light, such as welding torches and sun lamps, can lead to burning of the delicate tissue in the eye. The highest risk comes from direct exposure to sunlight, light reflected from snow and snow-covered surfaces, or when flying above clouds with light reflected from cloud surfaces. The retina is mostly spared the harmful effects of UV because this part of the Electromagnetic (EM) spectrum is absorbed by the front part of the eye. However, the high energy violet and blue parts of the sunlight spectrum are considered harmful to the retina.

UV EXPOSURE IN THE COCKPIT

The results of the measurements of UV radiation in the cockpit have been somewhat varied, controversial, and conflicting. Some studies show significant UVA pilot exposure, whereas recent studies show very little, if any, pilot UV exposure. UV radiation intensity increases with flight altitude, but the cockpit windows absorb UV radiation depending on the windshield. Currently, it seems that most of the UV exposure that pilots are facing is a result of sun exposure on ground, either on a layover or at home while engaging in outdoor activities.

CATARACT

A cataract is a clouding of the lens in the eye. They develop slowly and may form within one or both eyes. There are several risk factors attributed to cataract formation: smoking, family history of cataracts, poor diet, use of steroid medication, and sunlight exposure. UV exposure is one of the risk factors for cataract formation, proven by epidemiological studies. Typically, cataract surgery is a common procedure in the elderly population. During the procedure, the lens with the opacification(s) is removed and replaced by an artificial lens, restoring clear vision. However, accommodation may be lost unless accommodative intraocular lenses are utilized during cataract surgery.

The results of the incidence of cataract in pilots compared to general population have been controversial. Some studies show higher incidence whereas others do not. The reasons for such varying results may be the diagnostic criteria for cataracts and whether the diagnosis is made by an ophthalmologist or aviation medical examiner.

Infrared radiation is also believed to contribute to the development of cataracts mediated via painful thermal effects.

EYELID MALIGNANCIES

Basal cell carcinoma (BCC) and squamous cell carcinoma (SCC) are the two common malignant tumors of the eyelid. Both epidemiological and molecular studies support the association of these skin cancers with exposure to UV radiation. It is thought that UV-B radiation plays a bigger role than UV-A radiation. However, the pathophysiology is also believed to be multifactorial including the following: fair skin (less melanin), gender (males > females), age > 50 years old with regard to the development of SCC, a history of sunburn and or fragile skin (people with rare genetic predisposition), the use of certain immunosuppressive medications, weakened immune systems, and a history of skin cancer.

MACULAR DEGENERATION

(age-related damage in the central vision area)
Macular degeneration is a medical condition which may result in **blurred vision** or **no vision** in the center of the **visual field**. Early symptoms are few or mild, but over time there might be a gradual degeneration of vision that may affect one or both eyes. Macular degeneration does not result in **total blindness**; however loss of central vision can make it difficult to recognize faces, drive, read, or perform other daily activities.

Macular degeneration was previously thought to be linked to UV radiation exposure, but currently the association is not clear-cut. Violet and blue light from the visible light spectrum seem to play a role in the development of macular degeneration. The anterior parts of the eye absorb UV radiation, protecting the retina due to absorption prior to reaching the retina. Other risk factors for macular degeneration include age, smoking, and genetic background.

Medication exists to slow the development of macular degeneration, however, currently no means exist to restore any associated loss of vision.

Though the cause(s) of macular degeneration remain unclear, protection of eyes from UV radiation is recommended because of known harmful effects of exposure.

PHOTOKERATITIS

(snow blindness)

Photokeratitis requires strong UV exposure, often from bright sunlight with reflection from water or snow or from an activity engaging bright light for long periods, for example welding (welder's flash).

In this instance, acute UV-B and UV-C exposure damages the surface layer of the cornea, resulting in sunburn-like damage to the cornea. The eye becomes red, watery, irritated, sometimes painful (the feeling of sand in the eyes), and sensitive to light exposure. Pilots should seek medical advice if they develop these symptoms. Treatment is to avoid UV-radiation, use eye drops, and avoid rubbing the eyes. Symptoms usually resolve in a couple of days.

Typically, UV exposure during flying is not so strong that it will cause photokeratitis.

PROTECTION OF THE EYES

Pilots should wear sunglasses when potentially exposed to UV radiation. Protection is recommended in flight and in the cockpit sun visors may be useful.

Pilots should opt for sunglasses that include protection against UV-A and -B radiation. Typically, a **100% UV absorption** label on protective eyewear means that all UV-A radiation and wavelength up to 400nm of UV-B is absorbed.

From the medical perspective, it is also recommended to protect the eyes from the blue- violet spectrum of visible light, as these wavelengths have similar effects to the eyes as UV radiation. However, a side effect of screening out all such rays with eyewear is severe color distortion, whereby images become yellowish which may be incompatible with flying.

The sunglasses that pilots use should be of good optic quality, there should not be any reduction in the visual acuity and no color distortion. If a pilot has a refractive error, their sunglasses should have the same correction as their prescription glasses. The use of polarized or photochromic sunglasses is not recommended when flying.

TIPS FOR SUNGLASSES SELECTION

(for both flying and leisure time)

Blocks 99% of Ultraviolet Rays

You should always select sunglasses marked with a notice reading Blocks 99% of Ultraviolet Rays. It is important to note that the sun does not have to be immediately visible for harmful UV radiation to be present. Both plastic and glass lenses absorb some UV light. UV absorption can be improved by adding chemicals to the lens material during manufacturing or by applying special lens coatings. The color or darkness of these lenses does not necessarily coincide with their UV blocking ability.

Some manufacturers' labels read **UV absorption up to 400nm**. This is the same thing as **100% UV absorption**.

Blocks 90% of Infrared Rays

Infrared wavelengths are invisible (they are longer than those of visible light) and produce heat. Some sunglasses manufacturers make health claims for their products based on infrared protection, but research has not demonstrated a conclusive relationship between eye disease and infrared rays. IR is also believed to contribute to the development of cataracts mediated via painful thermal effects and overall is not considered a significant in-flight exposure risk.

Blue-blocking

Whether blue light is harmful to the eye is still debated. Lenses that block all blue light are usually amber and make your surroundings look yellow or orange. The tint supposedly makes distant objects appear more distinct, especially in snow or haze. For this reason, amber sunglasses are popular among skiers, hunters, and sailors.

Pilots are best advised that color blocking sunglasses are **not** recommended when flying, and therefore, IFALPA does not recommend the use of sunglasses that completely block blue light.

Polarized

Polarized lenses cut reflected glare: that is, sunlight that bounces off smooth surfaces like pavements, roofs, or water. Such lenses can be particularly useful for driving and fishing.

Polarized lenses should not be used by pilots. Polarization can reduce or eliminate the visibility of instruments incorporating anti-glare filters and they may interfere with visibility through aircraft windscreens by enhancing striations in laminated materials. Furthermore, polarized lenses may mask the sparkle of light that reflects off shiny surfaces, such as another aircraft's wing or windscreen, which can reduce the time a pilot has to react in a *see-and-avoid* traffic situation.

Mirror-coated

Mirror-finished lenses comprise thin layers of various metallic coatings on an ordinary lens. Although they do reduce the amount of visible light entering your eyes, they are not considered to fully protect you from UV radiation exposure.

Gradient

Gradient lenses are permanently shaded from top to bottom or from top and bottom towards the middle. Single-gradient lenses (dark on top and lighter on the bottom) can cut glare from the sky but allow you to see clearly below. They are useful for flying because they don't dim your view of the instrument panel.

However, double-gradient lenses (dark on top and bottom and lighter in the middle) are **not** recommended for flying, as they interfere with adequate visualization of the flight deck.

Photochromic

A photochromic glass lens darkens automatically upon bright light exposure and lightens with low light exposure. The darkening process takes approximately 30 seconds, while up to five minutes may be needed for the glasses to fully lighten, which can be problematic.

These lenses may have a uniform or gradient tint. Although photochromic lenses may be good UV-absorbent sunglasses, (label must state **UV absorption up to 400nm** or **100% UV absorption**), because they take time to adjust to different light conditions they are not recommended for use while flying.

Ground and polished

Some non-prescription glasses are ground and polished when they are manufactured to improve the quality of the lenses. Non-prescription lenses that are not ground and polished will not hurt your eyes. You should ensure that the lenses you buy are made properly.

To assist you with your assessment of the quality of non-prescription sunglasses, IFALPA recommends the following method:

- Hold the glasses at a comfortable distance while covering one eye.
- Look at an object with a rectangular pattern, such as floor tile.
- Move the glasses slowly from side to side, then up and down.
- If the lines stay straight, the lenses are fine.
- If the lines appear to wiggle, especially in the center of the lens, try another pair.

Impact resistant

No lens is truly unbreakable, but plastic lenses are less likely than glass lenses to shatter when hit by an object. Most non-prescription sunglass lenses are made of plastic. Polycarbonate plastic, used in many sports sunglasses, is especially tough but scratches easily. If you buy polycarbonate lenses, look for ones with scratch-resistant coatings.

Wrap-Arounds

If you expect to spend a lot of time in the sun, wrap-around, close-fitting sunglasses will provide the most protection for your eyes by preventing light from shining around the frames and into your eyes.

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