Blue Light Radiation, A Material Solution

[1 CE CREDIT]

By Mark Mattison-Shupnick, ABOM

The Vision Council released a new report in January 2016 titled, "Eyes Overexposed, A Digital Device Dilemma" (visit www.thevisioncouncil.org for a downloadable copy). It provides an excellent review for both the office and your patients of the contemporary advantages of our digital world and the vision issues faced by a connected population. The report describes a concern about high-energy visible (HEV) blue light and how that might be exacerbating concerns about AMD because of our patterns of use of electronic devices. This course is a review of those concerns and highlights a new product method to attenuate blue light radiation.

CONTEMPORARY BLUE LIGHT CONCERNS

Let's take a look at two excerpts from the report to frame our discussion. First: "A combination of factors including the proximity at which we view digital screens, the frequency and length of time of this use, physical responses to screen habits and exposure to high-energy visible (HEV) or blue light, have conspired to cause visual discomfort in 65 percent of Americans (VisionWatch 2015). This stress and strain, combined with other physical discomforts, is called digital eye strain."

Next, the report starts the section on the effect of blue light damage as follows: "Virtually every digital device, as well as light-emitting fixtures and appliances including fluorescent lamps, has light emitting diodes (LED) that radiate blue wavelength light. Emerging research suggests cumulative and constant exposure to the blue light emitted from backlit displays can damage retinal cells." (From *Photochemistry and Photobiology*, "Effects of Light-emitting Diode Radiations on Human Retinal Pigment Epithelial Cells In Vitro," March 2013)

As the report teaches, discomfort and the symptoms of blurred vision and fatigue are, of course, temporary. The report effectively describes ways to reduce digital eye strain with proximity,

LEARNING OBJECTIVES:

Upon completion of this program, the participant should be able to:

1. Understand contemporary blue light radiation concerns.
2. Learn how the sun and various electronic devices emit potentially harmful radiation that is of concern for certain individuals.
3. Know how UV+420cut addresses the ability to produce a protective lens that allows expected lens attributes like premium AR, thinness and lightness lens materials while removing potential patient ghosting issues.

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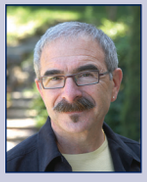

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frequency, time used and general body posture recommendations, as well as getting unplugged, as unlikely as that may seem. The report then highlights what is not temporary: "Preliminary research points to a potential long-term hazard from the effects of too much screen time: consistent exposure to HEV, or blue light, may be linked to long-term vision issues such as age-related macular degeneration (AMD) and cataracts. (From *Experimental Eye Research*, "Transmission of Light to the Aging Human Retina: Possible Implications for Age Related Macular Degeneration," December 2004)

Blue light has also been shown to affect sleep patterns. From an original research article in *Frontiers in Public Health* (Oct. 13, 2015) titled "Bigger, Brighter, Bluer - Better?" the authors (Paul Gringras et al) describe the testing of a variety of current light-emitting devices and the resulting adverse effects on sleep. The authors write, "Since this type of light is likely to cause the most disruption to sleep as it most effectively suppresses melatonin and increases alertness, there needs to be the recognition that at nighttime 'brighter and bluer' is not synonymous with 'better.'"

While blue light, high-energy visible radiation is of concern for electronic device use, that same radiation is also part of sunlight in our everyday outdoor environment. And like UV radiation, the effects of HEV can be accumulated in retinal tissue. That suggests we consider outdoor methods to effectively reduce these hazardous wavelengths as well as reduce potentially hazardous HEV wavelengths indoors and at night.

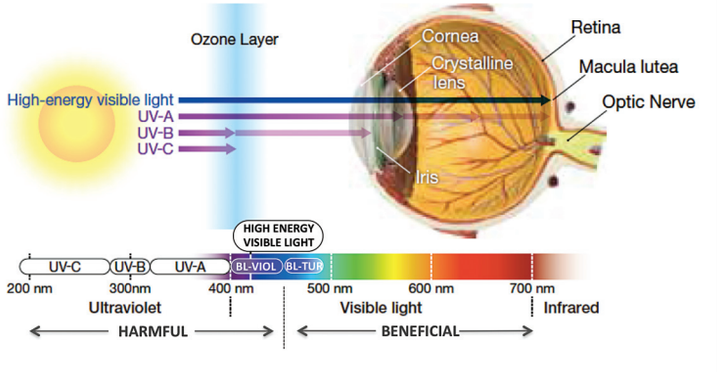
BLUE LIGHT, SHORT REVIEW

Visible blue light is associated with eye health as well as sleep and memory concerns. Luckily, two separate portions of the blue light spectrum have been shown to be responsible. That allows us to address them differently. First, the shorter, higher energy blue-violet light (Fig. 1, 415-455 nm) penetrates deeply into the retina, and for some individuals, the long-term cumulative exposure can hasten age-related macular degeneration. Blue turquoise light (Fig. 1) affects melatonin production (reduces it), which the body uses to prepare for sleep. Sleep affects the mechanism for memory storage as well as daytime alertness and emotions. The bright blue turquoise light of smartphones and tablets used for extended periods, for example, right before bed stimulates the brain, retards melatonin production and interrupts sleep.

The mechanism of blue-violet radiation damage is still under study. However, "It is said that blue-violet light disrupts cellular metabolism in the retinal pigment epithelium (RPE) layer. This layer contains melanin granules, which attract and absorb the energy found in shorter wavelengths of light like blue light. After absorbing this energy, photochemical lesions are formed which impair metabolic cell function in the RPE layer leading to retinal cell death there. People with macular degeneration and those at risk for it should take precautions to protect themselves against the damaging effects that blue light may have on the retina." (From "Balancing the Blues," *20/20* April 2014)

That puts the older adult at risk both for its effects on lifelong independence and mobility, as well as the time and cost of care on family and friends. While diet, genetics and lifestyle are components of the causes of AMD, the opportunity to affect that which is blue light associated is an optical opportunity. From the CDC (Center for Disease Control and Prevention), "It is estimated that 1.8 million Americans aged 40 years and older are affected by AMD, and an additional 7.3 million with large drusen (fatty proteins) are at substantial risk of developing AMD. The number of people with AMD is estimated to reach 2.95 million in 2020. AMD is the leading cause of permanent impairment of reading and fine or close-up vision among people aged 65 years and older."

FIGURE 1



Non-Visible and Visible Radiation. UV and blue-violet radiation are potentially harmful; blue violet is associated with AMD, UV with cataract. Blue turquoise is beneficial (sunlight) and in its absence triggers melatonin production that prepares the body for sleep.

PREVENTATIVE STRATEGIES

Therefore, the question of prevention is the key message that the optician and doctor should help patients to understand. That means a preventative solution for outdoors during daytime as well as indoors at all hours. In addition, the continued use of digital devices before bed should also be addressed.

With whom should that conversation take place? As we've learned, UV and

HEV are cumulative; that means one should start early and advise mom and dad that their children should be wearing both UV and HEV protective eyewear, regardless of the need for a prescription. And if a third of children use a digital device three or more hours a day, the concern about both blue-violet and blue turquoise radiation should be of concern. After all, children typically use digital devices closer than adults, and their crystalline lenses are more transparent to UV (chromophores not yet developed) and HEV (lens not yet yellow). The closer the distance, the more concern about radiation effects. That's also true for teens and young adults but with presbyopia, there's a period of time for farther focusing distances. In fact, many progressive lens options can be produced in a distance/intermediate focused design.

There are already a variety of products and suggestions that are good general practice. For example, reducing screen brightness at least 50 percent, teaching good posture and trying to maintain a further distance from screens help. For desktops, lower the screen and tilt it so that eyes are more perpendicular to the center of the monitor surface. In the office and at home, try to get the surrounding lighting to be about the same brightness; that reduces glare and pupil size. Reading in dark surroundings may enlarge the pupil, allowing more blue light; therefore, adjust lighting for less eye strain.

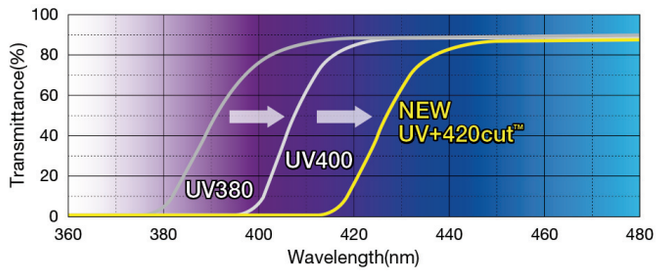
Adding an app like F.lux (justgetflux.com) to an iPad or laptop uses the internal clock of the computer to reduce the blue light component starting in the early evening. Getting used to the more salmon color of the screen late at night may take some getting used to.

Given the access of the Internet by older adults and their adoption of digital devices, 60 is the new 40. That means a population initially less aware of the UV and HEV concerns is potentially more susceptible to its issues. This author, now in his late 60s, rarely wore sunglasses as a child and when prescription lenses were required, wore glass. If the individual was susceptible to the potential damage, that damage has already been done. Therefore, one should ensure that the AMD-prone individual now wears blue light attenuating eyewear.

There is a bit of serendipitous protection against blue light damage to the older adult's retina. Yellowed crystalline lenses, the accumulated effect of UV absorption, will in some cases naturally filter out some of the blue light to which they are exposed.

How many of you or your patients will live to be 100 years old? I ask because I saw a recent estimate that by the year 2030, the number of 100-year-olds in the U.S. will quadruple from the estimated 50,000-plus in 2000. What will be the opportunity for visual independence for this population and those following close behind in their 70s, 80s and 90s? Clearly, one must provide solutions for the potential accumulated effects of UV and HEV blue light.

FIGURE 2



UV+420cut lenses push absorption farther into the visible range, reducing potentially harmful blue-violet radiation.

SPECTACLES ARE THE RIGHT SOLUTION

Vision and research scientists' descriptions of the potential retinal damage from blue light began in the early 1970s with concern for the workplace environment. Ultraviolet absorption and the eyes were a discussion item in the original 1950s Ray-Bans. However, over the last few years it became apparent that HEV has become more of a potential problem, and spectacle lens companies began to provide blue light attenuating lenses.

In bright sunlight, sun lens filter colors like browns and ambers can be used to significantly reduce or eliminate the blue-violet wavelengths. As a result, selling quality UV attenuating sunglasses also reduced a patient or customer's HEV exposure. Over the last few years, some companies have also improved gray filter attenuation to also reduce the blue wavelengths.

Before 2007 when the iPhone was introduced and 2010 for the iPad, quality sunglasses effectively handled HEV radiation outdoors except not everyone wore sunwear or understood the reasons for quality sunwear. The lack of digital devices and changes to lighting hadn't yet created an issue for indoors or at night. However, new lighting, digital devices with high intensity blue phosphors, close and prolonged use,

SOURCES OF BLUE LIGHT RADIATION

THE SUN
- Exposure and brightness outdoors
- Outdoors is important for the developing eye

DIGITAL DEVICES
- Use and habits
- Proximity
- Smartphones, tablets, computer screens

LIGHTING
- LEDs, CFLs

late night use and adoption by all age groups require new solutions. As a result, lens companies recognized that a solution was needed for blue light attenuation in clear lenses especially for patients without sunglasses for daytime use and for indoor especially in the evening.

The current lens methods include yellow or amber lenses, augmented AR and lenses that are a combination of both. Yellow lenses have never been popular as a fashion item, except for skiers and snowboarders or worn by older adults to enhance contrast. In fact, most lens manufacturers work hard to reduce the yellowness (measured as yellowness index) of their lenses. Augmented AR, using a tuned AR coating can effectively reduce the blue-violet wavelengths. These new AR coatings have a blue to blue-violet reflex color. Recognizing that blue-violet radiation is harmful and blue turquoise is beneficial provides direction to manufacturers to develop coatings that are selective and can differentiate between the two. There are also lenses that are a combination of both, i.e., only slightly yellow or noticeable color to sun lenses, with AR. These lenses provide an opportunity for the ECP community to switch over all patients to HEV attenuating products.

FIGURE 3

UV400, SLIGHTLY YELLOW UV+420cut, BLUE GRAY

INTRODUCING NEW UV+420CUT, A MATERIAL SOLUTION

New Mitsui UV+420cut lenses embody an in-mass solution to HEV attenuation. However, unlike previous in-mass chemistry, where lenses were significantly yellow or of noticeable color to achieve attenuation, these lenses are slightly blue/gray. Also, by making the attenuation a property of the substrate lens material, existing hard and AR coatings can be used.

Transmission: Using a transmission curve to compare lens properties (Fig. 2), we can see that the curve has been moved into the visible portion of the spectrum. The blue-violet wavelengths of concern are 435 ±20 nm. There's near zero transmission at 415 nm, about 75 percent at 435 nm and just less than 90 percent at 455 nm when beginning to enter the blue turquoise range of wavelengths. This effectively reduces blue-violet radiation through the lens. When reviewing the transmission of augmented AR lenses in this category, in a variety of lens material indices, transmission of the blue-violet wavelength are reduced 10 to 30 percent at 430 to 435 nm. As a result, this material option achieves the desired attenuation through absorption.

Yellowness: Next, what are the lens cosmetics, i.e., how yellow are these lenses? UV+420cut lenses, in their final cast form are slightly blue/gray. In the past, creating a lens material with this transmission would have required that the patient wear lenses of noticeable yellowness. This comparison demonstrates lens whiteness.

LENS OPTIONS

Shifting a material's UV and HEV cutoff also means that it should be applicable to a variety of lens materials. In that regard, UV+420cut is available in high index 1.74, 1.67 and 1.60 lens materials. Initially cast as a semi-finished single vision lens blank and finished single vision, this allows the production of SV lenses as the application of free-form techniques to produce the variety of free-form progressives, single vision and concave surface round segment bifocals. These can be produced using average fitting values or position of wear (vertex, tilt and wrap). As a new product, there may be limited availability initially; confirm with your lens supplier that they can supply UV+420cut as an option for concerns for both UV and HEV. Current suppliers include Conant (branded as UV++), Asahi-Lite, Chemi, PFO Global (branded as Vitaris) and SOMO.

Premium AR: Like UV, shifting attenuation of HEV from the AR to the substrate material allows the use of current premium AR with their existing reflex colors. In addition, some patients notice the difference in the increased reflective color of augmented AR and in some

RESOURCES

THE VISION COUNCIL
www.thevisioncouncil.org

REVIEW OF OPTOMETRY
www.reviewofoptometry.com

20/20 MAGAZINE
www.2020mag.com/ce

OPTICIANS HANDBOOK
www.opticianshandbook.com

Search Blue Light Hazard online using your browser

FIGURE 4A-C

4A. Path of ~410 nm LED, see the light spot created at the eye model fovea

4B. UV400 1.60 lens, placed in front of the eye has no effect on the light path

4C. A UV+420cut lens, held in line with the blue LED, eliminates the spot on the fovea

prescriptions/lens shapes ghosting. UV+420cut allows the use of current premium AR.

A PRACTICAL DEMONSTRATION

Often, many of the inventions that have become very successful for optical offices are invisible until the patient receives the new glasses. For example, that was true when we began to switch lenses to new digital designs that included position-of-wear measurements. It was hard for the patient to understand the claims of better vision versus the added cost. Though at this point, digital lens successes and improved sight results in a more confident sales discussion. The same is true about describing HEV attenuation.

The above video screen captures (Fig. 4A-4D) show a series of specific wavelength LEDs to simulate important wavelengths in the visible spectrum. An eye model can be used to focus an LED light (~410 nm) onto the retina. Using various lenses, the elimination of this light can be demonstrated. Fig. 4A shows the path of the LED, 4B, the path of light when a UV400 lens (index 1.60) is placed in front of the eye. In 4C, the light path has been stopped with a UV+420cut lens. Illustration 4D shows an enlargement of the image of the light spot on the fovea of the model eye (left) and eliminated with UV+420cut. Use of this video can be effective with patients.

CHILDREN'S EYEWEAR

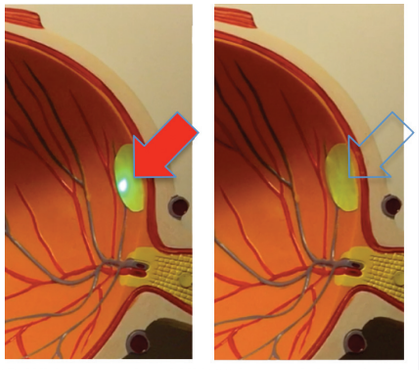
UV radiation protection has become one of the default requirements for children's eyewear along with improved impact resistance. As a result, polycarbonate and Trivex materials have become the lens materials of choice. Those lenses are highly durable today though only with premium AR. Augmented AR can protect a young eye from HEV radiation, though parents may be reluctant to spend for AR.

One of the components of new premium AR lenses has been a dual hard coat, applied for best scratch and abrasion resistance, as well as providing a terrific surface onto which to apply the AR. However, one of the attributes of the first or primer coating applied directly to the lens is its ability to increase impact resistance. As a result, this suggests that if the parent does not want to add AR to their children's lenses, then this dual hard coat system can be applied to a UV+420cut lens for increased impact resistance. That allows the ECP and the parent to provide both UV and HEV-absorbing lenses suggested for children.

A COMPANY COMMITMENT

This innovation to push the absorption of lens materials is part of the Mitsui Chemicals, Inc., commitment to better health and vision. In fact, these lens products as part of the Health Care Materials Division are part of the Vision Care Materials Department and comprise a variety of personal, pharmaceutical and medical products.

FIGURE 4D



4D. With conventional UV400 lenses (left) and with UV+420cut lenses (right)

CONCLUSION

Teach patients about the ophthalmic and scientific communities' concerns about blue light radiation as part of the larger community's digital device concerns. Describe it as an important part of digital eye strain and the way it affects people of every age. Ensure that we take every opportunity to demonstrate, instruct and provide a way to protect our patients from potential blue light harm. Be specific about the differences between damaging and beneficial blue light. Make patients understand that the products at your fingertips are selective about the way that they can be used, especially that a lens material with in-mass HEV protection can form the basis for both indoor and outdoor lenses. Make digital eye strain a discussion every day with every patient. ■

SELF-ASSESSMENT EXAMINATION

1. Mitsui UV+420cut lenses attenuate blue violet radiation using:
a. Tinted lenses
b. Augmented AR
c. In-mass chemistry
d. Existing hard and AR coatings

2. Longer wavelength blue turquoise light has been shown to affect:
a. Sleep patterns
b. Retinal ganglia
c. The rods
d. Screen habit posture

3. All of the following except _____ are components of sunlight.
a. Invisible HEV
b. Wavelengths 415 to 455 nm
c. Ultraviolet radiation
d. Infrared

4. _____ in smartphones and tablets used right before bedtime can retard melatonin production and interrupt sleep.
a. Ultraviolet A radiation
b. Bright blue turquoise light
c. Bright blue violet light
d. Ultraviolet C radiation

5. The transmission of UV+420cut lenses at 420 nm is about:
a. 75 percent
b. 45 percent
c. 25 percent
d. 10 percent

6. All of the following except _____ have combined to cause visual discomfort from digital screens.
a. Proximity
b. Screen habit posture
c. Exposure to infrared
d. Exposure to HEV

7. LED means:
a. Light-emitting diode
b. Light entry device
c. Luminant electronics devices
d. Long-standing electronic discomfort

8. _____ is deep penetrating into the retina.
a. UVB
b. Ozone layer
c. UVC
d. HEV

9. Which retinal structures absorb HEV light?
a. The rods
b. Melanin granules in the iris
c. Choroid
d. Melanin granules in the RPE

10. What's the estimate of the number of Americans over 40 affected by AMD?
a. 18 million
b. 7.3 million
c. 9.1 million
d. 1.8 million

11. UV+420cut is available in all of the following indices except:
a. 1.74
b. 1.67
c. 1.60
d. 1.59

12. To improve the impact resistance of high index lenses, add:
a. A super hard scratch resistant layer and a second layer as an AR coating
b. A two-layer AR surface
c. AR directly onto the lens substrate surface
d. An impact primer, then scratch resistant hard coat

13. The concern about blue violet light is because those wavelengths are focused onto the:
a. Macula
b. Peripheral retina
c. Cornea
d. Vascular retinal layer

14. Good general practice suggests which fix to digital screens?
a. Maximum brightness
b. Maximum brightness only at night
c. 50 percent of the maximum brightness
d. Vertically straight and raised to eye level when seated

15. What naturally occurring aging effect protects the retina from HEV?
a. Increased pupil sizes
b. Yellowing crystalline lens
c. Glaucoma
d. Presbyopia

16. A way to confirm the attenuation of HEV by clear lenses or sun lenses are:
a. Transmission curves
b. Heat lamp exposure
c. Measurements from a lensometer
d. Thicknesses more than 2 mm

17. The most common method today to attenuate potentially damaging blue light is:
a. Tint baths
b. Augmented AR
c. The use of high index glass
d. Dual scratch resistant coatings

18. AMD prevention strategies include all the following except:
a. Indoor eyewear
b. Outdoor eyewear
c. Maximum screen brightness
d. Diet counseling

19. Why is it important to start HEV counseling early in the case of children?
a. All kids are on a tablet four or more hours a day
b. A third of kids use digital devices an hour a week
c. Half of kids are 14 years of age or younger
d. A third of kids use digital devices three or more hours a day

20. A unique attribute of a UV+420cut lens is its:
a. Moderately yellow color
b. Slight blue/gray color
c. Slight haze when cleaned
d. Very low index

Examination Answer Sheet

1 hour of CE credit by the American Board of Opticianry ~ Valid for credit through April 15, 2017

This exam can be taken online at www.2020mag.com. Upon passing the exam, you can view your results immediately. You can also view your test history at any time from the Web site.

BLUE LIGHT RADIATION, A MATERIAL SOLUTION

Directions: Select one answer for each question in the exam and completely darken the appropriate circle. A minimum score of 80% is required to obtain a certificate.

Mail to: Jobson OptSC, PO Box 488, Canal Street Station, New York, NY 10013.

This program is supported by an educational grant from **Mitsui Chemicals**

1.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	11.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
2.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	12.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
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1=Excellent 2=Very Good 3=Good 4=Fair 5=Poor

In questions 21-23 please rate the effectiveness of each activity:

21. Met the stated learning objectives? ① ② ③ ④ ⑤
22. Avoided commercial bias/influence? ① ② ③ ④ ⑤
23. Rate blue light protection effectiveness using the substrate lens versus other methods. ① ② ③ ④ ⑤
24. What is your go-to lens material, i.e., most commonly sold in your practice?
    - Ⓐ CR-39 (1.50)
    - Ⓑ TRIVEX (1.53)
    - Ⓒ Middle Index (1.56)
    - Ⓓ Poly (1.59)
    - Ⓔ High Index (1.60)
    - Ⓕ Super High Index (1.67-1.74)
25. Please describe the office in which you work.
    - Ⓐ Independent Optician
    - Ⓑ Independent Optometry
    - Ⓒ Chain retail
    - Ⓓ HMO/Military/Other

Comments on this course: _____

Future Topics: _____

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By submitting this answer sheet, I certify that I have read the lesson in its entirety and completed the self-assessment exam personally based on the material presented. I have not obtained the answers to this exam by any fraudulent or improper means.

Signature _____ Date _____

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