

What Blue Can Do: Harm or help?

Overview

Blue light can be beneficial or harmful, depending on when and how your patient is exposed to it. The eye care professional (ECP) can provide maximum protection from the harmful aspects of blue light by offering patient education, lens options and other beneficial methods to protect the eye. This course will assist the ECP to broaden his or her understanding of blue light, how it can help or harm the patient, as well as give practical recommendations for patient care.



3

Hazards of blue light is not a new concept

The hazards of blue light have been known for several decades. Historically, the idea of altering which wavelengths could reach the eye has been promoted in various ways. As early as 1750 ocular professional David Ayscough promoted the idea that “glaring light” could be favorably altered by the use of tinted lenses. In the past, Bollé issued the “tennis advantage” lens, which had a purple hue and could favorably enhance the appearance of a white or yellow tennis ball. Bollé now markets various sun lenses for athletic visual enhancement.

While all of the research is not in, there is enough evidence to show that blue light can damage retinal cells, wreak havoc with the circadian rhythm and even contribute to immune system deficiencies.^{5, 10, 14} Blue light causes part of the phenomenon known as “digital strain” or “digital device syndrome.”¹⁷ Physical manifestations of digital strain are neck, shoulder and back pain; headaches; and problems specific to the eyes known as “digital eye strain,” which includes blurred vision and dry eyes. In spite of the symptoms, approximately 35% of American adults say they aren't concerned about the impact of digital device usage on their eyes¹⁷. Fortunately the ECP has easy-to-offer solutions for digital eye strain and blue light problems.

While every patient should be made aware of blue light hazards, four types of patients can especially benefit from blue light protection: patients with macular degeneration, heavy technology users, children and post-cataract patients.

Lighting then and now

Let's travel back in time about 100 years and take a look at the light. World War I was of national concern and the president was Woodrow Wilson. Rural America was still very much a sun-up to sun-down society, meaning that your work day was regulated by the natural sunlight available. The demands on your eyes most likely decreased at sunset. Evening and night time hours were augmented by the light from a fire source, such as a fireplace, candles or possibly a kerosene lamp. City dwellers during this time used candles, kerosene lighting, and gas lighting; which were all being phased out in favor of electrical lighting. In the larger cities, almost all of the households already used some form of electrical incandescent lighting. All of those light sources radiated in the yellow to red ranges of the light spectrum. Exposure to blue light was primarily encountered during the day in full sunlight.³



3

By contrast, today's patient uses artificial lighting methods well into the night time hours, often pressing the eyes into service for long hours without a respite.¹⁷ In addition to the natural exposure to the blue energy found in sunlight, indoor lighting has shifted from yellow to a bright white, which contains much more blue. Modern lighting sources that radiate blue light are light-emitting diodes (LEDs), neon lighting, fluorescent lighting and compact fluorescent lighting (CFLs). More than 70% of adults report that in addition to playing outdoors, favorite activities are playing on a digital device (23.1 %) and watching TV. (20.1 %.) Even though about 70% of parents say that their child is exposed to a digital screen for 2 or more hours per day, fully 1/4 of those parents are not concerned with the impact on a child's developing eyes.

In the adult populations, typically nearly 90% rack up 2 or more hours using a digital device every day. Think of how many of these devices you used today: desktop computer, laptop computer, smart phone, tablet or e-reader, television or perhaps a video game. Nearly 60% use digital devices for 5 or more hours.¹⁷ The millennial patient seems to be the most intensive user of hand-helds, with 9 out of 10 using a secondary screen while watching television¹⁷; while many others use two or more hand held devices simultaneously. Nearly 90% of millennials check their devices in the hour just before going to sleep.¹⁷ Hand held digital devices have higher luminance levels than most computer screens.



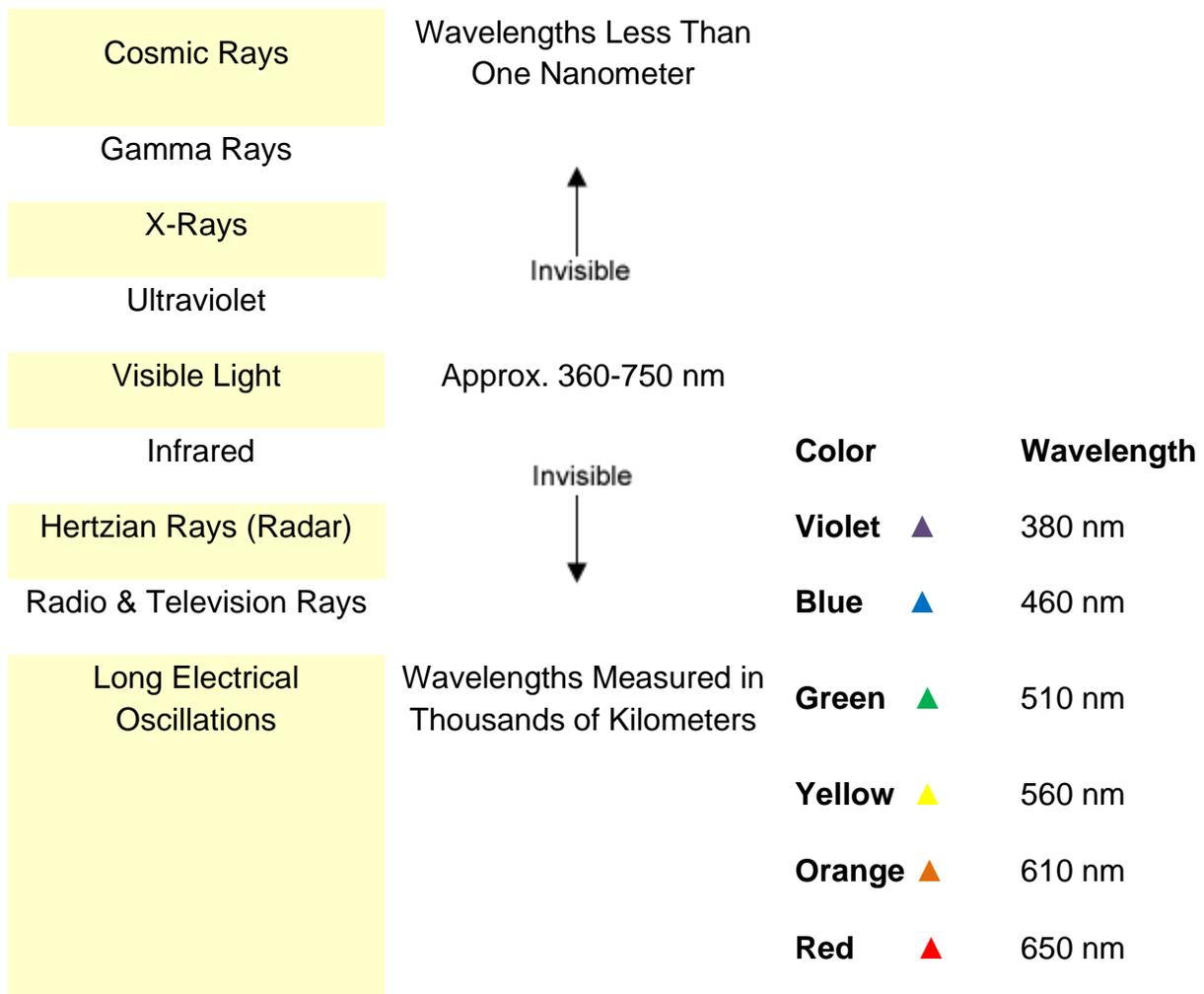
The human eye was not meant to use computers, smart phones and tablets for hours at a time. However, modern jobs and pastimes require this type of use and even overuse of digital devices.

Suffice it to say, older incandescent light bulbs, older computer screens and even older television screens emitted more yellow light as a side effect of their construction and components. A bit later, when white light was heralded as better and brighter for screens of all types, technology users embraced white. Unfortunately, there is a high concentration of blue light also emitted by these white screens.³

The light spectrum

Let's take a quick look at the light spectrum, both visible and invisible, and the effect on the human eye. The visible light spectrum is a very small portion of the overall radiant spectrum in which we live. This spectrum is measured in nanometers. From the very short and dangerous cosmic rays to the opposite end of the scale with Hertzian and television waves, we all live in an energy field. As the wavelengths get shorter, the radiant energy increases.

The visible spectrum ranges from about 400 nm to 760 nanometers. In addition to the visible parts of the spectrum, the ECP is also concerned with radiation found just beyond what we can see, specifically UV radiation and infrared rays. At the short end of the spectrum of visible light is blue with an nm range from blue violet (450 nm approximately) to blue turquoise (470 nm approximately.) High energy violet light (HEV) ranges from 400 to 440 nm and is not essential for sight. It is interesting to note that the human eye can best see the color green, which is right in the middle of the visible spectrum.



18

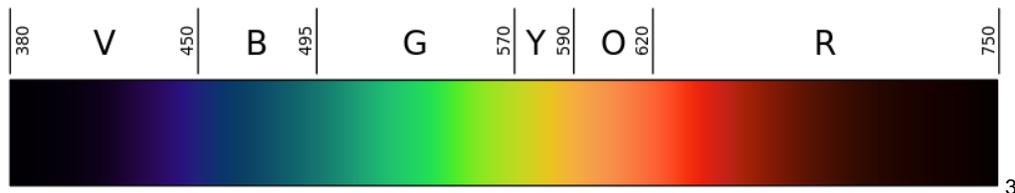
Television, computer monitors, smart phones and tablets create color by radiating light into an object, such as a light-emitting diode (LED) via sub-pixel clusters. This will stimulate the senses to create good representations of color that are very real-to-life. Since these devices use a black screen, additional light is used to create the colors seen.

When white light is refracted, it naturally disperses into the component colors of red, orange, yellow, green, blue, indigo and violet (ROYGBIV). All parts of the light wave travel at the same speed, yet have different vibrations; but for understanding of light perception, it is sometimes easier to think of this as “time of arrival” instead of vibrations. So, when a light ray enters the eye and is refracted by the cornea and crystalline lens, green is focused immediately on the macula while the red part of the light has a natural focal point behind the retina. In that same instant, blue (being a shorter wavelength) is in effect “trying to arrive” on the retina. All human eyes are naturally slightly myopic for the color blue since the blue portion of the light beam scatters and defocuses in front of the retina. The eye works harder to properly focus

blue and this in turn causes chromatic aberration, with accompanying blurry vision and glare.

Ultraviolet light is comprised of the electromagnetic spectrum from 400 nm down to about 200 nm. It is first absorbed by the ozone layer of the atmosphere, and then by the cornea and crystalline lens. This absorption by the cornea and crystalline lens can cause corneal damage during an extreme exposure. Long term exposure to UV can contribute to cataracts and other ocular problems.¹⁶ Most patients are aware of the need for protection from UV rays, yet may have no knowledge of the possible hazards posed by blue light.¹⁷

The cornea and crystalline lens provide protection to the inner eye from UV rays, but blue light enters the eye unhampered. Protection of the retina from blue light is extremely important for a patient's entire life.



The retina and UV/HEV light

The retina is extremely responsive and sensitive to light. The retina is comprised of approximately 120 million rods and 6 million cones. Rods perceive motion plus give peripheral vision and night vision, while cones are central to the retina and perceive color using light.

Rods detect motion and can function in very little light, such as that available at night. Rods also provide peripheral vision and are located at the periphery of the retina. Night vision from the rods is poor when compared to the central, color-vision perceived by the cones. Damage to the rods will hamper night vision, but daylight and central vision will usually remain if the cones have not been also damaged. Thus the rods, while responding to the visible wavelengths, are not sensitive to the actual colors. Rods respond much better to motion and can detect light as small as a single photon.

When the eye has become dark-adapted (after about 30 minutes), a person can perceive a dim star in the peripheral vision, yet it might seem to disappear if he or she tries to look directly at it. Due to a specific photo-pigment, motion response to blue is good but there is no response to red by the rods. It is for that reason that the eye adapted to darkness will not be affected by a red light, such as is used for night instruments like a telescope.

Cones, on the other hand, need light to work. Cones require tens to hundreds of light photons before they are activated. Tightly packed into the macula, cones are further divided into specific color receptors of red, green and blue. Directly at the center of the macula is the fovea and this is where the best visual acuity in lighted conditions occurs. Blue cones begin to respond to the spectrum at about 445 nm, but only constitute about 2% of the total number of cones in each eye. Intensely blue objects seem less distinct since the blue cones are located outside of the sharp focus of the fovea; there are no blue cones in the fovea. The blue cones also communicate with an area of the brain called the suprachiasmatic nucleus, which is called the body's clock. This communication is accomplished when a substance called melanopsin influences the sleep/wake cycle.²⁰

Cones & Rods

CONES	RODS
Day Vision	Night Vision
Detail	Peripheral Vision
Color	Black & White

18

Retinal pigment epithelium (RPE) contains melanin granules that absorb high energy wavelengths. Blue light can disrupt this RPE resulting in the impairment of the metabolic functions, possible photochemical lesions, and even RPE cell death. This is problematic for adults with age related macular degeneration (AMD), yet might begin in childhood and have a lifetime cumulative effect.¹⁰

Drawbacks and advantages of blue light

Blue light has always been part of the visible spectrum, so why do the potential dangers seem more important now than ever before? The answer is that we have become a technology dependent society where the eyes are exposed to many other sources of blue light in addition to sunlight. Most forms of indoor lighting and computerized or LED technologies contain blue light. This exposure to HEV affects the retinal cells in the long term, and can also affect the natural circadian rhythm of the body in the short term. Almost every technological device with any type of video screen or interface emits blue light, especially those that have back lighting.¹⁴

Some blue light, including the blue-turquoise range, can be beneficial as found in the natural spectrum of sunlight. At the right time the day, blue light will stimulate alertness, increase the feeling of well being and overall happiness, improve reaction times and

elevate awareness. It is best to receive this healthy blue light from sunlight. But at night the body is designed for sleep and that is when blue light becomes adversarial.¹⁴



Babies, children and blue light

How often have you seen a parent hand their phone or tablet to a child as a visual “pacifier?” While the device will certainly hold the child’s attention, it is most likely producing blue light. Increasingly, children are even given cell phones of their own for safety’s sake. Today’s typical 5-year-old has never lived without knowledge of or use of a cell phone. It almost seems as if a cell phone is permanently implanted into the hands of most children and teens. With a special attraction to hand held devices, some media sources call these youngsters “digital natives.”

A child has nearly transparent crystalline lenses leaving those young eyes more vulnerable to UV and HEV. With a tendency to use a hand held device quite close to the eyes, children are at special risk. Later in life with exposure to sunlight, the crystalline lens becomes yellow and more opaque. Thus, adult eyes develop some natural filtering of the blue light over time.

This occasional use of a hand-held device compounded with long hours of television, gaming systems and household lights can tax a child’s eyes. It becomes apparent that parents need to monitor their children in the use of these devices. Without some form of parental guidance and monitoring, it is estimated that by the time a child is 17 years of age, he or she will have spent the equivalent of six years using a blue-light emitting device.¹⁹

Along with the increasing incidence of personal use by children, hand held digital tablets are replacing books in many schools. A child will acquire the approved tablet and then will download required curriculum to the device as needed. There are future students who may rarely handle a paper-bound book. The intense hours of study needed using these devices will certainly result in more digital eye strain and, unfortunately, more exposure to blue light at a close distance.

Blue light hazards: a serious component of digital eye strain

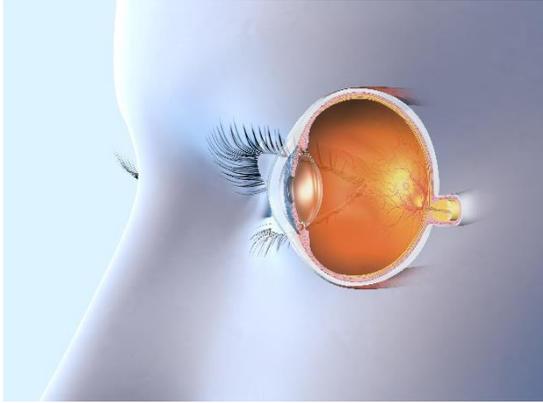
Once thought to be merely a work related problem, digital eye strain now affects your patient's personal life. Hand held digital devices are often held a mere 8 to 12 inches from the eyes and can be used for a prolonged period of time. Proximity, frequency of use, length of daily time in use and individual physical response all combine and can lead to visual discomfort (asthenopia).

Digital devices are very convenient and useful; but with more than 90% of adults using these devices for more than 2 hours per day, digital eye strain has become a common patient complaint. Even so, only one in four adults knows that digital devices emit blue or HEV light. The larger majority feel that eye discomfort is just an inevitable side effect of using technology and will acquiesce to it. You, the ECP, can increase their understanding of the problem and offer preventative solutions.

Blue light hazard is defined as the potential for the retina to suffer cumulative or irreversible damage from the high-energy wavelengths. Photo-receptor cell damage, damage to melanin and age-related macular degeneration (AMD) have all been linked to long-term high energy violet light (HEV) exposure. Multiple in-viva and in-vitro studies in animals, and limited human trials, show that both UV and HEV can result in retinal tissue damage and even damage to the DNA. ²

One problem is that a patient does not immediately feel any major damage to the eye or the retina. When exposed to blue light, eye strain and dry eyes result, but most patients easily blame these symptoms on a general tiredness. It can be greatly helpful to use a demo frame outfitted with blue blocking lenses for the patient to actually experience improved clarity and contrast. Patients who suffer from migraines, and computer users, will often notice an immediate improvement or feeling of ease. If the patient has a hand held device, such as a phone or tablet, viewing this familiar device with blue attenuating demonstrator frames makes the experience personal.²¹

Age related macular degeneration (AMD) is the major cause of visual impairment in the over 50 population in the United States. This statistic is likely to increase as this segment of the population reaches the age of 60. As part of several research studies, the concept of free radical and oxidative damage to the retina is linked to both UV and HEV exposure. A paper published by the American Macular Degeneration Foundation states that the blue rays of the light spectrum seem to accelerate AMD more than any other rays of the spectrum.¹⁰



The aging retina is more prone to damage even though the natural yellowing of the crystalline due to the absorption of UV can help. This protection by the natural ocular mechanisms becomes less effective with age. Photo toxicities (chromophores) accumulate in the retina and when blue light reacts with them, the regenerative process is stopped. Aphakes and pseudophakes do not even have this mild natural yellowing of the crystalline lens, so they will need optical lenses or coatings to protect against the harms of both UV and HEV.¹⁰

The wavelength most damaging to the macula is located at approximately 460 nm. Exposure to high levels of blue light in this range has been found to kill photoreceptor cells, and to increase the risk of developing age related macular degeneration (AMD). Since visible light passes through the cornea and the crystalline lens, it goes directly to the retina.¹⁰ Another effect of blue light constantly hitting the retina is a general reduction in the sensitivity to color.

According to Reuters Health, one study conducted in England determined that the amounts of blue light from most devices was less than the high amounts of blue light emitted by the sun on a clear day. That very obvious statement has been recently misconstrued to mean that computers and hand held devices are not harmful to the retina, when the study actually only confirms that sunlight is the strongest source of blue light.⁷

A dilated exam allows the doctor to look for AMD and other changes to the retina. Early detection of any damage to the retina will facilitate recommendations for treatments to help prevent further damage.

The function of melatonin

Even though white light containing HEV seems to make things look brighter and nicer, exposure at the wrong time of the day can seriously interfere with the patient's circadian rhythm.¹⁴

Daytime blue light stimulates alertness, a feeling of well-being and keeps one awake. As the sun sets, melatonin naturally begins to increase to facilitate the sleep cycle. During a 24 hour day, we would not want to completely block all blue light as this could adversely affect alertness by preventing the body from natural awareness of daytime. Daylight exposure to blue-turquoise light at 465 to 495 nm is essential to vision, the pupillary reflex and overall health. However, as the sun goes down, the body prepares for the sleep cycle. This cycle was practical when civilization was in a sunup to sundown life pattern, but today's longer work hours cut into the night time. On top of that, many patients routinely take their smart phones or tablets to bed to use social media or read an online novel until they fall asleep, not knowing that this very action is disrupting the sleep cycle they seek.



It is conjectured that the natural yellowing of the crystalline lens might interfere with the reception of natural blue light during the day. This in turn can interfere with the circadian rhythm and contribute to the insomnia that some elderly patients experience. If the body is not sufficiently stimulated by daylight blue light, the wake/sleep cycle is changed. Swedish researchers found that insomnia and daylight sleepiness was reduced when cataract surgery restored clarity with an intraocular lens.¹⁵

According to pubmed.gov, new mothers who awaken frequently during the night to feed and care for a baby have a disruption of the normal flow of melatonin. In addition to losing actual sleep time, the ability to return to sleep might be hampered. It is theorized that this sleep deprivation and circadian disruption might contribute to post-partum depression in a few new mothers. The use of blue blocking lamps or, if the lighting is high in the ceiling, having a pair of blue attenuating glasses next to the bed to put on before turning on the light can offer comfort. This can also help to maintain the level of melatonin in breast milk that assists the infant's sleep.²

The immune system and blue light

The disruption of the natural awake and sleep cycles of the circadian rhythm has been linked to breast cancer, obesity and affecting disorders. This all relates to the blue light interfering with the proper production of melatonin. It may surprise your optical patient when you begin a discussion regarding the quality of his or her sleep rather than only vision needs.

Melatonin is also a powerful antioxidant. Improper melatonin production, such as that resulting from excessive blue light exposure, can depress the immune system, thus increasing the risk for type 2 diabetes, heart disease and cancer. Blue light exposure has also been shown to aggravate epilepsy and migraine syndrome.

One suggestion is that warm-tone lamps with no blue light component should be used in bedrooms and bathrooms, which are the rooms most commonly used at night.

Can artificial blue light ever be beneficial?

According to Dr. Charles Czeisler of the Harvard Medical School,²² artificial light can shift a traveler's internal clock by four or more time zones, depending on when the patient is exposed to it. This will in turn make sleeping and waking in the new time zone more comfortable.

A proposed radical theory is that blue light might be used to increase attention when studying. In the same way that melatonin puts the body into a natural state of sleepiness, it is conjectured that blue light might act as a sort of new type of "coffee." There is obvious controversy regarding this type of shifting the body's sleep cycle through the manipulation of blue light.

How to reduce exposure to blue light with attenuation

Attenuation of light relates to a lens material, coating, matrix, structure or other method that changes how quickly a light beam reaches the eye, and also what frequencies of the light beam can penetrate the substance. Attenuation coefficient indicates how easily a material or a volume of materials can be penetrated by a beam of energy, such as light and sound. For instance, dark glasses attenuate sunlight, lead attenuates X-rays, and water attenuates both light and sound.

Attenuation of blue light is one of the best ways to prevent macular damage and disruption to the body cycles.¹⁴ Knowledge of the radiation involved and the resources available for attenuating blue light should become second nature to the ECP. To maximize the attenuation, the frame should be of sufficient size and fit well to offer optimum coverage and protection. Remember that light also reaches the eye over the top, bottom and sides of an eye wire. In outdoor eye wear or sun wear, frame wrap is a good additional protective option.

Blue light attenuation is best accomplished using all possible means: lens material, coatings, polarization, and possibly photochromics. Glass, polycarbonate, CR-39 and other high index plastics are not able to completely attenuate the blue wavelength and need special coatings or filters.

Blue blocking lenses can be plano, prescriptive, or can be designed for computer and close work. A lens that includes an AR coating can be designed to filter out blue-violet

light. Lenses with blue attenuating features will provide the ultimate protection and comfort.

The original Blu-Blockers™ and similar lenses from years ago had a problem: they were usually an orange, amber or brown/amber color. Thus, color perception was altered and indoor or night use was problematic, if not downright dangerous. Recognition of traffic signal lights could be adversely affected by those tints.



original Blue Blockers

Clear or mildly tinted attenuating lenses

Many tech lenses increase the absorption level of the material itself to work effectively in the longer blue radiation area and thus filter out the short, blue-violet wavelengths. Chemicals added to the actual monomer of the lens plastics attenuates using absorption, while alteration of the substrate of the lens works most effectively with a blue blocking AR coating.

BluTech lenses were originally designed with HEV filtering built into the lens and were first available in clear and sun lenses. BluTech lenses used pigment and melanin, and this type of lens is now also available from several different manufacturers in a variety of designs.



Of course, a natural marriage of UV and HEV protection can be found in sun lenses, both plano and Rx-able. Some sun lenses that do double protection duty are: Transitions®, NuPolar® (Younger Optics), Coppertone® (Vision Ease), Happy Lens™ (Spy Optics), 580 Lens (Costa®), and Protective Sunwear by WileyX®, among others.

A blue filter can be embedded automatically, and often free of charge, into select Essilor® lenses, including certain Varilux®, Transitions® and Eyezen™ lenses.

Eyezen+™ from Essilor® provides mild accommodative relief along with blue light filtering and is marketed as a single vision lens to prevent digital eye strain. With the filter embedded into the lens material, this lens reduces blue light exposure by 20%.

Vitaris™ was a clear lens originally available in two indices and offers UV and HEV blocking built into the lens. TheraBlue™ has UV and HEV protection in the lens material, comes in four different materials/indices, and can include an AR coating or can be left un-coated. TheraBlue™ lenses attenuate the most blue light at the 415 nm range, with the attenuation going down to about 10% at 450 nm. Plano blue light filter spectacles are available from many of these same companies. Gunnar lenses are available in amber or crystalline, and in prescriptive or plano lenses.

Lens coatings

Lens coatings offer another form of HEV protection and are often included in AR treatments. Virtually every major lens manufacturer offers blue attenuation lens coatings. These coatings will provide superior protection both indoors and outdoors on clear lenses, using no visible tint change to the lens. The brand names with each major manufacturer change with every advancement, and updated information from lens representatives, trade journals and trade shows is readily available.

Sun lenses get an additional boost of protection with a blue attenuating filter provided. When added to a Transitions® lens, for instance, Hoya Recharge™ will effectively block up to 95% of the blue light outdoors, as well as reducing blue light exposure indoors.

laboratory supplier has their own form of blue light attenuation available, such as **BPI®** Filter Vision/Blue Barrier® Tints that selectively filter out blue light from the spectrum.

Shields that fit over prescriptive lenses can be found with HEV protection, such as Fitovers and Cocoons. Also, blue light protection in a plano lens can be found in Chemistrie clips/sun lenses, as well as eClips.

Another good protection is a film screen specifically designed to be applied directly to the screen of a device, such as the Liqui-Pel filter/cover for iPhone and other hand held device screens.

Household tips for attenuation

It is suggested that the use of yellow, amber or orange lighting in rooms at night, such as the bathroom or bedroom, is helpful. This might just be one lamp easily accessible at night, while the balance of the lighting in the room is standard white for use at other times. Some digital lighting systems are available with a remote control selection of the color of light and brightness used.



Blue light is shades or from seeping into might be needed in neighborhoods with bright night lighting. This may become more necessary as communities replace the yellowish sodium-vapor street lights with blue-white lamps.

pervasive in modern society. Black-out window treatments to prevent blue light homes though windows or slats in blinds

Other suggestions to conquer digital devices

If possible, increase the distance between your eyes and the light source. A computer screen should be at least 20 to 24 inches away, preferably an arm's length. A smart phone or tablet should be about 16 to 20 inches away, yet most patients hold them considerably closer. Findings show that most people had a tendency to hold electronic devices 2 to 9 inches closer than traditional printed materials like magazines and books.¹

Myopes who slip off their eyeglasses, or gaze under the bottom of the frame, may hold these devices at an extremely close range. In addition to close contact with blue light, these reduced distances add strain on the focusing and convergence systems of the eyes.

Increase the text size so that the device can be easily read at a further distance from the eyes. Also, decrease the contrast on the device screen by adjusting the screen brightness. A setting to 50% brightness will reduce the overall light intensity and thus the blue portion of the spectrum.²³

Adjust the viewing angle to be below the eye level. This is a natural location for hand held devices and laptop computers, but might be more problematic with desk top computers. The center of your computer screen should be 4 to 5 inches lower than your line of sight and at an angle of about 15° to 20°. This ergonomic change will help the patient's posture as well as the eyes and might reduce neck and shoulder strain.

Downloadable apps are available for nearly every digital device and computer; some are free and some have a download cost. The variety of blue attenuating apps include: screen dimmers, gray screen color addition, and orange or amber screen color addition. Some have a timer to automatically engage on the device a certain number of hours prior to the user's bedtime.²³ These filters, coatings, apps and films might impart an amber or red appearance that takes a bit of acclimation. Most patients learn to ignore the color change after a day or two.

Take more frequent breaks. "20/20/20" is a key phrase to remind your patient that he or she can very simply reduce overall eye strain by taking a brief break. It is recommended that when using a computer or other digital device, every 20 minutes the patient should gaze at an object or scene 20 feet away for about 20 seconds. Practice of this technique also allows the crystalline lens a relaxation period, which may give further overall relaxation to the eyes.²³



Contact lenses, IOL's and blue light protection

At this time, it is reported that some RGP lenses have built in protection against UV rays, but those contact lens materials do not protect against blue or HEV light. Research for contact lens materials that can protect against HEV is being conducted. However, due to the many scientific and medical trials that must be performed as required by the FDA, approval of these new materials is a very slow process. Years ago, a contact lens created under the Nike brand offered some blue light protection due to the orange amber color of the lens used to enhance contrast on the playing field. However, it was also because of that unusual color that the lens never caught on and was discontinued.

74 % of contact lens wearers remove their lenses when experiencing digital eye fatigue. It is unclear how much blue light might contribute to this discomfort. The “20/20/20” break for digital eye strain can also help to avoid ocular dryness in the contact lens wearer. And, while a rewetting drop will not protect against blue light, it will help reduce the overall discomfort when doing near work in contact lenses. Computer, digital or plano eyeglasses worn over contact lenses is the modern protection standard. Just as sunglasses protect the contact lens wearer outdoors, HEV attenuating lenses provide indoor protection.

For the debilitating condition of aniridia, a soft, tinted contact lens with an opaque layer can be used. This condition is when all or a portion of the patient’s iris is missing and allows light to pour into the eye. The soft, tinted lens will restrict the overall amount of light allowed to enter the eye, which offers comfort to the patient. However, since these lenses must necessarily have a clear center, little or no filtering of blue light is achieved.

Studies using intraocular lenses (IOL’s) with a yellow tint have demonstrated protection against harmful blue light. One lens of this type is the AcrySof IOL by Alcon, which filters both UV and high-energy blue light through the use of a proprietary yellow chromophore. According to the company website, it more closely approximates the light transmission of a youthful human lens and provides excellent color perception across the spectrum. Other IOL’s on the market that have been tested show the ability to block between 3% and 40% of blue light, depending on the brand. The mild yellow hue of the IOL does not seem to be a problem to the patient.¹⁵



The future of blue

The incandescent bulb has been in use from when Edison first invented it until recent years; however it is rapidly being phased out, often due to energy efficiency laws. Incandescent bulbs emitted either no blue light or very low levels, and emitted more evening-friendly yellow to amber light. New, energy saving devices, use a strong white light to increase candle-power while at the same time saving energy. Unfortunately these energy efficient bulbs usually have a strong blue spectral component.

For decades, incandescent lighting was used in the home and fluorescent lighting was primarily found in offices and work environments. Incandescent lighting provides high

color fidelity and visual comfort but is not energy efficient. Fluorescent and LED lighting is energy efficient but cannot provide the same comfort level for the eyes. Blue light output in an LED light is nearly 200 times more than that of an incandescent lamp.



LED light bulb

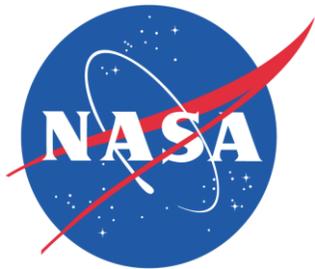
The light emitting diode (LED) was invented in 1927 by Oleg Losev and had no practical purpose at the time. It wasn't until 1962 that Texas Instruments created the first commercial LED product. Modern LEDs are considered sustainable lighting and are replacing both incandescent lamps and fluorescents/CFL's. Unfortunately, they are capable of exceeding the safe limits of "blue light hazard" as defined by ANSI and by the standards of Photobiological Safety for Lamp and Lamp Systems (IESNA).

Many countries have mandated that incandescent lighting be completely replaced with energy efficient CFL or LED lighting. Some countries that have already eliminated the sale and use of incandescent lighting are Brazil, Venezuela, Switzerland, Argentina and Russia. The phase out of incandescent lighting began in the United States, Canada and Mexico in 2014. Additionally, in many areas, even compact fluorescent lighting is being phased out due to the mercury content of these bulbs, leaving LED lamps as the only choice. The use of LED screens or lighting is on the increase with no expectation of slowing down.

A special challenge to the eye care industry will be to get the word out to all patients, including the emmetrope who might skip regular eye exams. Some suggestions to reach this population: placing plano protective eye wear near hand held devices; providing informational inserts in packaging, and using warning labels. While this information is not readily promoted by most manufacturers of digital devices and LED sources, the opportunity for the ECP to provide guidance through demonstration, discussion and providing ophthalmic brochures is a great service to the patient.^{13, 16}



Of the many employees of industries who are vulnerable to blue light exposure, the medical and dental fields are especially at risk with the use of brightly lighted equipment. Even equipment in the optical industry can expose both employees and patients to prolonged exposure or to strong doses of blue light. Equipment requiring protective goggles or lenses include: unfiltered slit lamps or biomicroscopes; dental curing lamps and dental bleaching equipment. A quick review of your patient's job could help to define UV and blue light exposure with any equipment used at a job site.



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Even NASA recognizes hazards of blue light. Under the guidance of neuroscientist George Brainard of the Thomas Jefferson University, the International Space Station is undergoing refitting of the lighting with a less disruptive fluorescent light. Says Brainard, "Electrical lighting is fundamentally a good thing, but there are unseen consequences." The lighting will slowly transition from "alert" lighting wavelengths to longer "warmer" wavelengths to help prepare the astronauts for sleep periods.²⁵



Your role as an ECP

Your patients look to you as the authority on vision needs. Educate yourself and your staff about blue light and offer blue light attenuating lenses to all, either prescriptive or plano computer glasses. First hand wearing experience of your staff combined with good education can open a natural dialogue with each patient. Work with your

physician, ophthalmologist and optometrist to initiate doctor driven sales of blue light attenuation aids. When the doctor speaks of and recommends optical goods, patients listen. Eyezen™ (Essilor) has implemented positive steps in the past that partnered with vision plans to help expand education and the availability of HEV protection. Other industry leaders are also stepping forward with ways to assist the ECP and patient.

A discussion regarding the potential dangers of blue light can go hand in hand when discussing the need for UV protection, of which most patients are already familiar. By speaking with your patient about their work habits and surroundings, quality of sleep and hobbies or activities at home, the patient will gain a better understanding of your concern for his or her vision.¹³

Include questions about screen and hand held device usage on patient intake forms or questionnaires. Discuss general lighting and work place conditions with each patient and probe into habits at work and home. Blue light posters, informational pamphlets and verbal presentation of information are keys to your success as a blue light expert. Be sure to demonstrate the blocking or diminishing of blue light. By trying on a pair of blue attenuating plano lenses in a demo frame, most patients see an immediate increase in contrast. Use this difference to further explain that blue light scatters, but when eliminated or decreased, the perception of all colors is enhanced.

Instead of just selling a lens or a brand, embrace the opportunity to inform your patients of the potential danger inherent in blue light. A simple discussion often leads a patient to purchase lens options. When you tell your patient about the drawbacks of blue light and demonstrate blue blocking lenses, the patient will more naturally want to purchase the option. Discuss immediate protection and long-term prevention benefits.



3

In addition, offering blue filters as a lens upgrade can often be an income upgrade for the practice. Whether an attenuation feature is built into the lens, or is offered as a coating, the opportunity to positively demonstrate AR coatings with attenuating

properties is created. This simple action by the ECP will certainly increase the practice's reputation for professionalism and good will.

Demonstration of the blue attenuating lenses can be as simple as using a blue laser pointer and a white surface, such as a wall. By allowing the beam of blue light to hit a white wall, and then placing the blue light blocking lens in between, a reduction of blue light is immediately visible. This is one instance when seeing truly is believing.

Some companies offer training, tools and technology for your staff members. Partner with your lens or coating company representative by using tools or programs they can provide. Online information is available to you and will help to keep you current on this technology. Although blue light attenuating lenses are available in almost every style of lens needed, check with your lens supplier or laboratory to be sure the features and combinations you wish to order are available.

Some alternate spectral concerns

Dark Adaptation

A newly recognized phenomenon related to cell phone use is "dark adaptation." According to the New England Journal of Medicine, looking at a cell phone at night, especially when lying on your side, can cause a type of blindness that will last for up to 15 minutes. The light from the cell phone prevents the other eye from adjusting to the dark and causes this odd phenomenon. It can be quite alarming to your patient since suddenly one eye can see and the other cannot. Your patient can be assured that this is only temporary.^{26, 27} Oddly enough, a similar phenomenon can be experienced when looking into a keratometer for a very long period of time. After this prolonged period of time, the vision in one eye may seem dimmed for about 5 minutes, but will become normal after acclimation to the light.

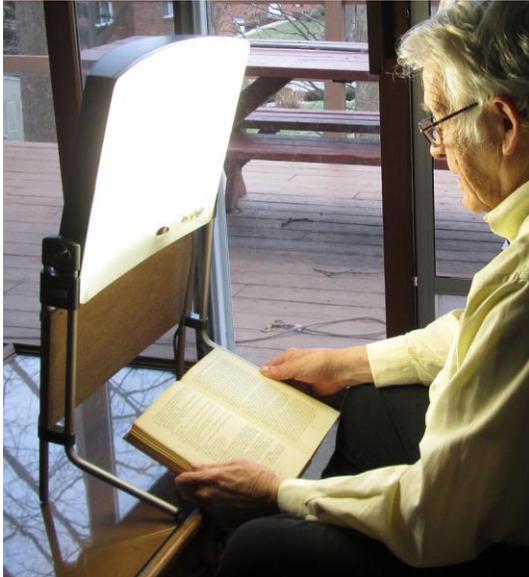
Another consequence of spectral light: Seasonal Affective Disorder (SAD)

Seasonal affective disorder (SAD) is also known as summer/winter depression, winter blues, or seasonal depression. This is a mood disorder in which patients who have normal moods throughout most of the year experience depressive symptoms for a part of the year, typically winter. The alteration of indoor lighting can have a positive effect on these patients.

Disruption or alternation of the melatonin production in the SAD patient can cause the patient to sleep too much, feel sluggish during the waking day, or just seem to lack motivation. Overeating, lack of concentration and withdrawal from social activities are also common symptoms. A possible additional cause of SAD is the relative lack of serotonin, which is a biological neurotransmitter related to melatonin.²⁸

Proper levels of serotonin are considered essential in mood regulation. Bright light therapy, where the patient commonly sits a distance of approximately an arm's length

away from a full spectrum light for 30 to 60 minutes per day, is helpful to some. The UV range of this light is blocked to prevent sunburn and skin cancer.



3

SAD patient during a light therapy session

This light supplement in the morning simulates dawn, and might be prescribed by a physician to replace or supplement antidepressant drugs. When light therapy does work, it is relatively fast, helping the patient in as little as four to seven days. Some SAD therapists have already begun using the blue-turquoise range, while the blue violet range is partially attenuated. This helps to promote serotonin and the resultant positive changes associated with proper serotonin function. It is interesting to note that the Happy Lens™ (Spy®) has technology based upon the benefits of light therapy in combating seasonal affective disorder.

In Conclusion



While the optical industry has done a great job of educating patients about the dangers of UV and UV filters, we now have the opportunity to expand and continue this dialogue with information about protection from blue light. As an ECP, you can provide valuable education for your patients about blue light attenuation and related optical technology. Your ability to provide modern solutions to this potential blue light hazard leads to happy patients and patient referrals.

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Test Questions

1. Which company invented the “Tennis Advantage” lens?
 - a) Essilor
 - b) Bolle
 - c) Nike
 - d) Transitions

2. What is another term for digital strain?
 - a) HEV
 - b) Digitized drama
 - c) Digital device syndrome
 - d) Any of the above is correct

3. Where is exposure to blue light primarily encountered?
 - a) A sleeping environment
 - b) Overhead lighting
 - c) Incandescent lighting
 - d) Exposure outdoors to the sun

4. What is the approximate percentage of adults who use digital devices for 2 or more hours every day?
 - a) 55%
 - b) 90%
 - c) 32%
 - d) 11%

5. What increment is used to measure the visible light spectrum?
 - a) Mm
 - b) Inches
 - c) Nm
 - d) Meters

6. Which wavelength is in the middle of the visible spectrum?
- a) Blue
 - b) Yellow
 - c) Turquoise
 - d) Green
7. The eye works harder to focus blue, resulting in _____
- a) Digital eye strain and decompensation
 - b) Chromatic aberration with blurry vision and glare
 - c) Distortion of vision and fatigue
 - d) Peripheral blurring
8. Which ocular structures provide partial protection from UV light to the inner eye?
- a) canthus and bleb
 - b) orbit and sclera
 - c) sclera and limbus
 - d) cornea and crystalline lens
9. Approximately how many cones are found in the eye?
- a) 120 million
 - b) 3 million
 - c) 100 million
 - d) 6 million
10. Which cells provide peripheral vision?
- a) cones
 - b) rods
 - c) ganglion
 - d) limbal
11. In the United States, approximately what percentage of the adult population say that they are not concerned with the impact of digital usage on their eyes?
- a) 52%
 - b) 75%
 - c) 87%
 - d) 35
12. What does HEV stand for?
- a) High emitting variable

- b) Hot energy voltage
- c) High energy violet
- d) High electrical volume

13. Which is the shortest of the following wavelengths?

- a) HEV
- b) 780
- c) UV
- d) Red

14. In the United States, what is the major cause of vision impairment in persons over 50 years of age?

- a) Glaucoma
- b) AMD
- c) Dry eyes
- d) Corneal injuries

15. What light seems to make things look brighter?

- a) White light containing HEV
- b) Amber
- c) Orange
- d) Blue-turquoise

16. What is a powerful antioxidant?

- a) Eyezen
- b) Melatonin
- c) Exposure to blue light
- d) Substrates

17. What is true about blue light exposure?

- a) It is not found during the day
- b) It has been shown to aggravate migraine syndrome
- c) It is found only in sunlight between 2 and 4 p.m.
- d) Children are immune to blue light exposure

18. What can attenuate x-rays?

- a) Water
- b) Glass
- c) CR-39

d) Lead

19. What is a good additional protection that can be provided with a frame?

- a) Frame wrap
- b) Dark plastic eye wires
- c) Translucent plastic eye wires
- d) Orange plastic eye wires

20. Which lens was designed originally using pigment and melanin?

- a) Vision Ease
- b) Costa
- c) BluTech
- d) Polycarbonate

21. How long should a patient occasionally gaze at optical infinity?

- a) For 20 minutes
- b) For 20 seconds
- c) For 20 alternating seconds
- d) For 20 blinks

22. What is aniridia?

- a) A severe form of glaucoma
- b) An inflammation of the iris
- c) An attenuating method
- d) Absence of part or all of the iris

23. Who developed a contact lens that was unpopular due to the unusual color?

- a) Ionlens
- b) Nike
- c) The FDA
- d) Genomeware

24. Who invented the light emitting diode?

- a) David Ayscough
- b) Texas Instruments
- c) Thomas Edison
- d) Oleg Losev

25. The standards of Photobiological Safety for Lamps and Lamp Systems were defined by which organization?
- a) ANSI
 - b) The FDA
 - c) IESNA
 - d) NASA
26. What NASA related structure underwent re-fitting with less disruptive light sources?
- a) The Space Shuttle
 - b) The Space Needle
 - c) The original Space Lab
 - d) The International Space Station
27. How long does dark adaptation typically last?
- a) Up to 5 minutes
 - b) Up to 15 minutes
 - c) Up to 1 hour
 - d) Overnight
28. A patient with SAD can experience which of the following symptoms?
- a) Hyperactivity during the day
 - b) Excessive hunger
 - c) Lack of motivation **
 - d) Nervousness
29. Which lens uses technology based upon the benefits of light therapy?
- a) Transitions
 - b) Happy Lens
 - c) Essilor
 - d) Blu Blocker
30. Which group of patients seems to be the most intensive users of hand held devices?
- a) Children
 - b) Baby boomers
 - c) Millenials
 - d) Adults over 60
31. Which bulb emitted more yellow light as a side effect?

- a) The incandescent bulb
- b) The LED bulb
- c) The CFL bulb
- d) The fluorescent bulb

32. Which radiations are found just beyond what can be seen?

- a) Blue and green
- b) Ultraviolet and infrared
- c) Deep violet and orange
- d) White and black

33. What part of the eye is especially responsive and sensitive to light?

- a) The puncta
- b) The cornea
- c) The crystalline lens
- d) The retina

34. The potential for the retina to suffer cumulative or irreversible damage due to the high energy wavelengths is known as _____?

- a) Blue light hazard
- b) Defocus
- c) Glaucoma
- d) Energy deficiency

35. Why do aphakes and pseudophakes especially need UV and HEV protection?

- a) They are elderly
- b) They do not have mild natural yellowing of the crystalline lens
- c) They always wear contact lenses
- d) They are missing part of the iris

36. What is the circadian rhythm?

- a) Sunup to sundown work pattern
- b) The opening and closing pattern of the iris
- c) The natural awake and sleep cycles
- d) The ability to stay awake long into the night

37. Blue blocking lenses can be _____:

- a) Always found in a hand held magnifier
- b) Only found in polarized lenses

- c) Opaque
- d) Sometimes plano

38. The Hoya Recharge will effectively block up to _____% blue light outdoors?

- a) 80%
- b) 95%
- c) 50%
- d) 10%

39. What is the suggested ergonomic angle for a computer screen?

- a) 10° to 15 °
- b) 45° to 60°
- c) 15° to 20°
- d) No tilt at all

40. What does IOL stand for?

- a) Intermediate orange lens
- b) Interval ocular luminance
- c) Intermediate optical length
- d) Intraocular lens