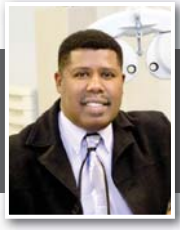
HOW TO MANAGE BLUE LIGHT



Prof. Paul Ramkissoon
BOptom (UDW)
CAS (NECO)
MPhil (RAU)
ACSpVis (RAU)
MOptom (UDW)
OD (NECO)
DPhil (RAU)
FAAO (USA)

PO Box 1097
Newcastle 2940
email:pauleyes@mweb.co.za

It is not uncommon to find the busy practitioner and student overwhelmed by research publications. *Vision*, in each edition will present summaries of certain clinical research topics highlighting some of the most salient points. This will aid clinicians and students to keep in touch with the latest developments in eye care and related fields.

INTRODUCTION

BLUE LIGHT is part of the visible spectrum of the electromagnetic radiation spectrum. Visible light covers a narrow range of electromagnetic wavelengths from approximately 380nm to 780nm and the region called "blue light" is specifically called for emphasis- purposes. These blue-coloured bands of light, known also as high-energy visible (HEV) light are much more energetic than their longer wavelength counterparts. Blue light exposure is important since it has been found to penetrate deeper into the eye than other wavelengths of light, and thus has the potential to cause changes in retinal tissues, including the macula as well as refraction. The renewed interest in blue light exposure is due to the increased use of modern technology that emits high energy blue light in addition to natural blue light.

WHY IS BLUE LIGHT EXPOSURE IMPORTANT?

From day break until going to bed late at night (or early morning), we are using all kinds of digital devices, for work as well as for recreation. Communication a decade ago was where we sat across or next to each other and spoke. This extended also to talking to one another over the telephone. These days, we are not surprised when people who are friends and even intimate hold conversations via smart devices while sitting next to each other in a restaurant- a new kind of friendship/intimacy!

Figure1. A patient deeply engaged with his smart device while at his work station. P. Ramkissoon, 2016.

Devices emitting blue light include: laptops, tablets, smartphones, televisions and room lights. The steep rise in light-emitting diodes (LED), personal electronics use and the transition from traditional incandescent lighting sources to compact fluorescent lights (CFL) is dramatically increasing our exposure to blue light, raising new fears about ocular health risks.

The frequent use and access to most of these devices at a short distance increasingly exposes our eyes to the light emitted by the screens of these devices. Moreover, this requires our eyes to switch continuously between photos, illustrations and text or follow moving images. Research has shown that more than 34% of the population spends about 4 to 6 hours a day with digital devices, while 14% even spends between 10 and 12 hours a day. As the quality of such screens improves continuously, their blue light emission is increasing. Consequently, it is not surprising that more and more people complain about visual symptoms following prolonged use of LCD and LED computer and television screens, smartphones, tablets and GPS devices that emit blue light.

Blue light exists in itself as a natural phenomenon. It is present in daylight and helps us to stay awake. Natural blue light plays an important role in the body: it maintains circadian rhythms, and improves alertness. However, excessive amounts of natural blue light can have an adverse effect and cause eye strain and fatigue.

Studies focused on the hormone melatonin, which is produced in darkness by the pineal gland from the amino acid tryptophan, and from the tryptophan-based neurotransmitter serotonin reaches peak levels during the hours of 3 am to 4 am. It is at this time that the human body is most likely to sleep. With the advent of new gene analysis techniques, a large number of receptors for melatonin were located in the SCN, confirming the SCN's role in the circadian rhythm cycle. However, it wasn't until 2002 that a new type of retinal photoreceptor, the intrinsically photosensitive retinal ganglion cell (ipRGC) was identified as the primary mediator of the circadian rhythm pathway within the SCN of the hypothalamus. Researchers discovered that a photopigment called melanophore in the ipRGCs is involved in the neuronal relay process to the hypothalamus.

In 2014, researchers found that light exposure at night (LEN) suppresses melatonin production, and that altering light/dark cycles with dim LEN speeds the development of breast tumours and leads to tamoxifen resistance. They concluded that dim light exposure at night disturbs melatonin production and can render tumours insensitive to tamoxifen.

As optometrists routinely follow patients being treated with tamoxifen on a semi-annual or annual basis because of the potential for tamoxifen retinopathy, we are in a unique position to discuss the health risks of nighttime light exposure with these patients.

Using computers, cell phones, and televisions at night will have a 1.5 to 2 -hour delay in nighttime rise in melatonin after going to bed in the dark, and this will have an important negative impact on breast cancer or other malignancies. While the blue wavelengths of 415nm to 455nm were found to be damaging to the retina, the wavelengths between 450nm to 550nm provide the strongest stimulation of circadian and neuroendocrine responses.

Blue light exposure at night has been shown to disrupt the sleep cycle and affect the quality of sleep. Researchers recently tested the effects of using e-readers prior to sleep for four hours vs. reading from a traditional book for four hours before sleep each night. The study found three notable results:

- **Exposure to e-readers caused a 10-minute delay in sleep onset vs. the control group.**
- **The experimental group spent less time in rapid eye movement (REM) sleep (109.04 ± 26.25 min vs. 120.86 ± 25.32 min in the print-book condition).**
- **There was a significant difference between groups in subjective feelings of tiredness and alertness the following morning.**

The researchers attribute the difference to decreased time spent in REM sleep, given its importance in learning and storing memories.

These results are important particularly among techno savvy people who tend to spend almost their entire day (work, recreational and leisure time) using digital devices. Nowadays, concerns already exist that we have a sleep epidemic—people receive fewer hours of sleep at night than in the past and significantly less than the recommended amounts. This with reduced sleep from electronic use prior to bedtime, results next-morning in reduced alertness and lethargy, and we are at risk for having an underproductive, fatigued population prone to industrial and motor vehicle accidents and poor performance at work, school and at home.

HOW TO MANAGE BLUE LIGHT

Blue light has been shown to cause significant over-accommodation in students. Researchers found that when exposed to wavelengths below 430nm, rather than having the typical 0.3D lag of accommodation when focusing on a near target, students experience 1.0D of over-accommodation on average, or 1.3D sum total accommodative change from the normal posture for focusing at near. Additionally, this overaccomodation can cause distance blur as well. These accommodative changes are constant even in decreased luminance. The overaccommodation, mediated by the parafovea, appears to be caused by the absence of short-wavelength sensitive cones in the central fovea. This mechanism is also thought to trigger night myopia and is a potential driver of the myopic shift seen in our population in recent years.

LED lighting in the classroom has been found to cause asthenopia and distance blur. Since student performance is of major concern in our schools and universities, optometrists can proactively meet with the school/university management team to recommend retaining traditional fluorescent lights in the classrooms and lecture halls, reserving the installation of LED lights for areas only where student focusing needs are not required, such as in the hallways and cafeteria.

Most optometrists are already aware of the impact of blue light on the different tissues and structures in the eye. In 2004, researchers found evidence suggesting the impact of blue light exposure on the risk of macular degeneration in the retina. This led to subsequent studies on the long-term effects of visible light on the eye. In 2013, researchers identified the most damaging visible wavelengths to be in the blue-violet range of 415nm to 455nm. These wavelengths were found to be the most harmful to cells in the eye, as they can penetrate deeper into the eye and harm the retina, particularly the retinal pigment epithelium, causing the development of a toxic, apoptosis-causing molecule called N-retinlyidene-N-retinylethanolamine (A2E) to be produced within the RPE cells, causing cell viability loss.

A newly conducted study by *École d'Optométrie* from the University of Montreal found that:

- **Wearing a lens treated with a blue-light filter coating helped reduce symptoms of eyestrain by half during prolonged computer exposure. 2.42 symptoms before versus 1.47 symptoms with blue coating (p=0.04).**
- **After wearing a lens treated with a blue-light filter coating, subjects with symptoms of eyestrain due to prolonged computer exposure felt a significant improvement of the following symptoms: dry eyes, sticky eyes, and the feeling of grittiness or "sand" in the eye.**
- **They also reported a trend of the overall vision and improved visual performances in situations of low contrast.**

Figure 2. Patient appreciating his spectacles that alleviate his blue light exposure symptoms. P.Ramkissoon, 2016.

MANAGEMENT

The use of protective eyewear can play an important role in shielding our eyes against the effects of blue light. For indoors, in low light or at night, protective ophthalmic lenses with a special coating designed to reflect and cut high energy blue light penetration are available. This type of lens coating is referred to as a blue light filter coating. Blue light filter coatings, the harmful portion of blue light is cut while allowing the good portion of blue light to pass through. Due to the reduced amount of blue light entering the eyes, contrasts are improved by reducing screen brightness, flickering and eye fatigue to provide a strain-free visual experience while providing the most complete protection. Blue light control lenses are available in South Africa via most of the major laboratories. At this stage, they are relatively exhorbitant.

Tinted lenses are another option to help reduce both harsh office lighting and balance colours since they help filter out harmful blue and violet light emitted by many digital devices. Sunglasses, which are specially tinted or polarised to absorb the HEV blue rays, are perfect for outdoors during the day.

Handheld devices should be placed at an appropriate distance from the eyes. Irrespective of the type of device, digital screens should always be directly in front of one's face, and slightly below eye level.

A clean, dust-free, smudge-free screen helps reduce glare. The brightness of the smart screen needs to be adjusted by checking the device's control setting. Also, consider changing the background colour from bright white to neutral gray. Glare reduction filters for computer screens are also available.

It is also recommended to reduce the amount of light competing with the screen. Dim indoor lighting and when outside try to avoid using the device in direct sunlight. Text size can be increased to better help define screen content and to make reading more comfortable for the eyes.

Patients must be reminded to blink more often. Staring at a digital screen can affect the number of times one blinks, causing the eyes to dry.

Adopting the 20-20-20 principle is a useful mantra. Every 20 minutes, take a 20-second break and look at something 20 feet (6m) away.

Consider limiting the amount of time spent on a digital device. Spending just two consecutive hours looking at a digital screen can cause eyestrain and fatigue. Parents should supervise and limit the amount of screen time their children are permitted, and reduce the amount of their own screen time around the children to set and lead by a good example.

CLINICAL PEARLS

- Breast cancer is a major public health concern worldwide, and identifying an easily modifiable contributor to its development and successful treatment is of enormous consequence. We need to take particular care to address this issue with our patients actively undergoing cancer treatment as well as those patients that are in remission, particularly with patients on tamoxifen adjuvant therapy.
- Blue light is used in photodynamic therapy to treat cancerous lesions.
- We should specifically point out to patients the sources of blue light.
- We need to educate all our patients regarding the risks of blue light from electronics as well as light exposure at night. As our patients become more dependent on their use of computers in all walks of life, they are exposed to more blue light than any generation before. It is vital to consider the potential hazards of such exposure and to educate our patients about its risks, including the loss of antioxidant and anticancer functioning, disruption to the circadian rhythm and sleep cycle, and potential vision loss from AMD.
- Optometrists should educate patients on the ways to protect the eyes through optical lenses, changes to the lighting sources for computer monitors, software that reduces blue light emissions from computer screens and through general public health education. As new hazards emerge and evolve, it is our responsibility to update our education and interventional efforts.

CONCLUSION

Optometrists are encouraged to learn the science, latest studies and key clinical points of blue light exposure in order to help educate and ultimately protect our patients given the behaviour of our society from teenagers to adults, who tend to spend their most of their time using digital devices.

REFERENCES

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