As primary eye care providers we now have the tools to help stem the tide of the coming vision loss epidemic from AMD. Doctors can counsel patients providing solutions for both internal and external protection from the deleterious effects of cumulative blue light exposure. Simply prescribing a carotenoid supplement containing all three macular carotenoids (MacuHealth®) and Blu-Tech Lenses with H.E.L.P Technology will provide both internal and external protection, with the assumptive effect of reducing the incidence of AMD and vision loss in the years to come.

The key to controlling the risks of AMD is proper patient education on protective measures they can take. At this time, researchers are only beginning to understand the physical, emotional, and economic burden vision loss in our aging population will have on our society. It is up to each of us, doctors and patients alike to educate others and make a difference now to help mitigate the effects of AMD later.

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The Macular Degeneration Epidemic: Beyond UV Protection

Dr. Gary L. Morgan

ep•i•dem•ic: *Affecting or tending to affect a disproportionately large number of individuals within a population; usually something unpleasant.*

The number of people with Age-related Macular Degeneration (AMD) will increase significantly over the next 20 years. The statistics are startling; 2.7 million Americans will develop Dry AMD, and 210,000 will develop wet AMD each year through the year 2050. There currently are 2,321 Retinal Specialists registered with the American Academy of Ophthalmology. Some quick, back-of-the-envelope math shows we are woefully under-prepared for the coming AMD epidemic.

So, what can we do as eyecare practitioners? In an infectious epidemic, measures such as quarantine, improved hygiene, vaccinations, etc. are undertaken to stop its spread. AMD is largely inherited with underlying systemic and environmental causes. Therefore, comprehensive programs for detection, risk assessment, education, monitoring, treatment programs, and prevention must be undertaken to limit the effects of AMD. As a profession, we are uniquely qualified (and even obliged) to lead the fight against this devastating disease.

There is a growing body of evidence that cumulative lifetime exposure to blue wavelength light increases the risk of AMD. Developmentally, by early childhood, the cornea and crystalline lens of the eye effectively block ultraviolet light from reaching the retina[1,2]. However visible light, which includes blue wavelength light, is transmitted to the retina and macula. The *Beaver Dam Eye Study* found that subjects in their teens through thirties, when exposed to an additional 3 hours of sunlight per day (over a normal exposure rate of 2 hours) advanced the onset of AMD in their lives by 10 years, effectively doubling the likelihood of becoming blind during a lifetime[3].

Another well established risk factor for developing AMD coincident with blue light exposure is low macular pigment, which consists of the carotenoids meso-zeaxanthin, zeaxanthin, and lutein (Figure 1). Lutein and zeaxanthin are dietary and found in foods such as spinach, brightly colored bell peppers and egg yolks. However, the Centers for Disease Control (CDC) estimates that the average daily intake of lutein and zeaxanthin in the US is approximately 2 mg, which is well below that shown to reduce the risk of age-related eye disease[4]. Meso-zeaxanthin is also dietary, but is not found in foods normally consumed, (i.e. skin of trout and salmon, shrimp shells, and turtle fat), yet has been shown to be the strongest of the three in terms of its antioxidant capabilities[5].

There is a growing body of evidence that ***cumulative lifetime exposure to blue wavelength light*** *increases the risk of AMD.*

In addition to serving as an antioxidant, macular pigment attenuates blue wavelength light, relieving oxidative stress occurring at the level of the RPE / Bruch's membrane complex. Measurement of Macular Pigment Optical Density (MPOD) has the potential to become an important biomarker to measure one's risk for developing AMD, as there are more than 250 published studies supporting macular carotenoids as essential for maintaining healthy vision[4]. In-office devices to measure MPOD are becoming more common in eye care practices. An alarming statistic confirmed in US and Irish-based population studies demonstrated that when MPOD is measured, 43% of subjects have low MPOD[6,7]. It is becoming clear that measuring MPOD in patients with AMD

and those at risk (family history, light complexion), is an important component of prevention. For those with low MPOD, oral supplementation with meso-zeaxanthin, zeaxanthin and lutein has been shown to lead to increased serum and macular concentrations, effectively raising MPOD[8].

In yet another study, the European Eye Study (EUREYE), it was found that a combination of blue light exposure and low plasma concentrations of antioxidants, particularly the macular carotenoids, was associated with an increased incidence of developing AMD[9]. As per the discussion above, it is well-documented that the macular carotenoids are potent blue light filters and macular pigment density is inversely related to AMD susceptibility.

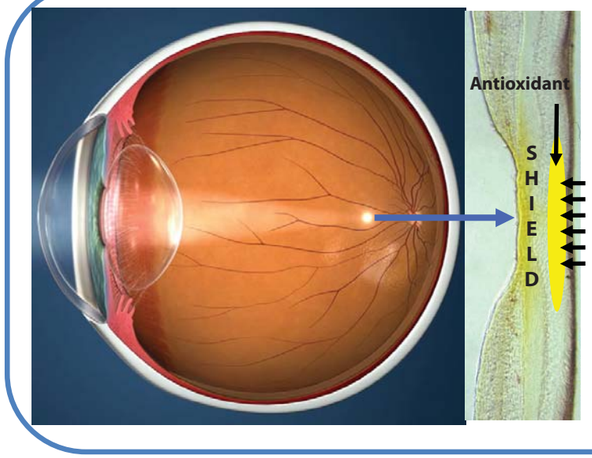
But how do we escape blue light? Sunlight contains the full visible spectrum and there is a growing threat of an 'Indoor Blue Light Hazard'. Incandescent light bulbs are being legislated away to conserve energy – the "greening" of America. This would be OK if replacement light sources were *green*, as in green wavelength light. However, fluorescent, CFL, and LED bulbs, while energy efficient, have a high blue-spectral emission. If you are reading this online, you are getting a large dose of blue light as LCD computer screens are backlit by fluorescent bulbs. So efforts to reduce our carbon footprint may have the unintended consequence of potentiating AMD.

While for years doctors have prescribed UV blocking lenses to guard against cancers of the eyelid, pterygia, pinguecula, photokeratitis, and cataracts, it is now possible to prescribe lenses on the basis of *wavelength selective light filtration* – the ability to filter blue light. Besides macular pigment, our eye contains two other natural blue blocking components in the form of Melanin and Ocular Lens Pigment (OLP), which combined filter 90% of the light that enters the eye. Spectacle lenses containing synthetic melanin and OLP are poised to revolutionize tactics to reduce the risk of AMD.

It is now possible to prescribe lenses on the basis of ***wavelength selective light filtration.***

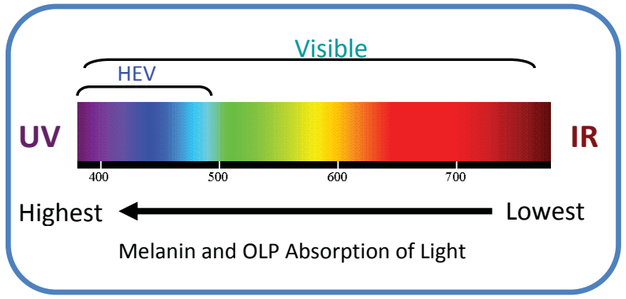
Melanin protects ocular tissue by physical and biochemical mechanisms, acting as a photo-screen and as an antioxidant[10, 11]. In the iris, melanin selectively absorbs near-infrared, visible light, High Energy Visible light (HEV) and UV radiation with absorption increasing at the shorter, more damaging wavelengths[10].

Figure 1



Shown on the left is an enlarged cross section of the macula. Macular pigment is just under the surface of the tissue, the yellow band labeled "shield". It has a double action of shielding blue light from reaching the lower levels of the retina (RPE / Bruch's Membrane) represented by the dark band on the right, which is where oxidation occurs. In addition, since it extends into the photoreceptors of the retina, it also acts to quench the free radicals that are formed, acting as a powerful antioxidant, represented by the yellow shaded area at the arrow tips.

Figure 2



Melanin is also found in the RPE where absorption diminishes light reflection and scatter from the neural retina, effectively reducing glare[12]. Melanin found in the RPE and choroid may deactivate Reactive Oxygen Species (ROS) brought about by blue light exposure, protecting the retina from oxidative damage[13, 14]. However as we age, through constant exposure to oxygen and light, melanin in the RPE / choroid (uveal melanocytes) may lose antioxidant properties becoming pro-oxidant, leading to increased lipofuscin production which is a precursor to drusen formation in AMD[15]. Interestingly, uveal melanocytes in darker colored eyes contain a greater amount of melanin, retaining their antioxidant effects until a later point in life. As AMD is more common in those with lighter than darker complexions, research suggests this may explain why melanin may be protective against AMD development[15].

Ocular Lens Pigment (OLP) refers to the yellow brown color the crystalline lens incurs with age, the result of the oxidative polymerization of 3-Hydroxy-kynurenine[16, 17]. This chemical process occurs slowly over time; the crystalline lens of a child is devoid of OLP. As we age, OLP gradually increases, ultimately leading to cataract[18]. OLP is protective of oxidative retinal damage incurred through blue light exposure as OLP has a similar absorption spectrum to melanin (Figure 2). However with cataract formation, vision diminishes leading to cataract removal with implantation of an artificial intraocular lens (IOL).

While blue light-filtering IOLs have been available since 2003, there has been debate primarily on their effects on mesopic and scotopic vision, and possible sleep disturbance related to photoentrainment of circadian rhythm; blue light suppresses melatonin receptors in the retina stimulating wakefulness during the day. As such, it was postulated that implanting blue-filtering IOLs would diminish color perception and contrast sensitivity in dim lighting and cause a decrease in alertness during the day. In what can be considered a landmark paper comparing all previous studies on the subject up to February of 2011, Davison et al. established these fears to be unfounded and concluded that blue light filtering IOLs which mimic the natural human lens should be considered a safe preventive measure to reduce cumulative blue light-induced retinal photo-oxidation leading to AMD[19]. This conclusion is further supported by results using the Farnsworth-Munsell 100 color tests. Subjects who took this highly-discriminating color perception test while wearing sun lenses[20] and computer lenses[21] with melanin, consistently retained full perception of color.

Blue Light Filtering Lenses which mimic the natural human lens should be considered a safe preventive measure to reduce cumulative blue light induced retinal photo-oxidation leading to AMD.

The majority of IOLs implanted after cataract surgery are still of the non-blue light filtering variety. Millions more have had standard UV-blocking IOLs implanted over the last 30+ years leaving a large segment of our elderly population at risk of blue light-induced oxidative retinal damage. In addition, pseudophakic children, as a result of congenital cataract removal, are at an even greater risk due to their unprotected lifetime cumulative blue light exposure.

In June of 2012, Eye Solutions, a leader in AMD protection, announced the launch of Blu-Tech Lens™ with H.E.L.P. (High Energy Light Protection) Technology. These patented lenses contain natural ocular melanin and OLP, and are available for both outdoor and indoor use. Sun lenses will be available in polarized, and in either a brown or grey tint. Indoor lenses will have a light brown tint that is visually soothing to the wearer. Blu-Tech Lenses will protect wearers, from youth through retirement, blocking the dangerous effects of blue light naturally.