Exploring
the latest findings and research in
Blue Light

Report of expert round table discussion,
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Introduction

A round table discussion held in January 2016 – chaired by Professor John Marshall with a panel of experts representing research, ophthalmology, academia and retail optometry – set out to determine the extent to which blue light is a hazard to the human eye and to establish whether it is implicated in disease such as age-related macular degeneration (AMD).

Discussions included the availability of existing research and the likelihood of future studies being conducted, which will help support the increasing body of evidence that blue light is a concern for eye health. They concluded by suggesting how this potential risk should be discussed in the practice environment.

The Panel

John Marshall MBE

Professor at University College London's Institute of Optometry in association with Moorfield's Eye Hospital. John has sat on many of the world's safety committees concerned with protecting individuals against lasers and other sources of optical radiation. He has generated substantial data, now used in codes of practice and is interested in utilising light as a form of intervention in terms of surgery and diagnosis. He had the first patents for UV lasers to carry out refractive surgery and has had a lifelong interest in the interaction between light and cellular ageing, especially ageing in the retina. He has published many papers on the interactions between light, ageing and the membrane between the neural retina and the underlying choroidal blood supply membrane which is one of the first elements to undergo change during the process we know as AMD.

Tom Margrain

Based at Cardiff University Tom has had a long running interest in age-related macular disease and in particular the effects of light on the condition. Amongst other things he has worked as an optometrist and electrophysiologist.

Mike Killpartrick

An optometrist and independent practitioner based in Bath and Cheltenham, Mike is interested in light as a contributing factor in macular degeneration and in ensuring his customers are well informed on the latest evidence and thinking.

Bill Harvey

An optometrist with a specialism in low vision, Bill has lectured in low vision at City, Plymouth and Surrey Universities for many years and he is also involved in professional training for Boots Opticians. He is interested in prevention rather than heavy back-end management of macular degeneration – and ensuring he has appropriate, accurate and evidence–based information to share with practitioners.

Serge Picaud

As a scientist and physio-pathologist at the Vision Institute in Paris, Serge is interested in understanding how retinal cells degenerate and how this can be prevented. The aim of this research is to examine the mechanisms used by the retina to process visual information and to use this to develop new neuro-protective or rehabilitation strategies. He is also concerned with the effect of light on retinal cell degeneration and restoration of vision in blind patients.

John Nolan

Principal investigator of the Macular Pigment Research Group based in Waterford in Ireland, John's primary interest involves the study of nutrition for the eye and how this can be optimised in macular pigment, which plays a key role in filtering blue light. He believes that filtering blue light optically has a key role in visual functions and that enhancing visual function today while protecting our vision into later years is something that needs to be understood particularly by the optometry community.

What does the science and current thinking tell us?

Is there adequate data to say we ought to treat short wavelength blue-violet with suspicion and perhaps take protective measures to limit the amount we are allowing to pass into the retina?

"We do not have a great deal of chronic data so we have to balance that against recent studies – from behavioural psychologists rather than vision scientists – which show that there is a requirement for the longer wavelength blue – at around 480 nanometres (nm) – in order to harmonise our lives and prevent us from getting acute depression.

"At one end there's the blue we don't want which is the short wavelength blue – blue-violet as some people refer to – and at the other end we have the longer wavelength blue – blue-turquoise - that we absolutely do need.

"It is quite clear that UV light and short wavelength visible light impacts on skin ageing so even in a system like the skin, which is renewing itself, accumulated damage will result from chronic exposure to light. The retinal system is not turning over so does that give rise to special problems? We don't need to live beyond the age of 30 but we are living much longer. We also need to consider changed environment. Because of various government misconceptions, we've moved to low energy sources and now LEDs with very bright blue components and some UV components are creeping into our homes. At the flick of a switch we can have daylight illumination anytime we want." John Marshall.

"I think there is a pretty large body of evidence which does implicate light in the development of AMD and the paper that did it for me is by Sui et al[1] in the British Journal of Ophthalmology in 2013 - a meta-analysis of all of the epidemiological data. Although the emphasis is on sunlight exposure, we might deduce that blue light is the major damaging component in sunlight." Tom Margrain

"The Sliney[2] paper showed how important the geometric analysis of exposure is in all of these studies - just monitoring how long a person stays outdoors gives you no idea of their ocular exposure. Sui et al[1] is a good clarifying paper and it would be even better if someone could look at the geometry of exposure and better analyse the reality of exposure." John Marshall

"There are so many factors associated with the progression of AMD – some which you can't do much about such as your family history, many of which you can such as smoking and diet – but it's difficult, unless you've got a really good meta-analysis of a load of papers, to establish any definites because most of these things are difficult to control.

"Stephen Dane does repeat the fact that there is surface damage in the short wavelength; it is accepted now that it will damage the replication of cells and there will be surface problems with basal cell carcinomas (BCCs), corneal changes and so on. But the further back into the eye there are question marks about cumulative damage at different ages. Do these things accumulate over time or does it more likely depend on how your recovery processes are ingrained in you genetically? There is agreed significant output, for example, from LED sources and significant potential danger in the ophthalmic equipment we use day to day so I don't think it would be controversial to suggest that short wavelength visible light has safety concerns especially in younger people where significant amounts can access the retina and the macula.

"Do we act now before the evidence bank is enough to confirm that younger patient exposure is damaging and should we be intervening now with younger patients in filtering out the potentially phototoxic wavelengths? And I think this is where the debate has to focus.

"I think the blue light impact on surface tissues is difficult to argue against, but it seems to me we're still having to make a reasoned decision on what is, as yet, not conclusive evidence." Bill Harvey

"We've got this confusion between UV and blue. Even in the very young not a lot of UV is going to get through except through the little window. Blue is certainly going to get through and it is certainly going to fall on the retina. Hazardous blue, i.e. the high photon blue, is around 440 nm whilst the melanopsin blue is around 480 nm so it would be easy to differentially block those two.

"Ask an audience of ophthalmologists today "how many of you would put in an intraocular lens without a UV blocker?" and not one person would put their hands up. That's on the basis of no clinical evidence. Ask the same audience how many will use these new intraocular lenses with a degree of blue blocking and, depending on which country you're in it's about 50/50. The argument there is that there is no clinical evidence, but there was no clinical evidence previously. Should we act now and prevent something or wait until we get the data by which time we'll have lots more people with problems?" John Marshall

"Concerning the evidence of blue light toxicity and light toxicity related to AMD, I was quite convinced by all the clinical evidence which has shown that blue and violet light can be toxic. It does seem that blue light in general can enter the eye and reach the retina and these wavelengths can be toxic to the cells.

"In animals, when you deprive the antioxidant defence you do see some damage to the cells at low light levels. So with patients with low antioxidant defence you may see this kind of damage as well.

Why would you see this in animals and not in humans? This is not acute light damage, but chronic effects. It's difficult to reach a clear conclusion for patients but we have shown that the blue-violet light is much more toxic to the retinal pigment epithelium cells (RPE) at the back of the eye when you load them with chromophore like A2E, which is a natural pigment that you find edging a retinal pigment cell.

"We do believe that in ageing patients where you have an accumulation of this kind of chromophore you could have damage from blue-violet light. Although we normalise the light used in our experiments to the light of the sun reaching the retina, it's clear that we always use higher intensities than those which reach the retina. So it's possible this type of light would damage other cells such as the photoreceptors. But we are quite convinced blue light - and maybe more blue-violet light - can be really toxic not only to retinal pigment cells, but also other neurons such as ganglion cells and the photoreceptors." Serge Picaud

"We have to address the difference between cumulative damage and ageing and cumulative damage and the flip between ageing physiology and overt disease like AMD. In my mind it's clear that light exposure certainly is a rate limiting driver for ageing processes. The consensus is that we all feel we have an issue here with short-wavelength radiation and it's not biologically friendly, but how far are we prepared to stick our necks out?" John Marshall

"Where do we sit in terms of the evidence for short wavelength blue light? From a human perspective it's difficult to quantify light exposure. The answer to the human question is that we can't attribute retinal disease to any one factor such as blue light. We're talking about a disease that's the result of cumulative (chronic) impacts over a person's lifetime with many contributing factors - some of which are set in stone - such as genetics. We can begin by looking at animal studies – where you can accelerate a process such as blue light exposure and create irreversible retinal changes, but it's a multi factorial disease and we have to understand many other factors, such as the antioxidant potential, the shape of the eye and the quantity of light. In summary, I would have no issue with making a comment that is scientifically backed that we need to be aware of the impact of shortwave light on the human population." John Nolan

Why it is difficult to prove a link between blue-violet light and ocular disease

Although there was general agreement that blue light could well be a factor in ocular disease, an emerging theme throughout the discussion was the lack of appropriate human research to demonstrate the link between blue light and macular degeneration and support the compelling animal studies that exist. The panel agreed on the usefulness of such research but there was a lack of consensus as to whether such research could succeed or indeed be funded given the scale, complexity and duration required.

"There is one research design that's tried and tested and used when introducing a new intervention and that's the randomised control clinical trial. There is a lot of great underlying cell biology and some good epidemiological data but the clinical trials evidence is missing.

"One challenge we have with AMD is that if you look at studies such as AREDS (Age Related Eye Disease Study) for example they typify the difficulties, i.e. a massive sample size and people followed up over a long period of time, so there are challenges but it is achievable." Tom Margrain

"To do a clinical trial in a human population is impossible." John Nolan

"You can't even do that with intraocular lenses. It would be very difficult to do a randomised control trial." John Marshall

"I'm personally dubious about how much a randomised controlled study trial would be available and how trustworthy it would be." Bill Harvey

"It's very difficult for non-scientists to understand the difficulties involved here and even for scientists to discriminate between ageing and AMD because if you look at ageing you see many of the clinical symptoms of AMD." John Marshall

Risk factors for AMD, risk groups and comparisons with sunlight and skin

Comparisons were made with sunblock – especially in terms of compliance and consumer understanding of risk. There was also broad agreement about the risk factors for AMD.

"Everyone in this room will happily put on sunblock when you go out in the sun and we all believe that's a good thing. Does it significantly reduce the incidence of skin cancers? We haven't got that evidence for the same reason it will be difficult to do. We're still happy to say it, it does work!" Mike Killpartrick

"Sunblock is probably not a bad analogy as a lot of the problems are to do with compliance and understanding on the patient's part. There is a potential danger someone will slap sun cream on once at the beginning of the day. It has a minimal impact as the day progresses. It might even give them an inherent belief that they are invincible and stay in the sun longer. Increasingly, the primary care sector has an astoundingly important role to reduce the burden on secondary care by giving good solid advice. Ten years ago you never asked a patient if they smoked in their history of symptoms. Hopefully now that's taught at all the universities." Bill Harvey

"We're very aggressive. I now say to my patients, if you want to increase the risk of macular degeneration start smoking." Mike Killpartrick

"What macular pigment is doing and the pigments at the back of the eye that are likely to be sensitive... it's an interplay of all these things that are likely to be taken into account. The feeling is that older adults stand to benefit more than younger people." Tom Margrain

"I think we would all agree that the ability of the eye to function begins to degrade with age. We can all agree that age is the biggest risk factor in AMD and smoking is accepted as a significant risk factor in AMD. Then we've got genetics and we all agree genes are playing a role. Then we get into dietary issues and light exposure. There is agreement that light exposure may have a role but we're not defining it and all the work we've done has shown it does increase ageing in experimental models." John Marshall

"The AMD story is not conclusive but based on the evidence that's available from the basic science all the way up to the gold standard clinical trials, I think the evidence for nutrition is absolutely favourable that we should be active in that space and the patients we've worked with will confirm that." John Nolan

"Regarding risk factors from blue light and whether risk is higher at certain stages in the disease, we don't have the data, but my research would seem to indicate it is a cumulative effect and from the twenties onwards you're beginning to build up debris in the system. The evidence is not there but, the earlier the intervention the better." John Marshall

The potential for negative effects when filtering out blue light

Although some blue light is needed to regulate sleep, memory and brain performance, the use of spectacles to filter out unwanted blue light was not seen as a concern. Experts support the idea of precisely filtering harmful wavelengths, while allowing transmission of beneficial blue.

"I cannot personally see anything that's negative about this." John Marshall

"From a spectacle point of view I agree. From the macular pigment point of view the evidence is all supportive that vision gets better. So you can infer from what the pigment does and what the lenses do, I think it's complimentary." John Nolan

"It goes back to 'will' versus 'is likely.' Now I think we have to say to people are you aware smoking causes damage? Are you aware that UV causes significant surface damage and some internal damage depending on the exposure? I think we are now in the realms of saying there is some evidence that a blue light filter on the spectacle lens has some protective benefit." Bill Harvey

"When we talk about intraocular lenses with blue filters – I'm much more comfortable as a vision scientist to say to a patient that if the evidence is in support of blue filtering to do so with spectacles rather than intraocular filters." John Nolan

"If I was wearing glasses, especially outdoors, I would like to keep bright light for the activation of the chronobiology which is around 480 nm. We know it's quite useful to have some kind of bright exposure and maybe it also has a role in progressive myopia control. So I wouldn't want to completely block all wavelengths with sunglasses.

"When we apply photosensitisers like A2E on the retinal pigment epithelium (RPE) cells the toxicity is from 415 to 455 nm³ so I would take no risk in blocking these wavelengths and keeping those at 480 nm to excite my chronobiology because I want to be awake and also because it has a lot to do with your well-being." Serge Picaud

"If we could block this end and not block that end, in terms of the spectra, we really want to have this significant reduction around 450 down and we want good transmission up around 465." John Marshall

What does this mean for those in practice when talking to patients?

"I think patients should be aware of light damage. They should be aware that there's some evidence of short wavelength not necessarily being good long term, in terms of external particularly and then less so with internal exposure. I think the UV message has to be got across absolutely to all patients and I don't have an issue discussing what we currently know regarding blue light with patients the way I think we should be discussing what we know regarding nutrition. I think those two things need to be out there in the primary care sector." Bill Harvey

Key Takeaways

We need longer wavelength blue (blue-turquoise) exposure to synchronise our biological clock and preserve health functions.

Sunlight is strongly incriminated not only in acute ocular damage, but also in the development of chronic changes such as cataracts and even severe diseases such as AMD. There is growing evidence that, in particular, blue light could be implicated in the development of AMD.

AMD has a multifactorial pathogenesis: age, genetics, smoking, diet low in vitamins, retinal phototoxicity, obesity and hypertension are all likely to play a role.

Prevention matters. Blocking sunglasses, specialist lenses to filter out UV and possibly blue-violet light and nutraceuticals can all play a part. Clear everyday lenses that filter harmful wavelengths (blue-violet), whilst allowing the transmission of beneficial blue light (blue-turquoise) could also help protect against long term damage of the eye.

Informing patients of UV danger and growing evidence on blue-violet light is important and particularly with patients who have a strong family history of macular degeneration, already have signs of it or have a high exposure to sunlight.

Those most vulnerable to the chronic effects of light exposure are children as well as the elderly; people with a family history of AMD; those who have had cataract surgery; outdoor workers or people who are exposed to sources of radiation and heat, or in prolonged contact with LEDs – and people with fair complexions.

References

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