fool ourselves that we will have any real say in the matter—once data are out there they will be used by anyone in any way. The best we can achieve is publishing our interpretation alongside any others while working hard to get it accepted.

Can we as surgeons be individually identified and judged? Yes. Should we be judged in this way? Yes—provided the data are accurate and the reporting is fair.

Br J Ophthalmol 2006;**90**:938–939.
doi: 10.1136/bjo.2006.094805

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REFERENCES

- 1 Do Once and Share Cataract programme survey (unpublished data).

- 2 <http://www.rcophth.ac.uk/docs/college/daos/HSCIC-CNDv1.3WIP.xls>.
- 3 <http://www.rcophth.ac.uk/docs/college/daos/CataractCarePathwayPlanv0.9.xls>.
- 4 Johnston RL, Sparrow JM, Canning CR, et al. Pilot national electronic cataract surgery survey: I. Method, descriptive, and process features. *Eye* 2005;**19**:788–94.
- 5 Burack JH, Impellizzeri P, Homel P, et al. Public reporting of surgical mortality: a survey of New York State cardiothoracic surgeons. *Ann Thorac Surg* 1999;**68**:1195–200.
- 6 Halm EA, Chassin MR. Why do hospital death rates vary? *N Engl J Med* 2001;**345**:692–4.

Retinal damage

Blocking the blue

P Hawse

The role of blue light exposure from ophthalmic diagnostic equipment deserves further study

Recent research surrounding the development of a blue blocking intraocular lens (IOL) for cataract surgery has again raised the question of the potentially harmful effects of light on the retina, particularly the blue light hazard. Does the literature support the hypothesis that blue light exposure contributes to the development of retinal damage, particularly macular degeneration? And, if we are developing blue blocking IOLs to reduce this risk, should regulators consider mandating the use of blue blocking filters in diagnostic equipment (slit lamps, direct and indirect ophthalmoscopes, ophthalmic cameras, and magnifying lenses) as well?

The controversy over the immediate visual benefits of blue blocking IOLs is still under debate. Recent research has found that contrast sensitivity and colour vision improved with blue blocking IOLs in diabetics,¹ while earlier research found that blue blocking IOLs reduce scotopic sensitivity in ageing individuals.² None the less, regardless of whether or not blue blocking IOLs make sense for different types of cataract surgery patients, the research regarding the detrimental effects of blue light on the retina still remains.

Research on rhesus monkeys, conducted decades ago, found that exposing the retina to the light of ophthalmoscopes produces retinal lesions and damages the retinal pigment epithelium after 15 minutes.³ More recent research on the indirect ophthalmoscope supports these early findings. Using spectral radiometric measurements from a standard indirect ophthalmoscope and comparing them to

the threshold limit values (TLV) adopted by the American Conference of Governmental Industrial Hygienists, Bradnam and colleagues reported that when using a clear lens with the indirect ophthalmoscope, the TLV was exceeded after approximately 2.5 minutes. However, when a yellow (blue blocking) lens was used it increased the “safe” operating period by a factor of approximately 20. Concluding that in a clinical practice, using a clear lens, the TLV could be exceeded easily if the patient is subjected to prolonged or repeated examination with the indirect ophthalmoscope, because the “blue light hazard is additive in a linear manner for periods as long as 3 hours with a potential for a cumulative effect over longer periods.”⁴

Biomicroscopy using the slit lamp produces at least three times the retinal exposure of light compared with the indirect ophthalmoscope and was thought to merit caution regarding potential retinal damage. When using the slit lamp, light is often shone in one area, often at full intensity, which increases the risk of damage. The calculated safe time for slit lamp biomicroscopy was found to be “as little as 8 seconds at maximum intensity,” which may be exceeded in many clinical situations.⁵

Several studies have shown that light emitted from operating microscopes used in cataract surgery can damage the retina leading one investigator to a call for the routine placement of blue blocking filters in operating microscopes,^{6–8} while light exposure during endoillumination for vitrectomy surgery

was also studied and found to pose a retinal phototoxicity hazard.⁹

The simple effort of mandatory blue light blocking filters would potentially protect millions of vulnerable patients from retinal damage caused by blue light exposure during ophthalmic examinations and treatments

More general animal research, not specific to one ophthalmic instrument, but none the less regarding blue light exposure and retinal damage, continues to find that blue light is toxic to the retina. In albino rat retinas, the death pathways mediating light induced apoptosis were studied, and a striking response with exposure to either blue light of 403 nm (3.1 mW/cm²) or green light of 550 nm (8.7 mW/cm²) was obtained. No apoptosis and no other light induced lesions could be found in green light exposed retinas, whereas massive apoptotic cell death occurred after illumination with blue light.¹⁰

Additional evidence is accumulating indicating that blue light is also toxic to the human retina. Braunstein and Sparrow, looking at blue and green light exposure on cultured human pigment epithelial cells, found that blue light exposure led to cell death, while placing a blue blocking filter over the cells, protected them. Furthermore, they found that only blue light caused cell damage; there was no adverse effect to the cells when they were exposed to green light.¹¹

Epidemiological studies of the impact of light on the retina have produced conflicting results. The Chesapeake Bay Waterman Study found advanced age related macular degeneration (AMD) was more common in men exposed to increased levels of blue light (400–500 nm), than in those with increased levels of ultraviolet exposure.¹² Similarly, the Beaver Dam Study found that exposure to visible light was associated with AMD in men, but not in women.¹³ However, the Pathologies Oculaires Liees a l'Age, POLA, study, conducted in the south of France, found no relations between a history of light exposure and

the development of AMD.¹⁴ Overall, the data appear consistent with the possible harmful effect of light on the retina.

Of course, we do not see any immediate detrimental effect of blue light damage after an ophthalmic examination. However, we must realise that a cascade effect of cellular changes is induced when blue light strikes the retina. In an animal model researching exposure to blue light and photoreceptor apoptosis, the most pronounced cell death was found to occur 16 hours after exposure.¹⁵ In addition, photochemical damage from blue light exposure is proposed to emanate from a given amount of light, regardless of whether that amount of light is absorbed over a brief or extended period of time.¹⁶

Luckily, the human eye is naturally made to protect itself from light damage. By pupil constriction, lid squinting, and eye movement, the eye naturally shields itself from the focusing of intense light rays onto the retina. Unfortunately, in a dilated eye examination, these natural defences are compromised: the pupil is dilated and unable to constrict, light rays are concentrated directly onto the macula, and the patient is asked to keep their eye still, and remain fixated on an object.

Some may believe that there is not enough evidence to show a definitive causal link between blue light exposure and retinal damage, specifically macular degeneration. However, even if that is the case (that the jury is still out waiting on even more evidence) why wouldn't

the ophthalmic community err on the side of caution and make the use of blue light blocking filters mandatory on slit lamps, direct and indirect ophthalmoscopes, and magnifying lenses?

Most ophthalmoscopes and diagnostic lenses, and some slit lamps, now come with a yellow filter option. In addition, yellow clip-on filters are also available and would be an inexpensive way to correct older equipment purchased without yellow filters. The simple effort of mandatory blue light blocking filters would potentially protect millions of vulnerable patients from retinal damage caused by blue light exposure during ophthalmic examinations and treatments. Finally, the role of blue light exposure from ophthalmic diagnostic equipment, as a contributing factor of retinal damage, deserves further study.

Br J Ophthalmol 2006;**90**:939–940.
doi: 10.1136/bjo.2006.095653

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REFERENCES

- Rodriguez-Galietero A, Montes-Mico R, Munoz G, et al. Blue-light filtering intraocular lens in patients with diabetes: contrast sensitivity and chromatic discrimination. *J Cataract Refract Surg* 2005;**31**:2088–92.
- Mainster M, Sparrow J. How much blue light should an IOL transmit? *Br J Ophthalmol* 2003;**87**:1523–9.
- Friedman E, Kuwabara T. The retinal pigment epithelium. IV. The damaging effects of radiant energy. *Arch Ophthalmol* 1968;**80**:265–79.
- Bradnam MS, Montgomery DM, Moseley H, et al. Quantitative assessment of the blue-light hazard during indirect ophthalmoscopy and the increase in the "safe" operating period achieved using a yellow lens. *Ophthalmology* 1995;**102**:799–804.
- Kirkness C. Do ophthalmic instruments pose a hazard of light induced damage to the eye? *Hazards of light*. New York: Pergamon Press, 1986:179–86.
- Parver LM, Auker CR, Fine BS. Observations on monkey eyes exposed to light from an operating microscope. *Ophthalmology* 1983;**90**:964–72.
- Irvine AR, Wood I, Morris BW. Retinal damage from the illumination of the operating microscope. An experimental study in pseudophakic monkeys. *Arch Ophthalmol* 1984;**102**:1358–65.
- Michael R, Wegener A. Estimation of safe exposure time from an ophthalmic operating microscope with regard to ultraviolet radiation and blue-light hazards to the eye. *J Opt Soc Am A Opt Image Sci Vis* 2004;**21**:1388–92.
- van den Biesen PR, Berenschot T, Verdaasdonk RM, et al. Endoillumination during vitrectomy and phototoxicity thresholds. *Br J Ophthalmol* 2000;**84**:1372–5.
- Reme CE, Grimm C, Hafezi F, et al. Apoptosis in the retina: the silent death of vision. *News Physiol Sci* 2000;**15**:120–4.
- Braunstein RE, Sparrow JR. A blue-blocking intraocular lens should be used in cataract surgery. *Arch Ophthalmol* 2005;**123**:547–9.
- Taylor HR, West S, Munoz B, et al. The long-term effects of visible light on the eye. *Arch Ophthalmol* 1992;**110**:99–104.
- Cruickshanks KJ, Klein R, Klein BE, et al. Sunlight and the 5-year incidence of early age-related maculopathy; the Beaver Dam Eye Study. *Arch Ophthalmol* 2001;**119**:246–50.
- Delcourt C, Carriere I, Ponton-Sanchez A, et al. Light exposure and the risk of age-related macular degeneration: the Pathologies Oculaires Liees a l'Age (POLA) study. *Arch Ophthalmol* 2001;**119**:1463–8.
- Algevre PV, Marshall J, Seregard S. Age-related maculopathy and the impact of blue light hazard. *Acta Ophthalmol Scand* 2006;**84**:4–15.
- Sparrow JR, Zhou J, Ben-Shabat S, et al. Involvement of oxidative mechanisms in blue-light-induced damage to A2-E laden RPE. *Invest Ophthalmol Vis Sci* 2002;**43**:1222–7.