Science Abstracts on LED Lighting

Retinal Damage Induced by Commercial Light Emitting Diodes (LEDs)

I. Jaadane, et al, Free Radical Biology and Medicine (84) p. 373-384 (2015)

Abstract:
Spectra of “white LEDs” are characterized by an intense emission in the blue region of the visible spectrum, absent in daylight spectra. This blue component and the high intensity of emission are the main sources of concern about the health risks of LEDs with respect to their toxicity to the eye and the retina. The aim of our study was to elucidate the role of blue light from LEDs in retinal damage. Commercially available white LEDs and four different blue LEDs (507, 473, 467, and 449 nm) were used for exposure experiments on Wistar rats. Immunohistochemical stain, transmission electron microscopy, and Western blot were used to exam the retinas. We evaluated LED-induced retinal cell damage by studying oxidative stress, stress response pathways, and the identification of cell death pathways. LED light caused a state of suffering of the retina with oxidative damage and retinal injury. We observed a loss of photoreceptors and the activation of caspase-independent apoptosis, necroptosis, and necrosis. A wavelength dependence of the effects was observed. Phototoxicity of LEDs on the retina is characterized by a strong damage of photoreceptors and by the induction of necrosis.

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Potential Danger of Light Emitting Diode Illumination to the Eye, in Children and Teenagers

P. Zak and M. Ostrovsky, Light and Engineering, 20(3), p. 5-8 (2012)

Abstract:
Modern white light emitting diodes (LED) have an expressed emission band in a blue and dark-blue interval of 440-460 nm, which completely coincides with the spectrum causing photochemical damage of eye retina and its pigmented epithelium. This radiation represents an increased level of risk danger for the eyes in children and teenagers, because their crystalline lenses are twice as transparent in the blue and dark-blue interval than adult eyes. Photochemical damage of the retina progresses over a long period of time and causes gradual irreversible degradation of sight. The use of luminaires with LEDs in childcare facilities of the Russian Federation can have unpredictable negative and irreversible consequences for children's sight and demand a serious professional ophthalmology and physiological substantiation.

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Effects of White Light-Emitting Diode (LED) Light Exposure with Different Correlated Color Temperatures (CCTs) on Human Lens Epithelial Cells in Culture

C. Xie, et al, Photochemistry and Photobiology, 90(4), p. 853-859 (2014)

Abstract:
Cataract is the major cause for legal blindness in the world. Oxidative stress on the lens epithelial cells (hLECs) is the most important factor in cataract formation. Cumulative light-exposure from widely used light-emitting diodes (LEDs) may pose a potential oxidative threat to the lens epithelium, due to the high-energy blue light component in the white-light emission from diodes. In the interest of perfecting biosafety standards for LED domestic lighting, this study analyzed the photobiological effect of white LED light with different correlated color temperatures (CCTs) on cultured hLECs. The hLECs were cultured and cumulatively exposed to multichromatic white LED light with CCTs of 2954,

5624, and 7378 K. Cell viability of hLECs was measured by Cell Counting Kit-8 (CCK-8) assay. DNA damage was determined by alkaline comet assay. Intracellular reactive oxygen species (ROS) generation, cell cycle, and apoptosis were quantified by flow cytometry. Compared with 2954 and 5624 K LED light, LED light having a CCT of 7378 K caused overproduction of intracellular ROS and severe DNA damage, which triggered G2 /M arrest and apoptosis. These results indicate that white LEDs with a high CCT could cause significant photobiological damage to hLECs.

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Light-Emitting Diodes (LED) for Domestic Lighting: Any Risks for The Eye?

F. Behar-Cohen, et al, Progress in Retinal and Eye Research, 30(4), p. 239-257 (2011)

Abstract:
Light-emitting diodes (LEDs) are taking an increasing place in the market of domestic lighting because they produce light with low energy consumption. In the EU, by 2016, no traditional incandescent light sources will be available, and LEDs may become the major domestic light sources. Due to specific spectral and energetic characteristics of white LEDs as compared to other domestic light sources, some concerns have been raised regarding their safety for human health and particularly potential harmful risks for the eye.

To conduct a health risk assessment on systems using LEDs, the French Agency for Food, Environmental and Occupational Health & Safety (ANSES), a public body reporting to the French Ministers for ecology, for health and for employment, has organized a task group. This group consisted physicists, lighting and metrology specialists, retinal biologist and ophthalmologist who have worked together for a year. Part of this work has comprised the evaluation of group risks of different white LEDs commercialized on the French market, according to the standards and found that some of these lights belonged to the group risk 1 or 2. This paper gives a comprehensive analysis of the potential risks of white LEDs, taking into account pre-clinical knowledge as well as epidemiologic studies and reports the French Agency's recommendations to avoid potential retinal hazards.

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White Light–Emitting Diodes (LEDs) at Domestic Lighting Levels and Retinal Injury in a Rat Model

Y. Shang, et al, Environmental Health Perspectives, 122(3), p. 269-276 (2014)

BACKGROUND: Light-emitting diodes (LEDs) deliver higher levels of blue light to the retina than do conventional domestic light sources. Chronic exposure to high-intensity light (2,000–10,000 lux) has previously been found to result in light-induced retinal injury, but chronic exposure to relatively low-intensity (750 lux) light has not been previously assessed with LEDs in a rodent model.

OBJECTIVE: We examined LED-induced retinal neuronal cell damage in the Sprague-Dawley rat using functional, histological, and biochemical measurements.

METHODS: We used blue LEDs (460 nm) and full-spectrum white LEDs, coupled with matching compact fluorescent lights, for exposures. Pathological examinations included electroretinogram, hematoxylin and eosin (H&E) staining, immunohistochemistry (IHC), and transmission electron microscopy (TEM). We also measured free radical production in the retina to determine the oxidative stress level.

RESULTS: H&E staining and TEM revealed apoptosis and necrosis of photoreceptors, which indicated blue-light induced photochemical injury of the retina. Free radical production in the retina was increased in LED-exposed groups. IHC staining demonstrated that oxidative stress was associated with retinal injury. Although we found serious retinal light injury in LED groups, the compact fluorescent lamp (CFL) groups showed moderate to mild injury.

CONCLUSIONS: Our results raise questions about adverse effects on the retina from chronic exposure to LED light compared with other light sources that have less blue light. Thus, we suggest a precautionary approach with regard to the use of blue-rich “white” LEDs for general lighting.