Contact Lens Update
CLINICAL INSIGHTS BASED IN CURRENT RESEARCH

Contact Lens Technologies of the Future

June 15, 2021

Chau-Minh Phan is a research assistant professor at the Centre for Ocular Research & Education, where he oversees the commercialization of innovative research. He is also the co-founder of Tricolops Technology and OcuBlink Inc.

Jones L, Hui A, Phan CM, et al. CLEAR – Contact lens technologies of the future. Cont Lens Anterior Eye 2021;44:398-430.

Future contact lens technologies will revolutionize the management and treatment of ocular diseases. Many of the incredible innovations and growth in this space have been made possible by advancements in nanotechnology and the miniaturization of microelectronics. An in-depth review of these technologies is available for free online as part of the BCLA-led Contact Lens Evidence-based Academic Reports (CLEAR) series.[1] Broadly, the applications of smart contact lenses can be grouped into three areas – (1) detection of disease, (2) management of disease, and (3) optical enhancements.

For the detection of disease, there is already a commercial device available. Sensimed's Triggerfish® is an FDA-approved contact lens that measures intraocular pressure (IOP) for the management of glaucoma. The device utilizes a strain gauge, in combination with onboard microelectronics, to seamlessly provide 24 hour continuous IOP measurements. The technology allows researchers to study factors, such as the effects of medication, body position, and circadian rhythm on IOP, which are not currently possible with existing methods.

Future contact lenses will also be able to sense changes in tear analytes to detect the onset of diseases such a dry eye, cancer, and diabetes. In all of these diseases, a specific set of biomarkers in the tear film is elevated, which then can be measured by nanosensors embedded in the contact lens. For conditions that benefit from continuous monitoring, such as diabetes, the data from the contact lens can be streamed wirelessly to an external device for further processing. While the potential of this technology for the continuous monitoring of glucose levels is evident, challenges exist in relation to ensuring accurate and stable glucose sensors are used, along with overcoming the difficulties associated with incorporating, and supplying power to, microelectronics embedded in the lens. Examples of challenges such as these illustrate why some future technologies may take many years to become a commercial reality.

The second application of contact lenses that is of significant interest for optometry relates to the management of diseases. Currently, the most common method for treating many ocular diseases is with an eye drop. However, eye drops are highly inefficient because they are rapidly removed from the ocular surface by blinking, tear dilution, and non-specific absorption. Furthermore, there are problems with patient compliance for treatment regimens that require frequent dosing such as when treating acute microbial keratitis.

Drug delivery utilizing contact lenses provide a unique solution to this problem by enabling sustained, targeted and controlled delivery of a pharmaceutical agent to the target tissue. To further enhance its efficacy, contact lenses can also be combined with nanotechnology vehicles, such as nanoparticles, liposomes, and microemulsions. Modifying contact lens materials using processes such as vitamin E coating or molecular imprinting can further enhance drug delivery. Numerous drug-releasing contact lenses are currently being developed that could one day be used to treat diseases such as microbial infections, dry eye, glaucoma, and diabetic retinopathy. Johnson & Johnson Vision recently gained regulatory approval for the first commercial antihistamine-delivering contact lens in Japan and Canada. The ACUVUE® Theravision™ daily disposable contact lens releases ketotifen to relieve the itch caused by ocular allergies.

The third application for smart contact lenses is the integration of optical components, in particular head-up displays. Imagine a transparent screen capable of displaying real-time information right in front of a person's eyes. While a decade ago, this concept may have sounded like science fiction, the commercialisation of this technology may only be a few years away. Mojo Vision already has a working prototype contact lens with a micro display containing 100,000 LEDs packaged in a diameter of only 0.41 millimetres. The integration of a head-up display in a contact lens opens up limitless possibilities, such as being able to detect road signs in the far distance and displaying this information clearly to the user. The initial application of this contact lens is likely to be as an aid to patients with low vision and then gradually adopt this technology to other applications in augmented reality.

The CLEAR report on "contact lens technologies of the future" also covers a number of other exciting innovations, including novel optical designs for myopia control, contact lenses with embedded controllable optical elements for real-time management of presbyopia, lenses with special filters for colour vision deficiencies, and specialty contact lens cases with antimicrobial properties. Eventually, contact lenses could even evolve into theranostic platforms that combine both diagnostics and therapeutics into one cohesive system. As these technologies gradually become available over the next few years, clinicians will need to adapt their clinical practice accordingly. The future of smart contact lenses, as exciting and unbelievable as it may sound, is just around the corner.

REFERENCES:

1. Jones L, Hui A, Phan CM, *et al.* CLEAR – Contact lens technologies of the future. *Cont Lens Anterior Eye* 2021;44:398-430.