

Keep your eyes on Ophthalmology

Within the ophthalmologic sector, eye care professionals are obligated to ensure the highest level of infection control is adhered to for the safety of patients and staff. The infection from microorganisms can be transmitted in a myriad of ways, whether this be from the inadequate disinfection of ophthalmologic equipment, or patient to staff transmission. Pathogens with the ability to cause disease and infection are explained in this paper, along with current and new disinfectant procedures to help raise general awareness.

Acanthamoeba keratitis

Acanthamoeba keratitis (AK) is a disease of particular concern within the field of ophthalmology, albeit rare in its prevalence. The main route of infection is through the eye, although entry to the body can also occur through the nasal passage and ulcerated skin.¹

Free living amoebae (FLA) invade the cornea of the eye, causing AK. The amoebae feed as a parasite off a susceptible human host.

FLA are a genus of protozoa, and are ubiquitous within the environment. They are commonly found in contact lens accessories, tap water, dust and swimming pools. FLA are known to act as hosts to bacterial infections such as legionellosis. Acting as a host provides protection to pathogens in the aquatic environment against standard water treatment methods.

Symptoms of AK can often be confused with common eye infections such as conjunctivitis and herpes simplex virus keratitis. If infection is left untreated, AK has the ability to cause permanent corneal scarring, and in extreme cases, blindness.²

For medication to have the best chance at effectively treating AK, an early diagnosis for the patient is essential. Individuals who wear contact lenses are most susceptible to contracting AK, although infection can occur to anyone. The main reason for contraction is due to poor hygiene practice.

For contact lens wearers, the risk of infections is increased from the following factors:

- The failure to remove contact lenses when coming into contact with water from showering, swimming or hot tub use.
- Improper cleaning of contact lenses after use. Cleaning, rubbing and rinsing contact lenses aids the removal of harmful microbes and their endotoxins.
- Incorrect storage and replacement of contact lens cases. Cases need to be replaced at least once every three months to eliminate the harboring of any harmful microorganisms.¹

Studies have revealed that within the United States approximately 85% of AK infections occur in contact lens wearers. The reports of AK have dramatically increased in parallel with the use of contact lenses, with incidence rates of 0.15 per million population in the United States and 1.4 per million population in the United Kingdom being reported.^{3,4}

A study conducted at Moorefields Eye Hospital NHS Foundation Trust, London, (United Kingdom) concluded serious eye infections affect up to 1 out of every 500 contact lens users per year.⁵

Adenoviral epidemic keratoconjunctivitis

Approximately 92% of acute epibulbar infections are caused by adenoviral epidemic keratoconjunctivitis (EKC). It is a highly contagious, severe form of conjunctivitis. It is most prevalent in causing infections in late winter, spring and early summer.

Within larger hospitals, (>500 beds) for every 1000 treatment cases 4.7 are estimated to be from EKC. Major risk factors relating to nosocomial outbreaks or epidemics include inadequately disinfected ocular instrumentation and insufficient hand washing between healthcare staff and patients.⁶

During 2008 and 2010, six unrelated EKC outbreaks associated with human adenovirus (HAdV) were reported to the Centers for Disease Control and Prevention (CDC) in America. Within the four states (Florida, Illinois, Minnesota and New Jersey) 411 EKC cases were identified. Health care associated transmission of the virus appeared to occur via ophthalmologic examination in each outbreak.⁷

EKC is a hostile pathogen in its ability to survive for long periods outside of the human body. It is resistant to adverse pH

¹ Centers for Disease Control and Prevention, *Acanthamoeba - Granulomatous Amebic Encephalitis (GAE); Keratitis*, www.cdc.gov/parasites/acanthamoeba/biology.html

² Knobbe CA. Corneal Ulcer, www.allaboutvision.com/conditions/corneal-ulcer.htm

³ Parmar DN, Awwad ST, Petroll WM, Bowman RW, McCulley JP, Cavanagh HD. Tandem scanning confocal corneal microscopy in the diagnosis of suspected *Acanthamoeba keratitis*. *Ophthalmology*. 2006;113:538-47.

⁴ Coulon C, Collignon A, McDonnell G, Thomas V, 'Resistance of *Acanthamoeba* Cysts to Disinfection Treatments Used in Health Care Settings' *J Clin Microbiol*. Aug 2010

⁵ Dart JK, Radford CF, Minassian D, Verma S, Stapleton F. 'Risk factors for microbial keratitis with contemporary contact lenses: a case-control study'. *Ophthalmology*. 2008

⁶ Bialasiewicz, A. 'Adenoviral Keratoconjunctivitis' *Sultan Qaboos Uni Med J*. 2007 April

⁷ Centers for Disease Control and Prevention, 'Adenovirus-Associated Epidemic Keratoconjunctivitis Outbreaks – Four States, 2008-2010' www.cdc.gov/mmwr/preview/mmwrhtml/mm6232a1.htm

conditions in the environment and remains stable against many chemical agents.

With studies revealing that serotype HAdV 19 is viable on tonometer tips for nine days and up to 35 on plastics, the necessity for adequate infection control is emphasised. This information is reinforced when considering the 2008-2010 outbreaks mentioned above. In the Illinois outbreak, more than one week after the inadequate disinfection of ophthalmologic equipment HAdV was detected and cultured. Furthermore, HAdV was detected on high touch surfaces four days after clinic disinfection in one of the New Jersey outbreaks.^{7,8}

Mycotic eye diseases

In addition to the risk of infection from FLA and viruses, infections from mycotic eye diseases are commonplace. The pathogenesis of fungal eye infections will be known by ophthalmologists and optometrists, but should be made aware to the general population.

Fungi are eukaryotic organisms that are ubiquitous in nature. Moulds, yeasts and diphasic fungi are the three classes of fungi important in ocular pathogens.

Moulds, also known as filamentous fungi, are multicellular organisms that form mycelium in ocular infection. From the mycelium either septate or non-septate hyphae (filamentous projections) branch out. Common septate filamentous fungi are *Aspergillus flavus* and *Fusarium solani*. These two species of fungi may constitute up to one third of all cases of traumatic infectious keratitis.^{9,10}

Endophthalmitis is an inflammatory condition of the intraocular cavities, caused by either bactericidal or fungal infection. *Candida* spp. are a common cause. For example, *Candida albicans* (also implicated with opportunistic oral and genital infections) is the most common cause of endogenous endophthalmitis. This particular infection occurs through metastatic spread from a distant bodily site.

Exogenous endophthalmitis arises through the direct introduction of microorganisms (predominantly *Candida* spp.) into the eye during surgery or trauma. The epidemiological characteristics of patients who contract this infection include:

- Postoperative infection incurred after lens removal.
- Postoperative infection incurred after lens implantation.
- Postoperative infection incurred after corneal transplant.¹⁰

Eliminating the initial risk of infection is essential in helping prevent the spread of these pathogens.

Ophthalmologic equipment used within the health care industry has the potential to harbor and spread a variety of infections. This is particularly hazardous with FLA, due to their ability to act as hosts, as well as provide protection to microorganisms. *Acinetobacter*, *Enterobacter*, *Legionella*, various mycobacteria, *Pseudomonas* and *Serratia* spp. are examples of microorganisms able to resist disinfectant methods and proliferate after amoebal ingestion.¹¹

There is no specific British Standard EN test to assess a disinfectant's efficacy against amoebae. Tristel however, have performed a bespoke suspension test on the *Acanthamoeba* cysts as a representative surrogate for oocysts. An oocyst is the general term used to describe when a zygote (the daughter cell formed when a mother cell duplicates) is formed by parasitic protozoan.¹²

Tristel Duo for Ophthalmology

Tristel Duo for Ophthalmology which utilises patented chlorine dioxide (ClO₂) chemistry, achieves a >3 log₁₀ reduction against *Acanthamoeba* cysts in 30 seconds. This is highly beneficial to the ophthalmologic sector when solutions with fast turnaround time combined with maximum disinfectant ability are required. Biocidal efficacy in 30 seconds is also attained against HAdV, *Aspergillus flavus*, *Fusarium solani* and *Candida albicans*.

Sodium hypochlorite (NaOCl), is commonly used within the ophthalmologic sector at a concentration of 10,000 parts per million. This concentration is required to reduce potential nosocomial transmission from microorganisms, as well as transmissible spongiform encephalopathies (TSEs). Examples of TSEs include classic Creutzfeldt-Jakob disease (CJD) and variant Creutzfeldt-Jakob disease (vCJD).

NaOCl has a higher oxidative strength than ClO₂, consequently being less selective in its reactions. It reacts with more material limiting its effectiveness as a disinfectant, whilst also producing harmful chlorinated, carcinogenic by products, such as trihalomethanes and haloacetic acids.¹³

The Royal College of Ophthalmologists (2012, United Kingdom) recommends soaking instruments for 10 minutes in a 1% hypochlorite solution. However, by using an immersion technique there is no control over contact time. NaOCl is highly alkaline and possesses corrosive properties to metal, causing damage to delicate devices.¹⁴

⁸ Bialasiewicz, A. 'Adenoviral Keratoconjunctivitis' Sultan Qaboos Uni Med J. 2007 April

⁹ Wu L. 'Fungal Endophthalmitis' <http://emedicine.medscape.com/article/1204298-overview>

¹⁰ Klotz SA, Penn CC, Negvesky GJ, Butrus SI 'Fungal and Parasitic Infections of the Eye' Clin Microbiol Rev. Oct 2000; 13(4): 662-685.

¹¹ Thomas, V., G. McDonnell, S. P. Denyer, and J. Y. Maillard. Free-living amoebae and their intracellular pathogenic microorganisms: risks for water quality. FEMS Microbiol. Rev. 34:231-259. 2010

¹² Oxford Dictionaries 'Definition of 'oocyst' in English' www.oxforddictionaries.com

¹³ EPA, 'Water: Basic Information about Regulated Drinking Water Contaminants' <http://water.epa.gov/drink/contaminants/basicinformation/disinfectionbyproducts.cfm>

¹⁴ Hawksworth N (2012) 'Ophthalmic Instrument Decontamination', *The Royal College of Ophthalmologists, Ophthalmic Services Guidance*, pp.10

The World Health Organisation states that incineration is the only effective measure in ensuring no risk of residual infectivity on surgical instruments of TSEs. However, following this procedure is not feasible for instruments and materials that are not designed for single use.¹⁵

Tristel Duo for Ophthalmology is a safer and more effective alternative to NaOCl. The solution is sporicidal, mycobactericidal, virucidal, fungicidal and bactericidal. Alongside NaOCl, ClO₂ chemistry is listed as a partially effective biocide against TSEs in the 'WHO Infection Control Guidelines for Transmissible Spongiform Encephalopathies'.¹⁵

When used according to the user instructions, the chemical properties of ClO₂ present no health concerns to the end user, as highlighted in Tristel's toxicological studies conducted in the United Kingdom and the United States. No contraindications or reactions were observed when Tristel's ClO₂ was tested for eye or skin irritation, skin sensitisation or acute oral toxicity.

The chemistry is uniquely generated by means of a base and activator solution. The activator solution consists of sodium chlorite (NaClO₂), a chemical compound with a variety of applications.

The base solution is composed of citric acid (C₆H₈O₇), sorbic acid (C₆H₈O₂) and boric acid (H₃BO₃). Citric, sorbic and boric acid are natural organic compounds. When these four compounds are mixed together, ClO₂ is instantaneously produced.

Categorised as a Class IIa Medical Device, Tristel Duo for Ophthalmology can be used on a variety of instruments and equipment, including:

- Diagnostic and laser contact lenses
- Tonometer prisms and cones
- Metal clamps for scleral buckling
- Ophthalmic ultrasound probes

The disinfection of tonometer prisms and contact glasses using Tristel Duo for Ophthalmology is recommended by Haag Streit. Globally, Haag Streit is one of the largest manufacturers of ophthalmologic equipment.

The ClO₂ chemistry contained within Tristel Duo for Ophthalmology is dispersed in a foam format for ease of application. It can be applied directly onto the medical device, or onto a Tristel Dry Wipe for high-level disinfection of long and thin ophthalmic devices.



Picture 1: Tristel Duo for Ophthalmology.