ABSTRACT

The key functions of lens care solutions are to clean and disinfect lenses, in addition to potentially making them more comfortable to wear. Although tears contain numerous proteins and lipids that are often deposited on contact lenses, the quantity that is removed from the lens during cleaning after wear varies with the constituent material of the lens and the lens care solution used. This article examines the effects of lens care solutions on the tear film and the lens itself. This article also reviews the efficacy of multipurpose and hydrogen peroxide solutions with regard to cleaning and disinfection, and addresses solution reactions and other noninfectious complications associated with contact lenses.

The key functions of a contact lens care solution are to clean the lens by removing proteins and lipids deposited by the tear film, to disinfect the lens, and to make wearing the lens as comfortable as possible. All 3 functions are closely interrelated in that a cleaner lens is likely to be more comfortable and less likely to be contaminated with microbes. In this context, it is easy to understand how essential proper lens cleaning and disinfection are to patient comfort, which is a major determinant of satisfaction and continued lens use. As revealed in a cross-sectional survey of 730 current and previous contact lens wearers, dry eyes and lens discomfort were the most common reasons for dissatisfaction and discontinuation, followed by preference for a different modality, problems with the modality, and inadequate vision correction.

Before addressing the efficacy of lens care solutions with regard to cleaning, disinfection, and comfort, it would be helpful to examine the role of the tear film in deposition, the stability of the tear film, and the effects of lens care solutions on the tear film and the lens itself.

THE TEAR FILM

PROTEIN DEPOSITION

The tear film contains numerous proteins (eg, lysozyme, lactoferrin, lipocalin, albumin, transferrin, and immunoglobulins) that have several biologic effects on the surface of the eye, including host-defense and antimicrobial function. When these proteins are deposited on contact lenses, they may become denatured, which would increase the eye’s susceptibility to infection. Moreover, protein deposition might alter the wettability of the lens surface, which reduces tear film stability and coverage over the lens surface, increases osmolality, decreases comfort, and can ultimately lead to increased expression of inflammatory-mediator proteins that are associated with dry eye and ocular surface disease.

Deposition of proteins, lipids, and inorganic materials is also influenced by the characteristics of the constituent materials of contact lenses. For protein deposition specifically, it is generally accepted that US Food and Drug Administration group I lens materials have the least amount of protein deposits (10–20 µg/lens) whereas group IV materials have the most (up to 1000 µg/lens). In general, ionic, high water content...
materials attract more protein than nonionic materials. The total amount of protein identified in silicone hydrogel lens materials appears to be approximately 10 µg/lens, but again, may vary by specific material.

** Tear Film Stability **

When applied to the eye, a contact lens divides the tear film into 2 layers: the prelens tear film and the postlens tear film. A stable tear film depends on the surface of the contact lens and its physical interactions with both tear film layers. A stable tear film is thought to be necessary for comfortable contact lens wear.

If the structure of the prelens tear film is altered by the presence of a contact lens, it will evaporate, resulting in dehydration of the hydrogel lens and discomfort. The postlens tear film, by comparison, is thought to enhance comfort by cushioning and lubricating the lens on the conjunctival and corneal epithelium.

A randomized study was conducted to determine the impact of compositional differences in 2 multipurpose solutions on the tear film during contact lens wear. Thirty-one subjects without dry eye symptoms were included, and the study showed that the solution containing the lubricant hydroxypropyl methylcellulose (HPMC) was associated with a thicker prelens tear film than the solution that did not contain HPMC. There were no differences between the solutions with regard to the thickness of the postlens tear film. However, the latter solution, which contains surfactants targeted at improving the surface wettability of lenses, was associated with less tear film thinning (ie, evaporation).

** Multipurpose Solutions **

To emphasize the importance of compliance with lens care regimens, optometrists and other eye care professionals should tell their patients that they are prescribing—not merely recommending—a suitable lens care regimen. This should be followed by explicit instructions on proper use of the regimen.

** Cleaning Efficacy **

Multipurpose solutions, which provide 1-step cleaning and disinfection, are effective for the vast majority of patients who wear soft contact lenses. In general, these solutions vary in physical properties, such as osmolality, viscosity, pH, and surface tension. They also vary in their ability to remove deposits in accordance with the composition of the lens materials and the quantity of tear film components they attract.

For example, an analysis of tear film proteins removed from 2 brands of silicone hydrogel lenses (Acuvue Advance [Vistakon, Jacksonville, FL] and O2Optix [CIBA Vision, Inc, Duluth, GA]) using 4 different multipurpose solutions (OPTI-FREE Express [Alcon Laboratories, Inc, Fort Worth, TX]; ReNu with MoistureLoc [Bausch and Lomb, Rochester, NY]; Complete Moisture PLUS [Advanced Medical Optics, Inc, Santa Ana, CA]; and AQuify [CIBA Vision, Inc, Duluth, GA]) found that more than twice as much protein was removed from each O2Optix lens than from each Acuvue Advance lens by the care solutions. This finding may be related to the different tear protein-binding affinities of the lens polymers.

A similar analysis of protein deposition on the same silicone hydrogel lens brands cleaned by AQuify and ReNu with MoistureLoc found similar amounts of protein deposition and a similar deposition proteome across both lens brands regardless of which solution was used.

The idea that a cleaner lens is a more comfortable lens is borne out by a randomized, concurrently controlled trial comparing 2 multipurpose solutions in 362 group IV lens wearers with ocular symptoms. Subjects were fitted with a new pair of group IV lenses and randomly assigned to OPTI-FREE RepleniSH (Alcon Laboratories, Inc, Fort Worth, TX) or ReNu MultiPlus No Rub Formula (Bausch and Lomb, Rochester, NY) for 4 weeks. All subjects recorded comfort and ocular symptoms at days 0, 14, and 28. Lens deposits were significantly lower in subjects using OPTI-FREE RepleniSH, with mean scores for comfort and dryness significantly better at day 28, mean scores for scratchiness and burning significantly lower at day 14, and average lens wearing time significantly longer at day 14.

** Antimicrobial Efficacy **

Multipurpose solutions are formulated to provide adequate disinfection. However, outbreaks of *Fusarium* and *Acanthamoeba* keratitis in wearers of soft contact lenses using certain multipurpose solutions have raised some concerns about the antimicrobial efficacy of some of these solutions. Although the outbreaks were associat-
ed with the use of specific solutions, other factors, such as noncompliance (eg, solution reuse) and showering while wearing contact lenses, cannot be overlooked as contributors to increased risk for microbial keratitis.8,9

HYDROGEN PEROXIDE REGIMENS

Hydrogen peroxide-based solutions generally provide disinfection only (with the exception of 1 solution—ClearCare [CIBA Vision, Inc, Duluth, GA]); a separate cleaning solution must be used first to remove protein and lipid deposits from the lens. During disinfection with hydrogen peroxide, the solution must be neutralized before the lens can be reapplied to the eye. The time required for neutralization varies from solution to solution, but can be as quick as 5 minutes and up to 30 minutes. The concern with this is that times at the lower end of the range may not be long enough to provide adequate disinfection. Other than disinfection, there is really little to no scientific evidence that peroxide cleans lenses by removing protein and lipid deposits. A peroxide-based lens care system is still a good option for patients who have a hypersensitivity reaction to any chemical ingredients associated with a multipurpose solution.

NONINFECTIONOUS COMPLICATIONS

Frequent complications of contact lens wear are associated with improper lens care and solution uses, as well as with lens spoilage.8,9 Complications can include solution toxicity,8,9 hypersensitivity,8 general inflammation, staining of the bulbar conjunctiva,10 and corneal staining.11 However, some evidence suggests that there is not a difference in corneal staining when comparing chemical and hydrogen peroxide-based care systems.11

Solution reactions may present with fine corneal staining (with or without infiltrates), conjunctival injection, and/or edema.10 If a solution reaction is suspected, lens use should be discontinued until the reaction is reversed. A different care regimen or a switch to daily disposable lenses can then be initiated.

CONCLUSIONS

The key functions of lens care solutions are to clean and disinfect lenses so that they are comfortable to wear and free of deposits and microbes. The effects of these solutions on the tear film and the lens itself are important with regard to these key functions.

Multipurpose solutions, which provide 1-step cleaning and disinfection, are effective for the vast majority of patients who wear soft contact lenses. Hydrogen peroxide solutions generally provide disinfection only and often, a separate cleaning agent must be used first; the solutions must be neutralized before the lenses can be reapplied to the eye.

The most frequent complications of contact lens wear are noninfectious and often associated with lens care and solution noncompliance, as well as with lens spoilage. Complications include solution toxicity, hypersensitivity to solution ingredients, and corneal staining, which often results from poor compliance with the lens care regimen.

Educating patients about proper wear and care of contact lenses is essential in improving compliance with lens care regimens and should reduce the risk of noninfectious and infectious complications.

REFERENCES