



The Science of Peroxide for Contact Lens Disinfection

Panelists discuss the evidence that supports their clinical experiences.

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PANELISTS:

Arthur B. Epstein, OD, FAAO, moderator

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Christine W. Sindt, OD, FAAO

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Arthur B. Epstein, OD, FAAO, moderator

Dr. Epstein is a founding partner of North Shore Contact Lens & Vision Consultants, Roslyn, NY. He is cofounder of Phoenix Eye Care in Arizona, where he heads the Dry Eye – Ocular Surface Disease Center and serves as director of clinical research. He is an adjunct clinical associate professor at Midwestern University, Arizona College of Optometry Eye Institute. Dr. Epstein is a consultant/advisor to Alcon, NiCox, Tear Science and Valeant Pharmaceuticals. He has received research support from Alcon. He is a lecturer for Alcon and VSP.



Christopher W. Lievens, OD, MS, FAAO

Dr. Lievens is an associate professor and chief of primary care at Southern College of Optometry, Memphis, Tenn. Dr. Lievens has received research funding from Alcon, Allergan, Eyegate and Merck. He has received lecture honoraria from Alcon, Transitions and Zeiss.



Loretta B. Szczotka-Flynn, OD, PhD, FAAO (Dipl)

Dr. Szczotka-Flynn is Professor, Departments of Ophthalmology & Visual Sciences and Epidemiology & Biostatistics at Case Western Reserve University, Cleveland, Ohio and Senior Optometrist at University Hospitals Case Medical Center Eye Institute in Cleveland. She has received research support from Alcon, CooperVision and Vistakon.



Mile Brujic, OD

Dr. Brujic is a partner in a four-location practice in northwest Ohio. He practices full-scope optometry with special interests in contact lenses and ocular disease management of the anterior segment and glaucoma. Dr. Brujic has been an advisor to Alcon, Allergan, Eyemaginations, NiCox, Transitions, TelScreen, VMaxVision and Vistakon. He has received research support from Alcon and VMaxVision. He has lectured for Allergan and Bausch + Lomb.



Christine W. Sindt, OD, FAAO

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The Science of Peroxide for Contact Lens Disinfection

Panelists discuss the evidence that supports their clinical experiences.

Arthur B. Epstein, OD, FAAO: Remarkably, hydrogen peroxide has been in continuous use for contact lens disinfection for nearly three decades. Our discussion today focuses on why peroxide has been so successful for so long, how it works and when it's the best choice for our patients. Specifically, we'll be focusing on Clear Care Cleaning and Disinfecting Solution (Alcon), which is the No. 1 most recommended hydrogen peroxide product and the gold standard in the category. Let's begin with a simple question: How does hydrogen peroxide work?

// We're surrounded by peroxide. It's in the food we eat, the water we drink and the air we breathe. It's an important and common byproduct of metabolism. The human body is accustomed to it and has mechanisms for handling it. //

Christine W. Sindt, OD, FAAO

Christine W. Sindt, OD, FAAO: We tend to think of hydrogen peroxide as a benign chemical compound, because it breaks down into water and oxygen, but it's a potent disinfectant. It produces hydroxyl free-radicals that attack the lipid membrane, as well as the DNA, the mitochondria and other cell components.¹ Even though these hydroxyl free-radicals exist only a short time, they're highly reactive, and because hydrogen peroxide is lipid-soluble, it can easily penetrate a cell and release its cascade of destruction inside.^{2,3} Peroxide is active against amoebae, protozoa, viruses, bacteria and fungi, but its efficacy depends on contact time and concentration, and some organisms have built up resistance to peroxide because it's so common in our environment.^{4,6}

We're surrounded by peroxide. It's in the food we eat, the water we drink and the air we breathe. It's an important and common byproduct of metabolism. The

human body is accustomed to it and has mechanisms for handling it, such as the antioxidant enzyme catalase, which catalyzes the decomposition of hydrogen peroxide. This is an important mechanism for contact lens disinfection with hydrogen peroxide.

William D. Townsend, OD, FAAO: That was a wonderful explanation of why peroxide is so effective as a disinfectant.

Dr. Epstein: Great! Let's switch focus to how we use hydrogen peroxide for disinfecting contact lenses.

Christopher W. Lievens, OD, MS: Research has shown that 3 percent hydrogen peroxide effectively disinfects the microbes, bacteria and a broad variety of other pathogens that adhere to a contact lens during a wearing cycle.^{4,7-8} The challenge was to develop a lens disinfecting system in which the peroxide would be neutralized in a reasonable period, so that patients could apply their lenses the next day without risking adverse effects. Fortunately, industry found a way to combine disinfection efficacy with rapid neutralization. As a result, we have many healthy and satisfied patients who do well with peroxide disinfection.

Dr. Epstein: Well by far. Clear Care solution has been the market leader for years. It combines a surfactant cleaner and functional wetting agent (Pluronic 17R4) with peroxide in a single bottle, which makes it easier for patients and, in my opinion, provides enhanced disinfection. It has a 6-hour neutralization period and disinfected lenses can be stored for up to 7 days. I should add that it's been cleared by FDA for use with silicone hydrogel lenses. Another important benefit for those of us who

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Christopher W. Lievens, OD, MS, FAAO

fit GPs — and especially for piggyback lenses — is that with the addition of a digital rubbing step, it's approved for use with GP lenses.

So I think we've covered why and how peroxide disinfection works. I've always believed that science provides a foundation for clinical practice. Let's explore some of the current and more interesting research related to hydrogen peroxide disinfection of contact lenses.

BIOFILMS

Dr. Epstein: The first and probably the hottest topic I want to explore are biofilms and peroxide disinfection. I'm excited that we have Dr. Szczotka-Flynn with us today. She is an acknowledged and respected expert in this area. Dr. Szczotka-Flynn, we know that some microorganisms become functionally more virulent and resistant to disinfection by producing protective biofilms. We recognize this as a significant challenge for disinfection systems. Can you tell us how well peroxide works in the presence of microbial biofilms?

Loretta B. Szczotka-Flynn, OD, PhD, FAAO (Dipl): My colleagues and I have worked with fungal and bacterial biofilms using clinical isolates from contact lens inflammatory conditions.⁹ We found that all of the clinical and reference strains of *Pseudomonas aeruginosa*, *Serratia marcescens* and *Staphylococcus aureus* formed biofilms on contact lenses. Although there is no standard testing for biofilms, we developed a model to help evaluate disinfection activity on these biofilms. In our model, of the solutions tested (five MPS and one peroxide system), only Clear Care solution showed activity against all three strains. In our model, none of the polyhexamethylene biguanide (PHMB)-preserved systems showed activity against biofilms. In the same model, we also found that only peroxide systems were effective against fungal biofilms of *Fusarium oxysporum* and *Fusarium solani* on the three lens types we tested.¹⁰

These results differ from those of planktonic experiments performed on free-floating organisms.¹⁰ When we look at planktonic organisms, we see that most disinfect-

Private-label Peroxide Systems: Know the Differences

Dr. Epstein: One of my pet peeves are generic or store brand lens care products. Patients think they're getting a bargain, but often find that they're getting even less than they paid for. As a doctor, it is important that patients use the products I recommend. Generic hydrogen peroxide contact lens systems have started to appear on store shelves and while some of us may be in denial about how many of our patients are choosing generics, the numbers don't lie. What are your concerns regarding these generic products?

Dr. Sindt: As we know, there are differences in products and "inactive" ingredients may change how they work. One important difference between Clear Care Cleaning and Disinfecting Solution and the generic peroxides is the addition of Pluronic 17R4 to Clear Care solution. This surfactant cleaner has a detergent-like action that reduces surface tension to help remove contaminants and improve surface wettability.

Dr. Epstein: That's an important point. Knowing what differentiates these products is becoming increasingly critical. Beyond the formulation, synergy between individual components can make a huge difference. In this case, the whole can be greater than the sum of the elements. I think this is another reason that explains why Clear Care solution has been dominant for so long.

The point that Dr. Sindt made is that there are significant formulation differences between apparently similar products and we're dealing with the eyes, which have some of the most sensitive and fragile tissues in the body. Clear Care solution wasn't created by accident. It was carefully and scientifically formulated

and is broadly recognized as the gold standard. We shouldn't forget that and we should make sure our patients know this.

Another concern — one that I wrote a paper about decades ago — is residual peroxide levels. There is a possibility that some generic products may have higher levels of residual peroxide. Any thoughts on this issue?

Dr. Sindt: Our bodies have a way of dealing with residual peroxide, although some people deal with it better than others. Someone with eye dryness, for example, may not handle it as well as someone who has a thick, robust tear film. Obviously, if we can make the residual peroxide as low as possible, we're more likely to have comfortable, happy eyes in the greatest number of our patients.

Dr. Epstein: Ideally, we want 0 percent residual peroxide, which may not always be possible, but the less we have, the better it is for patients. Clear Care solution has less than 20 ppm residual peroxide (in vitro, measurement at 50 cycles).¹¹ That needs to be communicated to patients to help understand the importance of being compliant.

The key for practitioners is not to assume that our patients are using Clear Care solution or any product as we recommend. We need to consistently reinforce what we're recommending and make sure patients understand that we don't want them using other products.

As a clinician, I know what I'm recommending, and I want to know what my patient is using. With private-label products, that becomes increasingly difficult.

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tants perform well, but when we look at the resistant biofilms, we start to see clear differences. In the biofilm phase, organisms encapsulate themselves as protection from the environment, making their eradication more difficult because of both physical and genetic differences that make them more resistant to the host responses and disinfection products.

Dr. Epstein: That is groundbreaking research. It also draws attention to the fact that our disinfection standards are based on laboratory testing using only planktonic bacteria, while in reality, we deal with biofilm-forming organisms more often in practice. Currently, standards organizations are looking at testing which is more reflective of what we see in the clinical environment, but until then, it's important to recognize these differences.

CORNEAL INFILTRATES

Dr. Epstein: Let's turn to the topic of corneal infiltrates — another hot topic today. Are they clinically significant? Are they related to lens care solutions?

Dr. Szczotka-Flynn: Corneal infiltrates are a major concern in extended wear. We've long recognized that. With daily wear, we're more likely to see asymptomatic infiltrates at a low and manageable level, usually in hypersensitive

patients. Hydrogen peroxide lens disinfection or daily disposable contact lenses are good options for these patients, although infiltrates can still occur in both of these modalities.

Chalmers and colleagues¹² published a large-scale retrospective study involving thousands of lens wearers, and peroxide had a lower rate of infiltrative responses than the multipurpose solutions as a group.

Peroxide is not immune to infiltrates, but when infiltrates do occur, they're usually caused by bacterial contamination from the patient's eyelid margins.¹³ These factors can't be avoided, regardless of the lens care product being used.

Dr. Epstein: I suspect that some of us have become hyper-focused on care solutions as the source of infil-

// An Australian study ... reported that burning and stinging were linked to increased staining. Subjects with staining had poorer comfort scores during the day and at the end of the day. They also found overall dryness and dryness at the end of the day, which we associate with staining. All these findings point to a definite association between solution-related staining and discomfort. //

William D. Townsend, OD, FAAO

trates. In my experience, the vast majority of sterile corneal infiltrates in lens wearers are from *Staphylococcus exotoxin* either from normal flora or, more typically, due to staph overpopulation associated with MGD or blepharitis, conditions frequently overlooked in contact lens patients. It's the body doing what it's supposed to do, responding to foreign proteins by mobilizing inflammatory cells to defend against a perceived attack. If you have a patient with a history of infiltrates and you're concerned about recurrence, consider that peroxide has been associated with the lowest rate of infiltrates.

Dr. Lievens: After being asked about solution-induced infiltrative response several times over the past couple of years, I queried our electronic health records at the Southern College of Optometry and pulled every infiltrate case that arose. In reviewing the histories, I could not link the infiltrate as being related to a specific lens care solution. I have not seen solution-related infiltrates. I agree with Dr. Epstein and believe they are predominantly lid-disease induced or a result of contact lens overwear and/or noncompliance.

CORNEAL STAINING

Dr. Epstein: Although the relevance of corneal staining has been questioned, I feel it's an important issue for

// I've found that peroxide produces the lowest levels of staining of any of the lens care solutions that I recommend. //

Arthur B. Epstein, OD, FAAO

our patients — too important to sweep under the rug. What experiences has the panel had with peroxide disinfection and corneal staining?

Dr. Sindt: Corneal staining can occur in any patient who wears contact lenses. I'm currently conducting research using confocal microscopy to study the relationship between the level of corneal staining and the

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Loretta B. Szczotka-Flynn, OD, PhD, FAAO (Dipl)

amount of dendritic cell infiltration into the tissue. We’re seeing that corneal staining is driving inflammatory cells on a subclinical level, if not on a clinical

level. Do we see corneal staining in patients who use hydrogen peroxide? Yes, we do, but I believe it may be more lens-dependent and in my experience, it’s usually slight and not clinically relevant.

Dr. Epstein: I’ve found that peroxide produces the lowest levels of staining of any of the lens care solutions that I recommend. Dr. Brujic, what’s been your experience?

Mile Brujic, OD: I find very low levels of corneal staining with Clear Care solution, along with a high level of efficacy.

Dr. Lievens: I agree. In fact, during the past 2 years, I’ve made it a habit to look specifically for evidence of staining of the cornea and conjunctiva before I instill fluorescein. Significant keratitis or conjunctival disturbance is often visible, and the fluorescein simply confirms what was observed on the naked ocular surface. I absolutely agree that across all brands of lenses, I see the lowest levels of staining with hydrogen peroxide systems in general.

Dr. Epstein: It’s also important to remember that not all MPS solutions are the same when it comes to staining and we need to be clear about the differences. Polyquad and Aldox are associated with low levels of staining similar to peroxide; the PHMB-based solutions are generally associated with higher levels of staining.

It’s also important to note that staining isn’t just staining alone. It also represents inflammation, and staining can influence comfort. Any thoughts on this, Dr. Townsend?

Dr. Townsend: Many of us knew that association intimately, but we now have evidence that staining may be linked to discomfort. An Australian study by Diec and colleagues¹⁴ at the Brien Holden Institute looked at the relationship between contact lens solution-associated corneal staining. They reported that burning and stinging were linked to increased staining. Subjects with staining had poorer comfort scores during the day and at the end of the day. They also found overall dryness and dryness at the end of the day, which we associate with staining. All these findings point to a definite association between solution-related staining and discomfort.

Dr. Brujic: I want to add another thought. Patients

who experience discomfort, whether from allergies or hypersensitivities, often benefit from using Clear Care solution. I’ve found that many patients who dropped out can return to comfortable contact lens wear when they use Clear Care solution. That has to do with everything we’ve been discussing — corneal and conjunctival staining, clean lenses and a high level of disinfection. **CLS**

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