AN ANALYSIS OF THE NEUTRALIZATION OF "BROWN BOTTLE" HYDROGEN PEROXIDE

by

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CHAPTER 2

METHODS

Thirty-six contact lens neutralization cases from each of three popular one step H2O2 care systems underwent the neutralization process with "brown bottle" H2O2 instead of the corresponding solution. Once the neutralization process had begun, samples were taken at ten-minute intervals over the first hour and once every following hour. Four unaltered samples of un-neutralized H2O2 was analyzed for each bottle opened. For each sample, an assay was prepared and then titrated with potassium permanganate. Endpoints were determined by comparing against a pre-made distilled water blank. The concentration of H2O2 was then calculated from the volume of permanganate solution used during the titration process. Altogether, 112 samples across three different case designs were used in the analysis. Due to known delays in neutralization with new platinum catalyst disks, investigators used cases that had previously undergone one full 8-hour cycle of neutralization[2].

Figure 1: Left: B + L Peroxiclear™ Case; Middle: Sauflon One Step Case; Right: Alcon® Clear Care® Case

With the knowledge gained from the aforementioned study, investigators explored how the use of "brown bottle" H2O2 instead of the appropriate solution affected the same variables. In other words, does neutralization rate and total hydrogen peroxide exposure differ when "brown bottle" hydrogen peroxide is substituted for the appropriate corresponding solution? Does it differ amongst various case designs? To the author(s) knowledge, this is the first independent study comparing the H2O2 neutralization process in this manner.

ABSTRACT

Background: Hydrogen peroxide (H2O2) care systems have been proven safe and effective when used per the manufacturer's directions. However, at times patients and some practitioners will use 3% hydrogen peroxide solution, or "brown bottle" hydrogen peroxide, instead of the appropriate solution and corresponding case combination. Therefore, it is important to understand how "brown bottle" H2O2 differs from approved systems in terms of contact lens care. *Methods:* 36 contact lens neutralization cases from each of three popular one step H2O2 care systems underwent the neutralization process with "brown bottle" hydrogen peroxide. Once the neutralization process had begun, samples were taken at ten-minute intervals over the first hour and once every following hour. Four unaltered samples of un-neutralized H2O2 were analyzed for each bottle opened. For each sample, an assay was prepared and then titrated with potassium permanganate to determine H2O2 concentration. Due to known delays in neutralization with new platinum catalyst disks, investigators used cases that had previously undergone one full 8-hour cycle of neutralization. *Results*: All three case and "brown bottle" combinations exhibited faster neutralization rates ($p < .005$). Within the first 10 minutes, there was a rapid 88-94% decrease in H2O2 concentration for all three case and "brown bottle" H2O2 combinations. Thereafter, the samples exhibited a steady decrease in hydrogen peroxide concentration. All samples reached less than

100ppm by the third hour of neutralization. Total hydrogen peroxide exposure was decreased when the corresponding solution was substituted with "brown bottle" H2O2 ($p<.005$). *Conclusion*: Substituting "brown bottle" H2O2 for the appropriate corresponding solution results in statistically significant differences in both neutralization rates and hydrogen peroxide exposure over time. For all three case and "brown bottle" H2O2 combinations, the H2O2 concentration was at a "safe" and "comfortable" level (<100 ppm) for contact lens insertion by three hours.

ACKNOWLEDGMENTS

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CHAPTER 1

INTRODUCTION

Hydrogen peroxide (H2O2) care systems have been proven safe and effective when used per the manufacturers' directions. However, at times, patients will use 3% hydrogen peroxide solution, or "brown bottle" hydrogen peroxide, instead of the appropriate solution and corresponding case combination. Sometimes this decision is patient-driven due to reasons such as perceived cost-savings or convenience. Other times, practitioners have been known to instruct patients to use "brown bottle" solution. This may be suggested, for example, when disinfecting large-diameter scleral lenses. Regardless of the reason for its use, it is important to understand how substituting "brown bottle" H2O2 for the appropriate solution affects lens care and the patient experience.

A 2014 study by Dinardo & Andrews compared three popular hydrogen peroxide care systems in the United States. The investigators determined that case design and solution ingredients play a role in the neutralization process. B +L PeroxiClear™ exhibited a slower rate of neutralization over the first four hours versus Alcon® Clear Care® and Sauflon One Step (commonly marketed as a private label care system). Therefore, of the three care systems, total hydrogen peroxide exposure is greater with B+L PeroxiClear™ ($p < .0001$)[1].

CHAPTER 3

RESULTS

All three case and "brown bottle" combinations exhibited faster neutralization rates ($p < .005$). Within the first 10 minutes, there was a rapid 88-94% decrease in H_2O_2 concentration for all three case and "brown bottle" H_2O_2 combinations. Thereafter, the samples exhibited a steady decrease in hydrogen peroxide concentration. All samples reached less than 100ppm by the third hour of neutralization. Total hydrogen peroxide exposure was decreased when the corresponding solution was substituted with "brown bottle" H_2O_2 ($p<.005$).

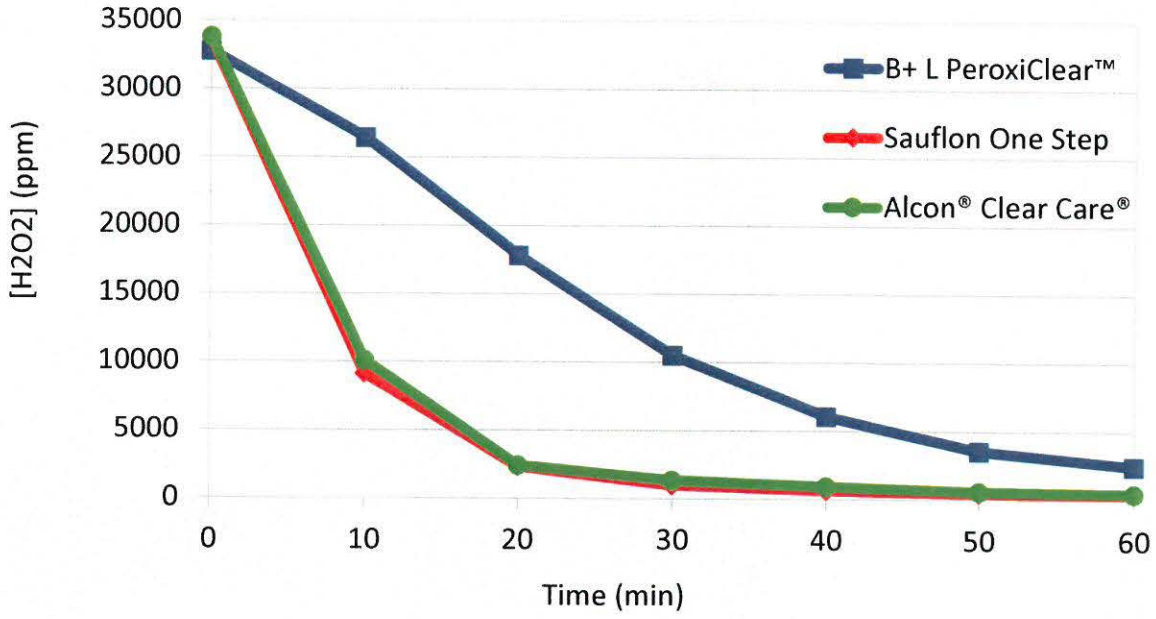

Fig 2. First Hour of Neutralization with Care System[1]

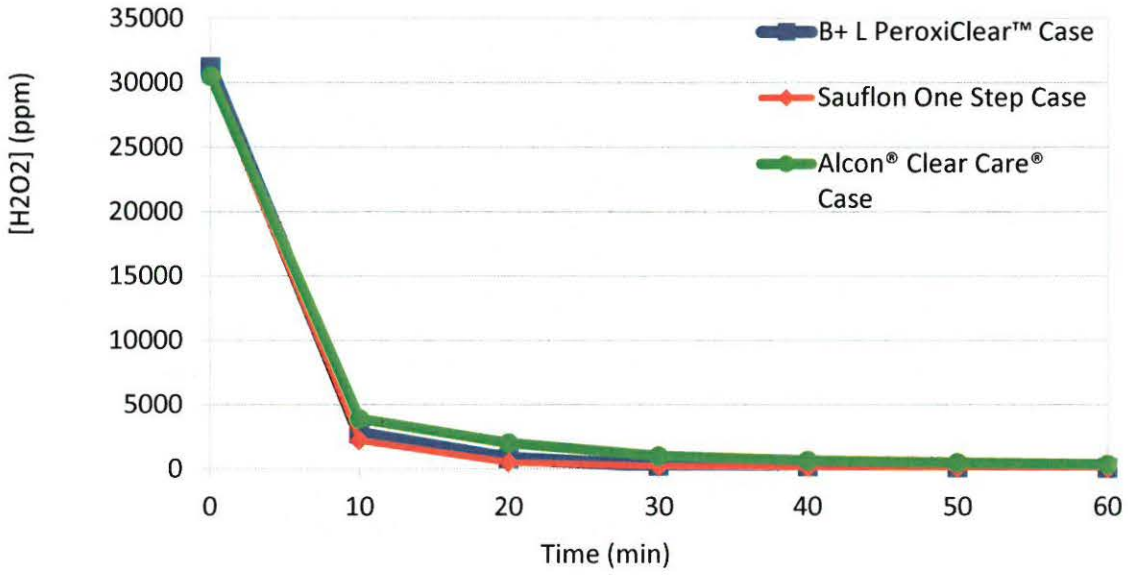

Fig 3. First Hour of Neutralization with "Brown Bottle" H2O2 + Case

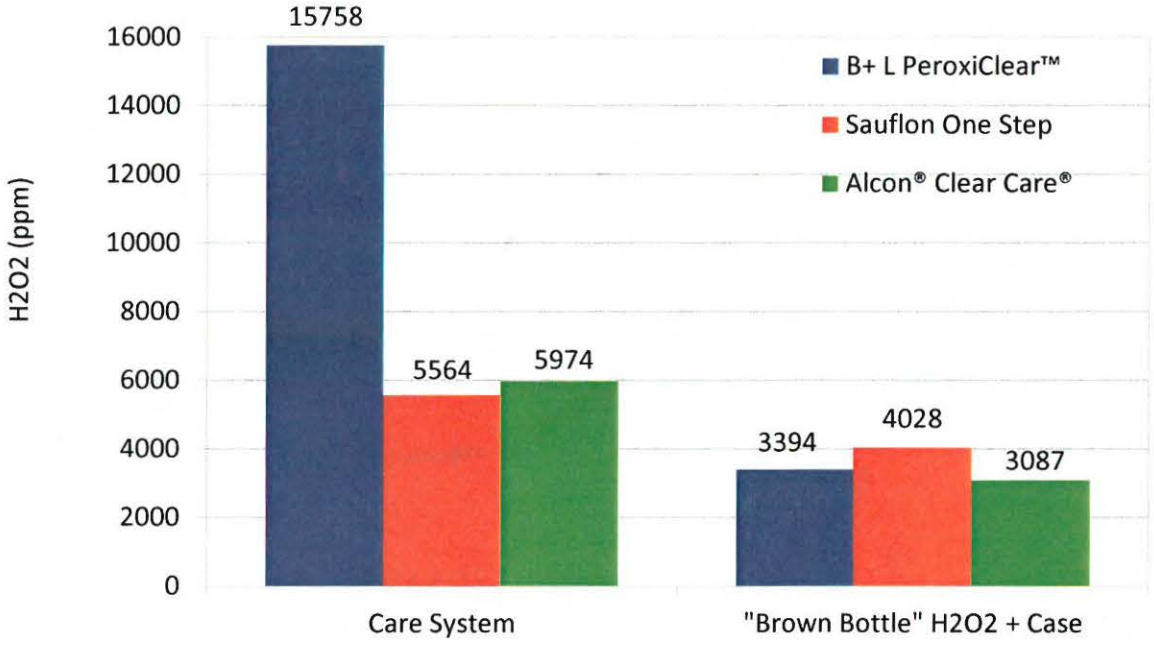

Fig 4. H2O2 Exposure (Total Area Under the Curve)

CHAPTER 4

DISCUSSION

In conclusion, it was determined that substituting "brown bottle" H2O2 for the appropriate corresponding solution results in statistically significant differences in both neutralization rates (Fig 2. vs Fig 3.) and hydrogen peroxide exposure over time (Fig 3.). It is unclear yet how this affects clinical care. The authors did not explicitly test other variables such as anti-microbial efficacy. One might infer that increased H2O2 exposure would lead to increased anti-microbial efficacy, but to the authors' knowledge, this has not been determined under these specific conditions. There have been claims that 15 minutes of liquid exposure to 3% H2O2 solution is enough to kill a wide variety of microorganisms and inactive HIV, but there is no specific data relating an exposure threshold to proper disinfection of contact lens materials.[3]

Neutralization rates, and ultimately, hydrogen peroxide exposure varied amongst the three cases when paired with "brown bottle" H2O2 instead of the appropriate solution (Fig 3. and 4.). Even if statistically significant, it is unclear whether it has any clinical significance, particularly as the samples exhibit very low hydrogen peroxide concentrations after the first 60 minutes of the neutralization process. Therefore, when paired with "brown bottle" H2O2, it is unclear if one case design is superior to the others.

For all three case and "brown bottle" H2O2 combinations, the H2O2 concentration was at a "safe" and "comfortable" level (<100 ppm) for contact lens insertion by three hours. This is a level that is known to exhibit minimal damage to the ocular surface and is below the ocular awareness threshold[4-5]. Therefore, patients could insert their lenses after three hours without noticing symptoms or exhibiting ocular damage. However, "brown bottle" H2O2 solution does not contain the proprietary components designed to improve comfort with contact lens use. Also, it is uncertain what additives exist in "brown bottle" solution that might contribute to discomfort or ocular damage.

In recent studies, it has been demonstrated that hydrogen peroxide-based contact lens solutions that contain surfactants have shown better removal of lipids from contact lens materials than similar solutions without surfractants.[6] Therefore, it could be reasoned that the removal of lipids correlates with the removal of biofilm produced by various bacteria. With the removal of biofilm, the potential for disinfection could be amplified. Further understanding of what is contained not only in "brown bottle" solution but generic and branded solutions could give further insight into the disinfecting potential of various peroxide-based solutions. This is also demonstrated by the largest exposure to H2O2 being offered by B+L PeroxiClear™ when paired with its appropriate solution (Fig 2.). This significant exposure was not mirrored in the "brown bottle" trials (Fig 3.), inferring that the components of B+L PeroxiClear™ solution play a larger role in delaying initial peroxide neutralization rather than the case design and catalyst.

When "brown bottle" H2O2 is used, the highest concentration of H2O2 exists within the first few minutes of neutralization. There is a dramatic drop in H2O2 concentration between zero and 10 minutes. In order to achieve maximal H2O2 exposure, patients must expose their contact lenses to the hydrogen peroxide as early in the neutralization process as possible. In other words, if patients begin the neutralization process prematurely, their lenses may not be exposed to optimal levels of hydrogen peroxide.

While the goal of this study focused on the formula of peroxide used, various other environmental factors should be considered when talking about peroxide solutions in a clinical setting. Variables of interest include storage temperature, the orientation of the neutralization container, and patients who attempt to "top off" their solutions prior to use. While it can be assumed that most clinicians are conservative with their approach to peroxide-based system patient education, it's worth investigating how certain variables affect the neutralization process and ultimately contact lens safety. Looking forward, it is worth echoing that little has been quantified in regards to hydrogen peroxide exposure and contact lens disinfection. Therefore, it's best to take a conservative approach when deviating, if at all, from traditional contact lens cleaning practices.

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