

THE BEST PRACTICES FOR CONTACT LENS CASE CARE

by

Carissa Rae Trontvet

Has been approved

1 May, 2008 2015

APPROVED:



Faculty Advisor:

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Best Practices for Contact Lens Case Hygiene

I, Carissa Trontvet, hereby release this Paper as described above to Ferris State University with the understanding that it will be accessible to the general public. This release is required under the provisions of the Federal Privacy Act.

  
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Carissa Rae Trontvet

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## ABSTRACT

*Background:* Contact lens storage cases are a potential reservoir for microorganisms. Contamination of these lens cases can compromise contact lens wear and may result in a severe ocular infection. Many of the recommended hygiene practices do not necessarily ensure a case free of contamination and multipurpose solutions may not be effective against biofilm formation. Therefore, additional cleaning steps may be necessary. Only limited information is available to patients about case hygiene practices, and the advice given to patients varies from manufacturers and eye care practitioners because of the lack of evidence-based findings on the effectiveness of these guidelines. The purpose of this literature review is to compile evidence based research to determine the best practices for contact lens case hygiene. *Methods:* The Ferris State University FLITE Library online database was used to assimilate information. Only peer reviewed journal articles were reviewed that were published within the past five years. *Results:* A recent study conducted by Vijay et al. found that the most widely used case hygiene regimen of rinsing with solution and air drying is not sufficient to remove biofilm of commonly recovered storage case bacterial contaminants.<sup>6</sup> Adding the additional steps of rubbing then wiping the contact lens case with clean facial tissue along with the current recommendations was most effective in removing the biofilm.<sup>6</sup> A study by Wu et al. showed that lens cases that were positioned face up while air-drying had a significantly higher rate of contamination (71%) compared with lens cases air-dried face down (12%).<sup>7</sup> *Conclusions:* The clinical relevance of this project is based upon the needs of patients. Poor understanding about best practices for case hygiene and differing opinions from manufacturers and eye care practitioners has led to poor patient compliance. If all entities can agree on the best recommendations to give patients about lens case cleaning techniques, there may be an increase in patient compliance and a decrease in case-related ocular complications.

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## Introduction

Contact lenses are an effective modality for vision correction although a large number of complications are associated with their use. Aside from daily disposable and continuous wear contact lenses, other types of lens modalities require the use of contact lens storage cases in which contact lenses are disinfected and stored overnight.<sup>1</sup> However, if the contact lens storage case itself is not cleaned properly, it can become contaminated with various microorganisms and can become a medium for direct ocular transmission of these microbes.<sup>1</sup> Contact lens case contamination is frequent in the contact lens-wearing population and the lens case is often the most contaminated lens accessory item.<sup>1</sup> In multiple studies, more than half of all lens cases were contaminated, with many documenting contamination rates as high as 81%.<sup>2</sup> Pathogenic bacteria isolated from contact lens cases include *Serratia marcescens*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, fungi, and *Acanthamoeba*. In studies that cultured for *Acanthamoeba*, the frequency of isolation was about 8%.<sup>2</sup> An epidemiologic study by Stapleton et al. has confirmed that poor lens case hygiene is strongly associated with contact lens-related corneal infections and other complications such as bacterial keratitis and corneal infiltrative events.<sup>1</sup> Lens case contamination has been identified as a major risk factor for keratitis, with up to a fourfold increase in the risk for microbial keratitis among contact lens wearers if the lens care system is handled inappropriately. Current recommended hygiene practices do not necessarily ensure a lens case free of contamination. Assessing the lens storage case for contamination may provide insight into organisms that can penetrate into the contact lens and ultimately onto the cornea surface.<sup>2</sup>

Although lens contamination is almost exclusively bacterial, contact lens case contamination usually involves mixed contaminants of bacteria, fungi and protozoa.<sup>2</sup> Biofilm

formation and inherent microbial resistance may be associated with persistent microbial contamination of contact lens storage cases.<sup>1</sup> Bacterial biofilm can be defined as a structured community of bacterial cells enclosed in a self-produced polymeric matrix which adheres to a surface.<sup>3</sup> In response to a low nutrient environment, microorganisms in the sessile form are embedded in a glycocalyx which is a polysaccharide-containing matrix produced by bacteria.<sup>3</sup> The colonizing bacteria first adhere to a surface by weak, reversible bonds.<sup>3</sup> The bacteria then facilitate attachment of other pathogens by using cell adhesion protein molecules on their surfaces, and they begin to produce matrix that holds the biofilm together.<sup>3</sup> Biofilms can initially be easily removed because of the loose attachment of cells, however this adhesion between the microbial cells and the contact lens case can become more persistent with time.<sup>3</sup>

Biofilm is a common culprit in the failure of care solutions to be effective against case contamination.<sup>2</sup> The formation of biofilm on contact lens accessories is largely resistant to the biocide properties of lens care products.<sup>2</sup> It is the cell surface attachment to the lens case in the early stages of biofilm formation that largely contributes to the resistance of care system disinfectants.<sup>2</sup> After glycocalyx forms and the cells persist in the hostile environment, the mature biofilm provides a seed of inoculum for continued biofilm growth. Lens care systems have varying efficacies against biofilm and the ability of the organism to transfer from the case to the lens. Current multipurpose disinfecting solutions may not be effective against biofilm formation, so additional cleaning steps in addition to these solutions are necessary with lens case hygiene practices.<sup>1</sup>

The United States Food and Drug Administration (U.S. FDA) advises patients of the following for their contact lens case hygiene practices:<sup>4</sup>

- Always wash your hands before handling contact lenses to reduce the chance of getting an infection
- Always follow the directions of your eye care professional and all labeling instruction for proper use of contact lenses and lens care products
- Do not “top-off” the solutions in your case. Always discard left over contact lens solutions after each use and never reuse any lens solutions
- Do not expose your contact lenses to any water
- Clean, rinse, and air-dry your lens case each time lenses are removed
- Flip over your lens case while air drying so excess solution may drain out of the case
- Replace your case every 3 months

**TABLE 1:** Solution Manufacturers Recommendations for Contact Lens Case Hygiene

<b>Solution Type</b>	<b>Recommend Rinsing with Multipurpose Solution</b>	<b>Recommend Rubbing Lens Case</b>	<b>Recommended Wiping with Facial Tissue</b>	<b>Recommend Air Drying Face Down</b>	<b>Lens Case Included with Solution Purchase</b>	<b>Recommended Case Replacement Schedule</b>
B+L Bio True	Yes	No	No	Yes	No	“Frequently”
B+L Renu	Yes	No	No	Yes	No	Monthly
B+L Peroxyclear	Yes	No	No	No	Yes	90 days or 35 uses
Clear Care	Yes	No	No	No	Yes	With new purchase of Clear Care
Opti-Free Pure Moist	No	No	No	No	No	1-3 months
Opti-Free Replenish	Yes	No	No	No	No	None

For over 10 years, researchers have observed a direct correlation between contact lens complications and decreased compliance with the recommended care guidelines.<sup>5</sup> Only limited

information related to lens case hygiene practice is available to lens wearers and the advice that is available varies among eye care professionals, industry, and the U.S. FDA.<sup>5</sup> The lack of details in the recommendations leads to noncompliance.<sup>5</sup> It is unknown whether noncompliance is intentional or not. Although patients have a responsibility to strictly follow recommended lens care guidelines, many patients do not due to insufficient understanding, lack of awareness of risk, or simply consciously ignoring the recommended guidelines.<sup>5</sup> The noncompliance is made even more prevalent due to inconsistent or inadequate contact lens storage case hygiene recommendations given by manufacturers, regulatory authorities and eye care practitioners.<sup>5</sup> There is also a deficit in evidence-based data for eye care providers to use to best inform their patients on the optimal hygiene regimen. The purpose of this literature review is to compile all current data in the literature in order to provide practitioners with the best practices for contact lens case care.

## **Methods**

The Ferris State University FLITE Library online database was used to assimilate information. Only peer reviewed journal articles were reviewed that were published within the past five years.

## **Results**

The rate of lens case contamination was found associated with the duration of its use.<sup>6</sup> The FDA is currently advising patients to replace contact lens cases every 3 months.<sup>4</sup> This recommendation is interesting, because published studies do not appear to support this time period with most studies recommending replacement periods of 1 month or less.<sup>6</sup> In 1990, Larkin et al. recommended that contact lens cases be replaced every 2 weeks to limit bacterial contamination.<sup>7</sup> A recent survey by Dubmleton et al. showed that only 26% of American and

Canadian patients replace their cases in 1 month or less, almost 50% replace them after 6 months or longer, and 10% never replace them.<sup>7</sup> Yung et al. showed that 63% of patients do not change their lens cases trimonthly, even if given explicit instructions to do so.<sup>7</sup> Regular contact lens case replacement contributes to the maintenance of lens case sterility.<sup>5</sup> Contamination rate is about 4 times higher in patients using the same contact lens case for more than 3 months compared to those using it for less than 3 months.<sup>6</sup> 60% of patients with sterile cases reported regular case replacement compared to only 35% of patients with contaminated cases.<sup>5</sup> This suggests that frequent replacement of contact lens cases will reduce case contamination and consequently reduce risks of developing ocular complications among conventional lens users.<sup>6</sup> Sweeney et al. recommend that contact lens solution manufacturers provide contact lens cases with each bottle of solution, and contact lens wearers replace their old case with a new one each time they switch to a new bottle of contact lens solution.<sup>7</sup> Patients use different contact lens solution quantities over different periods of time and solutions come in different size bottles, so it is more difficult to regulate the frequency of case replacement based upon purchase of a new bottle of contact lens solution. There should be one universal recommendation by all entities for contact lens case replacement. One potential method of enhancing compliance with case replace would be to adopt some form of automatic reminder for the patient when their case should be replaced, such as LensAlert and Acuminder.<sup>7</sup> These tools may lead to increased patient compliance for case replacement and decreased contact lens-associated complications.

Regular lens solution replacement is shown to be a protective factor against case contamination.<sup>5</sup> Soaking lens cases in disinfecting solution for the minimum disinfection time recommended by manufacturers was able to reduce the bacterial load in cases.<sup>1</sup> The antimicrobial effects of different multipurpose solutions may differ for different species and strains of bacterial

microorganisms.<sup>1</sup> Another common practice of non-compliant contact lens wearers involves reusing contact lens cleaning solution in the contact lens cases, also known as “topping off” solution.<sup>5</sup> This should be strongly discouraged due to the significant risk factor for developing case contamination. 100% of patients reusing old solution had case contamination.<sup>5</sup> Daily cleaning of the lens case with fresh contact lens solution is recommended in order to reduce the development of microbial biofilms in contact lens cases.<sup>5</sup> A study by Wu et al. showed that patients who used more than 180 ml (half a bottle) of disinfecting solutions per month had consistently lower levels of lens case contamination than those who used less than half a bottle.<sup>3</sup> It was speculated that the reduction of recoverable microbes from the lens case was due to longer rinse of the lens case or a higher filling level of the case during the soaking cycle of the contact lenses.<sup>3</sup>

The current recommendation of rinsing with multipurpose solution and air-drying lens storage cases is inadequate in removing bacterial biofilm formed after only 24 hours of incubation in the laboratory.<sup>8</sup> Mechanical disruption of the biofilm with a tissue was found to be most effective in an in vitro study using 24 hour grown biofilms.<sup>8</sup> A recent study conducted by Vijay et al. found that the combination of rinsing and rubbing with multipurpose solution, tissue wiping, and air-drying face down was the most effective method in removing bacterial biofilm.<sup>8</sup> This study showed that the most widely used case hygiene regimen of rinsing with solution and air drying is not sufficient to remove biofilm of commonly recovered storage case bacterial contaminants, even when a current generation multipurpose solution is used.<sup>8</sup> A robust biofilm forms which is resistant against a multipurpose solution disinfection cycle.<sup>8</sup> Adding the additional steps of rubbing then wiping the contact lens case with clean facial tissue along with the current recommendations was most effective in removing the biofilm. This study used gloved

fingers for rubbing cases, although it is known that hands are the most common cause of contact lens and contact lens storage case contamination. This supports the recommendation of hand washing before contact lens and storage case handling.<sup>8</sup>

The removal of bacterial biofilm attributed to rubbing and tissue wiping the lens case is likely due to the mechanical friction and shearing forces applied by the fingers and tissue.<sup>1</sup> This mechanical interaction has been proven to be effective in cleaning contact lens cases even without a disinfectant.<sup>1</sup> This treatment effectively removed more than 75% of *P. aeruginosa* and 50% of *S. aureus* biofilm regardless of the multipurpose solutions used.<sup>8</sup> A study Vijay et al. suggested that the mechanical disruption was most likely the cause of the biofilm removal.<sup>8</sup> A study by Wu et al. showed that rinsing lens cases alone has no significant effect in reducing biofilm.<sup>1</sup> Practitioners must be aware that the effectiveness of applying shearing force of rubbing and tissue-wiping in removing contaminants may vary according to lens case internal surface.<sup>3</sup> Although no specific studies have been conducted to determine how different case designs affect biofilm formation, it may be hypothesized that cases with a multiple grooved internal surface would have more biofilm formation between the grooves even after rubbing and wiping with a tissue compared with a smooth internal surface.

In the past, hot water rinsing and air-drying of contact lens storage cases was recommended as an effective way to reduce microbial load.<sup>8</sup> The proven association between water-borne contaminants and contact lens-related corneal infections has led to a reconsideration of this case cleaning regimen.<sup>8</sup> A recent publication showed that the use of tap water is further associated with higher levels of lens storage contamination, especially with gram negative bacteria such as *Stenotrophomonas maltophilia*, *Achromobacter sp.*, and *Delftia acidovorans*,

which have been implicated in contact lens-related ocular disease.<sup>8</sup> Water should never be recommended in lens case cleaning regimen.

Immediate recapping and not allowing the contact lens case to dry is a risk factor for microbial keratitis.<sup>3</sup> Although air drying the lens case alone cannot be relied on to prevent bacterial growth.<sup>1</sup> A study by Wu et al. showed that lens cases that were positioned face up while air-drying had a significantly higher rate of contamination (71%) compared with lens cases air-dried face down (12%).<sup>9</sup> For lens cases that were air-dried face up only, more contamination occurred when lens cases were placed in humid environments such as the bathroom than in the non-humid environments such as an office or bedroom.<sup>9</sup> The rate of lens case contamination between the locations was similar when lens cases were air-dried face down.<sup>9</sup> Not only does air-drying the lenses face down reduce the exposure to air-borne contaminants, but it also promotes faster drying of the excessive multipurpose solution from the lens wells.<sup>9</sup> A study by Wu et al. also showed that among the air-drying locations, lens cases dried face up near the toilet/bathroom were found more frequently contaminated than those in other locations.<sup>9</sup> An appreciable amount of droplet contamination is found in the vicinity of the toilet.<sup>9</sup> Closing the toilet bowl before flushing only minimized the dispersal of larger-sized microorganisms, and small-sized microorganisms still managed to escape and remain suspended in the air for several hours.<sup>9</sup> Lens cases should be air-dried face down in order to reduce contamination and allow the excessive moisture to dry between uses.

The use of other types of cleaning systems such as silver-impregnated lens cases and hydrogen peroxide systems is also common in contact lens wearers.<sup>10</sup> Silver-impregnated lens cases are designed to decrease bacterial colonization by releasing silver ions from the case material.<sup>10</sup> Hydrogen peroxide is also an effective microbial disinfectant, and it destroys



pathogens by oxidation.<sup>10</sup> One-step hydrogen peroxide systems are usually accompanied by basket lens cases that include a platinum neutralizing disc. Because these cleaning systems employ different cleaning mechanisms compared with other types of multipurpose disinfecting solutions, the lens case cleaning instructions also differ.<sup>10</sup> Manufacturers cleaning instructions for the silver-impregnated lens cases supplied with polyhexanide multipurpose solution advise recapping of lids after rinse. Instructions supplied with hydrogen peroxide basket lens cases suggest rinsing the lens cases with saline followed by inversion of the lens cases for air drying.<sup>10</sup>

A study by Wu et al. compared the effectiveness of various cleaning methods in removing biofilms from silver-impregnated and hydrogen peroxide lens cases.<sup>10</sup> Before the use of any additional cleaning, the silver-impregnated cases exhibited superior antimicrobial effect on initial biofilm formation, and these cases had consistently lower number of biofilm formation compared with other propylene lens cases.<sup>10</sup> Despite the antimicrobial feature of the lens case, the remaining biofilm was not removed by rinsing alone. When rubbing was incorporated there was significant biofilm reduction.<sup>10</sup> The advantages of silver-impregnated lens cases were not as prominent if the rubbing and wiping steps were incorporated into the cleaning regimen which showed that rubbing and tissue wiping are essential for detaching microorganisms colonized on lens case surfaces.<sup>10</sup> Although the manufacturer recommends recapping the cases, data showed no significant difference between the level of bacteria recovered in lids recapped and air drying conditions after rubbing and rinsing.<sup>10</sup> Because silver-impregnated cases perform better if moisture remains in the cases as a result of the silver ions slowly getting released from the case in exchange for ions present in the residual moisture, it is hypothesized that air-drying face down leaves some residual moisture for the exchange process to take place.<sup>10</sup> Manufacturers should recommend that silver-impregnated cases should include rubbing and tissue wiping step along

with the already recommended rinsing step in order to further reduce the bacterial load from the lens case. These cases may be left capped, although since there is no significant difference from air drying, it may be beneficial for all manufacturers to recommend air drying face down, in order to decrease confusion among patients and increase case hygiene compliance.

The current manufacturer's cleaning instructions for hydrogen peroxide basket lens cases are to rinse with saline, which is not included in the solution pack, and invert the lens basket holder without the cap to air dry.<sup>10</sup> Although rinsing with saline minimizes contact lens wearers potential exposure to unneutralized hydrogen peroxide, it is very unlikely that lens wearers will purchase saline to rinse their stand-up basket lens in addition to the hydrogen-peroxide cleaning system.<sup>10</sup> Although rubbing and tissue wiping have been shown to be effective in two flat wells lens cases, these procedure are not practical in the stand-up basket lens case because the hinge of the lens basket, the two flap sides of the lens holder, and the cap have areas that are hard to reach.<sup>10</sup> The study by Wu et al. suggested re-soaking the case in hydrogen peroxide between uses.<sup>10</sup> The recurrent disinfecting cycle reduced significant bacterial load than the manufacturers current recommendations.<sup>10</sup> Although this will speed up solution consumption, neutralized hydrogen peroxide can be used to rinse and rub the contact lenses on removal from the eye.<sup>10</sup>

The ability of bacteria to survive and regrow on surfaces may depend on numerous factors such as the antimicrobial effect of the multipurpose disinfecting solution, surrounding temperature, drying speed, and level of nutrients available.<sup>1</sup> Therefore additional cleaning steps, such as rubbing then wiping with a tissue before air-drying should be recommended not only to dislodge the bacteria but also to reduce nutrients that may promote bacterial growth.<sup>1</sup> The findings of the aforementioned studies should benefit practitioners by enabling them to give

evidence based advice on how to clean contact lens cases and possibly reduce the incidence of contact-lens related complications associated with contact lens case contamination.

## **Discussion**

The clinical relevance of this project is based upon the needs of patients. Poor understanding about the best practices for case hygiene and differing opinions from manufacturers and eye care practitioners can possibly lead to patient noncompliance. Contact lens case contamination is likely due to a range of factors including disinfecting solution type, storage case design, storage case material, age of the lens case, compliance with disinfection, contact lens wear schedule, wear experience, gender of the wearer, and hand washing before handling lenses and cases.<sup>8</sup> Currently, lens case hygiene guidelines from various advisory bodies and manufacturers are a heterogeneous collection that may confuse contact lens wearers. Noncompliance with lens storage case care recommendations is a major risk factor in the contamination of cases, and complete compliance is low among soft contact lens wearers.<sup>8</sup>

The results from the literature review show that practitioners should recommend the following to their patients about contact lens case hygiene:

- Hand washing is the most important initial step in significantly reducing microbial contamination of the lens storage cases
- The lens cases should be rinsed and rubbed with multipurpose solution
- Water should never be used to clean contact cases
- Fresh contact lens multipurpose solution should be used to rinse the lens case, and contact lens solution should never be reused or “topped off”

- The lens case should be wiped with a clean facial tissue in order to prevent biofilm formation
- The case should be air dried face down in order to prevent contamination from the air and allow the case to dry completely
- Peroxide based basket lens cases should re-soaked with hydrogen peroxide between uses
- Patients should replace contact lens cases every month

The FDA and manufacturers of contact lens solutions are omitting a few of the most important recommendations in contact lens case hygiene. Currently they are not recommending rubbing the lens case or wiping with tissue before air drying. Without the mechanical disruption, biofilm formation will accumulate on the lens case after 24 hours.<sup>8</sup> The mechanical disruption steps are one of the most important to reduce case contamination and hopefully prevent contact-lens related complications. Although many of these organizations recommend air-drying the lens case and not re-capping, very few recommend air-drying the case face down. Not only does air-drying the lenses face down reduce the exposure to air-borne contaminants, it also promotes faster drying of the excessive multipurpose solution from the lens wells.<sup>9</sup> The final recommendation that varied among the FDA and different contact lens manufacturers was the case replacement schedule. Larkin et al. recommended that contact lens cases be replaced every 2 weeks to limit bacterial contamination.<sup>7</sup> A more recent study should be conducted to determine the best case replacement interval so that uniform advice can be recommended from all entities which may decrease patient non-compliance.

A study by Wu et al. showed that the patients who had practitioners reinforce the contact lens cleaning instructions displayed positive behavior changes with increased number of patients who rubbed and rinsed their lens cases and air-dried their cases face down.<sup>3</sup> This highlights the significance of describing detailed hygiene practices when advising lens wearers in clinical practice. Because of the possibility that compliance may drop off over time, periodic reinforcement of hygiene practices might be warranted to ensure maintenance of good hygiene behavior.<sup>3</sup> This literature review also highlights the benefits of daily disposable contact lens. Eliminating the need to use a contact lens storage case may reduce the risk of contamination by environmental microorganisms and remove the burden of precise hygiene procedures.

In clinical practice, optometrists should invest time and effort to stress the importance of compliance as a protective factor against contamination. These educational endeavors will lead to the reduction in lens wearers' frequent recurrence of non-compliant behaviors and will lower the risk of lens case contamination. Improved case hygiene regimen and frequent replacement of storage cases alone could possibly reduce the rates of severe contact lens-related microbial keratitis by more than 60%.<sup>8</sup> If all entities can agree on the best recommendations to give patients about lens case cleaning techniques, there may be an increase in patient compliance and a decrease in case-related ocular complications. After an industry standard has been set, a study should be conducted to see if patient compliance related to contact lens case hygiene has increased. A study should also be conducted to determine the effect of case design on contamination in order to obtain scientific evidence for contact lens case manufacturers to use when designing their cases.

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