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REVIEW

Contact lens care tips for patients: an optometrist's perspective

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Abstract: Contact lens (CL) wear has been a viable alternative to spectacle wear for several decades. The interest and desire to wear CLs have been stable in recent years, evidenced by the consistency of new wearers into this category of refractive correction. CLs have become one of the most commonly used medical devices in the market, with more than 40 million wearers in the US. There are many activities in which patients report a preference of CL wear over spectacles (athletics for example). Nearly all patients (even presbyopic patients) have the option of contact lenses today given the expansion of powers and parameters in recent years. Patients eyes are getting dryer as factors of age and the environment. CL materials have improved in recent years in an attempt to meet the challenges of dryer eyes. Despite the improvements in CLs and their care, challenges persist. Patient education, handwashing, compliance with care, and wearing schedule are some of the challenges that providers face in the care of CL patients even today.

Keywords: contact lenses, microbial keratitis, disinfection, compliance, handwashing

Introduction

Contact lens (CL) fitting success has many times been jeopardized by the occurrence of complications. Wearer's inadequate behaviors such as improper cleaning, disinfection, reuse of solutions, inadequate or absent handwashing, lack of lens case replacement, and CL overwear have been proposed as causes of complications and issues with CL intolerance and failure.[2,3] In some instances, poor understanding of proper hygiene and care of CLs is an issue. A total of 30% of respondents to a 2003 survey considered themselves poorly prepared with regards to the proper regimen of CL care and maintenance, which is suggestive that wearers might have a lack of knowledge and understanding.[2,4] In general medical care, there were nearly 760 million visits to physicians for medical problems in year 2000. A total of 188 million of those visits were by patients not following the advice and instructions of their providers (a noncompliance rate of 25% at a cost of $300 billion USD).[5] Worse yet, another study has found general medical noncompliance to be as high as 44%.[6] It has been reported that patients forget as much as 50% of presented medical education within minutes of leaving a medical visit.[5]

When education and understanding of hygiene in CL care are not the issues, nonadherence to instructions is potentially a factor. CL noncompliance was reviewed by a 2011 questionnaire study, and it was found to be 98% with problematic activities arising in the following order (most common first): tap water exposure, sleeping in

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unapproved lenses, wearing lenses beyond the manufacturer's recommended replacement frequency (MRRF), failing to wash hands, failing to replace the lens case, and solution misuse.[7] Glaucoma has commonly been reported as a disease state that is confounded by patient misunderstanding and non-adherence to pharmaceutical therapy. In comparison to CLs, noncompliance in glaucoma is reported to be 25–50%.[8] The worse report yet out in the UK reported that daily wear CL use had a noncompliant behavior rate of 99.7% of the time.[9] CL compliance was targeted for improvement in past years through the introduction of multipurpose disinfection systems or multipurpose solutions (MPS) and, more recently, the vast availability of daily disposable lenses (which avoid the need for disinfection altogether). Combined with media patient education via video, pamphlets, internet, etc., there has been little to no improvement on patient compliance.[10]

Only 53–77% of CL wearers wash their hands before handling their lenses.[10] For that reason, handwashing should be a detailed conversation for both new and existing CL wearers. Handwashing is the most important and fundamental principle of infection control.[11] It can eliminate much of the transient flora on the hands and is one of the major issues associated with CL user noncompliance. When surveyed, CL users routinely reported very high levels of compliance with handwashing (upwards of 85%). However, this statistic is believed to be artificially inflated due to unwillingness to admit to noncompliant behaviors and incorrect perceptions of appropriate hand hygiene.[12] Common issues include not washing hands with soap, not washing hands effectively, not washing hands often enough, and not drying hands properly.

Hygiene and handwashing

Commensal microorganisms as well as potential pathogens constitute the skin's microflora, and commonly include bacteria, viruses, protozoa, fungi, and parasites, among others.[13] In addition to the skin, microorganisms present in the mouth, nose, ears, genitals, anus, inanimate objects, and vegetation can all be spread to the eye with the insertion and removal of CLs.[14] Because interacting with the environment by touch is a second-nature behavior, CL users may not realize how often they come in contact with potentially pathogenic agents. Additionally, commonly transferred materials include finger grease, oily creams, mascara, lipstick, detergents, nicotine, and dirt.[14] Regular and effective handwashing can reduce stress to the ocular surface and greatly reduce the chance of infectious and non-infectious keratitis. One study cited a 33% reduction in the potential for infection with good hygiene.[15]

Failure to properly wash hands before inserting CLs essentially makes the finger and lens a vector for the transfer of potentially pathogenic agents to the ocular environment.[13] This can lead to a number of ocular pathologies, the most serious of which is sight-threatening microbial keratitis. This infection is linked to a number of bacterial species and while they are not all associated with the skin, they are commonly encountered in the environment. For this reason, users should avoid touching their eyes and face between handwashings. Poor hand hygiene also leads to increased chances of acute and chronic inflammation in the eye. Inflammation is a key component in the development of dry eye, and can be initiated by repetitive ocular stress associated with CL wear.[16] Maintaining appropriate handwashing habits can greatly reduce the impact of CL wear over time. Apart from infection, poor hand hygiene can be associated with other forms of complications due to increased bioburden potentially contributing to the development of symptoms, a reduction in wearing times, and even ultimate failure to continue with lens wear.[16]

The aims of hand hygiene practices are to rapidly eliminate the transient (contaminating) flora and to have persistent effects on the resident flora.[17] Transient flora is less adherent to the surface of the skin than resident flora. This makes it more easily transferrable, which means it is also easier to remove with handwashing. The efficacy of microbial removal depends on the type and level of microbial and organic matter contamination present, the use of potable versus non-potable water, the wash time, the type and volume of soap used, the extent to which the fingers, palms, backs of hands and subungual areas are exposed to the washing process, and the vigorousness of rubbing of the hands during rinsing.[18] While the basic guidelines of handwashing remain consistent, certain elements of the task may change depending on soil level of hands before washing. For example, increased wash and rinse time, amount of soap used, and scrubbing of areas with greater exposure to contamination should all be considered when washing. Hands should be wet under clean running water. The water temperature can be warm or cool. It is widely believed that to be maximally effective, hands should be wet and rinsed under hot water. However, there is no evidence that shows hot water is more efficient at removing microorganisms, and the level of heat required as well as the exposure time to neutralize pathogens is beyond the temperature that is considered safe for prolonged contact with the skin.[19] Once wet, enough soap should be applied to cover all surfaces of the hands when lathered. Handwashing with plain soaps or detergents suspends microorganisms and allows rinsing off the microorganisms, minimizing the

possibility of transfer by decreasing the surface tension of the water and binding to the dirt, oil, and bacteria.[18,20] Washing using only water has been shown to reduce the number of bacteria on the hands, but is nowhere near as efficient as handwashing using soap.[21] It is not necessary to use an antibacterial soap to wash hands. Research does not support the idea that antibacterial soaps are more effective at removing transient microorganisms, and some evidence exists that suggests that antibacterial ingredients may cause more harm in the long run in the form of resistant bacteria.[22] These findings ultimately led to the 2016 ruling by the U.S. Food and Drug Administration (FDA) that companies cannot market antibacterial washes due to the lack of proof regarding their effectiveness over regular soap and water.

After dispensing soap onto the hands, rub the hands together to create lather with the soap. Hands should be rubbed together vigorously enough so that that visible bubbles form and can be easily spread around. Take care to cover and rub all surfaces of the hands with soap. According to the World Health Organization, proper technique includes rubbing hands palm to palm; the right palm over the back of the left hand with interlaced fingers and vice versa; palm to palm with fingers interlaced; backs of fingers to opposing palms with fingertips interlocked; rotational rubbing of left thumb in right palm and vice versa; and rotational rubbing, backwards, and forwards or right fingertips in left palm and vice versa.[23] Particular attention should be paid to the palms of the hands and the fingertips, because these areas come into direct contact with the lens before insertion into the eye. The scrubbing process should take between 20 and 30 seconds to complete, and the entire handwashing process should take around 1 minute.[18,20,23] After the hands are thoroughly rubbed, rinse them under clean running water until all of the soap is removed. Shortening the time needed to appropriately rinse off all soap residue can negatively impact CL optics, comfort, wettability, and fit; in some cases, this can ultimately lead to CL failure.[24] After rinsing, dry the hands thoroughly. Currently, there are conflicting studies regarding a superior method of hand drying when considering single-use paper towels, cloth towels, forced-air dryers, and spontaneous evaporation,[17,25] but some methods are more practical than others. Single-use paper towels are the most appropriate sanitary product to use, but the cost and environmental impact make them less appropriate for home use than cloth hand towels. However, care should be taken to keep cloth towels clean, or they can end up adding additional bacteria to the hands and increasing chances of infection.[16] Spontaneous evaporation is a reliable approach, but the time it takes for hands to be completely dry makes this impractical when considering insertion and removal of CLs.

There are several additional considerations regarding hand hygiene as it relates to CL wear. Handwashing with soap and running water is recommended over the use of alcohol-based rubs or wipes.[16] Not only can the alcohol damage the lens, but it can also cause irritation to the eyes. CL cases may contaminate fingers; so, it is a good idea to open the case prior to washing hands, especially because the fingertips in particular are likely to become re-contaminated when opening the case after washing.[16] Poor hand hygiene can also contribute to case contamination; so, it is important to make good hand hygiene a habit. Finally, it is recommended that fingernails are kept short. Bacteria are frequently more concentrated under fingernails, and this area is often not exposed to the same amount of friction as the rest of the hands during handwashing, reducing the effectiveness of the practice.[26] The polished surfaces of artificial nails make them more likely to harbor bacteria even after they are scrubbed; so, a nail brush should be used to scrub both surfaces during handwashing.[18,26,27]

CL case contamination has been associated with ocular complications for patients. After usage and especially with old cases, biofilm formation is commonplace and can be a breeding ground for pathogens. Biofilms are microbial communities adhering to a surface, contain an extracellular matrix of polymeric substances, and are associated with differential expressions of genes and proteins.[28] A 2010 study of used CL cases found 76–92% of them to be contaminated.[29] Different disinfecting solutions behave differently during CL storage in cases. Additionally, lens case-associated biofilms are more resistant to CL care solutions.[28] Practitioners should query their patients as to case replacement frequency and target compliance with replacement in a way that mimics lens replacement.

CL care challenges

Approximately 6% of patients report intentional overnight CL wear (in lenses that are not designed or approved for extended wear).[10] It remains to be noted how many accidental overnight wearers exist (or those who nap in lenses during the day). Risk factor analysis indicates that disease load is reduced by 60–70% by avoidance of overnight lens use.[30] Beyond overnight wear, CL overuse of replaceable lenses is a problem. A total of 40–74% of CL wearers do not replace reusable CLs on time and in conjunction with the MRRF.[10] After comparing lens replacement modalities, the 2-week frequent replacement schedule is reported to be much less

compliant than for those patients prescribed a 1-month replacement lens.[31]

A total of 22% of subjects in a multicenter study of wearers of silicone hydrogel (SiHy) lenses reported topping off multipurpose solution instead of using fresh solution.[31] This is particularly worrisome as this behavior has been implicated as a key factor in the outbreak of CL-related fungal keratitis.[32] SiHy lenses that are not daily disposable must be cleaned and disinfected on a daily basis, just like conventional hydrogels. They pose a unique challenge, though, in that the solutions must effectively disinfect and remove tear lipid deposits, and many solutions have been recently formulated to improve wettability of SiHy surfaces.[33,34] Unfortunately, the SiHy benefit of high oxygen transmissibility does not significantly reduce or eliminate microbial keratitis.[35] SiHy lenses appear to have different microbial adherence properties when compared to earlier generation hydrogel lenses. Dumbleton et al found that in the course of a year's wear of SiHy lenses, 23% of wearers reported CL-related problems in which signs/symptoms were consistent with common CL complications. These complications were categorized as abrasions, conjunctivitis, discharge, discomfort, eyelid problems, injection, keratitis, photophobia, redness, and pain. Fortunately, lens wear was ceased by the patients 91% of the time upon symptom initiation (median of 5 days of discontinued wear).[31] Unfortunately, 53% of the wearers did not (and never did) consult with a health care practitioner about the problematic events.

For those CL disinfection systems that require rubbing and rinsing of the lenses (per the package inserts), as many as 75–77% of patients fail to do so, despite the increased risk of biofilm formation and increased bioburden of pathogens.[10] Biofilms are extracellular sugar-protein secretions by bacteria and they increase the affinity to biomaterial surfaces. Biofilms increase the tolerance to antibiotics (i.e., more resistant) 1000× more than for non-biofilm protected planktonic cells.[36,37] Staphylococci have been historically associated with CL-related microbial keratitis and are the most frequently recovered microorganisms contaminating CL cases.[37] *Staphylococcus epidermidis* is known to be the highest biofilm producer.[37] It is important to note that the frequency of all CL-related adverse events in SiHy wearers is reduced through the usage of hydrogen peroxide disinfection.[3] Hydrogen peroxide is the gold standard for CL disinfection and, arguably, should now be the disinfection method of choice for patients using reusable CLs (note that daily disposable CLs have the lowest incidence rates for adverse events).[38]

Multipurpose solutions (MPS) were first introduced in the market in 1995. MPS are agents that are used to clean, disinfect, and store CLs in an all-in-one product. After 1997, MPS became the predominant disinfection method used by CL wearers. The preservatives, disinfectants, and other components used in CL solutions have continued to evolve over time. Unfortunately, the convenience of requiring only one solution to perform a multitude of tasks has resulted in noncompliance with labeling instructions in more than 79% of users.[1] In an attempt to use a single solution to clean, disinfect, and rewet lenses, manufacturers have introduced "no-rub" MPS in the market to replace the two-step process of cleaning and disinfecting between uses. Presumably, with fewer steps, patients would be more complaint and at less risk for keratitis. As previously noted, this was not the result. The no-rub complex formulations contained relatively low concentrations of biocides and the eventual interaction with the lens materials sometimes inhibited their effectiveness.[39] The FDA sponsored a 2-day Contact Lens Care Product Workshop in January 2009 several years after the outbreaks of CL-related fungal and Acanthamoeba keratitis. They orchestrated a comprehensive research plan to test CLs and their lens care products in experiments meant to mimic real-world challenges faced by patients and published the results in 2012.[1] In 2006, it was reported that biocides and MPS preservatives can be taken up into CLs, leaving what remained in the case questionably ineffective. Any loss of efficacy of a solution from preservative uptake, combined with MPS misuse by patients (topping off, for example), could have a marked effect on disinfection and safety.[40] The FDA experiments also attempted to determine preservative depletion and the resultant efficacy of the remaining preservative in solution. Because uptake into the lens is a potential problem, the subsequent release of the biocide is also problematic. When lenses containing a biocide are placed onto the eye, there can be an eventual release of the materials to the eye causing disruption of the corneal epithelium and posing an additional risk for corneal infection.[41]

Polyhexamethylene biguanide (PHMB) is a commonly used disinfectant in MPS brand-name products and is nearly exclusively used in generic formulations. PHMB was challenged to disinfect *Staphylococcus aureus* and *Fusarium solani* when an assortment of 8 different CLs (6 SiHys and 2 conventional hydrogels) was added to the solution and subsequently confronted with microbes during a 6-, 12-, 24-, 72-, or 168-hour soak.[41,42] The FDA found that a MPS containing PHMB can lose its bactericidal efficacy when the CL is introduced. When tested against *Staphylococcus aureus*, the

residual MPS used for 5 of the 8 lenses showed significantly reduced PHMB levels and a corresponding loss of antimicrobial activity.[41] In the *F. solani* study, 7 of the 8 solutions used for storage failed to obtain the recommended one log reduction of *F. solani* after a 6-hour soak. In fact, 3 of the lens materials induced more than a 50% reduction of PHMB concentrations after 6 hours of soaking. After a 24-hour soak, 3 had lost all or almost all of the fungicidal activity.[42] The FDA data confirmed that PHMB containing MPS, when used with lenses, can have less microbiocidal action against common eye pathogens. With the aforementioned approach, the FDA sponsored another study challenging a MPS containing polyquaternium-1 0.001% and myristamidopropyl dimethylamine 0.0005% (POLYQUAD) in its activity against *Staphylococcus*, after being used to store 7 different SCL types (including six silicone hydrogel lenses and a conventional hydrogel lens).[39] Unlike the PHMB challenges, the POLYQUAD concentration in the cases was reduced only very slightly over time. The presence of the lenses did not adversely affect the biocidal activity of POLYQUAD and, in some cases, the efficacy was significantly better. The FDA has noted that solution-lens negative interactions may contribute to adverse events related to CL wear.

CL case care

CL case replacement has been reported to be a challenge to patients and a risk for health consequences. A total of 26% of wearers report that they never cleaned their lens case and 47% report not replacing their cases.[7,31] When the latter group of wearers was re-questioned directly, it was found that many patients replaced a lens case if they were given a new one by their eye care practitioner at their yearly visit.[7] For those subjects who did report lens case cleaning, the vast majority use non-sterile tap water, which has been reported as a significant risk factor for Acanthamoeba infection.[43] Although there are no definitive studies linking noncompliant behavior with increased risk of lens-related complications, high levels of lens case contamination leading to heavy biofilm formation combined with the inappropriate use of currently available CL solutions are inarguably the suspects.[7] Studies have shown that up to 81% of lens cases are contaminated with the age of the case as the predisposing factor (9 months or more having the highest rate of contamination). These cases have high levels of protein and cellular debris, which form a scaffolding that enhances pathogen adherence (commonly *Pseudomonas aeruginosa*) and biofilm formation.[7] The storage case provides an environment that supports the growth of environmental organisms.[44,45] There has been poor education as to how to effectively clean CL cases. Patients have reported placing their cases in microwave only to witness melting of the cases. Others have placed them in dishwashers where the water temperature is not generally high enough to kill bacteria and fungi. Others have more wisely used disinfection solutions to clean and air-dry, but now even that strategy should be reconsidered. Unfortunately, drying multipurpose solutions leaves a residue in the lens case that ends up being a significant risk factor for the development of microorganisms that harbor microbes like *Fusarium* and *Acanthamoeba*.[46] Today, the best approach is a planned routine of case exchange.

Microbial keratitis

Microbial keratitis is the most common and serious complication of CL wear. A 2010 analysis estimated 930,000 doctor's office visits and 58,000 emergency room visits for keratitis and CL disorders annually, resulting in direct heath care expenditures worth $175 million USD.[47] Research has estimated that microbial keratitis affects 3–5 per 10,000 daily CL users per year.[44] Though there is a higher rate for extended wear CLs (>20 per 10,000), daily wear still accounts for approximately 50% of cases. The latter could largely be eliminated by better attention to lens case replacement, thereby removing 62% of the pathogen disease load.[44] Microbial keratitis is known to be caused by several common pathogens. In general, gram-positive bacteria are more frequently recovered in temperate climate regions and gram-negative bacteria and fungi in tropical or sub-tropical climates.[30,48,49] *P. aeruginosa* is the most commonly recovered causative organism in CL-related disease and is, arguably, one of the most dangerous and destructive microorganisms. It can adhere to and colonize on lens materials and survive in CL case biofilms for a long while. *Pseudomonas* is one of the few pathogens known to be capable of penetrating an intact corneal epithelium without a pre-existing micro-trauma.[50] There are several physiologic changes to the eye that occur as a result of normal CL wear. Some of these likely account for what places the eye at risk for infection. Stapleton and Carnt reported those changes as follows: inhibition of normal corneal epithelial cell shedding, corneal epithelial thinning, increased binding of bacteria to corneal epithelial cells through exposure of bacterial adhesions on basolateral cell membranes, increased internalization of bacterial through expression of membrane lipid rafts of epithelial cells, reduced tear exchange, and disruption to the eyelid-tear film-cornea interface and resurfacing mechanism.[30]

Patient compliance issues

There are nonspecific barriers to patient education in terms of understanding and retention. In the very short-term, lens care education can be effective. In a study by Soni et al, young teenagers were assessed with a questionnaire 6 months after their CL fitting (and in-office education). A total of 85% of the 11- to 13-year-olds correctly knew the purpose of disinfection, 90% understood the necessity of cleaning, 96% knew the correct disinfection steps, and 99% expressed confidence in their ability to care for their lenses.[5,51] After a couple years of uncomplicated wear, however, the level of knowledge dissipates. After an average of 2.6 years of CL wear, only 26% of wearers were compliant with their lens care.[5] Even though the majority of these noncompliant patients became symptomatic, they were unaware that a likely explanation was due to their own behaviors. In fact, it has been noted that 74% of noncompliant patients were completely unaware that their behavior practices were problematic.[52] It appears that some percentage of patients are unintentionally misusing their lenses due to factors such as misunderstanding, forgetfulness, poor explanations/educations by the provider, and inadequate information.[8]

General health care studies have shown that patients who are aware of their noncompliant behavior and report the problem are the most likely to become fully compliant when encouraged. Those who are unaware of their actions are also likely to improve when re-educated. The most difficult and challenging group of patients are those who do not admit poor or questionable practices. It is important to note that when one area of noncompliance has been admitted to by a patient, there is high likelihood that other areas are at risk as well.[8]

Patient education

Recommendations to educate CL patients include the following:

1. Educate and re-educate: Even for the established wearer, a checklist of key points should always be covered. Items to include are as follows:
   a. Wearing schedule per day and per week
   b. Potential problems that the patient may experience and what to do (integrated warnings throughout the education process)
   c. Recommended replacement schedule of lenses and lens cases
   d. Recommended disinfection system with an explanation as how to properly use
      i. Practitioners should seriously consider the importance of lens disinfection. Attention should be made to select the best system for each and every patient.
   e. When the patient is to return and why (with corresponding appointment reminders)
2. Education should be delivered in at least two different formats. Options might be:
   a. Verbal
   b. Pamphlet with illustrations
   c. Internet site
   d. Video
3. Incorporate intentional repetition. Given that many offices employ staff members to handle patients after they leave the exam room, those staff should be prepared to echo the key points delivered by the provider.
4. All touch points of education should include clear instructions, empathy, effective listening, and minimum use of jargon.

The following guidelines were developed by incorporating previously published material by the Contact Lens Association of Ophthalmologists and the Contact Lens Section of the American Optometric Association, along with the consensus of opinions of those attending the International Contact Lens Leadership Summit. They do not replace the education provided by the eye care provider (ECP) but are general guidelines to offer assistance in patient education.[53]

1. Always follow your ECP's recommended schedule for CL wear and replacement.
2. Do not wear your lenses overnight unless approved by your ECP and be aware that overnight wear of CLs increases the risk of complications.
3. Wash your hands before handling CLs. Use a fragrance-free soap and dry your hands using a lint-free towel.
4. Always use the lens care products recommended by your ECP. Not all solutions work with all lenses, and saline solution and rewetting drops do not clean or disinfect your lenses.
5. Follow the exact steps indicated in the packaging and package inserts in CL disinfection.
6. Never use tap water in your lens case or for rinsing, and never put your lenses in your mouth or use saliva to wet them.
7. Never reuse old solution or top off the solution in your lens case.
8. Always remove your lenses before swimming, entering a hot tub, or taking shower.
9. Remove your CLs as soon as possible if your eyes become red, irritated, or painful or if your vision worsens while wearing lenses, and consult your ECP immediately.

10. Even if you are not having a problem, see your ECP at least once a year to check the health of your eyes and determine if your current lenses and care products are still the best choice for you.

Key additional points were suggested in a 2014 Morbidity and Mortality Weekly Report, which include the following:[47]

11. Never store CLs in water.
12. Replace CL cases every 3 months.
13. Carry a backup pair of glasses with a current prescription in case CLs need to be removed.

The final step in CL success is that patients are informed and re-educated regarding the proper techniques for insertion and removal of lenses. When the patient removes the lens from the case, the lens should be placed on the tip of the index finger of the dominant hand. Patients should always inspect the lens prior to insertion, watching for rips, tears, or defects in the lens. Instruct the patient to discard and open a new lens when defects are noticed.[54] There are two common techniques to teach patients whether lenses are positioned inside out. Hold the CL up to the light and ask the patient to note whether the lens edges are up and curved slightly inward, like a bowl. This is the correct position. If the lens is inside out, the edges will flare outward, and it will look more like a saucer. An additional way to check for correct orientation is to push the lens edges together. If the edges of the lens curl toward each other, similar to the appearance of a taco, the lens is right side out. If the lens edges curl away from each other, the lens is positioned inside out.[55] While these two techniques are helpful in correctly positioning a lens, it can still be challenging to determine orientation, particularly in lower- powered thinner lenses. CLs that are placed on the eye inside out may cause some discomfort and blurred vision. On slit lamp examination, a practitioner might notice excessive lens movement with the edges of the lens flared out.[55,56] Certain CL manufacturers have designed orientation markers on the lenses to aid with correct orientation.[54,55] Instruct the patient to note if anything feels different that normal with the lens after insertion, remove, inspect, clean if necessary, and re-insert. Another tip that can be helpful for patients who wear toric lenses is the rotational position of the lens on the finger prior to insertion. If the orientation marker of the toric CL is at the 6 o'clock position, instruct the patients to rotate the lens on the finger so that the orientation marker is at the 6 o'clock position when they insert it. This helps position the CL more quickly, leading to less adaptation time and faster stabilization of the lens and astigmatism correction. Overall, it helps the vision become sharper in less time. This technique may not be possible for patients with high hyperopia or presbyopic patients since it will be too challenging to visualize the toric marker. Additionally, some manufacturers have toric orientation markers at 3, 6, and 9 o'clock positions. Adjust the positioning as indicated with different orientations to provide faster alignment.

Note that CLs should be inserted prior to the application of make-up and face or body lotions. This lessens the chance of contamination of the lenses and potential deposits. Also, the CL serves as a barrier that could prevent abrasions from mascara brushes and other objects that could potentially injure the eye if lenses are not instilled prior to application.[55] There are two common methods for inserting a lens. The patient should use a finger to pull the upper eyelid against the brow or superior orbital rim.[57] If the lid is secured against the bone, the patient cannot blink as the lens comes near the eye. Demonstrating lid control during insertion and removal training is beneficial. Similarly, the patient should secure the lower eyelid against the maxillary bone using the middle finger of the hand that will insert the lens. With the lids securely positioned, the patient can bring the index finger toward the eye, and while looking up place the lens on the inferior sclera. Then, make the patients look down, slowly release the eyelids, and blink several times. The lens should move into position on the cornea. The alternative method is to place the lens directly onto the cornea while looking straight ahead. Either method is correct, but it may be easier for novice wears to insert the lens off of or adjacent to the cornea in the beginning due to corneal sensitivity.

Removing a soft CL can be completed by holding the lids as already directed, positioning the index finger on the lens and moving the lens downward as the patient looks up. With the lens off the cornea, the patient can then use the pads of the index finger and thumb to gently squeeze and remove the lens. There is some discrepancy with removal instructions. Some instructions recommended positioning the index finger and thumb at 3 and 9 o'clock positions, respectively, on the cornea and pinching the lens directly off. This method can pose a risk of accidental corneal abrasion to patients.[55] Additionally, as the lens is moved downward and approaches the inferior fornix, it will cause the lens to buckle, thus making grasping the lens easier for removal. As patients become more adept at CL insertion/removal, they can oftentimes perform this task without a mirror and can become less intentional with regards to eyelid manipulation/control. Advising patients to perform insertion and removal on the same eye first is helpful to prevent mix-up of the lenses.[54,58] Patients with hyperopic

presbyopia can have a difficult time inspecting, inserting, and removing lenses. Magnification mirrors can be useful for these patients.

CL fittings with the pediatric population are often avoided, believing that children and teenagers do not have the maturity to succeed with lens handling, insertion, and removal. In a study by Paquette et al, 90.5% of children aged 8–16 years were able to successfully wear and handle lenses up to a 3-month follow-up period. The mean time to train children on handling, insertion, and removal was 30 minutes. There was no statistically significant difference in the mean time required to complete insertion and removal between the three age groups. A second training appointment was necessary for 5.3% of children, and only 2.3% were unable to continue due to inability to handle the lenses.[59] CLs in the pediatric population can be successful with right training and motivation for patients.

Conclusion

Proper disinfection, handling, insertion, and removal of soft CLs are essential components to successful lens wear. All of these must be combined with hygiene adherence to appropriate handwashing. It is necessary for practitioners and/or staff to communicate the importance of all of these aforementioned issues on an annual basis to patients. Experienced wearers are not necessarily compliant wearers. CLs are likely to remain one of the most commonly used medical devices in the world market and the eye care community must do all that it can to see that wearers remain safe in such devices.[1]

Disclosure

The authors report no conflicts of interest in this work.

References

1. Eydelman MB, Tarver ME, Kiang T, Alexander KY, Hutter JC. The Food and Drug Administration's role in establishing and maintaining safeguards for contact lenses and contact lens care products. *Eye Contact Lens*. 2012;38(6):346–349.
2. de Oliveira PR, Temporini-Nastari ER, Ruiz Alves M, Kara-José N. Self-evaluation of contact lens wearing and care by college students and health care workers. *Eye Contact Lens*. 2003;29(3):164–167.
3. Carnt NA, Evans VE, Naduvilath TJ, et al. Contact lens-related adverse events and the silicone hydrogel lenses and daily wear care system used. *Arch Ophthalmol*. 2009;127(12):1616–1623.
4. Stapleton F, Keay L, Jalbert I, Cole N. The epidemiology of contact lens related infiltrates. *Optom Vis Sci*. 2007;84(4):257–272.
5. Donshik PC, Ehlers WH, Anderson LD, Suchecki JK. Strategies to better engage, educate, and empower patient compliance and safe lens wear: compliance: what we know, what we do not know, and what we need to know. *Eye Contact Lens*. 2007;33(6 Pt 2):430–433; discussion 434.
6. Ley P. Satisfaction, compliance and communication. *Br J Clin Psychol*. 1982;21(Pt 4):241–254.
7. Robertson DM, Cavanagh HD. Non-compliance with contact lens wear and care practices: a comparative analysis. *Optom Vis Sci*. 2011;88(12):1402–1408.
8. Claydon BE, Efron N. Non-compliance in contact lens wear. *Ophthalmic Physiol Opt*. 1994;14(4):356–364.
9. Morgan PB. Contact lens compliance and reducing the risk of keratitis. *Optician*. 2007;234:20–25.
10. Ramamoorthy P, Nichols JJ. Compliance factors associated with contact lens-related dry eye. *Eye Contact Lens*. 2014;40(1):17–22.
11. Stevens S. Reducing the risk of infection: hand washing technique. *Community Eye Health*. 2008;21(65):17.
12. Bui TH, Cavanagh HD, Robertson DM. Patient compliance during contact lens wear: perceptions, awareness, and behavior. *Eye Contact Lens*. 2010;36(6):334–339.
13. Campbell D, Mann A, Hunt O, Santos LJ. The significance of hand wash compliance on the transfer of dermal lipids in contact lens wear. *Cont Lens Anterior Eye*. 2012;35(2):71–76; quiz 96–97.
14. Barlow M, Plank D, Stroud S, Henry VA, Tumosa N, Bennett ES. The effectiveness of typical hand-cleaning methods on hydrogel contact lenses. *Int Contact Lens Clin*. 1994;21(11–12):232–236.
15. Keay L, Stapleton F. Development and evaluation of evidence-based guidelines on contact lens-related microbial keratitis. *Cont Lens Anterior Eye*. 2008;31(1):3–12.
16. McMonnies CW. Hand hygiene prior to contact lens handling is problematical. *Cont Lens Anterior Eye*. 2012;35(2):65–70.
17. Jumaa PA. Hand hygiene: simple and complex. *Int J Infect Dis*. 2005;9(1):3–14.
18. Todd EC, Michaels BS, Greig JD, Smith D, Holah J, Bartleson CA. Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 7. Barriers to reduce contamination of food by workers. *J Food Prot*. 2010;73(8):1552–1565.
19. Carrico AR, Spoden M, Wallston KA, Vandenbergh MP. The environmental cost of misinformation: why the recommendation to use elevated temperatures for handwashing is problematic. *Int J Consum Stud*. 2013;37(4):433–441.
20. Garner JS, Favero MS. CDC Guideline for Handwashing and Hospital Environmental Control, 1985. *Infect Control*. 1986;7(4):231–243.
21. Burton M, Cobb E, Donachie P, Judah G, Curtis V, Schmidt WP. The effect of handwashing with water or soap on bacterial contamination of hands. *Int J Environ Res Public Health*. 2011;8(1):97–104.
22. FDA. Press Announcements – FDA issues final rule on safety and effectiveness of antibacterial soaps. http://www.fda.gov/. Available from: https://s3.amazonaws.com/public-inspection.federalregister.gov/2016-21337.pdf. Accessed February 15, 2017.
23. WHO. WHO guidelines on hand hygiene in health care: a summary. *WHO*. 2009;30(1):270.
24. Bitton E, Kronish S. The impact of hand washing time and soap on the surface of silicone hydrogel contact lenses: a pilot study. *Cont Lens Anterior Eye*. 2103;36 (Suppl 2):e25.
25. Gustafson DR, Vetter EA, Larson DR, et al. Effects of 4 hand-drying methods for removing bacteria from washed hands: a randomized trial. *Mayo Clin Proc*. 2000;75(7):705–708.
26. Lin CM, Wu FM, Kim HK, Doyle MP, Michael BS, Williams LK. A comparison of hand washing techniques to remove Escherichia coli and caliciviruses under natural or artificial fingernails. *J Food Prot*. 2003;66(12):2296–2301.
27. Tyhurst KN, Hettler DL. Infection control guidelines--an update for the optometric practice. *Optometry*. 2009;80(11):613–620.
28. Szczotka-Flynn LB, Imamura Y, Chandra J, et al. Increased resistance of contact lens-related bacterial biofilms to antimicrobial activity of soft contact lens care solutions. *Cornea*. 2009;28(8):918–926.
29. Willcox MD, Carnt N, Diec J, et al. Contact lens case contamination during daily wear of silicone hydrogels. *Optom Vis Sci*. 2010;87(7):456–464.

30. Stapleton F, Carnt N. Contact lens-related microbial keratitis: how have epidemiology and genetics helped us with pathogenesis and prophylaxis. *Eye (Lond)*. 2012;26(2):185–193.
31. Dumbleton KA, Woods CA, Jones LW, Fonn D. The relationship between compliance with lens replacement and contact lens-related problems in silicone hydrogel wearers. *Cont Lens Anterior Eye*. 2011;34(5):216–222.
32. Chang DC, Grant GB, O'Donnell K, et al; Fusarium Keratitis Investigation Team. Multistate outbreak of Fusarium keratitis associated with use of a contact lens solution. *JAMA*. 2006;296(8):953–963.
33. Lievens CW, Kannarr S, Zoota L, Lemp J. Lid papillae improvement with hydrogen peroxide lens care solution use. *Optom Vis Sci*. 2016;93(8):933–942.
34. Keir N, Jones L. Wettability and silicone hydrogel lenses: a review. *Eye Contact Lens*. 2013;39(1):100–108.
35. Stapleton F, Keay L, Edwards K, Holden B. The epidemiology of microbial keratitis with silicone hydrogel contact lenses. *Eye Contact Lens*. 2013;39(1):79–85.
36. Behlau I, Gilmore MS. Microbial biofilms in ophthalmology and infectious disease. *Arch Ophthalmol*. 2008;126(11):1572–1581.
37. Uno T, Ohashi Y, Imayasu M. Antimicrobial efficacy tests of multipurpose contact lens care solutions simulating poor contact lens hygiene behaviors. *Eye Contact Lens*. 2012;38(6):388–393.
38. Diec J, Papas E, Naduvilath T, Xu P, Holden BA, Lazon de la Jara P. Combined effect of comfort and adverse events on contact lens performance. *Optom Vis Sci*. 2013;90(7):674–681.
39. Shoff ME, Lucas AD, Phillips KS, Brown JN, Hitchins VM, Eydelman MB. The effect of contact lens materials on disinfection activity of polyquaternium-1 and myristamidopropyl dimethylamine multipurpose solution against Staphylococcus aureus. *Eye Contact Lens*. 2012;38(6):374–378.
40. Rosenthal RA, Dassanayake NL, Schlitzer RL, Schlech BA, Meadows DL, Stone RP. Biocide uptake in contact lenses and loss of fungicidal activity during storage of contact lenses. *Eye Contact Lens*. 2006;32(6):262–266.
41. Shoff ME, Lucas AD, Brown JN, Hitchins VM, Eydelman M. The effects of contact lens materials on a multipurpose contact lens solution disinfection activity against Staphylococcus aureus. *Eye Contact Lens*. 2012;38(6):368–373.
42. Clavet CR, Chaput MP, Silverman MD, et al. Impact of contact lens materials on multipurpose contact lens solution disinfection activity against Fusarium solani. *Eye Contact Lens*. 2012;38(6):379–384.
43. Joslin CE, Tu EY, Shoff ME, et al. The association of contact lens solution use and Acanthamoeba keratitis. *Am J Ophthalmol*. 2007;144(2):169–180.
44. Stapleton F, Edwards K, Keay L, et al. Risk factors for moderate and severe microbial keratitis in daily wear contact lens users. *Ophthalmology*. 2012;119(8):1516–1521.
45. McLaughlin-Borlace L, Stapleton F, Matheson M, Dart JK. Bacterial biofilm on contact lenses and lens storage cases in wearers with microbial keratitis. *J Appl Microbiol*. 1998;84(5):827–838.
46. Ahearn DG, Zhang S, Stulting RD, et al. In vitro interactions of Fusarium and Acanthamoeba with drying residues of multipurpose contact lens solutions. *Invest Ophthalmol Vis Sci*. 2011;52(3):1793–1799.
47. Collier SA, Gronostaj MP, MacGurn AK, et al; Centers for Disease Control and Prevention (CDC). Estimated burden of keratitis--United States, 2010. *MMWR Morb Mortal Wkly Rep*. 2014;63(45):1027–1030.
48. Bourcier T, Thomas F, Borderie V, Chaumeil C, Laroche L. Bacterial keratitis: predisposing factors, clinical and microbiological review of 300 cases. *Br J Ophthalmol*. 2003;87(7):834–838.
49. Keay L, Edwards K, Naduvilath T, et al. Microbial keratitis: predisposing factors and morbidity. *Ophthalmology*. 2006;113(1):109–116.
50. Fleiszig SM, Lee EJ, Wu C, et al. Cytotoxic strains of Pseudomonas aeruginosa can damage the intact corneal surface in vitro. *CLAO J*. 1998;24(1):41–47.
51. Soni PS, Horner DG, Jimenez L, Ross J, Rounds J. Will young children comply and follow instructions to successfully wear soft contact lenses? *CLAO J*. 1995;21(2):86–92.
52. Collins MJ, Carney LG. Patient compliance and its influence on contact lens wearing problems. *Am J Optom Physiol Opt*. 1986;63(12):952–956.
53. Guidelines for safe contact lens wear. *Eye Contact Lens*. 2007;33(6 Pt 2):435.
54. ACUVUE Brand Contact Lenses. Applying and removing your contacts. Available from: https://www.acuvue.com/contact-lens-care/how-to-put-in-and-take-out-contacts. Accessed February 15, 2017.
55. Bennett ES, Henry VA. *Clinical Manual of Contact Lenses*. 4th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2014.
56. BAUSCH + LOMB See Better, Live Better. Inserting and removing contact lenses. Available from: http://www.bausch.com/reference/inserting-and-removing-contact-lenses. Accessed February 15, 2017.
57. Cutler SI. Training the new contact lens wearer. *Optom Manag*. 2002:89–93.
58. CooperVision® Live Brightly®. How to Put Contacts in Your Eyes. Available from: https://coopervision.com/about-contacts/how-put-contacts-your-eyes. Accessed February 15, 2017.
59. Paquette L, Jones DA, Sears M, Nandakumar K, Woods CA. Contact lens fitting and training in a child and youth population. *Cont Lens Anterior Eye*. 2015;38(6):419–423.