

# Contact lens compliance and reducing the risk of keratitis

Dr Philip Morgan presents new data on contact lens compliance and how this information can be used to reduce the risk of contact lens-associated keratitis

**T**he popularity of silicone hydrogel (SH) contact lenses for both daily wear and extended wear<sup>1</sup> has shifted the emphasis in the examination of contact lens wearers at follow-up visits.

Previously, there was a particular requirement to carefully scrutinise the ocular surface for signs of hypoxic changes, such as epithelial microcysts and vessel dilation. With the virtual elimination of corneal hypoxia due to the increased oxygen performance of SH materials, such changes have become much less significant. For example, limbal redness has been reported as being less marked with SHs than with conventional hydrogels for both extended wear<sup>2,3</sup> and daily wear.<sup>4</sup>

The reduced prevalence of hypoxic changes and the increase in the use of extended wear lenses has led to a greater interest in the infiltrative response of the eye during contact lens wear. In the context of a contact lens wearer, the terms 'infiltrative response', 'infiltrative event' and 'keratitis' are essentially synonymous and describe the inflammatory response of the cornea, which is characterised by the ingress of leukocytes from the local vasculature to the site of inflammation. This is seen clinically as accumulations of small white areas in the cornea which can be readily viewed with a biomicroscope (Figure 1). A wide-ranging review of contact lens keratitis has recently been presented by Efron and Morgan.<sup>5</sup>

The term 'contact lens associated-keratitis' describes a spectrum of severity from innocuous and asymptomatic forms ('non-significant'), through symptomatic but non-serious varieties ('significant'), to severe infections ('serious').<sup>6</sup>

Broadly, the first of these three types usually can be noted and left alone; the second requires some intervention and management by the contact lens practitioner; the third needs rapid referral for ophthalmological assessment and treatment. The diverse nature of contact lens-associated keratitis means that it is not always a cause for immediate concern and rapid management.



**Figure 1** Corneal infiltrates seen in a contact lens-associated keratitis

The cause or aetiology of the range of the significant and serious keratitis responses to contact lens wear described by Sweeney *et al*<sup>6</sup> is varied, but has one common factor – the presence of micro-organisms. For example, the release of exotoxins from *Staphylococcus aureus* bacteria is thought likely to be involved in the aetiology of a contact lens peripheral ulcer (a significant but not serious contact lens-associated keratitis).<sup>7</sup> This form of response is inflammatory but noninfective in nature,<sup>6</sup> because although bacteria are the cause of the problem, they have not invaded the cornea. An infection of the cornea (a serious contact lens-associated keratitis) requires that a micro-organism is able to invade the corneal tissue and replicate within it. The current understanding of contact lens-associated infections has been recently authoritatively reviewed by Fleiszig.<sup>8</sup> Despite the fact that microbes are probably involved with all forms of contact lens-associated keratitis, the term 'microbial keratitis' is usually reserved for infections of the cornea.

A small minority of contact lens-associated keratitis cases are potentially sight-threatening. Efron *et al* recently calculated that up to 0.02 per cent of contact lens wearers each year may lose two lines of best corrected visual acuity.<sup>9</sup> Schein *et al* have reported a rate of 0.04 per cent in extended wear of silicone hydrogels.<sup>10</sup>

Although these numbers are very small, any negative effect to our primary sense – sight – must be considered very seriously, especially when some of these events are avoidable.

## Getting the balance right: bioburden and ocular defence

At any point in time, it is possible to culture potential pathogens from about 5 per cent of eyes.<sup>11</sup> However, eye infections are very unusual – this is because in most circumstances, the ocular defence mechanisms which help resist infection are superior to the ability of micro-organisms to invade the eye. In contact lens wear, the balance between bioburden (the number of micro-organisms at the ocular surface) and ocular defence is shifted significantly. Clear evidence for this comes from the calculations of Brennan which suggest that although the risk of an infection of the cornea during the daily wear of contact lenses is very low on an absolute scale, contact lens wearers are about 60 times more likely to have a corneal infection than non-wearers.<sup>12</sup>

Further consideration of this bioburden/ocular defence balance suggests that both sides are adversely affected by contact lens wear. The various aspects of contact lens handling and care tend to alter the types<sup>11</sup> and increase the number of bacteria<sup>13</sup> at the ocular surface. On the other hand, some of the defence mechanisms are inhibited. For example, an important part of ocular defence is the ability of the eye to remove potential pathogens via blinking and tearing. If bacteria are trapped between a contact lens and the cornea, the effect of blinking and tearing is much reduced due to the minimal tear exchange under a contact lens. Other defence mechanisms are also affected. For example, recent evidence suggests that some of the anti-microbial factors (human beta-defensin-2) released from the corneal epithelium to resist infection from *Pseudomonas aeruginosa* are diminished with contact lens wear.<sup>14</sup>

## The role of compliance

*Webster's Medical Dictionary* defines 'compliance' as 'the process of complying with a regimen of treatment'.<sup>15</sup> In the context of contact lens wear, this can be interpreted as a wearer correctly adhering to the instructions provided by the contact lens practitioner with respect



**TABLE 1**

**Relationship between risk factors for keratitis and wearer compliance and recommended action by contact lens practitioners**

| Contact lens care behaviour | No increased risk of significant or serious keratitis | Increased risk of significant or serious keratitis |
|-----------------------------|---|--|
| Good compliance             | Little or no specific action required                 | Some action required                               |
| Poor compliance             | Some action required                                  | Considerable action required                       |

to optimum lens wear and care.

In contact lens wear, it is important that the shifting of the balance between bioburden and ocular defence is minimised as much as possible. The impact on ocular defence is probably difficult to remedy as many of the changes to ocular defence are related to the physical presence of a contact lens at the ocular surface. However, it is possible that the increase in bioburden which occurs during contact lens wear can be reduced by the hygiene and lens handling practices of a contact lens wearer. Compliance, with appropriate instructions and guidelines, plays a key role in this aspect of minimising ocular infections and inflammations.

This article presents new information about the compliance of contact lens wearers across a wide range of lens care steps. However, on its own, the information presents only part of the total picture of how patient management can be improved to reduce the likelihood of an adverse event. The other part of the picture is to understand which parts of the lens care process, if performed inadequately, are associated with increases in contact lens problems; as the main focus currently is significant/serious keratitis (as detailed above), this report will specifically investigate how these forms of adverse events can be targeted and reduced.

Table 1 describes how the relationship between compliance and level of risk can influence practitioner behaviour. While it is important to optimise all steps of contact lens care, some judgements need to be made as to which specific areas deserve most attention. For example, some lens care steps which may have been identified as being potentially risky if not performed correctly may, in fact, be associated with already good levels of compliance so limited influence can be brought to bear by a practitioner on a wearer. Similarly, a factor where poor compliance is identified may not have been shown to be related to an increased risk of infection or inflammation, so does not warrant particular emphasis. The key target areas are those lens care steps which have been convincingly shown to render

a wearer at greater risk and for which compliance is identified as being poor.

A range of risk factors for significant/serious keratitis associated with contact lens wear has been identified in the past 20 years and a comprehensive overview of much of this work has recently been presented by Stapleton and colleagues.<sup>16</sup> The identified risk factors can be helpfully divided into 'non-modifiable' factors (over which neither wearer nor practitioner has any realistic control) and 'modifiable' factors (which can be influenced or altered).<sup>16</sup>

For non-modifiable risks, many authors have found that contact lens-associated infections are more common in young males than in other sectors of the population.<sup>17,18</sup> Modifiable factors, which are of particular interest when considering contact lens compliance, include sleeping in lenses,<sup>18</sup> wearing lenses beyond their recommended replacement date,<sup>19</sup> inadequate disinfection,<sup>17,20</sup> not handwashing,<sup>16</sup> 'topping-up' solution rather than discarding it fully,<sup>16</sup> and poor case care.<sup>21</sup> There are a range of other factors that may lead to increased levels of significant or serious keratitis (such as using care products beyond their expiry date or not replacing bottle tops) but the complexities of conducting epidemiological studies on events as rare as significant or serious keratitis means that any link is currently unproven.

## Assessing current contact lens compliance

### Methodology

In a new study, contact lens compliance was evaluated for 1,402 wearers of two-weekly or monthly-replaced lenses aged 16 to 64 years old across seven European countries (UK, Germany, France, Italy, Spain, Russia and Poland). This was a far-reaching web-based survey of contact lens use and covered areas such as the duration and frequency of contact lens wear, methods of lens cleaning and disinfection, the lens case and lens storage and the communications between lens wearer and contact lens practitioner.

On receipt of the study data a new 'traffic light' approach was adopted to

consider the compliance results. For each aspect of compliance, the responses of the subjects were categorised into:

- **Green behaviour** – a response considered to be wholly compliant with manufacturer guidelines and best contact lens clinical practice.

- **Amber behaviour** – a response considered to be moderately non-compliant. This category acknowledges that for some forms of contact lens misuse any associated risk is likely to be cumulative. For example, someone sleeping in daily wear contact lenses for one night a year is non-compliant but is at less risk of an associated adverse event than another person sleeping in daily wear contact lenses most nights. This categorisation acknowledges, therefore, that there are different levels of non-compliance in contact lens wear which assist in improving our understanding of wearer behaviour. However, amber behaviour should still be recognised as being clinically unacceptable and only green behaviour should be promoted to contact lens wearers.

- **Red behaviour** – a response considered to be very non-compliant.

Table 2 shows the compliance questions in the survey and how the various answers were categorised. Most questions were asked to both daily wearers and extended wearers; some questions were specific to these wearer groups.

The use of a rub/rinse step after lens removal and before insertion was also considered. This is not a matter of compliance as such because many practitioners do not recommend this step and a number of care products are marketed as being 'no rub'. Because rinsing lenses removes 99.7 per cent of bacteria,<sup>22</sup> a response of rinsing alone or rubbing and rinsing was considered to be acceptable in this context.

Another studied parameter was the receipt of information about lens wear and care. An acceptable response here was that each wearer should have recalled receiving information about lens insertion and removal, cleaning and soaking and contact lens-related complications.

## Results

For the purpose of this study, the various steps of lens wear and care across all the respondents were considered to have 'high', 'moderate' and 'poor' levels of compliance if correctly carried out by over 80 per cent, 40-80 per cent and below 40 per cent of respondents, respectively. Only 0.3 per cent of wearers were fully compliant for all 14 steps required for correct daily wear compared with 2.7 per cent of extended wearers.

# Contact lenses

**TABLE 2**

Key compliance measures. DW = daily wear group; EW = extended wear group

| Group   | Question   | Green response   | Amber response   | Red response  |
|---------|--|--|--|---|
| Both    | How many days do you wear your lenses before throwing them out?      | As recommended for lens type                             | Up to 10% extra  | More than 10% extra                                   |
| DW only | Do you sleep overnight in your lenses?                               | Never sleeping overnight in lenses                       | Sleeping overnight in lenses, but less often than once a month | Sleeping in lenses overnight at least once a month    |
| DW only | Do you nap in your lenses?   | Never  | n/a  | Some napping  |
| EW only | How often do you sleep in your lenses?                               | As advised by practitioner or less                       | n/a  | More than advised                                     |
| Both    | Do you wash your hands before inserting and removing, and what with? | Always wash hands with soap, antiseptic liquid, or wipes | Always washing hands with at least water                       | Not always washing hands                              |
| Both    | What do you use to clean/store your contact lenses?                  | Multipurpose solution/hydrogen peroxide                  | n/a  | Saline only/any water or saliva/cleanser-protein only |
| Both    | Where do you store your contact lenses?                              | In a lens case   | n/a  | In a mug/glass/other                                  |
| Both    | Do you replace your solution or top up?                              | Always replacing all solutions in the lens case          | n/a  | At least sometimes topping up                         |
| Both    | Do you cover your contact lens completely?                           | Always   | n/a  | Less frequently                                       |
| Both    | Do you close your lens case tightly?                                 | Always   | n/a  | Less frequently                                       |
| Both    | Do you clean your case?  | Every day with solution                                  | At least once a week with solution                             | Without solution or less often than once a week       |
| Both    | How often do you change your case?                                   | Monthly  | Every 3-4 months   | Anything worse  |
| Both    | Do you close the cap of your bottle tightly?                         | Yes - always   | n/a  | Anything worse  |
| Both    | Do you ever check the expiry date of your solution bottle?           | Yes - regularly  | Yes - occasionally   | Less frequently                                       |
| Both    | Do you ever share your contact lens case with other people?          | Never  | n/a  | At least sometimes                                    |

In general, there was considerable overlap in the areas of compliance and non-compliance between the daily wear group (Figure 2) and the extended wear group (Figure 3). Table 3 shows that the areas with good compliance were the self-evident and simple lens care steps required during the care of contact lenses.

This suggests that either (a) contact lens wearers are either well educated by their practitioners in these areas of lens care, or (b) the steps are so simple and obvious that there is inherent compliance by contact lens wearers.

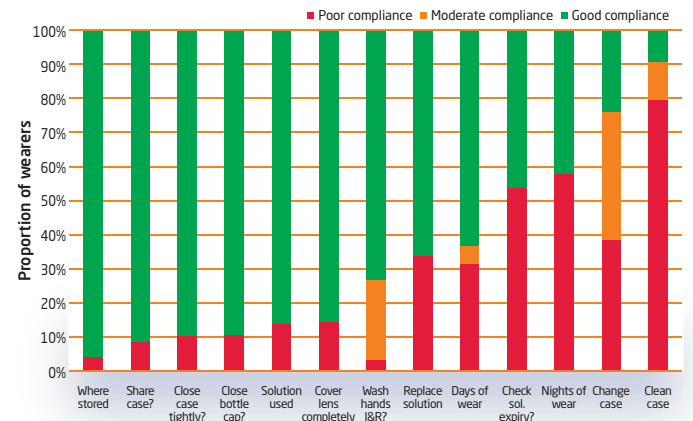
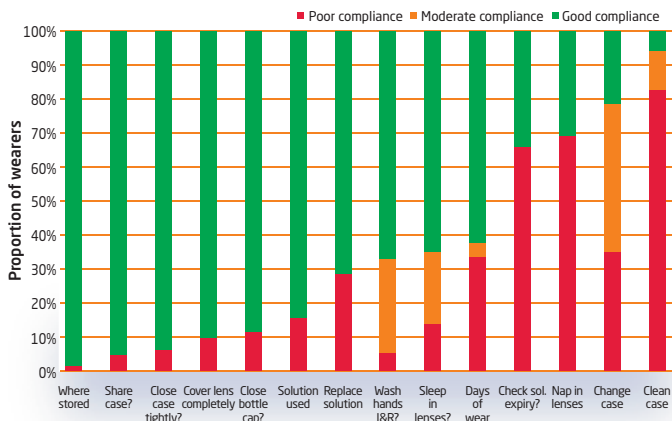
Overall, the areas with moderate compliance are those which are more complex and where the consequences of non-compliance might be less clear. The steps with poor compliance have probably received little attention during practitioner-patient interactions and may be perceived as being unlikely to cause any clinical problems.

**TABLE 3**

Summary of compliance of daily wear and extended wear respondents

|                                     | Behaviour of daily wear group   | Behaviour of extended wear group  |
|-------------------------------------|---|---|
| <b>High level of compliance</b>     | Using the correct solution<br>Lenses stored in a lens case<br>Lenses covered with solution during disinfecting<br>Case lid closed tightly<br>Bottle cap closed tightly<br>Case not shared | Using the correct solution<br>Lenses stored in a lens case<br>Lenses covered with solution during disinfecting<br>Case lid closed tightly<br>Bottle cap closed tightly<br>Case not shared |
| <b>Moderate level of compliance</b> | Too many days of wear<br>Overnight wear with lenses prescribed for daily wear only<br>Correct hand-washing<br>Replacement of all solution each day (ie no topping up)                     | Too many days of wear<br>Too many nights sleeping in lenses<br>Correct hand-washing<br>Replacement of all solution each time (ie no topping up)<br>Regular checking of expiry dates       |
| <b>Low level of compliance</b>      | Napping with lenses<br>Monthly replacement of lens case<br>Always cleaning lens case<br>Regular checking of expiry dates  | Monthly replacement of lens case<br>Always cleaning lens case   |

# Contact lenses



**Figure 2** Compliance measures for daily wear contact lens users

**Figure 3** Compliance measures for extended wear contact lens users

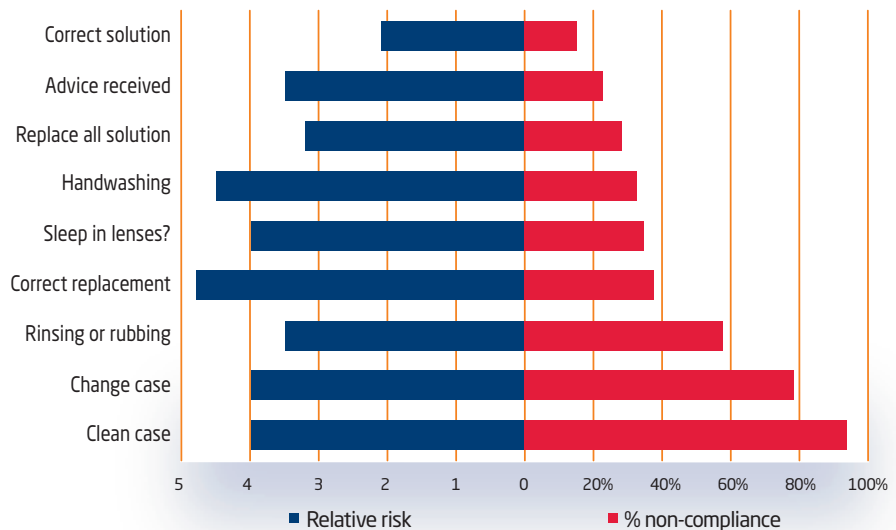
The assessment of lens cleaning after removal in the evening found that 58 per cent of wearers performed neither a rub-step nor a rinse-step, 18 per cent just rinsed, 11 per cent just rubbed and 11 per cent did both. About three quarters of wearers (77 per cent) recalled receiving advice about all three areas of lens care with the remainder having no recall of such information.

Figure 4 represents a number of compliance and other factors with a corresponding relative risk in each case. This allows a judgement to be made about the areas of lens care which should receive specific attention. Obtaining a precise 'marriage' between the range of identified lens care steps and reported epidemiological increases in the risk of infection is not possible in every case, but this figure nevertheless acts as a reasonable guide to understand where the main areas for improvement lie.

It is apparent from Figure 4 that care of the lens case is frequently inadequate and improper case care has been associated with an increased risk of infection.<sup>19</sup> Appropriate disposal and care of the contact lens case is an important part of the overall lens care process. Surveys have reported that up to 77 per cent of lens cases are contaminated with bacteria and 8 per cent with *Acanthamoeba*.<sup>23</sup> Contamination appears to be unrelated to solution type, and it is clear that the development of microbial biofilms in contact lens cases can reduce the effect of a disinfecting solution.<sup>24</sup>

We found that handwashing was performed well by the majority of wearers; however, as this function has been associated with a significant increase in risk of infection, it merits some consideration. Three-quarters of the 'hand washers' used soap, 14 per cent used just water with the remainder using antiseptic liquid or wet wipes.

Research suggests that 'normal' liquid soap and antimicrobial liquid soap



**Figure 4** Relative risks and non-compliance for a range of compliance and usage factors. Data for use of correct solution and unscheduled sleeping in lens for microbial keratitis.<sup>27</sup> Data for receipt of advice and lens cleaning for *Acanthamoeba* keratitis.<sup>29</sup> Data for replacing all solution and handwashing for *Fusarium* keratitis and microbial keratitis.<sup>16</sup> Data for correct lens replacement for *Fusarium* keratitis.<sup>19</sup> Data for case care from for microbial keratitis<sup>21</sup>

perform similarly in a typical population in terms of their ability to remove bacteria from the hands. In fact, neither approach is immediately effective and requires a number of weeks or months to routinely remove micro-organisms from the hands.<sup>25</sup> Evidence from the use of hand washes in hospitals confirms that an element of training in the best methods of hand washing is required in that setting,<sup>26</sup> and it would seem reasonable to assume that this would be helpful to contact lens wearers also. Perhaps a more formal instruction process in correct handwashing could be instigated into contact lens teach/dispensing appointments.

Rubbing or rinsing was performed only by a minority of contact lens wearers and inadequate surfactant cleaning has been reported as accounting for a three-fold increase in the risk of infection. Shih *et al*

reported that rubbing and rinsing a lens reduced the amount of bacteria on its surface by over three log units (that is, by more than 99.9 per cent).<sup>22</sup> Interestingly, the ISO standard for overnight contact lens disinfection requires a similar level of kill. This reinforces that lens surface cleaning has a very important role in the aim of maximally reducing the bioburden on a contact lens surface and suggests that contact lens practitioners should continue to recommend cleaning procedures to optimise the combined effects of both rub/rinse cleaning and overnight disinfection.

Sleeping in lenses was reported by about one-third of daily wearers; unscheduled overnight use was reported by Radford *et al* as being associated with a four-fold increase in the risk for microbial keratitis.<sup>27</sup> This is the area where non-compliance has a direct benefit to





the wearer beyond simple time-saving; the convenience of using contact lenses overnight means that many lenses are prescribed on this basis. However, it is important that any such use of lenses by a wearer is known to their contact lens practitioner so that the most suitable lenses are prescribed; in this case, silicone hydrogels would likely be the lens of choice because although the incidence of significant or serious keratitis has been shown to be similar for silicone hydrogel extended wear and conventional hydrogel extended wear, the severity of such an adverse event is lower when silicone hydrogels are worn.<sup>9</sup> It is also important that a wearer is made clear of the risks of overnight use of contact lenses to appropriately consent to this modality, and this can only be achieved if any such use is declared to the practitioner.

Using lenses beyond their recommended replacement schedule has been associated with an increase in infections in a recently-published report from Singapore.<sup>19</sup> The increased risk in this form of non-compliance may vary with different lens materials and would presumably be related to the degree of non-compliance, but a four-fold increase in risk compared with appropriately discarded lenses is clearly significant.

## Conclusions

This work has highlighted a number of areas where non-compliance with lens care steps is commonplace and where this behaviour has been associated with increased risks of significant or serious keratitis.

These areas of non-compliance should be considered when communicating with contact lens wearers – during clinical examinations, teach/dispensing appointments and at other opportunities such as when literature or information is sent to contact lens wearers in the post. The most effective manner in which this detail can be presented to a contact lens wearer is outside the scope of the current study.

Indeed, this is a very complex area, as previous work has shown that some methods of increasing information provision to contact lens wearers does not automatically lead to better compliance.<sup>28</sup>

The areas where improved compliance should lead to reduced risks for significant and serious keratitis are:

- Correct adherence to lens wearing schedules (not sleeping in lenses prescribed for daily wear and discarding lenses at the correct interval)
- Rub-cleaning and rinsing lenses to clean the lens surfaces and as an aid to disinfection

- Cleaning the lens case after each use and allowing it to air-dry
- Good handwashing before lens handling. ●

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