

## Demographics and Behaviour of Patients with Contact Lens-Related Infectious Keratitis in Singapore

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### Abstract

**Introduction:** This study aims to identify the demographics and hygiene behaviours associated with contact lens (CL)-related microbial keratitis in Singapore. **Materials and Methods:** The hygiene and social behaviours of lens wearers presenting with infectious keratitis in Singapore were examined using an externally validated questionnaire. Fifty-eight consecutive lens wearers who presented with infectious keratitis at Singapore National Eye Centre were surveyed using a self-administered questionnaire. Patients' demographics, CL-related behaviour, attitude to aftercare visits and microbial study results were collected and analysed. **Results:** More than half (55%) of the patients surveyed were female, and the average age of the participants was  $25.7 \pm 6.4$  years. Ninety-six percent of participants used soft CL, with the majority wearing monthly disposable lenses (74.1%). Myopia was the commonest reason for use of CL. CL overwear (81%), sleeping (50.9%) and swimming (33%) with their CL were the major non-compliant behaviours discovered. When encountered with eye discomfort as a result of lens-related infective keratitis, 83% of patients sought the advice of general medical practitioners prior to presentation at the hospital. Many (59%) patients have encountered media coverage but only 24% had any behavioural change as a result. Many patients relied on the recommendations of eyecare practitioners when purchasing disinfecting solutions (26%) and other hygiene practices. *Pseudomonas Aeruginosa* was the most common organism grown in 22.4% of patients while 47% of patients were culture-negative. **Conclusion:** Inadequate lens cleaning, poor aftercare, sleeping and swimming with CL were the major non-compliant behaviours among participants, and these are significant factors when assessing risks in acquiring CL-related infectious keratitis. General eyecare practitioners are the first-line of contact in patients presenting with keratitis symptoms and play an important role in emphasising the need for regular aftercare and good hygiene practices to CL wearers.

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**Key words:** Contact lens, Corneal ulcer, Infective keratitis

### Introduction

Contact lenses (CL) are a convenient method of correcting refractive error, and offer many advantages over spectacles. However, CL wear has its complications, which may be severe, resulting in vision loss. CL-related microbial keratitis is one of the most severe complications as it can lead to corneal scarring or perforation with permanent loss of vision.<sup>1</sup> In addition, microbial keratitis is also associated with a significant disease burden, including income loss due to days off work and treatment costs.<sup>2</sup>

Previous studies have identified several risk factors associated with CL wear complications in an attempt to encourage behaviour change among CL wearers and

minimise disease burden. Non-modifiable risk factors include male gender and a younger age of the CL wearer.<sup>3</sup> Modifiable risk factors include poor hand hygiene, inadequate lens cleaning, prolonged use of CL cases, lack of awareness of aftercare visit, water activity while wearing CL<sup>2,3</sup> and overnight CL use.<sup>4</sup> Recent associations of higher socioeconomic status and internet purchase with CL-related infections require further studies.<sup>5</sup>

Non-compliance to recommended CL use advice is a known problem among CL users.<sup>6</sup> Potential contributing factors are a lack of perceived direct threat and a lack of immediate benefits from following recommended practices.<sup>2</sup>

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A lack of awareness and advice about proper CL use may contribute to non-compliance.<sup>6</sup>

This study aims to identify the scope of hygiene behaviours and demographic profile of CL wearers with CL-related microbial keratitis in Singapore, with the aim of improving CL hygiene behaviour among the local population to minimise disease burden.

## Materials and Methods

A validated questionnaire regarding CL wear habits and hygiene behaviours<sup>2</sup> was modified to make it Singaporean centric.

Between January 2008 and May 2010, CL wearers between 15 and 64 years of age, presenting at the Singapore National Eye Centre with CL-related eye infections were invited to participate. These participants had to be CL wearers of at least once per week for the past 4 consecutive weeks. Exclusion criteria were those with previous corneal graft, refractive surgery, aphakia and those wearing CL for medical or therapeutic reasons.

Participants were not involved in any other CL clinical trials at the time of enrolment. Ethics approval for this study was granted by the Institutional Review Board and informed consent was obtained. Participants were recruited prospectively at their initial visit or during their hospital admission, and the attending ophthalmologist would invite them to complete the questionnaire.

Demographic data were collected, including gender, age, occupation, educational level, and income. In this questionnaire, the classification of occupation groups was based on those used by Singapore Department of Statistics in the General Household Survey 2005.<sup>7</sup> “Students” was added to the categories as a sizable proportion of students are seen wearing CL in our local population.

## Data Analysis

Analysis of demographic, hygiene behaviours and attitude to aftercare of the participants with CL-related eye infection was carried out using SPSS statistics 17.0.

## Results

Fifty-eight consecutive CL wearers with CL induced infectious keratitis participated in this study. The diagnosis of infectious keratitis was made by a corneal consultant at the Singapore National Eye Centre.

### Participants' Demographics

The average age of the total participants was  $25.7 \pm 6.4$  years, with a slightly higher percentage of female patients (55.2%). Eighty-six percent of participants were Singaporeans with the majority being Chinese (63.8%). English was the main language spoken at home in the

Table 1. Summary of Participants' Demographics

Average Age	25.7 ± 6.4 years
Gender Ratio	Male (44.8%) Female (55.2%)
Nationality	Singaporeans (86%)
Race Ratio	Chinese (63.8%); Malay (20.7%); Indian (10.3%); Other races (5.2%)
Language Spoken	English (56.9%); Mandarin (32.8%); Malay (22.4%); Tamil (3.4%)
Housing Mix	HDB flats (79.3%); Private housing (20.7%)
Average Household	4.67 people
Household Income*	67% of households earns <SGD4000
Education Qualification	60.4% of them holds professional qualifications of diploma & above
Profession Profile	Students† (29.3%); Professionals (24.1%); Managers (13.8%)

\*29.3% of households undisclosed their monthly income status.

†Mean age for student group is 20.4 years.

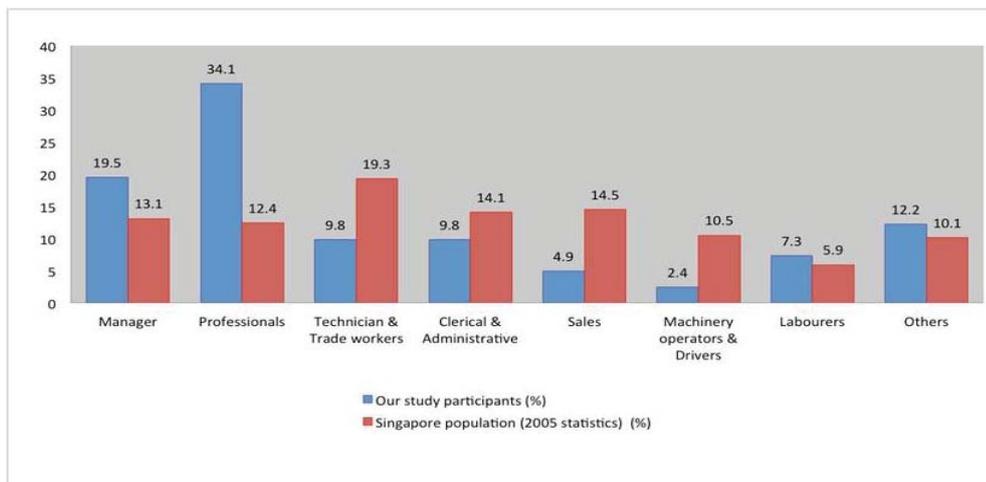


Fig. 1. Chart showing the occupational status of participants (excluding students).

majority of households. A summary of the participants' demographics is shown in Table 1. The occupational status of participants appeared to differ from Singapore's general population in the 2005 statistics<sup>7</sup> (Fig. 1), with the majority of participants being professionals.

### Lens Wear Modality and CL Purchase

As detailed in Table 2, the majority of participants surveyed used soft lenses (96.6%), while only 3.4% wore hard or rigid gas-permeable lenses. Of those using soft lenses, monthly disposables appeared to be the preferred choice (74.1%). Eighty-one percent (47/58) of participants wore CL for more than 8 hours a day, and 74.1% (43/58) wore CL for more than 4 days a week. Correction for myopia appeared to be the main reason for wearing CL (74.8%). Half (29/57) of participants reported having taken a nap with their CL on whilst a third of participants (19/58) reported having slept overnight with their CL on.

Ninety-seven percent (56/58) of participants usually obtained their CL from optometrists or optical outlets.

Table 2. Lens Wear Modality

Duration/Frequency of Lens Wear			
Wore more than 8hrs/day	81.0%	Wore less than 3 years	17.2%
Wore more than 4 days/week	74.1%	Wore more than 5 years	63.8%
Type of Contact Lenses Used			
Soft lenses	96.6%	Hard/rigid gas permeable lenses	3.4%
Daily	10.4%		
Fortnightly	13.8%		
Monthly	74.1%		
Yearly/Permanent	1.7%		
Purpose of Correction			
		Myopia	74.8%
		Hyperopia	8.1%
		Astigmatism	8.1%
		Other uses	2.7%
		Did not specify	6.3%
% of participants who nap with contact lenses on*			50.9%
		Daily	20.7%
		1 to 4 weekly	72.4%
		Hard lenses	6.9%
% of participants who slept overnight with contact lenses on†			32.8%
		Daily	15.8%
		1 to 4 weekly	78.9%
		Hard lenses	5.3%

\*24.1% of participants uses silicone hydrogel lenses.

†31.6% of participants uses silicone hydrogel lenses.

Common reasons for purchasing a particular brand of CL were recommendations by eyecare practitioners (optometrists or opticians) (38.5%), followed by suitability (35.4%), while common reasons for changing CL brands include discomfort (16.3%), and cost factor (14.3%). A summary of the participants' CL purchase profile is provided in Table 3.

### Aftercare Schedule Awareness

Forty-three percent (24/56) had their most recent routine aftercare visit to the optometrist/optician within the last 12 months, but 39.3% (22/56) participants had not had an aftercare visit for more than 2 years. Seventy-eight percent (45/58) of participants could not remember or claim that no advice was given on the recommended frequency of aftercare visits.

### Hygiene Practices

Lens wearers were questioned about what hygiene measures were carried out when CL were last handled, and a summary of the hygiene practices used by the participants is shown in Table 4. Most participants reported having washed their hands with water prior to handling CL (87.9%) and CL insertion and removal were carried out mainly in the bathroom (67.2%). Figure 2 shows a summary of multipurpose lens disinfection solution brands used by lens wearers. The average duration a bottle of disinfectant was kept open was 46 days (it has been recommended that

Table 3. Participants' Contact Lens Purchase Profile

Purchased Location			
Optometrist optical outlets		96.6%	
Other sources		3.4%	
Reasons for Purchasing a Particular Brand		Reasons for Changing Contact Lens Brand	
Recommendation by eyecare practitioners	38.5%	Discomfort	16.3%
Contact lenses suitability	35.4%	Cost factors	14.3%
Cost factors	16.9%	Dry eyes	12.2%
Did not specify		Lifestyle changes	12.2%
		Advice from eyecare practitioners	10.2%
		Did not specify	
Aftercare Schedule Awareness <sup>1</sup>			
Routine visit for the last 12 months		42.9%	
Did not have an aftercare visit for more than 2 years		39.3%	
Did not specify		17.9%	

<sup>1</sup>78% of participants unaware or not given any advice on the recommended frequency.

Table 4. Summary of Hygiene Practices

Washing of Hands Prior to Handling of Contact Lenses		Drying of Hands Prior to Handling of Contact Lenses	
Yes	87.9%	Yes	55.2%
No	12.1%	No	39.7%
		Unsure	5.2%
Insertion and Removal of Contact Lenses (Places)		Reasons for Choosing Disinfection Solution	
Bathroom	67.2%	Cost factors	26.0%
Bedroom	19.0%	Eyecare practitioner recommendation	26.0%
Kitchen	8.6%	Contact lens solution availability	21.0%
Other places	5.2%		
Size of Disinfectant Solution Bottles Purchased			
300 to 400 ml		59.3%	
Value packs		24.1%	
60 to 120 ml travel bottles		11.1%	
Other sizes		5.6%	
Cleaning Method (Contact Lenses)			
Rinse only			61.1%
Rinse and rub			31.5%
Did not specify			
Cleaning Method (Lens Cases)*			
Topping up disinfecting solution after previous use			11.1%
Participant rinse lens cases before topping up			64.8%
		Rinse with water	69.4%
		Rinse with disinfecting solution	22.2%
		Rinse with saline	8.3%
Did not specify			

\*Average usage of contact lens case is 4½ months; 31.5% of them air dried their lens cases after previous use while 68.5% of them did not; 19.3% of them do not replace their lens cases every 6 months.

Table 5. Summary of Water Activities, Wear-Related Problems and Participant Awareness

Water Activities and Lens Wear	
Showered with their contact lens on the last time they wore their contact lenses	46.6%
Swimming with their contact lenses on	32.8%
Wore goggles with their contact lenses on while swimming	33.3%
Swimming Locations	
Sea/river/lake	24.0%
Public pool	66.0%
Private pool	10.0%
Management of Contact Lens Wear-Related Problems*	
Management of contact lens wear discomfort†	
Stopping lens wear for a day	43.1%
Removing, rinsing, and reinserting the lens	29.2%
Using eye drops	16.7%
Continuing lens wear	8.3%
Did not specify	
Participants previously damaged a contact lens	
Discard lens and replace with new ones	90.0%
Use spectacles as backup	7.0%
Only wear lens on the unaffected eye	3.0%
Emergency measures‡	
Carry glasses	69.0%
Carry contact lens case	32.8%
Disinfecting solution	36.2%
Spare lenses	25.9%
Saline	25.9%

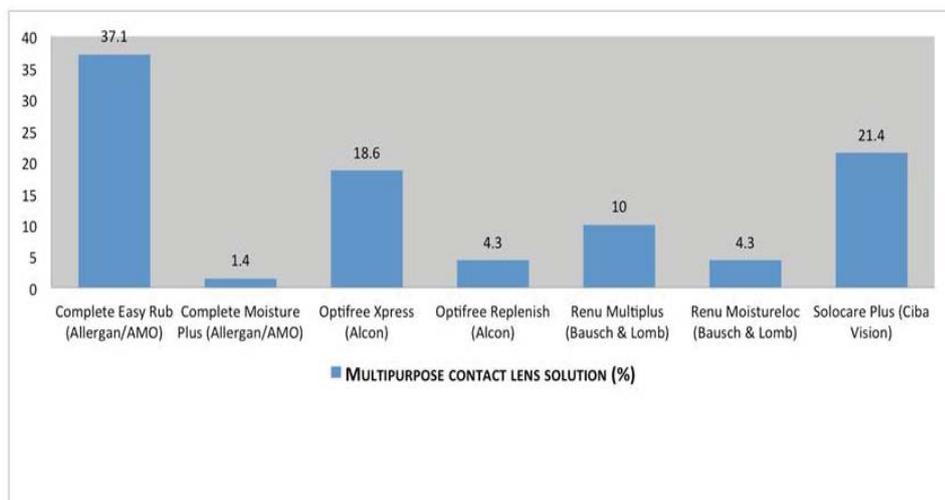


Fig. 2. Chart showing the types of multipurpose contact lens solutions used by participants.

Table 5. Summary of Water Activities, Wear-Related Problems and Participant Awareness (Con't)

Participant Awareness	
Media coverage on contact lenses in the past 2 years	58.6%
Resulted in participant behaviour change	23.5%
Possible consideration of refractive surgery	
Yes	41.4%
No	58.6%
Reasons for not doing refractive surgery§	
Costs	41%
Operative risks	17%
Advice against surgery by healthcare professionals	6%

\*96.6% of them have backup glasses adequate for their visual needs.

†31% of them recalled at least one previous contact lens-related eye problem requiring a visit to an eyecare provider.

‡For these questions, participants were allowed to choose more than one answer.

§For these questions, participants were allowed to choose more than one answer.

disinfecting solutions should be kept open no more than 60 days and saline 30 days). Of the 6 participants wearing daily disposable lenses, 3 admitted to reusing their lenses. All participants did not share their CL.

#### Water Activities and Lens Wear

Forty-seven percent (27/58) of participants recalled that they had showered with their CL on the last time they wore their CL. Thirty-three percent (19/58) of participants recalled that they had gone swimming while wearing their CL (Table 5), with the most common location being the public pool (67%).

#### Management of CL Wear-Related Problems

Thirty-one percent (18/58) of participants recalled at least one previous CL-related eye problem requiring a visit to an eyecare provider. A summary of the management practices adopted by participants when experiencing CL wear-related problems is detailed in Table 5.

#### Participant Awareness

More than half of participants have encountered media coverage on CL in the past 2 years, yet behaviour change resulted in only 24%. Forty-one percent (24/58) of participants have considered the possibility of refractive surgery. However, common reasons for not doing so include cost, operative risks and advice against surgery by healthcare professionals (Table 5).

Table 6. Summary of Infective Data in Participants

Participants Who Sought Professional Advice*	
Visited general practitioner	89.6%
Advice from other medical professionals (ie. company or school doctors)	10.4%
Onset of Symptoms Occurrence†	
Indoors	72.4%
Outdoor recreational areas	19.0%
Indoor recreational areas	3.4%
Other places	5.2%
Participants' Symptoms‡ (mean rating)§	
Decreased vision	1.21
Sensitivity to glare	1.78
Eye redness	2.38
Swollen eyes	1.58
Painful eyes	2.02
Organism Growth D	
<i>Pseudomonas aeruginosa</i>	22.4%
<i>Staphylococcus</i>	8.6%
<i>Serratia</i>	1.7%
Culture-negative	46.6%
Did not have culture-negative or specimens were rejected	20.7%

\*82.8% of participants had sought professional advice.

†Mean contact lens age at the time of infection was 29 days.

‡55.2% of participants suffered eye discomfort that required removal of their contacts within the past month.

§On a scale, with 0 (non-symptoms) to 3 (severe).

#### Infective Data

Mean duration of onset of symptoms prior to presentation at the hospital was 27 days, while median duration was 7 days. However, prior to presentation at the hospital, 83% (48/58) of participants had sought professional advice. A summary of the infective data is shown in Table 6. *Pseudomonas Aeruginosa* was the most common organism grown in 22.4% (13/58) of the patients while 47% (27/58) were culture-negative.

#### Discussion

This study aimed to explore the demographics, hygiene and aftercare behaviour and keratitis presentation among CL wearers in Singapore.

#### Demographics

Males and a young age are known demographic risk factors for CL-related complications.<sup>3</sup> In our study, the mean age of participants was 25.7 years, with a slight

female preponderance. This may be due to the larger number of female CL wearers in Singapore.<sup>8</sup> In previous studies, higher socioeconomic status was found to be associated with increased CL-related complications.<sup>5</sup> However, in our study, 70% of study participants had household incomes below the average Singaporean household income of S\$6826 (Singapore Statistics 2009). This may have been attributed to the sizeable 17% of participants who failed to disclose their household incomes. This can be shown by participants having higher educational qualifications compared to the general population. With CL infections affecting people of higher educational qualifications, the loss of productivity may have a significant economic impact to the country with respect to days of work lost.

### *CL Wear*

Participants were frequent CL users with three quarters of participants wearing CL for more than 4 days a week, and the majority wearing it more than 8 hours a day. Two thirds of participants were also experienced wearers with more than 5 years of use. Monthly disposable soft lenses were the most common type of lenses used. Soft lenses offer greater comfort over hard lenses, and monthly disposables are more economical than daily disposables. However, proper lens cleaning and storage are very important when using monthly disposables. The low proportion of patients wearing rigid gas permeable (RGP) lenses could be attributed to a similar proportion of RGP users in the general population and may not be significant in preventing CL-related infective keratitis. CL were most commonly used to correct myopia, likely due to the high prevalence of myopia in Singapore.<sup>9</sup> Most participants obtained their CL directly from optometrists or optical outlets. Online purchase of CL which has been associated with increase in non-compliance behaviours and decreased emphasis on regular aftercare was not common among study participants.<sup>10</sup> This may be due to the easy access to optical shops in Singapore that allows wearers to purchase lenses conveniently and immediately without having to wait for their online purchase. The prices of CL at local optical shops in Singapore are also comparable to those offered online.

Regular aftercare every 6 months or at least an annual visit is important as it allows early detection of ocular pathology,<sup>11</sup> and also provides an opportunity to assess wearers' compliance and provide appropriate eyecare advice.<sup>2</sup> However, less than half of study participants had sought routine aftercare in the past year, and three quarters could not remember or were never given advice on the recommended frequency of regular aftercare visits. This may be due to a lack of emphasis on the importance of regular aftercare in our fast-paced society, thus lens wearers tend to neglect going for aftercare visits. It highlights a need to

educate both CL wearers and opticians on the importance of such visits.

One third of participants reported sleeping overnight with their CL on. However, most did this infrequently, with only 1 person doing so more than 5 times a year. The hypoxia induced by overnight CL use causes physiologic changes in the corneal epithelium including compromised epithelial junctional integrity, increased epithelial fragility and punctate keratitis, resulting in increased susceptibility to microbial infection.<sup>12</sup> Theoretically, silicone hydrogels which reduce corneal hypoxia in CL wear should result in reduced CL-related infectious keratitis. However, overnight CL use is still not recommended, as studies have shown that overnight use increases the risk of CL-related infectious keratitis even with silicone hydrogel lens use.<sup>3</sup>

### *Hygiene Practices*

Non-compliance behaviours associated with CL-related infections include poor hand hygiene, inadequate lens cleaning, lack of regular CL case replacement, and water activity while wearing CL.<sup>2,3</sup>

In our study, only 12% of participants admitted to not washing their hands prior to handling CL. However, the perceived good hand hygiene compared to other studies<sup>13,14</sup> may not be an accurate reflection. Participants were asked if they washed their hands prior to handling CL. However, the questionnaire did not ask if participants used soap that is needed for adequate hand hygiene. Hence, this emphasises the need for healthcare professionals to be detailed when educating CL wearers on hygiene practices. Furthermore, less than one third of participants recalled rinsing and rubbing their contacts prior to storage. The majority of study participants replaced their lens storage case at least once every 6 months, and disinfecting solution bottles were kept open for an average of 1½ months. It has been recommended that CL users replace their CL case every 3 months, and discard their bottle of solution according to the specific CL cleaning and storage guidelines stated by the manufacturer.<sup>15</sup>

CL offer many advantages over spectacles for water activities; other studies have found a high level of CL wear among those who engage in water activities ranging from 56% to 60%.<sup>2,13,16</sup> However, in our study, only one third of participants swam with their CL on, usually at a public pool. Of these, one third wore goggles or used daily disposables while swimming. Water activities may not be a major non-compliance factor among study participants, but there is room for improvement in educating wearers who do engage in water activities to use goggles or daily disposable lenses.

### Participant Awareness

Compliance is defined as a behaviour that follows recommendations. Before attributing CL wearers' behaviour to non-compliance, one must establish if adequate and accurate instructions or recommendations were imparted to lens wearers.

Only 60% of participants have encountered media coverage on CL in the past 2 years. Of these participants, the media failed to bring about behaviour change in the majority. It may be due to the lack of perceived direct threat that the common practice of wearing CL may potentially result in infection and vision loss if proper hygiene is not practised. Further studies also need to be carried out on the adequacy and accuracy of information from the media.

Most participants purchase their CL from optometrists or optical outlets. Hence, eyecare professionals form the major line of interaction with wearers. Furthermore, many choose the brand of lens or disinfecting solution based on their eyecare practitioners' recommendations, which shows that eyecare practitioners' advice have a significant impact on wearers and hence, more emphasis should be placed on enlisting their help to improve the eyecare behaviour of wearers.

### Infective Data

The average duration of symptom onset to hospital presentation was 27 days, and most had sought prior professional medical advice usually at a general practitioner. The most severe complaints were eye redness and painful eyes. This highlights the important role of general eyecare practitioners in the management of patients with CL-related keratitis. Microbiologic investigations have shown to have only a moderate sensitivity of 50% in infective keratitis, which may account for almost half of participants having culture-negative results. This makes clinical diagnosis of infective keratitis imperative for the commencement of empirical antimicrobial treatment. *Pseudomonas Aeruginosa* was the most common organism grown followed by *Staphylococcus* species. The virulence of *Pseudomonas Aeruginosa* lies in its ability to invade and replicate within corneal epithelial cells allowing the bacteria to evade many extracellular defences, and its cytotoxic effect on these cells.<sup>17</sup>

As our study was only conducted on patients with CL-related infectious keratitis within a single institution, our sample size may not be entirely representative of the Singaporean community at large, hence the selection bias. However, the results shown by this study may form a platform for a larger community-based case control study to be conducted in the future. In view of the sizeable 17% of our study participants who declined to disclose their

household incomes, hygiene habits that were found to be closely related to an increased likelihood of infectious keratitis may be confounded by socioeconomic factors. In addition, all retrospective questionnaire-administered studies may be limited by the presence of recall bias, in which patients may over- or under-recall the usage of disinfecting solutions or other hygiene practices whilst cleaning their lenses.

### Conclusion

Inadequate lens cleaning and poor aftercare were the major non-compliant behaviours among participants, while others include sleeping and swimming with contacts, and this clearly is a significant factor when assessing risks in acquiring infectious keratitis associated with CL wear. Although most participants practised hand hygiene, we were unable to ascertain whether this was adequate. General practitioners are the first-line of contact in patients presenting with keratitis symptoms, with the most common organism being *Pseudomonas Aeruginosa*. Eyecare practitioners have a greater influence on lens wearers than the media, in view of their accessibility and frequency of contact with lens wearers, and play an important role in emphasising the need for regular aftercare and good hygiene practices to CL wearers.

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### REFERENCES

1. Palmer ML, Hyndiuk RA. Contact lens-related infectious keratitis. *Int Ophthalmol Clin* 1993;33:23-49.
2. Wu Y, Carnit N, Stapleton F. Contact lens user profile, attitudes and level of compliance to lens care. *Cont Lens Anterior Eye* 2010;33:183-8.
3. Dart JK, Radford CF, Minassian D, Verma S, Stapleton F. Risk factors for microbial keratitis with contemporary contact lenses: a case-control study. *Ophthalmology* 2008;115:1647-54.
4. Edwards K, Keay L, Naduvilath T, Snibson G, Taylor H, Stapleton F. Characteristics of and risk factors for contact lens-related microbial keratitis in a tertiary referral hospital. *Eye (Lond)* 2009;23:153-60.
5. Fogel J, Zidile C. Contact lenses purchased over the internet place individuals potentially at risk for harmful eye care practices. *Optometry* 2008;79:23-35.
6. Claydon BE, Efron N. Non-compliance in contact lens wear. *Ophthalmic Physiol Opt* 1994;14:356-64.
7. Singapore Department of Statistics in the General Household Survey 2005. Available at: [www.singstat.gov.sg/pubn/popn/ghsr1.html](http://www.singstat.gov.sg/pubn/popn/ghsr1.html). Accessed 1 October 2010.

8. Morgan PB, Efron N, Woods CA, Jones D, Tranoudis IG, van der Worp E, et al. International Contact Lens Prescribing 2002. Survey results from eight countries provide a snapshot of contact lens prescribing around the world. *Contact Lens Spectrum* 2002. Available at: <http://www.clspectrum.com/articleviewer.aspx?articleID=12086>. Accessed 1 October 2010.
  9. Seet B, Wong TY, Tan DT, Saw SM, Balakrishnan V, Lee LK, et al. Myopia in Singapore: taking a public health approach. *Br J Ophthalmol* 2001;85:521-6.
  10. Stapleton F, Keay L, Edwards K, Naduvilath T, Dart JK, Brian G, et al. The incidence of contact lens-related microbial keratitis in Australia. *Ophthalmology* 2008;115:1655-62.
  11. Veys J, Meyler J, Davies I. *Essential Contact Lens Practice*. 1st ed. Oxford: Butterworth-Heinemann, 2002.
  12. Liesegang TJ. Contact lens-related microbial keratitis: Part I: Epidemiology. *Cornea* 1997;16:125-31.
  13. Sokol JL, Mier MG, Bloom S, Asbell PA. A study of patient compliance in a contact lens-wearing population. *CLAO J* 1990;16:209-13.
  14. Yung AM, Boost MV, Cho P, Yap M. The effect of a compliance enhancement strategy (self-review) on the level of lens care compliance and contamination of contact lenses and lens care accessories. *Clin Exp Optom* 2007;90:190-202.
  15. The American Academy of Ophthalmology, the Contact Lens Association of Ophthalmologists, the Cornea Society and the American Society of Cataract and Refractive Surgery joint guidelines and recommendations. Available at: <http://www.geteyesmart.org/eyesmart/glasses-contacts-lasik/contact-lens-care.cfm>. Accessed 1 February 2013.
  16. Bowden T, Harknett T. Contact lens wearer profile 2004. *Cont Lens Anterior Eye* 2005;28:37-45.
  17. Fleiszig SM, Evans DJ. The pathogenesis of bacterial keratitis: studies with *Pseudomonas aeruginosa*. *Clin Exp Optom* 2002;85:271-8.
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