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Personal hygiene risk factors for contact lens-related microbial keratitis

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ABSTRACT

Objective Microbial keratitis is a sight-threatening complication of contact lens wear, which affects thousands of patients and causes a significant burden on healthcare services. This study aims to identify compliance with contact lens care recommendations and identify personal hygiene risk factors in patients who develop contact lens-related microbial keratitis.

Methods and analysis A case–control study was conducted at the University Hospital Southampton Eye Casualty from October to December 2015. Two participant groups were recruited: cases were contact lens wearers presenting with microbial keratitis and controls were contact lens wearers without infection. Participants underwent face-to-face interviews to identify lens wear practices, including lens type, hours of wear, personal hygiene and sleeping and showering in lenses. Univariate and multivariate regression models were used to compare groups.

Results 37 cases and 41 controls were identified. Showering in contact lenses was identified as the greatest risk factor (OR, 3.1; 95% CI, 1.2 to 8.5; p=0.03), with showering daily in lenses compared with never, increasing the risk of microbial keratitis by over seven times (OR, 7.1; 95% CI, 2.1 to 24.6; p=0.002). Other risks included sleeping in lenses (OR, 3.1; 95% CI, 1.1 to 8.6; p=0.026), and being aged 25–39 (OR, 6.38; 95% CI, 1.56 to 26.10; p=0.010) and 40–54 (OR, 4.00; 95% CI 0.96 to 16.61; p=0.056).

Conclusion The greatest personal hygiene risk factor for contact lens-related microbial keratitis was showering while wearing lenses, with an OR of 3.1, which increased to 7.1 if patients showered daily in lenses. The OR for sleeping in lenses was 3.1, and the most at-risk age group was 25–54.

Key messages

What is already known about this subject?

- Contact lens-related microbial keratitis (CLMK) causes significant burden on patients and healthcare services. Previous papers have identified certain risk factors for developing CLMK, such as type of contact lenses worn, hand hygiene and overnight wear.

What are the new findings?

- Our case–control trial is unique in that it uses face-to-face interviews to, not only identify contact lens hygiene practices, but to also capture patient opinions and experiences. We demonstrate for the first time the dose-dependent effect of showering in contact lenses. Showering in contact lenses increases the risk of CLMK (OR 3.1), while showering daily in lenses compared with never showering in lenses, increases the risk of microbial keratitis by over seven times (OR 7.1). Sleeping in lenses and being aged 25–39 are also significant risks. Our study also shows that despite most contact lens wearers buying their lenses from opticians and having regular follow-up appointments, contact lens wearers continue to perform poor hygiene practices.

How might these results change the focus of research or clinical practice?

- Focusing attention on improving contact lens education of infection and retention of information may help improve compliance with lens wear practices, which may help reduce incidence of CLMK.

INTRODUCTION

Contact lenses for visual correction offer many benefits to the 4 million wearers in the UK, yet contact lens-related microbial keratitis (CLMK) is a frequent cause of unilateral visual impairment.[1–3] Severe cases can result in permanent vision loss, a need for corneal transplant or loss of the eye. In all healthcare systems, CLMK poses a significant healthcare challenge as patients require intensive topical antimicrobial therapy and close monitoring of treatment response.[2–4]

Despite advances in contact lens technology, the incidence of CLMK has remained consistent at around 4 per 10 000 daily contact lens wearers per annum.[5–7] Poor contact lens hygiene is a known contributor to microbial keratitis. In a study by Brewitt *et al*,[8] 66% of complications observed in contact lens wearers were attributed to poor hygiene practices. There is great variation in contact lens hygiene awareness and recognition of the risks among regular contact lens wearers. Aftercare practices and demographic trends of contact lens wearers have been previously investigated to identify risk factors for microbial keratitis.[2 9–12] This study aims to identify patient demographics and current

compliance with contact lens care recommendations by contact lens wearers in the UK. The study also aims to identify modifiable risk factors for patients who develop CLMK, including, types of lenses worn, lens wearing habits, aftercare habits and water exposure. Further aims included analysing patient opinions and experience on contact lens wear and microbial keratitis. Our study is unique in that we used face-to-face interviews, to be able to accurately capture patient hygiene practices and experiences of CLMK.

METHODS

In this study, we interviewed contact lens wearers to compare contact lens hygiene practices in lens wearers with CLMK (cases) and lens wearers without infection (controls). Ethics committee approval was obtained from University of Southampton Ethics and Research Governance Online (ERGO reference: 14394).

Participant recruitment

Contact lens wearers attending University Hospital Southampton Eye Casualty between October 2015 and December 2015 were identified. A convenience sampling method was adopted, whereby patients who were identified to be contact lens wearers at triage were approached to take part. Participants were included if they were aged 18–75 and had worn refractive or cosmetic contact lenses for the last 30 days before attendance. Participants with therapeutic lenses, other ocular surface disease, herpes simplex keratitis, significant mental illness or learning disability were excluded.

Cases of CLMK were defined as contact lens wearers having a diagnosis of microbial keratitis made by an ophthalmologist for the first time or within the preceding 1 month prior to interview. Only patients with active infection, and who were still being treated or followed up for CLMK were included. Microbial keratitis was defined as

1. a positive culture from a corneal scrape or
2. a corneal infiltrate and overlying epithelial defect associated with either
   i. the lesion being within central 4 mm of the cornea, or
   ii. uveitis.

Controls were defined as contact lens wearers attending Eye Casualty for non-contact lens-related problems, and who had no previous history of corneal or infective complications from contact lens wear.

Data collection and questionnaires

Participants were given a patient information sheet and consent was obtained. A single trained researcher who had a medical background but was external to the eye department, conducted face-to-face interviews in a private room using a standardised questionnaire. The questionnaire was internally validated[13] by the research team, after trialling it in a pilot study with patients.

Both patient groups (CLMK and controls) were asked the same questions about demographics, and risk factors relating to contact lens wear and aftercare. Patients with CLMK were asked additional questions relating to their infection. This is summarised in table 1. Participants were able to withdraw from the study at any time.

Definitions of categories

Frequency of wear and frequency of performing a certain hygiene practice was categorised into daily (7 days a week), few times a week (between once to six times a week), few times a month (less than once per week, but more than once a month) and few times a year (less than once in a month to once in a month).

Data analysis

Data analysis was done using SPSS V.22. Mann-Whitney U and Pearson χ^2 test were used to compare demographic data. Risk factors were first analysed individually using simple binomial logistic regression to determine ORs, 95% CIs and p values. Risk factors with a significance $p<0.2$ were considered in the multivariate model using stepwise multiple logistic regression. Only risk factors with significance $p<0.05$ were included in the final model.

Patient and public involvement

Patients were involved in the study design. The questionnaire was designed by the research team and was trialled in a pilot study with patients with CLMK. The questionnaire was further improved based on the patient priorities and experiences of CLMK identified during the pilot study. Our study was designed to be conducted via face-to-face interviews, due to patient preference.

RESULTS

Demographics and contact lens types

Seventy-eight participants were recruited into the study (41 controls, 37 cases of CLMK), and no participants dropped out. Patient demographics and baseline characteristics are shown in table 2. Soft monthly disposable contact lenses were the most commonly worn (43%) contact lens type in our cohort. Table 2 also shows the breakdown of contact lens type and frequency of wear.

Univariate analysis

Univariate analysis was used to calculate risk factors for CLMK, as shown in table 3. Showering in lenses was the greatest modifiable risk factor (OR, 3.1; 95% CI, 1.2 to 8.5; p=0.025), with a dose-dependent effect. The OR for showering in lenses daily, compared with never, was 7.1 (OR, 7.1; 95% CI, 2.1 to 24.6; p=0.002). Sleeping in contact lenses also increased the risk of microbial keratitis (OR, 3.1; 95% CI, 1.1 to 8.6; p=0.026), as did being aged 25–39, when compared with being aged >55 (OR, 6.38; 95% CI, 1.56 to 26.10; p=0.010).

Multivariate analysis

The multivariate analysis model showed that age, contact lens type and showering in lenses were risk factors which reached statistical significance (table 4). The OR for being aged 25–39 was 8.16 (95% CI, 1.45 to 46.05;

Table 1 Data collected for cases and controls in standardised face-to-face questionnaire

	Collected data	Description
Data collected for cases and controls	Demographics	Age, sex
	Lens type	RGP, SDD, STWD, SMD or SEW
	Wear habits and water exposure	Wear frequency, wear duration Sleeping in lenses Showering/bathing in lenses Swimming in lenses
	Hygiene practices	Hand washing before handling lenses Lens case use, storage location and replacement frequency Contact lens soaking duration
	Lens purchasing history and follow-up	Frequency of contact lens aftercare appointment with contact lens practitioner Where lenses are purchased Were lens infections/complications explained when lenses first prescribed? Who should be responsible for providing information about risks of contact lens wear? How lens care advice should be given
Additional data collected for cases of CLMK	Subjective vision loss after infection	None, mild, moderate or severe
	Thoughts of giving up contact lenses after infection	Concerns over recurrence, vision loss, memories of symptoms
	Quality of life after infection	Affecting work, sight, sports, daily activities, physical appearance

Additional data were collected for cases of CLMK regarding patient experiences following infection.
CLMK, contact lens-related microbial keratitis; RGP, rigid gas permeable; SDD, soft daily disposable; SEW, soft extended wear; SMD, soft monthly disposable; STWD, soft 2-week disposable.

p=0.017), and the OR for being aged 40–54 was 7.78 (95% CI, 1.31 to 36.28; p=0.024), when compared with being aged >55. The OR for showering daily in lenses was 13.73 (95% CI, 2.35 to 80.07; p=0.004), when compared with never showering in lenses. The OR for wearing soft daily disposable was 16.76 (95% CI, 1.09 to 257.56; p=0.043) and soft 2-week disposable was 26.07 (95% CI, 1.18 to 577.16; p=0.039).

Visual outcomes and attitudes towards contact lenses after CLMK

In our cohort, the majority of patients felt that their infective episode had not resulted in significant visual loss. About 55.6% of patients with CLMK (n=20) felt that their infective episode had affected their quality of life, and of these patients, the breakdown of how their life was affected is shown in figure 1A. Figure 1B shows subjective visual outcomes following CLMK. Most patients (86.5%, n=32) had not considered discontinuing contact lens wear after an infective episode of microbial keratitis. Of the few patients who wished to discontinue contact lens wear (13.5 %, n=5), the greatest reason was fear of having another infection (n=3), fear of permanent sight loss (n=1) and recurrent memories of symptoms (n=1).

Responsibility of contact lens education

Participants were asked if they were told the risks of infections when first prescribed contact lenses, and nearly half of both patients with CLMK and control groups responded with either 'no' or 'not sure'. The responses were not statistically different between controls and patients with CLMK (figure 1C). Participants were asked whom they felt was responsible for providing education about contact lens-related complications. Ninety-two (n=71) per cent of respondents felt that contact lens education was the responsibility of the 'optician', 13.0% (n=10) stated 'self' and 1.3% (n=1) stated 'doctor' (with some participants choosing more than one option). Participants were asked how they thought advice and instructions about contact lens wear should be given. About 54.5% (n=42) of participants felt written information, 68% (n=52) felt verbal information and 48% (n=37) felt demonstrations (48.1 %, n=37) would help improve education.

Compliance with annual contact lens aftercare appointments with optician

About 80.8% (n=63) of all participants in the study were compliant with attending appointments at least annually. About 83.7% (n=31) of patients with microbial keratitis, and 78% (n=32) of controls reported that they were attending appointments at least annually.

DISCUSSION

Risk factors for CLMK

Our study is unique in that, not only does it investigate risk factors for microbial keratitis, but it also analyses the

Table 2 Demographic information for participants and information regarding contact lens types and contact lens wear frequency

	Controls n=41	Cases n=37	Total n=78	P value
Patient demographics				
Male, n (%)	12 (32)	17 (46)		0.128*
Mean age, years (range)	41.0 (20–73)	39.5 (19–69)		0.764†
Age categories				
<24, n (%)	12 (29)	4 (11)		
25–39, n (%)	8 (20)	17 (46)		
40–54, n (%)	9 (22)	12 (32)		
>55, n (%)	12 (29)	4 (11)		
	Controls n=40 (%)‡	**Cases n=36 (%)‡**	**Total n=76 (%)‡**	
Contact lens type and wear frequency				
SDD wear frequency n=25 (33%)				
Daily wear	5 (36)	8 (73)	13 (52)	
Few times a week	6 (43)	1 (9)	7 (28)	
Few times a month to few times a year	3 (21)	2 (18.2)	5 (20)	
SMD wear frequency n=33 (43%)				
Daily wear	11 (69)	13 (77)	24 (73)	
Few times a week	5 (31)	4 (24)	9 (27)	
Few times a month to few times a year	0	0	0	
STWD wear frequency n=9 (12%)				
Daily wear	2 (67)	4 (67)	6 (67)	
Few times a week	1 (33)	2 (33)	3 (33)	
Few times a month to few times a year	0	0	0	
SEW frequency n=3 (4%)				
Daily wear	1 (50)	1 (100)	2 (67)	
Few times a week	1 (50)	0	1 (33)	
Few times a month to few times a year	0	0	0	
RGP wear frequency n=6 (8%)				
Daily wear	3 (60)	1 (100)	4 (67)	
Few times a week	2 (40)	0	2 (33)	
Few times a month to few times a year	0	0	0	

*Not significantly different (Pearson χ^2).
†Not significantly different (Mann-Whitney U test).
‡Two contact lens types unknown (one each from control and case group) and excluded in this analysis.
RGP, rigid gas permeable; SDD, soft daily disposable; SEW, soft extended wear; SMD, soft monthly disposable; STWD, soft 2-week disposable.

opinions of patients after corneal infection. This gives useful insight into how contact lens practitioners can improve patient education and compliance. This was only possible with face-to-face interviews as it allowed for a lot of detail to be gathered from participants, and also ensured full completion of the questionnaire. Completing the questionnaire did not lengthen waiting times, which meant that no patients dropped out of the study. Our most significant risk factors for CLMK identified included showering in contact lenses, being aged 25–54 and wearing certain soft contact lenses.

Monthly contact lenses were the most frequently used contact lens type in our patient cohort. All forms of contact lens wear increase the risk of microbial keratitis but monthly and extended wear contact lenses have previously been shown to increase risk of sight loss.[1–3] Although monthly disposable lenses also increase the risk of infection, this did not reach statistical significance. In our patient group, 10.8% of patients reported significant sight loss, while 56.8% reported no change in their vision.

Pseudomonas aeruginosa is the most commonly identified pathogen among contact lens wearers followed by

Table 3 Independent risk factors for CLMK identified by univariate analysis, including patient demographics, contact lens wear habits, water exposure, hygiene practices and purchasing and aftercare follow-up history

Risk factor	OR	95% CI	P value
Demographics			
Age			
>55	1.00 (referent)		
<24	1.00	0.20 to 4.96	1.000
25–39	6.38	1.56 to 26.10	0.010**
40–54	4.00	0.96 to 16.61	0.056
Gender			
Female	1.00 (referent)		
Male	2.05	0.81 to 5.22	0.131
Contact lens wear habits			
Contact lens type†			
RGP	1.00 (referent)		
SDD	3.93	0.34 to 38.70	0.241
STWD	10.00	0.78 to 128.78	0.077
SMD	5.31	0.56 to 50.55	0.146
SEW	2.50	0.10 to 62.61	0.577
Frequency of wear			
Few times a month	1.00 (referent)		
Few times a week	0.70	0.10 to 5.18	0.727
Daily	1.83	0.28 to 11.88	0.528
Hours of contact lens wear			
1–8 hours	1.00 (referent)		
8–12 hours	2.25	0.39 to 13.17	0.368
12–18 hours	3.53	0.63 to 19.8	0.152
Continuous wear	4.50	0.41 to 49.63	0.219
Sleeping in contact lenses			
No	1.00 (referent)		
Yes	3.14	1.15 to 8.63	0.026*
Frequency of sleeping in contact lenses			
Never	1.00 (referent)		
Few times a year	2.33	0.67 to 8.06	0.183
Few times a month	1.46	0.19 to 11.12	0.718
Daily	2.18	0.34 to 14.15	0.413
Showering in contact lenses			
No	1.00 (referent)		
Yes	3.13	1.16 to 8.47	0.025*
Frequency of showering in contact lenses			
Never	1.00 (referent)		
Few times a year	0.59	0.06 to 6.18	0.663
Few times a month	2.38	0.54 to 10.53	0.255
Few times a week	1.70	0.41 to 6.98	0.464
Daily	7.13	2.06 to 24.61	0.002**
Swimming in contact lenses			
No	1.00 (referent)		
Yes	0.85	0.34 to 2.13	0.723
Frequency of swimming in contact lenses			
Never	1.00 (referent)		
Few times a year	0.92	0.34 to 2.46	0.580
Few times a month	0.58	0.043 to 5.874	0.229
Personal hygiene factors			
Compliance with hand washing prior to handling contact lenses			
Always	1.00 (referent)		
Most of the time	0.39	0.14 to 1.10	0.075
Occasionally	0.41	0.04 to 4.85	0.482
How hands are washed			
Soap and water	1.00 (referent)		
Water only	1.27	0.48 to 3.34	0.628
Use of contact lens case			
Do not use case	1.00 (referent)		
Use case	1.07	0.42 to 0.27	0.894
Contact lens case storage location			
Bedroom	1.00 (referent)		
Bathroom	0.53	0.16 to 1.82	0.314
Frequency of replacing contact lens case			
Monthly	1.00 (referent)		
1–3 months	0.46	0.10 to 2.17	0.328
3+ months	1.94	0.51 to 7.32	0.329
Purchasing lenses and follow-up history			
Where contact lenses are purchased			
Optician	1.00 (referent)		
Internet	0.55	0.09 to 3.18	0.500
Other	2.18	0.19 to 25.2	0.532
Were risks of infections explained when lenses were first prescribed?			
Yes	1.00 (referent)		
No	1.26	0.39 to 4.15	0.700
Not sure	0.85	0.30 to 2.39	0.758
Compliance with follow-up appointments (at least annually)			
Yes	1.00 (referent)		
No	1.20	0.47 to 3.07	0.700
Frequency of contact lens aftercare appointments with optician			
Every 3–6 months	1.00 (referent)		
Every 6–12 months	1.60	0.58 to 4.41	0.360
Less than annually	0.68	0.11 to 4.41	0.688
Never	1.09	0.24 to 4.03	0.911

**p<0.05. **p<0.01.
†Two contact lens types unknown and excluded in this analysis.
RGP, rigid gas permeable; SDD, soft daily disposable; SEW, soft extended wear; SMD, soft monthly disposable; STWD, soft 2-week disposable.

Gram-positive organisms.[3] *P. aeruginosa* is able to adhere and colonise contact lens materials during lens wear, survive in contact lens storage cases and has resistance to contact lens disinfectants.[14] *Acanthamoeba*e are free-living

Table 4 Independent risk factors for CLMK identified by multiple logistic regression analysis

Risk factor	OR	95% CI	P value
Age			
>55	1.00 (referent)		
<24	1.78	0.28 to 11.26	0.541
25–39	8.16	1.45 to 46.05	0.017*
40–54	7.78	1.31 to 46.28	0.024*
Contact lens type†			
RGP	1.00 (referent)		
SDD	16.76	1.09 to 257.56	0.043*
STWD	26.07	1.17 to 577.16	0.039*
SMD	10.33	0.72 to 148.27	0.086
SEW	1.58	0.04 to 71.50	0.813
Frequency of showering in contact lenses			
Never	1.00 (referent)		
Few times a year	0.38	0.03 to 4.89	0.454
Few times a month	1.55	0.27 to 8.90	0.626
Few times a week	3.24	0.58 to 18.05	0.181
Daily	13.73	2.35 to 80.07	0.004**

*p<0.05. **p<0.01.
†Two contact lens types unknown and excluded in this analysis.
RGP, rigid gas permeable; SDD, soft daily disposable; SEW, soft extended wear; SMD, soft monthly disposable; STWD, soft 2-week disposable.

cysts, forming ubiquitous protozoa found in air, dust, soil and fresh water. They are highly resistant to disinfection with chlorine and are thus not eradicated from tap water.[15 16] For this reason, showering, swimming or washing contact lenses in fresh water can be considered risk behaviours. In our study, showering while wearing lenses was identified as a significant independent risk factor for CLMK. The univariate regression model showed the OR for showering in lenses was 3.1 (95% CI, 1.2 to 8.5; p=0.025), with a dose-dependent effect. The OR for showering in lenses daily, compared with never, was 7.1 (95% CI, 2.1 to 24.6; p=0.002). The OR for showering daily in lenses in the multiple regression model was 13.73 (95% CI, 2.35 to 80.07; p=0.004).

Equally, our study showed that sleeping in contact lenses increased the risk of microbial keratitis (OR, 3.1; 95% CI, 1.1 to 8.6; p=0.026) in the univariate model but this was not significant in the multivariate model. The effect of sleeping in lenses was replicated from previous studies,[9 10 12] but these studies looked at overnight wear, whereas our study looked at sleeping in lenses for different amounts of time. The effects of contact lens-related hypoxia are likely increased in sleeping patients as oxygen diffusion is compromised when eyes are shut for a long time. Studies have shown that hypoxia can lead to increased binding of *Pseudomonas* to the cornea when a contact lens is present.[17]

Following an episode of CLMK, very few of our patients considered discontinuing contact lens wear. Of those whose quality of life or vision had been affected by the infection, 80% (n=20) wished to continue wearing their lenses, demonstrating the benefits that contact lens wear provide but also the importance of instilling good contact lens hygiene awareness and reinforcing this information when attending eye casualty. A large number of our participants (92.2%, n=72) identified the optician as being responsible for providing information about contact lens-related complications. Nearly half of all participants in both control and CLMK groups could not recall or were unsure if they were told specifically about the risks of contact lens-related infections when first prescribed their contact lenses (figure 1c).

Under guidance from College of Optometrists UK, contact lenses can only be fitted and prescribed by optometrists, doctors and contact lens opticians. Dispensers of contact lenses are required to give training and information about lens care, hygiene and wear schedules before lenses can be dispensed. About 89.2% (n=33) of the patients who developed microbial keratitis, stated that an optician supplies them with their contact lenses. The British Contact Lens Association (BCLA) recommends contact lens aftercare appointments at least annually. As shown in table 3, *non-compliance* with annual aftercare appointments was *not* found to be a risk factor for microbial keratitis. There was a high level of reported compliance in attending annual follow-up appointments, in both cases and control group. A 2010 Australian study[18] looking at contact lens compliance found similar results.

These findings are rather confusing, as despite regular follow-up with opticians and perceived good concordance with BCLA recommendations, patients' understanding and retention of contact lens hygiene and risk behaviour remains low. As patients are likely to want to continue wear lenses even after an infective episode, contact lens practitioners should focus efforts on improving patient retention of information about infections and aftercare practices, because persuading patients to stop wearing contact lenses may be ineffective.

Our study demonstrated that all three forms of information—verbal, demonstrations and written—were important for contact lens wearers to improve education about lens wear and complications. A possible way to increase awareness may be to supply printed material with each contact lens box to remind them about risks and aftercare practices.

A limitation of the study was that controls were also eye casualty attendees, presenting with other ocular problems, which could have introduced bias into the control group. These patients, however, presented with non-ocular surface problems and non-contact lens-related issues, which were typical for any person attending the department. To limit recall bias in the CLMK cases group, only patients who were newly diagnosed with CLMK and still had active infection were included in the study. The questionnaire used was developed and validated by the

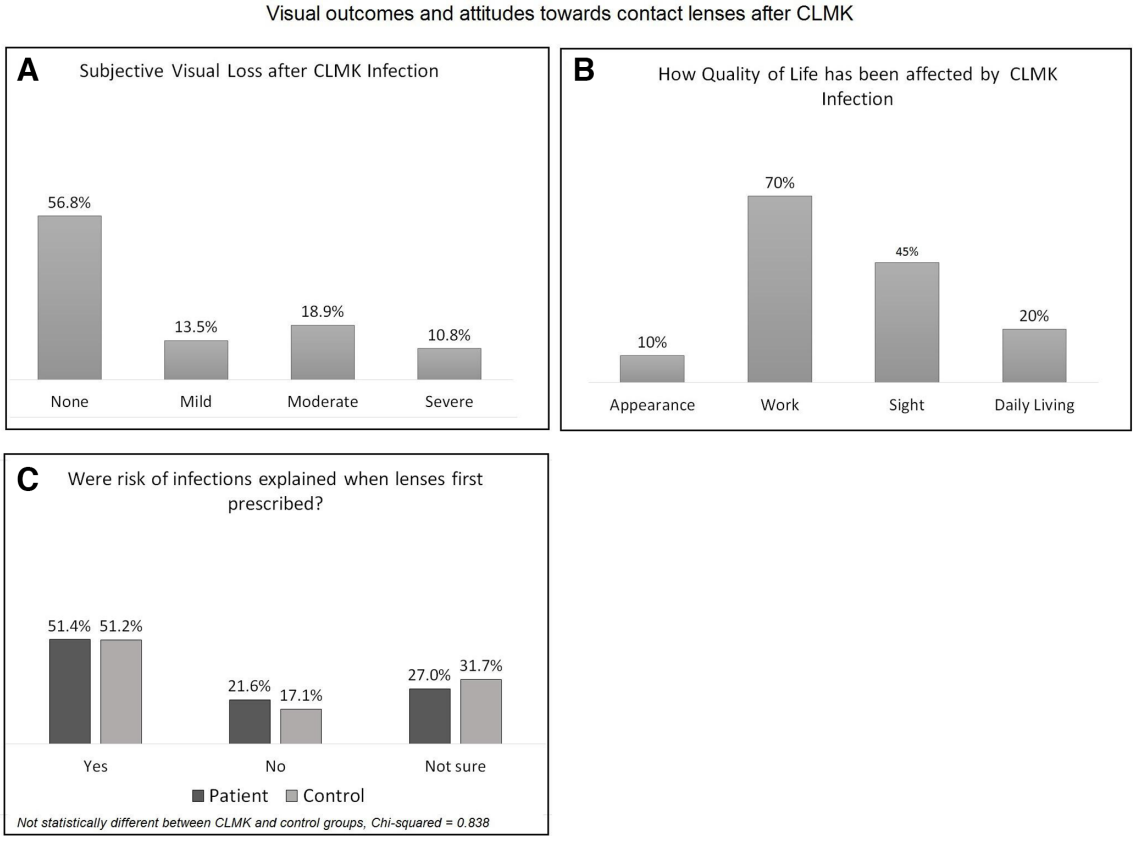

Figure 1 Graphs showing how the recent CLMK episode (A) subjectively affected patients' vision (B) and quality of life (more than one option could be chosen for this question) and (C) Responses for question: 'Were risks of infections explained when lenses first prescribed?' CLMK, contact lens-related microbial keratitis.

research team, and face-to-face interviews were chosen to accurately obtain data. To limit interviewer bias and limit influencing participant responses, only one researcher who was not involved in patient care, conducted the interviews in a standardised manner. A limitation was that the OR and CI ranges in the multivariate model were large. A larger sample size would be needed to calculate a more precise estimate of effect.

Risk factors that could be investigated further include: overall duration (eg, in years) of contact lens wear, smoking history, socioeconomic status, ethnicity and reason for contact lens wear (hyperopia, myopia, presbyopia or cosmetic). A multicentre study with a larger sample size could reduce sample bias, help evaluate risks and demographics further, and could show trends on regional and national levels. Precision and the number of significant results may also be improved. An interesting area for future work would be to further investigate the effect of showering in contact lenses, and to identify which organisms are isolated in patients with CLMK who shower in lenses.

The major personal hygiene risk factors for CLMK include showering, especially daily, in contact lenses and sleeping in lenses. Patients aged 25–54 are the most at-risk group. Despite most contact lens wearers buying their lenses from opticians and having regular follow-up appointments, contact lens wearers continue to perform poor hygiene practices and risk developing microbial keratitis. Focusing attention on improving education of infection and retention of information may help improve compliance with lens wear practices, which may help reduce incidence of CLMK and associated sight loss.

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