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Title: Patients' and Prescribers' Perception of Contact Lenses as a Potential Ocular Drug Delivery System

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Abstract

Contact lenses (CLs) designed to deliver medication gradually to the eye are being developed and investigated for the use in ocular drug delivery. The aim of the current research is to determine patients' acceptance of the use of lenses for ocular drug delivery. In addition, the study aimed to seek the views and perceptions of healthcare professionals (HCPs) on CLs as a method of ocular drug delivery and whether it will be prescribed to treat ocular conditions.

This was a cross-sectional survey targeted at patients and HCPs. Two separate questionnaires were created with open-closed ended and multiple response questions, gauging the perceptions and acceptance of CLs as drug delivery tool. The patients' survey was distributed in John Radcliffe (JR), Oxford and Moorfields eye hospital (MEH), London, UK. The HCPs' questionnaire was manually distributed and was also devised on Survey Monkey and sent by email to ophthalmologists, optometrists, opticians, GPs and hospital and community pharmacists. The data were analysed using SPSS statistical software and Excel.

Over 60% (92/151) of patients would accept the use of CLs for their ocular treatment with the highest acceptance being reported by patients in the age group of 30-49 years old. The most frequently used conventional treatment formulation was eye drops as indicated by 87% (131/151) of the responses. More than half of eye drop users (57%, 75/131) indicated that they would accept using CLs expecting them to reduce the frequency of application of the medicine and be less time consuming. Interestingly, half of HCPs were not aware of CLs as an ocular drug delivery method; nevertheless, a total of 65 HCPs out of the 112 surveyed stated that they would prescribe/dispense CLs to treat ocular disease.

Key words: contact lenses (CLs), drug delivery, questionnaire, acceptance, health care professionals (HCPs)

Introduction

Conventional ocular formulations such as eye drops, ointments and gels are the most commonly used ocular delivery formulations. However, there are numerous drawbacks and limitations associated with these dosage forms together with the physiological barriers presented by the eye (1). Physiological barriers include blinking and washing out drugs by tear fluid, nasolacrimal drainage and impermeability of the cornea. Studies revealed a high prevalence of non-compliance and an inability to adequately instil a drop into the eye (2). The problem gets more prominent with elderly or patients with arthritis as they could not generate enough force to squeeze the eye drop bottle (2). Thus, drug delivery to the eye can be a challenge and consequently new ocular delivery systems have been developed to overcome these issues, namely; nanomicelles, nanoparticles, liposomes, implants, in-situ gelling systems and CLs. CLs loaded with drugs have been developed using several active ingredients such as prednisolone (3), β -blockers (4), antihistamines (5) and antimicrobials (6). Poly- hydroxy methyl methacrylate (pHEMA) CLs allowed higher ocular bioavailability for dexamethasone compared to eye drops (7). A system of hydrogel formulation using β -cyclodextrin grafted onto pHEMA-coglycidyl methacrylate was found to enhance diclofenac loading by 1300% and sustain drug release for two weeks (8). A study conducted by Hu *et al.* demonstrated that modified functional hydrogel CLs loaded with puerarin had a better efficacy in lowering intraocular tension compared to commercially available eye drops (9). Dual therapy CLs for glaucoma were developed recently, and composed of 20% (w/w) vitamin E, timolol and dorzolamide. The lenses were found to be more effective in reducing intraocular pressure compared to eye drops (10).

Drug loaded CLs can be used as a potential dosage form, subject to patients' acceptance and willingness to use them. An example that reflects the importance of consulting patients' views prior to marketing is Exubera™ inhaler. It was marketed by Pfizer as a device for insulin lung delivery to replace short acting prandial insulin. It was withdrawn after a short period from the market because the product was not optimised according to the patients' desires (11). Thus, it is important to deeply investigate patients' views about a novel device before large-scale manufacturing and marketing.

Therefore, the aim of the current study is to assess patients' receptiveness and acceptance of this new ocular delivery approach. In addition, this study sought the feedback and perceptions of HCPs towards the use of medicated CLs as drug delivery systems. The aims can be translated into the following objectives; to gather information about the most common eye disease diagnosed and dosage form prescribed or used for treatment of eye conditions, to study the reasons why patients/HCPs might or might not be in favour of using CLs and to understand the factors that may influence the participants' decision in using/prescribing or dispensing CLs.

The outcomes will enable formulation scientists to understand the challenges that face the use of medicated CLs and eventually establish whether prescribers would prescribe/dispense CLs for ocular drug delivery. This will enable interested stakeholders to gain insight into current and future trends in the applications of CLs.

METHODS

A. Study design for patients' survey

Questionnaires were used as the data collection tool for the study. The patients' survey was made of 22 questions of different format. In total, there were 22 questions; twelve multiple choice questions, six dichotomous questions, two numerical rating scale questions, and two questions were open ended. The questions contained items on demographic characteristics, current ocular treatment, use of CLs and acceptance of CL use. The inclusion criteria were patients over 18 years old who suffer from an ocular condition. Responses were collected from both the John Radcliffe Hospital (JR) and Moorfields eye hospital (MEH), where the questionnaires were handed as hardcopies to patients who were willing to participate. A softcopy of the questionnaire was generated on a Google document and the link together with the participant information sheet were emailed to a list of patients who opted to take part in the research when approached by a pharmacist member of staff at MEH.. Consent was implied by completion of the questionnaire. The questionnaires were collected between March and September 2016.

B. Study design for Healthcare professionals' survey

The survey for HCPs included twenty questions; fourteen of the questions were multiple choices, three were dichotomous questions and three were open-ended questions. The survey sought HCPs' common prescribed treatments and the most common conditions they treat, their views on patients' perceptions on current treatments, and finally their perceptions on medicated CLs; the benefits and problems of their use and whether they would prescribe them. In addition, two questions were included to identify the exact profession of the HCP and their years of experience.

HCPs were either sent a Survey Monkey link to the questionnaire or given a hard copy to fill out. Another way that data were collected was by circulating the Survey Monkey link on the MEH network. Furthermore, the link was posted on an optometrist LinkedIn account. Lastly, a LinkedIn profile was produced in order to access ophthalmologists' email addresses, and emails containing the survey monkey link were sent to them. Responses were collected in the period from March to September 2016. The HCPs who took part in filling the questionnaire were ophthalmologists from MEH, optometrists, opticians, GPs, hospital pharmacists and community pharmacists working in Shepherd's Bush and Croydon, London, UK.

C. Data analysis

The responses of both questionnaires were coded and entered into SPSS for Windows, version 23 (International Business Machines (IBM), New York, USA). Two researchers reviewed the data for quality assurance. As the data were non-normally distributed and ordinal in nature, chi-square test was used to identify any associations between responses. Sub-analyses were performed by respondents' eye disease, formulation currently used, gender, age and awareness of current development in ocular drug delivery. The statistical values reported are a comparison between one group against the other. An a priori level of <0.05 ($P < 0.05$) was set as significant. Excel was used to generate graphs. All data remained anonymous throughout the research in order to protect participant confidentiality.

RESULTS

A. Patient Survey

I. Sample characteristics

The questionnaire was distributed to 42 patients at the JR where 24 responses were collected leading to a response rate of 57%. MEH patients were approached through Moorfields staff by email so it is difficult to determine the response rate as the email was distributed through a mass circulation. The final number of patient participants in the study was 151. The demographics of the patients are summarised in Table 1.

Table 1: Demographics of participating patients and HCPs and their acceptance of using CLs

Patients demographics

Gender	Number of patients (N=149), (%)	Acceptance of medicated CLs n, (%)
Male	57 (38%)	38/57 (67%)
Female	92 (62%)	53/92 (58%)

Age	Number of patients (N=150), (%)	Acceptance of medicated CLs n, (%)
18-29	28 (19 %)	20/28 (71%)
30-49	41(27%)	31/41 (76%)
50-69	69 (46%)	36/69 (52 %)
70+	12 (8%)	5/12 (42%)

HCPs demographics		
Occupation	Number of HCPs (N=112), (%)	Number of HCPs willing to prescribe/dispense medicated CLs n, (%)
Community pharmacist	34 (30%)	23/34 (68%)
Hospital pharmacist	14 (13%)	6/14 (43%)
General Practitioner	10 (9%)	6/10 (60%)
Consultant Ophthalmic surgeon	6 (5%)	5/6 (83%)
Optician/Contact Lens Optician	5 (4%)	4/5 (80%)
Consultant Ophthalmologist	5 (4%)	2/5 (40%)
Optometrist	23 (21%)	12/23 (52%)
Others	15 (13%)	7/15 (47%)

II. Patients' perceptions

Overall 92 (61 %) of patients said they would consider using CLs for drug delivery. More females claimed they would use CLs than males but the difference was not statistically significant ($p=0.31$). The highest acceptance percentage was reported by 30-49 years old (76%). This was statistically significant ($p=0.05$) (Table 1). Regarding the current formulation of ocular treatment, the data collected showed that 87% ($n=131$) of the total participants are using eye drops either alone or with other form of ocular medications and 36% ($n=54$) are using eye ointments. Patients who use eye drops were more likely to accept CLs as a treatment option ($p=0.03$) (Table2).

Table 1: Patients' Current treatment formulation stratified by acceptance of contact lenses use.

Current treatment formulation	Number of responses (N=151)	Acceptance of medicated CLs n, (%)	P value
Eye drops	131	75/131 (57%)	0.03*
Eye ointment	54	32/54 (59%)	0.80
Eye gel	33	20/33 (61%)	0.43
Tablets	43	27/43 (63%)	0.45
Eye inserts	12	8/12 (67%)	0.24
Injections	10	9/10 (90%)	0.06

P is the calculated probability and was reported as significant difference when $P < 0.05$. Chi-squared test was performed by comparing CLs' acceptance per patients' current treatment formulation against the acceptance of those using other formulation. *Statistically significant at 95% confidence level.

The questionnaire included a question about the duration of patient's current ocular treatment. Around 80 patients indicated that their eye drop usage was long term; 59% ($n=47/80$) of long term users indicated they would use CLs. When patients were asked about the difficulty in using their current medication, 25 claimed to face difficulty when applying their medication with half of them ($n=13$) stating that they are willing to use medicated CLs as an alternative.

Table 3 shows the prevalence of eye conditions among of the surveyed patients, whereby patients were allowed to choose more than one option. It was found that just above half of the patients who had age-related long-term conditions such as glaucoma and cataract would consider using CLs for treatment. There was no statistical association between the condition suffered and acceptance of CLs use (Table 3).

Table 2: Patients' current condition stratified by acceptance of contact lenses use

Patient current condition	Number of responses (N= 151)	Acceptance of medicated CLs n, (%)	P value
Dry eyes	60	35/60 (58%)	0.65
Glaucoma	48	26/48 (54%)	0.14
Cataracts	37	19/37 (51%)	0.16
Inflammation post-surgery	18	11/18 (61%)	0.85
Conjunctivitis	15	7/15 (47%)	0.18
Age-Related Macular Degeneration*	10	7/10 (70%)	
Keratoconus*	6	3/6 (50%)	
Stys*	5	3/5 (60%)	
Blepharitis*	5	5/5 (100%)	
TED*	5	1/5 (20%)	

Acanthamoeba Keratitis (AK) *	4	3/4 (75%)
Uveitis*	4	3/4 (75%)
Sjogrens*	4	2/4 (50%)
Others *	11	5/11 (46%)

P is the calculated probability and was reported as significant difference when $P < 0.05$. Chi-squared test was performed by comparing CLs' acceptance per patients' current condition against those with other conditions. *Chi-squared test was not performed as the sample size was too small. The "others" category included; 3 patients with blepharospasm, 3 patients with retinopathy, 2 patients with subconjunctival haemorrhage and 1 patient with either episcleritis, macular oedema or Usher syndrome. The patient's acceptance of medicated CLs was indicated as 2/3, 2/3, 1/2 and 0/1, respectively.

The questionnaire also enquired about patient satisfaction with their current treatment. A total of 136 patients answered the question with yes or no. Over two thirds of patients; 69% (94/136) patients were satisfied with their treatment whereas 42 (31%) were not satisfied. Of those who were satisfied, 53 % (50/94) of patients stated they would be willing to use CLs for treatment. On the other hand, 81% (34/42) of patients who were not satisfied claimed they would use medicated CLs. There was a statistical significance association between treatment dissatisfaction and the acceptance to use CLs ($P=0.012$). Further analysis on the dissatisfied patients showed that 90% (38/42) of those patients were using eye drops and mostly suffered from dry eyes (43% (18/42)).

Furthermore, the study assessed patients' awareness of current developments in eye medication delivery. Only 22% (33/151) of patients were aware of new developments and 61% (20/33) of those patients stated to indicate an acceptance to the use of CLs. However, there was no statistically significant association between having knowledge on developments of ocular drug delivery and the acceptance of using lenses for treatment ($P=0.77$).

In total, 24% (36/151) of the patients questioned were already CLs users and 86 % (31/36) of them accepted the use of CLs for treatment. Patients who have not used CLs before and did not want to use them indicated "worried about damaging my eye" or/and "I will have problems with applying CLs" as the main reasons for lack of acceptance (Figure 1).

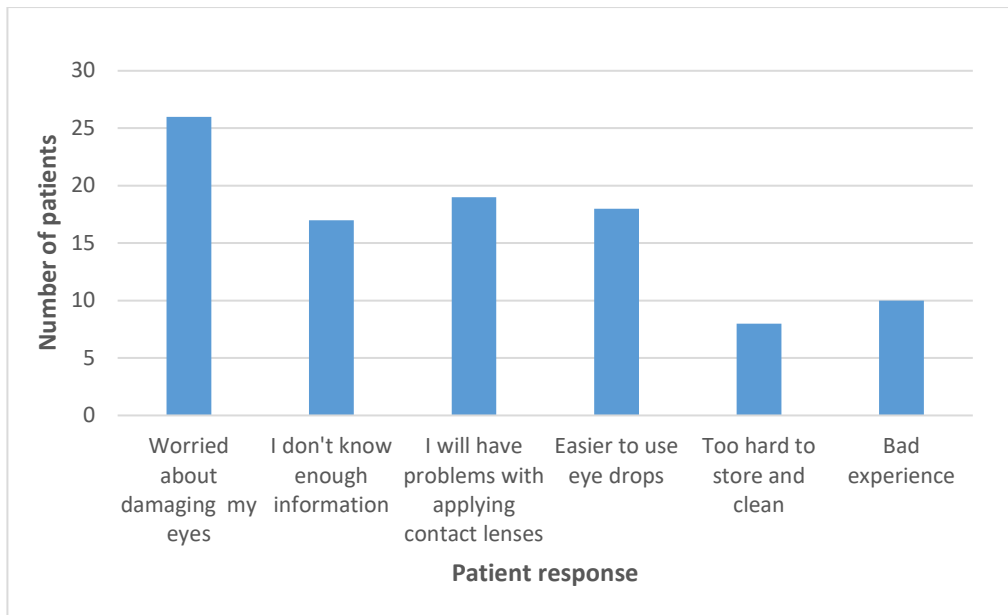


Figure 1: The views of non-CLs users who would not accept the use of CLs (n=50) for treatment. A multiple-choice question was used to understand the reason why non-CLs wearer would not want to use CLs for drug delivery.

A multiple-choice question enquired about the reason for potential use of CLs, participants (n=92) could choose more than one option and add their own views. Nearly two thirds of participants (n=64) explained the reason for accepting the use of CLs as ‘reduced applications of medication’ followed by 46 patients selecting ‘less time consuming’ (Figure 2).

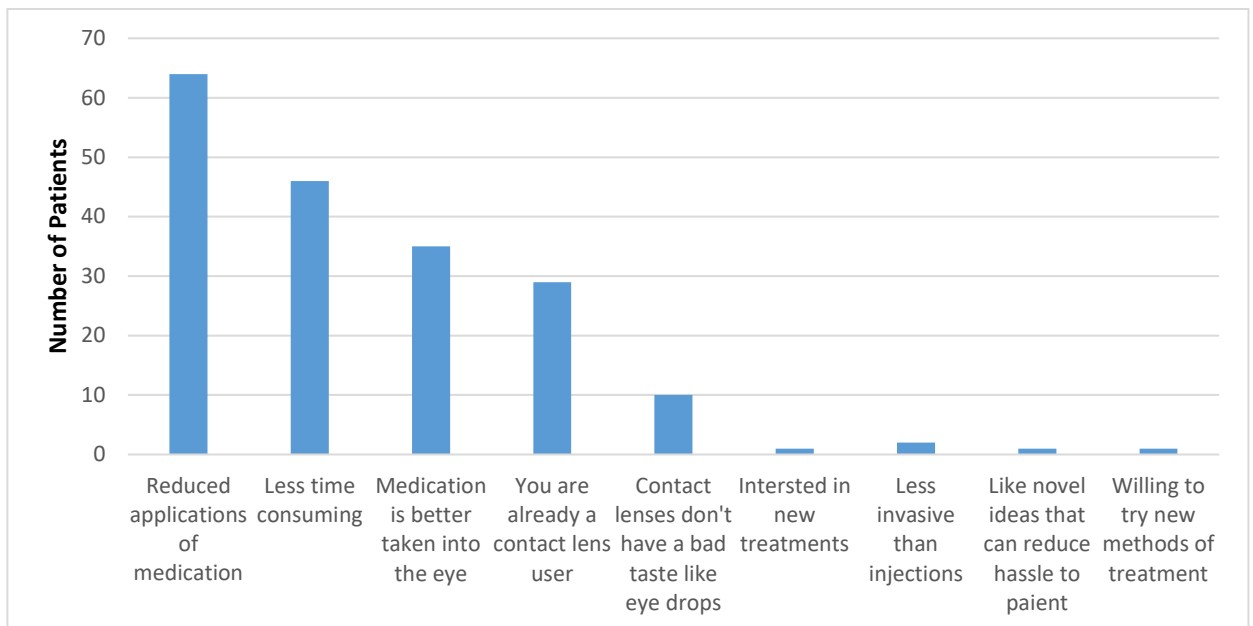


Figure 2: Reasons for accepting medicated CLs use by patients. A multiple-choice question was used to ask about the reason for opting to use of CLs for drug delivery (n=92).

B. Health care professionals

i. Sample characteristics

Hundred and twelve HCPs took part in the current study. Table 1 shows the response rate per the occupation of the participant. As illustrated in Figure 3, 7% (n=8) of practitioners had less

than 1 year experience, 34% (n=38) have 1 to 5 years of experience, 20% (n=22) have worked for 6 to 10 years and lastly 39% (n=44) had more than 10 years of experience.

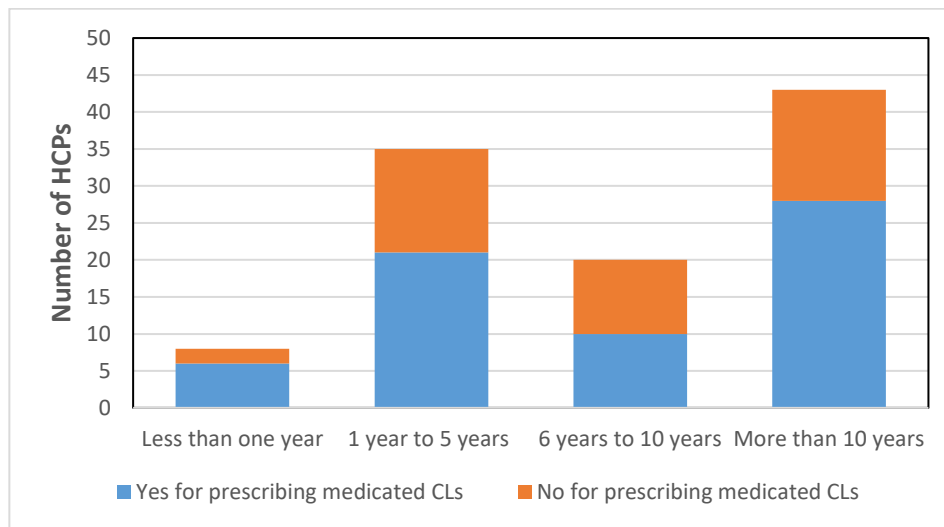


Figure 3: Years of experience versus acceptance to prescribe/dispense medicated CLs (N=112)

The most frequent eye condition HCPs deal with is conjunctivitis (80%), followed by blepharitis (60%) (Table 4). The vast majority of HCPs (83%) normally prescribe eye drops followed by eye ointments.

Table 3 4: The most common eye conditions HCPs deal with and eye formulation HCPs commonly prescribe/dispense. Multiple choice question was used and participants were able to select more than one answer.

Eye conditions	Number of responses
	(N=111), (%)
Conjunctivitis (Allergic or Infective)	89 (80%)
Blepharitis	67 (60%)
Glaucoma	58 (52%)
Cataracts	58 (52%)
Age-Related Macular Degeneration	35 (32%)
Uveitis	23 (21%)
Subconjunctival haemorrhage	22 (20%)
Others	13 (12%)
Formulation	Number of responses
	(N=112), (%)
Eye drops	93 (83%)

Eye Ointments/Creams	7 (6 %)
Eye gels	6 (5%)
Ocular inserts	0 (0%)
Other	6 (5%)

Most HCPs (81%) believed that eye drops are the patients' preferred treatment method. A follow up question was posed to understand why HCPs prescribe or dispense the preferred formulation, 60% contributed that to their effectiveness and 55% to them being patient friendly.

Half of HCPs (50%) believe that patients favour forms which are easy to administer while 21% believe that they favour treatments which are convenient. HCPs were asked about the problems that patients may face in relation to their current ocular medication and the response provided included; difficulty in administering the medication, the multiple applications needed and forgetfulness that negatively impacts their compliance. More than half of HCPs (54%) claimed that some patients need to re-visit the clinic or even the Accident and Emergency (A&E) for cases relating to ocular diseases mainly due to non-compliance (54%), ineffective treatment (23%) or wrong diagnosis (8%). HCPs were asked if they have heard of the concept of using CLs to deliver drugs to the eye prior to the current survey; nearly half of participants (51%) had not hear about them and 23/57 (40%) of those who did not have prior knowledge were not willing to prescribe/dispense medicated CLs. HCPs who said they know about medicated CLs were 55 and 62% of them (34/55) were willing to prescribe/dispense them.

Overall, 58% (65/112) of HCPs would be willing to prescribe/dispense medicated CLs. The majority of HCPs (71 %) agreed that having new formulation for ocular drug delivery such as CLs is good as it provides more options for ocular treatment. Whereas, 13% of practitioners found available treatments are sufficient (Table 5).

Table 4: Views of HCPs about the use of CLs as an alternative form of ocular drug delivery. A multiple-choice question was used and participants were asked to select one answer only (N=112).

Answer Options	Number of responses (N=112), (%)
Preferable to have another ocular treatment option for prescribers to select from based on patient needs/conditions to be treated	80 (71%)
Current ocular drug delivery methods, like eye drops, are sufficient	14 (13%)
It is necessary to use CLs as an alternative form of ocular drug delivery	11 (10%)
Others	7 (6%)

Figure 4 displays the expectations of HCPs from the use of CLs for drug delivery. Most practitioners (81%) expected that the benefit will be longer duration of action and so reduced frequency of administration, while 50% expected better efficacy compared to conventional ocular drugs. Additionally, 46% of practitioners believed that there will be increased regimen adherence with CLs use.

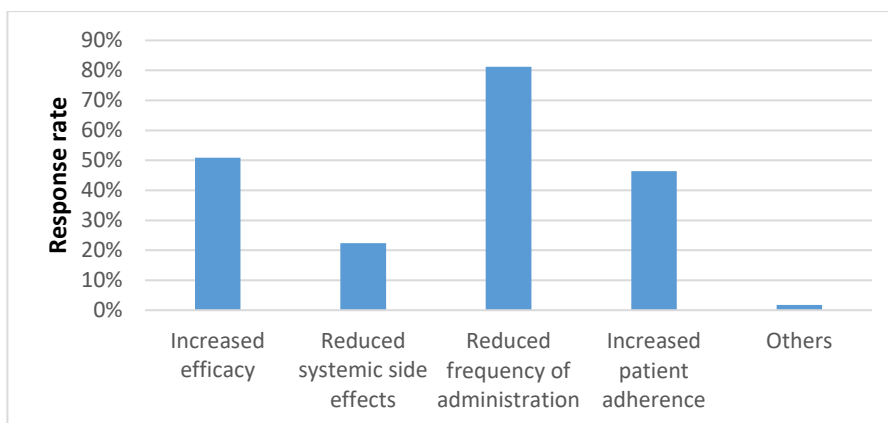


Figure 4: HCPs' views about the benefits of medicated CLs. HCPs were asked about the benefits of using CLs to treat ocular diseases/conditions. Participants were able to select more than one answer (N=112).

Based on HCPs' opinions, the risks and challenges of medicated CLs are the likelihood of eye infections and inflammation (74%) and high costs (69%). Additionally, 58% of HCPs speculated challenges in counselling patients on the use of medicated CLs (Table 6). The 'Other' responses given were "Can be hard to administer for certain people" or "Unsure how it would maintain its sterility if the patient touches the CL to put it into the eye".

Table 5: The risks and challenges of using CLs as a drug delivery tool. A multiple-choice question was used and participants were able to select more than one answer (N=111).

Answer Options	Number of responses (N=111), (%)
Eye infections/inflammations	82 (74%)
Expensive when compared to conventional ocular drugs like eye drops	77 (69%)
Challenges in counselling patients on its use	64 (58%)
Less patient adherence	27 (24%)
Other	8 (7%)

In spite of the risks and challenges associated with the use of CLs, 59% of practitioners felt that the benefits of CLs for drug delivery outweigh the risks of it, whereas 41% of HCPs disagreed.

Discussion

Despite the progress in CLs for ocular drug delivery, to our knowledge no studies have assessed patients' acceptance and HCPs' perceptions of this novel route of medicine administration to the eye. This study aimed to highlight the factors that would influence the acceptance of CLs which included treatment duration, treatment type, condition, demographics and awareness of formulation developments.

The most common eye conditions found in our sample were dry eyes, glaucoma, and cataract which are normally known as age-related eye diseases. From the patients' survey, eye drops were listed as the most used ocular dosage form which is consistent with previous findings where eye drops accounted for 90% of marketed ophthalmic formulations (1).

According to HCPs, conjunctivitis is the most commonly seen ocular disease as indicated by 80% of the responses, which is in correspondence with a study by Mcdonnell (12). The study found that two out of four of the most common ocular diagnoses were bacterial and allergic conjunctivitis. The reason for conjunctivitis being rather common in this study is possibly due to the high number of community/hospital pharmacists in the sample population, where

infective conjunctivitis is commonly treated by pharmacists using over the counter medication. For treatment of these conditions, 83% of practitioners prescribe eye drops and 81% of all HCPs feel that patients prefer them over other ocular formulations. Patient preference for eye drops, according to the HCPs' point of view, is mainly due to them being easy to administer. However, this contradicts their view that the main problem with current ocular medication, eye drops mainly, is the difficulty to administer them. Although eye drops are quite easy to administer when compared to other currently available forms, patients are still finding difficulties with their use. The problems that comes with eye drops cannot easily be overcome by education or counselling since the issues are mainly due to trying to aim the bottle into the centre of the eye, a fear of applying or reflex blinking (2). There was a statistically significant association between the use of eye drops by the patients and their acceptance to use CLs ($P=0.03$). Gender did not impact the patients' acceptance of medicated CLs ($P=0.31$) meanwhile the age did as participants within the 30-49 years age group ($P=0.03$) were more open to using the new treatment. On the other hand, more than half of eye drops prescribers (58%) are willing to prescribe medicated CLs.

The study revealed that 31% of patients were dissatisfied with their treatment and most of them ($n=38$) were using eye drops, 34 of these patients were open to the use of medicated CLs. A previous study (13) explained that patients tend to use alternative methods when they are dissatisfied with their conventional treatment which is not providing them with the expected results. Similarly, patients dissatisfied with their eye drops may welcome the novel technology.

Both HCPs and patients explained that the main reason for accepting CLs as "reduced applications of medication" (Figures 2, 4). Multiple doses of any medication may reduce compliance which can be combatted by a long acting medication or by replacing eye drops with medicated CLs or inserts. Studies have revealed that application of eye drops more than once a day can reduce patients' compliance to the dosage regime in patients with glaucoma (14). This correlates with our findings as patients who showed acceptance for CLs were seeking less frequent dosing and eventually better regimen adherence. Besides, over 75% of the HCPs agreed that CLs will offer a longer duration of action, hence greater compliance and better efficacy. Moreover, few studies suggested that elderly patients have lower compliance rate than younger patients (15) so the use of CLs with its advantageous longer duration and less frequent dosing would possibly improve their compliance.

Over 86% of the patients who currently wear lenses chose to use them for treatment which could be attributed to being familiar with CLs application so they would not be daunted to use them for treatment in the future. Nonetheless, the lack of knowledge and training about the use of CLs can put off non-users from using them in the future. Patients were worried that CLs might damage their eyes. The second concern was "will have issues applying lenses". Studies have shown issues associated with lenses including bacterial infections, corneal abrasions, microbial keratitis and allergic sensitivity (16). As many conditions can arise due to hygienic issues and noncompliant behavior, CLs users were questioned in previous studies about their lenses use (17, 18). It has been pointed out that poor hand hygiene (11%), inadequate cleaning of lenses (13%) and lens storage cases (61%) were the main contributors to non-compliance (19). This evidence would indicate that patients may have problems associated with lenses due to inadequate cleaning and hygiene, which put them at possible risk of getting infections (20) that could damage their eye as stated in the current survey. With proper education on lens application and removal, majority of these complications could be avoided. Unfamiliarity and lack of knowledge raises worry in patients as 44% of them stated they would not use lenses for treatment as "do not know enough information". This further adds to the reason why patients might not be accepting the use of lenses in treatment as they do not fully understand the potential of this treatment. HCPs share the same concern as the patients; one major issue that was highlighted by the HCPs in this study was the challenges of educating patients and verbal counselling on drug delivering CLs in terms of safe use, compliance and hygiene. In addition, even HCPs require further education and training on CLs for drug delivery. Such training would possibly overcome the hesitancy that 58% of practitioners felt about counselling patients on

correct and safe CLs use. Furthermore, the results showed that nearly half of the HCPs are not familiar with this novel tool, which again suggests that more education and training is required.

Few practitioners (11/112) were concerned about the difficulties that may arise by the elderly population in administering the medicated CLs due to manual dexterity or poor sight. However, CLs may suit elderly population, who find it difficult to squeeze the dropper bottle due to physical difficulty or rheumatoid arthritis. The long duration of action could also tackle forgetfulness as a cause for non-compliance. With the right materials and techniques for manufacturing such as molecular imprinting, drug delivering CLs could be worn for more than a few days at a time. This would allow for a drastically reduced frequency of administration compared to eye drops.

The other concern that practitioners linked with the use of CLs to treat ocular disease, is that medicated CLs would be much more expensive when compared to the price of eye drops. Although the price of eye drops is much cheaper than drug delivering CLs would be, the overall cost of non-compliance to eye drops is quite high. A study of 200 patients has already shown that 16% of patients had missed up to two doses of their eye drops per week (2), so this shows that non-compliance to eye drops is common and has subsequent negative impact. Furthermore, non-compliance to ocular medication can lead to progressive vision loss and eventually blindness (21). There is a massive financial burden due to non-compliance to general medication including ocular medication; the estimate cost of hospitalisation due to general medication non-adherence costs approximately \$100-300 billion in the US per year (21). Non-compliance to eye drops is well reported in literature for many reasons such as forgetfulness (23, 24), difficulty with administration (25), patients' struggle to follow medication schedule and cost (24). By introducing medicated CLs, patient regimen adherence is speculated to increase leading to reduced hospitalisation, A&E visits, and reduced progressive worsening of ocular disease. This in turn could reduce the financial burden. So, although the cost of drug delivering CLs are expected to be more expensive than eye drops, a greater amount of money will be saved on the long term. Overall, a greater number of HCPs believe that medicated CLs have more benefits than risks and disadvantages.

Although the study has provided a good insight into people's acceptance of lenses and the reasons for and against their use, it suffers from certain limitations. As perceptions were examined using a questionnaire not an interview, only limited questions could be asked and most of the questions were multiple choice ones which could have influenced the patients' answers. Patients may not have made a fully informed response due to the lack of knowledge on the field. Furthermore, the area where the research was conducted was populated mostly by white ethnic background which resulted in the majority of participants (68%) being from one ethnicity which might not be representative of all patients with ocular problems. As it was conducted on a relatively small sample size, it would benefit from follow up interviews to gather more detailed feedback from patients and a larger sample size.

Conclusion

A majority of patients and HCPs showed acceptance of the use of CLs as part of an ocular drug delivery system. The main benefit related to their potential to offer long duration of action, hence decreasing frequency of application thus increasing regimen adherence. More than half of patients were open to using medicated CLs as a new treatment method especially eye drops users who were more prone to accept CLs.

The main reservations were related to cost, ease of use and risk of infections. Nevertheless, the acceptance of use provides a driver for further research and development by both academics and industries.

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Appendix

Some of the questions used in Healthcare professionals' questionnaire

1. What is your profession?

- Consultant Ophthalmologist
- Consultant Ophthalmic Surgeon
- Optometrist
- Optician/Contact Lens Optician
- General Practitioner
- Hospital or Community Pharmacist
- Other (please specify)

2. How many years have you been working in your profession for?

- Less than 1 year
- 1 to 5 years
- 6 to 10 years
- More than 10 years

3. What are the most common eye conditions/diseases that you come across every day? More than one answer can be selected.

- Conjunctivitis – Allergic or Infective
- Blepharitis
- Uveitis
- Subconjunctival haemorrhage
- Glaucoma
- Cataracts
- Age-Related Macular Degeneration
- Other (please specify)

4. Which current treatment method for eye conditions do you prescribe/dispense the most? Please select one answer only.

- Eye drops
- Eye Ointments/Creams
- Eye Gels
- Ocular inserts
- Other (please specify)

5. Why do you prescribe/dispense this medication/formulation the most? More than one answer can be selected.

- Cheapest
- Easy to prescribe

- Patient friendly
- Effective
- High patient adherence
- Other (please specify)

6. **Which ocular drug treatment do you believe patients prefer in order to treat their eye conditions/diseases? Please select one answer only.**

- Eye drops
- Eye Ointments/Creams
- Eye Gels
- Ocular inserts
- Other (please specify)

7. **Why do you think patients prefer one treatment method/formulation over the others? Please select one answer only.**

- Easiest to apply
- Convenient
- Increased comfort
- No/fewer side effects
- Less frequency of administration
- Other (please specify)

8. **What problems do you feel patients face in relation to their ocular medication? More than one answer can be selected.**

- Recurrence of disease/ineffective medication
- Difficulty administering medication
- Patient forgetfulness in administering medication
- Need to administer medication multiple times a day
- Other (please specify)

9. **In your opinion, why do some patients need to re-visit the clinic/hospital or attend/re-attend A&E for cases relating to ocular diseases? Please select one answer only.**

- Non-adherence to medication
- Ineffective medication resulting in worsening of disease
- Misdiagnosed ocular disease
- Other (please specify)

10. **Prior to today, have you heard of the concept of using contact lenses to deliver drugs to the eye?**

- Yes
- No

11. **How did you hear about this concept? Please select one answer only.**

- Journals

- Internet sources
- Word of mouth
- Workplace
- Have not heard of this concept before today

12. **How do you feel about the use of contact lenses as an alternative form of ocular drug delivery? Please select one answer only.**

- It is necessary
- Current ocular drug delivery methods, like eye drops, are sufficient
- Preferable to have another ocular treatment option for prescribers to select from based on patient needs/conditions to be treated
- Other (please specify)

13. **What would you expect from this new form of ocular drug delivery? More than one answer can be selected.**

- Longer duration of action
- Greater efficacy
- More side effects
- Fewer side effects
- More patient adherence
- Less patient adherence
- More patient preference for use
- Less patient preference for use
- Other (please specify)

14. **In your opinion, what are the benefits of using contact lenses to treat ocular diseases/conditions? More than one answer can be selected.**

- Increased efficacy
- Reduced systemic side effects
- Reduced frequency of administration
- Increased patient adherence
- Other (please specify)

15. **What do you feel are the risks/challenges of using contact lenses in order to treat ocular diseases/conditions? More than one answer can be selected.**

- Eye infections/inflammations
- Less patient adherence
- Challenges in counselling patients on its use
- Expensive when compared to conventional ocular drugs like eye drops
- Other (please specify)

16. Would you prescribe contact lenses to treat ocular disease in patients? Give reasons for your answer.

Yes

No

Some of the questions used in assessing the Patients' acceptance of contact lens for ocular drug delivery

1. What treatment method have you used for your eye? (Tick all appropriate)

- | | |
|---------------------------------------|---|
| <input type="checkbox"/> Eye drops | <input type="checkbox"/> Tablets |
| <input type="checkbox"/> Eye ointment | <input type="checkbox"/> Eye inserts eg ocusert |
| <input type="checkbox"/> Eye gel | <input type="checkbox"/> Other (please specify) |

2. What was the condition you used it for?

- | | |
|---|--|
| <input type="checkbox"/> Conjunctivitis | <input type="checkbox"/> Glaucoma |
| <input type="checkbox"/> Dry eyes | <input type="checkbox"/> Subconjunctival haemorrhage |
| <input type="checkbox"/> Cataracts | <input type="checkbox"/> Inflammation post surgery |
| <input type="checkbox"/> Stys | <input type="checkbox"/> Other (please specify) |

3. Did you find difficulty in applying the medication by yourself?

- Yes
 No

4. How much does this effect the way you take medicine? (Scale 1-10)

Low 1 2 3 4 5 6 7 8 9 10 High

5. Do you get any eye/health issues associated with using contact lenses?

- | | |
|---|---|
| <input type="checkbox"/> Itchiness | <input type="checkbox"/> Dry eyes |
| <input type="checkbox"/> Tired eyes | <input type="checkbox"/> Viral infections |
| <input type="checkbox"/> Blurred vision | <input type="checkbox"/> Other (please specify) |
| <input type="checkbox"/> Red eyes | |

6. What is the reason you would NOT use contact lenses for drug delivery? (tick ALL appropriate)

- | | |
|--|--|
| <input type="checkbox"/> Worried about damaging your eye | <input type="checkbox"/> I have had a bad experience with contact lenses |
| <input type="checkbox"/> Easier to use eye drops | <input type="checkbox"/> I will have problems with applying contact lenses |
| <input type="checkbox"/> Don't know enough information | <input type="checkbox"/> Other (please specify) |
| <input type="checkbox"/> Too hard to store and clean | |

7. What method would you prefer to use?

- | | |
|--|---|
| <input type="checkbox"/> Eye drops | <input type="checkbox"/> Eye gels |
| <input type="checkbox"/> Eye ointments | <input type="checkbox"/> Other (please specify) |

8. Gender

- Male Female Not stated

9. Age

- 18-29
 30-49
 49-69
 70+

10. Ethnicity

- White
 White Other
 Mixed
 Indian
 Pakistani
 Bangladeshi
 Other Asian
 Black African
 Black Other
 Chinese
 Any other ethnicity

