



EYE CARE DURING COVID-19 SCARE: A REVIEW

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ABSTRACT

With the rise of COVID-19 cases, it becomes necessary and essential to have precautionary measures and also protective equipments during eye care as well as patient management in order to remain protected from any possible infection. All relevant latest research articles available on the PubMed related to the optometry point of view of the practice management were reviewed in order to summarize the ideal methodology of the optometric practice with standard guidelines and precautions in today's COVID-19 pandemic time. It has been realized that wearing glasses or a visor may reduce risk of contamination, but it does not protect against COVID-19 infections. Various other factors and aspects were considered for the formulation of standard operating procedures for the eye care during COVID-19 scare then standard guidelines and precautions were put forward by various eminent global organizations. These have been taken as gold standards and were incorporated to form a comprehensive guideline for the eye care with safety precautions for the Optometrists as well.

KEYWORDS: Eye care, Optometrist, COVID-19, Contact lenses, Patient management

INTRODUCTION

In January 2020, India also came in the grip of a new dreaded disease called COVID-19. This cluster of acute respiratory illness, now commonly known as Novel Corona virus – infected pneumonia (NCIP) originated in Wuhan, Hubei province of China during December, 2019. It rapidly spread out from Wuhan to other areas and even across various countries of nearly covering all continents.^{1,2,3} This SARS-CoV-2 which causes Corona-virus disease 2019 (COVID-19) belong to a family of enveloped positive-sense single-stranded RNA viruses that are known to cause the common cold, influenza, and acute severe respiratory illness.^{1,4,5} WHO (World Health Organization) on 30th of January, 2020 declared a public health emergency of International concern (PHEIC)⁶ and later on 11th of March, 2020 COVID-19 declared the COVID-19 as a pandemic.^{7,8} The new epidemic spread across the globe rapidly, affecting many countries especially Asian, European and American.^{6,9}

COVID-19 not only affected the business and working of our government/ private offices but also hampered the whole educational system. The increase and spread of this pandemic resulted in many significant changes to the daily lives of the people as well as large number of deaths and significant

economic losses. As of 23rd August 2020, COVID-19 has been confirmed in nearly twenty three million people and resulted in just over 8,08,715 deaths⁷ which is greater than caused by any other virus based disease globally in the past.

One of the first widely reported deaths due to SARS-CoV-2 was an ophthalmologist working at Wuhan Central Hospital in early January 2020, who reported that he had contracted COVID-19 from an asymptomatic glaucoma patient.^{7,11} Subsequently, there has been a great deal of interest in the scientific literature as well as in the lay press about the association of SARS-CoV-2 with the ocular surface. This has resulted in speculation regarding the safety of contact lenses.^{7,12,13} On realizing, the potential for transmission of the virus to and from the ocular surface, with implications for transmission among the general population and specifically in ophthalmic care, a set of recommendations for personal protective equipment (PPE) have been released based on the experience of MERS-CoV and SARS-CoV to counter the spread of infection amongst eye health workers. These recommendations include procedure and requirement of standard wearing goggles and/ or face shields for protection against ocular transmission of the CoV.^{6, 10}



As the percentage of SARS-CoV-2-positive cases increases day by day, affected patients might frequently present to eye clinics or emergency departments.¹⁴ When patients come to an ophthalmologist for an ocular examination, these patients have direct contact with examination equipment such as Slit lamp, Auto-refractometer, etc.¹⁵ A recent report by Lu and colleagues¹⁶ suggested that ocular surfaces may be a potential mode of SARS-CoV-2 transmission and that ophthalmologists are highly prone to getting infected. Lai *et al*¹⁷ reported infection control measures which were based on a three-level hierarchy of control measures: the use of personal protective equipment (PPE), environmental control and administrative control. Eye care practitioners like Optometrists are also prone to these COVID-19 related risks during patient management.

METHODOLOGY

In a previous observational study published in 2004, aimed at detecting corona virus in the tears by PCR, the investigators emphasized that the virus could be transmitted in tears – putting the ophthalmologist at risk of acquiring the infection.^{5,18} Based on this, we have reviewed the current literature and understanding that ocular implications and transmission of corona viruses based on the limited and rapidly expanding knowledge regarding the recent pandemic COVID-19. We have gathered and referred the available recent literature from PubMed search. We finally compiled narrative review article having comprehensive approach that can be implemented in an Optometry facility during COVID-19 scare.

CORONA VIRUS: STRUCTURAL COMPOSITION

The CoV name is a derivative from the Latin word corona which means crown. This is due to the characteristic structure of the virus whereby surface projections on the viral envelope, gives it an appearance similar to a crown. The diameter of virus is between 60 and 140 nm, capped by quite distinctive spikes, about 9 to 12 nm in length. The virus is a single-stranded positive-sense RNA virus with a genome of around 30 kb in length. This makes them the largest known RNA viruses.¹⁹ The RNA genome codes for both structural proteins (SPs) and non-structural proteins (NSPs). All known CoVs share a similar structure made of four main structural proteins: spike (S), membrane (M), envelope (E), and nucleocapsid (N) proteins.²⁰ The S-protein is responsible for attachment to host receptors, M protein helps shape the virion particles and binding to nucleocapsid, E-protein

plays a role in the assembly and release of particles while N-protein aids with the binding of the genome to a replication-transcription complex which is required for the replication of genomic material.⁶

TRANSMISSION OF VIRUS THROUGH OCULAR SURFACE

Many researchers have proved that SARS-CoV-2 is zoonotically transmitted.²¹ Like other airborne viruses, SARS-CoV-2 also transmitted from an infected person via aerosolized droplets when talking, sneezing, or coughing or via contaminated surfaces by body fluids (like door handles).²² Ocular surfaces possess ubiquitous viral receptor heparin sulfate, which is responsible for initial viral attachment. However, this is not sufficient for coronavirus infection. Furthermore, high concentrations of lactoferrin in tears (2mg/ml)²³ prevent viral attachment to heparin sulfate.²⁴ The ocular surface appears to possess the SARS-CoV-2, SAR-CoV and NL63 receptor ACE2, but may not possess the TMPRSS2 or Furin proteins, which is required for the spike protein of SARS-CoV-2 to bind to ACE2.⁷ Furthermore, apart from 9-O-acetylated sialic acid, the other co-receptors for coronaviruses (CD209, CD26, CD13, CD66e), have been found either in fibroblasts and dendritic cells that lie in tissue under the surface corneal and conjunctival epithelial cells, or have not been reported in ocular tissues. It is possible that the 9-O-acetylated sialic acid associated with proteins in tears can act as a decoy receptor, binding to the viruses and preventing them binding to cell associated 9-O-acetylated sialic acid.²⁵ Therefore, the evidence to date suggests that coronaviruses are unlikely to bind to ocular surface cells to initiate infection.

SARS-CoV-2 enters a cell following binding with the human angiotensin-converting enzyme (ACE) 2 protein⁵. The human eye has its own intraocular renin-angiotensin system (RAS), a system that has been of interest for developing antiglaucomatous drugs²⁶. The transfer of microorganisms along with the tears from the ocular surface into the nasal cavity and the upper part of respiratory tissues is because of the continuation of the mucous membrane via the puncta into the nasolacrimal duct and into the nasopharyngeal space can eventually deliver the virus into the lungs and the gastrointestinal tract, when swallowed, where it can bind to the ACE2 receptors⁵. The isolated surface protein S240 of SARS-CoV can bind to conjunctival epithelial and fibroblast cells and corneal epithelial cells, with this binding inhibited by soluble ACE2 indicating that the binding was being mediated through cell-surface ACE2.



Coronaviruses	Receptor	Role in human CoV disease	Ocular surface (cell types)	Lung
SARS-CoV SARS-CoV-2	ACE2	Host cell receptor and essential for infection	+ (conjunctival epithelium and fibroblasts; corneal epithelium)	+ (airway epithelia)
	TMPRSS2	primes spike protein for binding to ACE2	---	+ (airway epithelium)
	CD209	Cell-to-cell viral transfer	+(corneal dendritic cells)	+(alveola macrophages)
MERS-CoV	CD26	Host cell receptor and essential for infection	+/- (conjunctival vascular endothelium)	+ (lung epithelia and endothelia)
	CD66e	Co-receptor	+/- (palpebral conjunctiva)	+ (bronchial and alveolar epithelium)

+: the receptor has been found, -: there are no reports of the receptor on the ocular surface, +/-: found in tissue but only on non-virally-mediated inflamed tissue.

Table 1. Comparison of SARS-CoV-2, SARS-CoV and MERS-CoV receptors on ocular surface and lung

ROLE OF OPTOMETRIST IN COVID 19

In this pandemic, Optometrists are not considered as frontline health care workers for COVID 19, but it does not mean optometrist are not crucial in health services. Optometrists are frontline workers in eye care services thus every possibility is there in which optometrists can be exposed to asymptomatic patients or their close contacts while examining them. Therefore, they need to take precautions to protect themselves and others in their practices. Many people wear face masks, but far fewer consider the need for eye protection. Although the eye is probably a less important gateway for the virus, in the last few days, evidence has emerged of the likelihood of transmission via the conjunctival epithelium.^{27,29} Wearing glasses or a visor may reduce risk of contamination, but it does not protect against COVID-19 infections.^{28,29} Depending on local regulations, it is a sensible precaution to check the temperature of anyone entering the practice, including staff, and for all present to wear a surgical mask, and use hand sanitizers. In addition, ophthalmic instruments should be shielded as far as possible to prevent contamination and wiped down with disinfectant or alcohol after each patient. Clients may try on several frames when choosing new spectacles, the items that come into contact with

potentially infected persons must be wiped with alcohol or equivalently effective method. This means that clients trying on frames must be supervised to ensure that frames tried by the clients can be identified for cleaning.²⁹ An ocular condition may be the first symptom of COVID-19^{29,30} and it is considered that one of the first practitioners to draw attention to this new infection was Dr Li Wenliang, an ophthalmologist.³¹

CONTACT LENSES WEAR WITH CARE

After covering the long journey we are in the middle of an ongoing outbreak of the coronavirus disease and according to the World Health Organization, it is already characterized as a pandemic.^{32,33} In this pandemic, coronaviruses are capable of producing a wide spectrum of ocular disease, including anterior segment diseases such as conjunctivitis and anterior uveitis, and posterior segment conditions like retinitis and optic neuritis³⁴. Contact lenses represent a highly effective form of vision correction for an estimated 140 million people worldwide, with a very low incidence of either microbial keratitis or symptomatic inflammatory keratitis in strict daily wear of contact lenses.^{35,36,38}



Since, eye care practitioner play an active role in managing the patient and their ocular health as it relates to safe contact lens wear. But in contact lens (CL) practice, the impact of outbreak is massive because CL practitioners are exposed to the infection and need to consider how they can play a role in preventing the transmission³³. The contact lens wearers in normal usage also need to touch their eyes when inserting and removing their contact lenses,³³ so it is common question among all CL wearers and practitioners that has been raised as a potential concern for increasing their risk of exposure to the virus.

But, according to a PubMed a search on 24th March 2020 found that there is no evidence that contact lens wearers are more likely to contract COVID-19 than spectacle wearers.³⁷ The likely belief for this being a concern relates to the fact that SARS-CoV-2 has been isolated in tears.³⁷ Infrequently, the virus is known to be transferred by hand contact, and thus could be transferred to contact lenses during their insertion and removal. In one report, positive tear and conjunctival secretions occurred in a single patient who developed conjunctivitis from a cohort of thirty patients with novel coronavirus pneumonia.^{37,38} The study clearly mentioned that there is no evidence that contact lens wearer was more prone to Covid-19.

So, the best practice advice for contact lens wearers includes the same instructions that should be imparted under all situations, regardless of the COVID-19 pandemic. Every CL wearer should have kept one point in mind that when using contact lenses, careful and thorough hand washing with soap and water followed by hand drying with unused paper towels (generally known as 'kitchen roll' in the United Kingdom) is paramount. For contact lens wearers, this should occur before every contact lens insertion and removal, and such practice reduces the risks of infection and inflammatory responses and is highly effective.³⁹ It follows that as long as contact lens wearers are using correct hand hygiene techniques, they should be limiting any virus transmission to their ocular surface, and indeed, as already stated, there is currently no evidence that they are at any higher risk of developing COVID-19 infection than non-wearers.³³

Research has also indicated that with appropriate rubbing of contact lenses, most contact lens care systems would likely prevent the chance of the lens transferring the virus to the eye.³⁸ The consistent, unambiguous advice to protect individuals from the virus is to employ frequent hand-washing with soap and water. Additionally, of particular concern for ophthalmic practitioners, it should be noted that SARS-CoV-2 has been detected in the tears and conjunctival secretions in COVID-19 patients with conjunctivitis.³⁷

Unfortunately, CL practice can be particularly exposed to these modalities of transmission. Indeed, CL practice involves face-to-face communication, close examination of the patient (distance between patient and CL practitioner during a slit lamp assessment is approximately 50 cm), need to directly touch patient's eyelids (for example during CL insertion/removal or push up test or lid eversion). Finally, some CLs are still fitted using trial sets, which inturn need to be cleaned thoroughly between patients. Looking at available evidence in research papers, from the largest authorities in disease control and prevention around the world and from professional associations, there are at least 5 main areas of actions applicable in CL practice to minimize the transmission of COVID-19: patient management; personal protective equipment; disinfection of CL equipment and CL trial set; hands sanitization; CL practitioner and staff monitoring.^{40,41,42,43}

Lai et al.⁴⁴ have just published a paper sharing the experience in Hong Kong to minimize COVID-19 infection in Ophthalmology in which they suggest the installation of protective shields on slit lamps. Similar advice to this was made in the European Society for Cataract and Refractive Surgery (ESCRS) publication Euro Times.⁴⁵

SPECIAL CARE DURING SPECTACLE USAGE

According to U.S. Centers for Disease Control and Prevention (CDC), "*personal eyeglasses are NOT considered adequate eye protection.*"⁴⁶ Part-time wearers of spectacles who only use their spectacles for occasional distance use or for reading, their assumed 'protection' is intermittent, and additionally their increased frequency of putting on and removing their spectacles adds to the potential of touching their face each time, possibly in the absence of hand washing. Another important point to ponder is that some viruses such as SARS-CoV-2 can remain on hard plastic surfaces (similar to those found in spectacle frames and lenses) for hours to days. Upon touching their spectacles, virus particles could potentially be transferred to the wearers' fingers and face and thus adequate hand hygiene practices should also be extended to the regular handling of spectacle and sunglass frames to prevent transmission of viral particles to the fingers and subsequently to the face. Spectacles should be regularly cleaned with soap and water and dried with paper towel to remove any adhered viral particles.

Hand hygiene is very important to prevent the risk of COVID-19 while using the spectacle some guideline given by CDC and WHO regarding hand hygiene are as follows³⁸.



- Wash hands often with soap and water for at least 20 seconds especially after they have been in a public place or after blowing their nose, coughing, or sneezing. Otherwise use a hand sanitizer that contains at least 60% alcohol. They should cover all surfaces of their hands and rub them together until they feel dry.

- They should avoid touching their eyes, nose, and mouth with unwashed hands.

COVID-19 GUIDELINES FOR OPTOMETRIC PRACTICES

Practitioners of course, are responsible for impressing upon their patients the importance of good hygiene, but some additional precautions are needed during this time of pandemic such as precaution in optical store and optometry clinic. The main aim of this is to safeguard both, the health and the wellness of our team members. Some of guidelines regarding optometry clinic and optical store are as follows-

Prior to and after patient care

1. Make sure that staff members are symptom free each day.
 - a. Have a non-contact thermometer available to assess temperature, as needed. (NOTE: Temperature alone does not assess or exclude disease.) The CDC defines a fever as a temperature at or above 100.4°F.
 - b. Ask if they are coughing.
 - c. Ask if they have shortness of breath.
 - d. Ask if they have red eye or eyes (conjunctivitis can be a presenting sign of COVID-19).
 - e. If staff report or appear ill, recommend that they seek medical care from their primary care physician or specialist.
 2. Clean all equipment with best available disinfectant (best is diluted bleach solution or alcohol solutions having at least 70% alcohol).
 3. Ask staff to thoroughly wash hands for at least 20 seconds when they arrive, before and after each patient, before eating and after using the bathroom.
 4. Staff should use one phone and computer and maintain social distancing between the other staff members. Should they need to use the same phones or computers, have these disinfected in between uses.
2. Post a notice on your office door, advising patients not to enter if they are ill or were exposed to someone with the coronavirus, or have recently traveled to one of the affected countries.
 3. On arrival, if patients are at risk, isolate them and call your local health department for instructions.
 4. Instruct patients to call ahead if they feel sick, have red eyes (conjunctivitis) or have any concerns.
 5. Instruct patients to limit the number of people who accompany them to the visit.
 6. Offer to reschedule non-emergent patients 60 years and older, patients with co-morbidities or pre-existing conditions with decreased immunity. Consider setting aside blocks of time (e.g., the first two office operating hours) for older/ at risk patients for their safety and health.
 7. Limit points of entry into the office.
 8. Limit number of patients in waiting room.
 - a. Remove chairs/space out chairs (social distancing).
 - b. If sufficient room is not available, ask patients to wait in car/outdoors until doctor is ready.
 - c. If the patient has a cell phone, text patient to come in when ready. If not, ask staff to alert them to come into the office.
 9. Utilize Personal Protective Equipment, as available and in accordance with recommendations from the CDC.
 10. Maintain and practice social distancing as possible so as not to physically contact the patient outside of clinical necessity, including with regard to handshakes.
 11. Instruct patients to wash hands in bathroom upon entering for at least 20 seconds or use alcohol-based hand sanitizer.

Clinic/exam rooms

1. Clean exam room/patient rooms with best disinfectant in between each patient. Utilize as much disposable equipment as possible.
2. Utilize a slit lamp "breath" shield/barrier (whether purchased or fashioned). Size should be as large as possible while not interfering with clinical care.
3. Examine for conjunctivitis. Conjunctivitis can be a presenting sign of COVID-19.

During patient care

1. Share via email or post on office website and social media about guidance on coming to the office. But, in case experiencing cold or flu-like symptoms, do not come to the office.

CONCLUSIONS

Various factors and aspects were considered for the formulation of standard operating procedures for the eye care during COVID-19 scare then these standard guidelines and precautions were put forward



by various eminent global organizations like WHO & CDC. These have been regarded as the gold standard and were incorporated to form comprehensive guidelines for the eye care with safety precautions for the Optometrists as well with statutory and most important recommendation to wash hands thoroughly and as frequently as possible and use hand sanitizer. Caring for your patients during difficult times will always be remembered. Here are a few best practice tips: call your patients after hours of check up to know about their ocular or systemic health and consider making staff available to answer patient questions. Together and by taking these possible precautions, we can win this battle by defeating the CORONA Virus.

REFERENCES

1. Wang D, et al. Clinical Characteristics of 138 Hospitalized Patients with 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China. *JAMA*. 2020; 323(11):1061-1069.
2. Lu H, et al. Outbreak of pneumonia of unknown etiology in Wuhan China: the mystery and the miracle. *J Med Virol*. 2020. Apr;92(4):401-402.
3. Wuhan Municipal Health Commission. Report of novel coronavirus-infected pneumonia in China. Published January 20, 2020. Accessed May 30, 2020.
4. Guan W-J, et al. Clinical Characteristics of Coronavirus Disease 2019 in China. *N Engl J Med*. 2020;1-13.
5. Soumen Sadhu, et al, (2020): COVID-19: Limiting the Risks for Eye Care Professionals, *Ocular Immunology and Inflammation*, DOI:10.1080/09273948.2020.1755442
6. Seah I, et al. Can the Coronavirus Disease 2019 (COVID-19) Affect the Eyes? A Review of Coronaviruses and Ocular Implications in Humans and Animals. *Ocul Immunol Inflamm*. 2020; 28(3):391-395.
7. Mark DP, et al. The ocular surface, coronaviruses and COVID-19. *Clin Exp Optom* 2020. DOI:10.1111/cxo.13088
8. World Health Organization. WHO Director-General's opening remarks at the mission briefing on COVID-19. 2020. Available at: <https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19-11-march-2020>.
9. World Health Organization. Coronavirus disease 2019 (COVID-19) situation report 32. <https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200221-sitrep-32-covid-19.pdf>. 2020.
10. World Health Organization. Infection prevention and control during health care when novel coronavirus (nCoV) infection is suspected. [https://www.who.int/publications-detail/infection-preventionand-control-during-health-care-when-novel-coronavirus-\(ncov\)-infection-is-suspected-20200125](https://www.who.int/publications-detail/infection-preventionand-control-during-health-care-when-novel-coronavirus-(ncov)-infection-is-suspected-20200125). 2020.
11. Lai THT, et al. Stepping up infection control measures in ophthalmology during the novel coronavirus outbreak: an experience from Hong Kong. *Graefe's Arch Clin Exp Ophthalmol* 2020; 258: 1049-1055.
12. Jones L, et al. The COVID-19 pandemic: important considerations for contact lens practitioners. *Cont Lens Anterior Eye* 2020. <https://doi.org/10.1016/j.clae.2020.03.012>.
13. Zeri F, et al. Contact lens practice in the time of COVID-19. *Cont Lens Anterior Eye* 2020. <https://doi.org/10.1016/j.clae.2020.03.007>.
14. American Academy of Ophthalmology. Alert: important coronavirus updates for ophthalmologists. Available: <https://www.aao.org/nheadline/alert-important-coronavirus-context> [Accessed 27 July 2020].
15. Kruger JM, et al. Ophthalmology practice during the COVID-19 pandemic. *BMJ Open Ophthalmology* 2020; 5:e000487. doi:10.1136/bmjophth-2020-000487.
16. Wei LC, et al. 2019-nCoV transmission through the ocular surface must not be ignored. *The Lancet* 2020; 395:e39.
17. Lai THT, et al. Stepping up infection control measures in ophthalmology during the novel coronavirus outbreak: an experience from Hong Kong. *Graefes Arch ClinExp Ophthalmol* 2020;1-7.
18. Loon SC, et al. The severe acute respiratory syndrome coronavirus in tears. *Br J Ophthalmol*. 2004; 88(7):861-863.
19. Madhugiri R, et al. Coronavirus cis-acting RNA elements. *Adv Virus Res*. 2016; 96:127-163.
20. Chen Y, et al. Coronaviruses: genome structure, replication, and pathogenesis. *J Med Virol*. 2020; 92:418-423.
21. World Health Organization. WHO recommendations to reduce risk of transmission of emerging pathogens from animals to humans in live animal markets. 2020. <https://www.who.int/health-topics/coronavirus/who-recommendations-to-reduce-risk-oftransmission-of-emerging-pathogens-from-animals-to-humans-in-live-animal-markets>. Accessed in February 2020.
22. Sahin AR. 2019 novel coronavirus (COVID-19) outbreak: A review of the current literature. *Eurasian J Med Invest*. 2020; 4(1):1-7.
23. Willcox MDP. Tear film, contact lenses and tear biomarkers. *Clin Exp Optom* 2019; 102: 350-363.
24. Lang J, et al. Inhibition of SARS pseudovirus cell entry by lactoferrin binding to heparan sulfate proteoglycans. *PLoS One* 2011; 6: e23710.
25. Argüeso P, et al. Characterization of a carbohydrate epitope defined by the monoclonal antibody H185: Sialic acid O-acetylation on epithelial cell surface mucins. *Glycobiology* 2006; 16: 1219-1228.



26. Holappa M, et al. Many faces of renin-angiotensin system - focus on eye. *Open Ophthalmol J*. 2017; 11(1):122–142.
27. K.P.Y. Hui, et al., Tropism, replication competence, and innate immune responses of the coronavirus SARS-CoV-2 in human respiratory tract and conjunctiva: an analysis in ex-vivo and in-vitro cultures, *Lancet Respir Med* (May (7)) (2020), [https://doi.org/10.1016/S2213-2600\(20\)30193-4](https://doi.org/10.1016/S2213-2600(20)30193-4) pii: S2213-2600(20)30193-30194.
28. R.J. Roberge, Face shields for infection control: a review, *J Occup Environ Hyg* 13(4) (2016) 235–242.
29. Cho P, et al. COVID 19-An eye on the virus. *Cont Lens Anterior Eye*. 2020;43(4):313-314.
30. P. Wu, et al. Characteristics of ocular findings of patients with coronavirus disease 2019 (COVID-19) in Hubei Province, China, *JAMA Ophthalmol* (March (31)) (2020), <https://doi.org/10.1001/jamaophthalmol.2020.1291>
31. K. Hu, et al. Ophthalmic manifestations of coronavirus (COVID-19) [Updated 2020 Apr 13], StatPearls Publishing, Treasure Island (FL), 2020 Jan.
32. World Health Organization, WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020, (2020) <https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19-11-march-2020>.
33. Zeri F, et al. Contact lens practice in the time of COVID-19. *Cont Lens Anterior Eye*. 2020; 43(3):193-195.
34. I. Seah, et al. Revisiting the dangers of the coronavirus in the ophthalmology practice, *Eye (Lond)* In press (2020).
35. K.R. Steele, et al. Epidemiology of contact lens-induced infiltrates: an updated review, *Clin Exp Optom* 100 (5) (2017) 473–481.
36. F. Stapleton, et al. The epidemiology of microbial keratitis with silicone hydrogel contact lenses, *Eye Contact Lens* 39 (1) (2013) 79–85.
37. J. Xia, et al. Evaluation of coronavirus in tears and conjunctival secretions of patients with SARS-CoV-2 infection, *J Med Virol* In press (2020).
38. Jones, Lyndon et al. The COVID-19 pandemic: Important considerations for contact lens practitioners. *Contact lens & anterior eye : the journal of the British Contact Lens Association* vol. 43,3 (2020): 196-203.
39. D. Fonn, et al. Hand hygiene is linked to microbial keratitis and corneal inflammatory events, *Cont Lens Anterior Eye* 42 (2) (2019) 132–135.
40. T.H.T. Lai, et al. Stepping up infection control measures in ophthalmology during the novel coronavirus outbreak: an experience from Hong Kong, *Graefes Arch ClinExp Ophthalmol* (March) (2020), <https://doi.org/10.1007/s00417-020-04641-8>.
41. US Centre for Disease Control and Prevention. How COVID-19 Spreads. <https://www.cdc.gov/coronavirus/2019-ncov/about/transmission.html> [Accessed 15 May 2020].
42. European Centre for Disease Prevention and Control. Q & A on COVID-19. <https://www.ecdc.europa.eu/en/novel-coronavirus-china/questions-answers> [Accessed 15 May 2020].
43. The Department of Health and Social Care (DHSC) and Public Health England (PHE). COVID-19: infection prevention and control guidance. <https://www.gov.uk/government/publications/wuhan-novelcoronavirus-infection-prevention-andcontrol> [Accessed 15 May 2020].
44. T.H.T. Lai, et al. Stepping up infection control measures in ophthalmology during the novel coronavirus outbreak: an experience from Hong Kong, *Graefes Arch ClinExp Ophthalmol* (March) (2020), <https://doi.org/10.1007/s00417-020-04641-8>.
45. EuroTimes, Coronavirus and ophthalmology: what can ophthalmologists do to protect themselves, staff and patients from COVID-19? (Priscilla Lynch), 11 March (2020) https://www.eurotimes.org/coronavirus-and-ophthalmology/?fbclid=IwARIATvYEIC_TwWU5PSEEW5ozBfKUQckH0weWtkl_FcuDEpME2yTBbGwfRU.
46. Centers for Disease Control and Prevention, Interim Infection Prevention and Control Recommendations for Patients with Suspected or Confirmed Coronavirus Disease 2019 (COVID-19) in Healthcare Settings, COVID-19, (2020) Accessed 24 Mar 2020. <https://www.cdc.gov/coronavirus/2019-ncov/infection-control/control-recommendations.html>.
47. S.L. Warnes, et al. Human Coronavirus 229E Remains Infectious on Common Touch Surface Materials, *mBio* 6 (6) (2015) e01697–15.
48. N. Ikonen, et al. consortium, Deposition of respiratory virus pathogens on frequently touched surfaces at airports, *BMC Infect Dis* 18 (1) (2018) 437.
49. G. Kampf, et al. Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents, *J Hosp Infect* 104 (3) (2020) 246–251.
50. S.W.X. Ong, et al. Air, Surface Environmental, and Personal Protective Equipment Contamination by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) From a Symptomatic Patient, *JAMA* In press (2020).