ARHAI Scotland

Antimicrobial Resistance and Healthcare Associated Infection

NHS National Services Scotland

# Rapid review of the literature - Eye protection in health and care settings for the prevention of COVID-19 transmission

**Version 3.0**

# Version history

| Version | Date | Summary of changes |
|---|---|---|
| 1.0 | 03/07/2020 | First version of document |
| 2.0 | 26/08/2020 | Update based on review of evidence base |
| 3.0 | 8/10/2020 | Update based on review of evidence base |
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# Contents

# 1 Aim

Transmission of infectious agents can occur when splashes or droplets of contaminated body fluids land on the mucous membranes in the eyes, mouth or nose, or when the same mucous membranes come into contact with contaminated skin, such as when rubbing the eyes with a contaminated hand. Current UK COVID-19 remobilisation infection prevention and control (IPC) guidance states that eye protection can be achieved by wearing polycarbonate safety glasses or equivalent. Concern has been raised regarding the suitability and efficacy of safety glasses procured for use in UK health and care settings as part of the COVID-19 pandemic response. Concern has also been raised in relation to whether a full face visor or goggles are more appropriate for AGPs as well as the requirement to doff eye protection along with respirators out with the clinical area and by extension, general concerns over ocular transmission of COVID-19.

The aim of this rapid review is to assess the available evidence to determine the most effective mode of eye protection for the prevention of transmission of COVID-19 in health and care settings as well as to provide an overview of the evidence base concerning ocular transmission of COVID-19.

# 2 Objectives

The following research question were assessed:

- What is the current evidence base regarding ocular transmission of COVID-19?
- What type of eye protection should be worn to prevent transmission of COVID-19 in health and care settings?
- Should eye protection be doffed within or out with the treatment area following patient care or performance of aerosol generating procedures?

# 3 Methodology

For details of the search strategy see Appendix 1.

As this was a rapid review, evidence was critiqued by a single reviewer but not formally graded with the use of an appraisal tool.

# 4 Results

From the literature searches conducted for this rapid review, 59 papers were included, consisting of 5 systematic reviews,[1-5] 2 rapid reviews,[6, 7] 3 observational sampling studies,[8-10] 2 experimental studies,[11, 12] 15 cross sectional studies,[13-27] 8 lab based observational studies,[28-35] 12 case reports,[36-47] 9 guidelines/guidance summaries,[48-56] 1 survey[57], 1 case-control study[58] and 1 case series[59]. Only 6 of the included studies assessed different types of eye protection; five of these were guidelines/reviews and only one was an experimental study. No randomised controlled trials were identified which assessed eye protection. The relevant legislative and international standards that apply to eye protection are also discussed. None of the papers describe proven ocular transmission events.

## 4.1 Indications for use

The official UK COVID-19 IPC remobilisation guidance states that as part of SICPs, eye or face protection (including full-face visors) must be worn if blood and/or body fluid contamination to the eyes or face is anticipated or likely and must always be worn during AGPs.[52] In regards to TBPs, the eye protection required for routine care of patients during the COVID-19 pandemic, and when undertaking AGPs, differs depending on which of the 3 care pathways the patient is on and is currently under review, however, it is clear that for AGPs on both the Medium and High Risk Pathways, an FFP3 respirator with *"eye/face protection (visor)"* is required.[52]

## 4.2 Standards and Legislation

The wearing of PPE in health and care settings is covered by the Health and Safety at Work Act (1974),[60] Control of Substances Hazardous to Health (COSHH) Regulations (2002 as amended)[61] and the Personal Protective Equipment at Work Regulations (1992 as amended).[62] The Health and Safety at Work Act broadly covers the use of PPE, but is not healthcare specific.

It is important to note that there is no specific standard for eye protection worn in the health and care setting. The standards available for eye protection are general and apply to all eye protection worn in the working environment. This means that many of the tests are designed to ensure eye protection is appropriate for industrial uses e.g. chemical splashes, high impact projectiles, molten metals etc. General European standard EN 166:2002 applies to glasses (with or without lateral protection), goggles and face visors, all of which may conceivably be worn within the health and care setting. EN166:2002 eyewear must be tested in accordance with EN167 (optical requirements) and EN168 (non-optical requirements) to pass the appropriate standards. BS EN ISO 18526-3:2020 is the international standard that sets out the physical and mechanical properties required for eye and face protection. There are no specific legislative requirements regarding the use of eye/face protection as PPE for infection control purposes, and there is no specific infection control test for eye protection.

Standards EN 166 and EN 168 make it clear that safety glasses cannot be tested for liquid splash or droplet protection as they are unable to protect against those hazards. It is outlined that face visors can be tested to meet splash requirements and goggles can be tested to meet droplet requirements but no eye protection appears to be able to meet both standards. A frame marking of '3' denotes that the eye protection is designed to protect against liquids but presumably the design of the eye protection (goggles or face visor) indicates which of these (i.e. droplet or splash protection) applies.

## 4.3 Ocular transmission

Currently, only weak, circumstantial evidence for ocular transmission of COVID-19 exists. The concept of ocular transmission being a plausible infection route is based on a number of factors; the expression of ACE-2 receptors (the binding sites of SARS-CoV-2) in the conjunctiva and cornea of the eye, reports of ocular manifestations associated with COVID-19 including their presence as a presenting, initial symptom and PCR positive conjunctival swabs of COVID-19 infected patients.

There appears to be general consensus that ACE-2 receptors are present on the ocular surface,[28-31, 35] however, there is disagreement in the literature[32] and authors highlight that the eye has many physical and chemical protective elements which could explain the low number of COVID-19 infections presenting with ocular symptoms.[30]

There is evidence to support that a small percentage of COVID-19 infected patients present with[13, 26, 36, 37] or develop ocular complications, such as conjunctivitis.[13, 25-27, 38-42] Conjunctivitis can also be the only symptom.[26, 43, 44, 59] Limited evidence suggests that ocular manifestations may be more likely in those with upper respiratory symptoms.[25, 26] However, most of these cross sectional studies do not have a control group of non-infected patients with which to compare rates of ocular symptoms. Studies show a variable rate of COVID-19 patients who present with ocular symptoms from 0.8% to 22.7%. In two studies, 20 of 93 sequentially hospitalised COVID-19 patients (21.5%) and 49 of 216 COVID-19 infected children (22.7%) had at least one ocular abnormality, however, authors do not report on the patients' ocular histories and medical/symptom histories taken from children may be less reliable.[14, 26] In a study which included 359 patients diagnosed with COVID-19, ocular disease was observed in 16 (4.5%) of the patients.[15] In a large study from China consisting of 1099 laboratory-confirmed hospital-admitted COVID-19 cases, nine patients (0.8%) had conjunctival congestion on admission, however, the authors do not state how this was assessed and how long patients had been experiencing conjunctivitis related symptoms.[16] One cross-sectional, telephone administered, questionnaire study of 108 European non-hospitalized patients reported 69.4 % as having experienced at least one ocular symptom during COVID-19, however, self-assessment of ocular health is considered less reliable than expert clinical examination.[27]

Ocular manifestations do not provide evidence of transmission via the eyes. There is a paucity of evidence in this regard, as there is no way of determining the exact route

of entry of respiratory droplets/aerosols (i.e. eyes/mouth/nose) during a transmission event. A highly cited event in the literature is that of the transmission of COVID-19 to Guangfa Wang, a member of the national expert panel on pneumonia.[63] He reported that he was infected during an inspection in Wuhan where he wore an N95 mask but did not wear anything to protect his eyes.[63] Several days before the onset of pneumonia, Wang complained of redness of the eyes.[63] This event, however, does not appear to be associated with a formal case report or investigation, and data is not provided regarding activities carried out during inspection, hand hygiene, eye touching etc. A rapid review conducted by the Centre for Evidence-Based Medicine found limited evidence in relation to eye protection and COVID-19 but concluded that HCWs' conjunctivae could be exposed to infectious COVID-19 droplets/aerosols during close contact, however, not necessarily that transmission was likely via this route.[6] A systematic review and meta-analysis regarding physical distancing, surgical masks and eye protection identified 42 observational studies for meta-analysis.[4] Thirteen studies addressed the association of eye protection with virus transmission.[4] Twelve studies reported on SARS or MERS and only 1 study related to COVID-19.[4] In this study, odds ratios could not be calculated as no transmission events occurred from positive contacts to 42 of those with eye protection and 34 of those without.[4] Overall, however, in relation to SARS and MERS, eye protection was associated with less infection (n=3713; OR 0·22, 95% CI 0·12 to 0·39).[4]

Detecting the presence of SARS-CoV-2 RNA in conjunctival samples is variable and does not appear to correlate with presence of ocular symptoms.[10, 17-24] In a recent retrospective cohort study of 40 COVID-19 positive patients, 3 had PCR positive conjunctival swabs, only one of whom had conjunctivitis with a further 9 patients having conjunctivitis but no positive swabs.[19] A Spanish cross sectional study, including 18 COVID-19 patients without conjunctivitis and 18 patients with, found that there was no difference in the rates of positive conjunctival swab samples depending on the presence of this ocular condition.[20] In a recent laboratory based study, Hui et al isolated SARS-CoV-2 from a COVID-19 confirmed patient and assessed its ability to infect ex-vivo cultures of human conjunctiva (n=3).[33] Authors report that SARS-CoV-2 infected the conjunctival mucosal cells, however, this study has a very small sample size and does not represent in vivo transmission scenarios.[33] Recent case reports reveal that COVID-19 RNA can be detected in conjunctival samples beyond cessation of respiratory symptoms and days beyond RNA becoming undetectable in nasal swabs.[39, 45, 46] It is important to note that detection of RNA via PCR is not detection of live virus; sampling can also be affected by inadequate technique, timing of sample collection and detection limitations.

Experimentally, the infectivity of ocular secretions was investigated with the inoculation of a positive ocular sample into monkey kidney cells, with a cytopathic effect observed 5 days post inoculum.[39] Viral replication was confirmed by real-time RT-PCR on RNA purified from spent cell growth medium.[39] Such experimental trials do not however provide proof of ocular infectivity in real-life.

To summarise, there is no clear evidence of ocular transmission of COVID-19. The perceived risk is based on circumstantial evidence (PCR analysis, expression of ACE-2 receptors, and ocular manifestations) and the possibility of respiratory

droplets/aerosols making contact with the mucosal surfaces of the eye during close contact.

## 4.4 Type of eye protection

It should be noted that eye protection is not worn in isolation; both eye and face protection are required as part of both SICPs and TBPs to provide protection against mucosal surface contamination. From the literature, options for eye protection include goggles, safety glasses, half and full face visors. As per the NIPCM, eye/face protection for SICPs should be provided by goggles or a half face visor (in combination with a fluid-resistant surgical mask) or a full face visor that fully covers the front and sides of the face.[2] In regards to TBPs, the NIPCM outlines that either goggles or a full face visor should be worn in combination with a fluid-resistant Type IIR surgical face mask (droplet precautions) or FFP3 respirator (airborne precautions).

The official UK COVID-19 IPC remobilisation guidance states that eye protection can be achieved by wearing a full face visor, half face visor (surgical mask with integrated visor) or polycarbonate safety glasses.[52] As part of the COVID-19 response, the Cabinet Office and Department of Health and Social Care produced guidance for potential manufacturers of PPE which stated that safety glasses must be optically clear and resistant to fogging.[48] A rapid review of PPE for COVID-19 conducted by the Health and Safety Executive (HSE) concluded that safety glasses constitute eye protection however the review did not assess any published studies that assessed the efficacy or suitability of safety glasses for infection prevention and control.[7] This is not in line with Scottish IPC guidance (NIPCM), which does not recommend the use of safety glasses. ECDC, CDC and WHO COVID-19 IPC guidance consistently recommends eye protection (visor or goggles) for the care of suspected or confirmed COVID-19 cases.[54-56] Out with COVID-19 guidance, English IPC guidance does not provide recommendations on the type of eye protection that should be worn.[53]

There is consensus in the identified literature that safety glasses are not appropriate for IPC and that goggles are the preferred mode of eye protection, particularly in the surgical setting, however a face visor provides additional protection to other facial areas. Guidelines produced by the Association of Surgical Technologists in 2017 state that safety glasses do not provide proper infection control protection; goggles are the preferred option and should be indirectly vented with an anti-fog coating.[50] Directly-vented goggles may allow droplets/splashes to enter; indirect venting consists of angled vents which face away from the front of the lens, preventing influx of droplets. The guideline advises that prescription glasses both with and without side shields do not adequately protect against splashes or spray, and surgical masks with integrated face shields should not be relied upon to provide optimal protection. The Association of Perioperative Registered Nurses (AORN) in their 2019 guideline summary for transmission-based precautions state that prescription eyeglasses with side protection may not protect against splashes or sprays as well as goggles do.[51] AORN advise that goggles that are indirectly vented and anti-fog should be worn, and a face visor used when more coverage is needed to protect the face and eyes

outside the area covered by the mask and goggles.[51] Practice recommendations from the US Centers for Disease Prevention and Control (CDC) in collaboration with the National Institute for Occupational Safety and Health (NIOSH) also state that safety glasses do not provide the same level of splash or droplet protection as goggles and generally should not be used for infection control purposes.[49] They advise that face visors are a commonly used alternative to goggles and should have crown and chin protection and should wrap around the face to the point of the ear to reduce the likelihood that a splash could go around the edge of the visor and reach the eyes.[49] A systematic literature review conducted to assess the COVID-19 PPE requirements for orthopaedic and trauma surgery concluded that goggles that cover the eyes and the periocular skin should be worn by all HCWs present in the room during AGPs to prevent COVID-19 transmission.[3] The review referenced an experimental study by *Mansour et al* that used mannequin heads and cadavers to mimic contamination of surgeons' heads during orthopaedic surgery.[11] The study found that disposable plastic eye glasses that provide protection above and below the eye as well as contoured side protection minimize the risk of contamination. However, none of the tested eye protection devices provided 100% protection, and goggles and full face visors were not tested. The need for a seal above the eyes was reported in a retrospective survey of HCWs that found that 26% of the 404 respondents reported wearing personal eyeglasses during insertion and removal of IV catheters; anecdotal evidence supported the need for both the wearing of proper eye protection and the need for a seal above the eyes.[57]

In an experimental study an aerosol generator was used to create an experimental aerosol spray of live attenuated influenza particles within a test chamber.[12] Six different modes of facial protection were tested however only goggles were used as eye protection; unfortunately the sample size of this study was very small which did not allow significance testing or trend analysis.

These is some evidence from experimental studies to suggest that face visors alone may be insufficient to provide full protection against influx of droplets/aerosols. The first laboratory-based study tested the efficacy of a face visor worn as part of droplet precautions, using an airbrush system that produced a range of particles sizes (<1 to >100µm) of live Influenza virus (H1N1 A/WS/33) directed towards an anatomical head.[34] The face visor tested was found to reduce large particle/droplets from contacting the simulated oral mucosa by ~95-100% but had a minimal effect on smaller aerosol particles (<4.7µm) (~0.7-11% reduction). The second experimental study utilised a breathing and coughing simulator with differing set-ups based on variables of distance between simulators, 'sizes of coughs', presence of face visor and times of sample collection.[64] The face visors were found to reduce the amount of droplets inhaled in the 1-30 minute exposure period following a cough but were less effective over longer periods of time and against smaller particle coughs.[64] Unfortunately for both these experimental studies, it is not clear whether the face visors used met EU and/or international standards, and there was no comparison with goggles. These studies were included in a systematic review that concluded that face visors should not be used alone to provide respiratory protection as the absence of a close face fit may allow influx of droplets/aerosols.[65] As per the

NIPCM, a full face visor should be worn with a fluid-resistant surgical face mask when droplet precautions are being employed.

Two reviews did not provide any conclusive evidence regarding mode of eye protection. These included one systematic reviews (Cochrane review)[1] and a rapid review conducted by the Centre for Evidence-Based Medicine.[6]

## 4.5 Doffing eye protection

In regards to doffing, the CDC recommend for COVID-19, that eye protection (face visor or goggles) be removed after leaving the patients room,[66] however, no evidence is provided to support this recommendation and this is not recommended as part of their general droplet precaution-based guidance.[67-69] The clarity on doffing location would be based on evidence of ocular transmission of COVID-19 via airborne atmospheric aerosols rather than contamination via droplets/splash.

# 5 Conclusion

There is weak circumstantial evidence to suggest that close range ocular transmission of COVID-19 via droplets may be possible, but there is currently no strong evidence to support aerosol transmission via the ocular route and therefore, no strong argument for wearing eye protection beyond direct patient care or completion of an AGP. Therefore, it is not currently recommended that eye protection be doffed out with the treatment area.

Whilst ocular transmission may be biologically plausible, it is important to note that presence of viral RNA in conjunctival swabs and ocular manifestations could arise as a result of spread from the nasopharyngeal system through being anatomically linked or through contamination via hand to eye contact.

A major limitation of the evidence base is the lack of both experimental studies and trials in health and care settings for the evaluation of eye protection. This, coupled with the fact that there are no recognised infection control standards for eye protection, limit the ability to provide strong practice recommendations for eye wear.

In general, eye protection devices should be designed to prevent blood and body fluids from making contact with the eyes; for this reason, the design should allow the eye protection to fit close to the face and should not have any gaps/entry points. Limited evidence suggests that goggles (indirectly vented) and full face visors provide the best overall protection for all types of droplet contamination (not just COVID-19) as they provide full coverage of the eye area and reduce the risk of side influx of droplets. The choice of eye protection should be proportional to the risk of droplet, splash or spray exposure i.e. a full face visor instead of goggles may be warranted in certain clinical situations.

Safety glasses are not currently tested for droplet/splash protection under EN standards (or any official standard). Whilst Scottish and International IPC guidelines do not recommend safety glasses for use in health and care settings, it is understood that these are currently used in many settings, and were recommended for use in the UK response to COVID-19. Where safety glasses are being used in health and care settings for COVID-19, it is essential that their design features and suitability are reviewed and that open design features that allow side/top influx are avoided. Goggles and face visors continue to be the preferred choice for droplet associated eye protection.

Whilst current standards and evidence suggest that droplet transmission is likely to be mitigated by a face visor, the efficacy of face visors in protection of mucosal membranes from airborne transmission is, in theory, likely to be limited in comparison to goggles. However the evidence base for this is limited. Industrial standards would suggest that face visors are not tested for this purpose. As per current IPC guidance, face visors must be worn in combination with an FFP3 when used during AGPs on suspected/confirmed COVID-19 patients.

# 6 Recommendations

- There is currently no strong evidence to support aerosol transmission via the ocular route and therefore, no strong argument for wearing eye protection beyond completion of an AGP or direct patient care. It is not currently recommended that eye protection be doffed out with the treatment area.
- In line with current guidance, it is recommended that goggles or a face visor be used in combination with a fluid resistant surgical face mask for direct care of patients with suspected/confirmed COVID-19 infection where splashing/spraying is anticipated.
- For AGPs on suspected/confirmed COVID-19 infected patients, eye protection (googles/visor) should be worn in combination with an FFP3 respirator. If the respirator is not fluid resistant (e.g. valved, non-shrouded) a full face visor (rather than a half) should be used.
- Eye protection should ideally fit close to the face and wrap around the lateral aspect of the eyes. Safety glasses are not currently tested for droplet/splash protection under EN standards (or any official standard) and are therefore not recommended in Scotland.

# Appendix 1

**Search 1**

The following search strategy was processed in Medline, Embase and CINAHL on 15th April 2020; papers published prior to 2000 were excluded. The search was rerun on 1st June 2020, 20th August 2020 and 17th September 2020 in Medline and Embase to capture the latest papers. A total of 501 papers were screened in the first update, 45 in the second and 6 in the third. Additional grey literature searches of online resources was also carried out.

1. eye protective devices/
2. goggles.mp.
3. face shield*.mp.
4. visor*.mp.
5. safety glasses.mp.
6. exp hospitals/
7. exp infections/
8. exp infection control/
9. exp disease transmission, infectious/
10. 1 or 2 or 3 or 4 or 5
11. 6 or 7 or 8 or 9
12. 10 and 11

**Search 2**

To capture more articles on ocular transmission an additional search was conducted on the 21st August 2020 in Medline and Embase and updated on 17th September 2020. A total of 591 papers were screened in the first search and 28 in the update. Additional grey literature searches of online resources was carried out.

1. (eye* or ocular).mp
2. (transmission* or infect* or transmit*).mp.
3. 1 and 2
4. English language
5. Human
6. Humans
7. covid-19

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