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**Clinical and Perioperative Management in
Ophthalmology during the COVID-19 Pandemic**

Ella H. Leung MD,^{1,2} Harry W. Flynn Jr MD,³ Steven Gayer MD,⁴ Steven Yeh MD,⁵
Audina M. Berrocal MD,³ Lisa C. Olmos de Koo MD,⁶ Royce W.S. Chen MD,⁷
Thomas A. Albini MD,³ Rod Foroozan²

¹ Georgia Retina, Atlanta, GA

² Cullen Eye Institute, Baylor College of Medicine, Houston, TX

³ Bascom Palmer Eye Institute, University of Miami, Miami, FL

⁴ Department of Anesthesiology, University of Miami, Miami, FL

⁵ Emory Eye Center, Emory University, Atlanta, GA

⁶ University of Washington Medicine Eye Institute, University of Washington, Seattle, WA

⁷ Edward S. Harkness Eye Institute, Columbia University, New York, NY

Corresponding Author:

Ella Leung, MD
833 Campbell Hill St NW, Suite 300
Atlanta, GA 30339
ellaleungmd@gmail.com

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Please note that due to the rapidly evolving nature of the COVID-19 pandemic, every effort was made to ensure accuracy of the information at the time of publication; however, some information and guidelines may change over time. For the most recent recommendations, please visit www.CDC.gov and www.aao.org

Abstract

The novel coronavirus COVID-19 or severe acute respiratory syndrome-related coronavirus 2 (SARS-CoV-2) was officially declared a pandemic in March 2020 by the World Health Organization. The virus is highly contagious, causes significant morbidity and mortality, and ophthalmologists are at risk for contracting the infection. The interim recommendations from international and national public health organizations are reviewed, including minimizing patient contact, deferring elective cases, frequent hand hygiene, thorough disinfection, and use of personal protective equipment. Additional precautions are implemented for patients with known or suspected COVID-19 infections, including preoperative testing, specially designated negative pressure operating rooms, and thorough disinfection. Current testing options and recommendations on when precautions may be eased are also reviewed.

Introduction

In December 2019, an outbreak of pneumonia was first reported in China, and the causative organism was later identified to be a novel coronavirus, initially named 2019-nCoV,¹ then renamed COVID-19 or severe acute respiratory syndrome-related coronavirus 2 (SARS-CoV-2).² The World Health Organization (WHO) officially declared it a pandemic on March 11, 2020.² By April, over 2.6 million people in 212 countries and territories had confirmed COVID-19 infections and over 188,000 people have died worldwide.³

The virus is highly contagious, and early estimates of the basic reproduction number (R0) were increased from 2.24 to as high as 5.7 (95% CI 3.8-8.9).⁴ Although initial reports suggested that the virus was spread by direct human-to-human contact and respiratory droplets, additional studies suggested possible transmission via aerosolized respiratory droplets and oral-fecal transmission.⁵ Aerosolized virus particles may be detected in the air up to 3 hours later, cardboard for up to 24 hours, stainless steel for 48 hours, and plastic for 72 hours.⁶ Asymptomatic carriers can also transmit the virus.^{4,7}

Ophthalmologists are at risk for contracting COVID-19 due to the close proximity of the physician and patient during examinations and procedures. The WHO defines close contact as being within 1 meter (3 feet) for more than 15 minutes.³ Slit lamp biomicroscopy and indirect ophthalmoscopy are within an arm's length, and aerosolized particles from a sneeze can travel up to 6 meters.⁸

Several national and international organizations have released their interim recommendations on the management of patients during the pandemic, including the WHO, Centers for Disease Control and Protection (CDC), United States (U.S.) Surgeon General, American Academy of Ophthalmology (AAO), American Society of Retina Specialists (ASRS), the American College of Surgeons (ACS), American Society of Anesthesiologists (ASA), and several large ophthalmology practices heavily affected by the virus.^{2,7-13} The current article will review the systemic and ocular manifestations of COVID-19, testing options, and interim guidelines on minimizing infections in the clinics and operating rooms (**Table 1**).

Clinical Manifestations

Systemic Manifestations

Evaluation of 72,314 cases from the Chinese Center for Disease Control and Prevention found that the most common systemic symptoms of COVID-19 included fever, cough, dyspnea, and malaise.¹⁴ The incubation period was approximately 5 to 7 days but could be as long as 14 days. The majority of patients affected (87%) were between 30 and 79 years old, with most (81%) having mild symptoms. Unfortunately, 5% of affected patients were in critical condition, with a mortality rate of 49%.¹⁴ Healthcare workers comprised 3.8% of the infected population, with 14.8% being in severe or critical condition.¹⁴ The overall mortality rate in China was approximately 2.3% and ranged from 0.6-3.5% globally;¹⁴⁻¹⁶ however, the numbers may change as more people are tested.

The virus can cause respiratory distress, and computerized tomography (CT) of the chest may demonstrate ground glass opacities.¹⁷ While treatment at this time is primarily supportive, therapies under investigation include anti-viral agents such as remdesivir, immunomodulatory therapy, convalescent plasma from recovered patients, and vaccines.^{7,18,19}

Testing

There are several methods of testing for the coronavirus with different sensitivities and specificities, viral limits of detection, and turnover times (**Table 2**). The U.S. Federal Drug Administration (FDA) has issued over 30 emergency use authorizations in an effort to increase testing availability.²⁰

Reverse transcription-polymerase chain reaction (RT-PCR) can be used to detect small amounts of viral material, but the clinical sensitivity may vary depending on when and where the specimen was collected. In one study of 51 COVID-19 patients in China who underwent throat swabs or sputum samples with RT-PCRs and chest CTs, 98% had abnormal CTs while only 71% had positive RT-PCRs.¹⁷ If the clinical suspicion for COVID-19 is high but the initial test was negative, repeating the test in 24-48 hours, altering the site of testing, or obtaining a CT chest may be considered. The viral load is higher with bronchoalveolar fluid and sputum than with swabs, and nasopharyngeal swabs having higher diagnostic yields than oropharyngeal samples.^{17,21} Tests are more likely to be positive when performed within the first week of symptoms, when respiratory viral shedding is the greatest;²¹ however, SARS-CoV-2 RNA can be detected in some individuals for up to 37 days after infection, prompting concerns about re-infections and immunity.²²

Serologic tests can help differentiate between current and prior exposure to COVID-19, but the tests may take longer to perform, and the sensitivities may also be affected by the timing of the samples. The rapid diagnostic test takes 10-30 minutes to provide a result, the enzyme-linked immunosorbent assay (ELISA) takes 20 minutes to 5 hours, and the neutralization assay takes 3-5 days.²³ Most patients will have rising antibody titers within 10 days of symptoms.²⁴ IgM can be detected in the blood within 4-5 days, is present in 70% of symptomatic patients within 2 weeks, and 90% within 24 days; more than 94% will develop IgG reactivity within 14 days.^{21,24,25}

Ocular Manifestations

The majority of patients with SARS-CoV-2 do not have ocular involvement, but the infection may rarely present as conjunctivitis. In a study of 1,099 COVID-19 patients in China, only 0.8% had conjunctival congestion.⁷ PCR testing of 30 patients with SARS-CoV-2 found that the virus was present in the tears of only one patient with conjunctivitis; patients without conjunctivitis tested negative.²⁶ A 30 year old male with COVID-19 and acute bilateral follicular conjunctivitis had viral RNA present in conjunctival swabs on days 14 and 17 but tested negative by day 19; there were no other ocular abnormalities.²⁷ While the coronavirus can cause intraocular inflammation in animals, intraocular complications have yet to be reported in humans.^{27,28} Similarly, a case series of 48 COVID-19 patients in Thailand reported none with ocular manifestations.²⁹ In contrast, a case series of 38 patients with COVID-19 in Hubei, China found that 31.6% had conjunctivitis, including chemosis, epiphora, secretions, and conjunctival hyperemia; the authors suggested that ocular symptoms were uncommon but may be associated with more severe systemic disease.³⁰

The recovery of virus particles in tears raises the question of viral transmission. The spike protein of the coronavirus can bind to the angiotensin converting enzyme 2 (ACE2) receptor to help the virus enter the host cell; ACE2 is more commonly found in the lungs, intestine, and retina while ACE1 is in the cornea and conjunctiva.^{27,28,31} Qing et al. therefore suggested that the virus may enter through the nasolacrimal drainage system, which then

passes to the respiratory tract and body.³¹ At this time, systemic ACE inhibitors do not need to be discontinued in stable patients.³²

Management of Ophthalmology Clinics

Clinic Management

The CDC and AAO recommend limiting clinics to emergent and urgent cases in order to minimize the risk of transmission.^{7,9,10} The ophthalmologist should carefully consider the patient's comorbidities and weigh the risks and benefits of continuing or delaying procedures or spacing out injection intervals.⁹ Patients in the early postoperative period should continue to be evaluated.

Clinic flow may need to be reorganized.³³ Patients and staff should be screened for signs and symptoms of COVID-19 daily, preferably with an infrared thermometer and standardized questionnaires.³⁴ A sign can be posted at the door, telephone calls made prior to the visit, and messages posted online asking patients to reschedule if they have symptoms, have been in close contact with a COVID-19 patient, or had recent travel to a heavily impacted area. Automated check-ins and clear plastic shields between patients and staff may help minimize contact.³⁴ Appointments may be spaced out, patients reminded to remain at least 6 feet apart in the waiting rooms or wait in their vehicles until they are ready to be evaluated, and limits placed on the number of companions. Items in the waiting rooms that may serve as fomites, such as magazines or books, should be removed.

In the examination rooms, large slit lamp barriers, minimizing verbal communication during the examination, deferring routine dilated fundus examinations unless necessary, and using face masks and eye protection may help to decrease the spread of infection.^{7-9,12} Indirect ophthalmoscopes may increase the distance between the patient and the examiner but needs to be thoroughly cleaned in between use. Computers, examination chairs, slit lamps, and commonly touched surfaces like light switches and doors should be cleaned frequently.³⁴ The use of shared medical equipment and micro-aerosol generating procedures, such as non-contact air tonometry, should be minimized whenever possible; disposable tonometry tips may be preferable in patients requiring intraocular pressure (IOP) measurements.¹² Depending on staff availability, healthcare personnel may be separated into different teams to prevent cross-infection, responsibilities divided between patient and non-patient contact activities, and ancillary staff in human resources and billing may work from home.^{35,36} Satellite offices may be closed, patients redirected to the main offices, entrances and exits restricted, and doors left open to minimize contact.³⁶

Personal Protective Equipment and Equipment Disinfection

Equipment and surfaces should be frequently disinfected after each patient encounter, following the manufacturer recommendations and using Environmental Protection Agency (EPA)-registered hospital-grade disinfectants, such as 70% ethyl alcohol or 10% sodium hypochlorite. Frequent hand washing should be encouraged, and the staff should be trained on proper infection control and use of personal protective equipment (PPE).^{8,10,37} The AAO currently recommends that the patient wear a mask during procedures while the physician wears a mask (preferably N95) and eye protection.⁷

While it is not recommended that disposable filtering facepiece respirators be routinely reused and decontaminated, global shortages have prompted the CDC to state that certain measures have shown promise in decontaminating face masks, even after repeated cleanings. Masks that underwent ultraviolet germicidal radiation (0.5-950J/cm²) passed filtration performance tests even after 3 cycles, vaporous hydrogen peroxide can be used for up to 20 cycles, and moist heat (15-30 minutes at 60° Celsius or 140° Fahrenheit, 80% relative humidity) passed even after 3 cycles.¹⁰ Masks can be reused for up to 2 cycles with dry heat at 70°C (158° F), but ethanol decontamination was not recommended.³⁸ Healthcare workers may also consider storing their used masks in breathable paper bags and waiting at least 5 days before reusing.¹⁰

Confirmed COVID-19 Infection or Person Under Investigation

Patients with confirmed or suspected COVID-19 infections (person under investigation/ PUI) who need an urgent ophthalmic evaluation may be sent to the emergency department or hospital for SARS-CoV-2 testing and evaluation in an isolation room.^{7,10} All equipment should be gathered ahead of time, patients should wear a mask and minimize verbal communication, and the physician should wear full PPE, including a grade 3 filtering face piece with 99% filter efficacy (such as an N95 mask), long-sleeve waterproof gown, face shield and/or eye protection, and single or double gloves.^{8,10,35,35} The sequence of donning and doffing depends on whether equipment will be reused, institutional policies, and resource availability (**Figure 1**). Before or upon entry into their homes, some healthcare professionals will also change out of their work clothes, disinfect their personal belongings, and self-isolate. The CDC currently recommends that healthcare professionals exposed to a COVID-19+ patient without PPE self-monitor and self-isolate for 14 days.¹⁰ If testing becomes widely available, healthcare workers could be assessed for potential exposure and immunity prior to returning to work.

The CDC has released testing and non-testing-based criteria for when COVID-19 patients may discontinue their transmission-based precautions and return to outpatient care. The test-based strategy requires fever resolution without antipyretics, improvement in respiratory symptoms, and at least 2 negative COVID-19 tests taken at least 24 hours apart. For the non-test-based strategy, at least 72 hours must have passed after fever resolution (without antipyretics), symptoms improved, and at least 7 days have passed since symptom onset. Patients should still wear a mask for at least 14 days after the onset of symptoms. Consultation with infectious disease specialists may provide additional guidance for immunocompromised patients, who may need to continue to isolate for at least 14 days after symptom onset or 72 hours from resolution of symptoms, whichever is longer. For asymptomatic patients with laboratory-confirmed COVID-19, they may discontinue isolation if at least 7 days have passed since their first positive SARS-CoV-2 test, but they should still wear a mask and limit social contact for 3 days afterwards.¹⁰ Patients may also consider telehealth visits.

Telehealth

The Centers for Medicare and Medicaid Services (CMS) have relaxed their requirements for telehealth visits.⁹ Phone and video triage systems can help screen in ocular emergencies while screening out non-emergent conditions. Vision and Amsler grids may be checked virtually with electronic devices. At-home optical coherence tomographies may become available in the

future.³⁹ Teleretinal screenings for retinopathy of prematurity (ROP) should continue as scheduled.

Retinopathy of Prematurity Screening and Treatment

While COVID-19 has primarily affected older individuals, there have been reports of infants, children, and pregnant women being infected.⁴⁰ ROP screening and treatment should be continued with appropriate precautions. The medical equipment should be carefully disinfected after every use, disposable equipment used whenever possible, PPE implemented, and frequent handwashing performed. Only essential personnel should be involved, and screenings are consolidated or spaced out as much as possible. For infants who have transitioned to in-office clinical examinations, dilating drops may be instilled prior to the visit, children are placed in an examining room directly after check-in, handwashing is encouraged, PPE is used, and the appointments are spaced apart.⁴⁰ Good communication may help encourage parents to bring in their children for timely examinations and treatments.⁴⁰

Patients on Immunosuppression

Surveys are being conducted of uveitis specialists around the world to determine their approach to immunosuppression during a pandemic. The American College of Rheumatology has released guidance for the management of patients on systemic immunosuppression, including recommending social distancing, hand hygiene, using telehealth and decreasing lab testing if possible, and using the lowest dose of glucocorticoids tolerated but not stopping steroids abruptly.³² Patients who have been stable on immunosuppressive therapy and have not been exposed to SARS-CoV-2 can continue their medications. On the other hand, patients with presumed or confirmed COVID-19 should consider consulting a rheumatology specialist and withholding certain medications such as sulfasalazine, methotrexate, leflunomide, tacrolimus, cyclosporine, mycophenolate mofetil, azathioprine, non-interleukin-6 biologics, and Janus kinase inhibitors. Patients who have been stable on hydroxychloroquine can continue their medications if available.³² The Global Rheumatology Alliance has a registry to assess the risk of infection in patients with rheumatologic diseases on immunosuppression.⁴¹

Perioperative Management

Preoperative

In an effort to decrease infections and conserve resources, governments and medical societies have recommended that elective surgeries be deferred for now. Some medical boards have passed regulations allowing disciplinary action against physicians who violate these recommendations.⁴² Several ophthalmic organizations have provided clarification of emergent, urgent, and elective ocular conditions (**Table 3**). For instance, acute fovea-threatening retinal detachments (RD) may need to be repaired emergently to prevent vision loss. Pneumatic retinopexies can be considered in the appropriate candidate, with thorough disinfection of the equipment after use; surgical repair in a PUI or COVID-19 patient may prompt additional precautions. Depending on the location of the RD, previous literature has suggested that macula-on RDs could potentially wait up to 72 hours for repair, which may provide PUIs time to obtain the results of their SARS-CoV-2 tests and allow confirmed COVID-19 patients to decrease

their viremia;⁴³ in relatively mild cases of COVID-19, viral loads typically decrease within 7 days of symptom onset.²⁵

Depending on the specific surgery center and testing availability, some institutions are performing routine preoperative SARS-CoV-2 testing in all preoperative patients or selectively in those who are symptomatic, immunocompromised, expected to be hospitalized after surgery, or are undergoing high-risk procedures involving the airways or sinus. If testing is unavailable, it may be prudent to proceed with the assumption that any patient may have COVID-19, even if asymptomatic.

A patient with confirmed COVID-19 or a PUI should be kept separate from other patients in the preoperative waiting area, the patient should wear a mask or be placed in a negative pressure isolation transfer cabin, and there should be a dedicated and cleared route for transporting the patient to the operating room (OR).^{13,44} If the patient is intubated, a high quality heat and moisture exchanging (HMEF) filter should be inserted between the self-inflating ventilation bags and the patient.¹¹ Researchers at the Anesthesia Patient Safety Foundation (APSF) have recommended decolonizing patients with chlorhexidine wipes and giving 2 doses of nasal povidone iodine within 1 hour of surgery.⁴⁴

Intraoperative

Universal precautions are recommended for all surgical cases. For surgery in patients with known or suspected SARS-CoV-2, the American College of Surgeons and the CDC have recommend having a dedicated COVID-19 operating room, preferably separate or secluded from the main operating room, with negative air pressure and high frequency air changes if possible (i.e. 25 per hour), negative pressure anteroom, and restricted entry.^{13,44} Staff should wear biosafety level 3 protective medical equipment (N95 masks or powered air purifying respirators (PAPRs), goggles or face shield, protective suits or gowns, double gloves, caps, and boot covers). A dedicated OR team with separate COVID-19 OR carts (for airway, equipment, and medications) could help prevent cross-infection. The OR should be cleared of non-essential items, disposable equipment used whenever possible, and a runner outside the OR can help retrieve any additional equipment.

Aerosol-generating procedures such as endotracheal intubation or nasal endoscopy should be deferred if possible. For cases under monitored anesthesia care (MAC), some physicians have suggested using low-flow oxygen and placing a suction under the drape to create a negative-pressure environment.³⁶ For cases requiring general anesthesia, healthcare providers who are not immediately required for intubation or extubation should wait outside the OR; if the air turnover time is 12 times per hour, the ophthalmologist may consider scrubbing and waiting outside for at least 5 minutes after intubation. Anesthesia providers should wear face shields for protection and consider additional precautions. Two high quality viral filters (HMEF or high efficiency particulate air [HEPA] filters) should be placed in the anesthesia circuit, and there should be minimal interruptions to the airway circuit.^{13,44} Some anesthesia providers have also created their own intubation shields with clear plastic boxes or drapes to decrease aerosolization. The anesthesia team should diligently pre-oxygenate/denitrogenate since COVID-19 patients often have compromised respiratory systems, ensure a well-fitting face mask and use smaller tidal volumes during manual ventilation to decrease dispersion of viral particles or perform rapid sequence induction to decrease the need for bag-

mask ventilation, use a video laryngoscope to aid in visualization of the airway, inflate the cuff before initiating positive pressure ventilation, and consider using closed suction apparatus.^{13,37,44}

Surgical cases should be performed as expediently as possible. Silicone oil may be considered in eyes with retinal detachments to minimize the chance of reoperation.⁴⁵

Postoperative

COVID-19 patients may recover in the operating room rather than in the post-anesthesia care unit; anesthetics and antiemetics to hasten and improve recovery should be considered.^{13,44} Supplemental oxygen can be provided underneath a facial mask.

COVID-19 infected ORs should undergo a terminal cleaning after each case. Operating room surfaces should be cleaned with healthcare-approved and EPA-registered disinfectants, such as sodium hypochlorite, hydrogen peroxide vaporization, or ultraviolet C irradiation.^{10,13,44} Medical devices should be cleaned with a quaternary ammonium chloride disinfectant. Healthcare personnel should continue wearing PPE when evaluating and treating COVID-19 patients postoperatively.

Discussion

The novel coronavirus has disrupted all aspects of society, healthcare, economies, and governments worldwide in the year 2020. At the time this article was written, the number of new cases and deaths continue to rise. There is also growing concern about a second wave of infections when social restrictions are eased¹⁵ and patients re-testing positive after their infections have resolved. The WHO has listed 6 criteria that should be met prior to easing restrictions: 1. transmission is controlled, 2. healthcare systems are capable of detecting, testing, isolating, and treating every case and contact, 3. risks for outbreaks are minimized in special settings like hospitals and nursing homes, 4. preventative measures are implemented for work, school, and essential spaces, 5. importation risks are managed, and 6. communities are educated, engaged, and empowered to adjust to the new precautions.⁴⁶ Certain infection precautions may need to be continued for months to come. As greater information is gained about the virus and resource availability changes, the clinical and perioperative guidelines may continue to evolve.

Many ophthalmologists are continuing to treat patients during the pandemic and may need to consider extra precautions. Patients and staff should be screened for symptoms of COVID-19 before they enter the office, clinics should be limited to urgent or emergent cases, personal protective equipment should be worn, and frequent disinfection and handwashing encouraged. Patients with symptoms of fever, cough, and dyspnea should be tested for SARS-CoV-2 if possible. The diagnostic yield is highest in the first week of symptoms, and bronchoalveolar lavage, sputum, and nasopharyngeal swabs are more sensitive than oropharyngeal swabs.

PUIs or confirmed COVID-19 patients should be evaluated in isolation rooms by physicians wearing full PPE, including N95 masks, long-sleeve waterproof gowns, gloves, eye protection, and face shields. Operating rooms may have to be specially retrofitted to protect patients and healthcare workers, with negative pressure ventilation, frequent air turnover,

minimization of aerosol-generating procedures, dedicated instruments and surgical teams, and terminal cleanings after every case.

The pandemic has demonstrated the interconnectedness of people around the world and how the global community can work together. Lessons learned from one heavily impacted area are being used to mitigate the effects in other countries. Efforts to control the spread of the virus, such as social distancing, hand hygiene, epidemiological tracing, and quarantines have decreased the worst infection projections. Physicians across all specialties in medicine are task shifting, and ophthalmologists are working in the emergency rooms and hospital wards to help their colleagues. Communities are volunteering and donating supplies. The infrastructure and supply chains are being strengthened. Patients who have recovered from the virus are donating their plasma. Clinical trials for vaccines and treatments are underway. Hopefully lessons learned from this pandemic will help prepare the world for the next infectious disease outbreak.

Figure 1. Simplified Flowchart of Donning on and Doffing PPE. Under usual circumstances, PPE should not be reused or decontaminated; however, there is currently a significant shortage of PPE. The sequence for donning and doffing depends on resource availability, and the individual institution's policies; it may change over time. Efforts should be made to gather all materials beforehand, minimize entry/exit, and conserve resources. Per the CDC, gowns should be put on outside the patient's room with all ties tied, N95 masks should be placed with the top strap on the crown of the head, the bottom strap at the base of the neck, pinching the metal nose clip, and ensuring no air escapes.¹⁰ Reused facemasks will need to be placed on a disinfecting wipe on a table, with the front and back of the shield cleaned, then the elastic band, then the foam band; reused goggles will need the front and back of lenses wiped, then both ear pieces. The flowchart is adapted from the CDC guidelines (for single use PPE) and the Emory University recommendations for conserving PPE (<https://med.emory.edu/departments/medicine/divisions/infectious-diseases/serious-communicable-diseases-program/covid-19-resources/conserving-ppe.html>).^{10,48}

Key= DG= double-gloved, PPE= personal protective equipment, *= dispose of if resources are available for single-use or if the items are wet, soiled, or damaged

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Table 1. Methods of Infection Control in Clinics and Operating Rooms during a Pandemic. The following measures were amalgamated from the recommendations of the CDC, WHO, U.S. Surgeon General, AAO, ASRS, ACS, ASA, and APSF. The guidelines may change over time.

Key: EPA= Environmental Protection Agency, PPE= personal protective equipment, PUI= person under investigation

Clinics	
Patient Volume	<ul style="list-style-type: none"> • Use telephone triage to screen for ocular emergencies and reschedule non-urgent examinations • Use telehealth visits if possible
Clinic Flow	<ul style="list-style-type: none"> • Screen patients and staff before they enter the office • Space out appointments • Ask patients and family members to wait in the car or at least 6 feet apart in waiting rooms • Room infants and immunocompromised patients in rooms as soon as possible • Defer routine imaging and dilation unless necessary • Consider indirect ophthalmoscopy or indirect laser • Remove potential fomites
Equipment	<ul style="list-style-type: none"> • Clean after each patient with EPA-approved disinfectants following manufacturers' recommendations • Use disposable tonometry tips if available
PPE and Hand Hygiene	<ul style="list-style-type: none"> • Patients should wear a mask and the physician should wear a mask (preferably N95) and eye protection during procedures • Frequent handwashing
Surgeries	
Preoperative	<ul style="list-style-type: none"> • Reschedule non-urgent surgical cases • Preoperative testing for SARS-CoV-2 if available • If COVID-19+ or PUIs: isolate patient, consider nasal povidone iodine or chlorhexidine wipes
Intraoperative	<ul style="list-style-type: none"> • Universal precautions for all patients • Preference for monitored anesthesia care (with low-flow oxygen and suction under drape); avoid intubation and aerosolization if possible • If COVID-19+ or PUI: <ul style="list-style-type: none"> • Use a dedicated OR with negative pressure ventilation, restrict entry and personnel, use dedicated OR equipment, perform surgery as expediently as possible, minimize risk for reoperation • Use PPE: N95, waterproof surgical gowns, eye protection, and face shields • If intubating/extubating: non-essential staff wait outside, anesthesiology team uses extra precautions (shields, filters, extra pre-oxygenation, closed suction)
Postoperative	<ul style="list-style-type: none"> • Recover in operating room or isolation room with negative pressure if possible • Terminal cleaning with EPA-approved disinfectants, such as sodium hypochlorite, hydrogen peroxide vaporization, or ultraviolet C irradiation • Clean medical devices with quaternary ammonium chloride disinfectant • Thoroughly disinfect anesthesia machine

Table 2. COVID-19 Tests. Multiple companies have developed tests for COVID-19 with different methodologies and clinical sensitivities and specificities. The viral limits of detection (LOD) is the lowest concentration of the SARS-CoV-2 RNA that can be detected in a sample with 95% probability or higher; different companies reported different measurements and units. The information was obtained from the FDA,¹ Johns Hopkins Center for Health Securities,² and the companies' websites; it may change as more information is gathered. A study conducted at the Cleveland Clinic that has not yet been published or peer-reviewed evaluated the sensitivity of several tests.³

Key: CE= Conformitè Européenne, Co= company, EUA= emergency use authorization, FDA= Food and Drug Administration, Inc= incorporated, IVD= *in vitro* diagnostic medical device, Ltd= limited company, LOD= limit of detection, n/a= information not available, NMPA= China's National Medical Products Administration, RDT= rapid diagnostic test, RT-PCR= reverse transcriptase polymerase chain reaction, TCID₅₀= 50% tissue culture infective dose (amount of virus required to produce a cytopathic effect in 50% of inoculated tissue)

Company (name of test)	Accuracy	Type of Test	Approval
Center for Disease Control (2019-nCoV Real-Time RT-PCR Diagnostic Panel)	100% sensitive ³ QIAGEN EZ1 Advanced XL LOD= 10 ^{0.5} RNA copies/ μ L QIAGEN DSP Viral RNA mini kit LOD= 10 ⁰ RNA copies/ μ L	RT-PCR	FDA EUA
Abbott (ID NOW COVID-19)	85.2% sensitivity (stored in viral media) ³ LOD= 125 genome equivalents/ml	RT-PCR	FDA EUA
Abbott (Abbott realTime SARS-CoV-2)	LOD= 100 virus copies/ml	RT-PCR	FDA EUA
Cepheid (Xpert Xpress SARS-CoV-2 test)	98.2% sensitivity ³ LOD= 250 copies/ml	RT-PCR	FDA EUA
Diasorin Molecular LLC (Simplexa COVID-19 Direct assay)	89.3% sensitivity ³ LOD= 500 copies/ml	RT-PCR	FDA EUA
LabCorp (COVID-19 RT-PCR Test)	LOD= 6.25 genome copies/ μ L	RT-PCR	FDA EUA
Quest Diagnostics (Quest SARS-CoV-2 rRT-PCR)	LOD= 136 copies/ml	RT-PCR	FDA EUA
Roche (cobas SARS-CoV-2)	96.5% sensitivity ³ LOD= 0.007 TCID ₅₀ /ml	RT-PCR	FDA EUA, CE
Thermo Fisher Scientific Inc. (TaqPath COVID-19 Combo Kit)	LOD= 10 genomic copy equivalents/ reaction	RT-PCR	FDA EUA
Abbott Basepoint COVID-19 IgG/IgM Rapid Test Device	86.43% sensitivity, 99.57% specificity	Serology (RDT)	n/a
Cellex Inc (qSARS-CoV-2 IgG/IgM Rapid Test)	93.8% sensitivity, 95.6% specificity	Serology (RDT)	FDA EUA, CE
Aytu Biosciences/ Orient Gene Biotech	87.9-97.2% sensitivity, 100% specificity	Serology (RDT)	CE
Sensing Self	92% accuracy	Serology (RDT)	CE
Sure Biotech	92-96% accuracy	Serology (RDT)	CE
Liming Bio	82-93.1% sensitivity, 100% specificity	Serology (RDT)	CE IVD
Shenzhen Yhlo Biotec Co.	90-95% sensitivity, 95% specificity	Serology (ELISA)	CE IVD
ScanWell Health/ INNOVITA	87.3% sensitivity, 100% specificity	Serology	NMPA
Singapore Wang lab test	90% sensitivity	Serology	Singapore
SD Biosensor	82% sensitivity, 97% specificity	Serology (RDT)	Korean EUA

Table 3. Summary of emergent, urgent, and less urgent cases. The table is adapted from the updated recommendations of the American Academy of Ophthalmology (AAO), American Society of Retina Surgeons, and the American Association of Ophthalmic Oncologists and Pathologists. Elective cases defined are those that may be safely delayed for 2 months without significant risk to the patient's vision or health.

Classification	Examples
Emergent, Urgent, and Semi-Urgent Cases	<p data-bbox="386 464 597 491"><i>Anterior Segment</i></p> <ul data-bbox="435 499 1403 926" style="list-style-type: none"> <li data-bbox="435 499 743 527">• Repair of open globes <li data-bbox="435 535 1403 638">• Cataract surgery in monocular patients or pediatric patients in the amblyopic period, lens-induced glaucoma, angle-closure glaucoma, acute lens complications, retained lens fragments, severe anisometropia <li data-bbox="435 646 1247 674">• Corneal transplants in pediatric patients in the amblyopic period <li data-bbox="435 682 932 709">• Repair or revision of keratoprosthesis <li data-bbox="435 718 1403 890">• Glaucoma surgery (glaucoma drainage device implantation, revision, or removal; goniotomy; trabeculectomy; trabeculotomy; transscleral cyclophotocoagulation; closure of cyclodialysis) for uncontrolled intraocular pressures, sight-threatening hypotony, or complications related to an existing glaucoma procedure <li data-bbox="435 898 1175 926">• Anterior chamber washout for sight-threatening hyphema <p data-bbox="386 968 607 995"><i>Posterior Segment</i></p> <ul data-bbox="435 1003 1393 1436" style="list-style-type: none"> <li data-bbox="435 1003 808 1031">• Endophthalmitis treatment <li data-bbox="435 1039 932 1066">• Removal of intraocular foreign bodies <li data-bbox="435 1075 1338 1144">• Retinal detachment repair (scleral buckle and/or vitrectomy, pneumatic retinopexy, laser retinopexy) <li data-bbox="435 1152 1182 1180">• Choroidal drainage for appositional choroidal detachments <li data-bbox="435 1188 1393 1291">• Vitrectomy for vitreous hemorrhages due to suspected retinal tears or detachment, monocular patients with retinal detachments or dense vitreous hemorrhages, aqueous misdirection <li data-bbox="435 1299 1393 1369">• Membrane peels for proliferative vitreoretinopathy, macular holes, complex macular pathologies, or proliferative diabetic retinopathy <li data-bbox="435 1377 1230 1404">• Laser retinopexy for retinal tears or retinopathy of prematurity <li data-bbox="435 1413 1159 1440">• Removal or repair of exposed or infected ocular implants <p data-bbox="386 1478 716 1505"><i>Orbit and External Diseases</i></p> <ul data-bbox="435 1514 1403 1858" style="list-style-type: none"> <li data-bbox="435 1514 1403 1583">• Enucleation or evisceration for globe perforations from an intraocular tumor, life-threatening infection, trauma, intractable glaucoma, intractable pain <li data-bbox="435 1591 1386 1694">• Examination under anesthesia, biopsies, and treatments for suspected high-grade malignancies, infections, or tumors causing vision loss or optic nerve compression <li data-bbox="435 1703 1036 1730">• Temporal artery biopsies for giant cell arteritis <li data-bbox="435 1738 1289 1808">• Dacryocoele decompression in neonates with obstructive respiratory compromise <li data-bbox="435 1816 1370 1858">• Reconstruction of the ocular surface due to acute chemical injury or acute Stevens Johnson Syndrome

	<ul style="list-style-type: none"> • Repair of orbital fracture causing hemodynamic instability or oculocardiac reflex • Lid surgery (tarsorrhaphy, canthotomy and/or cantholysis, ptosis repair) for sight-threatening conditions; canalicular repair
Less Urgent or Non- Elective Cases	<ul style="list-style-type: none"> • Dislocated intraocular lenses* • Diabetic vitreous hemorrhage without macula-threatening detachments • Retained silicone oil • Epiretinal membranes • Vitreomacular traction • Biopsies of suspected benign tumors

* May be considered urgent or emergent in monocular patients or if there are extenuating circumstances.

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