

# Tonometry and Tonometer Disinfection in the COVID-19 Era

Consider the data and put safety first.

By Nicholas Tan and Nathan Radcliffe, MD

**R**isk of cross contamination from the use of medical devices and instruments is not a new topic of discussion, but the emergence of COVID-19 has elevated concerns about disinfection to levels not seen since the AIDS epidemic of the 1980s. As a result, eyecare professionals are reviewing the use, disinfection, and general safety profile of practically every instrument, test, and procedure in their toolbox. Early evidence that the virus that causes SARS-CoV-2 illness might be present in tears caused understandable concern throughout the eyecare community.<sup>1</sup> After all, the doctor who is credited with sounding the alarm about the novel virus, Li Wenliang, was an ophthalmologist who is thought to have contracted the illness from a glaucoma patient during a routine examination.

Despite that only a few months have passed since the start of the COVID-19 pandemic, we already have an impressive amount of evidence in the literature about the transmissibility of the disease. It is well known that the primary path of infection is through droplets produced by and entering into the mouth, nose, and lungs. Multiple studies evaluated the presence of SARS-CoV-2 in tears and conjunctival secretions of the eye and found the risk to be low (0% to 5.2%) and only present in patients with ocular manifestations such as chemosis, conjunctival hyperemia, or conjunctivitis.<sup>2,3</sup> It is thought that the eyes might be a portal of entry for the virus because of the presence of

ACE receptors, but there is currently no clinical evidence for this theory (and the dermis also contains ACE receptors).<sup>4</sup>

Regardless, procedures and tests that require direct or close contact with the eye should be evaluated seriously. Tonometry is perhaps the most obvious offender. It constitutes an important part of essentially every glaucoma patient encounter and requires close patient-to-clinician proximity, often including touching of the patient's eyelids, face, and ocular surface. The purpose of this article is to review various options for performing tonometry and to discuss the safety and practicality of these methods in the COVID-19 era.

## General Disinfection Guidelines

Before we begin, it may be useful to introduce some terminology used by the Centers for Disease Control and Prevention (CDC) to categorize medical devices and their disinfection requirements. It is also important to consider that not all devices fit neatly into any box, so it may not always be obvious which CDC guidelines are appropriate for which devices.<sup>5</sup>

- Critical items, such as surgical instruments and implantable items, must be germ-free because any contamination could transmit disease. Most items in this category are single-use or must be sterilized with steam or germicidal chemical sterilants.
- noncritical items contact intact skin but not mucous membranes. Because skin acts as

**Nicholas Tan, BA**, is a first-year medical student at the SUNY Downstate College of Medicine in Brooklyn, New York; he reports no related disclosures.

**Nathan M. Radcliffe, MD**, is a clinical associate professor of ophthalmology at the New York Eye and Ear Infirmary of Mount Sinai in New York, New York, and a surgeon at the New York Eye Surgery Center in Bronx, New York. He reports consultancy to Zeiss, Reichert Technologies, Lumenis, Ellex, Iridex, New World Medical, and BVI.

**Table 1: Tonometers by Type, Use, and Disinfection Method**

Tonometer Type	Goldmann/ Perkins	Single-Use GAT Prism	Electronic Applanation	Noncontact (Air Puff)	Pneumatic Tonometer	Applanation Rebound	Transpalpebral Scleral
Contact/noncontact	Corneal contact	Corneal contact	Corneal contact	Noncontact	Corneal contact	Corneal contact	Contact (eyelid)
Typical clinician-patient distance	6"	6"	18"	36"	18"	12"	18"
Requires lid holding (yes/no)	Frequently	Frequently	Occasionally	Rarely	Frequently	Occasionally	Always
Disinfection required	High level	None	Exterior cleaning	Exterior cleaning	High level	Exterior cleaning	Physician discretion
Tip disinfection	10-minute soak 1:10 dilute bleach + 10-minute rinse	None	None	None	Two 15-minute soak H2O2 + rinse	None	Physician discretion
External cleaning method	Bleach wipe	Bleach wipe (slit-lamp)	Bleach wipe	Bleach wipe	Bleach wipe	Bleach wipe	Bleach wipe
Per-use disposable	No	Single-use prism	Single-use cover	No	No	Yes	No
Anesthesia required (yes/no)	Yes	Yes	Yes	No	Yes	No	No
Common brands	Haag-Streit Keeler CSO CATS Reichert Kowa	Haag-Streit Keeler	Reichert Tono-Pen Accutome Accupen	Reichert ORA G3 Keeler Topcon Nidek/Marco Canon	Reichert Model 30	iCare	Diaton

an effective barrier to most disease-causing agents, sterility is “not critical.” Examples of noncritical items are bedpans, blood pressure cuffs, and crutches. Noncritical items can be decontaminated using low-level disinfectants that kill most, but not all pathogens.

- Semicritical items contact mucous membranes or nonintact skin. Mucous membranes are generally resistant to infection by common bacteria and spores but are susceptible to virulent microbes and viruses. Semicritical items require high-level disinfection to widely eliminate pathogens, save for small numbers of resistant bacterial spores. Tonometers that touch the cornea with a reusable tip are considered to be semicritical devices (Table 1).

**Goldmann Applanation**

The Goldmann Applanation Tonometer (GAT) is the most prevalent method of tonometry worldwide. A recent study on tonometer disinfection practices found that the majority of optometrists and ophthalmologists are using 70% isopropyl alcohol wipes between patients.<sup>6</sup> Unfortunately, this does not comply with CDC guidelines. The CDC historically recommended a 10-minute soak in either 3% hydrogen peroxide or 70% isopropyl alcohol (followed by a cold-water rinse). More recent data, however, suggest that these methods are not effective against adenovirus and other viruses capable of causing epidemic keratoconjunctivitis.

Since 2017, the AAO has stated that sodium hypochlorite is the only disinfectant recommended by both the tonometer

manufacturers and the CDC. The prescribed methodology for disinfecting reusable prisms is a 10-minute soak in 1:10 dilute bleach followed by a 10-minute cold water rinse.

So, while GAT is generally considered to be the gold standard method of tonometry, its disinfection requirements make it among the most time-consuming and cumbersome devices available. Single-use prisms save time and eliminate the need for tip (but not slit-lamp) disinfection, however not all clinicians have adopted them because they are costlier and contribute to plastic waste. More significantly, even proper disinfection may not suffice to prevent COVID-19 transmission. GAT requires the closest patient-clinician distance of practically any ophthalmic diagnostic procedure, and lid holding is frequently needed. Even if clinicians and patients are wearing masks, ill-fitting or improperly worn masks may allow respiratory droplets to escape.

Anecdotally, I (NMR) was able to spot a visible mask gap on most of 20 of the masked patients I examined on May 18. Given the proximity required for GAT assessment, it seems likely that exposure risks from proximity, physical contact, and mask malfunction would outweigh those specifically related to tonometer surface contact. As a result, in the time of COVID-19, it is reasonable to re-evaluate alternative methods to GAT.

### **Alternatives to Goldmann Applanation**

The Model 30 Pneumatonometer (Reichert) is a benchtop unit with a handheld probe featuring a contact tip assembly. Like GAT, the contact tips must be removed and cleaned using high-level disinfection between patients. The handheld nature of the probe facilitates slightly greater clinician-patient distance. However, lid holding is frequently required with this tonometry method. The Model 30 is considered to be very accurate, but it is not the most technician-friendly method available and is primarily used in special situations, such as research, corneal disease, supine measurements, ocular pulse evaluation, and tonography.

Electronic applanation (Tono-Pen; Reichert) and rebound (iCare) tonometers are both handheld devices featuring single-use disposable covers or probes that eliminate the need for high-level disinfection. These methods are also more technician-friendly than GAT, requiring less skill to obtain an objective IOP measurement. Clinicians can be somewhat further from patients with these devices but, in some instances, lid holding and/or patient contact for instrument stabilization is unavoidable. The accuracy of these methods is generally considered to be acceptable. Use of these devices, even if only as a screening tool, can help to greatly reduce dependency on GAT and its cumbersome disinfection requirements. Single-use Tono-Pen tip covers cost about as much as single-use iCare probes, and both cost less than disposable Goldmann prisms, but they are still an additional expense to consider.

Additional handheld options include transpalpebral scleral tonometry (Diaton), which takes measurements through the eyelid. Although this technique does not directly touch the cornea, the required placement of the tip on the superior tarsal margin may result in contact with tears and conjunctival secretions of the eye. Spread of staphylococcal blepharitis, viral conjunctivitis, or herpes simplex virus are among potential concerns even though the device does not directly touch the mucous membrane. It may seem pertinent to high-level disinfect the tip between patients. However, the manufacturer instructions only recommend wiping the tip with ethyl alcohol and caution against getting solutions inside the device. As such, it is difficult to formally recommend an appropriate disinfection method for this tonometer. Like Tono-Pen and iCare, the handheld nature of this device permits greater patient-clinician distance. However, lid holding is required, and the instrument shows poor agreement with Goldmann tonometry.<sup>7-9</sup> It may be useful in patients with a keratoprosthesis or in instances when IOP measurement by other methods is simply not possible.

Noncontact (air puff) tonometers do not touch the cornea or surrounding tissue of the

eye and therefore do not require high-level disinfection. Some have recently questioned the potential for tear aerosolization from this procedure, but there is no material evidence that this is a legitimate concern. In fact, there are no documented cases of infection by aerosolization of any virus from tears. In the only article in the literature on this subject, a 1991 article by Britt et al, the authors used fluorescence photography to capture visible tear film splatter from the air puff in eyes following instillation of supplemental topical fluorescein or methylcellulose artificial tears.<sup>10</sup> However, this photographic method is not capable of determining “aerosolization” as aerosols are particles suspended in air that are smaller than 10 microns (not visible to the eye). It is also worth mentioning that the devices featured in that article used air-pulse technology that is 4x to 6x stronger than what modern noncontact tonometers use, making the tear-film scatter much more likely.<sup>11</sup>

Noncontact tonometers have the advantage of offering the greatest patient–clinician distancing of any method and seldom require holding of the patient’s eyelid or any direct patient contact. The machine’s head and chinrest do need to be disinfected between patients as with slit lamps and OCT machines. Noncontact tonometers are objective and technician-friendly, and show good agreement with Goldmann tonometry. This modality is of particular interest to glaucoma specialists because the Ocular Response Analyzer (Reichert) measures corneal hysteresis in addition to IOP, which is independently valuable in glaucoma risk assessment and decision making.<sup>12</sup>

Finally, the nonocular exterior of all tonometers, especially handheld models, should be wiped down after use. For this purpose, 5,000 ppm bleach wipes are generally considered to be effective.

### Summary

When considering the safety of tonometers, or any instrument, in the COVID-19 era, it is important to place patient and provider safety first. Remember that the virus spreads

primarily through droplets from the lungs, mouth, and nose, and focus efforts on minimizing those well-established routes of infection. While it is possible that SARS-CoV-2 may survive in tears, this is a much less likely path of infection, particularly in patients without conjunctivitis. Tear aerosolization is also not a documented cause of viral spread. Regardless, it is incumbent upon clinicians to comply with CDC recommended guidelines for distance and disinfection. Each practitioner must look at his or her overall practice environment to determine which tonometer can be best employed by the practice for the safest and most accurate outcomes. **GP**

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