LETTERS

Caution on real-time data interpretation of aerosol generation during phacoemulsification

We commend Lee et al. on their attempt using a real-time particle monitor to detect possible aerosol generation from phacoemulsification.1 Such devices can be powerful tools to assist with bioaerosol exposure assessment, but the generated real-time data should only be used as surrogate data and interpreted with great caution.

The very low total cumulative particle counts from very short-grab sampling collection time of 21-second windows might not have sufficient signal-to-noise ratio for numeric quantification. The typical estimated limit of detection—the value above which it is considered truly detectable—and limit of quantification—value above which it is considered quantifiable—are 3× and 10× SD, respectively.2 Because the short sampling duration, particle counts were near or below limit of detection, thus offering low confidence to the reported values. Moreover, because the measured mean particle counts for all experiments were below limit of quantification, the reported numbers could be neither accurately quantified nor compared.

To improve accuracy, a longer sampling time of several minutes is recommended. To rule out buildup of bioaerosol from multiple operations, full-shift (8 hours) personal monitoring at the breathing zones of the operating personnel is also recommended. The volume of the room along with air change rate should be stated to help standardize equivalent observation in other room settings. The number of occupants in the room, temperature, relative humidity, and so on should also be noted to ensure that the observed data would not be affected by interday variations.

SARS-CoV-2 virus particle sizes were reported to exist as a continuum from less than 0.3 to more than 5 μm.3 An aerodynamic characterization study at Wuhan Hospital suggested virus particles found in the personal protective equipment doffing room were predominantly small particles between 0.25 and 0.5 μm.4 Therefore, it is crucial for any particle size study to accurately capture bioaerosol at all size ranges including size less than 0.3 μm. The data from Lee et al., suggesting no elevation of bioaerosol observed from less than 0.3 to 10 μm, was based on the TROTEC PC200 (Trotec GmbH) optical particle counter, which has a stated detection range between 0.3 and 10 μm diameter. Although it is claimed that the monitor can quantify particles below 0.3 μm, the accuracy of particle detection of less than 0.3 μm is highly questionable. As per instrument specification, the counting efficiency of 0.3 μm particle was reportedly only 50% at best.5 It is, therefore, unsure whether the monitor can detect particles smaller than 0.3 μm. If so, what is the counting efficiency for these smaller particles? Thus, the low count of particles at less than 0.3 μm range in the study might be insufficient to rule out fine bioaerosol generation during simulated phacoemulsification. Recommendations to lower personal protective equipment might be premature, especially when the major part of bioaerosol production in the operating environment is expected to be generated from the respiratory tracts of patients and staff, which is not captured in this simulation study.

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Disclosures: Neither author has any financial or proprietary interest in any material or method mentioned.

Reply: We thank Leung and Liu for their interest in our study. However, the points raised by them are misconceived and not relevant to our study. They refer to contribution of respiratory aerosols from patients/staff and reiterate evidence from an incomparable study by Liu et al., which found SARS-CoV-2 particles in the protective apparel doffing rooms to be predominantly 0.25 to 1.0 μm.1 This quoted study acquired aerosol samples through a filter and analyzed them using 3 different methods for a variety of environments.1

We would like to emphasize that our study aimed to investigate real-time aerosol generation during phacoemulsification only and not at gathering cumulative aerosol generation in theater through theater personnel/patient or in different parts of operating areas. To avoid any
The device is intended for measuring the size and number of particles in the air. Six channel sizes of 0.3 μm, 0.5 μm, 1.0 μm, 2.5 μm, 5.0 μm, and 10 μm 50% ± 20% at the minimum detectable particle size 100% ± 10% for particles 1.5 to 2 times larger than minimal detectable size 2.83 L/min (0.1 ft³/min)

Amount of all particles up to the selected particle sizes, eg, 0.5 μm = 417 means that 417 ppm of the particles have a size of >0.3 to 0.5 μm

unnecessary noise in the data, we standardized the acquisition process and included a minimal number of investigators who all wore fit-tested FFP3 respirators to reduce respiratory aerosol contribution. Furthermore, these personnel remained in the same position throughout the experiment to reduce aerosol turbulence due to movement.

With the routine time for phacoemulsification procedure being a few minutes, sampling times inclusive of additional 8-hour sampling with personal monitoring as suggested by Leung and Liu are impractical to answer our specific study question. On the contrary, longer duration sampling might produce unreliable data because the temperature and humidity changes with longer duration of breathing, talking, and movement. To reduce the impact of dynamic changes in humidity and temperature in theater, we conducted the experiment as a sequential, 1 day ex vivo study in a positive pressure ventilation system setting.

We would like to stress that our experiment was not designed to innovate a new optical particle counter (OPC), and therefore, the concepts of limits of detection and quantification do not apply. Our study used the TROTEC PC200 OPC, which is certified and adheres to the ISO 21501-4 standard for light scattering airborne particle counters (Table 1). This instrument was selected because of its portability and accuracy and because it was non-disruptive to the theater setup. Similar OPCs have also been used in relevant respiratory studies published in high impact journals such as the study by Doggett et al., which investigated aerosols produced during intubation and bronchoscopy.

Table 1. TROTEC PC200 OPC specifications and ISO 21501-4 requirements about false and zero counts.

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<thead>
<tr>
<th>A. TROTEC PC200 OPC specifications2</th>
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<tbody>
<tr>
<td>Intended use</td>
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<tr>
<td>Channels</td>
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<tr>
<td>Counting efficiency3</td>
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<tr>
<td>Flow rate</td>
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<td>Cumulative method of aerosol counting by this OPC</td>
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<th>B. ISO 21501-4 standards and requirement about false and zero counts3</th>
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<tr>
<td>• The false count rate is determined by measuring the particle number concentration in the unit of counts-per-cubic-meter at the minimum reported size range when sampling clean air.</td>
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<td>• The zero count test is a measurement of “electrical or signal noise”.</td>
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<td>• The ISO 21501-4 standard requires that only the count rate be reported.</td>
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<td>• Going beyond this requirement, particle counter calibrations include a final zero count test, which challenge the instrument to achieve restrictive limits on false counts.</td>
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<td>• The use of restrictive limits, even when not required by the standard, guarantees higher accuracy in the instrument performance and avoids false counts that appear as particle counts.</td>
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OPC = optical particle counter

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Importance of corneal topography in surgical planning for toric intraocular lenses

The study by Sheen Ophir et al. investigated the outcomes of toric intraocular lens implantation (IOL) in eyes with preexisting oblique anterior corneal astigmatism. The authors stated that repeated measurements were continued by both automated keratometry and IOLMaster (Carl Zeiss Meditec AG) to achieve differences less than 0.50 diopter in power and 10 degrees in axis of astigmatism. However, it would be more appropriate to consider the effect of possible corneal irregularities in astigmatic outcome in such patients because this discrepancy might have resulted from irregular corneal surface. Furthermore, the authors did not provide enough data about their eligibility criteria regarding corneal topographic measurements in this case series. Extreme caution must be exercised when there is any mismatch between keratometric values to rule out mild ectatic disorders and irregular corneal astigmatism.

Although obtaining keratometric measurements by different techniques including automated keratometry and IOLMaster are comparable in most cases, it might not be reasonable to perform toric IOL implantation without assessing corneal topography because of the inconsistency in different refractive indices and areas used by different devices. It has been demonstrated that automated keratometry performs poorly when applied to measure the location of the axis and magnitude of corneal astigmatism in suboptimal ocular surfaces.

Corneal topography is a prerequisite to obtain reliable measurements of astigmatism and axial position in candidates for toric IOL. That would especially be of importance in the presence of any disagreements between measurements using optical biometer and automated keratometry to achieve postoperative optimal refractive outcome because the 2 methods would have led to error in astigmatic measurements in eyes with oblique astigmatism.

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REFERENCES


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Reply: Aghaei and Es’haghi mentioned that our method of assessing corneal astigmatism prior to toric IOL power and axis calculation was to repeat “both automated keratometry and IOLMaster (measurements) to achieve differences less than 0.50 diopter in power and 10 degrees in axis of astigmatism.” In fact, our method is more accurately described as it appears in our article thus: “For routine IOL calculation, the IOLMaster keratometric values obtained at the preoperative assessment were compared with similar data from the Nidek autokeratometer. Difference of more than 0.50 D in power or 10-degrees in axis between devices required repeated IOLMaster keratometry until an agreement between IOLMaster readings within these limits was reached.” Only IOLMaster measurements were repeated.

They asserted that “it would be more appropriate to consider the effect of possible corneal irregularities in astigmatic outcome in such patients because this discrepancy might have resulted from irregular corneal surface.” We, as stated in our article, excluded “eyes that had been subjected to keratorefractive procedures, had corneal disease, or other conditions reducing the visual potential.” Eyes with the irregularity referred to had already been excluded.

They mentioned that we “did not provide enough data about their eligibility criteria regarding corneal topographic measurements in this case series.” We would suggest that the above-mentioned exclusion criteria fully address this point.

We agree that caution must be exercised to recognize ectatic disorders and irregular corneas. Such eyes were not included in our dataset. We, however, do not agree that “it might not be reasonable to perform toric IOL implantation without assessing corneal topography” or that “Corneal topography is a prerequisite to obtain reliable measurements of astigmatism and axial position in candidates for toric IOL.” Clinical recognition of relevant corneal disease by history and clinical examination is possible in the hands of adequately trained ophthalmic surgeons. The necessity for routine tomographic or topographic examination of every case where a toric IOL is considered is not clearly established.

Using the method we have described, we have published several unselected consecutive series demonstrating accurate clinical outcome in the absence of routine topographic measurement. Furthermore, the significant test-to-test variability in simulated keratometric measurement derived from one topographer vs the IOLMaster and an autokeratometer that we have demonstrated might make these values less, not more, suitable for toric IOL calculation in eyes with healthy corneas.