Nasal preparation with local anesthetic should be considered an aerosol-generating procedure

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Patients and methods
Ethics approval and informed consent was obtained. We recruited a convenience sample of 3 patients scheduled to undergo endonasal pituitary surgery. Surgery was performed in a 126-m³ OR under 20 Pa of positive pressure. After induction of general anesthesia, nasal preparation commenced with lidocaine hydrochloride at 5 mg/spray combined with phenylephrine hydrochloride at 500 μg/spray (CoPhenylcaine Forte Spray; ENT Technologies, Hawthorn East, Victoria, Australia), This was delivered as 4 metered sprays from a 50-mL bottle with an atomizing nozzle via each nostril. This was followed by submucosal infiltration of the nasal septum with 1.8 mL of lidocaine hydrochloride 2% with adrenaline 1:80,000 (Lignospan Special; Septodont, Saint-Maur-des-Fossés, France) using a 25G needle on a dental syringe. Each nostril was then packed with 3 CoPhenylcaine Forte-soaked cottonoid patties for a duration of 5 minutes.

Particle image velocimetry (PIV) was used to detect relatively larger particles by capturing disturbances in a laser light sheet with high- and low-speed cameras. Trajectory lines and tracking algorithms were used to calculate airborne distances and durations (Fig. 1). Air sampling with time-of-flight spectrometry was used to detect relatively smaller particles, with an aerodynamic particle sizer (APS) and a mini wide-range aerosol spectrometer. Background noise was evaluated with normal theater traffic to set detection limits. Statistical analysis was performed using an independent-samples t test to compare mean values using open source SciPy version 1.5.2 (Scientific computing in Python).

Results
Nasal preparation generated significantly more aerosols than baseline concentrations (p < 0.005). Specifically, the CoPhenylcaine spray produced a 40-fold increase above background noise (Fig. 2), with particle sizes ranging from 0.1 to 5 μm, which decreased to baseline noise levels after 180 seconds and traveled to the boundaries of the...
FIGURE 1. Subtracted gray-scale high-speed image obtained during submucosal injection showing trajectory lines used to calculate particle dispersion.

FIGURE 2. Time-series demonstrating number concentrations generated during nasal preparation measured by aerodynamic particle sizing (aps). Dashed lines represent background noise.

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Theater walls. Submucosal injection produced a 50- to 100-fold increase above baseline with particle sizes >75 μm, with a total airborne duration of 3 seconds traveling a distance of 1.7 meters. Due to the larger particle sizes generated, this was not captured as signal on APS measurements but was captured on the PIV system. Nasal packing with CoPhenylcaine-soaked patties did not produce signals above background noise.

Discussion

To our knowledge, nasal preparation has not been previously assessed in live patients for its ability to generate aerosols. Our data suggest that nasal preparation with local anesthetic spray and submucosal injection generates aerosols. These findings are not altogether surprising. It is likely that nasal spray generates an airflow jet that reflects off nasal walls back through the nasal aperture. Likewise, particles can be generated during submucosal injection if the bevel of the needle is not entirely submucosal, or if high enough submucosal pressures are generated that an airflow jet forces its way around the submucosal needle tip. These events are hypothesized to carry a combination of particles that are both introduced and the patient's own.

The particle profile is important in understanding the risk that such events may present. Nasal spray generated small particles, which are known to remain suspended in airflows for long durations and are transported long distances by airflows within the room. On the other hand, injection generated large particles of >75 μm. These behave ballistically, remaining airborne for short durations, and traveling short distances before settling on surfaces.

These findings have important clinical implications, not just in ORs but also in clinics. First, local anesthetic spray is used commonly in an outpatient clinic setting before endonasal procedures such as nasoendoscopy or nasal cautery. Our findings suggest that this step generates small particles that remain suspended for 180 seconds in the OR with 26 volume air exchanges per hour. US Centers for Disease Control and Prevention recommendations for similar rates of air exchange indicate that approximately 14 minutes is required to remove 99% of airborne contaminants. In an outpatient setting, the rate of air exchange is much lower and thus one would expect the particles to remain suspended for longer. This means that, for outpatient procedures that require nasal preparation, it is critically important to have appropriate personal protective equipment for staff. Second, nonessential staff should vacate the OR after nasal spray administration for ≥180 seconds and, during submucosal injection, should maintain a distance of ≥1.7 meters from the patient's nose. These times are likely to be longer in an outpatient setting.

This study has several limitations. First, the sample size was small. Second, aerosols were not assessed as biologically active. Third, PIV requires a clean line of sight for the laser light sheet, and air sampling is a point measurement.

Local anesthetic spray administration generates small particles that persist for durations dependent on the rate of air exchange. These rates likely underestimate the true duration of particle suspension. This study is a first step in understanding the potential impact of nasal preparation on airborne pollutants. Further research is needed to fully characterize the aerosol generation and spread in various clinical settings.

1. Dhillon et al. FIGURE 1. Subtracted gray-scale high-speed image obtained during submucosal injection showing trajectory lines used to calculate particle dispersion.
2. Dhillon et al. FIGURE 2. Time-series demonstrating number concentrations generated during nasal preparation measured by aerodynamic particle sizing (aps). Dashed lines represent background noise.
of room air exchange. In the OR, this duration is $\geq 180$ seconds, but in an outpatient setting this may be longer. On the other hand, local anesthetic submucosal injection generates larger particles that travel a distance of approximately 1.7 meters. Nasal preparation should be treated as an AGP and particle-size-appropriate personal protective equipment should be worn.

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