Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Coronavirus Disease-19 and Rhinology/Facial Plastics

Morgan E. Davis, MD, Carol H. Yan, MD*

KEYWORDS

• COVID-19 • Rhinology • Facial plastic surgery • Nasal endoscopy
• Aerosol generating procedure • Viral transmission risk • Anosmia • Povidone-iodine

KEY POINTS

- The nasal and oral airway contain high viral loads, posing high risk of viral transmission even in asymptomatic individuals and possibility of false negative PCR viral tests.
- Aerosol generating procedures (AGPs) include nasal endoscopy and use of high-speed energy instruments in endoscopic nasal surgery and energy-based procedures in facial plastics; performance of AGPs require maximal PPE.
- Novel devices and techniques in the operative and clinical settings have been proposed including topical decontaminating agents, nasal tents and VENT masks, and use of HEPA filters.
- Olfactory loss is highly associated with COVID-19. For those with inflammatory sinonasal pathology or allergies, continued use of topical nasal steroids is recommended.
- Aesthetic concerns and the desire to improve self-image may increase during these high-stress times and with the use of mask-wearing and telemedicine.

INTRODUCTION

The ongoing coronavirus disease-19 (COVID-19) pandemic caused by the novel coronavirus severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) has created unprecedented challenges for our health care system and society as the number of new cases continue to increase. Here we discuss the practical and clinical implications of COVID-19 as it specifically pertains to the subspecialties of rhinology and facial plastic surgery and summarize relevant practice guidelines for clinical and surgical management as of June 2020. For the rhinologist and facial plastic surgeon, the risk of exposure to SARS-CoV-2 is high owing to close proximity and frequent manipulation of the nasal and oral cavities. A solid understanding of evidence-based recommendations to mitigate the risk of viral transmission is therefore crucial for the

Department of Surgery, Division of Otolaryngology–Head and Neck Surgery, University of California San Diego School of Medicine, 9350 Campus Point Drive, Mail Code 0970, La Jolla, CA 92037, USA
* Corresponding author.
E-mail address: c1yan@health.ucsd.edu

Otolaryngol Clin N Am 53 (2020) 1139–1151
https://doi.org/10.1016/j.otc.2020.08.002
0030-6665/20/Published by Elsevier Inc.

optimization of health preservation and patient care. Additionally, we highlight some of the recently published clinical outcomes research brought forth by COVID-19. Given the fluid nature of the current pandemic and rapidly emerging data, this article is a representation of the best evidence and information to the best of our knowledge available at the time of this literature review.

DISCUSSION

High Viral Loads Are Found in the Nasal Airway

The nasal cavity is known to be a major site of SARS-CoV-2 infection and transmission. Studies on the transmission of SARS-CoV-2 suggest the primary mechanisms of spread include inhalation of respiratory droplets or aerosols and direct contact with contaminated objects.[1–3] When comparing upper respiratory specimens, higher viral loads are detected from nasal swabs compared with that of throat swabs in symptomatic patients.[4] One theory explaining this heightened association is that susceptibility genes required for viral infection, including angiotensin-converting enzyme 2, have the highest expression in the ciliated epithelial and goblet cells of the nasal mucosa, making this anatomic region an ideal target for viral invasion and replication.[5] Viral transmission is also possible in asymptomatic patients, with some data demonstrating similar levels of viral loads among asymptomatic and symptomatic individuals, suggesting that transmission of disease is possible even early in the disease course and without clinical signs.[4] Thus, the infection route of SARS-CoV-2 poses a particular threat to the rhinologist or facial plastic surgeon whose surgical practices include diagnostic and therapeutic procedures involving the nasal airway.

Risk of False-Negative Results Owing to Nasal Pathology

The current gold standard for SARS-CoV-2 testing relies on reverse transcriptase polymerase chain reaction via nasal, nasopharyngeal, or oropharyngeal swabs. The potential for a false-negative result is not uncommon[6–8] and it has been suggested that patients with nasal pathologies, including septal deviation, nasal polyps, or masses, may be at higher risk for a false-negative result owing to inaccurate sampling.[9] Bleier and Welch[9] reported a case of a false-negative COVID-19 result during preoperative testing on a patient with chronic rhinosinusitis (CRS) with nasal polyps. As the patient underwent endoscopic sinus surgery, nasal polyps were noted obstructing the nasopharynx and a repeat intraoperative SARS-CoV-2 swab of the nasopharynx was in fact positive for COVID-19. There was inadvertent exposure for multiple health care personnel wearing only traditional surgical masks instead of higher level personal protective equipment (PPE) given the false-negative preoperative screening test result.[9] In response, DeConde and colleagues[10] have suggested performing both a nasal and oropharyngeal swab on select patients at high risk for an inadequate or inaccessible nasal or nasopharyngeal sample.

Nasal Procedures Carry a High Risk of Viral Transmission

One of the earliest reports highlighting the high risk of rhinologic procedures were 2 cases of endoscopic transsphenoidal surgery performed in Wuhan, China in January 2020 that resulted in SARS-CoV-2 transmission and illness of health care workers thought to be acquired intraoperatively.[11] Although the details and timing of the viral transmission have been debated,[12,13] the distribution of Patel and colleagues[11] letter brought attention to the uniquely high risk of viral transmission from aerosolizing nasal and endoscopic skull base procedures. Research has since been aimed at

determining specific risks of aerosolization of the SARS-CoV-2 virus and categorization of true aerosol generating procedures (AGPs).

Although there is well-established evidence supporting SARS-CoV-2 transmission via droplet and direct contact, the risk of airborne transmission through AGPs (transmission of particles of <5–10 μm in size) remains controversial. One study demonstrated that aerosolized SARS-CoV-2 particles of less than 5 μm remain viable in air for at least 3 hours and on surfaces up to 72 hours depending on the surface material.[3] Simulated nasal endoscopic procedures have investigated the aerosolization risk associated with endonasal instrumentation owing to concern that potential AGPs would require enhanced safety precautions. The manipulation of nasal mucosa during endoscopy was found to distribute larger droplets up to a distance of 66 cm.[14] The use of high-speed drills and electrocautery during endonasal surgery carried the highest risk for aerosolization of virus particles, whereas cold instruments and powered suction microdebriders were lower risk.[14,15] Although diagnostic nasal endoscopy was initially thought to be non–aerosol-generating, a subsequent study by the same authors reported that both rigid and flexible nasal endoscopy can generate aerosols.[15] Perhaps, more important, they found a regular surgical mask insufficient in protecting against particle transmission generated by simulated airborne aerosol conditions in contrast to an N95 mask, which effectively contained aerosol spread.[15] Studies outside the otolaryngologic literature demonstrated similar findings of particle distribution with the use of drills and other high speed energy instruments including saws, cautery, laser, and ultrasonic technology.[14,16–18] Proposed methods to mitigate potential microscopic particle contamination include judicious use of high-powered drills with cutting burs recommended over diamond burs and use of continuous suctioning in the surgical field.[2,19] Additional research is warranted to better understand the mechanism of SARS-CoV-2 airborne transmission and further stratify risk of aerosol generation associated with different endonasal procedures and instrumentation to guide appropriate PPE use and ensure maximum safety in nonsimulated scenarios.

Oral Procedures Risk Viral Transmission

Aerosolization and risk of SARS-CoV-2 transmission during transoral facial plastic surgery procedures such as open fixation of acute facial fractures and/or removal of maxillomandibular fixation should be also considered. Although higher viral loads are typically found in the nasal cavity and nasopharynx, asymptomatic and minimally symptomatic patients have demonstrated modest levels of viral RNA in oropharyngeal samples that persists for at least 5 days.[4] As such, limited in-person evaluation was recommended for emergency department facial trauma consults and photo documentation and telehealth communication was favored.[20] Careful evaluation of specific soft tissue and hard tissue (bony) injuries can help to determine, which injuries could be treated with conservative therapy or delayed surgical management. This includes conservative treatment of mandibular and maxillary fractures and local wound care for intraoral lacerations. Hsieh and colleagues[21] proposed a facial trauma protocol for the surgical management of facial fractures which included favoring closed procedures over internal fixation when possible, use of scalpel over monopolar cautery, use of osteotome over power saw when osteotomy is required, and application of lowest speed and/or lowest power settings when such instrumentation is necessary and cannot be avoided.

General Safety Recommendations During the Coronavirus Disease-19 Era

Given the rapid spread of COVID-19 and a high degree of uncertainty of infectious transmission, prudent attention should be paid not only to the safety of the provider

team and patient, but also toward environmental infection control measures during routine outpatient and surgical procedures. Although there are no universal guidelines to date, several institutions have released various versions of safety recommendations for the otolaryngologist in their clinical practices. The American Academy of Otolaryngology—Head and Neck Surgery initially recommended in March 2020 that extreme caution should be used during any transnasal or transoral procedure with use of standard universal precautions during any evaluation of these areas. These guidelines also favored limiting not only surgeries, but also routine clinic examinations (nasal endoscopy and flexible laryngoscopy), to those strictly deemed necessary.[22] Vukkadala and colleagues[23] at Stanford University proposed the following guidelines for management of otolaryngologic surgeries during the initial COVID-19 outbreak based on risk stratification and COVID status.

- All transoral and intranasal surgeries are considered high risk.
- High-risk surgeries/APGs should be performed under enhanced airborne precautions regardless of COVID status. Recommended PPE includes gloves, gown, eye protection, and a minimum of an N95 respirator.
- Patients with positive symptoms despite negative COVID test, persons with pending COVID status, and/or unknown COVID status requiring emergency surgical treatment should be treated according to enhanced airborne precautions
- For patients with confirmed COVID-19, surgery should be delayed if possible or use of powered air-purifying respirators for all OR staff is recommended if surgery involves upper airway mucosal surfaces and delay until resolution of COVID-19 infection is not possible.

Overall, with the exception of emergent conditions, surgical procedures should not proceed without preoperative confirmation of COVID-19 status.[22]

OVERVIEW OF CORONAVIRUS DISEASE-19 EFFECT ON CLINICAL PRACTICE

At the onset of the COVID-19 pandemic in March 2020, health care systems were urged to delay all elective or nonurgent surgeries in accordance with the Centers for Disease Control and Prevention (CDC) recommendations.[24] Among all surgical specialties, otolaryngology and maxillofacial surgery took a particularly hard decline in surgical activity.[25] Given the higher risk associated with upper airway exposure, Radulesco and colleagues[26] proposed the following 3 tiers of management for endonasal surgical procedures.

- Group A: patients whose surgery cannot be postponed (eg, complicated sinusitis such as cavernous sinus thrombosis, invasive fungal sinusitis, nasal foreign bodies, sinonasal cancers, life threatening epistaxis unable to be controlled by other measures) → proceed with surgery after COVID-19 testing.
- Group B: patients whose surgery can be postponed for up to 4 weeks without significant prognostic impact→ surgery postponed.
- Group C: patients whose surgery can be postponed for at least 6 weeks without significant impact on prognosis or disease be controlled by other measures → surgery postponed.

As recommendations for social distancing and stay-at-home orders surfaced all over the country and worldwide, the general consensus for rhinologic and facial plastics surgical practices between late March and April was the cancellation of nonurgent in-person clinic appointments. Widespread implementation of telemedicine visits surfaced shortly thereafter. Although perhaps limited in comprehensive patient evaluation

and patient–provider interaction, telemedicine can be advantageous in not only eliminating risk, but also in patient convenience, effective time management, and electronic transfer of patient files.[27]

On May 12, 2020, the CDC released a general framework outlining the gradual resumption of nonurgent hospital services and expansion of elective operative care in the United States.[24] Between late May and June, elective in-person clinic visits ensued, although the option of telemedicine visits remained. To safely carry out elective office-based practices, new clinic protocols were developed to ensure patient and health care worker safety and adherence to social distancing.[28] General considerations for safe reopenings of rhinologic and facial plastics surgical clinics included previsit patient screening and education 24 to 48 hours before scheduled appointments as well as day-of symptom screening and temperature checks. Previsit COVID-19 testing is also routinely used, when available, to screen asymptomatic carriers, especially for new patients and those who are expected to undergo AGPs.[16] One must be mindful of select patients for which COVID-19 nasal swabs are contraindicated or of low yield owing to decreased test sensitivity. This cohort includes postoperative skull base patients, patients with postoperative packing or nasal splints, and patients with unfavorable anatomy owing to severely deviated septum, obstructing nasal mass, or thick mucus and polyps.[16]

Patients necessitating high-risk in-clinic procedures should be identified early on to facilitate appropriate scheduling and ensure the availability of adequate PPE for all staff.

Full capacity clinics are difficult to implement owing to enhanced sanitation measures and appropriate downtime of rooms after AGPs. Although respiratory droplets dissipate after 30 minutes of generation, AGPs pose a greater danger for transmission owing to the production of airborne aerosol particles that can travel 23 to 27 feet and remain viable in air for up to 3 hours.[3,16] In accordance with CDC guidelines, procedure rooms without negative pressure and continual HEPA filtration and air turnover should remain vacant following any AGP before cleaning, with timing based on a room's ability for air handling and duration of time spent in room.[29]

As clinical practices continue to expand and function at higher capacities despite persistent increases in the number of COVID-19 cases, an important challenge will be finding the proper balance between resumption of sustainable and safe elective clinical and surgical care and the preservation of hospital resources in anticipation of a potential second surge of COVID-19 cases.

Safety Recommendations in the Operative Setting

Coronavirus Disease-19 testing

Current guidelines recommend perioperative COVID-19 testing to be performed within 24 to 48 hours before elective high-risk aerosol generating surgeries.[16,30]

Use of topical decontaminating agents

Given that the nasopharynx and oropharynx are key reservoirs harboring SARS-CoV-2 virus, povidone–iodine (PVP-I) rinses have been proposed as a potential oral and nasal decontaminating agent. Although there are limited data in regard to specific efficacy against COVID-19 infections, PVP-I solutions of various dilute concentrations have been reported as safe and effective in decreasing viral and bacterial colonization of other species.[31] Although studies have shown that concentrations of 2.5% and higher are associated with ciliotoxic effects on ciliated human respiratory epithelial cells, safe use has been used at concentrations of 1.25% or less.[31,32] In contrast with the nasal mucosa, the oral mucosa, which lacks cilia, has been shown to tolerate

concentrations to 5% PVP-I rinses applied intraorally for a duration of up to 6 months.[31] In regards to SARS-CoV-2, preliminary studies primarily based on viral homology with SARS-CoV-1 and anecdotal evidence suggest nasal mucosal decontamination using 0.5 to 2.0 mL of 1.25% PVP-I and oral rinses with up to 10 mL at 2.5% before scheduled surgical procedures could effectively reduce the risk of COVID-19 infection transmission to providers and health care personnel without the risk of adverse effects to the patient.[31] PVP-I solutions with concentrations as low as 0.5% have recently been shown to inactivate SARS-CoV-2 in vitro after only 15 seconds of contact,[33] which further supports the applicability of use under prophylactic perioperative surgical conditions. PVP-I should be avoided in patients who are pregnant or allergic to iodine, have thyroid disease, or are undergoing radioactive iodine treatment owing to potential systemic effects.[31,33–36]

Chlorhexidine has also been suggested as a possible solution to decrease viral load and transmission risk.[37] Studies have demonstrated that chlorhexidine alone is less effective than PVP-I and other standard disinfectants against a wide range of human viruses, not including SARS-CoV-2, in both in vitro experiments[38] and studies of disinfection of inanimate surfaces.[39] Studies investigating the efficacy of chlorhexidine specifically against the novel coronavirus do not yet exist; therefore, no recommendation has been made regarding its routine use as a disinfectant for SARS-CoV-2.

Nasal tents

The implementation of a nasal tent using a simple 160 × 200 cm clear plastic sheet to create a barrier between the patient and the provider has been proposed as a feasible and cost-effective adjunct to limit potential viral spread during high-risk nasal procedures.[40] Maharaj[40] describes using this barrier with a low-flow continuous suction circuit to filter contaminated particles as well as a setup of all necessary surgical instruments beneath the tent to avoid passage of instruments after the start of the procedure and to minimize contamination for operating room personnel. This novel technique has the potential for more widespread application if additional studies can validate its efficacy. Nevertheless, it highlights the potential for innovation in surgical protective equipment to enhance operating room safety during the current COVID-19 pandemic and future outbreaks.

Safety Recommendations in the Outpatient Setting

Use of portable high-efficiency particulate air filters

The CDC currently recommends the use of negative-pressure isolation rooms when performing AGPs or allowing adequate down time in procedure rooms after AGPs to allow clearance of SARS-CoV-2 by other means.[28,29] Negative-pressure rooms are not readily available in the outpatient setting and long wait periods in between room use is cumbersome and not conducive to efficient workflow. As a result, the use of portable air purifiers with HEPA filters have been discussed because of their theoretic ability to decontaminate airborne particles generated during in clinic AGPs.[41] The CDC supports the use of HEPA filtration systems found in powered air-purifying respirators effective against SARS-CoV-2[41,42]; however, its broader application in portable systems for clinic and procedure rooms has not been established. The implementation of portable HEPA filters intended to decontaminate airborne SARS-CoV-2 in the clinical setting should only be used as an adjunct to other already well-established measures for infection control.[41]

Use of topical lidocaine/phenylephrine

Irritative conditions that can trigger a sneeze or cough have the potential to distribute and transform larger respiratory droplets into airborne aerosols,[14–16] indicating the

potential for any routine endoscopy to unexpectedly become an AGP. Ironically, the use of common anesthetic and decongestant sprays during nasal endoscopy, which are intended to increase patient comfort and decrease airway irritability, have been discouraged owing to the risk of aerosolization of viral particles with the use of nasal atomizer sprays. As alternative means of anesthesia to prevent irritation of nasal mucosa, the American Academy of Otolaryngology supports use of lidocaine- and phenylephrine-soaked pledgets.[22]

Experimental modifications in routine endoscopy

The use of nasal endoscopy plays a fundamental role in the evaluation and diagnosis of common pathologies in otolaryngology. Workman and colleagues[14,15] developed a modified valved endoscopy of the nose and throat masks using regular surgical masks and N-95 masks that they engineered to allow passage of an endoscope while maintaining a tight seal to prevent droplet and aerosol contamination. In contrast with standard endoscopy performed in unmasked conditions, the use of modified valved endoscopy of the nose and throat masks with surgical and N-95 masks prevented droplet and airborne particle distribution, respectively, during simulated AGPs.

Another proposed modification to standard endoscopy technique is the back endoscopy approach, during which the endoscopist stands behind the patient and faces the monitor to avoid standing in the direct trajectory of droplets or aerosols.[43]

Aesthetic care procedures

PPE is required for all office aesthetic treatments with surgical masks, safety glasses, gown, and gloves recommended for injectables and noninvasive body contouring. Energy-based procedures of the head and neck such as those using laser, light, and heat, may involve AGPs and thus maximal PPE including N-95 masks are recommended.[44] Smoke evacuator suction systems are necessary during these procedures. Cooling positive air pressure traditionally used for pain management during a number of laser and other energy-emitting device procedures are not recommended.

TREATMENT OF THE RHINOLOGIC PATIENT IN THE CORONAVIRUS DISEASE-19 ERA

Given the aforementioned risks of viral exposure from nasal procedures and the prior temporary cessation on elective surgical procedures, one must consider how to best manage patients with CRS in this era. The impact of systemic corticosteroids on COVID-19 infection is still being investigated[45] and not generally supported for SARS-CoV-2 pulmonary disease under guidelines from the World Health Orgnization.[46] New prescriptions of systemic corticosteroids for sinonasal symptoms is not advised.[47] However, various allergy societies including the Allergic Rhinitis and its Impact on Asthma initiative and European Academy of Allergy and Clinical Immunology Society have recommended to continue the use of intranasal corticosteroids for those with CRS or rhinitis particularly those who are at risk of worsening chronic symptoms by stopping their topical therapies.[48]

Recent studies have shown efficacy in the use of high-volume nasal steroid irrigations in patients with CRS who had not previously undergone surgery.[49,50] A double-blinded, randomized controlled trial in CRS without nasal polyposis patients without prior surgical intervention demonstrated clinically meaningful improvement in SNOT-22 scores with high-volume nasal steroid irrigations compared with steroid sprays.[49] In a retrospective study, 64.4% of all patients with CRS treated with nasal steroid irrigations did not require surgical management after treatment for at least 6 weeks.[50] These studies are preliminary but promising given the likely prolonged COVID-19 environment.

Given the high prevalence of chemosensory dysfunction and in particular, olfactory loss associated with COVID-19,[51–57] it is more important than ever to recognize smell loss and taste loss and address the impact of chemosensory loss with subjects. Otolaryngologists and rhinologists need to be aware of sudden onset hyposmia/anosmia as a predictor of SARS-CoV-2 infection, particularly in those who are otherwise asymptomatic, and gain familiarity with use of treatment options such as topical steroid rinses and olfactory training.[58–60] Of those who reported smell loss associated with COVID-19, an estimated 25% of the subjects may not regain their smell, although these data are still preliminary.[51] Thus, chemosensory dysfunction may ultimately involve a portion of a otolaryngologist's clinical practice with a potential role for validated measurements of olfactory dysfunction both during in-person visits and telehealth visits.[61]

Treatment of the Facial Plastics Patient in the Coronavirus Disease-19 Era

As elective and routine care resumes, medical aesthetic specialties including cosmetic facial plastics practices have identified a need in providing positive self-image and sense of well-being to patients following a lengthy and stressful period of quarantine.[44]

With the increased prevalence of mask wearing during the COVID-19 pandemic, there is increased attention to the upper half of one's face. Botulinum toxin treatment of the glabella complex has been suggested to decrease negative emotions and promote well-being for both the treated individual and others who come into contact with the individual.[62] One study found that more than 40% of patients without prior facial

Table 1
Proposed safety recommendations in the literature for operative and ambulatory settings

Operative Setting	Ambulatory Setting
All patients should receive COVID-19 testing within 24–48 h before surgery. With the exception of emergencies, surgeries should not proceed without confirmation of COVID-19 status.	Previsit screening questionnaires 24–48 h prior with COVID-19 testing for AGPs. Day-of symptom screening and temperature checks.
High-risk surgeries (all transoral and intranasal) should be performed under enhanced airborne precautions including gloves, gown, eye protection, and a minimum of an N95 respirator.	Maximum PPE should be worn during all potential AGPs including nasal endoscopy, injectables, noninvasive body contouring, and procedures involving lasers, light, and/or heat
Use of barriers such as nasal tents may limit potential viral spread.	Modifications in standard endoscopy technique include use of valved endoscopy of the nose and throat masks or back endoscopy approaches.
Continuous suctioning of the surgical field. Limit or avoid the use of high-powered drills with cutting burs, monopolar electrocautery, and power saws when possible.	Use of portable HEPA filters may be used as an adjunct for infection control but have not been tested specifically against SARS-CoV2.
PVP-I rinses at 1.25% and 2.5% for intranasal and intraoral use, respectively, may be safe however, in vivo efficacy against SARS-CoV2 is not well-established.	Use of topical medications on pledgets for nasal anesthesia and decongestion before nasal endoscopy is preferred over sprays, and may decrease irritative conditions resulting in aerosols.

cosmetic treatments now wished to pursue treatment after identifying concerns over their facial appearance highlighted during their initial telehealth visits.[63] These findings suggest that the increased use of video conferencing technology during the current pandemic may translate to increased number of patients pursuing nonsurgical and surgical facial cosmetic procedures, which may be challenging to achieve in a safe but timely manner.

SUMMARY

In response to the novel COVID-19, new practices have been implemented in rhinology and facial plastics, which are at high risk for viral exposure (**Table 1**). The safety of the patient and provider team are of utmost importance with the emphasis on environmental infection control measures in both practices. Safety recommendations involving procedures have included preoperative and preprocedural COVID-19 testing, enhanced PPE usage including N-95 masks for all high-risk procedures regardless of COVID status, and particular precautions while performing AGPs or using energy instruments, including high-speed drills, electrocautery, and lasers. Optional adjuncts to avoid viral transmission include prophylactic use of PVP-I rinses for nasal and oral decontamination and barrier methods such as nasal tents. The use of HEPA filters and various modifications to standard endoscopy technique to decreased risk are currently under investigation but may be promising in the future. Nonsurgical, conservative management of sinonasal and facial pathologies should be considered with the use of high-volume nasal steroid irrigations for CRS and olfactory dysfunction and increased nonoperative management of facial traumas. Olfactory dysfunction associated with COVID-19 may be seen more frequently in a rhinologic practice, and facial plastics clinics may experience an increase in patient demand for aesthetic procedures.

DISCLOSURE

None.

REFERENCES

1. Sharma A, Tiwari S, Deb MK, et al. Severe Acute Respiratory Syndrome Coronavirus -2 (SARS-CoV-2): a global pandemic and treatments strategies. Int J Antimicrob Agents 2020;106054. https://doi.org/10.1016/j.ijantimicag.2020.106054.
2. Sharma D, Rubel KE, Ye MJ, et al. Cadaveric simulation of endoscopic endonasal procedures: analysis of droplet splatter patterns during the COVID-19 pandemic. Otolaryngol Head Neck Surg 2020;163(1):145–50.
3. van Doremalen N, Bushmaker T, Morris DH, et al. Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. N Engl J Med 2020;382(16):1564–7.
4. Zou L, Ruan F, Huang M, et al. SARS-CoV-2 viral load in upper respiratory specimens of infected patients. N Engl J Med 2020;382(12):1177–9.
5. Sungnak W, Huang N, Bécavin C, et al. SARS-CoV-2 entry factors are highly expressed in nasal epithelial cells together with innate immune genes. Nat Med 2020;26:681–7.
6. Yang Y, Yang M, Shen C, et al. Evaluating the accuracy of different respiratory specimens in the laboratory diagnosis and monitoring the viral shedding of 2019-nCoV infections. 2020. Preprint. https://doi.org/10.1101/2020.02.11.20021493.

7. Arevalo-Rodriguez I, Buitrago-Garcia D, Simancas-Racines D, et al. False-negative results of initial RT-PCR assays for COVID-19: a systematic review. 2020. Preprint. https://doi.org/10.1101/2020.04.16.20066787.
8. Woloshin S, Patel N, Kesselheim AS. False negative tests for SARS-CoV-2 infection - Challenges and implications. N Engl J Med 2020. https://doi.org/10.1056/NEJMp2015897. 10.1056/NEJMp2015897.
9. Bleier BS, Welch KC. Pre-procedural COVID-19 screening: do rhinologic patients carry a unique risk burden for false negative results? Int Forum Allergy Rhinol 2020. https://doi.org/10.1002/alr.22645. 10.1002/alr.22645.
10. DeConde AS, Yan CH, DeConde RP. In reply: navigating personal risk in rhinologic surgery during the COVID-19 pandemic. Int Forum Allergy Rhinol 2020. https://doi.org/10.1002/alr.22649. 10.1002/alr.22649.
11. Patel ZM, Fernandez-Miranda J, Hwang PH, et al. Letter: precautions for endoscopic transnasal skull base surgery during the COVID-19 pandemic. Neurosurgery 2020;87(1):E66–7.
12. Huang X, Zhu W, Zhao H, et al. In reply: precautions for endoscopic transnasal skull base surgery during the COVID-19 pandemic. Neurosurgery 2020. https://doi.org/10.1093/neuros/nyaa145. nyaa145.
13. Patel ZM, Fernandez-Miranda J, Hwang PH, et al. In reply: precautions for endoscopic transnasal skull base surgery during the COVID-19 pandemic. Neurosurgery 2020;87(2):E162–3.
14. Workman AD, Welling DB, Carter BS, et al. Endonasal instrumentation and aerosolization risk in the era of COVID-19: simulation, literature review, and proposed mitigation strategies. Int Forum Allergy Rhinol 2020;10(7):798–805.
15. Workman AD, Jafari A, Welling DB, et al. Airborne aerosol generation during endonasal procedures in the era of COVID-19: risks and recommendations. Otolaryngol Head Neck Surg 2020. https://doi.org/10.1177/0194599820931805. 194599820931805.
16. Howard BE, Lal D. Rhinologic practice special considerations during COVID-19: visit planning, personal protective equipment, testing, and environmental controls. Otolaryngol Head Neck Surg 2020. https://doi.org/10.1177/0194599820933169. 194599820933169.
17. Nogler M, Lass-Florl C, Wimmer C, et al. Contamination during removal of cement in revision hip arthroplasty: a cadaver study using ultrasound and high-speed cutters. J Bone Joint Surg Br 2003;85:436–9.
18. Garden JM. Viral disease transmitted by laser-generated plume (aerosol). Arch Dermatol 2002;138:1303.
19. Snyderman CH, Gardner PA. Endonasal drilling may be employed safely in the COVID-19 era. Int Forum Allergy Rhinol 2020. https://doi.org/10.1002/alr.22642. 10.1002/alr.22642.
20. Edwards SP, Kasten S, Nelson C, et al. Maxillofacial trauma management during COVID-19: multidisciplinary recommendations. Facial Plast Surg Aesthet Med 2020;22(3):157–9.
21. Hsieh TY, Dedhia RD, Chiao W, et al. A guide to facial trauma triage and precautions in the COVID-19 pandemic. Facial Plast Surg Aesthet Med 2020;22(3):164–9.
22. American Academy of Otolaryngology–Head and Neck Surgery. Academy supports CMS, offers specific nasal policy. 2020. Available at: https://www.entnet.org/content/academy-supports-cms-offers-specific-nasal-policy. Accessed June 24, 2020.

23. Vukkadala N, Qian ZJ, Holsinger FC, et al. COVID-19 and the otolaryngologist: preliminary evidence-based review. Laryngoscope 2020. https://doi.org/10.1002/lary.28672. 10.1002/lary.28672.
24. Coronavirus Disease 2019 (COVID-19). Centers for Disease Control and Prevention. 2020. Available at: https://www.cdc.gov/coronavirus/2019-ncov/hcp/framework-non-COVID-care.html. Accessed June 20, 2020.
25. Farid Y, Schettino M, Kapila AK, et al. Decrease in surgical activity in the COVID-19 pandemic: an economic crisis. Br J Surg 2020. https://doi.org/10.1002/bjs.11738. 10.1002/bjs.11738.
26. Radulesco T, Verillaud B, Béquignon E, et al. COVID-19 and rhinology, from the consultation room to the operating theatre. Eur Ann Otorhinolaryngol Head Neck Dis 2020. https://doi.org/10.1016/j.anorl.2020.04.013. S1879-7296(20)30103-30104.
27. Unadkat SN, Andrews PJ, Bertossi D, et al. Recovery of elective facial plastic surgery in the post-coronavirus disease 2019 era: recommendations from the European Academy of Facial Plastic Surgery Task Force. Facial Plast Surg Aesthet Med 2020. https://doi.org/10.1089/fpsam.2020.0258. 10.1089/fpsam.2020.0258.
28. Centers for Disease Control and Prevention. Interim infection prevention and control recommendations for patients with suspected or confirmed coronavirus disease 2019 (COVID-19) in healthcare settings. 2020. Available at: https://www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control-recommendations.html#take_precautions. Accessed April 28, 2020.
29. Centers for Disease Control and Prevention. Appendix B: air. Guidance for environmental infection control in health-care facilities. 2019. Available at: https://www.cdc.gov/infectioncontrol/guidelines/environmental/appendix/air.html. Accessed June 30, 2020.
30. Taha MA, Hall CA, Rathbone RF, et al. Rhinologic procedures in the era of COVID-19: health-care provider protection protocol. Am J Rhinol Allergy 2020;34(4):451–5.
31. Frank S, Capriotti J, Brown SM, et al. Povidone-iodine use in sinonasal and oral cavities: a review of safety in the COVID-19 era. Ear Nose Throat J 2020. https://doi.org/10.1177/0145561320932318. 145561320932318.
32. Kim JH, Rimmer J, Mrad N, et al. Betadine has a ciliotoxic effect on ciliated human respiratory cells. J Laryngol Otol 2015;129(Suppl 1):S45–50.
33. Bidra AS, Pelletier JS, Westover JB, et al. Rapid In-Vitro Inactivation of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) using povidone-iodine oral antiseptic rinse. J Prosthodont 2020. https://doi.org/10.1111/jopr.13209. 10.1111/jopr.13209.
34. Foley TP Jr. The relationship between autoimmune thyroid disease and iodine intake: a review. Endokrynol Pol 1992;43(Suppl 1):53–69.
35. Furudate S, Nishimaki T, Muto T. 125I uptake competing with iodine absorption by the thyroid gland following povidone-iodine skin application. Exp Anim 1997;46:197–202.
36. Gray PEA, Katelaris CH, Lipson D. Recurrent anaphylaxis caused by topical povidone iodine(Betadine). J Paediatr Child Health 2013;49:506–7.
37. Parhar HS, Tasche K, Brody RM, et al. Topical preparations to reduce SARS-CoV-2 aerosolization in head and neck mucosal surgery. Head Neck 2020;42(6):1268–72.
38. Kawana R, Kitamura T, Nakagomi O, et al. Inactivation of human viruses by povidone-iodine in comparison with other antiseptics. Dermatology 1997;195(suppl 2):29–35.

39. Kampf G, Todt D, Pfaender S, et al. Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. J Hosp Infect 2020;104(3):246–51.
40. Maharaj SH. The nasal tent: an adjuvant for performing endoscopic endonasal surgery in the Covid era and beyond. Eur Arch Otorhinolaryngol 2020;1–3. https://doi.org/10.1007/s00405-020-06149-7.
41. Christopherson D, Yao WC, Lu M, et al. High-efficiency particulate air filters in the era of COVID-19: function and efficacy. Otolaryngol Head Neck Surg 2020. 194599820941838. https://doi.org/10.1177/0194599820941838.
42. Centers for Disease Control and Prevention. Considerations for Optimizing the Supply of Powered Air-Purifying Respirators (PAPRs): for Healthcare Practitioners (HCP). 2020. Available at: https://www.cdc.gov/coronavirus/2019-ncov/hcp/ppe-strategy/powered-airpurifying-respirators-strategy.html. Accessed June 30, 2020.
43. Di Maio P, Traverso D, Iocca O, et al. Endoscopic nasopharyngoscopy and ENT specialist safety in the COVID 19 era: the back endoscopy approach to the patient. Eur Arch Otorhinolaryngol 2020;1–2. https://doi.org/10.1007/s00405-020-06093-6.
44. Dover JS, Moran ML, Figueroa JF, et al. A path to resume aesthetic care: executive summary of project AesCert guidance supplement-practical considerations for aesthetic medicine professionals supporting clinic preparedness in response to the SARS-CoV-2 outbreak. Facial Plast Surg Aesthet Med 2020;22(3):125–51.
45. Russell CD, Millar JE, Baillie JK. Clinical evidence does not support corticosteroid treatment for 2019-nCoV lung injury. Lancet 2020;395(10223):473–5.
46. Clinical management of COVID-19. Who.int. 2020. Available at: https://www.who.int/publications/i/item/clinical-management-of-severe-acute-respiratory-infection-when-novel-coronavirus-(ncov)-infection-is-suspected. Accessed June 24, 2020.
47. Herman P, Vincent C, Parietti Winkler C, et al. Consensus statement. Corticosteroid therapy in ENT in the context of the COVID-19 pandemic. Eur Ann Otorhinolaryngol Head Neck Dis 2020. https://doi.org/10.1016/j.anorl.2020.04.014. S1879-7296(20)30104-30106.
48. Bousquet J, Akdis C, Jutel M, et al. Intranasal corticosteroids in allergic rhinitis in COVID-19 infected patients: an ARIA-EAACI statement. Allergy 2020. https://doi.org/10.1111/all.14302. 10.1111/all.14302.
49. Jiramongkolchai P, Peterson A, Kallogjeri D, et al. Randomized clinical trial to evaluate mometasone lavage vs spray for patients with chronic rhinosinusitis without nasal polyps who have not undergone sinus surgery. Int Forum Allergy Rhinol 2020. https://doi.org/10.1002/alr.22586. 10.1002/alr.22586.
50. Sweis AM, Locke TB, Douglas JE, et al. Management of chronic rhinosinusitis with steroid nasal irrigations: a viable non-surgical alternative in the COVID-19 Era. Int Forum Allergy Rhinol 2020. https://doi.org/10.1002/alr.22646. 10.1002/alr.22646.
51. Yan CH, Faraji F, Prajapati DP, et al. Association of chemosensory dysfunction and COVID-19 in patients presenting with influenza-like symptoms. Int Forum Allergy Rhinol 2020. https://doi.org/10.1002/alr.22579.
52. Yan CH, Faraji F, Prajapati DP, et al. Self-reported olfactory loss associates with outpatient clinical course in COVID-19. Int Forum Allergy Rhinol 2020. https://doi.org/10.1002/alr.22592.
53. Lechien JR, Chiesa-Estomba CM, De Siati DR, et al. Olfactory and gustatory dysfunctions as a clinical presentation of mild-to-moderate forms of the coronavirus

disease (COVID-19): a multicenter European study. Eur Arch Otorhinolaryngol 2020;1–11. https://doi.org/10.1007/s00405-020-05965-1.
54. Tong JY, Wong A, Zhu D, et al. The prevalence of olfactory and gustatory dysfunction in COVID-19 patients: a systematic review and meta-analysis. Otolaryngol Head Neck Surg 2020;163(1):3–11.
55. Sayin İ, Yaşar KK, Yazici ZM. Taste and smell impairment in COVID-19: an AAO-HNS anosmia reporting tool-based comparative study. Otolaryngol Head Neck Surg 2020. https://doi.org/10.1177/0194599820931820. 194599820931820.
56. Sedaghat AR, Gengler I, Speth MM. Olfactory dysfunction: a highly prevalent symptom of COVID-19 with public health significance. Otolaryngol Head Neck Surg 2020;163(1):12–5.
57. Speth MM, Singer-Cornelius T, Oberle M, et al. Olfactory dysfunction and sinonasal symptomatology in COVID-19: prevalence, severity, timing, and associated characteristics. Otolaryngol Head Neck Surg 2020;163(1):114–20.
58. Nguyen TP, Patel ZM. Budesonide irrigation with olfactory training improves outcomes compared with olfactory training alone in patients with olfactory loss. Int Forum Allergy Rhinol 2018;8(9):977–81.
59. Yan CH, Overdevest JB, Patel ZM. Therapeutic use of steroids in non-chronic rhinosinusitis olfactory dysfunction: a systematic evidence-based review with recommendations. Int Forum Allergy Rhinol 2019;9(2):165–76.
60. Soler ZM, Patel ZM, Turner JH, et al. A primer on viral-associated olfactory loss in the era of COVID-19. Int Forum Allergy Rhinol 2020;10(7):814–20.
61. Klimek L, Hagemann J, Alali A, et al. Telemedicine allows quantitative measuring of olfactory dysfunction in COVID-19. Allergy 2020. https://doi.org/10.1111/all.14467. 10.1111/all.14467.
62. Nestor MS, Fischer D, Arnold D. "Masking" our emotions: botulinum toxin, facial expression and well-being in the age of COVID-19. J Cosmet Dermatol 2020. https://doi.org/10.1111/jocd.13569. 10.1111/jocd.13569.
63. Cristel RT, Demesh D, Dayan SH. Video conferencing impact on facial appearance: looking beyond the COVID-19 pandemic. Facial Plast Surg Aesthet Med 2020. https://doi.org/10.1089/fpsam.2020.0279. 10.1089/fpsam.2020.0279.