



## SPECIAL ARTICLE COVID-19

# Safety for the Rhinologist in the Age of COVID-19: Mask Use, Nasal Corticosteroids, Saline Irrigation, and Endoscopic Procedures – Literature Review

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## Abstract

**Introduction** Coronavirus disease 2019 (COVID-19) has claimed millions of lives. Adequate protection of the professionals involved in patient care is essential in the battle against this disease. However, there is much uncertainty involving safety-related topics that are of particular interest to the rhinologist in the context of COVID-19.

**Objective** To evaluate the current evidence regarding three safety-related topics: mask and respirator use, performance of nasal endoscopic procedures, and use of topical nasal and intranasal medications (saline irrigation and nasal corticosteroids).

**Methods** A literature review was performed on the PubMed, Scopus, and Cochrane databases, with standardized search queries for each of the three topics of interest.

**Results** In total, 13 articles on mask use, 6 articles on the safety of nasal corticosteroids, 6 articles on the safety of nasal endoscopic procedures, and 1 article on nasal irrigation with saline solution were included in the final analysis.

**Conclusion** N95 respirators are essential for the adequate protection of otolaryngologists. If reuse is necessary, physical methods of sterilization must be employed. No evidence was found to contraindicate the use of nasal corticosteroids, whether acute (in the management of sinonasal inflammatory conditions) or continued (in patients who use them chronically). Nasal irrigation with saline solution apparently does not increase the risk in the context of COVID-19. Nasal endoscopic procedures should only be performed after testing the patient for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), and the surgical team must wear full personal protective equipment to prevent aerosol exposure.

## Keywords

- ▶ COVID-19
- ▶ safety
- ▶ corticosteroids
- ▶ masks
- ▶ nasal saline solution
- ▶ nasal endoscopy

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## Introduction

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), emerged in December 2019 in Wuhan, China.<sup>1</sup> At the time the present article was being written, there had been more than 80 million confirmed cases and 1.8 million deaths worldwide,<sup>2</sup> with nearly 8 million cases and 200 thousand deaths in Brazil alone.<sup>3</sup>

One of the most important aspects in guaranteeing the successful large-scale management of COVID-19 is to ensure the safety of health professionals caring for infected patients.<sup>4</sup> In this regard, otorhinolaryngologists are at a particular risk of contamination,<sup>5</sup> as they deal with anatomical sites bearing high viral loads, such as the tissues of the oropharynx and nasopharynx.<sup>6</sup> To date, there is no clear, definitive evidence from the literature as to what would be the best methods to ensure the protection of health care providers in the context of COVID-19, especially regarding the use of masks and/or respirators for personal protection.

The symptomatic management of COVID-19 is also a topic of heated debate in the current literature. Because it is a new disease, several established treatment concepts are being put to the test. As they specialize in diagnoses involving the upper airway, ear, nose, and throat (ENT) specialists will often encounter patients suspected to have COVID-19, the main symptoms of which are productive cough and fever,<sup>7</sup> as well as two manifestations of particular interest to the rhinologist: altered smell and taste.<sup>8,9</sup>

In view of the high likelihood that they will see patients with SARS-CoV-2 infection, it is particularly important that ENT specialists remain up to date on the management of this disease. It is common for ENT specialists to prescribe nasal irrigation with saline solution<sup>10</sup> and topical corticosteroids<sup>11</sup> to patients with upper-airway symptoms. However, the safety of these treatments in patients with COVID-19 has been called into question.<sup>9</sup>

The ENT specialist is also constantly faced with the possibility of contamination by SARS-CoV-2 when performing diagnostic and therapeutic procedures which involve manipulation of the nasopharynx.<sup>12</sup> Evidence is mounting to guide recommendations aimed at ensuring provider safety in performing these types of procedures, justifying the need for literature reviews to collate this advice and help physicians adapt their behavior during patient care to the most current evidence.

## Objective

To evaluate the safety of the rhinology practice in the era of COVID-19 in terms of three specific topics: use of masks and respirators, prescription of topical nasal therapies (saline irrigation and corticosteroids), and the performance of diagnostic and therapeutic procedures via nasal endoscopy.

## Methods

The present review of the literature was conducted in accordance with the Preferred Reporting Items for System-

atic Reviews and Meta-Analyses (PRISMA) statement. Three online databases were searched for relevant scholarly articles: PubMed, Scopus, and Cochrane Library Reviews. In addition to these databases, technical guidance from the leading Brazilian ENT society (Associação Brasileira de Otorrinolaringologia e Cirurgia Cérvico-Facial, ABORL-CCF) were also included when relevant to the understanding of the current COVID situation. ► **Tables 1, 2, 3, and 4** summarize the search queries used for each of the four questions:

- 1) Which is the safest type of mask to ensure that health care professionals are not contaminated by the airborne route?
- 2) Is it safe to prescribe nasal corticosteroids to patients with COVID-19?
- 3) Is it safe to prescribe nasal irrigation with saline solution to patients with COVID-19?
- 4) Is it safe to perform endoscopic endonasal procedures in the time of COVID-19?

The query designed to answer the first question was: (COVID-19 or SARS-CoV-2 or 2019-nCoV) and (respirator or mask or respiratory device or respiratory protective or industrial respirator or air purifying device); for the second question: (COVID-19 or SARS-CoV-2 or 2019-nCoV) and (corticosteroids or topical corticosteroids or inhaled corticosteroids or steroids or topical steroids or inhaled steroids); for the third question: (COVID-19 or SARS-CoV-2 or 2019-nCoV) and (nasal or nasal lavage or nasal washing or nasal irrigation

**Table 1** Research terms for mask use

COVID-19 or SARS-CoV-2 or 2019-nCoV	and	Respirator
COVID-19 or SARS-CoV-2 or 2019-nCoV	and	Mask
COVID-19 or SARS-CoV-2 or 2019-nCoV	and	Respiratory device
COVID-19 or SARS-CoV-2 or 2019-nCoV	and	Respiratory protective
COVID-19 or SARS-CoV-2 or 2019-nCoV	and	Industrial respirator
COVID-19 or SARS-CoV-2 or 2019-nCoV	and	Air-purifying device

Abbreviations: 2019-nCoV, 2019 novel coronavirus; COVID-19, coronavirus disease 2019; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

**Table 2** Research terms for nasal corticosteroids

COVID-19 or SARS-CoV-2 or 2019-nCoV	And	Corticosteroids
COVID-19 or SARS-CoV-2 or 2019-nCoV	And	Topical corticosteroids
COVID-19 or SARS-CoV-2 or 2019-nCoV	And	Inhaled corticosteroids
COVID-19 or SARS-CoV-2 or 2019-nCoV	And	Steroids
COVID-19 or SARS-CoV-2 or 2019-nCoV	And	Topical steroids
COVID-19 or SARS-CoV-2 or 2019-nCoV	And	Inhaled steroids
COVID-19 or SARS-CoV-2 or 2019-nCoV	And	Topical steroids
COVID-19 or SARS-CoV-2 or 2019-nCoV	And	Inhaled steroids

Abbreviations: 2019-nCoV, 2019 novel coronavirus; COVID-19, coronavirus disease 2019; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

**Table 3** Research terms for procedures

COVID-19 or SARS-CoV-2 or 2019-nCoV	And	Endonasal
COVID-19 or SARS-CoV-2 or 2019-nCoV	And	Sinus surgery
COVID-19 or SARS-CoV-2 or 2019-nCoV	And	Endoscopic skull base
COVID-19 or SARS-CoV-2 or 2019-nCoV	And	ENT surgery
COVID-19 or SARS-CoV-2 or 2019-nCoV	And	Otolaryngology procedures
COVID-19 or SARS-CoV-2 or 2019-nCoV	And	Nasal endoscopy
COVID-19 or SARS-CoV-2 or 2019-nCoV	And	Endoscopy
COVID-19 or SARS-CoV-2 or 2019-nCoV	And	Laryngoscopy

Abbreviations: 2019-nCoV, 2019 novel coronavirus; COVID-19, coronavirus disease 2019; ENT, ear, nose, and throat; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

or saline or saline washing or saline lavage or saline irrigation); and, for the fourth question: (COVID-19 or SARS-CoV-2 or 2019-nCoV) and (endonasal or sinus surgery or endoscopic skull base or ENT surgery or otolaryngology procedures or nasal endoscopy or endoscopy or laryngoscopy).

Articles published in languages other than English or Portuguese were excluded from the search results. In addition, incomplete articles and/or those not available for full-text reading were excluded. Letters to the editor and Comments were not considered for the review. The following variables were extracted from the selected articles: journal, main country where the study was conducted, study design, results, and conclusions.

## Results

### Safety of Mask-wearing in the Context of COVID-19

The search query initially returned 1,146 records. After the removal of duplicates, 763 articles remained. Of these, only 156 were retained for full-text reading after title and/or abstract screening. After full-text reading, only 13 articles were considered relevant to the specific topic of this review. ►Fig. 1 summarizes the article screening flow in accordance with the PRISMA statement.

Bartoszko et al.<sup>13</sup> conducted a meta-analysis to assess whether N95 respirators were superior to surgical masks to prevent contagion. They based their analysis on four studies, but most addressed patients with the influenza virus; only one study focused on coronaviruses in general (not SARS-CoV-2 specifically). The authors concluded that surgical masks did not appear to be inferior to N95 respirators in preventing contamination, but did recognize that one of the main biases of the study was the inclusion of studies involving several types of viruses rather than the coronavirus family alone.

Boškosi et al.<sup>14</sup> and Ha<sup>15</sup> conducted non-systematic reviews on the use of surgical masks and N95 respirators in the context of epidemics of influenza and other viruses, seeking to ascertain the superiority of one type of mask over the other; the potential superiority of the powered air-purifying respirator (PAPR) was also assessed. The authors

**Table 4** Research terms for nasal douching

COVID-19 or SARS-CoV-2 or 2019-nCoV	And	Nasal
COVID-19 or SARS-CoV-2 or 2019-nCoV	And	Nasal lavage
COVID-19 or SARS-CoV-2 or 2019-nCoV	And	Nasal washing
COVID-19 or SARS-CoV-2 or 2019-nCoV	And	Nasal irrigation
COVID-19 or SARS-CoV-2 or 2019-nCoV	And	Saline
COVID-19 or SARS-CoV-2 or 2019-nCoV	And	Saline washing
COVID-19 or SARS-CoV-2 or 2019-nCoV	And	Saline lavage
COVID-19 or SARS-CoV-2 or 2019-nCoV	And	Saline irrigation

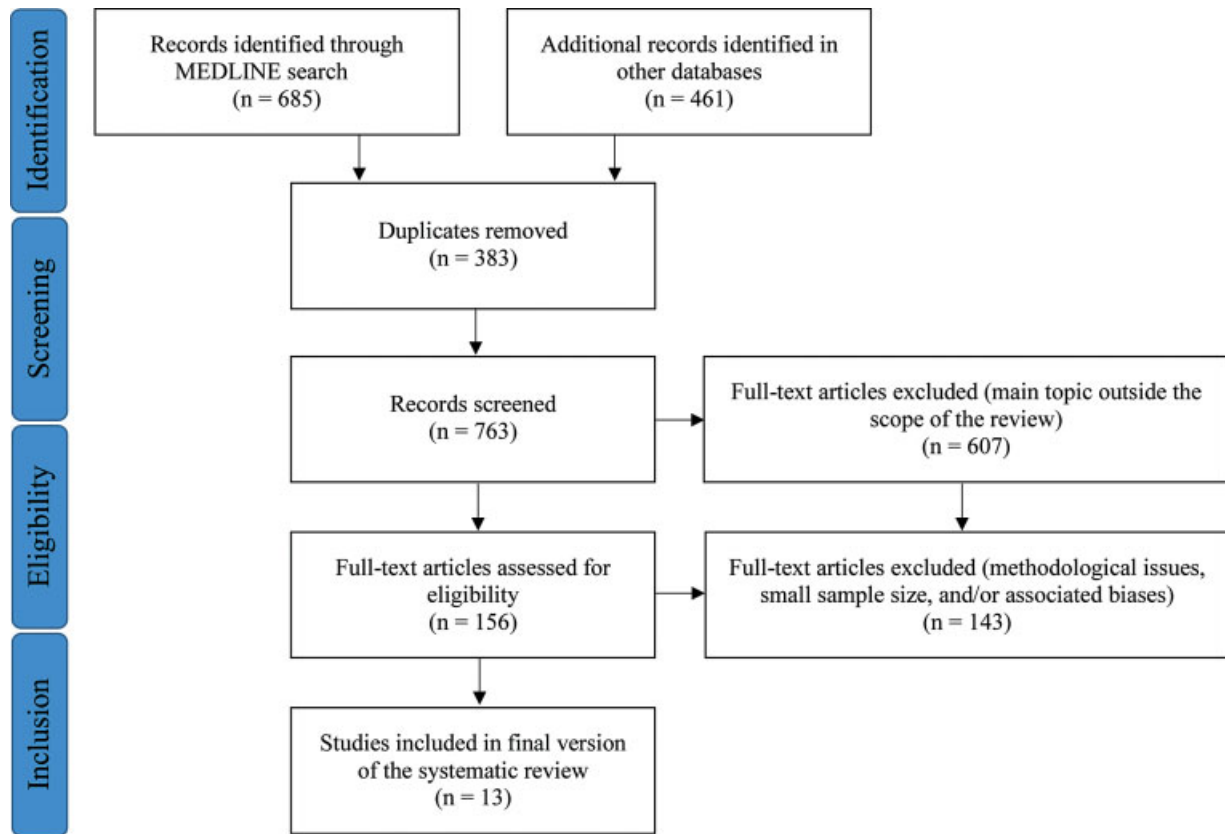
Abbreviations: 2019-nCoV, 2019 novel coronavirus; COVID-19, coronavirus disease 2019; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

concluded that there are no consistent data to confirm the superiority of N95 respirators over surgical masks. Conversely, PAPR devices provided 99% filtration, but were deemed expensive, and would require highly trained individuals to avoid contamination when donning and doffing the device.

In two simple reviews without meta-analysis, Iannone et al.<sup>16</sup> and MacIntyre et al.<sup>17</sup> argued that, in the more recent literature on non-SARS-CoV-2 coronaviruses, a certain degree of benefit in the use of N95 respirators over simple masks was found; however, the differences were not significant, leading the authors to conclude that there is no evidence to definitively recommend one type of mask over the other in protecting against contamination by SARS-CoV-2. On the other hand, this stance has been strongly criticized by authors such as Ippolito et al.<sup>18</sup> and Garcia Godoy et al.,<sup>19</sup> who cited a small number of articles showing the superiority of N95 respirators during medical procedures and even in simple contact with infected patients. Although these studies indeed did not report statistically significant differences, these authors argued that, when in doubt as to which type of mask would be superior, one should err on the side of caution and recommend the use of N95 respirators for all health professionals.

Mick et al.,<sup>20</sup> Bann et al.,<sup>21</sup> and Lammers et al.<sup>22</sup> conducted systematic reviews specifically on the use of personal protective equipment (PPE) by ENT specialists in the age of COVID-19. All 3 studies reported that SARS-CoV-2 can remain in aerosol form for up to 3 hours, and that, as the importance of aerosols in the transmission of COVID-19 is still unknown, health professionals should wear N95 respirators as a precaution. In addition, when performing high-risk aerosol-generating procedures (such as extensive manipulation of the nasal/oral mucosa), a higher level of PPE (N95 respirator + face shield + goggles) or PAPR device should be worn.

Finally, several authors wrote procedural recommendations and reviewed the literature on mask decontamination, due to the constant need for reuse of masks and respirators to prevent a collapse of the PPE supply. Ma et al.<sup>23</sup> advocated for the use of water vapor, demonstrating that, after 30 minutes of steam exposure, masks are satisfactorily decontaminated



**Fig. 1** Article screening flow in accordance with the PRISMA statement - mask use.

while maintaining adequate filtration and protection capacity. Kim et al.<sup>24</sup> conducted an experimental study using aerosolized potassium chloride (KCl) particles and demonstrated that, after autoclaving at 121°C at 15 atm for 15 minutes, N95 respirators maintained their filtration efficiency.

The most comprehensive work on decontamination of N95 respirators to date has been performed by Liao et al.,<sup>25</sup> who compared several methods: bleach solution, 70% alcohol, water vapor, and ultraviolet (UV) radiation. The authors concluded that liquid-based methods, such as bleach solution and 70% alcohol, dramatically decrease the filtration effectiveness of respirators, and are thus contraindicated for routine use. Water vapor proved to be both efficient and safe, with respirators maintaining good filtration capacity after several sterilization cycles. Ultraviolet radiation was also able to sterilize the outer surface of the mask while maintaining its ability to filter particles. However, the authors speculated about the true ability of UV waves to penetrate all layers of the N95 respirator and actually sterilize it, noting that additional studies would be needed to prove the effectiveness of this form of decontamination.

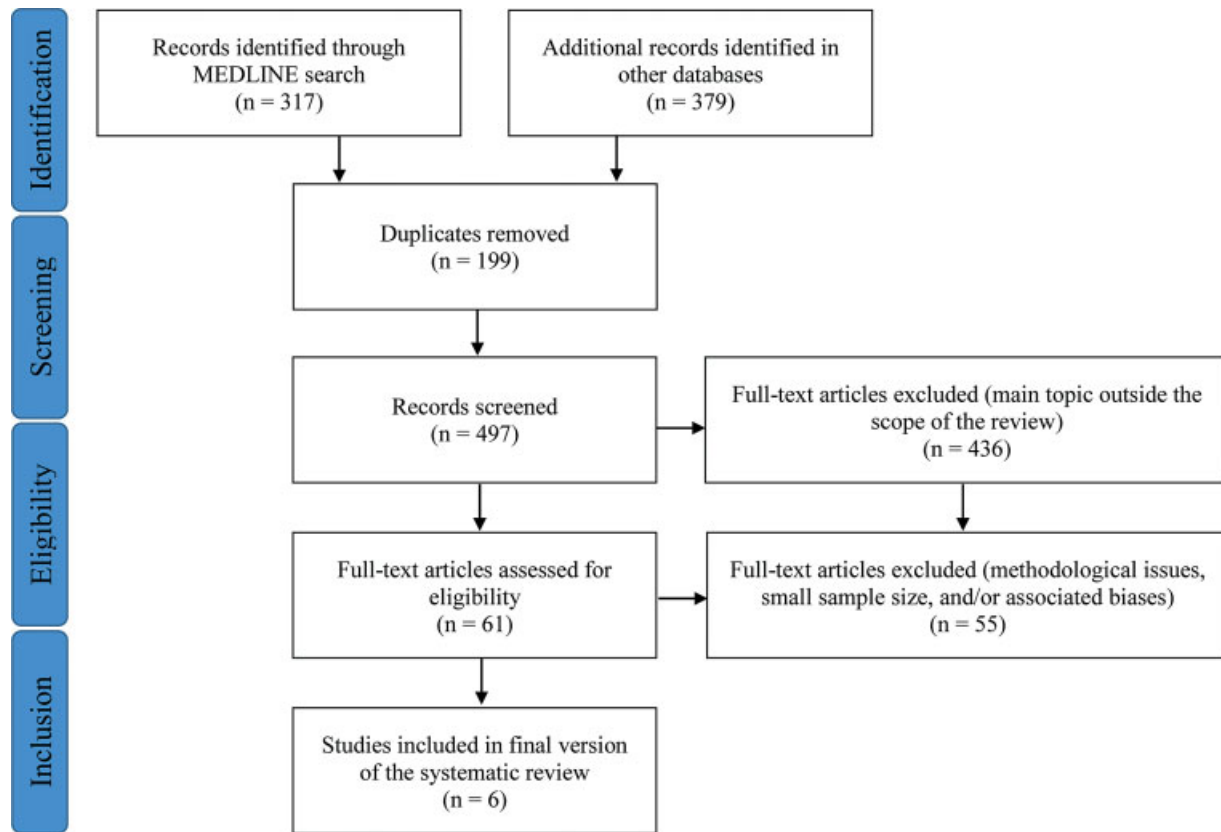
### Safety of Nasal Corticosteroids in the Context of COVID-19

The search query initially returned 696 records. After removal of duplicates, 497 articles remained. Following a close screening of titles and abstracts, 61 articles were retained for

full-text reading. After careful reading of these studies in full, 6 articles were selected for inclusion in the review (as shown in ► Fig. 2).

Gong et al.<sup>26</sup> performed a retrospective study to evaluate the influence of corticosteroids (methylprednisolone) on the progression of the radiological signs of COVID-19 pneumonia and on the duration of polymerase chain reaction (PCR) positivity for SARS-CoV-2 in nasopharyngeal swab specimens. Aware of their various biases (lack of a control group, no standardization of methylprednisolone dose or duration), the authors concluded that the use of corticosteroids did not cause worsening of the radiological signs of pneumonia, but the duration of PCR positivity was indeed longer in the steroid-treated group. Nevertheless, the authors themselves recognize that this finding may be due to the presence of non-infectious virions. Similar findings were reported in another systematic review with meta-analysis performed by Li et al.,<sup>27</sup> who also concluded that the duration of PCR positivity for SARS-CoV-2 in nasopharyngeal swabs was longer in patients who received corticosteroids.

Jian et al.<sup>28</sup> conducted a non-systematic review of 10 articles on the pathophysiology of SARS-CoV-2 infection and how topical corticosteroids could influence this process. It is known that the virus infects cells by using its spike (S) protein to bind to angiotensin-converting enzyme (ACE) receptors, which are present in large quantities on the surface of airway cells. The reviewed articles demonstrated that patients with chronic rhinosinusitis with nasal polyps



**Fig. 2** Article screening flow in accordance with the PRISMA statement - nasal corticosteroids.

underexpress the ACE receptor in their nasal mucosa (whether this is causally related to the prolonged use of topical corticosteroids or to chronic rhinosinusitis itself is unknown). Thus, the authors postulate that more studies are needed to assess the possible effect of topical corticosteroids in the initial stages of SARS-CoV-2 infection.

Hasan et al.<sup>29</sup> conducted a non-systematic review of 62 articles on the use of inhaled corticosteroids in the context of COVID-19. Although the evidence is not robust, according to yet-unpublished data compiled by the authors, some corticosteroids could have beneficial effects in hindering the invasion of respiratory epithelial cells by SARS-CoV-2; specifically, ciclesonide and mometasone would inhibit non-structural protein 15, which is responsible for cleaving and activating the viral spike protein. The authors also note that budesonide significantly reduces SARS-CoV-2 replication *in vitro*, through mechanisms that are still poorly understood.

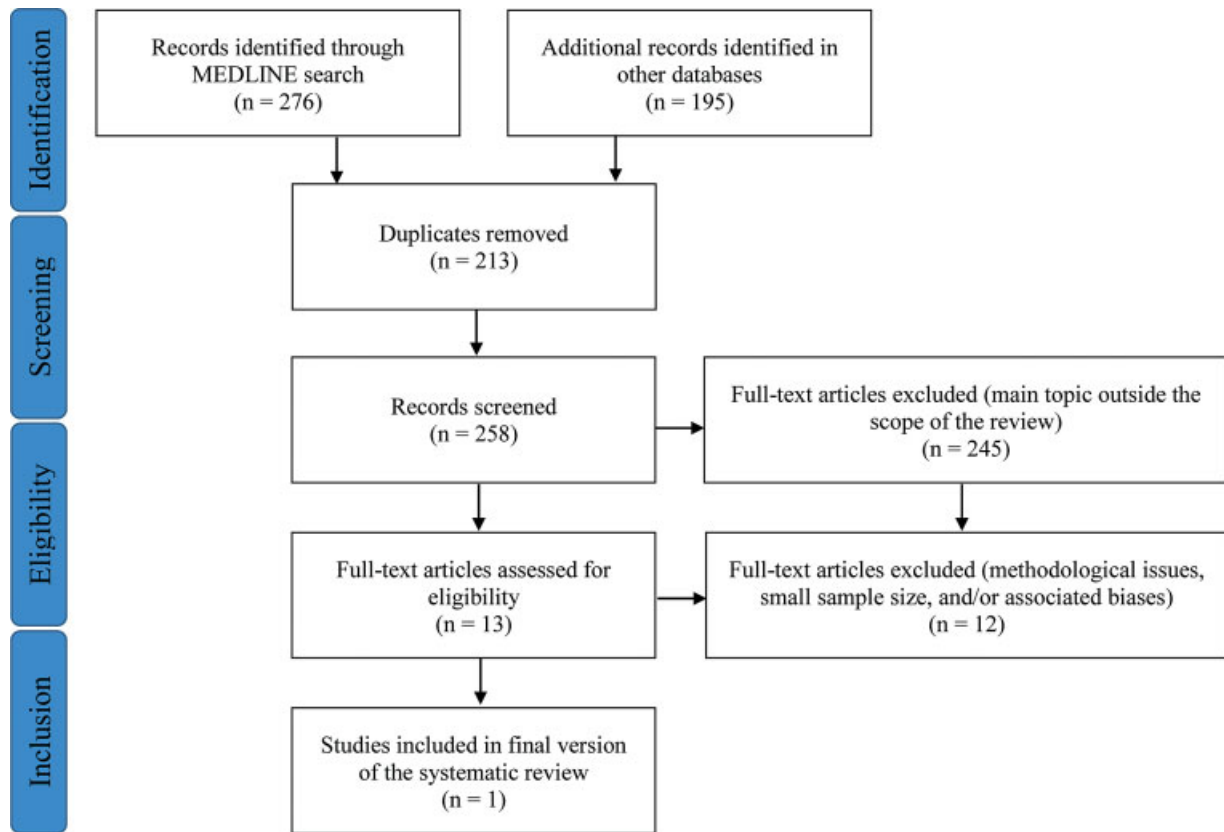
Herman et al.<sup>30</sup> published a consensus statement on the prescription of corticosteroids by ENT specialists in the context of COVID-19. After a non-systematic review of the literature, they concluded that, due to an absence of robust evidence, systemic corticosteroids are justified only in patients with severe Bell palsy (House-Brackmann grades V or VI) and severe or profound sudden hearing loss. Regarding the use of topical corticosteroids, the authors conclude that the current evidence is insufficient to indicate these drugs in any situation, especially in the acute anosmia that often occurs in COVID-19.

In its fourth guidance note to ENT specialists on patient management during the COVID-19 pandemic, ABORL-CCF<sup>9</sup> stresses that the use of topical nasal corticosteroids in acute viral conditions conflicts with current guidelines, and should be avoided in acute infections of the upper airways in the context of the COVID-19 pandemic.

### Safety of Nasal Irrigation with Saline Solution in the Context of COVID-19

The search query initially returned 471 records. After the removal of duplicates, 258 articles remained. After careful screening of titles and/or abstracts, 13 articles remained. Following full-text reading, only one article was considered to fall within the scope of the present review (→ Fig. 3).

In the aforementioned article, Ramalingam et al.<sup>31</sup> reassessed data from the 2015 Edinburgh and Lothians Viral Intervention Study (ELVIS), which included 66 patients and studied the use of hypertonic solution (nasal irrigation and gargling) in airway infections caused by several viruses. The ELVIS found superiority of the intervention in terms of decreased symptom duration, decreased secondary infection of family members, and shorter viral excretion time. The 2020 review reassessed these findings with a focus on patients infected with  $\alpha$  and  $\beta$  coronaviruses (8 individuals in the control group, which did not use hypertonic saline, and 7 individuals in the intervention group). Those patients who performed nasal irrigation with hypertonic saline solution had a statistically significant



**Fig. 3** Article screening flow in accordance with the PRISMA statement - nasal saline irrigation.

decrease in hoarseness and nasal congestion. However, there were no data on symptom duration, number of infected family members, and duration of viral excretion specifically in the subgroup of patients infected with  $\alpha$  and  $\beta$  coronaviruses.

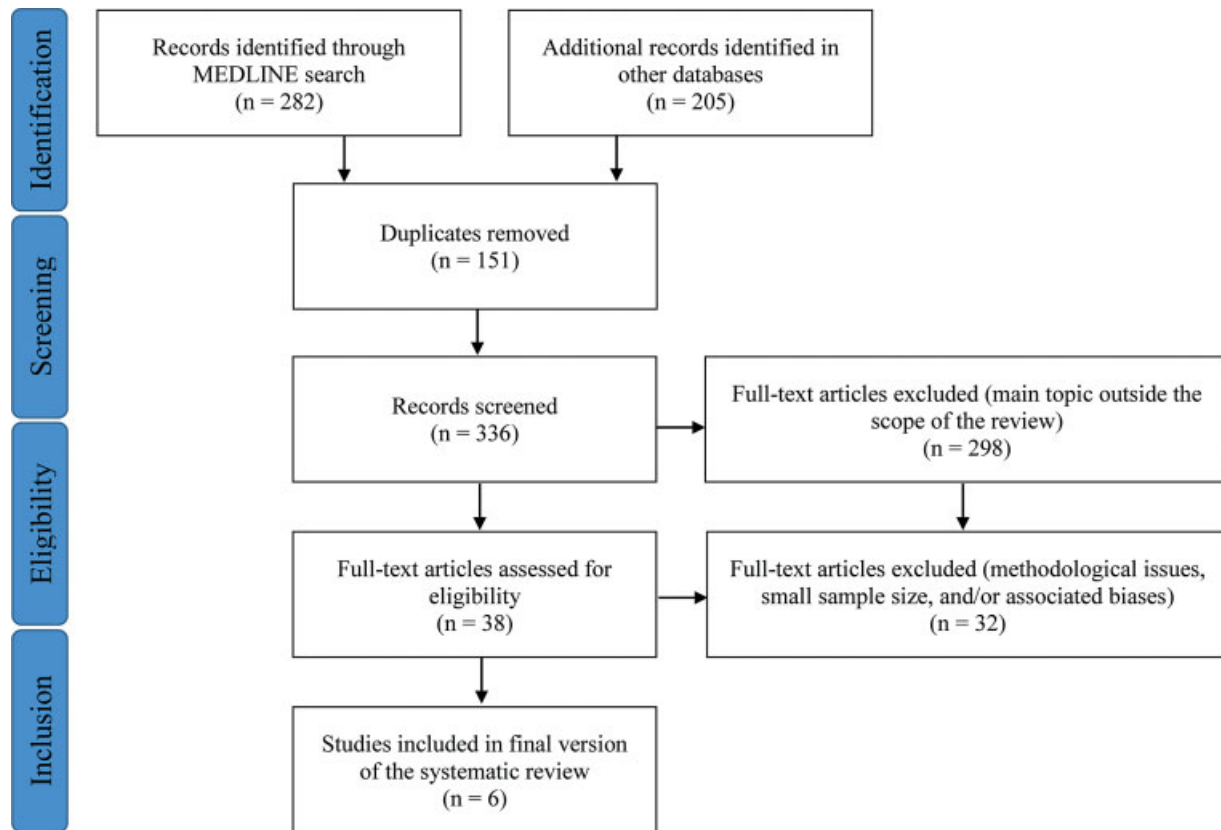
### Safety of Endoscopic Endonasal Procedures in the Context of COVID-19

The initial search query (►Table 4) returned 487 records. After the removal of duplicates, 336 articles remained. After screening of titles and abstracts, 38 of these were selected for full-text reading. Following a judicious analysis of these full-text articles (►Fig. 4), we found that only 6 were relevant to and fell within the scope of the present review.

In a series of three articles,<sup>32–34</sup> Workman et al. evaluated the safety of endoscopic endonasal procedures during the COVID-19 pandemic. Initially, the researchers simulated potential clinical situations with volunteers, and performed endoscopic endonasal procedures on cadavers using a 0-degree scope. To evaluate particle dispersion during such procedures, an UV light filter was used to visualize fluorescein-labeled particles (the fluorescein solution was atomized into the entire nasal cavity, resulting in particles with a size of 30–100  $\mu\text{m}$ ). In outpatient conditions, the simulated sneeze generated a maximum particle distribution within 30 cm, extending as far as 66 cm. Both a standard surgical mask and a modified valved endoscopy of the nose and throat (VENT) mask eliminated all detectable droplet propagation.

In surgical conditions, cold-steel instrumentation and the use of a suction microdebrider (for 10 seconds) did not generate any detectable particles. On the other hand, the use of a high-speed bur produced significant environmental contamination by fluorescein-labeled aerosol particles. According to the authors,<sup>32</sup> the study had a major limitation in relation to the size of the generated particles, which were in droplet range and not consistent with aerosolized particle sizes.

In the second article in the series,<sup>33</sup> the authors used a particle sizer (a device which counts flow of particles up to 10  $\mu\text{m}$  in size) to assess aerosol generation during rhinologic procedures. Again, outpatient procedures were tested on live volunteers (speech, simulated sneezing, and nasal endoscopy), while surgical procedures (nasal endoscopy, hand instrumentation with nonpowered instruments, and use of a microdebrider, electrocautery, and high-speed drills) were tested in cadavers. All clinical procedures generated a significant amount of aerosols, but no more than regular speech did. Simulated sneezing generated the largest amount of aerosols; however, when the patient was wearing an N95 respirator (valved or unvalved), aerosol generation was completely abolished. The same result was not achieved with the use of a standard surgical mask. Regarding surgical procedures, the researchers concluded that nasal endoscopy, nonpowered instrumentation, and microdebridement did not generate significant levels of aerosolized particles. Conversely, use of high-speed drills and of electrocautery caused significant aerosol generation.



**Fig. 4** Article screening flow in accordance with the PRISMA statement - endoscopic endonasal procedures.

In their last article on this topic, Workman et al.<sup>34</sup> describe the use of continuous nasopharyngeal suctioning as a way of mitigating the generation of aerosolized particles in sino-nasal endoscopic surgery. Using cadaver models, the authors simulated aerosol generation with the same method described in the previous article. To perform continuous suctioning of the nasal cavity, a rigid suction probe was placed in the nasopharynx contralateral to the nostril through which the endonasal procedures were being performed. During electrocautery and high-speed drilling, simultaneous nasopharyngeal suctioning significantly decreased aerosol production to levels comparable to those in the normal environment. The authors postulated that this finding may be due to changes in nasal aerodynamics once suction is introduced in the most posterior region of the nasopharynx.

Sharma et al.<sup>35</sup> investigated droplet splatter patterns during endoscopic endonasal procedures performed on cadavers. The nasal cavity was saturated with fluorescein, and droplet spread was then visualized under UV light. No droplets or splatter were observed during cold-steel instrumentation or use of an ultrasonic aspirator. Use of a microdebrider for 10 minutes during functional endoscopic sinus surgery (FESS) and high-speed drilling were associated with droplet spread. However, simultaneous suction while drilling resulted in no droplets or splatter. The limitations of the study included no assessment of forced aerosolization (such as during sneezing) and the fact that droplets and splatter were visualized only with the naked eye.

David et al.<sup>36</sup> evaluated droplet and aerosol spread in four patients who underwent endonasal and/or transoral surgery using a negative pressure “viral isolation drape,” consisting of a clear plastic chamber encasing the surgical field to which a smoke evacuator is attached. The use of the microdebrider, high-speed drill, and electrocautery was evaluated. The surgical field was examined under UV light before and after the procedure to detect fluorescein. Minimal contamination was observed, except during high-speed drilling, after which droplets were found under the isolation barrier and at the tip of the smoke evacuator. The authors stress that particular attention is warranted in the manipulation of instruments and cottonoids, which appeared to contribute more to contamination of the surgical field.

Taha et al.<sup>37</sup> evaluated the effectiveness of a “provider protection protocol” in reducing the incidence of infection among otolaryngologists and other providers. The protocol was used in 152 diagnostic and surgical procedures (17% COVID-positive, 75% COVID status unknown) over a 5-week period. For surgical procedures, urgent cases were tested 24 hours in advance, and emergencies were considered COVID-positive. All providers wore a P100 respirator, goggles, face shields, surgical gowns, and gloves. Outpatient procedures followed the same measures, with added scheduling of appointments at a minimum of 30-minute intervals, symptom screening, and temperature measurement. All providers were tested by PCR and SARS-CoV-2 serology at the end of the study; there were zero infections.

## Discussion

### Safety of Mask-wearing in the Context of COVID-19

As explained, opinions on mask-wearing in the context of possible SARS-CoV-2 transmission differ in the current literature. Some authors<sup>12–14</sup> believe there is no robust theoretical framework to support the mandatory use of N95 respirators, as there are no studies demonstrating the clear superiority of this PPE model over plain surgical masks. However, other authors<sup>15–18</sup> argue that the few individual articles focusing specifically on mask-wearing to protect against other coronaviruses, which have shown a small benefit of N95 respirators over surgical masks, would already justify the use of this level of PPE.

In the ENT-specific literature, there is no clear evidence to support the strict use of N95 respirators. However, as SARS-CoV-2 can remain viable in the environment for up to 3 hours in aerosol form,<sup>20</sup> several authors<sup>19–21</sup> unanimously advise the use of N95 respirators, since ENT procedures generally involve airway manipulation and pose a risk of aerosol generation. The second<sup>38</sup> and third<sup>39</sup> guidance notes to otorhinolaryngologists issued by ABORL-CCF reinforce this understanding, recommending the use of N95 respirators during physical and endoscopic examinations, in addition to supplemental PPE, including eye protection, scrub caps, gloves, and a gown or apron.

There is also debate regarding the need to wear PAPR for procedures with a high risk of aerosol generation, such as high-speed drilling during endonasal surgery. This speculation is attributable to a single report from China<sup>34</sup> in which 14 providers are alleged to have been contaminated during a single endonasal skull-base access procedure. However, these specific reports are difficult to validate, and it has been suggested that most of the contaminated providers were not actually involved in the surgical procedure, but rather in other settings and at other times during care of the patient; furthermore, not all wore N95 respirators correctly.<sup>21</sup> The fourth ABORL-CCF guidance note<sup>9</sup> to otorhinolaryngologists, released before the knowledge that these health professionals were possibly contaminated in scenarios other than the operating room, recommended the use of PAPR for sinonasal surgery during the COVID-19 pandemic.<sup>9</sup> However, with the current level of knowledge about aerosol spread during sinonasal surgical procedures, it can be inferred that there is no robust basis for the absolute requirement of PAPR during rhinologic procedures, in addition to the known disadvantages of these devices, such as high cost and risk of contamination while doffing. Therefore, a PPE complement consisting of an N95 respirator, eye/face protection, scrub cap, gloves, and gown/apron would be sufficient for adequate protection of the ENT specialist.

In view of the growing demand for PPE, the debate on respirator reuse seems valid. Several methods have been proposed for their decontamination; of these, liquid-based methods (70% alcohol, sodium hypochlorite solution) are contraindicated because they greatly reduce respirator filtration efficiency.<sup>24</sup> Methods such as using water vapor for

30 minutes and autoclaving are safe and allow N95 respirators to be reused.<sup>22,23</sup>

### Safety of Nasal Corticosteroids in the Context of COVID-19

Corticosteroid use generally remains a major controversy in the treatment of COVID-19. Initial reports on the management of infected patients showed evidence of harm from steroids, including prolonged nasopharyngeal PCR swab positivity for SARS-CoV-2,<sup>26,27</sup> longer hospital stay, a higher rate of secondary infections, and higher mortality as compared with patients who did not receive corticosteroids.<sup>26</sup> However, the authors of these studies themselves admit to several biases, particularly regarding the lack of standardization of therapy and the fact that steroids are usually given to patients who already have severe COVID-19, in a last-ditch attempt at rescue.

There is still no evidence regarding the use of topical corticosteroids in COVID-19. To date, there have been no controlled experimental studies to assess the natural history of COVID-19 in patients receiving topical corticosteroids. However, there are several reports on the *in vitro* effect of these medications and theoretical mechanisms of action whereby they would hinder binding of SARS-CoV-2 to respiratory epithelial cells. In this respect, budesonide, mometasone, and ciclesonide have the greatest potential for *in vivo* effect.<sup>28,29</sup>

We found no evidence that the use of topical corticosteroids could in any way lead to adverse outcomes in patients with COVID-19. When these drugs are indicated due to a comorbid sinonasal condition, their use can be considered.

### Safety of Nasal Irrigation with Saline Solution in the Context of COVID-19

Nasal irrigation with saline solution is widely prescribed for patients with viral upper respiratory tract infections (URTIs) to provide symptom relief, loosen secretions, and prevent secondary bacterial complications.<sup>9,10</sup> However, a Cochrane systematic review<sup>40</sup> published in 2015 demonstrated that there is little scientific evidence to corroborate the effectiveness of saline irrigation in reducing symptom intensity and disease duration in patients with URTIs; the only evidence comes from small, low-quality clinical trials, which enrolled few participants and evaluated widely different outcomes. For this reason, saline irrigation is merely mentioned as an option for the treatment of these infections in the most recently published guidelines for the management of patients with rhinosinusitis.<sup>11,41</sup>

The only article<sup>31</sup> on the topic considered suitable for inclusion in the present systematic review describes a review of data already published on the use of nasal irrigation in viral URTIs. The authors of the review conclude that patients infected with common cold-causing coronaviruses who performed nasal irrigation as part of a treatment protocol did not have worse outcomes than patients who did not perform irrigation, and indeed experienced improvement in some clinical parameters. However, there was no between-group



comparison of outcomes such as secondary infection of household contacts—one of the main fears regarding the theoretical dispersion of viral particles caused by saline irrigation of the nasal cavity. In the original study, which included patients with respiratory infections caused by a wide variety of viruses (rhinoviruses, alphacoronaviruses, and betacoronaviruses), there was no increase in the secondary attack rate among household contacts of the saline irrigation group. Nevertheless, the authors themselves recognized several biases in this study, and difficulties in applying their findings to the context of COVID-19 (post-hoc analysis, no direct comparison using SARS-CoV-2). In view of these findings, we conclude that nasal irrigation with saline solution does not pose an increased risk of adverse outcomes, and may even be beneficial. However, as the possibility of onward transmission to household contacts cannot be ruled out, care must be taken to sanitize the environment and the bottle or pot used for irrigation.

### Safety of Endoscopic Endonasal Procedures in the Context of COVID-19

Early in the pandemic, endonasal endoscopy and nasal surgery were considered high-risk procedures for SARS-CoV-2 transmission, as they are potentially aerosol-generating, and due to the high viral load measured in the nasal cavity even of asymptomatic patients.<sup>42</sup> Although the virus remains viable in aerosol form for up to three hours and on plastic and metal surfaces for much longer,<sup>20,21</sup> transmission via the aerosol route or via contact with surfaces is not yet well established.<sup>43</sup>

Based on an initial report<sup>44</sup> that endonasal skull-base surgery might have infected a large number of health professionals, several rhinology and skull-base centers recommended the discontinuation of elective procedures, postponement of cancer surgery,<sup>44</sup> bans on microdebridement and high-speed drilling,<sup>45</sup> PAPR use when treating COVID-positive patients,<sup>20</sup> and even changes in access route, such as external drainage of orbital abscesses and transcranial approaches to sellar tumors.<sup>46,47</sup> However, as previously stated, such reports are difficult to validate, and further analysis of the case suggests that the majority of the infected providers were not actually involved in the surgical procedure, but rather were contaminated at other moments during patient care, and that not all were wearing N95 respirators properly.<sup>21</sup>

Nasal endoscopy per se can be considered an aerosol-generating procedure merely because it induces sneezing and coughing.<sup>32,33</sup> Conversely, endoscopic endonasal surgery has a low potential for aerosol generation when limited to cold-steel instrumentation and microdebridement with concurrent ultrasonic suctioning. High-speed drilling and use of the electrocautery are indeed associated with a greater risk of droplet and aerosol spread,<sup>32–34</sup> but the generation of aerosolized particles was entirely abrogated by simultaneous suctioning of the nasopharynx.<sup>34</sup> In one study,<sup>35</sup> the use of a proposed negative-pressure isolation chamber minimized contamination beyond the operative field. In a large series of ENT procedures (including

endonasal surgeries), most performed in patients with confirmed SARS-CoV-2 infection or unknown COVID status, there were zero cases of transmission to providers when the latter wore full PPE consisting of P100 respirators, eye and face protection, aprons/gowns, and gloves.<sup>36</sup> Nosocomial SARS-CoV-2 infections appear to occur while doffing PPE, when the hands, eyes, and nose come into contact with contaminated surfaces.<sup>48</sup> Current evidence on droplet and aerosol generation during sinonasal procedures allows us to infer that they are relatively safe for the ENT surgeon, provided that the surgical team is adequately protected by the aforementioned PPE.

### Conclusion

Having reviewed the evidence currently available in the literature, we conclude that ENT specialists should wear N95 respirators while performing their clinical duties to ensure adequate protection against aerosolized particles, since plain surgical masks only provide definitive protection against droplets. There is no indication for PAPR devices. When reuse of respirators becomes a necessity due to extreme PPE shortages, physical decontamination methods such as autoclaving and steam sterilization should be used instead of substance-based methods such as cleaning with 70% alcohol or bleach.

There is no robust evidence that nasal corticosteroids might harm patients with COVID-19. Therefore, they can be used and prescribed in the presence of concurrent sinonasal conditions that would benefit from their local anti-inflammatory effect. Furthermore, chronic users of topical corticosteroids should continue using them as prescribed even if they contract COVID-19.

Regarding nasal irrigation with saline solution, there is no specific evidence related to COVID-19. However, extrapolation of data from other coronaviruses shows that there is no risk of worse outcomes, and some potential for benefit. Although there does not appear to be any risk of increased transmission to household contacts, particular care in sanitizing the environment and the bottle or pot used for irrigation is recommended.

All patients should be tested for COVID-19 by PCR of a nasopharyngeal swab specimen prior to endoscopic endonasal procedures. If diagnostic testing for COVID-19 is unavailable or infeasible, the patient should be considered potentially infected and treated as such. Endoscopic endonasal procedures, including diagnostic nasal endoscopy, must be performed in full PPE, including apron/gown, scrub cap, gloves, an N95 (or better) respirator, and eye protection (sealed goggles or face shield). Personal protective equipment must be worn as long as the provider is in the procedure or operating room. Continuous concurrent suctioning of the nasopharynx during endonasal surgery can minimize or even abrogate aerosol dispersion. Contrary to widespread belief early in the pandemic, there does not appear to be an unusually heightened risk of contamination of the surgical team, as long as appropriate PPE is worn, and proper care is taken.

### Conflict of Interests

The authors have no conflict of interests to declare.

### References

- Liu YC, Kuo RL, Shih SR. COVID-19: The first documented coronavirus pandemic in history. [published online ahead of print, 2020 May 5] *Biomed J* 2020;43(04):328–333. Doi: 10.1016/j.bj.2020.04.007
- WHO, World Health Organization. Weekly epidemiological update—5 January 2021. Accessed 5 January 2021 online: [https://www.who.int/docs/default-source/coronaviruse/situation-reports/20210105-weekly\\_epi\\_update\\_21.pdf](https://www.who.int/docs/default-source/coronaviruse/situation-reports/20210105-weekly_epi_update_21.pdf)
- Brazilian Ministry of Health. Brazil. Relatório epidemiológico - COVID-19 no Brasil. Accessed 5 January 2021 online: <https://covid.saude.gov.br>
- The Lancet. COVID-19: protecting health-care workers. *Lancet* 2020;395(10228):922. Doi: 10.1016/S0140-6736(20)30644-9
- Tysome JR, Bhutta MF. COVID-19: Protecting our ENT Workforce. *Clin Otolaryngol* 2020;45(03):311–312. Doi: 10.1111/coa.13542
- Hu Z, Song C, Xu C, et al. Clinical characteristics of 24 asymptomatic infections with COVID-19 screened among close contacts in Nanjing, China. *Sci China Life Sci* 2020;63(05):706–711. Doi: 10.1007/s11427-020-1661-4
- Yang W, Cao Q, Qin L, et al. Clinical characteristics and imaging manifestations of the 2019 novel coronavirus disease (COVID-19): A multi-center study in Wenzhou city, Zhejiang, China. *J Infect* 2020;80(04):388–393. Doi: 10.1016/j.jinf.2020.02.016
- Reinhard A, Ikonomidis C, Broome M, Gorostidi F. Anosmia and COVID-19. *Rev Med Suisse* 2020;16(691-2):849–851
- ABORL-CCF. Associação Brasileira de Otorrinolaringologia e Cirurgia Cérvico-Facial. 4ª nota de orientação aos médicos otorrinolaringologistas em relação à doença causada pelo novo coronavírus (Covid-19). Accessed 29 June 2020 online: [https://www.aborlccf.org.br/secao\\_detalhes.asp?s=51&id=5951](https://www.aborlccf.org.br/secao_detalhes.asp?s=51&id=5951)
- Kanjanawasee D, Seresirikachorn K, Chitsuthipakorn W, Snidwongs K. Hypertonic Saline Versus Isotonic Saline Nasal Irrigation: Systematic Review and Meta-analysis. *Am J Rhinol Allergy* 2018;32(04):269–279. Doi: 10.1177/1945892418773566
- Rosenfeld RM, Piccirillo JF, Chandrasekhar SS, et al. Clinical practice guideline (update): adult sinusitis. *Otolaryngol Head Neck Surg* 2015;152(2, Suppl)S1–S39. Doi: 10.1177/0194599815572097
- Di Maio P, Traverso D, Iocca O, De Virgilio A, Spriano G, Giudice M. Endoscopic nasopharyngoscopy and ENT specialist safety in the COVID 19 era: the back endoscopy approach to the patient. [published online ahead of print, 2020 Jun 4] *Eur Arch Otorhinolaryngol* 2020;277(09):2647–2648. Doi: 10.1007/s00405-020-06093-6
- Bartoszko JJ, Farooqi MAM, Alhazzani W, Loeb M. Medical masks vs N95 respirators for preventing COVID-19 in healthcare workers: A systematic review and meta-analysis of randomized trials. *Influenza Other Respir Viruses* 2020;14(04):365–373. Doi: 10.1111/irv.12745
- Bošković I, Gallo C, Wallace MB, Costamagna G. COVID-19 pandemic and personal protective equipment shortage: protective efficacy comparing masks and scientific methods for respirator reuse. [published online ahead of print, 2020 Apr 27] *Gastrointest Endosc* 2020;92(03):519–523. Doi: 10.1016/j.gie.2020.04.048
- Ha JF. The COVID-19 pandemic, personal protective equipment and respirator: A narrative review. [published online ahead of print, 2020 Jun 8] *Int J Clin Pract* 2020;74(10):e13578. Doi: 10.1111/ijcp.13578
- Iannone P, Castellini G, Coclitte D, et al. The need of health policy perspective to protect Healthcare Workers during COVID-19 pandemic. A GRADE rapid review on the N95 respirators effectiveness. [published online ahead of print, 2020 Jun 3] *PLoS One* 2020;15(06):e0234025. Doi: 10.1371/journal.pone.0234025
- MacIntyre CR, Chughtai AA, Seale H, Dwyer DE, Quanyi W. Human coronavirus data from four clinical trials of masks and respirators. *Int J Infect Dis* 2020;96:631–633. Doi: 10.1016/j.ijid.2020.05.092
- Ippolito M, Vitale F, Accurso G, et al. Medical masks and Respirators for the Protection of Healthcare Workers from SARS-CoV-2 and other viruses. *Pulmonology* 2020;26(04):204–212. Doi: 10.1016/j.pulmoe.2020.04.009
- Garcia Godoy LR, Jones AE, Anderson TN, et al. Facial protection for healthcare workers during pandemics: a scoping review. [published online ahead of print, 2020 May 5] *BMJ Glob Health* 2020;5(05):e002553. Doi: 10.1136/bmjgh-2020-002553
- Mick P, Murphy R. Aerosol-generating otolaryngology procedures and the need for enhanced PPE during the COVID-19 pandemic: a literature review. [published online ahead of print, 2020 May 11] *J Otolaryngol Head Neck Surg* 2020;49(01):29. Doi: 10.1186/s40463-020-00424-7
- Bann DV, Patel VA, Saadi R, et al. Impact of coronavirus (COVID-19) on otolaryngologic surgery: Brief commentary. *Head Neck* 2020;42(06):1227–1234. Doi: 10.1002/hed.26162
- Lammers MJW, Lea J, Westerberg BD. Guidance for otolaryngology health care workers performing aerosol generating medical procedures during the COVID-19 pandemic. [published online ahead of print, 2020 Jun 3] *J Otolaryngol Head Neck Surg* 2020;49(01):36. Doi: 10.1186/s40463-020-00429-2
- Ma QX, Shan H, Zhang CM, et al. Decontamination of face masks with steam for mask reuse in fighting the pandemic COVID-19: Experimental supports. [published online ahead of print, 2020 Apr 22] *J Med Virol* 2020;92(10):1971–1974. Doi: 10.1002/jmv.25921
- Kim HP, Jo MS, Kim CH, Choi JS, Yu IJ. Re-use of health masks after autoclaving. *NanoImpact* 2020;19:100231. Doi: 10.1016/j.impact.2020.100231
- Liao L, Xiao W, Zhao M, et al. Can N95 Respirators Be Reused after Disinfection? How Many Times?. *ACS Nano* 2020;14(05):6348–6356. Doi: 10.1021/acsnano.0c03597
- Gong Y, Guan L, Jin Z, Chen S, Xiang G, Gao B. Effects of methylprednisolone use on viral genomic nucleic acid negative conversion and CT imaging lesion absorption in COVID-19 patients under 50 years old. [published online ahead of print, 2020 May 22] *J Med Virol* 2020;92(11):2551–2555. Doi: 10.1002/jmv.26052
- Li H, Chen C, Hu F, et al. Impact of corticosteroid therapy on outcomes of persons with SARS-CoV-2, SARS-CoV, or MERS-CoV infection: a systematic review and meta-analysis. *Leukemia* 2020;34(06):1503–1511. Doi: 10.1038/s41375-020-0848-3
- Jian L, Yi W, Zhang N, et al. Perspective: COVID-19, implications of nasal diseases and consequences for their management. *J Allergy Clin Immunol* 2020;146(01):67–69. Doi: 10.1016/j.jaci.2020.04.030
- Hasan SS, Capstick T, Zaidi STR, Kow CS, Merchant HA. Use of corticosteroids in asthma and COPD patients with or without COVID-19. [published online ahead of print, 2020 May 26] *Respir Med* 2020;170:106045. Doi: 10.1016/j.rmed.2020.106045
- Herman P, Vincent C, Parietti Winkler C, et al. Consensus statement. Corticosteroid therapy in ENT in the context of the COVID-19 pandemic. [published online ahead of print, 2020 May 4] *Eur Ann Otorhinolaryngol Head Neck Dis* 2020;137(04):315–317. Doi: 10.1016/j.anorl.2020.04.014
- Ramalingam S, Graham C, Dove J, Morrice L, Sheikh A. Hypertonic saline nasal irrigation and gargling should be considered as a treatment option for COVID-19. *J Glob Health* 2020;10(01):010332. Doi: 10.7189/jogh.10.010332
- 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(07):798–805. Doi: 10.1002/alr.22577

- 33 Workman AD, Jafari A, Welling DB, et al. Airborne Aerosol Generation During Endonasal Procedures in the Era of COVID-19: Risks and Recommendations. [published online ahead of print, 2020 May 26] *Otolaryngol Head Neck Surg* 2020;163(03):465–470. Doi: 10.1177/0194599820931805
- 34 Workman AD, Xiao R, Feng A, et al. Suction mitigation of airborne particulate generated during sinonasal drilling and cautery. [published online ahead of print, 2020 Jun 18] *Int Forum Allergy Rhinol* 2020;10(10):1136–1140. Doi: 10.1002/alr.22644
- 35 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(01):145–150. Doi: 10.1177/0194599820929274
- 36 David AP, Jiam NT, Reither JM, Gurrola JG II, Aghi MK, El-Sayed IH. Endoscopic skull base and transoral surgery during COVID-19 pandemic: Minimizing droplet spread with negative-pressure otolaryngology viral isolation drape. *Head Neck* 2020;42(07):1577–1582. Doi: 10.1002/hed.26239
- 37 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(04):451–455. Doi: 10.1177/1945892420927178
- 38 ABORL-CCF. Associação Brasileira de Otorrinolaringologia e Cirurgia Cérvico-Facial. 2a nota de orientação aos médicos otorrinolaringologistas em relação à doença causada pelo novo coronavírus (Covid-19). Accessed 29 June 2020 online: [https://www.aborlccf.org.br/secao\\_detalhes.asp?s=51&id=5946](https://www.aborlccf.org.br/secao_detalhes.asp?s=51&id=5946)
- 39 ABORL-CCF. Associação Brasileira de Otorrinolaringologia e Cirurgia Cérvico-Facial. 3a nota de orientação aos médicos otorrinolaringologistas em relação à doença causada pelo novo coronavírus (Covid-19). Accessed 29 June 2020 online: [https://www.aborlccf.org.br/secao\\_detalhes.asp?s=51&id=5948](https://www.aborlccf.org.br/secao_detalhes.asp?s=51&id=5948)
- 40 King D, Mitchell B, Williams CP, Spurling GK. Saline nasal irrigation for acute upper respiratory tract infections. *Cochrane Database Syst Rev* 2015;CD006821(04):CD006821. Doi: 10.1002/14651858.CD006821.pub3
- 41 Fokkens WJ, Lund VJ, Hopkins C, et al. European Position Paper on Rhinosinusitis and Nasal Polyps 2020. *Rhinology* 2020;58(Suppl S29):1–464. Doi: 10.4193/Rhin20.600
- 42 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):1177–1179. Doi: 10.1056/NEJMc2001737
- 43 Ong SWX, Tan YK, Chia PY, et al. Air, Surface Environmental, and Personal Protective Equipment Contamination by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) From a Symptomatic Patient. [published online ahead of print, 2020 Mar 4] *JAMA* 2020;323(16):1610–1612. Doi: 10.1001/jama.2020.3227
- 44 Turri-Zanoni M, Battaglia P, Karligkiotis A, Locatelli D, Castelnuovo P. Managing care for patients with sinonasal and anterior skull base cancers during the COVID-19 pandemic. *Head Neck* 2020;42(07):1503–1506. Doi: 10.1002/hed.26257
- 45 Van Gerven L, Hellings PW, Cox T, et al. Personal protection and delivery of rhinologic and endoscopic skull base procedures during the COVID-19 outbreak. *Rhinology* 2020;58(03):289–294. Doi: 10.4193/Rhin20.119
- 46 ENT UK - British Association for Paediatric Otolaryngology (BAPO) BAPO statement on SARS Cov2 and Paediatric Otolaryngology Provision. Accessed 29 June 2020 online: <https://www.entuk.-org/covid-19>
- 47 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(01):E66–E67. Doi: 10.1093/neuros/nyaa125
- 48 Zhao C, Viana A Jr, Wang Y, Wei HQ, Yan AH, Capasso R. Otolaryngology during COVID-19: Preventive care and precautionary measures. *Am J Otolaryngol* 2020;41(04):102508. Doi: 10.1016/j.amjoto.2020.102508