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“Hot Zones” for Otolaryngologists: Assessing the geographic distribution of aerosol-generating procedures amidst the COVID-19 pandemic

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Objective: Given high COVID-19 viral load and aerosolization in the head and neck, otolaryngologists are subject to uniquely elevated viral exposure in most of their inpatient and outpatient procedures and interventions. While elective activity has halted across the board nationally, the slow plateau of COVID-19 case rates prompts the question of timing of resumption of clinical activity. We sought to prospectively predict geographical “hot zones” for otolaryngological exposure to COVID-19 based on procedural volumes data from 2013 to 2017.

Methods: Otolaryngologic CPT codes were stratified based on risk-level, according to recently published specialty-specific guidelines. Using the Medicare POSPUF database, aerosol-generating procedures (AGPs) were mapped based on hospital referral regions, against up-to-date COVID-19 case distribution data, as of April 24, 2020.

Results: The most common AGPs were diagnostic flexible laryngoscopy, diagnostic nasal endoscopy, and flexible laryngoscopy with stroboscopy. The regions with the most AGPs per otolaryngologist were Iowa City, IA, Detroit, MI, and Burlington, VT, while the states with the most COVID-19 cases as of April 24th are New York, New Jersey, and Massachusetts.

Conclusions: Our study provides a model for predicting possible “hot zones” for otolaryngologic exposure based on both COVID-19 case density and AGP-density. As the focus shifts to resuming elective procedures, these potential “hot zones” need to be evaluated for appropriate risk-based decision-making, such as “reopening strategies” and allocation of resources.

1. Introduction

With the majority of the country now in social isolation, Coronavirus disease 2019 (COVID-19) has rendered essential healthcare workers disproportionately susceptible to persistently elevated viral exposure. Viral RNA exposure and load correlate highly with severity of clinical manifestations, namely requiring ICU admission [1]. COVID-19 is transmitted through direct contact and aerosol transmission, mirroring distribution patterns described in the 2003 SARS outbreak [2].

Certain otolaryngologic procedures have very high risk of viral exposure, due to high mucosal viral load and aerosolization. While general otolaryngology examination techniques have a baseline risk of exposure to viral-dense anatomy, endoscopic examinations of the head and neck mucosa (i.e. nose, oropharynx, larynx, etc.) are considered aerosol-generating procedures with an even greater level of risk of exposure [3]. Givi et al. noted that the highest risk of head and neck procedures to the clinicians were aerosol-generating interventional procedures, including but not limited to intubation, extubation, tracheostomy care, drainage of peritonsillar abscesses, and nasal packing [3]. For these procedures, guidelines demand surgeons don N95 masks or powered air-purifying respirators (PAPR) regardless of patient presentation. This is juxtaposed with guidelines for soft tissue surgery, which recommend standard operating room personal protective equipment (PPE), such as mask, face shield, gown, and gloves. Protocols differentiating these two procedure categories have been corroborated by academic otolaryngologic societies globally [4].

Anecdotal reports note higher rates of infection in otolaryngologists in Wuhan, China compared to their colleagues in other specialties [5]. Patel et al. noted that significant numbers of doctors internationally...
have been infected and have died, potentially due to exposure to pa-
tients with high viral shedding from nasal and oropharyngeal cavities
[6]. Despite this elevated risk to otolaryngologists, protocols for
managing COVID-19-positive patients have been equivocal and have
not yet wholly adapted to procedural exposure risk. For example, re-
commendations for preoperative testing and PPE requirements have
been variable [3,6].

In light of recommendations from the Centers for Disease Control
and Prevention to prioritize urgent and emergency visits, the American
Academy of Otolaryngology-Head and Neck Surgery has temporarily
recommended the provision of only “time-sensitive” or “emergent” care
[7]. Accordingly, at the hands of local governments, many elective
procedures have ceased for weeks in an effort to limit exposure risk and
preserve resources such as PPE and hospital beds for dire circumstances
[8–10]. Following the interim cancellation of elective surgical proce-
dures, the American College of Surgeons suggested that, in order to
reopen elective surgeries, geographic areas should see sustained re-
ductions in rates of new COVID-19 cases and have adequate hospital
resources to take care of all patients sufficiently [11]. In this way, as
case numbers have begun to plateau, the resumption of clinical activity
for hospital systems nationally is on the horizon. Therefore, we sought
to geographically characterize the predicted burden of aerosol-gener-
ating otolaryngology procedures based on previously reported pro-
cedural volumes to predict areas of high-risk to otolaryngologists as
recovery plans are implemented and elective procedures resume in the
near future.

2. Methods

We utilized the Medicare Physician and Other Supplier Public Use
File (POSPUF), including annual aggregated claims data from over one
million physicians to identify all services billed by otolaryngologists
between 2013 and 2017. Data were filtered by current procedural
terminology (CPT) code and geography. Based on recently published
specialty safety guidelines, we stratified CPT codes based on risk: non-
aerosol-generating procedures versus aerosol-generating procedures
[3]. POSPUF data within the study period were imported into the
geospatial mapping software QGIS (version 3.12.1) and joined with a
shapefile of hospital referral regions (HRR) from the Dartmouth Atlas of
Healthcare [12]. Procedural volume data were then grouped into
quintiles by HRR, which approximate the local market for tertiary
healthcare services, appropriately reflecting specialized otolaryngologic
care, whose patients travel outside county boundaries for treatment. In
addition, COVID-19 case volume distribution as of April 24, 2020 was
mapped, using up-to-date geospatial mapping by the New York Times
[13]. The present study was approved for exemption status by our in-
stitution’s Institutional Review Board (STUDY20200432).

3. Results

Based on our risk stratification, approximately 1.3 million aerosol-
generating procedures (AGPs) were performed per year nationally in the
Medicare population between 2013 and 2017. The most common
were diagnostic flexible laryngoscopy (43.5%), diagnostic nasal endo-
scopy (37.3%), and flexible laryngoscopy with stroboscopy (4.8%) (Table 1). The regions with the most AGPs, in total, were Los Angeles,
CA, Boston, MA, and Philadelphia, PA, while those with the most AGPs per
otolaryngologist were Iowa City, IA, Detroit, MI, and Burlington, VT
(Table 2, Fig. 1). Conversely, the areas with the least AGPs per
otolaryngologist were Corpus Christi, TX, El Paso, TX, and Tallahassee, FL.
As of April 24th, the states with the top five highest confirmed COVID-
19 cases were New York, New Jersey, Massachusetts, California, and
Pennsylvania (Fig. 2). Regions identified as potentially highest-risk
(90th percentile) both in terms of COVID-19 density and AGP-density
include Chicago, IL, Boston, MA, Ann Arbor, MI, Detroit, MI, and Phila-
adelphia, PA (Fig. 3).

4. Discussion

Our study demonstrates that otolaryngologists are at risk of trans-
mission not only in COVID-19-dense regions, but also in areas with
uniquely high AGP case burden per otolaryngologist. These additional
“hot zones” do not correlate with population density, but rather with
low otolaryngologist per capita rates. The regions deemed potentially at
the highest risk with both high COVID-19 density and elevated AGP-
density reflect regions with major academic centers with high pro-
cedural volumes, coupled with high population density and subsequent
high COVID-19 growth rates. While the provided data only represent a
snapshot of time in this pandemic, this mapping analysis can serve as a
dynamic tool that is adaptable to constantly changing procedural vol-
umes and COVID-19 case rates for resource allocation nationwide.

As the focus shifts to resuming elective procedures in hospitals, ambu-
latory surgery centers, and outpatient clinics, we must appreciate
that otolaryngologists remain at very high risk of exposure due to their
unique susceptibility of aerosol-generating procedures. With over 85%
of otolaryngologic AGPs accounted for by outpatient ambulatory en-
doscopy, appropriate risk management of elective activity in both in-
patient and outpatient settings is paramount [3]. In this way, while
health systems across the country have instituted changes to their ap-
proach to these procedures during the pandemic, it is critical for all
institutions to re-evaluate the risk of certain procedures involving high

Table 1

| Code | Most common aerosol-generating procedures between 2013 and 2017. |
|------|-----------------------------------------------------------------|
| 31575 | Diagnostic examination of voice box using flexible endoscope |
| 31231 | Diagnostic examination of nasal passages using an endoscope |
| 31579 | Examination to assess movement of vocal cord flaps using an endoscope |

Table 2

| Rank (top 20) | HRR # | HRR State | HRR Name/City | Total # AGPs (13–17 avg) | # ENTs per HRR (13–17 avg) | # AGPs per ENT (13–17 avg) |
|---------------|-------|-----------|---------------|--------------------------|----------------------------|----------------------------|
| 1             | 194   | IA        | Iowa City     | 1,799                    | 24                         | 76.44                       |
| 2             | 234   | MI        | Detroit       | 2,872.8                  | 39                         | 72.79                       |
| 3             | 424   | VT        | Burlington    | 1,442.4                  | 21                         | 69.57                       |
| 4             | 221   | ME        | Bangor        | 514                      | 8                          | 68.34                       |
| 5             | 85    | CA        | San Mateo Co. | 3,421.8                  | 51                         | 67.35                       |
| 6             | 281   | NH        | Lebanon       | 1,224.4                  | 18                         | 67.21                       |
| 7             | 275   | MT        | Great Falls   | 252.8                    | 4                          | 65.75                       |
| 8             | 309   | NC        | Asheville     | 978                      | 17                         | 56.86                       |
| 9             | 134   | FL        | Pensacola     | 1,166.4                  | 20                         | 56.74                       |
| 10            | 324   | ND        | Minot         | 195.4                    | 4                          | 55.32                       |
| 11            | 320   | NC        | Winston-Salem | 2,188.2                  | 40                         | 55.29                       |
| 12            | 413   | TX        | Temple        | 758.4                    | 14                         | 55.28                       |
| 13            | 146   | GA        | Columbus      | 267                      | 5                          | 54.29                       |
| 14            | 31    | CA        | Chico         | 395.2                    | 7                          | 53.01                       |
| 15            | 429   | VA        | Newport News  | 646.8                    | 12                         | 52.36                       |
| 16            | 227   | MA        | Boston        | 10,774.8                 | 206                        | 52.26                       |
| 17            | 56    | CA        | Los Angeles   | 11,993.2                 | 233                        | 51.47                       |
| 18            | 321   | ND        | Bismarck      | 267.4                    | 5                          | 50.98                       |
| 19            | 232   | MI        | Ann Arbor     | 2,821.8                  | 56                         | 50.86                       |
| 20            | 356   | PA        | Philadelphia  | 8,586.6                  | 17                         | 49.26                       |
viral load based on predicted procedural volumes to establish appropriate clinical protocols as we look to restore surgical practices to normalcy.

With elective activity halted over the last six weeks, health systems have experienced significant financial ramifications. For instance, among other surgical subspecialties, otolaryngology ambulatory visits saw up to a 75% drop during the pandemic [14]. Similar effects have been seen in the operating rooms, with significant reductions in operating room productivity due to widespread procedure cancellations. Accordingly, given the backdrop of lost revenues and increased costs associated with pandemic, there has been fiscal pressure to resume scheduled procedures as soon as circumstances are deemed “safe enough” to proceed [8]. It is expected that, as return-to-work practices are established, hospital throughput will accelerate, with operating rooms flooded with little to no vacancy in schedules for months [11]. Although our analysis uses retrospective data from prior years to estimate anticipated procedural volume, we expect that volumes may be even greater than predicted, given recent policies cancelling elective procedures for a prolonged amount of time. Unfortunately, it is difficult to quantify that relative increase in volume from baseline activity. However, qualitatively, case burden for all physicians, including otolaryngologists, will increase significantly, as hospitals strive to make up for lost revenue. Accordingly, healthcare institutions must make appropriate risk-based decisions when approaching the resumption of clinical practice to protect the health and safety of their surgeons.

Our findings have important implications on the resumption of clinical activities, for which otolaryngology committees globally have published guidelines and proposed solutions. Those solutions and guidelines are further supported by our data, and decision-making on a regional level ought to account for past volumes of aerosol-generating procedures in designing individual “reopening” strategies. For example, rather than complete and simultaneous resumption of all procedures, a tiered approach to ramp up procedural volume based on risk-level and patient need could be employed. As many of their procedures are aerosol-generating, it is important to consider the persistent high-risk for otolaryngologists, as we resume these procedures. This could entail reinitiating non-aerosol generating procedures first, followed by aerosol-generating procedures, reintroduced based on acuity and urgency. This tiered approach will allow for the ability to treat patients who have had their care postponed, while still prioritizing our clinicians’ safety from high-risk procedures. Alternatively, in a recent statement by The American College of Surgeons identifying 10 key issues for health institutions to address prior to ramping up elective clinical activity, they identified additional considerations and strategies for prioritizing cases for the near future [11,15]. These include increased operating room workforce to support higher volume, increased operating room availability with extended hours or weekend OR time, phased opening of operating rooms, and COVID-19-related surgical outcomes data — all of which will have important implications on how we return back to our baseline clinical activity.

Another recommendation to be considered prior to resuming procedures is targeted preoperative COVID-19 testing for patients undergoing aerosol-generating procedures. In the setting of conservative testing, a risk-based utilization of resources should include prioritization of diagnostics for all patients in “hot zones.” Similarly, personal protective equipment (PPE) has been at the forefront of appropriate resource allocation discussions. With surgeon exposure to high-risk patients in high-risk procedures, extra attention ought to be paid to “hot-zones.” It is important that we not ignore the highly trained workforce that has been one of our most valuable “resources” in this pandemic. In order to prioritize our patients, we must first prioritize our healthcare providers.

5. Limitations

The present study utilized a Medicare claims dataset from 2013 to 2017, which does not precisely quantify volumes and distributions of procedures in 2020. However, by examining volume trends over a five-year period, the data provide a predictive model for approximating case distributions preceding the COVID-19 pandemic. Additionally, by adhering to recent clinical guidelines for stratifying CPTs based on risk category, we hoped to mitigate the deficiency of CPT procedure codes.
Fig. 2. (A). Average aerosol-generating procedural per otolaryngologist between 2013 and 2017, stratified by HRR, mapped against COVID cases as of April 24, 2020. (B). Average aerosol-generating procedural volume per otolaryngologist between 2013 and 2017, stratified by HRR, mapped against COVID cases for Northeast United States as of April 24, 2020.
in comprehensively reflecting case risk and clinical severity. Furthermore, our model cannot account for geographic variability in PPE availability, screening practices, and hospital-specific procedural policies, all of which play significant roles in nosocomial transmission during this pandemic. Moreover, our study provides a snapshot of the most recent data of COVID-19 case rates for each state. Given the rapidly changing landscape of COVID-19 case volumes, this is subject to change. Subsequent analysis ought to retrospectively assess and validate whether the hot zones identified herein reflect true “hot zones.”

6. Conclusion

Otolaryngologists are susceptible to uniquely elevated risks of COVID-19 nosocomial transmission given their invasive procedures in high viral load regions in the head and neck. Accordingly, as we target restoring clinical activities to normal, this model may help us to predict resource needs related to adequate PPE and testing based on density of aerosol-generating procedures and at-risk regions. Furthermore, utilization of this predictive framework may show utility for future surges of COVID-19 or other system stressors. In this way, we can prioritize the delivery of care to patients in need, while protecting the providers who deliver that care.

Declaration of competing interests

None.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Fig. 3. Venn Diagram for identifying potentially highest HRRs (90th percentile in aerosol-generating procedures per otolaryngologist and COVID-19 case density).
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