Title: A Multimodal Multi-Institutional Solution to Remote Medical Student Education for Otolaryngology during COVID-19

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Conflict of interest, competing interests, sponsorships: Dr. Sarah E. Mowry: The author has done consulting work for Stryker, and has received a travel grant from Cochlear and Medel. The Great Lakes Otolaryngology Consortium used in the curriculum was developed by University Hospitals Cleveland Medical Center in collaboration with the Cleveland Clinic Foundation and other academic institutions. There are no further significant conflicts of interest with products or services that are discussed in this article.
IRB: This study did not require IRB approval.

Key Words: Otolaryngology; COVID-19; Remote education; Medical Education; Acting internship; Multimodal

Funding: None.

Manuscript Word Count: 1168
Tables and Figures: 2
References: 9

Author Contributions

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<th>Author names: list corresponding author first then all others</th>
<th>Authorship: specific contribution to the manuscript or research process*</th>
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<td>Corresponding: Sarah E. Mowry</td>
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Abstract:
During the COVID-19 pandemic, there has been a surge in production of remote learning materials for continued otolaryngology resident education. Medical students traditionally rely on elective and away sub-internship experiences for exposure to the specialty. Delays and cancellation of clinical rotations have forced medical students to pursue opportunities outside of the traditional learning paradigm. In this commentary, we discuss the multi-institutional development of a robust syllabus for medical students using a multimodal collection of resources. Medical students collaborated with faculty and residents from two major academic centers to identify essential otolaryngology topics. High-quality, publicly-available and open-access content from multiple sources were incorporated into a curriculum that appeals to a variety of learners. Multimodal remote education strategies can be used as a foundation for further innovation aimed at developing tomorrow’s otolaryngologists.
Introduction

The COVID-19 pandemic has disrupted medical student education and, as a result, medical education delivery must adapt to meet the needs of students. Due to stay-at-home orders, medical students are currently unable to attend in-person classes and complete their clinical duties. While preclinical students are able to transition lectures to online platforms, remote learning for students on clinical rotations is more challenging. Due to disruptions in core clerkships, students may have fewer weeks dedicated to clinical electives as they work to fulfill graduation requirements. As most traditional medical school curricula lack required, intensive otolaryngology (ENT) education, students have become dependent on elective experiences to gain exposure to the field. In the setting of fewer opportunities for rotations due to COVID-19, the implications on student interest in the field are uncertain.

Need for ENT Exposure During Medical School

Traditionally, for students exploring the field of otolaryngology, elective time allowed students to observe and work with otolaryngology attendings and residents. Subspecialty rotations allowed students to further their knowledge through hands-on experiences in the clinic and operating room (OR) and participate in didactics with residents. Direct exposure to the field has been vital for fostering students' interest in the field. While just 1% of student responses to the 2015 Matriculating Student Questionnaire expressed interest in otolaryngology, the 2019 Graduating Student Questionnaire showed that 1.9% of respondents intended to practice in ENT. Normalizing this growth in interest to the percentage of students entering the field, ENT
is one of the top five most “changed-to” specialties (Figure 1, p=0.040). These findings reflect the immense value of clinical elective time not only for surgical subspecialties, but uniquely for otolaryngology. In addition to clinical experience, students compensate for their lack of exposure to otolaryngology by using various supplementary materials such as ENT Secrets. This prior preparation is vital to optimizing their time and making lasting impressions with residency programs. Naturally, the more otolaryngology experience students have, the better prepared they are for future electives.

Evolving Clerkship Experiences in the Setting of COVID-19

The COVID-19 pandemic has left medical students seeking opportunities beyond the traditional learning paradigm to supplement what they are missing from the clinical environment. Fortunately, the remote virtual curriculum that students are completing for their clerkships due to COVID-19 provides ample opportunity to pursue outside interests. For students interested and eager to obtain additional learning opportunities, this time allows for remote education in subspecialties. Recently, there has been a surge in the production of remote learning materials for residents in otolaryngology. While remote content has focused on resident education, there is little consensus in terms of what medical students at a clerkship level should focus on to successfully prepare for future experiences.
Medical students sought faculty and residents from two major academic medical centers to identify essential otolaryngology topics that students are likely to see in clinic and in the operating room during acting internships. In the setting of COVID-19 limitations, there is now an abundance of high-quality, publicly available content, with a particular surge in material from national consortia targeting resident education. We compiled these resources and developed a multimodal curriculum that appeals to learners of all types (Figure 2). Such learning modalities include targeted readings, podcast interviews, virtual PowerPoint presentations, surgical videos with relevant anatomy, and case-based learning for each major topic area (Supplementary Data).

Readings include sections of *Otolaryngology-Primary Care*, a free online source that residency programs nationwide recommend that 4th year medical students use to prepare for acting internships. For lecture-based content, we use virtual presentations recorded for remote resident education as part of the Great Lakes Otolaryngology Consortium, a collaboration of many of the top regional academic institutions in the Midwest. Additionally, surgical videos as a part of Mayo Clinic's Otolaryngology-Head and Neck Surgery Surgical Video Atlas are utilized to provide students a preview of the operating room learning experience. These modalities are especially helpful for visual learners. Podcasts from Headmirror provide students the flexibility of an aural learning experience. Finally, a case-based program, developed by LearnENT at the University of Ottawa is used to engage medical students in active learning exercises pertaining to the diagnosis and management of commonly seen conditions in otolaryngology. These
artificial cases are supplemented with allocated time for virtual case discussions with otolaryngology faculty.

Discussion and Future Implications

Given the disruptions in medical student clinical education, it is imperative that institutions design and implement alternative learning streams to adequately prepare the next generation of otolaryngologists. Otolaryngology traditionally has been a top “changed-to” specialty during medical school. Virtual learning can allow for a larger number of students to be exposed to the field for students experiencing reductions in clinical elective time or lacking ENT elective opportunities altogether. We have compiled several open-source resources in a virtual curriculum to give students the necessary exposure to common otolaryngology topics to perform well on their rotations. Such a curriculum can serve as a launchpad for improving otolaryngologic education for medical students nationally. While this syllabus certainly cannot replace in-person, hands-on clinical education, this optimized remote educational model strives to accommodate students with diverse learning styles to help prepare them for both acting internships and residency during this global crisis.

In addition to the immediate benefits, we hope this multi-institutional - and notably international - collaboration offers an example of opportunities to share knowledge and wisdom for the benefit of all parties. This provides a framework for further collaboration, which is essential for the growth and development of the field. Furthermore, the potential exists to modify this curriculum for the education of pre-clinical medical
students, and can provide further exposure to a field that is minimally emphasized in most medical curricula in the United States.

Limitations

While course content is virtual, self-driven, and available through public resources, the involvement and leadership of departmental faculty allows for sufficient oversight in the delivery of such a curriculum. The proposed curriculum was developed with the support of two otolaryngology programs within large academic centers and may not represent resources available to all students nationally. While lectures and readings constitute passive learning, the interactive case-based problem solving (LearnENT) offers active learning virtually. Faculty may also supplement student learning with virtual case discussions and live seminars.

Furthermore, with the main impetus of this curriculum linked to the global pandemic, as society recovers and clinical opportunities return as the primary modality for medical student learning, we anticipate the popularity of such a course to fade with time. With that said, such a multimodal syllabus and clinical electives are not mutually exclusive; students could supplement clinical electives by preparing with a virtual elective. Especially for students at medical schools without ENT programs, this syllabus may continue to offer benefits beyond the pandemic.
Conclusion

Overall, the unique circumstances of COVID-19 have promoted innovation in education, facilitating alternative modalities for knowledge acquisition and student assessment. Such curricular development has facilitated a multi-institutional collaboration that is novel in medical student subspecialty education. We hope that a model incorporating multiple remote education strategies can be used as a foundation for further innovation aimed at developing tomorrow’s otolaryngologists, thereby having major implications on the advancement of the specialty.
References:


**Figure 1. Medical Student Changes in Career Choice**

Legend 1: High relative growth in interest was reported between the AAMC 2015 Matriculating Medical Student Questionnaire and 2019 Graduating Medical Student Questionnaire (p=0.040 comparing ENT with all other specialties using Firth’s penalized-likelihood regression).

**Figure 2. Multimodal Otolaryngology Curriculum for Medical Students**

Legend 2: Scalpel: Surgical videos, Books: Readings, Camera: PowerPoint Videos, Phone: LearnENT’s Case-Based Learning platform, People: Discussion and collaboration, Headphones: Audio podcasts
Medical Student Changes in Career Choice

This manuscript has been accepted for publication in Otolaryngology-Head and Neck Surgery.
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Supplementary Data - Syllabus

Resources
- learnENT
- Headmirror podcast
- Mayo Clinic’s Otolaryngology-Head and Neck Surgery Surgical Video Atlas
- Great Lakes Consortium
- Otolaryngology Primary Care

Intro: Headmirror: COVID-19 in OTOLARYNGOLOGY

General Otolaryngology
- ENT emergencies
  - Otolaryngology Primary Care: ENT Emergencies (21-29)
  - Otolaryngology Primary Care: Temporal Bone Fractures (56-57) & Maxillofacial Trauma (79-83)
  - HeadMirror: Temporal Bone Trauma
  - HeadMirror: Mandible Fractures
  - Mayo Surgical Atlas: Middle Cranial Fossa Approach for Facial Nerve Decompression

Head and Neck
- Salivary gland tumor
  - Otolaryngology Primary Care: Salivary Gland Disease (93-95) & Parotid Mass (107-108)
  - HeadMirror: Benign Parotid Tumors
  - HeadMirror: Malignant Parotid Tumors
  - LearnENT: Salivary Gland Mass
  - Mayo Surgical Atlas: Total Parotidectomy
- Skin cancer
  - Otolaryngology Primary Care: Malignant Melanoma (115-117)
  - HeadMirror: Melanoma of the Head and Neck
  - LearnENT: Malignant Melanoma
- Oral cavity/oropharyngeal cancer
  - Great Lakes Consortium: Oral Cancer - Part 1
  - LearnENT: Oral cavity cancer
  - LearnENT: Oropharyngeal Cancer
- Thyroid
  - Otolaryngology Primary Care: Thyroid cancer - pgs 98-103
- LearnENT: Thyroid nodules
- Mayo Surgical Atlas: Thyroid lobectomy

- Flaps
  - Great Lakes Consortium: Flaps
  - Mayo Surgical Atlas: Level 2-4 Neck Dissection

Laryngology
  - Laryngeal nodules
    - Otolaryngology Primary Care: Hoarseness - pg 106
    - Great Lakes Consortium: Laryngeal Cancer - Part 2
    - HeadMirror: Benign Vocal Cord Lesions
    - LearnENT: Hoarseness
    - Mayo Surgical Atlas: Laryngoscopy and Polyp Removal
  - Vocal cord paralysis
    - Mayo Clinic Radio: Vocal cord paralysis
  - Dysphagia
    - Otolaryngology Primary Care: Foreign Bodies - pg 126
    - Great Lakes Consortium: Dysphagia - Part 1
    - HeadMirror: Zenker's Diverticulum
    - LearnENT: Esophageal Foreign Body

Otology
  - Hearing
    - Otolaryngology Primary Care: Hearing Loss - pgs 41-48
    - HeadMirror: Sudden Sensorineural Hearing Loss
    - LearnENT: Sudden Sensorineural Hearing Loss
    - LearnENT: Tinnitus
  - Ear infections
    - Otolaryngology Primary Care: Otitis Media - pgs 31-39
    - HeadMirror: Pediatric Otitis Media
    - LearnENT: Acute Otitis Media
    - LearnENT: Otitis Media with Effusion
  - Vertiginous syndromes
    - Otolaryngology Primary Care: Dizziness - pgs 49-52
    - HeadMirror: Meniere's Disease
    - LearnENT: Dizziness

Pediatrics
  - Congenital hearing loss
    - Great Lakes Consortium: Hearing Loss in Children - Part 2
- **Acute pediatric airway**
  - *Otolaryngology Primary Care*: Stridor - pg 124-128
  - *HeadMirror*: Pediatric Aerodigestive Foreign Bodies
  - *LearnENT*: Pediatric Respiratory Distress
  - *LearnENT*: Laryngeal Foreign Body
  - *LearnENT*: Bronchial Foreign Body

- **Tonsillitis**:
  - *Otolaryngology Primary Care*: Tonsillectomy - pg 121-123
  - *LearnENT*: Tonsillitis
  - *Mayo Surgical Atlas*: Tonsillectomy via TORS

- **Pediatric neck masses**
  - *Otolaryngology Primary Care*: Neck Mass - pgs 129-130
  - *Great Lakes Consortium*: Pediatric neck masses - Part 1
  - *HeadMirror*: Branchial Cleft Anomalies
  - *HeadMirror*: Thyroglossal Duct Cyst

**Facial Plastics**
- Facial Nerve Pathology
  - *Otolaryngology Primary Care*: Facial Nerve Paralysis - pg 55-58
  - *HeadMirror*: Facial Nerve Anatomy and Testing
  - *HeadMirror*: Bell’s Palsy
  - *HeadMirror*: Chronic Facial Nerve Paralysis
  - *LearnENT*: Facial Nerve Paralysis

**Rhinology**
- Epistaxis
  - *Otolaryngology Primary Care*: Epistaxis - pgs 25-26
  - *LearnENT*: Epistaxis

- Rhinosinusitis
  - *Otolaryngology Primary Care*: Rhinosinusitis - pg 61-64, 131
  - *HeadMirror*: Chronic Rhinosinusitis
  - *Great Lakes Consortium*: Fungal sinusitis - Part 2
  - *LearnENT*: Acute rhinosinusitis
  - *LearnENT*: Chronic rhinosinusitis
  - *Mayo Surgical Atlas*: Functional endoscopic sinus surgery
- Skull base lesions (pituitary)
  - *HeadMirror*: Anterior Skull Base Reconstruction