

*This manuscript has been accepted for publication in Otolaryngology-Head and Neck Surgery.*

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

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35 **Conflict of interest, competing interests, sponsorships:** Dr. Sarah E. Mowry: The  
36 author has done consulting work for Stryker, and has received a travel grant from  
37 Cochlear and Medel. The Great Lakes Otolaryngology Consortium used in the  
38 curriculum was developed by University Hospitals Cleveland Medical Center in  
39 collaboration with the Cleveland Clinic Foundation and other academic institutions.  
40 There are no further significant conflicts of interest with products or services that are  
41 discussed in this article.

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42 **IRB:** This study did not require IRB approval.

43

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

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47 **Funding:** None.

48

49 **Manuscript Word Count: 1168**

50 **Tables and Figures: 2**

51 **References: 9**

52

53 **Author Contributions**

54

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Corresponding: Sarah E. Mowry	Concept and design, final approval and supervision of project, wrote manuscript, data interpretation, critical revisions
Jeremy S. Ruthberg	Concept and design, final approval of project, wrote manuscript, data interpretation, critical revisions
Humzah A. Quereshey	Concept and design, final approval of project, data interpretation, critical revisions, wrote manuscript
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Stephen Trudeau	Concept and design, final approval of project, critical revisions to the work, wrote manuscript
Emaan Chaudry	Concept and design, final approval of project, critical revisions to the work, wrote manuscript
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Alan Kominsky	Concept and design, final approval of project, critical revisions to the work, wrote manuscript
Todd D. Otteson	Concept and design, final approval of project, critical revisions to the work, wrote manuscript

Paul C. Bryan	Concept and design, final approval of project, critical revisions to the work, wrote manuscript
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56 **Abstract:**

57 During the COVID-19 pandemic, there has been a surge in production of remote  
58 learning materials for continued otolaryngology resident education. Medical students  
59 traditionally rely on elective and away sub-internship experiences for exposure to the  
60 specialty. Delays and cancellation of clinical rotations have forced medical students to  
61 pursue opportunities outside of the traditional learning paradigm. In this commentary,  
62 we discuss the multi-institutional development of a robust syllabus for medical students  
63 using a multimodal collection of resources. Medical students collaborated with faculty  
64 and residents from two major academic centers to identify essential otolaryngology  
65 topics. High-quality, publicly-available and open-access content from multiple sources  
66 were incorporated into a curriculum that appeals to a variety of learners. Multimodal  
67 remote education strategies can be used as a foundation for further innovation aimed at  
68 developing tomorrow's otolaryngologists.

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73 **Introduction**

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

85

86 **Need for ENT Exposure During Medical School**

87 Traditionally, for students exploring the field of otolaryngology, elective time allowed  
88 students to observe and work with otolaryngology attendings and residents.  
89 Subspecialty rotations allowed students to further their knowledge through hands-on  
90 experiences in the clinic and operating room (OR) and participate in didactics with  
91 residents. Direct exposure to the field has been vital for fostering students' interest in  
92 the field. While just 1% of student responses to the 2015 Matriculating Student  
93 Questionnaire expressed interest in otolaryngology, the 2019 Graduating Student  
94 Questionnaire showed that 1.9% of respondents intended to practice in ENT.  
95 Normalizing this growth in interest to the percentage of students entering the field, ENT

96 is one of the top five most “changed-to” specialties (Figure 1,  $p=0.040$ ).<sup>1,2</sup> These  
97 findings reflect the immense value of clinical elective time not only for surgical  
98 subspecialties, but uniquely for otolaryngology. In addition to clinical experience,  
99 students compensate for their lack of exposure to otolaryngology by using various  
100 supplementary materials such as *ENT Secrets*.<sup>3</sup> This prior preparation is vital to  
101 optimizing their time and making lasting impressions with residency programs.  
102 Naturally, the more otolaryngology experience students have, the better prepared they  
103 are for future electives.

104

### 105 **Evolving Clerkship Experiences in the Setting of COVID-19**

106 The COVID-19 pandemic has left medical students seeking opportunities beyond the  
107 traditional learning paradigm to supplement what they are missing from the clinical  
108 environment. Fortunately, the remote virtual curriculum that students are completing for  
109 their clerkships due to COVID-19 provides ample opportunity to pursue outside  
110 interests. For students interested and eager to obtain additional learning opportunities,  
111 this time allows for remote education in subspecialties. Recently, there has been a  
112 surge in the production of remote learning materials for residents in otolaryngology.  
113 While remote content has focused on resident education, there is little consensus in  
114 terms of what medical students at a clerkship level should focus on to successfully  
115 prepare for future experiences.

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119 **The Curriculum**

120 Medical students sought faculty and residents from two major academic medical centers  
121 to identify essential otolaryngology topics that students are likely to see in clinic and in  
122 the operating room during acting internships. In the setting of COVID-19 limitations,  
123 there is now an abundance of high-quality, publicly available content, with a particular  
124 surge in material from national consortia targeting resident education. We compiled  
125 these resources and developed a multimodal curriculum that appeals to learners of all  
126 types (Figure 2). Such learning modalities include targeted readings, podcast  
127 interviews, virtual PowerPoint presentations, surgical videos with relevant anatomy, and  
128 case-based learning for each major topic area (Supplementary Data).

129  
130 Readings include sections of *Otolaryngology-Primary Care*, a free online source that  
131 residency programs nationwide recommend that 4<sup>th</sup> year medical students use to  
132 prepare for acting internships.<sup>4</sup> For lecture-based content, we use virtual presentations  
133 recorded for remote resident education as part of the Great Lakes Otolaryngology  
134 Consortium, a collaboration of many of the top regional academic institutions in the  
135 Midwest.<sup>5,6</sup> Additionally, surgical videos as a part of Mayo Clinic's Otolaryngology-Head  
136 and Neck Surgery Surgical Video Atlas are utilized to provide students a preview of the  
137 operating room learning experience.<sup>7</sup> These modalities are especially helpful for visual  
138 learners. Podcasts from Headmirror provide students the flexibility of an aural learning  
139 experience.<sup>8</sup> Finally, a case-based program, developed by LearnENT at the University  
140 of Ottawa is used to engage medical students in active learning exercises pertaining to  
141 the diagnosis and management of commonly seen conditions in otolaryngology.<sup>9</sup> These

142 artificial cases are supplemented with allocated time for virtual case discussions with  
143 otolaryngology faculty.

144

## 145 **Discussion and Future Implications**

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

159

160 In addition to the immediate benefits, we hope this multi-institutional - and notably  
161 international - collaboration offers an example of opportunities to share knowledge and  
162 wisdom for the benefit of all parties. This provides a framework for further collaboration,  
163 which is essential for the growth and development of the field. Furthermore, the  
164 potential exists to modify this curriculum for the education of pre-clinical medical



165 students, and can provide further exposure to a field that is minimally emphasized in  
166 most medical curricula in the United States.

167

### 168 **Limitations**

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

177

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

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188 **Conclusion**

189 Overall, the unique circumstances of COVID-19 have promoted innovation in education,  
190 facilitating alternative modalities for knowledge acquisition and student assessment.

191 Such curricular development has facilitated a multi-institutional collaboration that is  
192 novel in medical student subspecialty education. We hope that a model incorporating  
193 multiple remote education strategies can be used as a foundation for further innovation  
194 aimed at developing tomorrow's otolaryngologists, thereby having major implications on  
195 the advancement of the specialty.

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197

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224  
225

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

227

228 *Legend 1: High relative growth in interest was reported between the AAMC 2015*

229 *Matriculating Medical Student Questionnaire and 2019 Graduating Medical Student*

230 *Questionnaire (p=0.040 comparing ENT with all other specialties using Firth's*

231 *penalized-likelihood regression).*

232

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

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235 *Legend 2: Scalpel: Surgical videos, Books: Readings, Camera: PowerPoint Videos,*

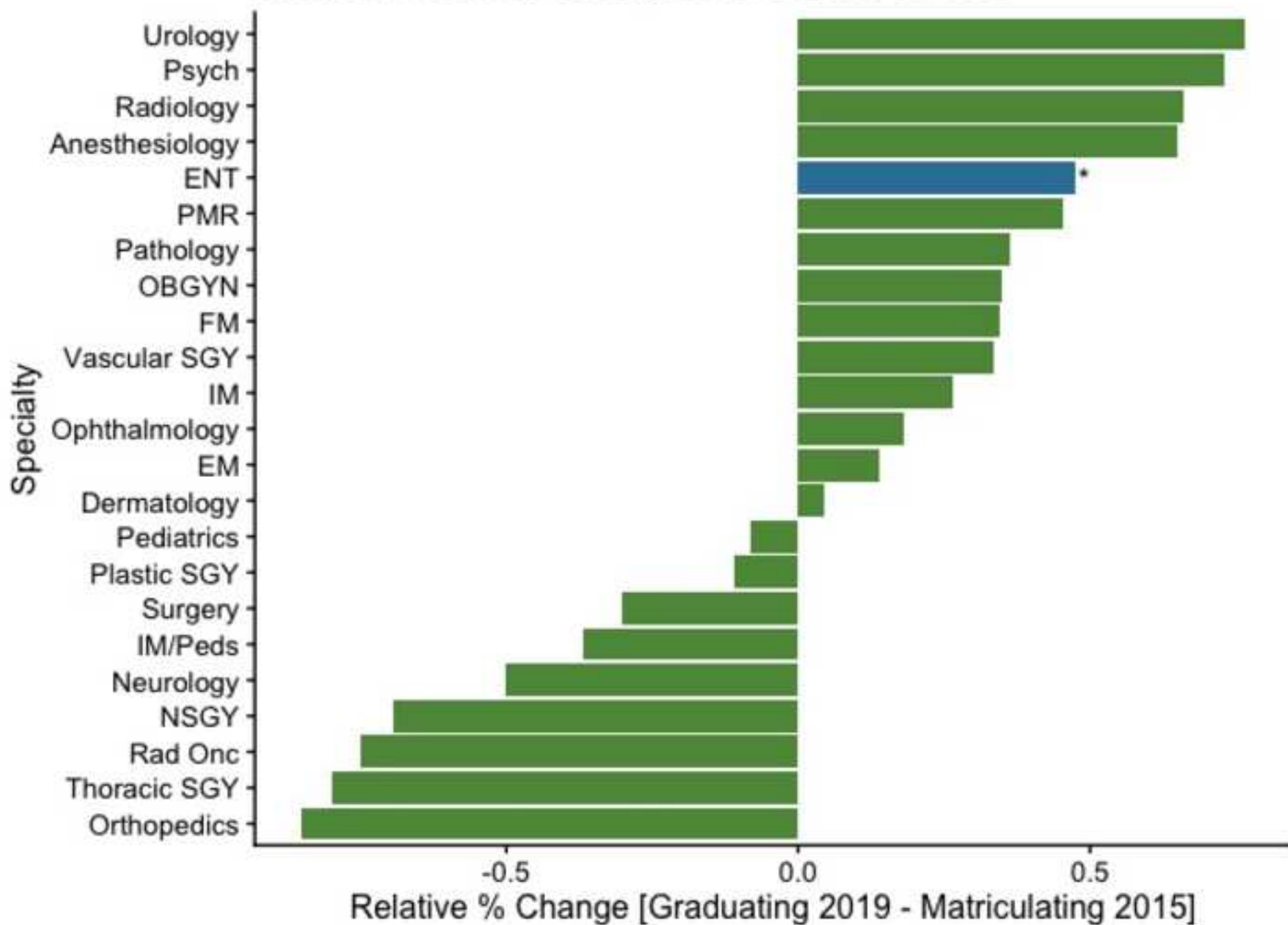
236 *Phone: LearnENT's Case-Based Learning platform, People: Discussion and*

237 *collaboration, Headphones: Audio podcasts*

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## Medical Student Changes in Career Choice



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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