Twenty-One for 2021: The Most Influential Papers in Laryngology
Since 2000

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Objectives/Hypothesis: To identify the most influential publications in laryngology since 2000.

Study Design: Modified Delphi process.

Methods: Samples of laryngologists drawn from editors of leading journals, organization officers, and thought leaders were invited to participate in a modified Delphi identification of influential laryngology papers. Influential was defined as follows: yielding meaningful practice changes, catalyzing further work as a foundation for an important topic, altering traditional views, or demonstrating durability over time. Quality and validity were not among the selection criteria. Each participant nominated 5 to 10 papers in Round 1. These nominations, augmented with papers from bibliometric analysis, were narrowed further in Round 2 as participants identified their top 20. The 40 papers with the most Round 2 votes were discussed by video conference and then subjected to Round 3 voting, with each participant again selecting their top 20 most influential papers. Final results were collated by the number of Round 3 votes.

Results: Sixteen of 18 invited laryngologists participated overall (all 16 in Rounds 1 and 3; 14 in Round 2). Twenty-one papers were identified as most influential. One paper appeared on all 16 Round 3 lists; three papers with eight (50%) votes each were last to make the list. Eleven of these 21 focused on voice; three each related to cancer, airway, and swallowing; and one encompassed all of these clinical areas.

Conclusions: This list of 21 influential laryngology papers serves to focus further research, provides perspective on recent advances within the field, and is an educational resource for trainees and practicing physicians.

Key Words: Laryngology, otolaryngology, influential, publications, Delphi technique.

Level of Evidence: NA

INTRODUCTION

The field of laryngology, which includes the management of voice, airway, and swallowing disorders, is one of the earliest recognized surgical subspecialties. The American Laryngological Association was formed in 1878. However, formalized postresidency fellowship training in laryngology did not begin in the United States until much more recently in 1992. Subsequently, over the past two decades, there has been marked growth in scholarship in laryngology. Many influential, important, and field-changing laryngology papers have been published over this period.

The most influential papers have been identified in different areas of otolaryngology as well as many other medical fields, but not yet in laryngology. Researchers across different disciplines have applied various methods to generate these lists of influential papers. Some lists are entirely bibliometric analyses of citations,1–9 some are built on expert consensus,10,11 and others combine these two approaches.12–14 As these publications become...
increasingly available in other fields, we aimed to fill this gap in laryngology. The objective of this project was to use a modified Delphi survey technique to identify 20 of the most influential papers published in the laryngology literature since 2000. The goal of this list is to generate discussion about contemporary topics with a look toward advancing the field of laryngology and also serve as a useful educational resource for students, residents, fellows, and colleagues in laryngology.

METHODS

Study Design
This was a modified Delphi process using sequential surveys and discussion to build consensus and identify influential laryngology papers. This research was determined to be exempt by the Institutional Review Board of Johns Hopkins University School of Medicine. Consent was implied by the voluntary completion of the surveys.

Participants
A sample of 18 expert laryngologists was identified from editorial members of leading otolaryngology journals, officers of national laryngology organizations, and thought leaders in the field. They were invited by e-mail to participate in the modified Delphi survey process. Thought leaders were identified based on the duration and quality of their scholarly contributions to the field. This was a convenience sample; not every thought leader was able to be invited. We attempted to create a broad enough sample, while keeping a small enough group to facilitate everyone’s participation during the discussion portion of the Delphi process.

Modified Delphi Process
Three rounds of surveys were sent to the participants by email. Surveys were completed online using Qualtrics Survey Software between June 2020 and September 2020. The results of each round of voting were anonymous. Participants received up to two reminder emails at weekly intervals to complete each round’s survey. After each round, the citations for all nominating or remaining papers were collected and collated by a single author (M.A.R.) who participated only as a methodologist and did not vote. The list of citations generated in each round formed the basis for voting in subsequent rounds. For each of the three voting rounds, the meaning of “influential” was left to the discretion of each voting panelist. Guidance provided in the survey instructions was the same for each round: “when you consider ‘influence’, you may use any criteria that you find most meaningful. To guide your responses, papers may be considered influential if they: (a) yielded meaningful practice changes for laryngologists, (b) catalyzed further work by serving as a foundational basis for an important topic in laryngology, (c) altered traditional views on a laryngology topic, and/or (d) demonstrated durability over time.” Participants were not asked to rank or explicitly consider quality or validity of the research papers that were nominated or voted on.

In Round 1, each participant nominated 5 to 10 papers they considered to be the most influential. Papers had to be published after January 1, 2000, to be included. There were no exclusions based on the type of study, clinical area within laryngology, or language of the paper. Since the frequency with which a paper is cited is one way to measure its influence, bibliometric analysis was performed to add to the list of panelist nominations generated in Round 1. Web of Science was used to complete the analysis. The search on June 30, 2020, included all papers published since January 1, 2000, using key words for four clinical areas within laryngology—voice, swallowing, airway, and cancer. Papers were ranked by the number of citations per year since publication, and those with the highest annual citations were identified to augment the list of papers nominated in Round 1. The search terms for each clinical area were as follows (TS = topic and includes title, abstract, author keywords, and Keywords Plus):

- “TS = (dysphonia or vocal or vocal cord or vocal fold or laryngology)” for the clinical area of voice.
- “TS = (swallow or dysphagia)” for the clinical area of swallowing.
- “TS = (subglottis or ((subglottic or laryngeal or tracheal or laryngotracheal) and stenosis))” for the clinical area of airway and some cancer.
- “TS = (larynx or laryngeal or glottis or glottic)” for the clinical area of cancer and some airway.

The searches were limited to otolaryngology, speech-language pathology, and general medical journals. There were no exclusions based on language. The results were ordered by the average number of citations per year. Two authors (M.A.R. and L.M.A.) independently identified the papers in each clinical area with the highest average citations per year that fulfilled the criteria for inclusion. These two lists were compared to identify 10 papers in each of the four clinical areas with the highest average citations per year. Consensus was achieved through discussion. Each paper could only be listed in one clinical area, and a total of 40 unique publications were identified by bibliometric analysis. If a paper appeared in more than one area, then it was placed in the clinical area where it had the highest ranking of average citations per year. A subsequent paper was identified in the other area(s).

The resulting 40 papers from the bibliometric analysis were added to the Round 1 nominations; duplicate papers were removed. The combined list was then used in Round 2 voting where participants received a unique, randomized sequence of the same list of papers generated by M.B.B. using Stata 12.1 (College Station, TX). Participants listed their top 20 papers. The 40 papers that appeared on the greatest number of participants’ lists in Round 2 were then placed in order of the most to least votes, with the number of votes listed for each paper. This collated list served as the basis for further discussion and voting.

A video conference using Zoom (San Jose, CA) was held between Rounds 2 and 3 of voting. This video conference was optional, but participation was encouraged. M.A.R. facilitated the discussion and did not vote. The top 40 articles based on Round 2 voting were discussed in order of the number of votes received. Each participant had the opportunity to share why they considered each paper to be influential or not influential. Participants who could not join were invited by email to provide their rationale for which papers they considered influential or not influential so that this could be shared during the video conference.

The same 40 papers that were discussed during the video conference were then subjected to Round 3 voting, with each participant again selecting their top 20 papers from the ranked ordered list. Final results were collated by the number of Round 3 votes. The decision to identify 20 papers at the end of Round 3 was made a priori with the caveat that the number of manuscripts, once ranked by tiers of votes received, might lead to a total number other than exactly 20. In this case, methodology emphasized picking the number of manuscripts closest to 20. For instance, in a hypothetical scenario in which 8 papers appeared on 10 lists, 6 papers appeared on 6 lists, 3 papers appeared on 5 lists, 5 papers appeared on 4 lists, and 7 papers appeared on 3 lists, this methodology would have identified 22 papers, all with ≥4 votes, as “most influential” (8 + 6 + 3 + 5 + 22) – a cutoff of 5 lists would have yielded 17 papers, while a threshold of 3 lists would have yielded 29 papers, each further away from the goal of 20 set initially.
| Paper                                                                 | Year of Publication | Votes in Round 3, No. (%) | Clinical Area | Total Citations | Average Citations per Year |
|----------------------------------------------------------------------|---------------------|---------------------------|---------------|-----------------|----------------------------|
| Hillel AD. The study of laryngeal muscle activity in normal human subjects and in patients with laryngeal dystonia using multiple fine-wire electromyography. Laryngoscope.23 | 2001                | 16 (100%)                 | Voice         | 91              | 4.6                        |
| Remacle M, Eckel HE, Antonelli A, Brasnu D, Chevalier D, Friedrich G, Olofsson J, Rudert HH, Thumbart W, de Vincentis M, Wustrow TP. Endoscopic cordectomy. A proposal for a classification by the Working Committee, European Laryngological Society. Eur Arch Otorhinolaryngol.24 | 2000                | 14 (88%)                  | Cancer        | 264             | 12.6                       |
| Altman KW, Yu GP, Schaefer SD. Consequence of dysphagia in the hospitalized patient: impact on prognosis and hospital resources. Arch Otolaryngol Head Neck Surg.15 | 2010                | 12 (75%)                  | Swallowing    | 230             | 20.9                       |
| Blitzer A, Brin MF, Simonyan K, Ozelius LJ, Frucht SJ. Phenomenology, genetics, and CNS network abnormalities in laryngeal dystonia: A 30-year experience. Laryngoscope.18 | 2018                | 12 (75%)                  | Voice         | 9               | 3                          |
| Franco RA, Jr., Husain I, Reder L, Paddle P. Awake serial intraluminal steroid injections without surgery as a novel targeted treatment for idiopathic subglottic stenosis. Laryngoscope.20 | 2018                | 12 (75%)                  | Airway        | 26              | 8.7                        |
| Rosen CA, Lee AS, Osborne J, Zullo T, Muny T. Development and validation of the voice handicap index-10. Laryngoscope.31 | 2004                | 12 (75%)                  | Voice         | 517             | 30.4                       |
| Bastian RW, Vaidya AM, Delsupehe KG. Sensory neuropathic cough: a common and treatable cause of chronic cough. Otolaryngol Head Neck Surg.16 | 2006                | 11 (69%)                  | Voice         | 80              | 5.3                        |
| Belafsky PC, Mouadeb DA, Rees CJ, Pryor JC, Postma GN, Allen J, Leonard RJ. Validity and reliability of the Eating Assessment Tool (EAT-10). Ann Otol Rhinol Laryngol.17 | 2008                | 11 (69%)                  | Swallowing    | 407             | 31.3                       |
| Gelbard A, Donovan DT, Ongkasuwan J, Nouraei SA, Sandhu G, Benninger MS, Bryson PC, Lorenz RR, Tierney WS, Hillel AT, Gadkaree SK, Lott DG, Edell ES, Ekdom DC, Kasperbauer JL, Maldonado F, Schindler JS, Smith ME, Daniero JJ, Garrett CG, Nettelle JI, Rickman OB, Sinard RJ, Wootten CT, Francis DO. Disease homogeneity and treatment heterogeneity in idiopathic subglottic stenosis. Laryngoscope.21 | 2016                | 11 (69%)                  | Airway        | 47              | 9.4                        |
| MacKenzie K, Millar A, Wilson JA, Sellars C, Deary IJ. Is voice therapy an effective treatment for dysphonia? A randomised controlled trial. BMJ.23 | 2001                | 11 (69%)                  | Voice         | 81              | 4.1                        |
| Paniello RC, Edgar JD, Kallogjeri D, Piccirillo JF. Medialization versus reinnervation for unilateral vocal fold paralysis: a multicenter randomized clinical trial. Laryngoscope.26 | 2011                | 11 (69%)                  | Voice         | 59              | 5.9                        |
| Hoffman HT, Porter K, Karmel LH, Cooper JS, Weber RS, Langer CJ, Ang KK, Gay G, Stewart A, Robinson RA. Laryngeal cancer in the United States: changes in demographics, patterns of care, and survival. Laryngoscope.24 | 2006                | 10 (63%)                  | Cancer        | 463             | 30.9                       |
| Kempster GB, Gerratt BR, Verdolini Abbott K, Barkmeier-Kraemer J, Hillman RE. Consensus auditory-perceptual evaluation of voice: development of a standardized clinical protocol. Am J Speech Lang Pathol.25 | 2009                | 10 (63%)                  | Voice         | 361             | 30.1                       |
| Sulica L, Rosen CA, Postma GN, Simpson B, Amin M, Couray M, Merati A. Current practice in injection augmentation of the vocal folds: indications, treatment principles, techniques, and complications. Laryngoscope.25 | 2010                | 10 (63%)                  | Voice         | 102             | 9.3                        |
| Zeitels SM, Akst LM, Burns JA, Hillman RE, Broadhurst MS, Anderson RR. Office-based S32-nm pulsed KTP | 2006                | 10 (63%)                  | Cancer        | 106             | 6.8                        |

(Continues)
Once the “most influential” papers were identified in this manner, the resulting papers were characterized into four possible clinical areas within laryngology: airway, voice, swallowing, and/or cancer. Each paper could be in more than one clinical area. For each included paper, the total citations and citation average per year were reported as per Web of Science on December 7, 2020.

Finally, to better understand the background of the Delphi participants in this study, the main one or two areas of focus for each participant’s research and clinical practice were obtained through the survey with choices of voice, swallowing, airway, and cancer. These questions were asked after submission of their Round 3 votes.

RESULTS

Sixteen of 18 (89%) invited laryngologists agreed to participate. All 16 participated in Round 1 voting, which resulted in nominations for 111 unique papers. After adding the 40 papers generated from the bibliometric analysis and removing duplicates, there were 142 unique papers that formed the basis for Round 2 voting. Fourteen of 16 participants (88%) responded in Round 2 voting and 12 (75%) joined for the video conference call between Round 2 and Round 3. One participant had to leave during the call due to a clinical emergency. A written set of opinions on nominated manuscripts was submitted to M.A.R. by one participant who could not attend and was shared with all other participants during the video conference. Duration of the conference call was 2 hours and all participants present contributed to the discussion. All 16 participants submitted a survey in the final Round 3 voting.

Twenty-one papers were identified as most influential and are listed in Table I.15–35 Papers are listed in descending order of the number of votes received and alphabetically by the last name of the first author when the number

### Table I. Continued

| Paper | Year of Publication | Votes in Round 3, No. (%) | Clinical Area | Total Citations | Average Citations per Year |
|-------|---------------------|---------------------------|---------------|-----------------|-----------------------------|
| Halum SL, Ting JY, Plowman EK, Belafsky PC, Harbarger CF, Postma GN, Pitman MJ, LaMonica D, Moscatello A, Khosia S, Cauley CE, Maronian NC, Meiki S, Wick C, Sinacori JT, White Z, Younes A, Ekbom DC, Sardesai MG, Merati AL. A multi-institutional analysis of tracheotomy complications. *Laryngoscope*. | 2012 | 9 (56%) | Airway | 113 | 12.6 |
| Rosen CA, Amin MR, Sulica L, Simpson CB, Merati AL, Courey MS, Johns MM, 3rd, Postma GN. Advances in office-based diagnosis and treatment in laryngology. *Laryngoscope*. | 2009 | 9 (56%) | All four | 67 | 5.6 |
| Stachler RJ, Francis DO, Schwartz SR, Damask CC, Digoy GP, Krouse HJ, McCoy SJ, Ouellette DR, Patel RR, Reavis CCW, Smith LJ, Smith M, Strode SW, Woo P, Nnacheta LC. Clinical Practice Guideline: Hoarseness (Dysphonia) (Update). *Otolaryngol Head Neck Surg.* | 2018 | 9 (56%) | Voice | 0 | 0 |
| Cohen SM, Garrett CG. Hoarseness: is it really laryngopharyngeal reflux? *Laryngoscope*. | 2008 | 8 (50%) | Swallowing | 32 | 2.5 |
| Johns MM, Garrett CG, Hwang J, Ossoff RH, Courey MS. Quality-of-life outcomes following laryngeal endoscopic surgery for non-neoplastic vocal fold lesions. *Ann Otol Rhino Laryngol*. | 2004 | 8 (50%) | Voice | 33 | 1.9 |
| Wang W, Chen D, Chen S, Li D, Li M, Xia S, Zheng H. Laryngeal reinnervation using ansa cervicalis for thyroid surgery-related unilateral vocal fold paralysis: a long-term outcome analysis of 237 cases. *PLoS ONE*. | 2011 | 8 (50%) | Voice | 31 | 3.1 |

Once the “most influential” papers were identified in this manner, the resulting papers were characterized into four possible clinical areas within laryngology: airway, voice, swallowing, and/or cancer. Each paper could be in more than one clinical area. For each included paper, the total citations and citation average per year were reported as per Web of Science on December 7, 2020.

Finally, to better understand the background of the Delphi participants in this study, the main one or two areas of focus for each participant’s research and clinical practice were obtained through the survey with choices of voice, swallowing, airway, and cancer. These questions were asked after submission of their Round 3 votes.

### Table II.

| Clinical Focus, No. (%) | Research Focus, No. (%) |
|------------------------|------------------------|
| Voice                  | Voice                  |
| 16 (100%)              | 16 (100%)              |
| Airway                 | Airway                 |
| 10 (63%)               | 7 (44%)                |
| Swallowing             | Swallowing             |
| 7 (44%)                | 9 (56%)                |
| Cancer                 | Cancer                 |
| 1 (6%)                 | 1 (6%)                 |
| No current clinical practice | No current research |
| 1 (6%)                 | 1 (6%)                 |
of votes were the same. One paper appeared on all 16 Round 3 lists and three papers with 8 (50%) votes each were the last to be included on the list. Eleven of the 21 (52%) papers focused on voice; three each related to cancer, airway, and swallowing; and one encompassed all four of these clinical areas. Some themes of papers were office-based procedures (4 papers), quality of care (4 papers), and patient-reported measures (2 papers). All included papers were clinically oriented and there were no basic science or translational papers chosen. There were 2 (10%) randomized controlled trials. The remaining 19 (90%) papers were retrospective, observational, or consensus papers. The majority of papers (N = 11, 52%) were published in Laryngoscope. Annals of Otology, Rhinology and Laryngology was the second most common journal on the list with 3 (14%) papers. All papers were written in English. The majority (N = 18, 86%) originated from the United States even though one paper originated in each of Belgium, Scotland, and China.

Almost all participants (N = 15, 94%) selected voice as one of their two main clinical and research focuses (Table II). One participant reported that all four clinical areas were represented equally and was, therefore, counted as focusing in the voice area as well as the three other areas.

**DISCUSSION**

This paper identified 21 highly influential papers in laryngology published from 2000 to 2020 as selected by 16 leading laryngologists. Although similar lists have been compiled and reported in other specialties, this is the first such list in laryngology. More broadly, this is also the first list of influential papers compiled in Otolar- yngology–Head and Neck Surgery using a modified Delphi method for consensus.

In 2015, Lenzi et al. performed a bibliometric analysis of Otolaryngology–Head and Neck Surgery papers to identify the top 100 cited articles from 1985 to 2014. Although there were 11 laryngology-related papers in their list and 5 of them were also published after 2000, only one paper by Hoffman et al. appeared on both their and our lists. Lenzi’s methodology favored older papers as they analyzed total citations rather than annual citations during their time frame. Their time period started 15 years earlier than ours, so their emphasis on older papers is not surprising. Although many of the papers included in our list have been highly cited, and that was not necessarily required for inclusion. Number of citations is one method to assess the influence of a paper, but it is also heavily influenced by the journal impact factor, the reputation of the authors, the frequency of self-citation, the number of previous citations, and the amount of time since the paper was published. In the twenty-first century, other methods of measuring the impact of research are index computations and social media. Although the average number of citations per year was used to augment the nomination-generated list from Round 1 voting, our study relied more on expert consensus generated through a modified Delphi method than on the number or frequency of citations.

The list of final manuscripts in Table I is not meant to be a referendum upon the quality or validity of the selected papers. Analysis of those aspects of the papers was beyond the scope of this project: included papers may be neither valid methodologically nor of high quality. Rather, the included papers were meant to represent those that were influential on how laryngologists care for their patients and think of conditions they treat. Papers that may have been controversial due to their quality or validity could have been included in the list as long as they were considered to have substantial impact on the field as determined by overall votes. That impact may not have necessarily been considered positive by any or all of the study participants. Common themes during the video conference call were that several papers discussed were considered to have methodological flaws, espouse invalid results, or generally be of poor quality. Although the influence of a paper may not be associated with its quality and validity, inclusion on this list may reflect emerging trends in clinical practice, change in awareness of emphasis of particular conditions, starting points for future research, or perhaps simply an early keynote paper in a still controversial topic.

A strength of this study is high rates of participation in all rounds of this modified Delphi survey approach to reach consensus among a large group of expert laryngologists. The Delphi method is considered an effective technique to reach consensus among a varied group of experts. Our approach allowed us to build consensus across a broad geographic area and during a pandemic that prevented in-person meetings. The journal, author, and publication date factors that can bias the results of bibliometric analysis to determine lists of influential papers were minimized with the modified Delphi approach. Bibliometric analysis is susceptible to influence by the high rates of self-citation. Nominating and voting for one’s own papers was also a risk with our modified Delphi approach, since the participating laryngology experts were invited at least in part due to their scholarly contributions to the field. All voting was independent and anonymous, so there should not have been undue external pressure for participants to vote for papers with other participants as authors. Furthermore, participants did not argue for their own papers during the video conference discussion. Although several included papers did include one or more of this study’s participants as an author, many more votes than those of the included authors were needed in order for papers to get at least the 8 (50%) votes required for inclusion in the final list. Even if there were nominations of participants’ own papers in Round 1, many more participants would have to agree with the nomination in order for a paper to make it through to the final list.

**Limitations**

Although voting was anonymous, the video conference discussion was not anonymous. Some negative comments about other participant’s papers may have been withheld in attempt to not offend colleagues. In turn, opinions and voting could have been influenced by this omission of negative commentary. The variety of included papers may have been limited by the academic focus and characteristics of the participants. All participants reported voice as one of their two
clinical and research focuses and the majority of papers related to voice. This may represent bias in the field itself as voice is foundational to laryngology as a subspecialty and may represent the relatively senior status of many of our voting panelists—while chosen for their mature perspective on the field, it seems that a strong focus in dysphagia or airway care to the relative exclusion of voice care as a career choice is a more recent phenomenon in the field. Although translational and basic science papers were included as options in all three rounds of voting, none were included in the final list. This may reflect the clinical career focus of most of the panelists. Also, basic science findings typically require incorporation into clinical studies before clinical practice patterns are influenced. This result was similar to the Lenzi et al. paper of 100 most cited otolaryngology papers in which 77% were clinical. Although there were no language restrictions, all included papers were published in English, which was likely due in part to English being the primary language of most of the participants. Additionally, most participants were located in the United States. Influential papers that are not initially published or available in English or US-based journals may have been overlooked. Although participation in the video conference portion of the Delphi methodology was high, some participants could not join due to conflicts including clinical obligations and time zone differences. Finally, the process of selection was subjective and based on the collective opinions of the participants. The resulting list may have been different with a different group of expert laryngology participants.

CONCLUSION

This list of 21 influential laryngology papers serves to focus further research, provide perspective on recent advances within the field, and function as an educational resource for trainees and practicing physicians. The included papers reflect a focus on office-based treatment, quality of care, and patient-reported measures over the past two decades. As the volume of laryngology papers continues to grow, it can be helpful to have a concise list such as the one generated here to steer the reader to some of the more influential papers in the field.

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