

Preface

This supplement commemorates the sesquicentennial of the American Otological Society (AOS), the second oldest medical society in America. Eminent historian Arnold J. Toynbee, grandson of 19th century London otologist Joseph Toynbee who is widely credited as the father of scientific otology, famously said that “Some historians hold that history is just one damned thing after another.” Our goal in assembling this monograph is to illuminate more than merely the dates and facts surrounding the early years of the AOS but rather to delve into the motivations of the founder generation and to describe the ingenious ways they strove to bring comfort to their patients despite the limitations of their day.

Many aspects of the history of the society have been preserved in the Transactions of the AOS which began with the formation of the Society in 1868 and was published annually as a bound volume for 138 years through 2006 with the exception of the war years of 1943 and 1945. The Transactions include many the seminal works in otology and represent a time capsule of the state-of-the-art during the later half of the 19th and throughout the 20th centuries. Two earlier histories, primarily upon material preserved in the Transactions, were published by the Society at its 100th and 125th years. For those interested, the full text of the entire Transactions run and the two earlier society histories are available online at the Society’s website (americanotologicalsociety.org).

The goal of the present compendium is to extend earlier AOS histories by considering a wide spectrum of contemporary sources beyond the Transactions. This more comprehensive perspective helps to put the emergence of otology as a specialty into the context of medical knowledge at the time in relation to the roots of modern surgery with seminal advancements such as the introduction of antisepsis and anesthesia. The foundation of the AOS was influenced by the beginnings of specialized medical practice in America and the nascent specialty organizations it spawned. The monograph begins with new insights into the fascinating story of how, why, and by whom the society was formed. It continues with descriptions of the state of otological practice and hearing testing during the first quarter century of the AOS (1868-1893). Perspectives into the AOS official publications over its 150 years and its many contributions to otological education and research are explored. The belated, but increasing role of women in the specialty is described. The concluding paper gives a perspective on the scientific contributions of the AOS over the most recent quarter century and a provides a glimpse into the prospects for future evolution of the field in the 21st century.

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About the cover

The official Seal of the American Otological Society (AOS) was adopted in 1960. The dominant image is symbolic. A scribe records knowledge on a large volume while a youthful student holds an oil lamp, evocative of learning and wisdom. A traditional wand of Aesculapius with a staff (walking stick) enwrapped by a single serpent is depicted as opposed to the more common caduceus which has two snakes coiled around a winged staff. (1) The Ocean House Hotel in Newport, Rhode Island, was the location of the organizational meeting of the American Otological Society on Wednesday, July 22, 1868. Daniel Bennet St. John Roosa (1838-1908) of New York was the driving force behind the formation of the

AOS. Cover page of the 1st volume of the AOS Transactions (1868-1874). Examination of the ear via sunlight reflected off of a hand held mirror from Roosa’s 1874 otological text. (2)

References

1. Taylor GD. History of the seal of the Society. Transactions of the American Otological Society (Centennial Meeting), Vol LXVII. 1979, 112-113.
2. Roosa DBSJ. A Practical Treatise on the Disease of the Ear Including the Anatomy of the Organ. New York: William Wood & Company; 1874.

Foreword

“The only thing new in the world is the history you do not know”, Harry S. Truman, 35th President of the United States.

From the vantage point of the present, President Truman’s oft quoted adage rings true. We must know our past to better understand where we are now. The past of the American Otological Society’s (AOS) is long and noteworthy with a lengthy list of contributions over the last century and a half which shaped otologic practice around the world. As the America’s second oldest medical society, founded in 1868, the AOS has been and continues to serve as the focal point for discoveries and discussions on otologic subjects.

Why is the history of the AOS important? Modern day otologists truly do stand on the shoulders of those who have preceded us. The work of generations past has answered many questions in our field, but has raised more, spurring on present research and the further acquisition of knowledge. This is an endless cycle that is best appreciated by staying current and by looking back.

The explosion of knowledge and technology has been dramatic over the past 150 years, which only makes the work of earlier generations of otologists more impressive. Imagine a practice of otology without the benefit of a surgical microscope or even an audiometer. Our predecessors were individuals with tremendous character, persistence and determination. We not only owe them a debt of thanks for their scholarly work, but we continue to hold their principles and grit in high esteem.

Through the efforts of past leadership, the highlights of AOS history have been well documented. Both primary sources

as well as synopses are available to interested readers. The primary source – the Transactions of the American Otological Society date back to the society’s first scientific session held during the second annual meeting on July 21, 1869 at the Atlantic House in Newport, Rhode Island (Figures 1, 2). The AOS Transactions, which summarized the proceedings of the most recent annual meeting, are available for nearly all of history of the AOS.¹

The Transactions of the American Otological Society began with the formation of the Society in 1868 and was published annually either as a bound volume (1868-2001) or online (2002-06) for 138 years with the exception of the war years of 1943 and 1945. Typically, the Transactions included a list of members and incumbent officers, the Presidential Address, remarks of the Guest of Honor, minutes of the annual business meeting, a group photo of members attending the annual meeting, the annual meeting program, and list of past Presidents and Award of Merit recipients. For most of the Transactions the full text of original scientific papers presented at the annual meeting were published. With the adoption of the journal *Otology & Neurotology* (originally the *American Journal of Otology* founded 1979) as the official publication of the AOS in the mid-1990s, there was no longer a need for the Transactions to serve as a vehicle for publishing AOS scientific manuscripts. For its later years, the Transactions included only the abstracts of papers from its annual meeting, sometimes supplemented by comments made from the floor during the meeting. With the maturation of the AOS online presence as a means of distributing the Society’s in-

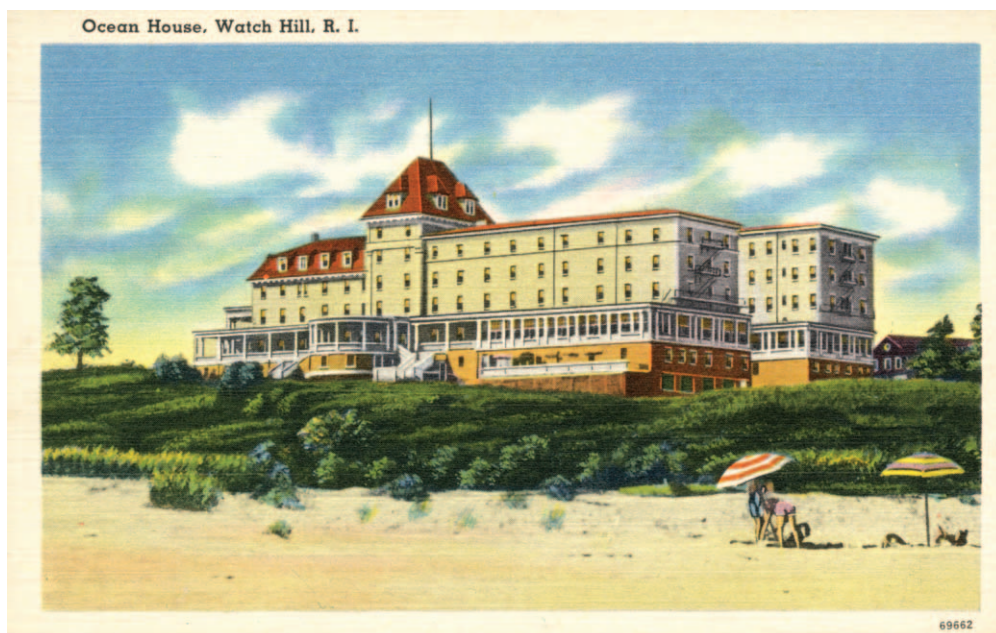


FIG. 1. The organizational meeting of the American Otological Society was held on Wednesday, July 22, 1868, at the Ocean House (opened 1868) Newport, Rhode Island.



FIG. 2. The first scientific meeting of the American Otological Society (July 21, 1869) was held at the Atlantic House (opened 1867) in Newport, Rhode Island.

formation, in 2007 the Council decided to cease publication of the Transactions. The thousands of scholarly manuscripts which appeared in the Transactions include many the seminal works in otology and represent a time capsule of the state-of-the-art during the later half of the 19th and throughout the 20th centuries.

Historical publications have been produced at two important AOS anniversaries – the 100th and the 125th. The 100th, edited by the renowned otologist Edmund Prince Fowler, was published in 1968, and the 125th was edited by Wesley H. Bradley and published in 1993. Both contain concise summaries, most often several paragraphs long, of the most salient points from each annual AOS Transaction distilled from more than a hundred pages of meeting minutes and scientific papers. The 125th publication reprinted the 100th and added material from the most recent 25 years. These monographs nicely summarized the foremost achievements of their respective eras.

There are several goals for this sesquicentennial supplement. Respecting prior tradition, one of the papers provides a summary of scientific advances in otology over our most recent quarter century while another conveys the perspective of recent past AOS Presidents. The other seven contributions seek to expand our knowledge of AOS history by encompassing a broader context than the earlier volumes. These utilize contemporaneous literature including books and journal articles published by AOS members, biographical material, other documents which enhance our understanding of the evolution of American otology over the last 150 years. The scope is intentionally broad covering the role of the AOS in the evolution of otological research and education as well as chronicling its varied scholarly publications. Special atten-

tion is given to the people, events, practices, and ideas of the society's formative years and to the gradually increasing role of women in the AOS. Taken together, this group of nine historical papers gives us an enhanced perspective on the role the AOS played in the evolution of the specialty. To make this supplement accessible to the broad community of otologists and historians of medicine the Society plans to make this publication accessible via PUBMED and also freely available on the AOS website.

As part of our longstanding traditions, the membership of the AOS takes pride in our Society's illustrious history. Those serving now, and in future generations, owe a debt of gratitude to the authors and editors of this compendium for enriching our understanding of how our Society helped to shape modern otological practice. While the contributors to this supplement have examined our collective past, the real excitement lies ahead. The AOS is a robust, financially stable, productive, and growing organization. While our future has yet to be written, the AOS is well positioned for what lies ahead. As so well-articulated by another US President, Thomas Jefferson in a letter to one his predecessors, John Adams on August 1, 1816, "I like the dreams of the future better than the history of the past".

So do I.

Samuel H. Selesnick MD FACS
President of the American Otological Society
at the 150th Annual Meeting.

Reference

1. Transactions of the American Otological Society 1868–2006: <http://www.americanotologicalsociety.org/transactions>

The American Otological Society at its Sesquicentennial: Insights Into the Society's Formative Years

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Objective: To elucidate the sequence of events which led to the formation of the American Otological Society (AOS) in 1868 and to examine the lives and contributions of the nine founding members of the Society.

Methods: Study of primary historical documents, biographical material, and previous histories of the AOS.

Results: Earlier treatments of the history of the AOS minimally covered the events and personalities from the Society's formative period. The founders of the AOS were much influenced by recent advances in European Otology and the success of the nascent American Ophthalmological Society which had been founded in 1864. The AOS has long credited Elkanah Williams as its first president of the AOS, although he never actually served in this role and was not a contributor to otological literature. Documents suggest that

30 years old New York physician Daniel Bennett St John Roosa, recently returned from a grand tour of the leading European otological centers, was the principal advocate for the creation of the AOS.

Conclusions: The 1860s were a pivotal period in the maturation of American Otology. Previously, most "aurists" were widely considered to be charlatans who practiced unscientifically and often unscrupulously. The AOS founder generation were a group of Ophthalmologists who strove to elevate otology from being a lesser appendage of the mother field to becoming a respected and scientifically based medical specialty in its own right. **Key Words:** American Otological Society—History—Sesquicentennial.

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By the 1860s, ophthalmology had been well established as a specialty both in Europe and America. The specialty's maturation was catalyzed by technical advances, most notably by the invention of the ophthalmoscope by Helmholtz in 1851 (1). By contrast, the majority of "aurists" practiced unscientifically and had little in the way of effective therapeutics to offer. They were widely viewed among the medical profession as quacks. Ophthalmologists focused principally on eye diseases and viewed otology as a sideline at most. Among the profession, otology was widely perceived as a poor step child of ophthalmology. The preface of the first volume of the Transactions of the American Otological Society Volume I (1868–1874) summarized the woeful state of the field of otology at mid-19th century: "Until within a very few years, the science and art of otology had been almost entirely neglected by the medical profession of the United States. In this respect, however, we are not much behind most other parts of the civilized world. In its very best position, otology was an appendage, not always very gracefully worn, to the Department of Ophthalmology." (2)

During the 1850s and 1860s an awakening of interest in ear diseases rose among a group of European physicians who became interested in medicine and surgery of the ear. These pioneers of scientific otology included German (Schwartz, Kramer, von Tröltsch), Austrian (Politzer), British (Toynbee), and Irish (Wilde) who emphasized otology in their practices and who authored textbooks in the field during the 1850s to 1870s. In 1863, the first medical journal dedicated to otology, *Archiv für Ohrenheilkunde*, was founded and began publication in 1864 (3).

The formative period of the American Ophthalmological Society in 1864 to 1865 is well documented (4–7). By contrast, the details of the American Otological Society (AOS) formation in 1868 to 1869 are minimally covered in the two otherwise excellent monographs which chronicle its history (8,9). While the members of the AOS are justly proud at how well our history has been preserved, much of this fascinating story of the Society's birth remains untold. The purpose of this paper is to elucidate the sequence of events which led to the society's foundation and to examine the lives and otological contributions of the nine founding members of the AOS.

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METHODS

The principal sources were primary historical documents including meeting minutes and scientific transactions of the American Otological Society (1868–1911) and American

TABLE 1. *Nine founding members of the American Otological Society (July 22, 1868)*

			Age at AOS	Meeting	AOS President
			Founding	Attendance ^a	
Elkanah G. Williams (Chair)	(1822–1888)	Cincinnati	46	0/5	1868–1869 ^b
Henry Drury Noyes	(1832–1900) ^c	New York City	36	4/5	1870–1873
D. B. St. John Roosa	(1838–1908) ^c	New York City	30	3/5	1875–1876
Oren Day Pomeroy	(1834–1902)	New York City	34	3/5	1890
John Green	(1835–1913)	St Louis	33	4/5	
Charles A. Robertson	(1829–1880) ^c	Albany	39	1/5	
Cornelius Rea Agnew	(1830–1888) ^c	New York City	38	2/5	
Freeman Josiah Bumstead	(1826–1879) ^c	New York City	42	0/5	
Charles Everts Rider	(1839–1909)	Rochester	29	2/5	

^aFirst five AOS scientific meetings 1869–1874.

^bWilliams chaired the organizational meeting of 1868, but did not attend meeting in his presidential year of 1869 (the Society's 1st scientific meeting).

^cAlso served as founding members of the American Ophthalmology Society in 1864.

Note: Two AOS founding members also President of the American Ophthalmological Society: C. R. Agnew (1874–1878) and H. D. Noyes (1879–1884). Noyes has the distinction of having been the only individual to serve as President of both Societies.

Ophthalmological Society (1864–1911). Biographical materials for the nine AOS founders were derived from their publications, comments by their contemporaries and later historians, and obituaries in medical journals and newspapers. Earlier historical treatments referring to the formative period of both eye and ear societies were also consulted. The scholarly contributions of the nine AOS founding members to the otological literature were assessed by evaluating the number of publications in the AOS transactions over the initial 14 years (1868–1881) of the of the Society's meetings.

The Emergence of the American Otological Society from the American Ophthalmological Society

When the American Ophthalmological Society was founded in the summer 1864 in New York it became the first American medical specialty society (4). At the Annual meeting of the American Ophthalmology Society at the Ocean House in Newport, Rhode Island on Tuesday, July 21, 1868, a motion was made to add the term "Aural" to the society's name (i.e., American Ophthalmology and Aural Society). According to Newell, "There was extended debate but the motion finally failed." (7) Interestingly, neither the motion nor the substance of the discussion which followed was recorded in the minutes of the 1868 meeting published in the Ophthalmology Transactions. Having been rebuffed by the membership, a group of nine members stayed on in Newport an extra day (Wednesday July 22, 1868) and held an organizational meeting during which it was decided to launch a separate society dedicated to the ear—the American Otological Society. Those meeting were a young group, even for the day, with one in the 20s, six in the 30s, and only two in their 40s with the senior member at age 46. Most were veterans of the American Civil War (1861–1865) having served in the medical services of the Union Army.

The Chair of this organizational session was the senior member Elkanah Williams of Cincinnati. During the proceedings Williams was elected the first President of the AOS to serve during the 1869 inaugural scientific meeting to be held the next summer. Williams, however, did not attend the AOS inaugural meeting, even though he was the nascent Society's President. He also did not attend the first five annual scientific meetings (Table 1). Williams was listed as an AOS member from 1868 to 1870, but was inexplicably dropped from the

membership list 1871 and 1872, perhaps from non-payment of dues, only to reappear 1873 onward. During his career, Williams did not contribute any publications to the AOS Transactions. As Williams did not appear to have any special interest in the ear, the senior members of the Ophthalmology Society may have asked him to participate in the organizational meeting to monitor the young advocates for otology and represent the interests of the parent Society. Freeman Josiah Bumstead, the only other participant in the 1869 formative meeting over the age of 40, never attended an AOS scientific meeting and resigned his membership in 1870. Bumstead and Williams may have been asked to oversee the proceedings on behalf of the Ophthalmology Society to influence such important formative decisions as having the AOS meet in concert with the Ophthalmology Society and to publish transactions of the two societies together.

Biographies of the Nine Founding Members and their Contributions to Otology

Elkanah G. Williams (1822–1888): Williams was born in Bedford, Indiana (10–13). He graduated from Asbury College (now De Pauw University) in Indiana in 1847 and obtained his medical degree from the University of Louisville in 1850. After 2 years in general practice, Williams left for Europe in 1852 for additional study in ophthalmology in Paris, London, Vienna, Prague, and Berlin. He is credited with introducing Hermann von Helmholtz's ophthalmoscope in London and was an early advocate for the device in the United States (5). His paper "The Ophthalmoscope: The principles on which it is based—The manner of its application—And its practical advantages" helped to introduce the device in America (14). Williams was described by Drury as "Above average height, with broad shoulders, slightly stooped, his genial face and kind eyes inspired confidence in his patients." (11) He became famous in Ohio and surrounding states for expertise in care of eye diseases. In 1856, he was named the first Professor of ophthalmology in the United States at Miami Medical College in Cincinnati. He was a member of the International Ophthalmologic Congress and elected as its presiding officer in 1876. He was also an honorary member of the United Kingdom Ophthalmology Society. Williams chaired the organizational meeting of the AOS in 1868. Although he was elected President



FIG. 1. Founders of the American Otological Society.

for the inaugural scientific meeting in 1869, he neither attended during his Presidential year nor many subsequent meetings of the new Society. While he presented a total of nine papers at the American Ophthalmological Society he never published in the AOS transactions. In an unusual honor, Williams was named an honorary member of the AOS shortly before his death in 1888. The minutes of the meeting explained: "The resignation of Dr. E. Williams of Cincinnati, O., on account of ill health, was presented by the Secretary. The resignation was accepted. Under suspension of the By-Laws, on motion of Dr. W. H. Carmalt, Dr. E. Williams was then unanimously elected to Honorary Membership in the Society." (15) As honorary membership in the AOS was customarily conveyed to distinguished non-members, such as Alexander Graham Bell, this most special honor may have been awarded in recognition in William's chairing the Society's organizational meeting two decades before. (see Table 1, Fig. 1).

Oren Day Pomeroy (1834–1902): Pomeroy was born in Somers, Connecticut (16–18). He attended Berkshire Medical College and graduated from the College of Physicians and Surgeons in New York in 1860. He served as Director of the Manhattan Eye and Ear Hospital. He was President of the New York Ophthalmological Society in 1872 and President of the American Otological Society in 1890. Indicative of his primary interest in otology, in the early years Pomeroy read a total of 12 papers at the AOS and only five papers at the American Ophthalmological Society. His papers addressed issues such as auricular abscesses, hemorrhagic otitis, paracentesis of the tympanic membrane, Politzerization, Eustachian tube catheterization, tenotomy of the tensor tympani muscle, and ear problems among the insane. Pomeroy is best known for his book, *The Diagnosis and Treatment of Diseases of the Ear*, which was published in two editions in 1883 and 1886 and was used as a guide by many medical schools at the time (19).

Daniel Bennet (DB) St. John Roosa (1838–1908): Roosa was born in Bethel, New York (20–23). He attended Yale

for college, was dismissed due to ill health, and much later received an honorary degree from Yale. He completed medical school at the University of the City of New York in 1860. During the Civil War he served in the New York National Guard and was at the battle of Gettysburg (1863). Roosa practiced at the New York Eye and Ear (founded 1820) and was a founding member of the Manhattan Eye and Ear Infirmary (1869). He also served as a founding member of the American Ophthalmology Society in 1864. While he was very productive as a scholar in otology, he also published important works in ophthalmology. He had 11 publications in the AOS transactions over its early years covering a diverse series of topics including mastoid surgery, myringotomy, external otitis, use of tuning forks, and the effects of quinine on the ear. More on Roosa's leadership role in the formation of the AOS is described in the next section.

Charles Archibald Robertson (1829–1880): Robertson was born in Mobile, Alabama (24–27). He graduated from Harvard University in 1850 and from Jefferson Medical College in 1853. He studied diseases of the eye and ear at the Perkins Institution for the Blind, Massachusetts Charitable Eye and Ear Infirmary, and Wills Hospital in Philadelphia. Robertson studied abroad in Dublin and Paris. His memorial describes him as "a man of strong social instincts, and, consequently, had hosts of warm friends." (24) He practiced at the St Peter's and Albany Hospitals in Albany. He also served as a founding member of the American Ophthalmology Society in 1864 and later its President (1874–1878). He published a number of papers in the ophthalmologic literature, with topics ranging from glaucoma to reflex phenomena after eye injury (27). He presented only one paper at the AOS, a case report of malignant disease of the ear. He resigned from the AOS in 1879.

Cornelius Rea Agnew (1830–1888): Agnew was born in New York City (28,29). He graduated from Columbia College in 1849 and finished his medical degree in 1852 at the College

of Physicians and Surgeons in New York. He completed postgraduate study in Dublin (under Sir William Wilde), London, and Paris before establishing practice in New York. A biographer commented that Agnew was: "A man of strong marked and wholly natural executive ability" and that "He was gently dignified in a manner and even in serious conversation had a way of smiling softly. . ." (28) Agnew served as a founding member of the American Ophthalmological Society in 1864 and later as President from 1873 to 1878. He was a founding surgeon for both the Brooklyn Eye and Ear Hospital and Manhattan Eye and Ear Hospital. He presented 13 papers at the American Ophthalmological Society but only two at the American Otological Society. His papers on ear disease involved a tumor of the auricle and trephination of the mastoid. He was known for his developments in strabismus surgery and cantholysis (30). He demonstrated an interest in public health throughout his career, serving as Surgeon General of the State of New York, as Secretary of the first New York Society for Sanitary Reform, and as a member of the committee that prepared the first draft of the city health laws.

Freeman Josiah Bumstead (1826–1879): Bumstead was born in Boston, Massachusetts (31,32). He graduated from Williams College in 1847 and from Harvard Medical School in 1851. He studied venereal diseases abroad in London and Paris for several months before returning to New York City for practice. Although he was a founding member of both the American Ophthalmological and Otological Societies, he is best known for his contributions to urology. He resigned from the American Otological Society in 1870, only 2 years after its founding in 1868, and never published in the AOS transactions. He published important translations of French urologic textbooks, including M. A. Cullerier's Atlas of Venereal Diseases in 1868 (33). He later published his own textbook, *The Pathology and Treatment of Venereal Diseases* which was released in five editions (34).

John Green (1835–1913): Green was born in Worcester, Massachusetts. He graduated from Harvard College in 1855, and Harvard Medical School in 1866 (35,36). Following travel to Europe for postgraduate medical studies in London, Paris, Berlin, Vienna, and Utrecht, he began practice in Boston before settling in St. Louis in 1866. A biographer described Green as "By nature gentle, refined and retiring, possessing a clear and logical mind, great learning and ability, an exceptionally cultured diction, and an absolute honesty of purpose. . ." (36) He was professor of ophthalmology and otology at the St. Louis College of Physicians and Surgeons. Green served as Chair of the Ophthalmology Society Membership Committee for an impressive 38 years (1868–1906). He was chairman of the St. Louis Ophthalmological Society, and became known for entropion operations, lachrymal duct treatment, and orbital exenterations. He read 35 papers at the American Ophthalmological Society, and three at the AOS on the subjects such as Aspergillus infection, use of salt in the treatment of draining tympanic membrane perforations, and the function of the Eustachian tube subjected to pressure.

Henry Drury Noyes (1832–1900): Noyes was born in New York City (37,38). He graduated from New York University in 1851 and completed medical school at the College of Physicians and Surgeons in New York in 1855. After a year of postgraduate study in Europe, he began practice in New York. He was an early advocate for the use of cocaine as local anesthetic in ophthalmic surgery (39). He practiced at the New York Eye and Ear Infirmary for 41 years and was Professor of ophthalmology and otology at the Bellevue Hospital

Medical College. Noyes also served as a founding member of the American Ophthalmology Society in 1864. According to the official history of the Ophthalmological Society, Noyes was the "guiding spirit" who led the formation of the society (7). His memorial in the ophthalmology transactions described him as "a graceful and forcible speaker, and a brilliant teacher." (37) Noyes was also President of the New York Ophthalmologic Society. He presented 47 papers at the American Ophthalmological Society, the most prolific of any founding member, but only five at the AOS. His handful of ear papers covered topics such as Eustachian tube catheters and bougies, facial paralysis, and Menière's disease. Noyes was the Ophthalmological Society recording secretary from its founding in 1864 until 1874. He served as AOS President from 1870 to 1873 and subsequently served as Ophthalmological Society President from 1879 to 1884—the longest term of any President. Noyes has the distinction of being the only individual to serve as President of both eye and ear societies, a feat unlikely ever to be repeated. He was well known for his *Treatise on Diseases of the Eye* on which he based his later *Textbook on Diseases of the Eye*, which was published in two editions (40,41).

Charles Everts Rider (1839–1909): Rider was born in New Haven, Vermont (42). He attended Oberlin and Middlebury Colleges, and completed his medical degree at the University of Vermont in 1863 before establishing practice in Rochester, New York. Rider was Professor of ophthalmology at Geneva Medical School (New York) and later at Syracuse University. He was not particularly academic having read no papers at the AOS and only one at the American Ophthalmological Society on the subject of the "The Winking Test." (43) Of interest, he went on to develop the world's largest hardwood floor manufacturing business and obtained a patent in parquetry, a wood inlay technique.

LEADING THE EFFORT TO CREATE THE AMERICAN OTOLOGICAL SOCIETY

The AOS was founded upon the impetus of Daniel Bennet (DB) St. John Roosa (1838–1908) (Fig. 2). Roosa traveled for a year (1862–1863) to Europe to the great centers of European medicine (Vienna and Berlin) during which time he visited many of the leading otologists of his day. Roosa was heavily influenced by the more advanced otological care he witnessed during his European travels and was inspired to champion otology as a worthy field of endeavor among his fellow ophthalmologists upon his return home to America. Wilhelm Kramer (1801–1875) of Berlin was a famous otologist who published two sentinel books in the field: *The Knowledge and Treatment of Ear Diseases* (1838) and *Aural Surgery of the Present Day* (1863) (44,45). Writing in 1864, 4 years before the formation of the AOS, Roosa praised his European hosts: "Through the extreme courtesy of Dr. Kramer, while in Berlin, I had the opportunity of seeing a good deal of his large private practice, and the pleasure of his peculiar views at some length." (46) In his writings, Roosa paid homage to European authors who made important contributions to the maturation of the field of otology (46). From connections made during his time in Germany, Roosa served as translator

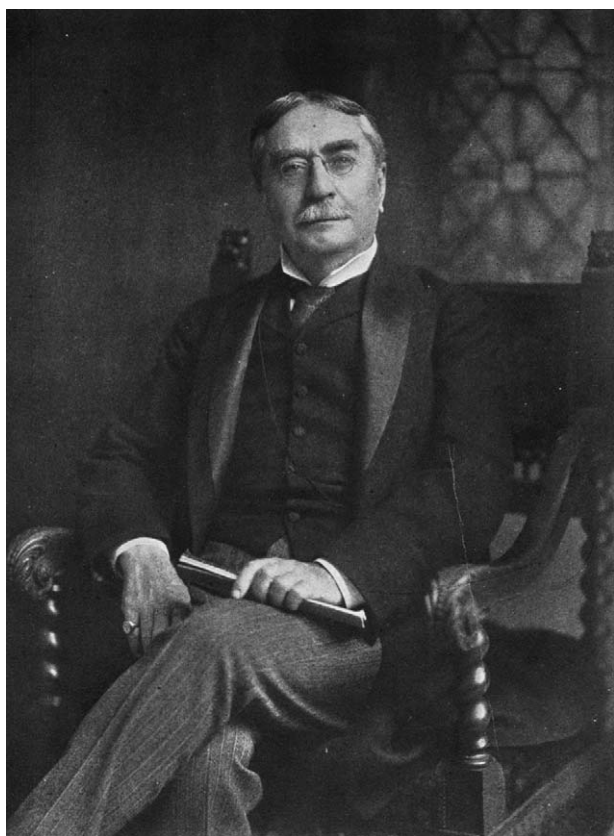


FIG. 2. Daniel Bennett St. John Roosa.

for two editions (1864, 1869) of one major German otology textbook authored by Anton von Trölsch of Würzburg (47,48).

Of relevance to his future role in forming the AOS, Roosa participated in the two planning meetings which led to the formation of the American Ophthalmological Society in January 1864 held in Noyes' medical office on 4th Avenue in New York and in June 1864 during the annual meeting of the American Medical Association in New York (4,5). Through this experience he became familiar with the steps involved in creating a medical specialty society including the elements of a constitution, committee structure, and annual meeting organization. At the time Roosa was less than a year of returning from his grand European tour and a mere 26 years old. Five years after his return to America, at age 30, Roosa attended the fifth annual meeting of the American Ophthalmological Society in 1868. Even though he was still a junior member, he made the motion proposing the addition of "Aural" to the organization's title. Disappointed by the failure of his motion, Roosa and eight other members met the next day to give birth to the AOS.

Observers described Roosa as a forceful and persuasive individual—the type of character to push forward new ideas and persevere to overcome opposition. Roosa's memorial in the AOS transactions of 1909

described him as: "Of strong dominant personality, full of sonorous voice and forceful expression; he made himself felt in all affairs in which he took part." (23) Spaulding described Roosa as "A man remarkable for his vigorous expressions of opinion in the two specialties which began to flourish at the time when he started in practice, specialties which he assiduously and successfully cultivated during the rest of his medical life." (21) Edmund Prince Fowler (1872–1976), writing in the 1968 Centennial History of the AOS, described Roosa's personality: "Dr. Roosa possessed a dynamic personality and dominated, at least for many years, most of the societies and hospitals to which he belonged, especially those he had played a major part in founding. Naturally, some did not agree with his ideas, and whenever he was on the scene many exciting debates and discussions ensued." (8) In discussing Roosa, Fowler went on to describe the dynamic nature of the society's early meetings which was quite different from our more sedate deliberations today. "There were other so-called 'giants' in those days, and they enjoyed "animated" discussions; they pulled no punches at the meetings." Clearly, the courteous and respectful tone typical of today's AOS meetings is a tradition of more recent origin.

One indication of Roosa's prominent role in founding the AOS is that he presented the first paper at the Society's inaugural scientific meeting in 1869 (49). His "Progress in Otology" represented a substantial 22 page long review of the current literature. For decades he was a prolific contributor to the AOS transactions on a wide variety of otological topics. Roosa went on to become the Society's third president serving from 1874 to 1876. Roosa's textbook "A Practical Treatise on the Diseases of the Ear, Including the Anatomy of the Organ." was first published in 1873 and appeared in seven editions through 1891 (50). His text republished in London and was translated into German. In 1876, the nation's centennial year, Roosa served as President of the first congress of the International Otological Society held in New York (51).

A second individual who deserves special credit for his leading role in the formation of the AOS was Henry Drury Noyes (1832–1900). He served as the AOS President from 1870 to 1873 and was the first President to actually preside over an annual scientific meeting. In contrast to Roosa, Noyes' career remained focused in ophthalmology. The great majority of his scholarly output appeared in the ophthalmological literature and his textbooks concerned eye diseases. Noyes was both a founder and of the Ophthalmological Society and its longest serving President.

The Evolving Attitudes Towards Otology in the 1860s and 1870s

The perception of otology as a field evolved considerably throughout the 1860s to 1870s. This is well illustrated by the writings of D. B. St John Roosa. In the early 1860s he was not shy regarding describing what he perceived as deficiencies in contemporary American

otological practice. In 1864 he wrote: “I believe aural surgery to be a comparatively neglected field, and my own experience has already been ample enough to show that a much larger number of chronic cases come to the surgeon’s eye than in other branches of our art; consequently, we cannot expect the same therapeutic results, as for instance, in ophthalmology, and our reward for labor cannot just now be the dazzling one that falls to the lot of successful practitioners in other departments; but if we but succeed in waking up the profession to the curability of recent ear cases, and to the fallacy of the idea of outgrowing these affections, perhaps our work will be done.” (46) He added the Latin phrase: *Arbores seret diligens agricola, quarum adspiciet baccam ipse nunquam* (translation: the industrious husbandman will plant trees, a berry of which he will himself never behold) suggesting that he anticipated that the full flowering of the specialty will occur beyond his own time.

In 1868, Roosa expressed more optimism: “The science of otology is fast taking its place in the van of the great movement in the ranks of Medicine. Diseases of the ear are now receiving the attention which humanity had vainly demanded of our profession for centuries.” (52) By 1873, Roosa’s tone had become even more optimistic including a somewhat congratulatory tone based upon progress over the previous decade. “The practice of otology in this country was, a few years since, almost exclusively confined to charlatans; but now it is cultivated by a class of men who are equals to any in the profession. Ten years ago, in most parts of the country, those who wished advice upon disease of the ear were forced to seek aid outside of the profession. At the present time, there can be found those in large cities who are constantly and successfully treating aural diseases; and all over the land the old familiar advice, “Not to meddle with the ear,” is growing far less frequent. The day will soon arrive—if indeed it be not already upon us—when otology will take equal rank with ophthalmology, to which department it has so long been a mere appendage, and when some knowledge of the diseases and treatment of the ear, will be required of every practitioner.” (50)

THE EARLY YEARS OF THE AMERICAN OTOLOGICAL SOCIETY

The meetings of the AOS were scheduled the day before the ophthalmology Society in the same location, most often Newport, Rhode Island. The two societies met together until 1911 when the AOS met in Atlantic City, New Jersey, and the Ophthalmology Society in New London, Connecticut. Thereafter, the eye and ear societies met together every third year as part of the Congress of American Physicians and Surgeons, but this coupling ended in 1933 (7). The first AOS transactions (2nd meeting, but first scientific session) were published jointly with the Ophthalmological transactions in 1869 (2). From 1870 onward, the AOS transactions were published separately. The “-ical” naming convention

TABLE 2. *Annual meetings of the American Otological Society: the first two decades*

	Members Present	Active Membership	
1868 Newport	9	9	(Organizational meeting)
1869 Newport	9	17	(1st Scientific meeting)
1870 Newport	10	33	
1871 Newport	7	36	
1872 Newport	6	29	
1873 Newport	17	42	
1974 Newport	13	42	
1876 New York City	17	47	
1877 Niagara Falls	4	(No Quorum, railroad strike)	
1878 Newport,	18	47	
1879 Newport	18	46	
1880 Newport	16	48	
1881 Newport	18	51	
1882 Lake George	19	55	
1883 Catskill Mountains	23	59	
1884 Catskill Mountains	23	61	
1885 New London	27	60	
1886 New London	26	65	
1887 New London	25	67	
1888 New London	27	69	

of the Society “Otological” follows that of the “Ophthalmological” and others such as the American “Surgical” Society (1880). By contract, the American Neurotology Society, founded over a century later in 1974, uses the specialty’s name rather than a descriptive term.

The first five meetings (1868–1872) of the AOS were surprisingly small with only 9, 9, 10, 7, and 6 members in attendance (Table 2). Nevertheless, the active membership list progressively grew from the initial nine in 1868 to 36 in 1871, 48 in 1880, and 69 in 1888. Participation was such a challenge in the early years that the quorum reduced from eight to five members in 1870. The initial seven meetings were all held in Newport, Rhode Island. In the early years, the members of the AOS were all from the East Coast except for a few “westerners” from the far away cities of Cincinnati, St Louis, and Chicago. In the minutes of the 1875 meeting a comment appears: “Dr. Williams called attention to the fact that the Western States felt themselves somewhat neglected in the selection of the place for the meeting of this Society.” (53) By western states he was likely referring to mid-western states such as his home state of Ohio as in the early years the AOS had no members from the far west. This is not surprising in that the transcontinental railroad was not completed in 1869, took nearly a week to cross the nation, and ticket rates for one way as of June 1870 were \$136 for first class in a Pullman sleeping car; \$110 for second class; \$65 for third (54). The transactions of the 44th annual meeting in 1911 lists Dr. Joseph Andrews

of Santa Barbara, California, evidently the first AOS member from the west coast.

The 1869 minutes reflect an annual “tax” on members of \$1, equivalent to approximately \$28 in 2017 dollars (2). By comparison, in 1865 the Ophthalmology Society assessed its members \$3 (4). In the mid-19th century physician incomes were comparable with middle class wages, generally under \$1000 per year (55). Financially well off physicians generally had inherited their wealth. In 1872, the AOS transactions minutes reflect the policy of the Society that “any member neglecting to pay the annual assessments for three years shall be considered to have forfeited his membership.” (2) The 1876 minutes of the AOS mentioned that the cost of the auditorium and a clerk for the day at Chickering Hall on 5th Avenue in New York was \$52 (53).

In 1881, the AOS asserted primacy for all papers presented at its annual meetings. “Dr. C. H. Burnett moves that members presenting papers may be allowed to publish them elsewhere, either in toto or in abstract. Dr. H. D. Noyes offers as a substitute, that papers read before the Society shall become its property, and shall, at the discretion of the Society, be published in its transactions. The author of a paper may have the privilege of publication in any other manner, provided he make request to that effect to the Business Committee at the meeting of the Society when it shall have been read. When published in another manner, the fact of having been read before the American Otological Society shall be stated.” (53)

In the formative years, it appears that any member of the American Ophthalmology Society with an interest in otology was routinely accepted into the AOS. Nearly two decades later (1885) the more rigorous selection criteria were applied: “Candidates for membership shall have been engaged in the practice of Aural surgery for at least five years, shall have given evidence of satisfactory scientific attainments, and shall have conducted themselves in conformity with the ethical rules of this Society.” (56)

It is noteworthy that Alexander Graham Bell, the famed inventor of the telephone, who considered himself an educator of the deaf, was an honorary member of the AOS. The transactions of 1885 comment: “Prof. A. Graham Bell, of Washington, DC, honorary member of the Society, addressed the Society with regard to the large number of Deaf-Mutes in the Institutions for Deaf-Mutes, that could yet hear to a certain degree, and therefore were simply hard-of-hearing members of society, also to the possibility of educating the hearing power in these persons and recommended the subject to the consideration of the Members of the American Otological Society.” (56)

DISCUSSION

The 19th century saw the emergence of medical specialization, although the prevalence of specialization remained far less than it is today. By the mid-1880s, 10 to 15% of physicians in large American cities listed

themselves as specialists whereas specialization in rural settings was rare (57). An 1866 report of the American Medical Association Committee (AMA) on Medical Ethics of Specialties reveals much of prevailing attitudes at the time (58). While recognizing the value of the superior knowledge and skill of specialists, the report cautions that: “There is often seen in specialists a tendency to undervalue the treatment of special diseases by general practitioners.” The report endorses the practice of “partial specialism” as opposed to “exclusive specialism.” In 1869, the AMA took a strong position against advertising by specialists: “That it shall not be proper for specialists publicly to advertise themselves as such, or to assume any title not specially granted by a regularly chartered college.” (59)

One expression of the emerging trend towards specialization in the mid-19th century was the formation of specialty societies. Ophthalmology was in the advanced guard of specialization both in Europe and America. The formation of the American Ophthalmological Society in 1864 represented the first specialty society in the United States with the American Otological Society in 1868 becoming the second. The advancement of otology as a specialty in the United States was clearly catalyzed by its close relation with ophthalmology. The founding generation of the AOS were all ophthalmologists who developed an enhanced interest in otology. Most of the 19th century leaders in otology continued to practice in both fields. The sequence of events leading to the AOS formation derived directly from experience in analogous actions by ophthalmologists in organizing their Society 4 years earlier.

During the 19th century, surgical specialties began to differentiate from the all encompassing field of general surgery. According to Friedenwald, while ophthalmology had a “rapid divorce from surgery” during the 19th century, it remained “wedded” to otology (5). This was exemplified by the creation of eye and ear hospitals. The prototype for eye and ear infirmaries in America was one established in London in 1805 by John Cunningham Saunders (60). The New York Eye Infirmary was founded 1820 with an otology service added in 1824. The name was changed to New York Eye and Ear Infirmary in 1864 (61). The Massachusetts Charitable Eye and Ear Infirmary was founded in 1824 with the word charitable removed in 1924 (60). The Manhattan Eye, Ear, and Throat Hospital was created in 1869 (62). In 1870, the institution treated 1227 eye and 430 ear cases.

A German Otological Society (*Deutsche Otologische Gesellschaft*) was formed in 1881 and a similar Austrian Society in 1895. London otologist George P. Fields gave an address before the Section of Otology of the British Medical Association in August 1883 lamenting the lack of a British Otological Society (63). “I am strongly inclined, indeed, to conclude, from the benefits which I perceive to accrue from our Association meetings, that great good would result from the formation of an Otological Society of Great Britain. Our nearest Continental neighbors, and our American friends, have their

otological societies and journals; and the fault will be ours if we in England, through self-seeking, jealousy, or other failings, do not vie with them in their generous work." He went on to say that: "Such organisations would naturally tend to foster a spirit of enquiring into yet unsolved problems of aural science." The Otological Society of the United Kingdom was eventually founded in 1900.

The events surrounding the birth of the AOS illustrates, this "marriage" between otology and ophthalmology was not without some degree of separateness. While the eye and ear are the two most important special senses, the clinical aspects of the two fields have important similarities and differences. Both share the need for illumination and magnification through a small aperture, but the technology used in otoscopy and ophthalmoscopy differs considerably. Aural surgery at the time emphasized bone removal with a hammer and gouge, techniques foreign to the ophthalmologist. As otolaryngology coalesced into a distinct specialty in the early years of the 20th century, otology gradually drifted further and further from ophthalmology until it evolved to become an integral part of the new specialty of otolaryngology (64).

In contrast to the separation of eye and ear societies, organizations arose that converged the entire spectrum of eye, ear, nose, and throat surgeons. Prime examples included the Section of Ophthalmology and Otolaryngology of the American Medical Association (proposed in 1877 and established 1879) and the American Academy of Ophthalmology and Otolaryngology (established 1896). In the case of the American Academy, ophthalmology did not formally separate from otolaryngology until 1978, decades after overlapping membership had become a rarity and the practice of "EENT" lay in the past (65).

While the vanguard of otology in the 19th century was clearly in Europe, during the latter part of the century American Otology established a handful of centers of excellence, notably in New York and Boston. A number of fine American textbooks of otology appeared in the second half of the 19th century authored by AOS members including Albert H. Buck, Charles H. Burnett, Edward B. Dench, D. B. St John Roosa, Samuel Sexton, Oren D. Pomeroy, and A. D. Williams (66–71). Nevertheless, during this era young American physicians seeking advanced training in otology made the pilgrimage to the great centers of Europe. This trend was not reversed until American Otology rose to prominence during the mid-portion of the 20th century elevated by luminaries such as Julius Lempert, John Shea Jr., Howard & William House, and George E. Shambaugh Jr.

The story of the formation of the AOS illustrates why it is important to go beyond traditional rosters of elected leaders to reveal the actual events of the past. For 150 years, the AOS transactions has honored Elkanah Williams as the Society's first President even though he was only elected to the position but never actually served in the role. If there is an individual worthy of being called the "founder" of the AOS, study of the documentary

record reveals that this credit should be accrued to D. B. St John Roosa who was the leading advocate for the new Society and who for decades thereafter was a distinguished practitioner and thought leader in field.

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Practice of Otology During the First Quarter Century of the American Otological Society (1868–1893)

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Objective: To describe the practice of otology in America during the first quarter century of the American Otological Society (AOS).

Methods: Two sources were used to determine the most prevalent disease conditions cared for and surgical procedures undertaken during this era. All articles published in the AOS transactions between 1868 and 1893 were studied as were the otology textbooks published by 6 of the first 10 Presidents of the Society.

Results: The primary emphasis of late 19th century American otological scholarship was on chronic ear infection with numerous articles focusing on complications of otitis including frequent descriptions of fatalities. Much emphasis was placed upon the Eustachian tube with catheterization and insufflation a major part of otological practice. Due to limitations in technology, the overwhelming focus was on diseases of the ear canal and middle ear. Understanding of

temporal bone anatomy was much superior to that of physiology. Erroneous speculations on the function of the middle and inner ear were common. Surgical interventions were largely limited to myringotomy and mastoidectomy, the latter of which was sometimes life saving during the preantibiotic era.

Conclusion: The latter half of the 19th century saw the emergence of otology as a specialty in America and many emerging diagnostic and therapeutic advances were adopted. While capabilities were notably limited during this era, the efforts of a small band of pioneer otologists in the founder generation of the AOS contributed greatly to the progress of the emerging specialty. **Key Words:** 19th century—American Otological Society—History of otology.

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In honor of the 150th anniversary of the American Otological Society (AOS), founded in 1868, we reflect upon the way otology was practiced in America during the first quarter century of the Society. In the first half of the 19th century, the decades leading up to the formation of the AOS, the diagnostic and therapeutic armamentarium of the otologist was decidedly limited. Indeed, the field was so devoid of capabilities that few reputable American practitioners were willing to take up the challenge of treating ear diseases. In this era of patent medicines, the void was filled by charlatans who peddled ineffective concoctions hawked with assurances of their miraculous curative power. That the title “aurist” became synonymous with quack served to diminish the attractiveness of otological practice among reputable practitioners.

The last quarter of the 19th century was a time of rapid maturation of otology as a clinical and surgical field. During this period many important advances in

otological therapy, both in medical and surgical realms, were achieved. While otological practice in America during this formative era was well behind what it was in leading centers of Europe (especially Vienna, Berlin, and London), the founding generation of the AOS played a major role in incorporating these emerging methods and refining their use for the benefit of the American public.

Our goal is to describe the clinical practice of otology in the United States during the quarter century between 1868 and 1893, an era worthy of special study as it was a transformational epoch during which otology first took root as a specialty in America.

METHODS

The primary resource for determining American otological practice in the early years of the AOS was the Transactions of the American Otological Society over its initial quarter century (1868–1893) (1). An additional source are the otology textbooks authored by 6 of the first 10 Presidents of the AOS including those of Roosa, Blake, Buck, Burnett, Pomeroy, and Bacon (2–7).

Anatomy

A large focus of scholarship leading up to the 19th century dealt with anatomy of the ear. As with many specialties of this

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FIG. 1. Examination of the ear via sunlight reflected off of a hand held mirror (3).

era, knowledge of gross anatomy was much better established than that of physiology, diagnostics, or therapeutics. In recognition of the pre-eminence of anatomy, the early issues of the AOS Transactions began with a section detailing advances in anatomical knowledge over the previous year.

B. Alex Randall of Philadelphia (AOS President 1903–1905) was an influential figure in advocating for the importance of anatomy in teaching ear surgery. At the 1895 American Medical Association meeting he stated: “the aural surgeon must have the topography of the ear and the surroundings clear in his mind and ready at his finger ends, when operating on the mastoid or still more within the tympanum, is evident to all (8).” He cautioned that without knowledge of proper anatomy, an ear surgeon:

“... endangers the structures beyond – the stapes, chorda and possibly the facial nerve, if operating up and back, the mucous membrane of the promontory below and the head of the jugular in the floor of the tympanum. The reported cases where the jugular has been thus opened are probably far fewer than the occurrences of the accident, for it must not be forgotten that the thinnest of bone, often dehiscent, alone intervenes. As to the facial nerve, its bony canal is not infrequently incomplete just above and behind the oval window; and aside from injury as the result of operation or even of mere probing or cleansing with cotton, this anatomic condition should not be forgotten in its relation to Bell’s palsy (8).”

Nevertheless, Randall recognized the imperfection of anatomical material: “many text-books of surgery, anatomy, and even of otology are distinctly at fault. Misstatements abound and pass current without the brief examination needed to correct them (8).”

Examination of the Ear

During this era, advances were made in speculae, illumination, and even the initial efforts at photographic documentation of the ear. Various specula were designed and employed to dilate the auditory canal and focus light on the tympanic membrane and middle ear. Much like today, however, there were limits to this form of direct visualization, with Clarence J. Blake (AOS President 1877–1878) lamenting at the 5th annual meeting of the AOS in 1872 that “the examination with the aural speculum... affords no view of the more remote portions of the tympanum beyond the limits of the circumference of the membrana tympani” (9). To overcome this, he developed a middle ear mirror over a century before modern endoscopes allowed angled views of the tympanic cavity. He argued for its benefits by reporting his use “when there is... destruction of the membrana tympani, or even a large perforation, it is possible to introduce a reflecting surface which shall give, with proper illumination, a view of those portions of the tympanum beyond the boundary of the perforation (9).”

The need for good illumination was universally accepted, and for centuries light sources included sunlight, candle, oil lamp, and limelight. The general consensus was summarized in Gorham Bacon’s (AOS President 1891–1894) text, “daylight from a northern exposure is the most satisfactory, since by this means the natural color of the drumhead will be observed (2)” (Fig. 1). There were many options available when adequate sunlight was not available, including various forms of gas and candle-lamps (Fig. 2) (10). With the proliferation of electricity and development of batteries, further modifications were made to existing headlamps, including a modification of the Trouvé lantern. Sexton presented these then state-of-the-art technologies at the 21st annual meeting of the AOS in 1888 and extolled the device as a “valuable acquisition to the aural surgeon when called upon to make an examination or operate at night in the sick room where ordinary light only is employed (11).” (Fig. 3). Of course, gas-powered lamps were commonplace at the time, however the discerning advantage of this design was that by eliminating a live flame, “[t]here need be no fear of igniting the ether used in narcosis” (12). The electric light garnered a great deal of discussion, but the new technology had vocal advocates, with C.H. Burnett (AOS President 1884–1885) proclaiming “I operated by sunlight, but I had the battery ready to use if the latter grew dim (12).”

Concentration of light on the ear was the key for proper illumination needed during exams and procedures. Texts of the

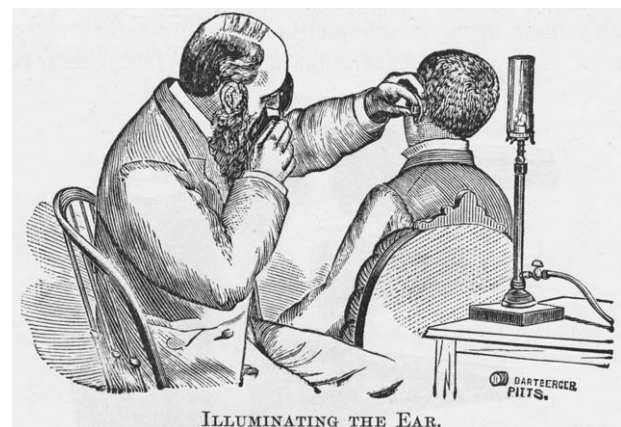


FIG. 2. Gas lamp artificial illumination for otoscopy (10).

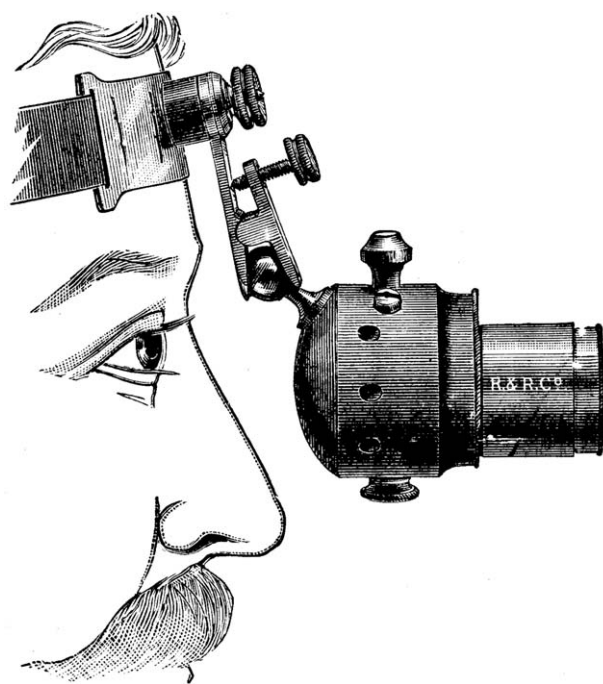


FIG. 3. Early electric headlight used in examination of the ear (12).

time provided descriptions of various reflectors, either head-mirrors or hand-mirrors, to direct light into the ear. Controversy did exist, with most authors providing recommendations of their preferred reflectors, consisting of “a concave mirror, with an aperture in the middle which allows the surgeon to look through the opening” (2), with specific details extolling their preferred devices. Daniel Bennett St. John Roosa (AOS President 1874–1876) advocated for the hand-mirror, stating it is “universally conceded by the profession, that this method is altogether the best that has yet been suggested” (3), while Albert H. Buck (AOS President 1879–1880) extolled the head-mirror and stated, “no one who has ever once experienced the comfort of working with a good forehead-mirror would ever think of returning to the habitual use of the hand-mirror (4).” Newer electric headlights had the advantage of not requiring a separate concentrator.

As the otologic equipment of the time was becoming more sophisticated and ubiquitous, the annual meeting of the AOS remained a gathering point to share interesting new diagnostic and clinical pearls. One such example was the demonstration and identification of a vascular tumor of the tympanic membrane by history and examination alone by Buck. At the 14th annual meeting in 1881, he described a woman with “slight impairment of the hearing” who on otoscopy possessed “a dark object which stood out in bold relief from the outer surface of the membrane tympani. . . the transition from the black of the tumor to the greyish white of the healthy drum membrane was abrupt,” leaving little doubt in his mind of the diagnosis of a vascular tumor (13).

At the 22nd meeting of the AOS in 1889, Randall presented a series of lantern slides of ear examination to demonstrate “how excellently photography may be made to serve us by the use of projections upon the screen in teaching our specialty” (14). The slides were black and white with grainy resolution, but nevertheless were of important teaching value. As Randall put it: “the essential value of photography is in its absolute accuracy

they have entirely abstained from retouching the negatives; preferring that their pictures should show imperfections in point of beauty, or even more serious shortcomings, rather than labor under suspicion of being warped from the truth (15).”

Exostoses

Surgical methods of removing obstructive exostoses developed during the 19th century included cauterizations, galvanic electrolysis, dilatation with a bougie as well as surgical extraction with chisel, forceps, rat-tailed file, or dental drilling engines (16). References made in the Transactions of the AOS indicate that exostoses of the external auditory canal were less common in the United States than in Europe in the late 19th century, yet treatment of the bony growths was seen as effective (17). When Burnett presented a series of cases at the AOS in 1887, he provided a detailed description of his technique using forceps and chisels performed under local anesthesia with 5% solution of hydrochlorate of cocaine. Corenelius Agnew (AOS founding member) lauded his techniques: “As specialists we should be careful to see that what we may do here shall belong to the great mass of surgery. I am therefore glad to see that there is really nothing new in the operation described. The chisel and bone forceps are instruments which have been used from time immemorial in the removal of osteomatous growths (18).”

Five years later, Roosa presented a similar case and his experiences, first noting that the only appropriate indications for such a procedure included, “The patient was suffering considerably from the sense of fullness, tinnitus, and loss of hearing on that side,” or “[a]n otitis media was very likely to recur, and an obstruction in the outlet of the pus would surely be dangerous and possibly fatal to her life (17).” He claimed his techniques provided “considerable improvement in the hearing power” and “the obstructive symptoms were declared to be much alleviated (17).” Roosa then expounded on his use of instruments: “It is a maxim in all surgery, political economy, and war, never to use any means beyond the necessity or the requirements of the case. Those who use the chisel and mallet, I think use means beyond the requirements of the case, and those which have no special advantages, but some disadvantages (17).” Howe agreed, stating: “I have not used the chisel at all. It seems to me rather odd that it should be discussed, when we have an instrument so infinitely its superior, in the drill which the dentists have given us. I have used that a number of times. This instrument we have under perfect control and we know exactly the amount of pressure exerted. There is, to my mind, no comparison between the dentists’ drill and the chisel (17,19).” (Fig. 4).

Foot powered drills entered dental practice in the 1870s and were sometimes used in ear surgery (20). Drilling efficiency decreased as the practitioner’s leg became progressively more fatigued from pumping the treadle during lengthy procedures. To the relief of surgeons’ lower extremities, electric drills were introduced into otologic practice in the last decade of the 19th century (21).

Cerumen

Understandably, cerumen management was one of the most effective treatments available for hearing loss during this era. Oren D. Pomeroy (AOS President 1890) presented a series of 100 cases of impacted cerumen, concluding a cause-and-effect relationship between impaction and chronic aural catarrh (22). The composition of cerumen was well documented, and it was considered an “established fact that at least the uppermost layer of the epithelium lining the external auditory canal moves constantly from within outward (4).”

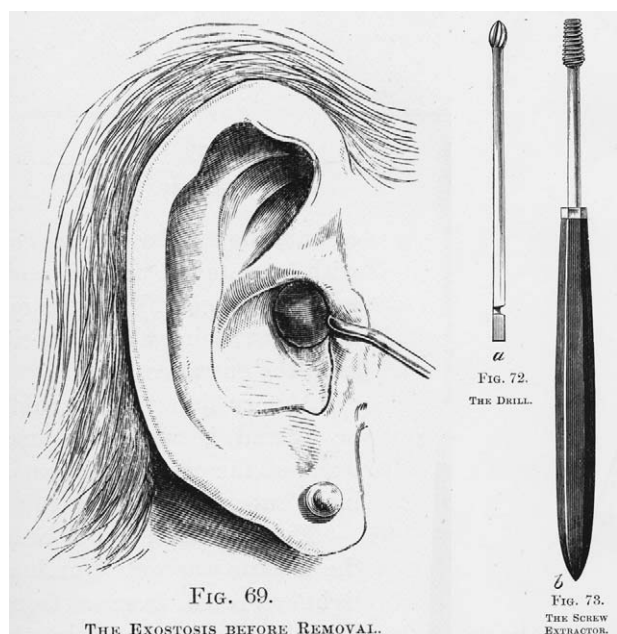


FIG. 4. Exostoses were removed with either a chisel, hand drill, or screw extractor (19).

Typical treatment, as Pomeroy explained, involved aural lavage. He went on: “As we are in the habit, at the Manhattan, of removing cerumen by syringing at the first sitting with simple warm water. . . some excuse is furnished for those who delight in ear-picks, spoons, etc., for removal of the cerumen (22).” Buck recommended, “removal of the masses could be effected much more quickly and pleasantly by the use of the currettes, the cotton-holder, and the angular forceps, than by any other plan (4).”

Foreign Bodies in the Ear Canal

Foreign bodies and cerumen of the external auditory canal were referenced sporadically in the AOS transactions of the times, because as William W. Morland put it: “[n]otwithstanding the triteness of the subject, its real and constant importance will perhaps justify me in occupying a few moments in regard to it (23).” In one of the more extensive series on the subject at the 21st meeting of the AOS in 1888, Sexton presented 101 cases with meticulous categorization of the various types of foreign bodies and methods of removal (24).

In the absence of conductive hearing loss, some otologists would reassure patients that, “foreign bodies, if undisturbed, may remain in the ear for an almost indefinite period without exciting any local irritation, though now and then reflex disturbances in other regions may be traced to this source (24).” Theobald described this “aural reflex” in greater detail at a subsequent meeting of the AOS as irritation of the ear canal causing cough and dysphagia (25). Interestingly, Sexton also noted that, “[t]he seed of fruit of other germinating objects, however, sometimes sprout in the canal, giving rise to irritation,” prompting sooner removal for some objects than others (25).

A common first-line treatment for cerumen and foreign bodies was aural syringing (Fig. 5) (26) as, “a strong stream of water being thrown into the ear, directed between the object and the canal wall, so that the former shall be carried out of the canal by the return current (24).” This was deemed safe for most general practitioners, and even patients, to perform.

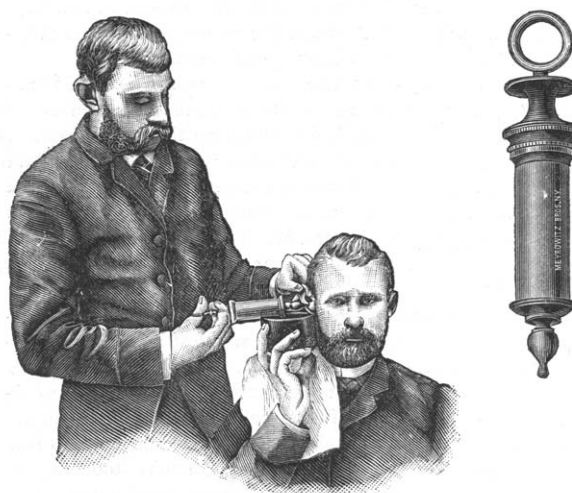


FIG. 5. Method of syringing the ear for removal of cerumen or purulence as described by DB St John Roosa (26).

Anything more challenging was best left for the skilled otologist, and it was recommended to, “remind the general practitioner that the syringe should be first resort, and we may even say, his only weapon (23).”

Otherwise, with the use of a head mirror, light source, and speculum foreign bodies were removed with, “various hooks and forceps, wire loops, the adhesive method, the galvano-cautery for breaking down organic substances, and others too numerous to mention (24).”

For more challenging cases, J. Orne Green (AOS President 1881–1883) described a new approach: “a semicircular incision was made above and behind the auricle, through the periosteum, and the periosteum with the auricle and cartilaginous meatus carried forward till the edge of the osseous meatus was reached; the insertion through in its upper and posterior part. The little finger inserted immediately felt a loose foreign body which was readily seized with forceps (27).” Objections to this approach were numerous, some suggesting that, “[t]he idea of separating the auditory canal from the squamous process of the temporal bone. . . is so absurd that it ought to be ranked among the exploded notions of the barbarous ages (27).” Ironically, this is a routine technique today in postauricular surgery.

Ear Trauma

Traumatic insults to the ear, both routine and extraordinary, were described by late 19th century otologists. For the removal of a small metallic bullet, with round edges making grasping with forceps difficult, Lucien Howe of Buffalo, NY recommended “the use of galvano-cautery for the removal of lead substances (28).” In doing so, he heated an electrocautery device and melted the fragmented bullet into a solid mass and allowed it to cool together to be withdrawn in entirety. While this was considered an extreme and invasive measure to those assembled, Howe insisted, “if a man with the experience also of Dr. Buck, finds it necessary to dissect off the back part of the ear and bring it forward, it seems that there are cases which do not readily yield to treatment, and even when they do, we do not see the bad results that follow (28).”

Multiple additional reports of traumatic injury to the auricle and tympanic membrane were offered. Examination techniques

of the time allowed for detailed descriptions and accounts, such as the following account of a traumatic insult to the middle ear from a hairpin:

“On examination I found the membrana tympani presenting a sunken appearance, the short process very prominent, and the malleus handle apparently twisted. . . a curious line extending obliquely across the malleus handle from below upward and backward near its extremity. On inflating there appeared a false point of motion where this line crossed the bone. The diagnosis of fracture was made, and the patient advised to allow the ear as absolute rest as possible.”

“Through the opening in the drum-membrane could be seen a dislocation of the incudo-stapedial joint, which had probably occurred at the time of the accident. The bones in sight were necrosed, as was ascertained by touching them with a probe (29).”

Auricular hematomas were often thought of as a disease of lunacy, with Howe offering, “it is usually associated, as is well known, with some form of insanity, either paresis, melancholia, or mania (28).” Additionally, it was generally accepted that, “the disease is rather rare in the female (28).” When Howe presented a case of an auricular hematoma, the fact that his patient was sane was itself note-worthy. Management at the time was, “generally considered best to allow such extravasations of blood, to subside as best they may (28).” In cases warranting intervention, he suggested injecting irritating mixtures, such as alcohol or ergot, subcutaneously. Sexton, on the other hand, offered that, “[i]n milder cases he has resorted to the withdrawal of the blood by aspiration. . . Where a large clot has formed, it may be necessary to make an incision (30).”

One of the more amusing reports was of a, “hitherto kind and gentle horse, on the preceding evening had suddenly seized the lady’s ear while she was hitching him and bitten it entirely off (31).” Holt presented the case, commending that “the horse did his work well” in completely severing the entire auricle. He found that debriding nonviable cartilage and suturing the auricle back on “was all there was left to be done.” Fortunately, the wound healed well and by “combing the hair a little lower than customary the disfigurement is but little noticed (31).”

Otitis Media

A great deal of attention was given to otitis media by members of the AOS during late 19th century. In 1877, Burnett described:

“When alluding to acute inflammation of the middle ear, the greatest stress was laid on preventing suppuration. If in spite of all efforts, suppuration does occur, or if before the patient consults any one concerning his aural disease, suppuration shall have become established in the ear, then every endeavor must be made to check the discharge. There should be no fear to do this as promptly as possible, for so long as chronic purulent discharge comes from an ear, the patient is in danger (5).”

Therapy at the time included topical and surgical interventions aimed at ceasing purulence, preventing complications of otitis, and providing symptomatic relief. Otologists would perform syringing and aural douches, often with warm water,

to cleanse the ear. Various topical therapies were introduced during the period, both solutions and powders.

Pomeroy and C.J. Kipp (AOS President 1908) noted that weak solutions such as common salt water were less irritating than pure water in the presence of perforation (32). Burnett, on the other hand, preferred treatment with hydrogen peroxide, which he presented at the 19th meeting of the AOS in 1886 (33). Arthur Mathewson (AOS President 1895–1899) used sulfuric acid and, “obtained most satisfactory results from the application of sulphuric acid. . . it dissolved away the dead bone, while it spared the osseous tissues still retaining vitality, and promoted the process of repair through healthy granulations (34).”

Powders could either be packed or blown into the ear. Holt extolled new powder blowing devices: “the powder blown into the ear. . . is carried en masse to the desired point and applied evenly to all parts (35).” He continued: “The advantages of this form of powder blower are: It can be obtained of the apothecaries at any time. It costs but a trifle. It can easily be kept clean and ready for use (35).” One such commonly used powder was boric acid, which Theobald reported, “the results which I have obtained from it have been exceedingly gratifying (36).”

J.B. Emerson alluded to the importance of proper ventilation of the middle ear when he wrote, “In some cases of deep-seated inflammation of the auditory canal or mastoid cells, in which it is necessary to establish drainage through a fistula, we are often much embarrassed by the rapid growth of granulations or by the closure of the fistula by the natural process of healing (37).” He tried many solutions to this problem, specifically to keep the external auditory canal patent and free from granulation tissue, before concluding: “I have used the various means for keeping such fistulae open, and I believe that in the flexible catheter we have a tube which best fills the requirements (37).” Seely, on the other hand, argued that, “treatment in a rational manner began, of course, with catheterization of the Eustachian tube (38).” Sexton was a champion of tympanic membrane and ossicular chain removal in the treatment of otitis media. He presented his surgical technique and noted the advantages in, “prevention of recurrent accumulations of mucous or purulent matter in the attic and antrum, the cure of otorrhoea together with the relief of the attendant pain, deafness, and distressing acoustic phenomena (39).” When his patient reported improved hearing postoperatively, he remarked, “[t]his marked improvement in hearing was quite unexpected by me, and has given rise to the conviction that the operation may be recommended for deafness alone in many cases where the drum is obstructed by the results of chronic purulent inflammation (39).”

There was perhaps no bigger proponent of this form of surgery than Burnett, who advocated for excision of the tympanic membrane and middle ear contents for the treatment of a multitude of conditions (40–43). With regard to otitis media, he believed a diseased ear drum and ossicles could obscure and harbor difficult to reach disease. Despite this, as was standard practice at the time, he would begin: “to treat symptoms, as my predecessors in the case had done, and for one year I applied all known rational means of treatment to the case. . . but all without any good result, simply because I had not reached and could not get at the true disease in the attic, so long as the membrana tympani and the malleus barred the way (42).” In those cases that failed, he would ultimately recommend surgery: “We see, therefore, that the operation of excision of the membrana tympani and the malleus offers not only a great means of curing chronic purulency, especially of the attic, but also of relieving deafness due to a stiffened membrana and ossicles, by the removal of pathological bands prohibiting free oscillations in

the ossicles, and by thus permitting sound waves to fall directly upon the stapes in the oval window (42).”

Myringotomy

The Eustachian tube has long been used to provide access to the middle ear and as a means for ventilation and drainage of accumulated tympanic fluid. During this period, there was increasing interest in the role of transcanal paracentesis or myringotomy first popularized by Sir Astley Cooper in 1800 (44). The subject was raised for discussion frequently at meetings of the AOS, and early American aurists played a role in leading the field, as Roosa proudly remarked on the subject, “for nowhere in the world is otology cultivated with more zeal, and, as it seems to me, with more knowledge, judgment and skill, than on this side of the Atlantic (45).” Comparative treatments at the time included “galvano-cautery, eye-lets, myringectomy, and acids, to maintain permanent openings in the membrane,” as well as division of the tensor tympani (45).

Many remained skeptical of the efficacy of the procedure and of the risks it posed. In cases of serous effusion, Roosa himself favored watchful waiting and noted that many cases resolved spontaneously. For persistent effusions, he favored as small of an incision as possible to drain fluid, noting that size is relative by comparing, “What would be a free incision in a finger becomes excessively large in a drum-head (45).”

Blake argued that the procedure and trauma to the tympanic membrane itself could cause irritation and worsen serous accumulation, stating that even in cases where, “a free evacuation would seem to be strongly indicated. . . even here such a procedure lavishly indulged in, while it gives immediate relief, may be the cause of future and prolonged trouble (46).” He continued to advocate for treatment via the Eustachian tube, arguing that, “Although the immediate results of the paracentesis. . . may be very gratifying, it is to be found as a rule that the ultimate results of treatment of the naso-pharyngeal and tubal affection alone, however tedious this may seem, are very much better (46).”

However, in cases that failed more traditional Eustachian tube approaches, Pomeroy was a proponent of paracentesis, presenting 10 cases and his results improving tinnitus, hearing, and aural fullness. He detailed technical points of the procedure: “[t]he point at which the punctures were made was just behind the short process of the malleus, sufficiently far to avoid the incus, and as high up as possible, without striking the chorda-tymp. nerve, although that has been pricked once or twice, without, however, doing any harm (47).” He concluded, “I am inclined to the belief that paracentesis in this class of cases often helps us along in the treatment, and without imperiling the present state of the patient (47).”

Roosa, ever cautious and echoing the sentiments of many at the time, warned, “I still regard paracentesis of the membrana tympani as an operation not to be lightly undertaken, and always to be performed with gentleness (45).”

Tympanostomy Tubes

One ubiquitous reality in otology is the tendency for myringotomy incisions to heal, and although placement of a tympanostomy tube is widely used today, practices were not as standardized in the 19th century. Various iterations were developed using a wide array of materials and designs, including aluminum, silver, gold, hard rubber, and gutta-percha (48). One popular solution was a hard rubber drain introduced by Adam Politzer of Vienna in 1868 (49). William Henry Winslow of Pittsburgh characterized its advantages and disadvantages:

“Politzer’s eyelet is the best and only thing now used for maintaining an opening in the membrane. . . it is difficult to fix the eyelet in place, more difficult to maintain it in position, and most difficult to keep its opening clear of mucus and epithelium. It sometimes occasions severe neuralgic pain, and may fall into the tympanum and excite violent inflammation. For these reasons Politzer’s little invention is now seldom used (50).”

Similar accounts of these difficulties were chronicled in the AOS transactions, with Henry D. Noyes (AOS President 1870–1873) describing its employment with great flourish: “The patient sat beside a window, at which I could employ direct sunlight. . . I guided [the eyelet] down to the place of incision, but could not see it when close to the drum-membrane, because the meatus was fully occupied by the forceps. I was, therefore, obliged to trust the sense of touch in engaging the eyelet in the slit (51).” He went on to describe one of the more frustrating complications:

“When I supposed it to have been put in place, I withdrew the forceps, expecting to find the eyelet either in the slit or in the meatus. But I had not brought it out; it was not in the meatus; it was not in the membrana tympani. The disagreeable conviction forced itself on my mind that I had lodged the eyelet in the cavity of the tympanum.”

“To do this much had been painful, and tested the patient’s endurance severely. He was greatly alarmed at the accident, and submitted to prolonged and futile efforts for its removal with such courage as he could, but with extreme difficulty, oftentimes compelling me to desist because of his sufferings (51).”

After treating the patient’s pain for several days with morphia and leeches, and following multiple subsequent attempts at retrieval, Noyes eventually put the patient under chloroform to extract the tube with a hook, and, “brought it safely and triumphantly out (51).” Following this ordeal, he was left to conclude, “to maintain a permanent opening is the problem not yet solved. Prof. Politzer’s eyelet has not conquered the difficulty, although it may deserve a yet longer experience (51).”

Another design for an open tubular ring made of gold was developed in Poland. This device, known as Voltolini’s ring, after its inventor Friedrich Eduard Rudolf Voltolini, was fixed via two incisions in the tympanic membrane on either side of the handle of the malleus and fixed directly onto the malleus with pliers (48). It did not enjoy the same popularity in the United States, with Burnett noting the potential risk for necrosis of the malleus, stating: “it would seem that this procedure could not be of universal application. . . though the conception of the plan must be considered brilliant (5).”

Leading otologists voiced their frustration with tympanostomy tubes of the time. Bacon noted that for most tubes, “it has been found impossible to keep this in place (2).” Roosa diplomatically proclaimed in his textbook, “[t]he published experience of those who have performed this operation do not commend it as a successful procedure, and I believe that it is now very seldom performed (3).” Despite the failures of the late 19th century, it is remarkable that many of the same principles that govern contemporary tympanostomy tubes were understood at the time. These included the need for a permanent opening to allow for ventilation of the middle ear space, the need for flanges to keep the tube in place, and the development of proper instrumentation to properly visualize and deploy the tubes. Indeed, these same principles were elucidated nearly a century later by the American Beverly Armstrong who



FIG. 6. Placement of a Eustachian tube catheter (5).

reintroduced the method, now the most common ear operation, reportedly without knowledge of the work done by his predecessors (52).

Eustachian Tube

Treatment of the middle ear via the Eustachian tube was a major part of late 19th century otological practice. It included the use of catheterization, insufflation, auscultation, dilation, cauterization, and instillation of therapeutic powders and liquids (53). Eustachian tube catheters, introduced during the 18th century, were made of a variety of materials, including metal, vulcanite, or rubber. Rubber catheters would not corrode like those of silver or nickel alloys, were less expensive, and would not uncomfortably heat up with steam (6,54). However, their shape was less easily manipulated than those made of metal (6). Following the introduction of the catheter into the Eustachian tube orifice transnasally, the surgeon would proceed to insufflate the ear through either the application of “the surgeon’s mouth. . . to a rubber tube attached to the catheter” or by using the Politzer air-bag (6,55) (Figs. 6–8). More

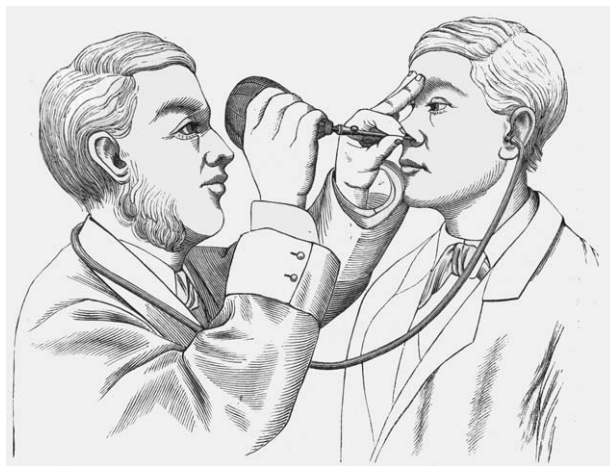


FIG. 7. Verifying the position of a Eustachian tube catheter via insufflation with the otologist listening for the verifying sound of inflation via a Toynbee tube (5).

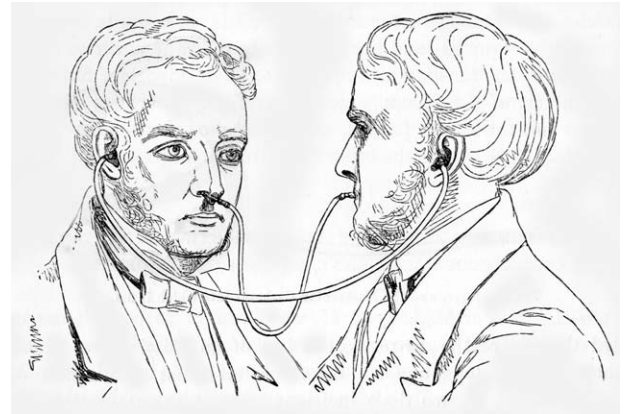


FIG. 8. Inflation of the middle ear via Eustachian tube catheter. The otologist provides both the air for insufflation and listens via a Toynbee tube for the sound of air passing through the Eustachian tube. The potential for contamination of the patient’s ear by the examiner’s oral flora is evident (55).

powerful means of inflating the middle ear were also advocated, including improbably large pumps (Fig. 9) (56).

Although Eustachian tube catheterization was widely used, it was not without complication, especially given the blind placement of the instrument. Pomeroy described that:

“Great care needs to be taken not to lacerate the mucous lining of the pharynx by the catheter, for on attempting to inflate subsequently, a very annoying and possibly dangerous emphysema may result. I have reason to believe that I once lacerated the mucous membrane in attempting to introduce a catheter, and subsequently on inflating the ear I produced emphysema of the cellular tissue surrounding the posterior pharyngeal space. . . The patient could not breathe well for some minutes, and he was fearful that suffocation might result (6).”

J.S. Prout (AOS President 1886–1889) described a specialized long specula developed to view the nasopharynx transnasally which could be employed during Eustachian tube catheterization, but these were not widely used (57). Catheters were used not only for insufflation, but also for the introduction of irrigation fluid or medications (58). Solutions of saline,

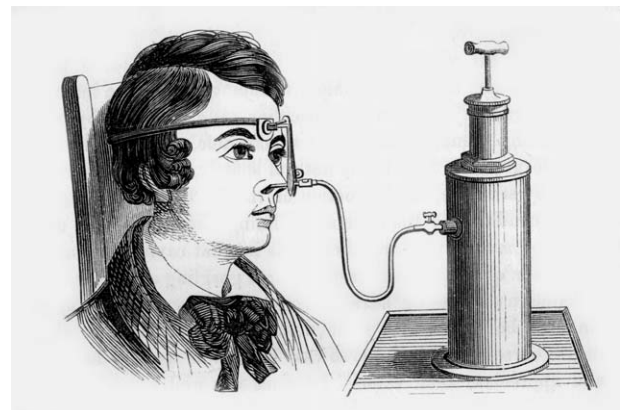


FIG. 9. Powerful insufflation of the Eustachian tube with a device which would seem to deliver an improbably large volume of air (56).

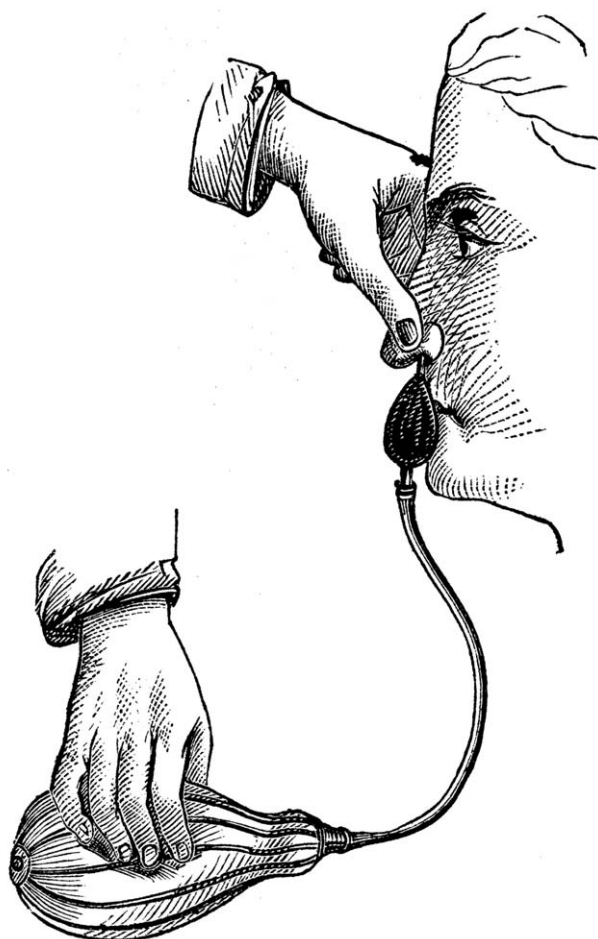


FIG. 10. Insufflation of the middle ear via a Politzer bag (3).

nitrate of silver, camphor, and ferric alum were used, as were vapors of steam, chloroform, ammonia, iodine silver compounds, and even honey (53,59–61).

Poltzer's method of "inflating the drum-head" was a significantly simpler means of insufflating the ear as compared with catheterization (62) (Fig. 10). Instead of introducing an instrument into the Eustachian tube, the procedure involved placing a hand-held air bag into the anterior nasal cavity (63). Several practitioners presented their modifications of Poltzer's original instrumentation. For example, Green's insufflation bag was smaller and therefore more portable. It was easier to operate, especially for, "mothers and nurses whose hands were not large and strong enough to grasp the whole bag" of Poltzer's device (64,65).

Bougies were used for both therapeutic and diagnostic purposes (62). They were introduced through the lumen of Eustachian tube catheters (66). Made of luminaria, catgut, or whalebone they ranged in size from 1/3 mm to "Nos. 2 to 5 of the French scale (58,66)." Bougies were used to assess for areas of tube stricture, and also to perform tube "dilatation (67)." Medicated bougies were sometimes employed, with nitrate of silver most commonly described (66).

Assessment of Eustachian tube function was performed using Toynbee's tube (55) (Fig. 7). This instrument consisted of rubber tubing with ear-pieces at either end: one for the patient, and the other for the surgeon. With the tube in position, the surgeon could auscultate whether there was the normal entrance of air through a

functional Eustachian tube. A normal Eustachian tube, "may be best described as breezy, while that produced by more or less stenosis is squeaky and high-pitched. It is always well to use this when using the Eustachian tube and inflation bag because it is unsafe to rely on the patient's word (68)." Others felt the tube was less useful: "The diagnosis tube was used somewhat, but not relied upon as proof of inflation, it requiring too much time and practice to distinguish exactly between the sounds made in the throat and those in the tympanic cavity (60)."

With the rise of tympanostomy in the mid-20th century, focus upon instrumentation of the Eustachian tube declined markedly. The recent innovations of Eustachian tube endoscopy and balloon dilation have begun to reverse this trend.

Tympanic Membrane Perforation

Although an understanding of the mechanism of the middle ear was emerging among contemporary scientists such as Hermann von Helmholtz, many late 19th century American otologists had a poor grasp of the role of the tympanic membrane (69). In 1888, Richey opined:

"The primary purpose of the tympanic membrane is that of protection to the tympanic cavity from the influence of the air; to prevent parching and stiffening of the membrana secundaria, the joints of the ossicula, the tendons of the tympanic muscles, and to prevent loss of labyrinthine fluid by evaporation (70)."

In discussing S.O. Richey's article, Dr. Samuel Theobald dissented with the general consensus regarding the primary protective function of tympanic membrane to argue for amplification function:

"The intricate structure of the ossicles, the attachment of the handle of the malleus to the tympanic membrane, and the peculiar concavity of the latter, all point to the fact that. . . [t]he primary and most important function of the tympanic membrane, it seems to me, is to aid in the transmission of sound to the labyrinth (70)."

The significance of tympanic membrane perforations with respect to hearing was also misunderstood, with Burnett remarking that a rupture was, "not directly inferring greatly with the function of hearing (5)." Rather than a loss of the conduction apparatus, hearing impairment was thought to occur secondary to loss of the protective functions of the tympanic membrane, which would expose, "the mucous lining of the tympanic cavity to the direct irritation of the external air, and thus lead secondarily to inflammation and loss of hearing (5)."

The capacity of the tympanic membrane to heal was recognized. Burnett stated that, "[t]he drum-head. . . has great power of healing and restoration" and "tympanic disease behind the perforated drum-head should receive more attention than the simple perforation, which is but the vent for the hypersecretion resulting from disease in the middle ear (5)." Management focused on conservative measures. This included measures such as iodine of potash, pilocarpine injections, leeches, and electric currents (2). One such treatment algorithm postulated by Bacon included, "that the instillation of all drops and syringing the ear should be carefully avoided," that the patient "be kept quiet, and placed on a low diet (2)," and that inflammation be controlled.

Artificial Eardrum

The artificial eardrum came into regular otological practice in the mid-nineteenth century after seminal work advocating its

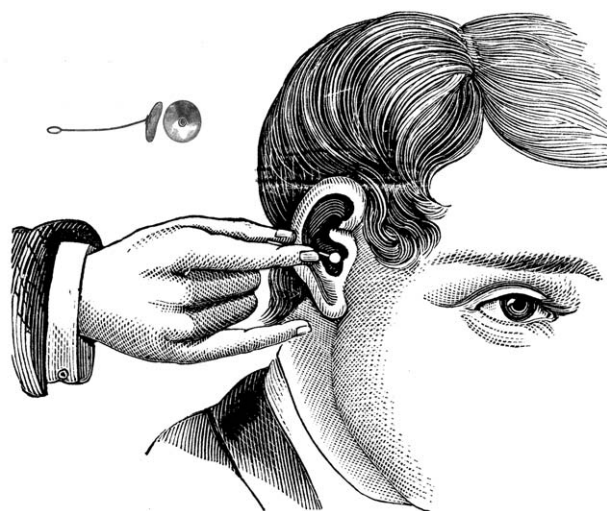


FIG. 11. Placement of an artificial tympanic membrane consisting of a wire and a rubber disk of the Toynbee design. Inset is Toynbee's device (3,55).

use by British otologists James Yearsley (1848) and Joseph Toynbee (1853) (71).

Yearsley's 1849 article "A New Mode of Treating Deafness" described his cotton pellet artificial tympanic membrane (TM), and one of his first patients stated, "To my utter astonishment I heard every sound so loud, that I felt I had never know what it was to hear until that moment (72)." This was followed shortly thereafter by Toynbee's India-rubber disk presentation (71,73) (Fig. 11).

While Yearsley stated that he "can offer nothing that is conclusive" regarding why his artificial TM improved hearing, Toynbee (who is widely viewed as the father of scientific otology) made a thoughtful conjecture:

"...it occurred to me, that as an orifice in the membrana tympani, by preventing the sonorous undulations, owing to their diffusion in the meatus, from being concentrated upon the membranes of the labyrinth, might be a direct cause of diminution of hearing power, so it was probably that increase of that power would follow an artificial closing of that orifice (55)."

Modifications included various materials (cotton-wool, rubber, collodion, silver foil, vitelline membrane of an egg, etc.), insertion tools, and wetting agents. As patients were expected to insert and remove the device after the initial fitting by the surgeon, Roosa opined that patient should, "be an adult, and possessed of a considerable amount of intelligence. . . [i]t is not of any use in the case of children, or of unusually heedless or stupid adults (3)." During the height of its popularity, the efficacy in improving hearing due to covering the perforation was widely accepted, however controversy began to arise regarding indications and contraindications for its use in a draining ear. In 1879, Hackley recommended their use only in cases with limited or no discharge, an intact ossicular chain, and patent Eustachian tube (74). By the late 19th century enthusiasm for artificial TMs gradually waned. Pomeroy stated, "Like all 'new methods' it was rather extravagantly extolled, and after a few years fell somewhat into disuse (6)."

As disfavor grew among otologists, the American public continued to invest their hope in artificial TMs for their incurable hearing loss. Supposedly miraculous "artificial eardrums" were heavily advertised to the general public in newspapers by quacks and hucksters. It was only prosecution of mail-order frauds by state and federal authorities that dissuaded unscrupulous charlatans from defrauding the American public (71).

When Blake introduced the concept of paper patching in 1888, it started a trend that would continue through the latter portion of the 19th century and early 20th century towards the introduction of microsurgical tympanoplasty in 1952 (75). At the 23rd annual meeting of the AOS in 1890, Robert Barclay recounted a series of cases to those assembled, which he claimed, "demonstrated that the paper dressing has these therapeutic advantages already claimed [over other forms of artificial TMs] (76)."

Complications of Otitis Media

Complications arising from otitis media were prominently featured during the first 25 years of the AOS. At the 4th meeting of the society in 1871, Morland presented a case of cerebellar abscess following trauma in a diseased mastoid, proposing a route of disease, "through the mastoid foramen, either directly, or by means of the circulation, the inflammation which resulted so destructively," concluding "It adds, also, another to the long list of fatal results, arising sometimes from ignorance, but too often from the culpable negligence or mistaken advice of even experienced and intelligent practitioners (77)."

Roosa shared a similar case of a cerebral abscess from suppurative disease of the middle ear, proposing that "[t]he inflammation extended to the brain through the roof the tympanum, and the cerebral abscess, which may have existed for months, had its origin from this point (78)." He cautioned others faced with similar clinical cases, lamenting, "I had neglected to embrace the opportunity to evacuate a cerebral abscess, an opportunity which if availed of might have saved a life (78)."

Merrill cautioned how rapidly diseases of the ear could spread in certain circumstances when presenting a fatal case only four days after the onset of aural symptoms, offering that, "[t]he fatal termination of the case was evidently due to the direct extension of the inflammation to the membranes of the brain through the roof of the middle ear, which in this patient was not a solid plate of bone, but cribriform in appearance (79)."

Holt presented a case of facial paralysis following otitis media, demonstrating an understanding of the relationship between the anatomy of the facial nerve through the tympanum as well as the method of insult. He stated that in cases of facial paralysis, "An examination of the ear is too often neglected and the cause of the paralysis is recorded 'a cold' or 'rheumatic (80).'" He continued: "[c]onsidering how frequently the cavity of the tympanum is subject to catarrhal inflammation, so familiarly known as earache, and how often it is neglected and forgotten, and remembering that the Fallopian canal is separated from this cavity only by mucous membrane and a thin plate of bone which is often deficient, is it not reasonable to suppose that in many cases the inflammation extends to this canal, thus exposed, and produces paralysis of the facial nerve in cases whose etiology is ascribed to indefinite causes?" (80)

Blake was faced with a similar case of a patient with purulent inflammation of the middle ear accompanied by facial paralysis, and he remarked, "a slight drawing of the angle of the mouth was noticed. A week later this paralysis was greater, and there was some difficulty in speaking - 'as if the tongue were swollen (81).'" The purulent disease improved with typical

treatment of the time, which included “the use of astringent instillations with gentle syringing, forcible syringing being not only unnecessary, but causing severe vertigo; application of the muriate tincture and of persulphate of iron to the mass (81).” For the patient’s persistent facial paralysis, Blake referred her for electric-based diagnostic and therapeutic management; “the Faradic reaction entirely gone and the galvanic reaction retained only in a few muscles about the angle of the mouth. Under continued use of the galvanic current, the muscles began to respond somewhat better (81).”

Burnett presented a case of fatal “pyaemia induced by long continued purulent disease in the middle ear and mastoid cavity. The embolic elements passed by the brain to lodge in the lung and liver, an unusual course in pyaemia from ear disease (82).” He used this case as validation for performing mastoid trephination in similar clinical scenarios, weighing the relative safety profile of surgery with potential complications of untreated disease, concluding, “in chronic purulent otitis media, on the other hand, should incline us to regard, in many cases, a prompt opening of the outer mastoid wall as the one great chance of saving the patient’s life (82).” Kipp agreed, stating he “would rather operate and not find pus than to allow the case to go on and the patient die with pus in the mastoid cells, that could have been removed readily by an operation (82).”

The intimate relationship of the emissary veins of the mastoid and the lateral sinus was well understood, with Green presenting a case of phlebitis due to untreated otitis, providing “...confirmative evidence that tenderness over the vein was due to inflammation of the vein, and that the inflammation was due to trouble in the lateral sinus (83).” Sexton quipped that, “Grave and even fatal ear disease in early life is of much more frequent occurrence, probably, than is generally suspected” when he presented cases of infant death from untreated ear disease (84). He offered, “Acute aural inflammation in children often gives rise to symptoms well calculated to puzzle the general practitioner, and hence its presence is liable to be unsuspected.” (84)

With the countless examples of complications arising from untreated otitis media, the AOS membership continued to dispel myths that aural disease was best left undiagnosed and untreated. As Sexton put it, “[t]he experience derived from the study of the treatment of this class of persons points to the necessity of the prompt liberation of pent up secretions (85).”

Mastoidectomy

In 1905, Whiting wrote:

“As a life-saving measure few surgical procedures rival and none surpass in efficiency the modern mastoid operation, the meritorious achievements of which very properly entitle it to the approbation and esteem of the appreciative public. Brilliant as are the triumphs of surgery, no brighter page ornaments its records than that which chronicles the recent remarkable progress in the diagnosis and treatment of mastoid and intracranial infective disease in the development of which the otologist, we are proud to say, has borne a by no means inconspicuous part (86).”

There is a rich and interesting history of mastoid surgery beginning with the incision and drainage of swollen, red, hot, and painful abscesses behind the ear by early barber-surgeons. But it was not until the mid-nineteenth century that it became a major part of otologic practice (87). European surgeons are credited with much of the earliest records of mastoid operations.

ON CERTAIN TECHNICAL DETAILS RELATING TO PERFORATION OF THE MASTOID PROCESS, AND THE AFTER-TREATMENT.

BY ALBERT H. BUCK, M. D., *New York, N. Y.*

In a series of communications to the “Archiv für Ohrenheilkunde”, Professor H. Schwartze, of Halle, Prussia, lays down in very clear and positive language what he believes to be the best manner of perforating the mastoid



process and of conducting the after-treatment. As is well known to members of this society, he very much prefers small gouges and chisels to the drill in accomplishing the desired object. While I hesitate, with my comparatively small experience, about disputing the correctness of the conclusions drawn by one who has already perforated the mastoid process one hundred times, I am satisfied that, so far as the form of drill commonly employed in this country is concerned, Schwartze’s condemnation is unjust. My impression is that his remarks have reference to some form of drill or boring instrument totally different from that which is pictured here and which

FIG. 12. Article by Albert Buck from American Otological Society Transaction of 1886 describing hand drill technique for penetrating the mastoid (88).

There was, however, great enthusiasm among American otologists to perform and refine surgical techniques. Mastoid surgery progressed from simple postauricular incision (Wilde’s incision) through trephination, chisel and curette, and ultimately mechanical and electric drills (88–90) (Figs. 12–14).

Buck provides some of the more detailed accounts of standard practice at the time in his textbook, where he presented 47 cases of acute inflammation of the mastoid (4). Common practice at the time would include noninvasive measures, as he wrote, “the application of heat and moisture, in the form of poultices, will often be found useful. . .they mitigate the pain in an appreciable degree (4).” Burnett preferred treatment with hydrogen peroxide through a perforation in the tympanic membrane, which he presented at the 19th meeting of the AOS in 1886 (33). Additional therapy might include the use of medicinal leeches: “[l]ocal depletion by means of leeches exerts a direct restraining influence upon the inflammation (4).”

In cases that failed to recover with these more conservative measures, it was widely accepted that the purulence of the middle ear and mastoid required drainage, as Buck stated, “[t]he establishment of an opening in the mastoid process constitutes undoubtedly the most effective procedure thus far discovered for checking an inflammation in this region, or for preventing it from spreading to important organs in the neighborhood (4).” There was, however, controversy regarding the best means by which this was accomplished, and the meetings of the AOS were often the setting of great debates.

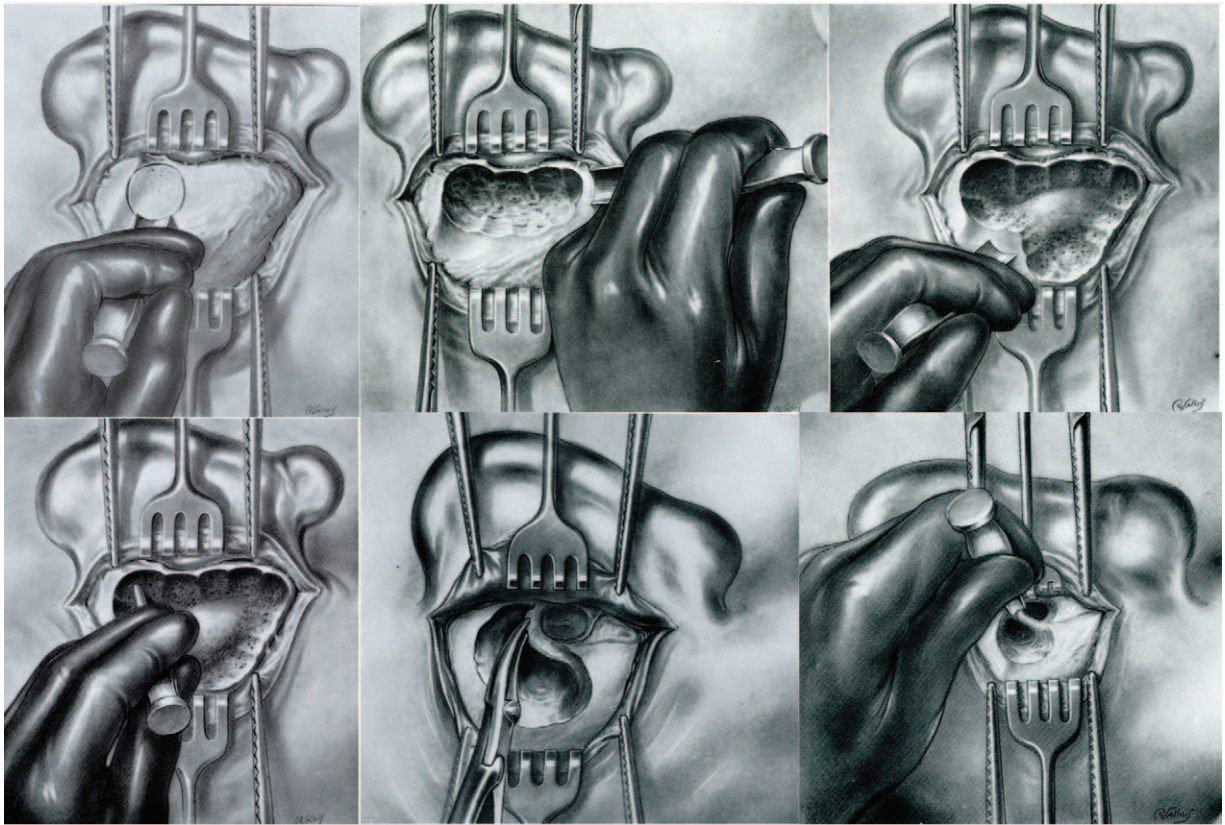


FIG. 13. Mastoidectomy performed with mallet, gouge, and rongeur. While less controlled than an electric drill, surgeons skilled with this technique were capable of anatomically precise mastoid surgery (89).

One such method would be carried out via an eponymous postauricular incision named for Sir William Wilde of Dublin, the father of author Oscar Wilde, followed by entry into the mastoid process, often via trephination with a gouge or chisel. At the 3rd annual meeting of the AOS in 1870, Agnew presented a case of mastoid trephination and remarked, “I am convinced...that mastoid-cell disease is very common in ear-diseases in adults, that it may escape and does escape attention except when the physical symptoms of its presence are very grave and conspicuous, and that we often lose time by not making an early opening” (91).

Buck presented the results of 24 of his own cases at the 19th annual meeting in 1886, 71% of which he claimed to have cured, to advocate for use of the drill over the chisel (88). It is important to distinguish contemporary otologic drills which principally use burrs from the penetrating hand drill in use at the time.

Dr. Knapp countered, “[t]he advantage of the chisel lies in the fact that at every step of the operation you can satisfy yourself of the nature of the tissue before you (88).” For the reader who considers the chisel to be a crude surgical instrument, keep in mind that it was the implement used by Michelangelo to sculpt the David. In the hands of an expert 19th century surgeon, chisels and gouges could be used with craftsmanship and relative precision. To eschew concern, “raised by surgeons in this country...that in the use of the drill there is danger of plunging it into the lateral sinus, into the brain, or into some other important part,” Buck recommended specific technical guidance that the “forefinger of the hand which guides the

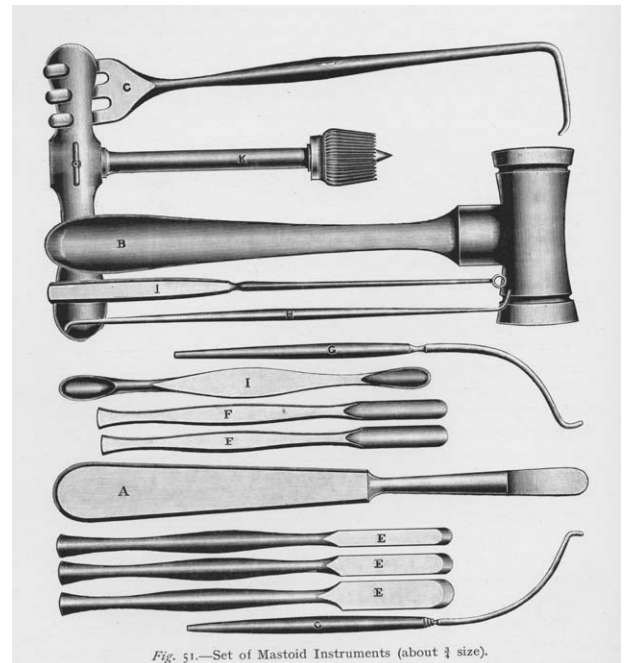


Fig. 51.—Set of Mastoid Instruments (about 1/2 size).

FIG. 14. Instruments used in mastoid surgery during the era of mallets, chisels, and gouges (90).

drill should rest firmly against the bone. If this precaution be taken, there will not be the slightest danger of our sudden plunging the sharp point of the drill into parts which might thereby receive serious damage (88)."

Sexton presented data from 2366 selected cases from over 20,000 cases of acute and chronic purulent inflammation of the middle ear and concluded, "I have never been convinced of the advantage of any trephining operations which opened up only the healthy cellular structure of the mastoid process (85)." Instead, he "favored keeping open the outlet through the tympanum into the canal rather than through the cortex of the mastoid (85)."

Later American contributions to the development of modern mastoid surgery include William Bryant of New York who reported on the notion of the modified radical mastoidectomy procedure in the AOS Transactions of 1906 around the same time as Austrian Gustave Bondy, who is generally credited as the pioneer of the procedure. Bryant failed to garner widespread acceptance for his procedure (and the credit that comes with it), likely because he failed to open the antrum while leaving the ossicles, tympanic membrane, and a portion of the superior canal wall potentially harboring disease (87,92).

Perhaps Burnett best summarized the enthusiasm for mastoid surgery towards the end of the 19th century by a quote from his 1884 textbook:

"It becomes, therefore, the duty of every conscientious practitioner of medicine to be carefully observant of the onset of an inflammation in the mastoid cavity, and prompt to relieve it; for, by so acting, he will in all probability save life, where, in similar cases, there is every reason to know that death has occurred, simply because the true nature of the mastoid disease was not recognized, and, consequently, no rational means of relief resorted to (5)."

Cholesteatoma

The term cholesteatoma was coined in 1838 by Müller and appears sporadically in the AOS Transactions of the period (93). A number of articles in the transactions refer to perforation in Shrapnell's membrane, inflammation of the attic, or desquamative inflammation (94–96). Randall pointed to the frequency of attic disease and stressed that it could be easily overlooked at otoscopy: "... my special purpose is to lay stress upon the point that perforation in Shrapnell's membrane is far from infrequent, and to claim that constant vigilance in this direction will bring to light an unexpectedly large number of cases, and in so doing will clear up not a few instances of difficult diagnosis and of exasperating and enigmatical obstinacy (95)." An understanding of the relationship between attic disease and cholesteatoma was not clearly articulated by most authors and, hampered by limitations in otoscopy at the time, the distinction between squamous pocket and actual tympanic membrane perforation was not made. In discussions of his article it was noted that Shrapnell's perforation seldom whistled, suggesting to the commentator that they are cut off from the tympanic cavity. Dr. Knapp commented that, "Cheesy masses may be located in the mastoid, which are at the bottom of these relapses (94)."

Stapedectomy

The story of stapedectomy in the United States should rightly begin in Boston, where Blake was appointed Chief of the Aural Service at the recently opened Massachusetts Charitable Eye and Ear Infirmary in 1888, and Frederick Lafayette Jack (AOS

President 1909–1910) served as his Assistant Aural Surgeon. Blake's intention was to "avail himself of the clinical material afforded by the Aural clinic" to perform stapedectomy (97). Unfortunately, he suffered an accident which led to the temporary loss of the use of his right hand, and he called upon Jack to perform these operations. These procedures were generally performed with an ear speculum, hand-held lens for magnification, and head mirror for illumination under local anesthesia, which was administered via the insufflation of 10% cocaine solution in the middle ear through a transnasal Eustachian tube catheter (97). These early procedures were performed via an incision of the tympanic membrane rather than by elevation of a flap.

"...After the incision of the membrana tympani, the incudo-stapedal articulation should be divided by means of the angular knife, the principal cutting being done from behind forward, the pressure in this direction being made against the pull of the stapedius muscle. The tendon of the stapedius muscle may be next divided, and the straight knife used for the purpose also passed around the niche of the stapes, in order to divide any adhesions; the stapes may then be extracted either by means of the hook forceps, curved forceps or by a blunt hook passed beneath the head of the stapes between the crura (98)."

The above excerpt from Blake was among the first reports of stapedectomy in the United States, which he presented to the AOS in 1892 at the same meeting that Jack reported on his own experiences (99,100) (Figs. 15 and 16). Blake ultimately attempted the procedure on 21 patients, the results of which appears in his 1906 text *Operative Otology: Surgical Pathology and Treatment of Diseases of the Ear* (7). He detailed his outcomes and noted that hearing improved in only three patients while six developed new onset of vertigo. While initially being a proponent of the procedure, these results lead him to remark: "The operation of stapedectomy, while very simple in itself, is open to question as to its advisability, because of the varied consequences which may follow invasion of the cavity of the internal ear, and because of its doubtful value for the purpose for which it is usually demanded, amelioration of an extreme degree of deafness" (7). In describing the pathology of otitis media insidiosa (otosclerosis) Blake recognized that the disease sometimes affects the inner ear in ways not remediable by surgery: "[i]t should be borne in mind, however, that the fixation which causes extreme symptoms, either of deafness or vertigo, is not infrequently only secondary to a hyperostotic process in the labyrinthine capsule, which removal of the stapes cannot relieve" (7).

Jack presented a number of cases at the same meeting of the AOS in 1892 and subsequently in 1893 and 1894, and while he noted, "there were absolutely no bad results," he ultimately concluded that the results of the procedure were not consistently beneficial (101). After compiling nearly 70 cases, Jack suggested that it was better to: "mobilize the stapes rather than remove it" and he admonished that: "most operations for mobilizing the stapes must be looked upon as largely experimental (99)."

There are obvious reasons offered for the poor initial stapedectomy outcomes including limitations in visualization and instrumentation as well as the unavailability of a replacement prosthesis. Due to poor results, stapes surgery for otosclerosis never really caught on during the 19th century and was relegated to obscurity for over 50 years. Its revival in the early era of

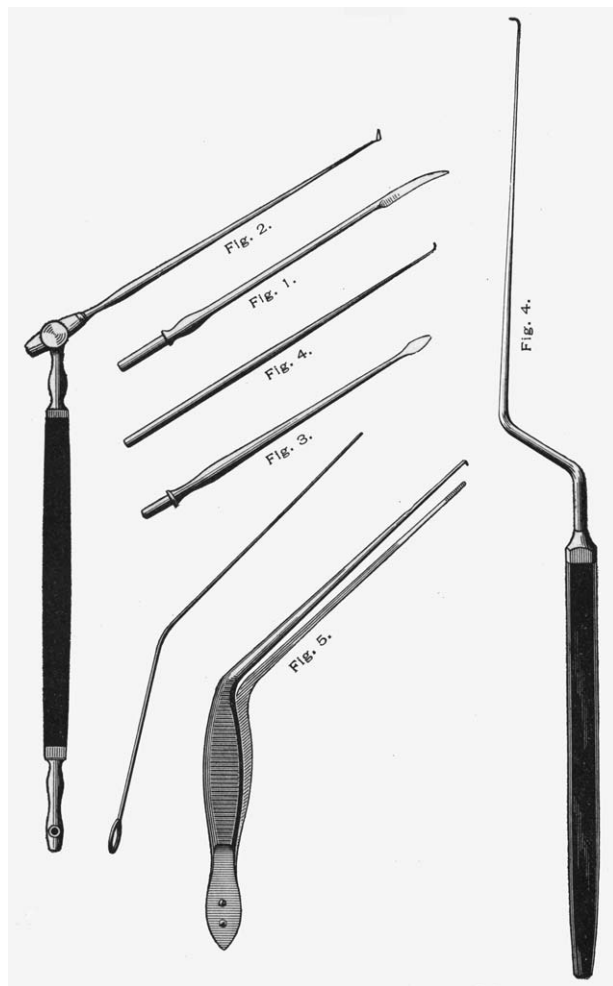


FIG. 15. Instruments used by Frederick L. Jack in performing stapedectomy in the early 1890s (99).

microsurgery came with stapes mobilization by Samuel Rosen (1952) and stapedectomy (with prosthesis) by John Shea Jr. (1956) (97,102,103). It remains an important part of the otosurgical armamentarium today.

Sensory Hearing Loss

Hearing loss has always been an integral part of the practice of otology. As expected, understanding and treatment options were limited in the nineteenth century. Presbycusis had long been observed and understood to be a part of the normal aging process, as Roosa put it at the 18th meeting of the AOS in 1885, "A certain degree of impairment or diminution of hearing power, is, I think, inevitably an accompaniment of old age, or even of life after fifty years (104)." Age fifty may seem early by today's standards, but keep in mind that the average lifespan of Americans in 1900 was 46 years for men and 48 years for women.

As otologists saw increasing number of cases, other etiologies of hearing loss were better characterized. During this early part of the industrial age hearing protection was seldom, if ever, practiced. For example, Holt examined 40 men from steam-boiler shops in Portland, Maine and deduced that they suffered:

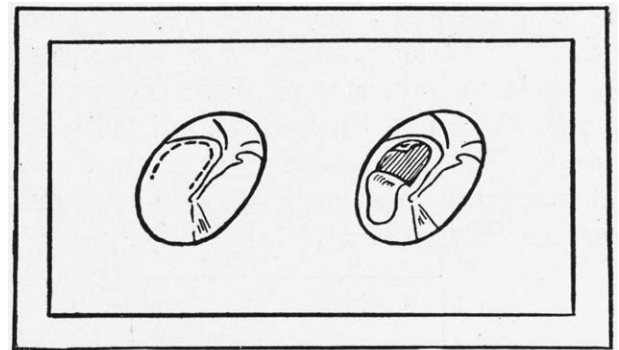


FIG. 146.—Diagrams showing line of incision, and the resulting flap, deflected.

FIG. 16. Tympanic membrane flap used for early stapes surgery (100).

"loss of hearing from constant concussions of the air produced by striking one substance against another," an affliction known as, "Boiler-maker's disease (105)."

After an epidemic of meningitis, Knapp noted high rates of profound deafness in survivors. Through his examination of various specimens, he found that in those whose hearing did not recover: "the affection that ends in total and irrecoverable loss of hearing which we notice so frequently – in about ten per cent of our latest epidemic—is an essential symptom, a homogeneous extension of the original morbid process, namely a suppurative inflammation in the labyrinth (106)." He made note that: "[t]he prognosis of the deafness consequent on epidemic cerebro-spinal meningitis, is, as far as my own experience teaches me, hopelessly unfavourable (106)."

Many other etiologies of hearing loss were considered. Morland treated several women who reported hearing loss immediately after miscarriage or childbirth, and postulated that "anaemic deafness" could be caused by excessive blood loss during labor (107). Obesity too was suspect, with a theory that: "adipose deposit, by diminishing the patency of the nasal passages as well as by pressing upon the membranous walls of the Eustachian tubes, should cause a loss of equilibrium of the atmospheric pressure within and without the membrana tympani, and consequently the symptoms . . . can be readily understood, and that a general treatment directed to the removal of the corpulence should be the remedy for the aural symptoms, follows as a matter of course (108)." Another prevalent thought of the time was that "habitual use of the telephone would be prejudicial to the hearing in many cases where the hearing was already impaired (109)."

Hearing Devices

Numerous clever hearing devices were invented in the pre-electric era including horns, trumpets, speaking tubes, pinnae inserts, and various other forms of sound collection (110,111). Due to the stigma associated with hearing impairment, many were camouflaged to fit under clothing (e.g., hats), disguised within hair or beard, within carried items (e.g., fans, parasols, walking sticks, canteens, bouquet holder), or even incorporated into furniture such as the arms of chairs (112).

During the latter part of the 19th century interest was growing in hearing devices not only among otologists but among influential inventors of the time. At the 18th meeting of the AOS in 1885, Sexton presented in conjunction with



FIG. 17. A binaural device to enable hearing impaired individuals to hear their own voice as well as that of others (117).

Alexander Graham Bell on binaural conversation tubes to assist deaf children in comparing their own voice with that of a teacher's to help acquire speech by imitation (113) (Fig. 17). This was followed by an address by Bell to the AOS President and those assembled where he applauded physicians for raising awareness of the use of hearing aids. In his experiments in schools for deaf-mutes, he noted:

“[w]e had no idea until within a year or two how large a proportion of the so-called deaf mutes in our institutions were only hard of hearing; the number is especially large among the congenitally deaf. A child is born with partial hearing, but not sufficient to enable him to acquire speech by imitation. It is now found that with artificial aides to hearing, such children can be taught to speak, and when so taught, they are only hard of hearing. . .

I think that all [deaf mutes] should be examined by competent aurists, simply for the information, if nothing more, to determine if anything can be done to benefit the hearing (114).”

Bell, whose mother and wife were both deaf, considered himself to be an educator of the deaf. His motivation in inventing the telephone was, at least in part, as an aid to the hearing impaired. His 1884 article titled, “Memoir upon the Formation of a Deaf Variety of the Human Race,” described the propagation of the disability via deaf-deaf marriages (115). Bell espoused a eugenic viewpoint manifest in support of oral education to mainstream hearing impaired children as a means of discouraging separate deaf culture and thus the trend toward intermarriage. Among the deaf community, his advocacy for assimilation was met with much controversy and consternation (116).

Pneumomassage

Massage of the ear, typically delivered through the ear canal either by compressed air or direct mechanical pressure on the malleus, was common in the later part of 19th century (117–119) (Figs. 18 and 19). In 1899, Houghton wrote:

“Aural massage is based on the same science as general massage, and implies the same art in use.

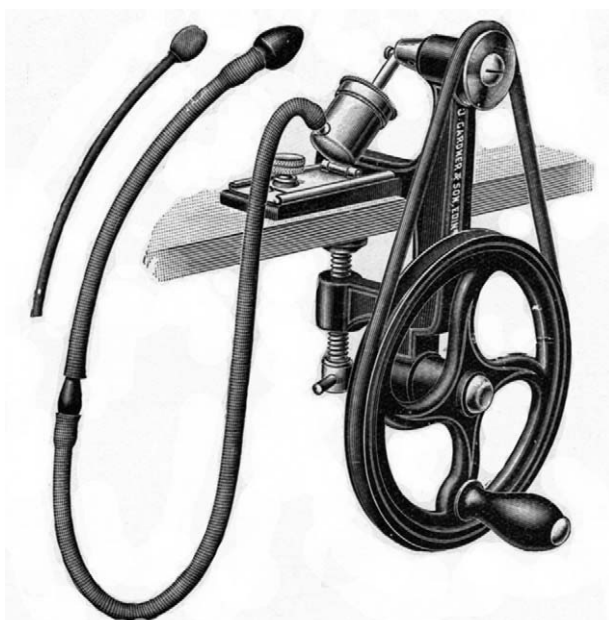


FIG. 18. Noebel's ear pneumomassager powered by a hand crank which was used for a wide variety of ear disorders (118).

Given rigid articulations, tense ligaments, wasted muscles, impeded venous or arterial circulation, dull, torpid nerve centres or terminals, then the law, the guiding rules, fixed by experience, give the indications by which the art is practiced (120).”

Houghton likened the rationale to that of traditional massage, noting: “We know that general massage gives mobility to rigid articulations, gives freedom to capsular or intercapsular ligaments, restores wasted muscles, overcomes stasis, increases destructive metamorphosis, aids nutrition, and lastly, but most vital, energizes the nerve at the centre and terminal (120).” Pneumomassage was administered by delivering alternating high and low pressure air via a sealed ear canal. There was hope that such techniques could relieve a litany of conductive

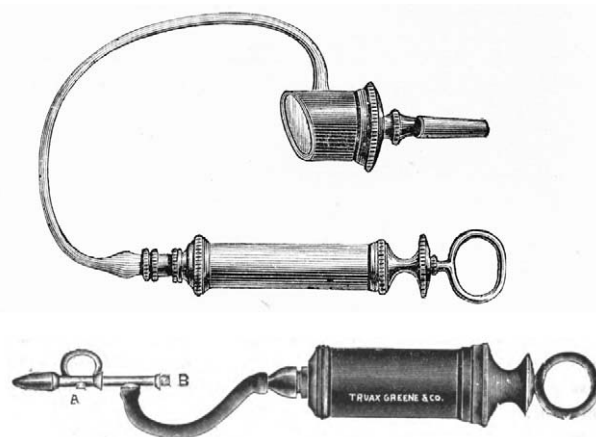


FIG. 19. Hand pump pneumatic otomassagers. Using a Siegle otoscope allows visualization of the tympanic membrane during the therapy (3,119).

forms of hearing loss, many of which were later recognized as otosclerosis. Hydrotherapy, or aural douching, was predominantly performed to clear cerumen or infectious debris but sometimes as a means of aural massage. Some proponents of hydrotherapy went so far as to recommend it as a cure for deafness (121).

While French and German otologists were the first to widely employ tympanic membrane masser, there were skeptics among the ranks of American aurists. At the 19th annual meeting in 1886 Theobald posed: "Have any of the members had favorable results from the use of any form of apparatus for rarefying and condensing the air in the auditory canal, with the idea that the drum-membrane would be moved in and out and thus rigidity of the ossicles be lessened? (122)" To this question Sexton replied: "an apparatus, consisting in a large glass ball to fit over the entire auricle, to which a little pump was attached and it was intended to accomplish the same purpose of the other rarefaction instruments. . . [i]t was the device of a charlatan well known fifty years ago (122)."

Randall, on the other hand, having presented on the subject numerous times was among the more vocal proponents. In 1901, he argued that the failure of others to obtain good results with massage was most often due to lack of air within the tympanum, for which he recommended concurrent tympanic insufflation, for which he recommended concurrent tympanic insufflation. He also argued that Siegle's otoscope was the best appliance of pneumatic massage, noting that its chief advantage was allowing the otologist to view the drum-head during treatment, thus ensuring positive results. He pragmatically remarked: "the dramatic value of electric or compressed-air manipulation will always appeal to some classes of patients and tempt the aurist who must be up to date (123)."

As an increasing number of American otologists gained experience with the practice, more began to question its indication and efficacy. In 1904, Emil Amberg argued that: "I think that it is the time to call a halt to the indiscriminate treatment of nonsuppurative middle ear affections without proper indication, or without a thorough knowledge, and consequently often with disastrous results. The subject which I am referring to is the inflation and massage of the middle ear...this massage carries with it a certain danger to the hearing, by producing a flabby membrane and perhaps by loosening the joints between the ossicles (124)."

Randall himself came to this conclusion when confronted with the indiscriminate explosion of so many massage devices, including motor driven apparatuses that he believed could lead to noise-induced hearing loss. In remarks given to the AOS in 1910, he reiterated, "so it is well to recall that the ideal form of massage is that by the voice, even though few will undertake to use it rightly (125)."

Electro-otiatrics

The employment of electricity for a variety of medicinal purposes was a rich topic of exploration for both exploitive charlatans and legitimate physicians. Electrical stimulation of the ear began with Volta in the 18th century and by the late 19th century was well enough established that the field had a name: electro-otiatrics (126). In otology during the early years of the AOS, application of galvanic current was proffered as a treatment for ailments including hearing loss, tinnitus, otitis media, and even mastoiditis. Entire books were written on the subject of electricity for the treatment of ear disease, including one by William Franklin Coleman (Fig. 20 (127)) In it, there are descriptions of "[t]he application of electricity to the treatment of chronic catarrhal otitis media. . . based upon the well-known effect of galvanism upon chronic inflammatory processes." In

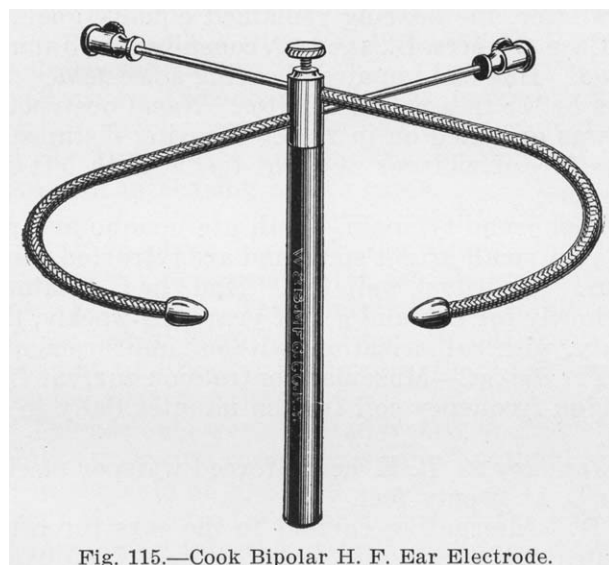


Fig. 115.—Cook Bipolar H. F. Ear Electrode.

FIG. 20. Ear electrode for delivering current in the treatment of deafness, tinnitus, and chronic inflammation (127).

diagnostic use, he recommended transillumination of the mastoid with an incandescent lamp to detect the presence of purulence or granulation, the presence of which would preclude the normal illumination expected in a healthy aerated mastoid. Coleman also described the treatment of mastoiditis with phototherapy, citing several successful cases, and concluding that, "in cases of acute mastoiditis, if caries is not present, the symptoms will yield promptly to treatment by the incandescent lamp. If they do not yield after a week or ten days' treatment, I conclude that caries exists and operate (127)."

Blake described a favorable effect of electricity upon tonal tinnitus: "the passage of the galvanic current increases not only the limit of perception of musical tones, but also the intensity of perception (128)." Often stimulation was titrated to the specific patient, with Blake advising "It will be found as a rule, that the current which diminishes the tinnitus aurium increases the hearing, and that the current which increases the tinnitus diminishes the hearing (128)." Burnett noted an effect on the opposite ear: "paradoxical formula, [which] implies a response to the electric current from the acoustic nerve of the armed as well as the unarmed ear (129)."

With increased experience, use of electricity in the treatment of ear diseases gradually faded. Robert F. Weir treated a young girl stricken deaf by an attack of measles and observed: "continuance of galvanism, however, afforded no change in the hearing (130)." Such cases led Weir and Buck to speculate that in the case of measles "the whole trouble might well be ascribed to the internal ears alone," explaining why electrical stimulation failed to benefit those patients (130). Eventually, otologists migrated away from use of electricity to treat otological diseases, but that did not deter hucksters from promoting false claims throughout the turn of the century (126).

Aural Vertigo

In 1861, Prosper Ménière noted the intermittent nature of vertiginous spells and the relation to hearing loss, which led him to conclude that dysfunction of the semicircular canals was causative (131). It was general convention in the late 19th

century to loosely apply the term Ménière's disease "to all those cases of sudden loss of hearing. . . which are associated with vertigo, tinnitus, nausea, inability to maintain one's balance, etc. (4)"

At the 7th annual meeting of the AOS in 1874, Burnett presented several cases of "so-called Ménière's disease" to expound on several points (40). He was able to observe "the various planes of the apparent motion experienced by the patient during his attacks of vertigo" and isolate it to the orientation of a particular semicircular canal. He attempted to rule out central pathology by noting that attacks of vertigo are "always accompanied, be it remembered, by perfect consciousness." He then postulated "chronic catarrh. . . induced the Ménière's disease by an extension of the proliferous disease to the semicircular canals." He concluded by stating "that, although the semicircular canals may not be devoid of acoustic functions, they seem to possess well-marked functions presiding over the pose of the head, and mediately over that of the entire body (40)."

Common treatments would include lifestyle and dietary modifications, namely "chiefly nourishing food, but avoiding excess as regards quantity of any kind of food" and the avoidance of stimulants (4). Solutions containing sodium bicarbonate and strychnine were also commonly prescribed, as well as more invasive interventions such as Eustachian tube cauterization and the application of silver nitrate to the torus of the Eustachian tube (4,5).

Due to the paroxysmal nature of aural vertigo and the apparent improvement between attacks, speculation grew that the "direct lesion cannot be in the labyrinth", but instead was due to "spasmodic affection of the muscular structures of the middle ear" causing inward pressure of the stapes onto the labyrinth fluid (5). At the 21st AOS meeting in 1888, Burnett presented a surgical intervention for relief of aural vertigo caused by Ménière's disease, which he believed was due to inward pressure on the labyrinth fluid from the ossicles and tympanic membrane. Using ether anesthesia, he excised the malleus and overlying tympanic membrane, while at the same time separating the incudo-stapedial joint and placing the incus in the attic. Two months postoperatively the patient reported "no sensation of fullness in the ear, which has so long distressed her, nor any vertigo" (41). This led him to conclude "[t]hat tinnitus and aural vertigo may be due entirely to disease in the middle ear, and therefore need not always be referred to disease of the internal ear" and more remarkably that "[w]e also see that nothing but good resulted from the operation performed in this case, and we may conclude that this would always be the result (41)."

Burnett's recommendations were immediately met with skepticism from C.J. Kipp who wrote in a comment to the article: "Lucae had performed this operation twenty-five times for the relief of tinnitus and vertigo. . . he said that he had abandoned the operation for this purpose because the results had been unsatisfactory (41)." Two years later, Burnett remained steadfast reporting that his patients sustained "permanently good results (42)." With more cases to report on by 1893, he continued, "I have long maintained the tympanic or mechanical origin of most cases of aural vertigo. . . morbid retraction of the auditory chain, and resultant cerebellar irritation, are not constant, but vary with the state of the general health and the condition of the catarrhal middle ear (43)." He postulated that, "[i]f the theory is correct that the vertigo. . . is due to the retraction of the conductors of sound and mechanical pressure upon the labyrinth fluid, then the surgical removal of

such retraction and pressure ought to relieve the tympanic vertigo (43)."

General Anesthesia in Otology

The use of local and general anesthesia was critical to allowing the early AOS practitioners to advance their craft. General anesthesia using ether, nitrous oxide, or chloroform had been in use since the 1840s, however it was not until the 1880s that local anesthesia using cocaine was developed (132,133). Ether was the most commonly used general anesthetic in aural procedures, and was "used to complete narcotism (134)." It allowed the patient to forgo the pain associated with ear surgery, and allowed the surgeon to "ensure perfect quiet of the head (135)." Chloroform was also used, but referenced much less frequently in the otologic literature. Ether inhalant anesthetic allowed otologists to progress from Wilde's postauricular incision simply to release pus to more formal mastoidectomy. According to Sexton, writing in 1876: "[A]fter the administration of chloroform, many hours' patient work with the 'American' drill" was [possible.] (136)" Nitrous oxide gas was seldom mentioned in the AOS transactions, as "owing to the spasmodic movements that usually take place when this agent is used it had to be abandoned (137)."

There was debate as to which procedures were painful enough to the patient to warrant the use of anesthesia. Some practitioners felt that all "grave operations about the ear in children should be done under anaesthetics (45)." In adults, paracentesis of the tympanic membrane to treat acute catarrh was generally not thought to be particularly painful (45). However, treatment of chronic catarrh, and in patients having operations for the "relief of deafness," general anesthesia was deemed necessary (45). Early AOS surgeons recognized the flammable potential of inhaled anesthetics, and advised that "the light afforded by an argand gas burner, or even an oil lamp, illuminates the ear sufficiently in ordinary cases; but in the more difficult ones an electric light illumination is best, especially where ether is administered, on account of the danger of its ignition from an exposed flame (24)." The comment refers to an improved oil lamp invented in 1770 by Aimé Argand which put out 6 to 10 candle power.

Local Anesthesia in Otology

Before the introduction of cocaine in 1884, cold (e.g., application of ice) was a common means of local anesthesia (138). In ear surgery morphine was sometimes infiltrated subcutaneously as a means of pain control after surgery (41). Cocaine was introduced to otology in the latter part of the 19th century and achieved some popularity: "Cocaine has demonstrated itself to be the most important local anaesthetic that medical science has yet discovered. But a few months old, in a therapeutic sense, its brilliancy of achievement has flashed like a meteor over the whole medical world (139)." It was less readily accepted in otology than in ophthalmologic or mucous membrane surgery (41,140). Otologists observed the hemostatic effects of cocaine: "the slight hemorrhage was checked by mopping the cut with a five per cent. solution of cocaine muriate (41)." In acute otitis it was said that: "...cocaine relieves the pain when used early and repeatedly," but it might "prolong the congestion (141)." Cocaine's side effects and abuse potential among physicians (e.g., Halsted, Freud) were also observed: "Impaired health and temporary insanity are attributed to the excessive use of this drug. . . Abuse of a remedy as potent for evil as it is powerful for good. Already the cocaine

habit has supplanted the morphine, alcohol or chloral habit (139).”

Antisepsis in Otology

Joseph Lister introduced antiseptic technique in 1867, marking a dramatic shift in the landscape of surgery that had previously been limited by the lack of sterility since the time of antiquity. Lister first described the use of carbolic acid, initially poured onto skin or by packing acid-soaked lint into wounds (142). Despite successes reported from centers across Europe, adoption was initially mixed in the United States. There have been several reasons offered for this. One prevailing thought was that American and European hospitals were intrinsically different, and that infection was due to overcrowding in European cities. John Mason Warren, an American, explained that, the “impaired hygienic condition...[was] consequent [of] crowding. . .for it is only necessary to travel a few miles into the country to find again the same favorable influences (142).”

Dismissive opinions in America were numerous and vocal. In an 1876 centennial celebration essay commemorating American influence to the field of surgery, eminent Philadelphia surgeon Samuel D. Gross, subject of a famous painting by Thomas Eakins and President of the International Medical Congress, opined: “Little, if any faith, is placed by any enlightened or experienced surgeon on this side of the Atlantic in the so-called carbolic acid treatment of Professor Lister (143).” Despite skepticism regarding the need for antisepsis and the slow rate of adoption, there were early American proponents. Edmund Andrews, a Chicago surgeon, after a tour of London in 1867 offered, “if it is a settled thing that an English hospital must not be ventilated, I think carbolic acid may be a good thing, as being, next after fresh air, the best preventative of pyaemia. It is powerfully antiseptic, and if it will prevent suppuration, it may be very valuable in cases of hectic exhaustion (142).”

Despite the slow, yet inevitable, adoption of asepsis among other surgical fields, otologists lagged behind. That is not to say there were not early adopters. In describing the removal of exostosis, Burnett referred to the use of carbolic acid, “I proceeded to remove this obstruction, as follows: First, five minims of a 5% solution of hydrochlorate of cocaine were injected hypodermatically into the concha near the exostosis; the tumor and the adjacent parts, as well as the instruments, were mopped with a 5% solution of carbolic acid (18).” One potential reason offered for the poor adoption of asepsis in otology is that during this era one of the main purviews of the aural surgeon was the treatment of grossly infected patients, often with purulent middle ears or infected mastoids. J. Holinger admitted as much in an 1896 JAMA article critical of the field of otology, stating, “there is no physician who comes so much into contact with putrid and virulently infective material as the otologist (144).” This, he argued, made aseptic technique more critical for the diagnosis and treatment of the ear. He argued that, “The principles of asepsis should be carried out in otology in the routine examinations of the ear, and especially in the seemingly unimportant details of ambulatory practice.” To further illustrate the point, he shared an old saying “As soon as you treat (with non-sterilized instruments) an acute suppuration of the ear, it becomes chronic.” He remained critical of carbolic acid, stating it was not strong enough for disinfection and useful only as a means to “lull our consciences.” He offered the following: “. . .practical rules for aural work:

1. Every instrument should be so constructed that it can be easily cleaned and examined.
2. Before every examination the instruments (speculum, probe, catheter, middle ear instruments) should be sufficiently boiled, and immediately after use they should be washed in cold water, so that the pus, mucus and blood may not coagulate and dry on them. Of course, it goes without saying that the hands must be kept clean according to the general rules of asepsis (144).”

DISCUSSION

The founder generation of the AOS saw their time as one of enormous progress during which interest in ear disease was kindled and new methods were enthusiastically explored. The latter half of the 19th century saw a transition in attitudes toward management of ear diseases from one of therapeutic nihilism to one of interventionism enabled by newly introduced anesthetic techniques which allowed less rushed and more meticulous surgical procedures. This newfound ability led to spirited and sometimes excessive use of operative approaches. For example, during this era resection of the tympanic membrane and ossicles was put forward as a highly successful “cure” for maladies as diverse as chronic otitis media, otosclerosis, tinnitus, and Ménière’s disease.

The spectrum of diseases reported upon in the Transactions focused primarily upon the external and middle ear with little attention to inner ear or the deeper regions of the temporal bone. Articles published in the AOS Transactions focused principally upon chronic otitis media, tympanic membrane perforation, mastoiditis, complications of ear infections, fatal cases of ear infections, cerumen, foreign bodies of the ear canal, and lesions of the auricle. Scant attention was focused on sensory hearing loss and vestibular disorders. In terms of surgical procedures, greatest attention was placed upon mastoidectomy, myringotomy, and destructive procedures such as resection of the tympanic membrane and ossicles. Medical therapy was principally topical, primarily application of powders, purges, and potions with few systemic therapies (e.g., arsenic, strychnine, mercury, quinine). Inflammation was sometimes countered with leeches. Overall, the primary occupation of the otologist was to fight infection, as it was for all of otolaryngology, a circumstance which would continue until the 1950s.

This was an era during which anecdote was the rule. Reports typically emanated from single surgeon’s series with no tendency to aggregate data across centers. Similar to today, reports of surgeries are often focused upon successful outcomes with few articles reporting upon techniques which were tried but failed to help the patient—or worse. The field of audiology had yet to develop and hearing testing relied upon tuning forks, whistles, whispers, and ticking watches. The lack of objective and reproducible means of recording hearing levels impaired the ability to evaluate the effectiveness of treatment upon hearing and thus the auditory implications of treatment we deemphasized.

The tonality of discourse during AOS sessions of the late 19th century was more acrimonious than today. This tendency was echoed in written scholarship, which were sometimes laced with dismissive and harshly critical opinions of colleagues bearing contrasting opinions. There was also a tendency to be more dramatic in written scholarship than typical in current style, which tends to be more formal and moderated. Case reports at the time were more comprehensive than today and often contained florid descriptions of a patient's suffering chronicled day by day with his ultimate demise despite the valiant efforts of the practitioner.

While we refer to the practice otology in America, in reality we are describing the level of practice by a mere handful of specialist practitioners in major Northeastern cities, principally New York and Boston. It was not until well into the 20th century that more advanced otological practices permeated most regions of the nation. The participation in AOS by Alexander Graham Bell, inventor of the telephone, illustrates the forward-thinking ethos of the founder generation. They were intrigued by its potential as an aid to the deaf. America did not assume a leading role in shaping otological practice until the latter half of the 20th century when innovations such as stapedectomy, cochlear implantation, and microsurgery of acoustic neuroma arose principally in the new world.

In many ways it is remarkable how much 19th century otologists were able to do without technologies central to the contemporary practice of otology such high resolution imaging, operating microscopes, high speed electric drills, standardized audiometric testing, and, of perhaps most importance, antiseptic technique and effective antimicrobials. It would be erroneous for contemporary observers to smugly conclude that our forbearers lacked understanding of pathophysiology of ear diseases and that they practiced ear medicine and surgery crudely with at most limited beneficial effect. This is all a matter of perspective. So-called "modern methods" are just that, the state-of-the-art for a given period in time.

At the tercentennial of the AOS, 150 years from now, our early 21st century advanced technology and sophisticated biological targeted therapies will appear naïve and ignorant to our late 22nd century successors. We hope that future historians of otology will be charitable, as we have attempted to be, in recognizing the achievements of the present era in their proper context.

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Evolution of Otology and Neurotology Education in the United States

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A brief history of the evolution of Otology and Neurotology training in the United States is presented. The development of the Neurotology Fellowship accreditation process by the Accreditation Council on Graduate Education and the certification of neurotology fellows by the American Board

of Otolaryngology is outlined. **Key Words:** Neurotology certification—Neurotology training.

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Otology/Neurotology training evolved dramatically over the past 150 years. Today, there are rigorous oversight, standardization of content, and minimum numbers of cases that must be accomplished by trainees. For many years, this was not the case. The American Otological Society (AOS) and the American Neurotology Society (ANS) were instrumental in bringing about these changes. A review of the events that precipitated this transformation is presented. The present educational model has involved medical education oversight organizations at the highest levels including the American Board of Otolaryngology (ABOto), American Council for Graduate Medical Education (ACGME), ACGME Residency Review Committee for Otolaryngology (RRC Oto), and the AOS Council and Executive Committee of the ANS (1).

EARLY TRAINING IN OTOLOGY

Early specialty training in the United States before World War I was unregulated and the centers that evolved specialty training engaged practitioners that traveled to Europe to study with individuals in major centers, such as Edinburgh, Paris, and Vienna (2). In the early 1900s, Robert Flexner was commissioned by the Carnegie Foundation to study American medical education because of the lack of oversight, irregular methods, and lack of standards. The Flexner Report examined medical education, but did not mention subspecialty or graduate education (3). Many of the current medical education practices of today stemmed from this review

and its suggestions. Evolving specialty training was apprenticeship-based training in large metropolitan hospitals. The standardizing of otolaryngology training was discussed in a report in the *Journal of the American Medical Association* in 1913 (4). The report was written by a Committee for the Laryngological, Rhinological and Otological Society, and consisted of a survey of 31 institutions in 20 states to determine the length of training, course of instruction, and the proper balance of medical and surgical topics. They discussed undergraduate and graduate curriculum, and how to standardize training at the graduate level and whether a PhD should be offered. It was suggested that other important societies such as the American Laryngological Society, the American Otological Society, and the Academy of Ophthalmology and Otolaryngology select representatives to finalize these standards.

The first hospitals in the United States to recognize the specialty of Otology included New York Eye and Ear (1820), Massachusetts Eye and Ear (1827), University of Pennsylvania (1870), and Johns Hopkins (1914). It is interesting that the University of Iowa College of Medicine had a lecturer in Ophthalmology and Otology (1902) and the University of Michigan Department of Otolaryngology recognized Otology in 1904. There were most likely others in this era that had a focus on otological disease. One of the first otologists in the United States was George Shambaugh, Sr. who graduated from medical school at the University of Pennsylvania. He then spent 2 years studying in Berlin and Vienna. Following this specialized training, he was appointed an instructor of anatomy at the University of Chicago in the Department of Otology at Rush Medical College (5).

Between World War I and World War II specialty training became more regulated and principally occurred in academic medical centers (2). In 1938, Julius Lempert published his strategy for the management of otosclerosis

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with a single-stage fenestration procedure (6). The success of this surgical strategy required specialized training by Dr. Lempert. Otolaryngologists were encouraged to travel to study with Dr. Lempert (6). A shift back to apprenticeship training outside of hospitals and colleges of medicine became a standard. Some eventual leaders of the AOS were fortunate to be able to study and observe Dr. Lempert in the 1930s and 1940s including George Shambaugh Jr., Howard House, and Claire Kos. These individuals became some of the first group of specialists to primarily focus their practices on ear disease after World War II. Howard House must be recognized as the champion of otologic apprenticeship training experiences. He was an early benefactor of the apprenticeship training experience in 1938 when he spent a year traveling in Europe and the United States where he was able to observe the great otologists of his time including Holmgren, Cawthorne, Giles, Mosher, and Lempert. He was one of the few surgeons to learn the technique of single-stage fenestration surgery from Dr. Lempert.

Howard House took this experience to the next level by expanding his practice to include specialized training in ear disease within his private practice. Howard opened The LA Foundation of Otology in 1946 and by 1959 the Otologic Medical Group (OMG) included Howard and his brother William (Bill), James Sheehy, and Fredrick Linthicum. The OMG offered courses on management of ear disease to those in practice as well as those in other academic training programs in the United States and international visitors. They were quite innovative and developed the observer tube for the microscope that greatly enhanced the students' ability to understand the intricacies of microsurgery. They also pioneered teaching films to improve training. This was a very exciting time in otology as Bill House and his team were developing pioneering approaches to the skull base that eventually became the new subspecialty of Neurotology. Bill's passion to improve outcomes for acoustic tumor management led to the development of the translabyrinthine and middle cranial fossa access for the removal of vestibular schwannoma. In 1960, the House Group began offering a 1-year fellowship in clinical otology and neurotology. In 1974, the clinical group became Ear Research Institute and in 1981 the House Ear Institute. The group held national and international conferences on the latest management of ear-related disorders. Another feature of the House Ear Institute was the large temporal bone pathology collection that Fred Linthicum amassed over the years. Some of the early trainees of the House group were John Shea, Jack Pulec, Michael Glasscock, Samuel Kinney, Malcom Graham, and Charlie Leutje. At the same time, other otologists visited Los Angeles and spent 2 to 4 weeks with Bill. They then returned to their programs and began to perform neurotology procedures. Some of these individuals include Brian McCabe, Herb Silverstein, Bill Montgomery, Rod Perkins, and Noel Cohen. The excitement surrounding neurotology expanded the field and increased the development of more training programs. Herb Silverstein, Jack Pulec,

Michael Glasscock, Noel Cohen, Brian McCabe, Rod Perkins, Fred Owens, Malcolm Graham, and Don Kamerer all developed their own neurotology fellowship programs. It is interesting to note that many of the present leaders in our specialty today turned again to Europe in the 1980s and 1990s to train with Ugo Fisch in Zurich, Switzerland.

By 1990 the growth of training became exponential with the eventual development of 31 known neurotology training programs, most outside academic institutions. The training was of variable length from 3 to 12 months duration. Some individuals only participated in a 3-month observational fellowship and then began a Neurotology practice. There was no oversight of the type of training or experience that the trainees were required to complete. This became an issue within the Executive Committee of the ANS, the AOS Council, and the American Board of Otolaryngology (ABOto). The ANS Executive Council considered the development of a process to regulate training programs and certifying trainees; however after the investigation of the process, it became apparent that the costs involved to regulate training, including time and expense, were overwhelming. The ABOto had similar concerns with regard to the explosion of fellowship training programs throughout Otolaryngology. Byron Bailey, then President of the ABOto, wrote an article on this subject, stating that there were over 150 Otolaryngology subspecialty fellowship programs in the United States (7). Most programs were not associated with ACGME residency programs, and the quality and curriculum of this training was unregulated. Standardization of subspecialty training was lacking throughout Otolaryngology–Head and Neck Surgery compared with most all other specialties of medicine.

ORGANIZATIONAL STRUCTURE OF THE ACGME AND ABMS

It is important to understand the complexities of the two national organizations responsible for standardization of training, accreditation of training programs, and certification of trainees. They are confusing, but explanation clarifies the reasoning for the regulations that have been established.

Accreditation of training programs in the United States is under the umbrella of the ACGME, which is sponsored by the American Medical Association, the American College of Surgeons, the American Association of Medical Colleges, the American Hospital Association, and the American Board of Medical Specialties (ABMS), among others. The ACGME oversees Residency Review Committees (RRCs) for the various disciplines within medicine. The RRC for Otolaryngology is made up of appointees from the American Medical Association, the American College of Surgeons, and the ABOto. The RRC oversees the quality of graduate medical education in the United States, establishes national standards for graduate medical education (GME), and monitors and upgrades educational programs. When training program

requirements are expanded, or changed, all ACGME member RRCs, as well as the parent organizations, must approve the changes. Any change of established requirements is evaluated based on needs within the specialty and also the impact it might have on other specialties. A training impact statement must also be developed and circulated to all constituents of this group. As one might expect, expansion of requirements into the domain of another specialty is met with resistance and political maneuvering. This process is time consuming, as you will see.

The ABMS is the over-arching organization for 26 medical specialty boards within the United States. The ABMS provides information to the public, the medical profession, the government, and its members regarding issues of specialization and certification. The ABOto is the second-oldest ABMS board; it has been certifying individuals since 1924. The ABOto is dedicated to ensuring that graduates of ACGME accredited programs have passed a certifying examination that validates their training. The ABOto has the ability to issue a general certificate as well as subspecialty certificates of added qualification (CAQ) in Neurotology, Pediatric Otolaryngology, and Plastic Surgery within the Head and Neck. The subspecialty certification process is similar to the ACGME process in that all of the other 25 boards evaluate the documents justifying subspecialty certification and comment on the overlap with their certificates and scope of practice. A majority of specialty boards must vote to accept any change in the type of certificates issued by an individual board.

Establishment of the Neurotology training guidelines and development of a certification process for trainees required parallel efforts within the ACGME and ABMS. The ABOto initiated the process of establishing the subspecialty within the ABMS with a request for a Certificate of Added Qualifications in Otolaryngology/Neurotology in 1986.

ACGME ACCREDITATION PROCESS

The training requirements and standards for training for Otolaryngology/Neurotology were completed by the RRC for Otolaryngology for the distribution to the ACGME constituents in 1992. These requirements were constructed in cooperation with the Executive Committee of the ANS, AOS Council, and ABOto. Maxwell Abramson, then a member of the Otolaryngology-Head and Neck Surgery RRC, organized the initial draft of the training requirements in the mid 1980s in anticipation of the ABMS approval of the CAQ. Bruce Gantz, an RRC Otolaryngology member following Dr. Abramson's untimely death, finalized the training requirements in collaboration with the ANS Executive Committee. Several issues regarding the length of training and where training took place had to be resolved before submission of the training documents to the ACGME in 1992. The issue of where the training occurred was a very important issue. The ACGME required all subspecialty training programs to

be affiliated with established ACGME specialty residency programs. Programs could not exist in freestanding private practice settings. However, it was acceptable if the practice had a teaching affiliation with an ACGME approved program. The length of training also had to be standardized. The leadership of the ABOto at the time felt strongly that all subspecialty fellowships needed to be 2 years in duration. The administrative staff of the ACGME also supported 2 years of training and intimated that a 2-year program would more likely pass the ACGME Executive Committee. The 2-year training concept was met with some resistance within the specialty, as a 1-year training program was the norm. The leaders of the ANS, Charles Leutje and Samuel Kinney, members of the executive council, and a neurotology subspecialty committee consisting of Derald Brackmann, Michael Glasscock, Robert Jackler, Herman Jenkins, and Bruce Gantz supported the 2-year training period. Another roadblock was encountered when the training requirements were criticized by the Neurosurgery, Neurology, and Rehabilitation Medicine RRCs. This required compromising language stating that when an operation was planned to enter the dura, a neurosurgical consultation should be obtained. The language was not thought to impact the practice of neurotology, as practice was a local issue, not national. The language was thought to be acceptable by the AOS and ANS. This issue had also been raised by Neurosurgery at the ABMS at the level, but the proposed language was found to be acceptable by the ABMS Board of Directors. The ACGME Council on Medical Education recommended approval of the requirement document in March 1993. Next an impact document was prepared that again required approval by the entire ACGME constituency. Unfortunately, during this time period there was national pressure on the ACGME to reduce sub specialization within medicine, and a moratorium was placed on expansion of subspecialization. The ACGME was requiring at least 40 sites of training before an application would be considered. Because of this change, all otolaryngology subspecialty applications were withdrawn as it was believed that 40 training sites should not be established for our specialty. Fortunately, the 40-site moratorium was lifted and the subspecialty training programs were re-initiated in late 1994. The final process for approval required presentation of the requirements to the ACGME Executive Committee. Both Pediatric Otolaryngology and Neurotology went through the process together. Robert (Bob) Miller represented Pediatric Otolaryngology and Bruce Gantz presented the requirements for Neurotology. Dr. Miller presented pediatric requirements first. The pediatric requirements included a provision to include up to 1 year of research during the training experience. This was a red flag for the ACGME executive committee. They explained that not more than 6 months of research training could be included in a 2-year subspecialty-training program. It was a Health Care Financing Authority regulation that GME training expenses could not incorporate more than 6 months of research per 2-year

period. It was explained that our subspecialty training came at a time when GME training money was not available to our subspecialty residents, as they were beyond the 5-year training period limit for training payment and did not qualify for GME financial support. This challenge was unsuccessful. The final approval of the ACGME Council occurred in June 1995, 4 years after submitting our program requirements.

The first subspecialty residency in Otolaryngology/Neurotology to receive ACGME accreditation was the University of Michigan in 1997. The first 10 approved programs included: University of Michigan, University of Iowa, New York University, Ohio State University, University of Virginia, Massachusetts Eye and Ear, Providence Hospital/Michigan Ear Institute, USC/House Ear Clinic, Northwestern University, and University of Miami. In 2017, 20 ACGME Neurotology Training programs are accredited (Table 1). Originally, the ACGME required the term resident for the trainees of accredited programs, but the term fellow has been assigned to differentiate the advanced level of training in these programs. There are specific numbers of index cases that the fellow must participate at the accredited institution and the case-loads, faculty participation, and performance on the certifying examination of fellows is monitored regularly.

ABOto CERTIFICATION PROCESS

Individuals within the ABOto who led the Neurotology process include George Reed, Byron Bailey, Robert Cantrell, Robert Kohut, Zan Schleuning, and all members of the ABOto. This process began in 1986, using the description of the subspecialty that was developed in conjunction with the Executive Committee of the ANS and AOS Council. The ability to issue a CAQ was finally approved by the entire ABMS assembly in September 1992 after much discussion with the American Board of Neurosurgery and the American Board of Neurology. The ABOto decided not to pursue issuing a certificate in Otolaryngology/Neurotology until there were a sufficient number of ACGME-approved training programs in the subspecialty, and the subspecialty societies requested that the ABOto proceed with a Certifying Exam. The Joint Executive Councils of the AOS and ANS asked the ABOto to move forward with the examination process

in 2002. A Neurotology subspecialty committee was established by the ABOto consisting of five members of the ABOto and two members each from the ANS and AOS. The ABOto also decided at this time that the subspecialty certificate would be limited to only Neurotology as it was strongly believed by the ABOto Board of directors that the general certificate for Otolaryngology included otology and the subspecialty of Neurotology required an additional training period of 2 years. The ABOto then sent a questionnaire to over 7500 Diplomates who hold ABOto Certificates regarding the sub-certification process. The survey established the fact that 65% of those responding (524) believed that the ABOto should proceed with issuing a Neurotology subspecialty certificate, and 23% (182) said they would take the subspecialty examination. Importantly, the Diplomates did not voice an opposition to a certification process for the subspecialty of Otolaryngology/Neurotology.

On April 29, 2002, the ABOto unanimously approved moving forward with the certifying examination for Neurotology. The development of a Neurotology subspecialty qualifying examination was led by Julianna Gulya and included ABOto members Richard Chole, Richard Miyamoto, Harold Pillsbury, and Bruce Gantz. The representatives from the ANS were Newton Coker and Douglas Mattox, and the representatives from the AOS were Charles Leutje and Paul Lambert. The first examination was scheduled for the spring of 2004. The 2-year delay was required to provide adequate notification for the examination. Two pathways were established enabling those in established Neurotology practices to qualify for the examination. The Standard Pathway is for those individuals who have satisfactorily completed an ACGME-approved subspecialty residency. The Alternative Pathway was open to those who did not complete an ACGME-approved program, but who limit at least 60% of their practice to Neurotology, have been in practice for at least 7 years, complete a Peer Associates' Rating Review, and submit a 2-year log of operative experience. To qualify for the Alternative Pathway the individuals needed to demonstrate that their practice involves advanced otology and the full spectrum of neurotology and lateral skull-base surgery. The Alternative Pathway was only open for 7 years after the date of 1st examination. After 2011, qualification for the certifying examination required completion of an ACGME-approved Subspecialty Neurotology Fellowship. Another aspect of the certification process is the maintenance of certification (MOC) that must occur on a 10-year recertification cycle. Originally, the certificate holder was required to pass a proctored recertification examination. The ABOto is presently modifying the MOC recertification and in the future, it is expected that a successful yearly review of specific items will replace a recertification examination. As of this writing in 2017 there are 328 Neurotology Diplomates that are engaged in the MOC process.

The nine examiners involved in the initial examination in 2002 are observed in Figure 1. The two groups of examinees nine in the morning (Fig. 2) and nine in the

TABLE 1. Fellowship programs 2017

Baylor College of Medicine	Stanford University
University of Miami	House Ear Clinic/UCLA
Johns Hopkins University	University of Iowa
Louisiana State University	University of Michigan
Massachusetts Eye and Ear	University of Minnesota
University of California (San Diego)	University of Pennsylvania
University of Cincinnati	University of Texas Southwestern
New York University	University of Virginia
Ohio State University Hospital	University of Pittsburgh
Michigan Ear Institute	Vanderbilt University



FIG. 1. Original examiners: Front Table: Harold Pillsbury, Herman Jenkins, Richard Chole, Richard Miyamoto, Bruce Gantz, Paul Lambert, Newton Coker. Back Table: David Schuller (ABOto President), Gerald Healy (ABOto Executive Director). Inset: Douglas Mattox, Charles Leutje.



FIG. 2. Morning examinees: Jeffery Harris, George Hashisaki, Robert Jackler, Alexander Arts, Steven Cass, Thomas Eby, John Keveton, Thomas Balkany.

afternoon (Fig. 3) are shown. This group of 27 individuals became the core examining team for the first few years that the examination was given. Presently, the examination is held every 2 years.

COMMENT

Neurotology training and certification in 2017 is regulated by organizations that require programs and boards that oversee them to comply with national standards of advanced medical education. This process occurred over an 18-year period between 1986 to 2004 when the ABOto first petitioned the ABMS to issue a subspecialty



FIG. 3. Afternoon examinees: Myles Pensak, Steven Telian, Debra Tucci, Michael McKenna, Sean McMenemy, Ashly Wackym, Richard Wiet, Bradley Welling, Peter Weber.

certificate and the first diplomates became board certified in Neurotology. A number of our former and present leaders from the AOS, ANS, ABOto, ACGME RRC, and ABMS participated along the way. The journey was not without stress, anxiety, and conflict, requiring multiple discussions and compromise by all involved. The outcome of this journey has been the outstanding patient care that has become a standard. One of the most unforeseen advantages of the certification process has been the recognition of the Neurotology subspecialty by our neurosurgical colleagues. Many of our diplomates are joint members of neurosurgical faculties in major academic medical centers and medical schools around the country. Prior to the certification process there was significant resistance by neurosurgery for our subspecialty to be involved in the management of intradural procedures. Today, management of skull base and cerebellopontine angle tumors is seamless between the specialties.

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History of the Research Fund of the American Otological Society

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The Research Fund of the American Otological Society (AOS) has been funding basic and applied research in ear disorders since 1926. The conception and capitalization of this fund were the result of the efforts of a number of far-sighted leaders almost a century ago. The value of the fund is now about \$10 M. Each year grant proposals are critically reviewed by the Research Advisory Board of the American Otological Society Research Foundation. The Foundation funds meritorious research grants of about \$300,000 each year.

ORIGINS—1921–1926

The seeds of the Research Fund were planted by Dr. Norval H. Pierce at the annual meeting of AOS at the Hotel Chelsea in Atlantic City, New Jersey on June 1, 1921 and June 2, 1921 (Fig. 1). Dr. Pierce "...brought to the attention of the Society the need of doing something about otosclerosis." He moved that the president (Dr. Wells P. Eagleton) form a "Committee to consider the scope and plan an investigation of the subject of otosclerosis, to report at the next annual meeting of the Society." President Eagleton appointed "Doctors Wilson, Shambaugh, Cahill and Dwyer, with Dr. Pierce as Chairman."

At the May 1, 1922 to May 3, 1922 meeting of the AOS at the Hotel Raleigh, Washington, D.C., the Committee on Otosclerosis made its report. Dr. Pierce stated, "As the cause of otosclerosis is unknown and treatment futile...and for several other relevant reasons..." the Committee made five recommendations:

1. A systematic course of research into the subject with supervision of the AOS.
2. An endowment of \$100,000 should be procured to support research.
3. An experienced pathologist should be hired.

4. A working committee of the AOS "...is to collect specimens of otosclerosis from large institutions such as poor houses, public sanatoria, large hospitals...and to make the temporal bones available...to the center of investigation."
5. "The center shall be determined by the Society."

There was, evidently, lively debate at this meeting about the proposal. Some thought it to be a "...waste of time and money," while others thought that the sum of



FIG. 1. Photo of Norval H. Pierce.

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money was inadequate. It was suggested that some funds first be raised from otolaryngological societies to "...prove their sincerity..." and then approach the Rockefeller Foundation for further funding. Dr. Edward P. Dench felt that further study of human temporal bones "...won't get to first base any more than they have in the past." He suggested studies to find out "What makes the living cell tick will be the answer, plus chromosome analysis, and detection of chromosome aberrations." Evidently, no official action was taken by the Society, but the seeds were planted.

At the June 4, 1924 to June 6, 1924 meeting of the AOS in Washington, D.C., the subject of the study of otosclerosis was again brought up. Dr T. J. Harris, the secretary of the AOS, announced that dues were raised to \$25, of which \$10 were put into a fund to study otosclerosis. The fund at that time was \$1000. At that meeting, Dr. Arthur B. Duel (Fig. 2) presented a review of the subject of otosclerosis and proposed that a fund of \$500,000 be raised to support "...otological research for the eradication of otosclerosis." He suggested that the funds should be administered by "...some well-organized institution...to administer it in an effective way." Interestingly, he added, "A century from now eugenics may hold such sway that otosclerosis along with insanity, epilepsy and other transmissible defects may be wiped out." His



FIG. 2. Photo of Arthur B. Duel.

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CERTIFICATE OF INCORPORATION

-of the-

AMERICAN OTOLOGICAL SOCIETY
INC.

Dated, June 3rd 1926.

NAME	PLACE OF RESIDENCE
Dr. Arthur B. Duel	74 East 65th Street, New York City.
Dr. E. W. Day	Westinghouse Bldg., Pittsburgh, Pa.
Dr. D. Harold Walker	2300 Commonwealth Avenue, Boston, Mass.
Dr. Eugene W. Crockett	489 Marlborough Street, Boston, Mass.
Dr. Thomas J. Harris	2104 West 40th Street, New York City.
Dr. John Gordon Wilson	2104 South Michigan Avenue, Chicago, Ill.
Dr. Max A. Goldstein	3385 Ashmun Place, St. Louis, Missouri.

Arthur B. Duel
E. W. Day
D. Harold Walker
Eugene W. Crockett
Thomas J. Harris
John Gordon Wilson
Max A. Goldstein

FIG. 3. Image from the incorporation articles of the AOS 1926. AOS indicates American Otological Society.

recommendations were referred back to the Committee on Otosclerosis "...with power to act."

CAPITALIZATION—1926—1930

It seems that the fund began with seed funds from the membership of the AOS, the Triological Society and the New England Oto-laryngological Society (1). At the 1926 meeting of the Society, the Committee on Otosclerosis announced that the Carnegie Foundation granted "...a subsidy to the AOS for five years in the total amount of \$90,000." Interestingly, it was in 1925 that the New York Academy of Medicine Building in New York was being planned. The Academy received \$1.55 M from the Carnegie Foundation to build the Academy headquarters; Dr. Arthur Duel (Fig. 2) chaired the Building Committee of the Academy that year and probably had a strong relationship with the Carnegie Foundation just before its gift to the AOS. It was soon apparent that without incorporation the AOS could not receive the funds from the Carnegie Foundation prompting its incorporation on June 3, 1926 (2) (Fig. 3). This corpus was later supplemented by pledges, donations, and bequests. For example, it was noted in the 1929 proceedings of the Society that "Mr. Harkness will add \$100,000..." and Dr. Dench promised a "residuary estate estimated to be not less than \$50,000." Later, Mr. Starling W. Childs, one of the legal advisors of the AOS, contributed \$100,000 plus other funds as a "...large bequest." The committee also planned to raise that amount to \$500,000 for "...research pertaining to otosclerosis to include allied branches of medicine, scientific, clinical and economic as it relates to the ear."

IMPLEMENTATION—THE CENTRAL BUREAU OF RESEARCH

With the establishment of a research fund, a Committee on Otosclerosis, led by Dr. Norval Pierce was established on June 3, 1926. This committee was officially "...discharged and ceased to function..."

on May 19, 1930 when the function of the committee was assumed by the "Board of Trustees of the Research Fund." (3) However, between 1926 and 1930 there are records of both the Committee on Otosclerosis and the Board of Trustees meetings. While the Board of Trustees of the AOS replaced the Otosclerosis Committee in 1930, it was not until June 1, 1946 when the Board was made an official part of the AOS by an amendment to the Certificate of Incorporation. The Board's official name became "The Board of Trustees of the Research Fund of the American Otological Association, Inc."(1) I could find no record of the incorporation of this entity separate from the AOS, Inc. The amendment also stipulated that there would be seven members selected to serve as trustees and lay members could be appointed.

At the June 1924 meeting of the AOS Dr. Arthur B. Duel reported that the Committee on Otosclerosis established the Central Bureau of Research as a repository of records. It was formally established "for the translation of foreign literature and collection of case records and temporal bones." In 1927, without much explanation, Dr. Duel announced that headquarters were established for this research at the New York Academy of Medicine, 5th and 103rd St. New York. He called these headquarters "The Central Bureau of Research." Evidently, the Bureau was a small office staffed by a secretary/bookkeeper. On May 20, 1927 the office within the Academy was considered to be the "permanent home" of the Central Bureau. The office was overseen by Dr. Duel from its inception in 1926 until his death on April 11, 1936, when Dr. Edward P. Fowler of Columbia University took over and managed the Bureau until his death in 1967 (Fig. 4). The Central Bureau of Research was never a legally constituted entity but was the designation by the AOS of the secretarial office located at the NY Academy of Medicine. Interestingly, Dr. Fowler, in writing about the history of the Central Bureau in 1963, stated, the "Committee on Otosclerosis in 1924... melded into the Central Bureau of Research in 1926." Evidently, the Central Bureau ceased to function after 1967 at the time of Dr. Fowler's passing, but confusion about the use of this term continued and may be found in affidavits as late as 1979.

Although the Fund was originally designated to study otosclerosis, the purposes of the Fund seemed to be expanded from time to time. A Resolution related to the Central Bureau of Research from approximately 1930 stated that, "... funds for and in connection with the advancement, conduct, support, and encouragement of research in otology." The funds solicited at the onset of the program from the membership and the Carnegie Foundation were clearly directed toward the study of otosclerosis, but subsequent contributions did not seem to be so designated. For example, in 1956, the Fund received a contribution of \$36,000 from the estate of Mrs. Pricilla Pierce and in 1961 "...one quarter of the estate of George Edward Cohen" without specific stipulations.

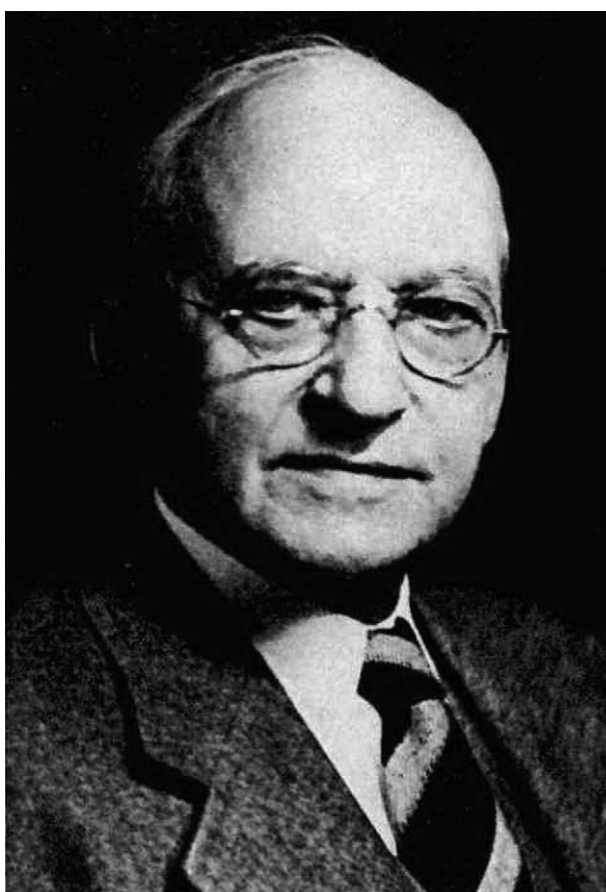


FIG. 4. Photo of Edmund P. Fowler.

Some confusion arose at the April 30, 1928 meeting of the AOS about the nature and organization of the AOS research endeavors. A handwritten note at the top of the report of the meeting states, "This meeting is poorly reported." Dr. Pierce raised a concern that there were "efforts by members to utilize the funds for purposes other than that for which it was given..." The author of the minutes of that meeting referred to the "Committee on the Study of Progressive Deafness" (handwritten note "*otoscle*"(sic)), "Otosclerosis Committee," the "Scientific Committee," "Central Bureau of Research," The writer of the minutes of this meeting stated, "Who appointed what and when is not easily recognizable." Evidently, Dr. Pierce chaired the Committee on Otosclerosis and Dr. Duel ran the Central Bureau of Research at the New York Academy of Science. By 1928 it was reported that the Fund amounted to \$193,241 "...in pledges and cash..."

The research supported by the fund continued to flourish and award research grants throughout the 1930s and 1940s. The investigators funded were at various universities as well as the Central Bureau. Dr. Fowler served as the Treasurer during much of that time and the fund had grown to \$353,065.12 by 1944. A crisis occurred in the spring of 1944 necessitating a meeting of the Central Bureau of Research on June 4, 1944 at the Waldorf-Astoria Hotel in New York. As recorded in the

proceedings of that meeting, the secretary/bookkeeper, named as “Miss Taylor,” had died suddenly on November 26, 1943 leaving the Bureau and the Fund devoid of records including all books, records, bank statements, accountant’s reports (3). There were disbursements from April 1943 through June 1944 totaling \$3377.74 without any detail whatsoever. Dr. Fowler served as Treasurer but stated, “I was Treasurer in name only, I simply signed checks.” At that meeting Dr. Marvin F. Jones stated, “There is obviously somewhere a badness.”(sic) Since no records could be found after a thorough investigation, the committee concluded that this was “water over the dam” and that they must “. . .eliminate the opportunity of any such mistake occurring in the future.” The motion was made and passed. Chairman D. Harold Walker stated, “Later on we will discuss how to stop the damn thing.” Eventually, Dr. Fowler was able to account for all but \$2000.00. He concluded, “Some of this money is in no doubt absorbed by legitimate payments which were not properly recorded. . .” At this same meeting, Drs. Walker and Fowler discussed the confusion surrounding the name “Central Bureau of Research.” Neither knew where the name originated but they knew that it was not officially established or incorporated.

RESEARCH FUNDING

One of the initial endeavors of the Central Bureau of Research was to accumulate and publish an index of the literature on otosclerosis initially under the direction of Dr. Noval Pierce and Dr. Arthur Duel (4). For most of its existence, the Central Bureau was led by Dr. Edmund P. Fowler (5–11).

In spite of some bumps in the road, the research fund continued to grow and fund significant research. Numerous, influential otological researchers were funded by the Trustees over the years. For example, Dr. Georg von Bekesy of Harvard University (awarded the Nobel Prize for Physiology or Medicine in 1961) was funded by the Research Fund for many years and was given the AOS Medal of Honor in 1957.

In 1957 there was consideration of hiring a full-time academician to perform otosclerosis research under the oversight of the Central Bureau. Catharine A. Smith was asked if she would agree to this position but she declined. Others were considered but the concept was dropped by the next year.

On May 18, 1963, Dr. Gordon Hoople suggested that the funds of the Central Bureau be sent to the Deafness Research Foundation. After discussion, the Executive Committee of the AOS was charged to “. . .look into this.” At the 1964 meeting of the AOS, Dr. Hoople withdrew his suggestion.

Before 1967, Dr. Edmund P Fowler “directed and managed” the fund. At that time the Board consisted of “small, self-perpetuating groups with not terms of office specified.” After Dr. Fowler’s death in 1967, Drs. Philip Melzer and Gordon Hoople reorganized the Board of the Research Fund to limit the tenure of Board members to

7 years with one new member rotating on each year. Additionally, the Board of Trustees ceased to fund projects initiated by the Board but instead fund only investigator initiated proposals (with some minor exceptions such as student travel awards). The Board of Trustees functioned as both a grant review committee (“Study Section” in NIH terminology) and a granting council (“National Council” in NIH terminology). Subsequently, the Board added consulting scientists to better review applications.

In 1985, the Board of Trustees recommended that in addition to research grants, a fellowship for young faculty members be established with a stipend of \$30,000 per year. The purpose of the research fellowship was “. . .to foster research in otosclerosis, other otologic disorders, and underlying processes. . .” However, only two applications were received between 1985 and 1989. At that time the stipend was increased to \$40,000 with an additional \$5,000 allowed for supplies. Applications for fellowship increased. The Board of the AOS Research Foundation changes these awards from time to time; currently the Foundation offers a Research Grant, a Fellowship Grant, a Clinical Investigation grant, and a Clinician/Scientist Award.

In 1989, The Board of Trustees of the Research Fund adopted an NIH style scoring system for grants: 1 being the highest and 5 being the lowest. The Board and the Research Advisory Board have continued to use that method in evaluating proposals.

At the March 24, 1990 meeting of the Board of Trustees at the Waldorf-Astoria Hotel in New York, the Trustees, Dr. Gregory Matz, Chairman, asked for clarification regarding “(1) What was the original intent of the contributors, Fund and (2) Should we expand the definition of research that may be funded?” As a result of this suggestion, the Board asked me (incoming Secretary-Treasurer) to organize a joint retreat on October 27, 1990 consisting of the members of the Council of the AOS and the Board of Trustees of the Research Fund to deliberate on the issues brought up by Chairman Matz. As a result of that meeting, and legal consultation with attorney Harvey Zimand of Kelley, Drye & Warren, the Board and the Council expanded the criteria for funding research grants and fellowships. Mr. Zimand pointed out that only the original funds (\$90,000) solicited from the Carnegie Foundation were restricted to otosclerosis research and those funds could be considered as spent. The Board, with the approval of the AOS Council could expand funding to any area of otological research and scholarly activity at their discretion. The following resolution was made by the joint committee and approved at the next annual meeting of the Society:

“Whereas the clinical problems associated with otosclerosis are not as prevalent as they were at the Initiation of the Research Fund of the American Otological Society, we resolve to broaden the responsibility of the Trustees of the Research Fund of the American Otological Society, to expend, grant or dispose of any part of its income or principle in

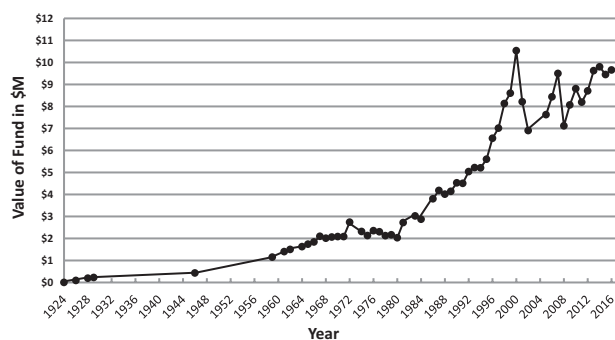


FIG. 5. The valuation of the American Otological Research Fund from inception. The changes in the value of the fund reflect variations in the equities markets and yearly withdrawals.

connection with the conduct, support and encouragement of research in otology.”

The corpus of the Fund has grown since its inception in about 1926 to be valued at almost \$10 M. The Board of Directors (Trustees) have awarded approximately \$4 M in research grants and fellowship awards (Fig. 5). The Fund has been invested wisely with long-term goals in mind to allow modest growth of the corpus and regular, annual support of meritorious research.

LEGAL STATUS OF THE ORGANIZATION

From the time of its inception in 1868, the AOS was unincorporated. To receive funds from the Carnegie Foundation, the Society was incorporated on June 16, 1926 in the State of New York (Fig. 3) (12). From that time until August 30, 2002, the AOS, Inc. operated as a “Domestic not-for-profit corporation” (at times called a “private foundation”) in the State of New York. Because of an unfavorable tax status, the corporation moved to Illinois and on August 30, 2002 and became a public charity, 501(c)(3) (13), under the designation “American Otological Society Education Foundation” (AOSEF) The educational and research funding was managed in this corporation until 2006. On June 19, 2006 the AOSEF moved to a new Illinois 501(c)(3) called the “American Otological Society, Inc.” Three days later on June 22, 2006, another new Illinois 501(c)(3) corporation was formed called the “American Otological Society Research Foundation” (AOSRF) (13). The corpus of the funds designated to support research in the AOS, Inc. were then transferred to the AOSRF where they reside today. The AOS Research Fund now operates under the guidance of the AOS, Inc (14). It established a Board of Directors (sometimes called the “Trustees of the AOS Research Fund”) who are the members of the Council of the AOS, Inc (15). The Board of the AOSRF appoints a “Research Advisory Board (RAB)” consisting of seven active members of the AOS with the addition of “. . . three otological researchers shall serve as consultants.” The function of the RAB is to review and prioritize requests for research or training activities.

CONCLUSION

The Research Fund of the American Otological Society is now valued at approximately \$10 M. Since its inception 90 years ago, over \$4 M in research and fellowship grants have been awarded while growing the corpus of the Fund. (Dr. Steven Telian, personal communication) It was the foresight, bold vision, and tenacity of Drs. Norval Pierce and Arthur Duel in the 1920s that began a research fund for otosclerosis through donations from members of the Society. The scope of the research supported has expanded to include other otological problems. The Fund has grown by early donations from Society members, the Carnegie Foundation and later gifts and bequests. Sound investment strategies have allowed the corpus of the Fund to grow while generously supporting otological research through grants and fellowships. Many of our careers were launched by seed grants from this Fund. In 1924, Dr. Duel said, “He who plants a tree, plants for posterity. May we plant a tree today which will become a boon to coming generations.” (16)

Acknowledgments: The author acknowledges the help of Kristen Bordignon, Administrator of the AOS, who gave the author access to the original documents upon which this review was based. The author also relied on the late Dr. Wes Bradley’s review of this topic in 1979 and personal discussions that they had in the 1980s (16). The author also wishes to thank Dr. Steve Telian who served as Secretary Treasurer of the Research Fund and supplied a valuable perspective and Dr. Robert Jackler for additional historical perspectives.

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History of Publications from the American Otological Society: A Celebration of the 150-Year History of the American Otological Society

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The American Otological Society (AOS) has been on the forefront of advancing the science of auditory and vestibular physiology, and art of ear medicine since its founding in 1868. For 150 years, through its publications, the AOS has provided a critical forum to debate these advances, highlighting treatment successes and failures, and served a place to celebrate its history. This historical review provides an overview of the publications of the AOS since its founding: the Transactions of the annual meeting from 1868 through

2006, *Treatises on Otosclerosis* (1928–1935), the History of the Society from the 100 and 125th anniversary, and the sponsored Society journals—*American Journal of Otology* (1879–1883, 1979–2000) and *Otology & Neurotology* (2001–present). **Key Words:** *American Journal of Otology*—American Otological Society—History—Neurotology—Otology—Otosclerosis—Transactions.

Otol Neurotol 39:S43–S58, 2018.

SETTING THE STAGE: THE 1860s

The mid-third of the 19th century was a time of great scientific advancement, and medicine and surgery were developing at an increasingly rapid pace. Despite this, in the mid-1830s, the treatment of ear diseases was still neglected and disdained by most surgeons. Sir Astley Cooper, credited with primacy of myringotomy paracentesis, had abandoned the ear for general surgery in the early 1800s. One of the pioneering ear surgeons, Anton Friedrich Von Tröeltsch, as late as 1863 bluntly stated, “There is scarcely any department of the science of medicine in which there is, even at this day, so much ignorance of facts, and such a want of possessiveness of opinion, as in aural medicine and surgery” (1). He later went on to state, “I need not speak to you, gentleman, of the importance of pathologic anatomy, for medical science, any more than I need to tell you that the sun illuminates the earth over which it shines. We have already seen how late it was in the history of aural medicine and surgery before pathological investigation

of the ear was undertaken, and that the slow and late development of this part of our science resulted as it necessarily must, from this neglect of the appearances of the organ on the cadaver” (1). Echoing similar sentiments, Toynebee wrote in the introduction of his text, “...if we carefully survey the history of the rise and progress of Aural, as a distinct branch of Scientific Surgery, one main cause of the disrepute into which it had fallen may be traced to the neglect of the Pathology of the organ of hearing—a neglect that doubtless led also to the ignorance which has prevailed as to the structure and functions of some of the most important of its parts” (2). Similarly, the eminent surgeon Theodor Billroth reiterated these sentiments in 1874 when he wrote that, “...the instruction in diseases of the ear was in a very bad state. I remember well from my own student days how the poor deaf people were sent from one clinic to the other; nobody felt inclined to take any interest in them. With a few obvious exceptions this field is therapeutically much too barren” (3). Billroth further stated that otologic surgery called, “...for a certain amount of heroism in a man to sacrifice himself to this, therapeutically the most thankless and limited, phase of surgery” (3).

Most physicians of this time felt as Billroth, Toynebee, and von Tröeltsch did; that the ear was complicated, inaccessible, and dangerous, as demonstrated by the disastrous early attempts at early mastoid surgery resulting in deafness or severe tinnitus. Though the anatomy of the ear was well described by this time, its physiology was far from completely understood and a rational approach to

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The authors report no conflicts of interest.

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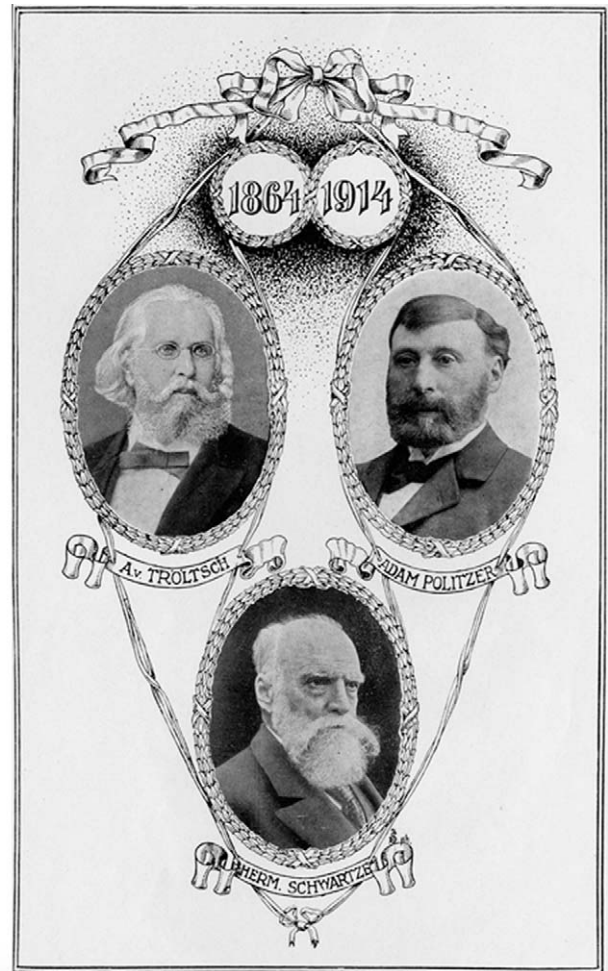
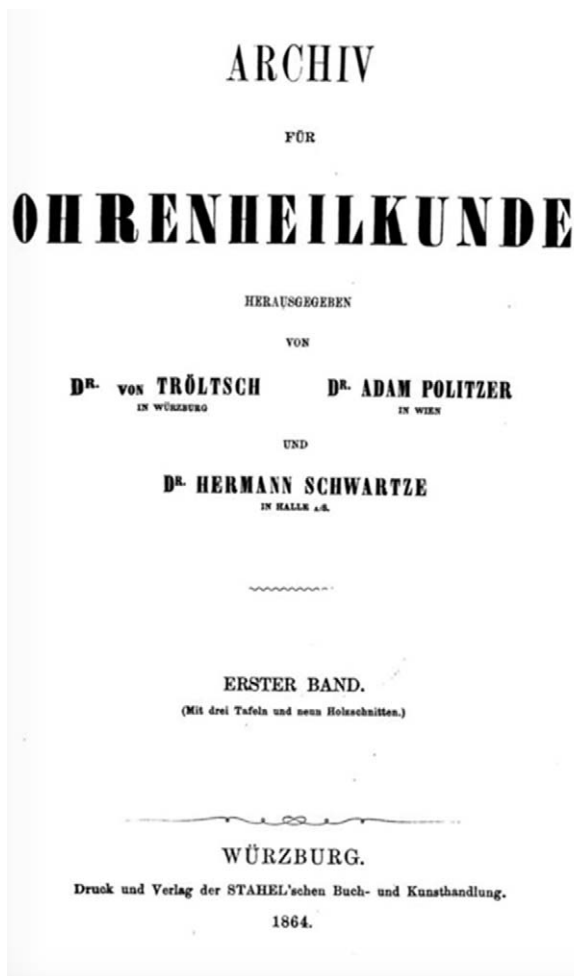


FIG. 1. The *Archiv für Ohrenheilkunde* (left) is the first journal dedicated solely to the ear. It was begun in 1864 by Adam Politzer, Herman Schwartz, and Anton Friedrich von Tröelsch. The 50-year anniversary edition in 1914 included a tribute to the three founders (right).

pathology was barely evident, being little more than that advanced by Valsalva and Du Verney 150 years prior. All this would be radically changed over the course of the ensuing 20 years by pioneering ear surgeons including Toynbee, Schwartz, von Trölsch, and Politzer. Together these men would transform ear surgery into a modern specialty, and train the myriad of Americans traveling through Europe to study this “neglected” field. These Americans then returned to the United States, where they would develop otology along similar principles.

One region that was particularly influential to medicine in America was the Vienna Medical School in the second half of the 19th century. The “Allgemeinen Krankenhauses” was the home to some of the greatest medical minds of the day, a concentration of physicians and scientists unequalled in the annals of medicine up to that time. Contributing to the development of otology and vestibular sciences, at this time Vienna claimed such notable figures as Politzer, Barany, Alexander, Gruber, and Brauer. According to Henry Hun, a neurologist and author of a guide for American medical students training in Europe at that time, “...there is,

undoubtedly, no place where a student can attend so many excellent clinics with so little loss of time, or where he can so well train his eyes and hands in methods of diagnosis and treatment, as in Vienna” (4). More directly, Lesky stated that during this seminal time period, “Vienna medicine had become world medicine” (5).

Within otology, the leaders of this new generation were Adam Politzer, Herman Schwartz, and the more senior Anton Friedrich von Trölsch. In 1863, together these three individuals founded the *Archiv für Ohrenheilkunde* (*Archives of Otology*), the first journal dedicated solely to ear disease (Fig. 1). As noted by Mudry, the timing for the creation of the journal was perfect—there was a need for a specialized journal in the burgeoning field of otology, which was just beginning to be recognized as a specialty, and “. . . otological knowledge was sufficiently broad to necessitate publishing its progress in its own specialized journal” (6). In fact, a number of other journals featuring otologic themes sprouted in the ensuing 20 years, including the *Archives of Otology* (English translations of the *Archiv für Ohrenheilkunde*, 1879), *Archives of Ophthalmology*

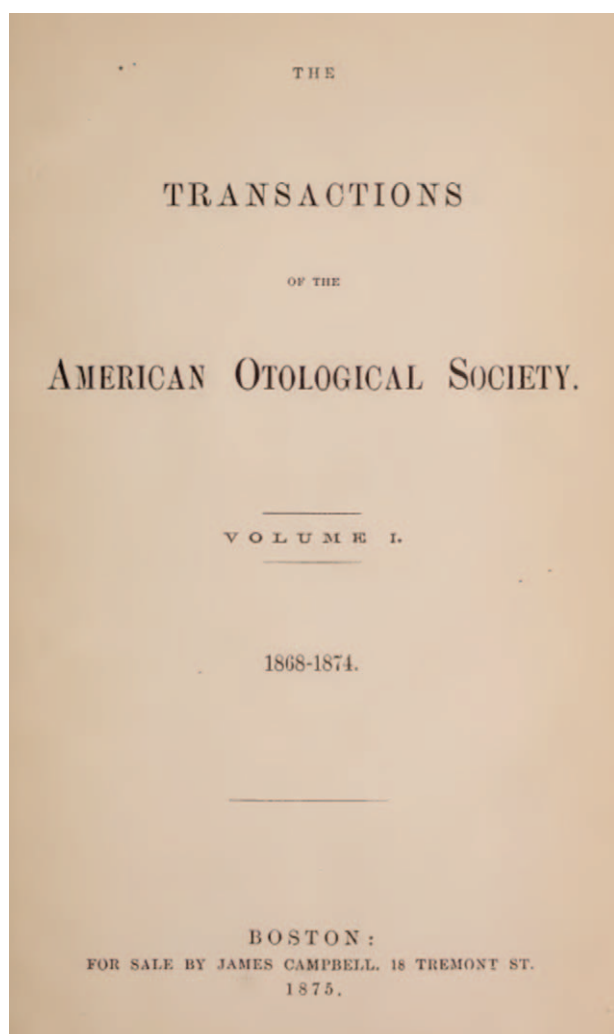


FIG. 2. Title page of Volume I of the *Transactions of the American Otological Society*, comprising the years 1868–1874, and covering the first 7 years of the Society. It was the only issue produced by James Campbell (publisher), in Boston. It begins with the transactions of the second meeting, since the first meeting was primarily to organize the Society and set out its bylaws.

and *Otology* and its German counterpart the *Archiv für Augen- und Ohrenheilkunde* (1869) (7), *Zeitschrift Ohrenheilkunde* (1871), the *American Journal of Otology* (1879) (8) (see below), and *Praktische Beiträge zur Ohrenheilkunde* (1866). These journals undoubtedly served as an intellectual inspiration to the myriad of surgeons traveling through Politzer's clinic at that time, who would return to the United States and start their own societies and related publications.

THE TRANSACTIONS OF THE AMERICAN OTOLOGICAL SOCIETY

The first meeting of the American Otological Society (AOS) occurred in 1868, on the tails of the American Ophthalmologic Society meeting, in Newport, Rhode

Island, at the Atlantic Hotel. The following year the second annual meeting occurred at the same location on Tuesday July 20, 1869. Although the minutes from the first meeting the year prior were read and approved, there were no Transactions produced, and the minutes were not available until the second meeting. The Transactions were subsequently bound into several larger volumes. Volume I (Fig. 2) comprising the years 1868–1874, represented the meetings of the first 7 years of the Society (9). It was published in Boston by James Campbell (18 Tremont St), in 1875. The preface of the Volume I provides a compelling “raison d’etre” of the Transactions and the Society itself:

Until within a very few years, the science and art of Otology had been almost entirely neglected by the medical profession of the United States. In this respect, however, we were not much behind most other parts of the civilized world.

In its very best position, Otology was an appendage, not always very gracefully worn, to the Department of Ophthalmology; for in this country, as in Ireland, diseases of the Eye and Ear have always been connected, both in the minds of the professional and the laity. The Ophthalmological Society of the City of New York thus far has for its object the cultivation of both ophthalmic and aural science.

After the American Ophthalmological Society had proved itself a useful organization, and had become firmly established, the question of amending its constitution so as to admit the discussion of aural subjects, was considered by the members, nearly all of whom were engaged in the practice of both Ophthalmology and Otology. It was proposed to devote one day of the annual sessions of the Society to aural medicine and surgery; but it was finally decided that such a union could not produce satisfactory results. Consequently, on the 22d of July, 1868, the American Otological Society was organized by certain members of the American Ophthalmological Society, who were then at Newport Rhode Island, in attendance upon the fifth meeting of the latter. Their names will be found in the minutes of the first meeting, which are printed in this volume.

As will be seen by reference to the record, no scientific business was then transacted; but at each annual meeting papers have been read and discussions held. It is believed that these articles and debates have contributed essentially to the interest in aural science that now obtains in this country and abroad; and it is confidently hoped that the Otological Society has but just begun a career which is to continue so long as medical science is cultivated. November 3, 1874. (9)

Each meeting Transactions followed a similar format. There was a roll call (Fig. 3), followed by a reading and approval of the minutes from the prior year. Committee memberships were appointed and approved. There then followed a “Report of the Progress of Otology” by one of the members, which was a compendium of the most important and compelling

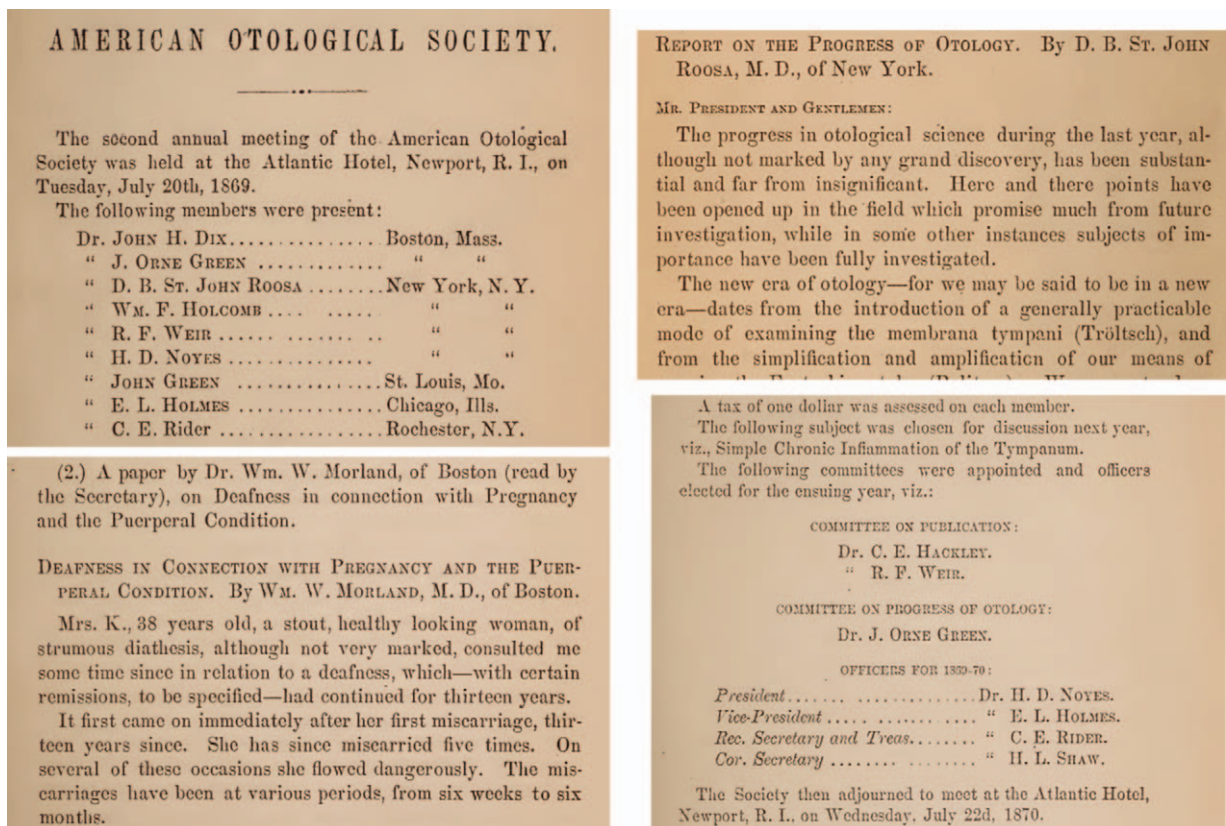


FIG. 3. Sections from the Transactions covering the second meeting of the American Otological Society in 1869. The structure of subsequent Transactions were very similar, and included a roll call (*upper left panel*), a report on the Progress of Otology from the prior year (*upper right panel*), a series of case reports and clinical observations (*lower left panel*), and finally additional societal business notes (*lower right panel*). The Transactions concluded with the designation of a committee to produce the following years' Transactions and a selection of who will deliver the Progress of Otology.

findings and publications over the prior year. In the transactions from the second meeting, this was read by D.B. St. John Roosa, M.D., of New York (Fig. 3). "The progress in otological science during the last year, although not marked by any grand discovery, has been substantial and far from insignificant," he wrote in the introduction. He further opined, "The new era of otology—for we may be said to be in a new era—dates from the introduction of a generally practicable mode of examining the membrane tympani (Tröltzsch), and from the simplification and amplification of our means of opening the Eustachian tube (Politzer)." St. John Roosa then went on to summarize advances in understanding of diseases of the auricle, opined on Aspergillus of the external auditory canal, described exostosis, diffuse inflammation of the meatus, described the confirmation of the existence of the foramen of Rivinus ("Rivinian Foramen"), reported on investigations of the tympanic membrane, discussed research on the Eustachian tube, anatomical discoveries of the petrous mastoid bone, discussed paracanthosis of the drum, described otitis media in neonates ("Otitis Neonatorum"), described voluntary contractions of the

tensor tympani muscle, and reported on research describing motion of the stapes.

In each Transaction, after the "Progress in Otology," there followed a variable number of case reports and clinical observations. In the Transactions from the second meeting, these included:

Deafness in Connection with Pregnancy and the Puerperal Condition. By Wm. W. Morland, M. D., of Boston.

A Case of Purulent Otitis Media caused by the Nasal Douche, and showing the Symptom of Double Hearing with both Ears. By H. Knapp, of New York.

Two Cases of Parasitic Growth (Aspergillus Glaucus) in the External Auditory Meatus. By J. Orne Green, M.D., of Boston.

Each Transactions ends with additional bylaws changes, other housekeeping matters, and then an announcement on the make-up of the following years' Committee on Publications, who were tasked with putting together the Transactions for the upcoming year, as well as a selection of who will prepare the Progress of Otology. For example, the Transactions of the second meeting noted the publications committee included

Dr. C. E. Hackley and Dr. R. F. Weir, whereas Dr. J. Orne Green was selected to provide the Progress of Otolology. It was also noted that a tax of \$1 was assessed on each member (Fig. 3).

There were several publishers during the early years of the Transactions. Volume I of the Transactions, covering the years from 1868 to 1874, was produced in Boston by James Campbell of 18 Tremont St, in 1875. Volume II of the Transactions, covering the meetings from years 1875 to 1881 (starting with the eighth meeting of the AOS) was published by A. Williams & Co., 283 Washington Street, Boston. Beginning with volume III (1882–1887) printing was taken over by Mercury Publishing Company, 112 and 114 Union St, New Bedford, Massachusetts, who developed a long-term relationship with the Society. Mercury Publishing Company was perhaps better known for publishing the daily newspaper, “The New Bedford Mercury” (est. 1807) chronicling news and life in the New Bedford region, a town important in the whale-oil gathering industry (10). How they came to be the publishers of the Transactions through the early years of the Society is unknown. Interestingly, in this initial edition printed by Mercury, there is a typo of the title page, listing the transactions spanning 1882–1887 when in fact it only includes the meetings to 1886 (Fig. 4)! (11) Another error occurred during the publication of Volumes 9 and 10. In fact, it was only volume 9, but in order to avoid a lapse in the numerical order, the volume was renumbered “IX and X,” with the following clarification written on the title page: “The complication of these volumes together is caused by a printer’s error, and probably less annoyance and misunderstanding will occur by the use of the above title” (12) (Fig. 5). In 1922, after 40 years, printing of the Transactions changed from Mercury Publishers to Geo H. Reynolds Printing, also located in New Bedford, Massachusetts (13). The reason for this change is unknown, since Mercury continued publishing after this date. George H. Reynolds Printing, later named Reynolds Printing, printed the Transactions at least through 1936 (Volume 26).

Beginning in 1941 (Volume 31), Printing was assumed by Britt Printing in St Louis, Missouri (14). During World War II, in 1943 and 1945, due to difficulty with travel, there was no AOS meeting and thus no Transactions were produced, the only two gaps in the 138 year history of the Transactions. In 1947, printing was taken over by the American Medical Association, 535 North Dearborn St, Chicago, Illinois (volume 35, published in 1949) (15). The following year, 1948, the Transactions printing was assumed by Zimmerman-Petty, St. Louis, Missouri (16). Interestingly, the 1948 Transactions were published in 1948, *before* the 1947 Transactions, which were printed a year later. Perhaps this lapse is what led to another change in printers. However, there was stability on this front, as Zimmerman-Petty had the role of printer through 1965. Following this another series of printers were employed (Z-P Graphic Arts, St. Louis, Missouri, from 1966 to 1968; Modern Typesetting Co., St Louis, Missouri, 1969). Thereafter, from 1970 through 1990,

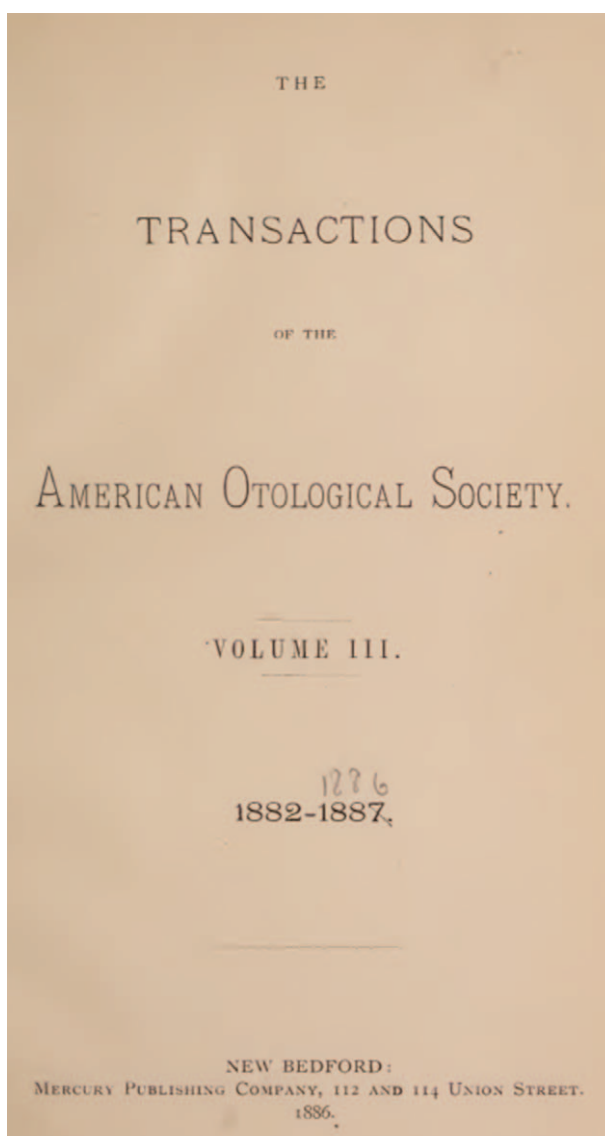


FIG. 4. Title page of the *Transactions of the American Otolological Society* Volume III. This title page erroneously lists the meetings spanning 1882–1887. In fact, the volume only includes up through 1886. In this copy, someone has penciled in the correct dates for the Transactions.

there is only a notation on each Transactions indicating “Published by the Society, St. Louis.” Then beginning in 1991, the printer was changed to Decker Periodicals Inc, from Hamilton, Ontario, the same publisher who would restart the *American Journal of Otolology*, in 1979 (17). Beginning in 1995, the printer was again changed to Lippincott-Raven (1995–1996) and later Lippincott Williams and Wilkins (through 2001).

However, the era of the printed Transactions was coming to an end. Production costs were expensive, and increased accessibility of digital media allowed the Transactions to become solely electronic. Further, with the adoption of the journal *Otolology & Neurotology*

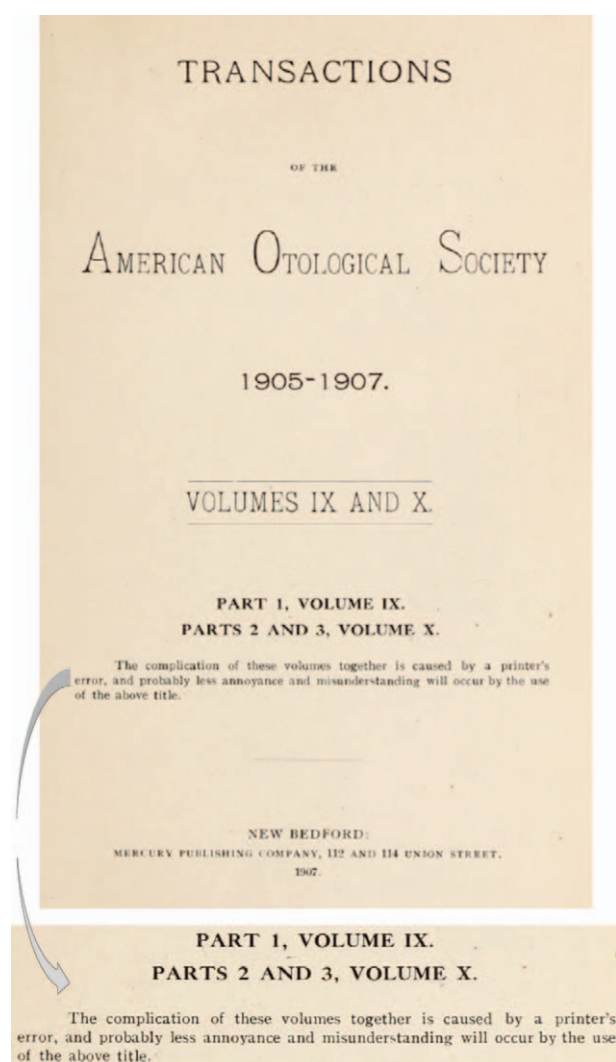


FIG. 5. Title page of the *Transactions of the American Otological Society*, Volumes XI and X. This represents another printer error, as the volume should only have been volume IX; the X designation was added to avoid future confusion. As noted on the title page (enlarged below in the lower panel), “The complication of these volumes together is caused by a printer’s error, and probably less annoyance and misunderstanding will occur by the use of the above title.”

(originally the *American Journal of Otology*) as the official publication of the AOS in the 1990s, there was no longer a need for the *Transactions* to serve as a vehicle for publishing AOS scientific reports. In fact, in its later iterations, the *Transactions* primarily included the abstracts of papers from its annual meeting, a far cry from its original purpose in the late 1800s. The 2003 AOS newsletter (volume 12) noted, “The Council is pleased to announce the AOS *Transactions* will no longer be published as a hard cover presentation on a yearly basis. The 2002 *Transactions* will be published on the AOS website. The AOS will

only publish a hard cover five year summary of the *Transactions*. The hard cover presentation of the *Transactions* has continued to be a significant cost factor for the Society and by publishing on the website, the Society will recognize a cost savings of eight to nine thousand dollars per year.” (Though it should be noted the 5-year summaries were never produced as suggested.) Furthermore, Dr. Sam Kinney’s Editor-Librarian report from the 2003 AOS *Transactions* noted that “The Council of the AOS decided in February 2003 to discontinue the hard cover distribution of the *Transactions*. In place of the hardcover book the *Transactions* will be placed on the AOS website.” With this move, the *Transactions* entered the modern digital age, with availability in an electronic format (pdf or Microsoft word) published by the Society (18). The last *Transactions* produced that were available for download were from 2006 (volume 94), corresponding to the 139th meeting of the Society that took place in Chicago, Illinois. At present, the entire run of the AOS *Transactions* is available online at: <http://www.americanotologicalsociety.org/transactions>

REPORT OF THE FIRST CONGRESS OF THE INTERNATIONAL OTOLOGICAL SOCIETY

The year 1876, 8 years after the founding of the AOS, was also the 100-year anniversary of America’s Independence. In addition to numerous celebrations around the country, a large international medical exposition was held in Philadelphia to mark the occasion. At this time the International Ophthalmological Congress was also held to coincide with these celebrations in New York City. Still being closely aligned with the field of Ophthalmology, the AOS decided to host the First Congress of the International Otological Society, to be held in New York at the conclusion of the Ophthalmologic meeting. The Committee for planning this event included D. B. St John Roosa, Clarence Blake, Herman Knapp, and J. Orne Green, important early members of the AOS. The meeting participants were a veritable “who’s who” of the burgeoning field of Otology during this time period, with several international luminaries joining the meeting, including Hjort (Norway), Löwenberg (Paris), Moos (Heidelberg), Politzer (Vienna), and Voltini (Breslan). The meeting concluded with the designation of the location of the next meeting in association with the International Ophthalmological Congress, with organizational arrangements made by Professors Voltini, Politzer, Moos and Löwenberg. The report of this meeting was put together by a committee appointed by D. B. St John Roosa and was composed of Charles J. Kipp, Arthur Mathewson, J. S. Prout, and J. D. Rushmore, and was Published in 1877 by D. Appleton and Co, New York (Fig. 6) (19). As the publication notes, “. . .at noon on the 15th of September, 1876, under the lead of the American Otological Society, the

International Otological Society was organized” (p.4). From there the publication included the drafted constitution of the International Otological Society, and it was advised that all members of the AOS be admitted to membership in the International Otological Society. The structure of the Report of the International Otological Society closely followed those of the Transactions of the AOS. This included a “Report on the Progress of Otology 1875–1876” by Burnett and Blake, divided into two parts—Part I Anatomy and Physiology, and Part II Pathology and Therapeutics. This was followed by a series of clinical reports, many from the same frequent contributors to the Transactions: Burnett, Knapp, Mathewson, Buck, Hunt, Holmes, Löwenberg, Blake, Pomeroy, St John Roosa, and Green.

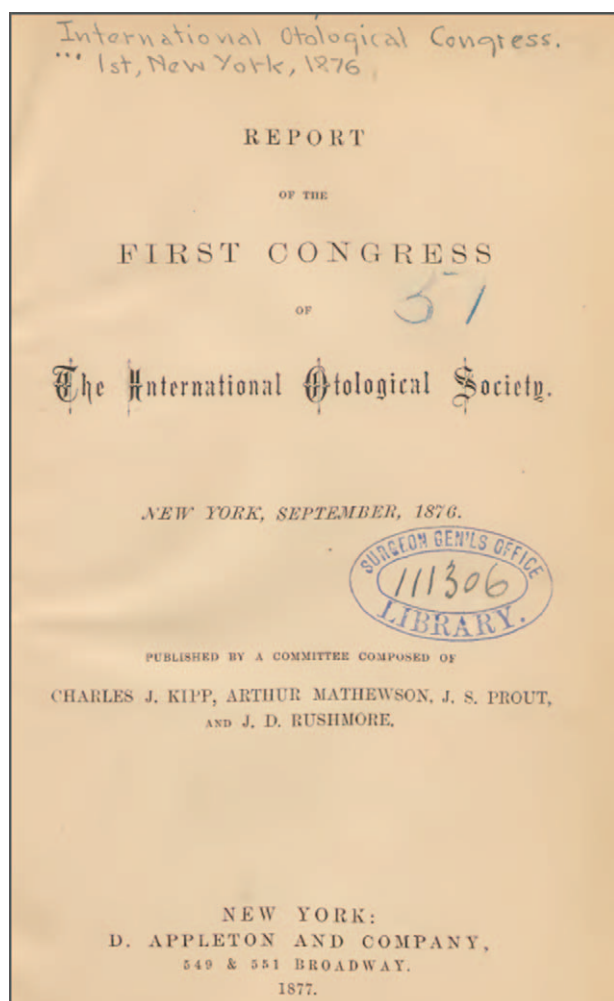


FIG. 6. Title page from the Report of the First Congress of the International Otological Society which took place in New York in 1876, 100 years after America’s independence. It was published by American Otological Society members Charles Kipp, Arthur Mathewson J. S. Prout, and J. D. Rushmore.



FIG. 7. Clarence John Blake (1843–1919) was one of the most distinguished early members of the American Otological Society. After studying with Adam Politzer in Vienna, he returned to Boston to become aural surgeon to the Massachusetts Eye and Ear Infirmary, and later a Professor of Otology at Harvard in 1868. He would found the original *American Journal of Otology*.

THE AMERICAN JOURNAL OF OTOLOGY: 1879–1883

While most contemporary otologists recognize that our Society’s journal, *Otology and Neurotology*, was originally named the *American Journal of Otology*, begun in 1979, few realize that the original *American Journal of Otology* was begun in 1879, exactly 100 years prior (Fig. 1). Clarence John Blake (1843–1919) (Fig. 7) was considered one of the most distinguished early members of the AOS. He was also considered a true clinician scientist of his day (20). He went to Boston Latin school, followed by Harvard Medical School, graduating in 1865 (21). He then studied abroad with Adam Politzer in Vienna, subsequently becoming his assistant. The *Archiv für Ohrenheilkunde* was begun in 1863 by Politzer, von Troeltsch, and Schwartz (6), and this publication no doubt influenced the young Blake during his training in Europe. Upon Blake’s return to the United States, he became aural surgeon to the

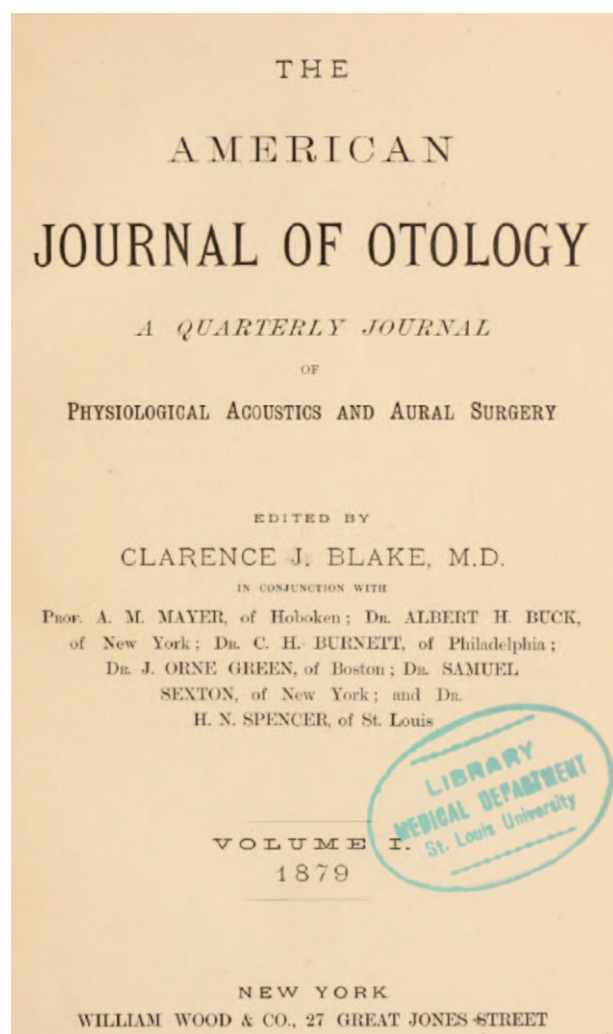


FIG. 8. The original *American Journal of Otology* was started in 1879 by Clarence John Blake. It ran for 4 years, through 1883. Many of the same contributors to the *American Journal of Otology* were also frequent contributors to the *Transactions*, and included many of the founders and early members of the American Otological Society.

Massachusetts Eye and Ear Infirmary, and later a Professor of Otology at Harvard in 1868 (21). During his tenure, he formed a scientific relationship with Alexander Graham Bell, and together they performed some critical early experiments on the telephone, beautifully researched by Snyder (22).

Blake founded and edited the original four volumes (1879–1882) of the 19th century version of the *American Journal of Otology* (Fig. 8). The impetus for the journal, in Blake's own introduction to volume 1, was based on his fascination with the science behind such recent inventions as the telephone and the phonograph: "The past ten years have seen a remarkable increase in the interest in the study of the laws which govern the production and propagation of sonorous vibrations, and correspondingly in the study of the structure, functions and diseases of the complicated apparatus which enables us to appreciate that mode of

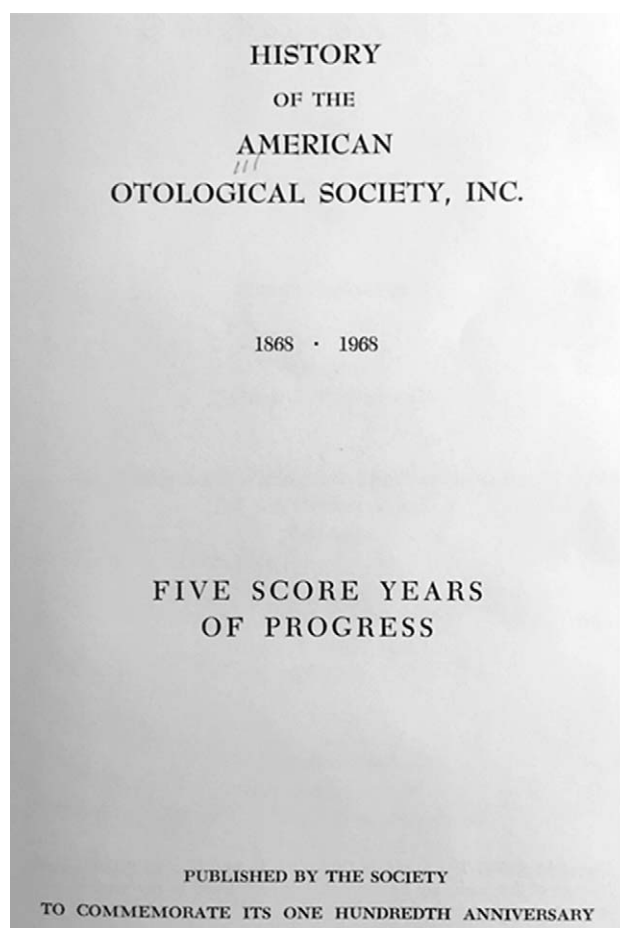
motion to which we give the name of sound" (8). Blake was fascinated by how these devices would inform our understanding of hearing, even more than what he termed, "...the practical advantages" that these devices offered the public. Blake thus sought to develop a scholarly journal that explored the basic science behind sound and hearing, as well as provide a medium to communicate advances in aural surgery.

The style of the journal was based on the *Archiv für Ohrenheilkunde*, which is no coincidence since Blake trained directly with Politzer in Vienna shortly after the founding of that journal. In the contemporary *American Journal of Otology* (see below), there were two manuscripts, in 1994 and 1995, that highlighted features from the original journal (23,24). There were only four volumes of the *American Journal of Otology*, with many of the same individuals contributing to the journal as to the *Transactions*, with prominent publications by Blake himself, Buck, Sexton, Greene, Knapp, and Burnett. It is not known why the journal stopped after four volumes, though it is perhaps this repetition of the same authors publishing in all these mediums with limited material that led to the journal's ultimate demise. In fact, these early AOS leaders were incredibly prolific, producing contributions not only to the *Transactions* and the many other new journals being developed, but also in the creation of numerous textbooks in otology (Table 1).

HISTORICAL PUBLICATIONS

From its inception, the AOS has been an able steward of the history of the specialty in general, and the Society itself. In the *Transactions* of the 59th annual meeting in 1926, the acting President, Dr. Thomas J. Harris, who presided over the incorporation of the Society (henceforth named the American Otological Society, Inc.) during this same year, delivered his presidential address on, "The Early History of the American Otological Society With Special Reference To Its Founders" (25). This speech was the first documented history of the Society itself, and recapitulated much of the history found in the early *Transactions*.

The 100-year anniversary was a momentous occasion, and required something more in-depth. "After four score and ten it seemed high time that a history of the world's senior Otological Society should be written," wrote Edmund P. Fowler, who served as the Chairman of the AOS History Committee until his untimely passing on October 7, 1966 (26). The history committee was comprised Edmund Fowler, M.D., along with Lawrence Boies, M.D., (who took over as chair after the untimely death of Dr. Fowler), Victor Goodhill, M.D. (who also passed away during the writing of the history), Moses Lurie, M.D., Philip Meltzer, M.D., Ben Senturia, M.D., and George Shambaugh Jr, M.D. Together these individuals created a comprehensive "History of the American Otological Society, Inc. 1868–1968," and was published by the Society in hardcover (Fig. 9) (26). Rather than simply recap the first 100 years of the *Transactions*, the



HISTORY
OF THE
AMERICAN
OTOLOGICAL SOCIETY, INC.

1868 · 1993

SIX SCORE AND FIVE YEARS
OF PROGRESS

PUBLISHED BY THE SOCIETY
TO COMMEMORATE ITS ONE HUNDRED TWENTY-FIFTH ANNIVERSARY

FIG. 9. On the 100th year anniversary of the Society, in 1968, a taskforce led by Edmund P. Fowler, and for whom the issue was dedicated following his death, created a comprehensive History of the American Otolological Society (*left panel*). For many years this was given as a gift to all new members to the American Otolological Society. When the original print run was exhausted, and in celebration of the 125th year anniversary, a “2nd edition” was created that updated the history through 1992 (*right panel*). Both editions are available as downloadable files from the American Otolological Society website.

committee “. . . thought it advisable to tell of the available particulars of the formation and early years of the Society, the personalities of some of the members, and especially some of the discussions at the early meetings”

(intro page viii). What followed was a comprehensive history of the Society from its founding shortly following the end of the civil war to the tumultuous 1960s. The work is broken into the following sections:

TABLE 1. Books published by the founders and early leaders of the American Otolological Society

Year	Author	Title
1873	Williams, A. D. ^a	Diseases of the ear, including the necessary anatomy of the organ. Cincinnati, <i>Robert Clarke & Co.</i>
1874	Roosa, D.B. St. John	A practical treatise on the diseases of the ear including the anatomy of the organ. New York, <i>William Wood.</i> (second edition)
1877	Burnett, Charles H.	The ear: Its anatomy, physiology, and diseases. Philadelphia, <i>Henry C. Lea's Son.</i>
1880	Buck, Albert H.	Diagnosis and treatment of ear diseases. New York, <i>William Wood.</i>
1883	Pomeroy, Oren D.	The diagnosis and treatment of diseases of the ear. New York. <i>Bermingham</i>
1889	Burnett, Charles H.	Diseases and Injuries of the Ear: Their Prevention and Cure (Practical Lessons in Nursing). Philadelphia. <i>JB Lippincott</i>

^aA. D. Williams was an early member of the American Otolological Society who joined in 1870. However he resigned in 1871 as noted in the minutes from that meeting. In contrast, Elkanah Williams from Cincinnati was elected as the first AOS president.

Year	Author (s)	Title
1868–1899	Edmond P. Fowler, M.D.	The Founding Fathers and the Early Decades
1900–1919	Moses H. Lurie, M.D.	The Old Order Passeth
1920–1939	Philip E. Meltzer, M.D., and Lawrence R. Boies, M.D.	The Science of Otology—Audiometric Threshold and Above Thresholds measurements, Research Fund of the Society
1940–1959	Lawrence R. Boies, M.D.	Sulfonamides, Penicillins and “Mycins,” Fenestration Stapes Surgery
1960–1968	Ben H. Senturia, M.D.	Better Understanding of Surgical Rehabilitation of Hearing More Accurate Diagnostic Tests

The work ends with a section entitled, “The Second One Hundred Years – Musings and Dreams of Things to Come” by Edmund Fowler. Some of Dr. Fowler’s predictions have yet to come true, including that “We will discover what causes the primary lesion of Meniere’s symptom complex and the true relationship of the

labyrinth pressure changes to the triggering of the attacks,” or “We will more and more use the metric system,” or “Electronic computers will be perfected so that it may even be able to discuss with the otologists difficult diagnostic problems.” However, he also made some prescient observations, including “The day of the specialty hospital will be over and all hospitals will be so crowded with patients that they will be compelled to increase their dependence of so-called “government grants”, which are really monies taken from the population at large.” He also predicted rising costs of medical testing, and that “Direct stimulation of the cochlear nerve will from time to time, be discovered” (though he incorrectly predicted it will never enable a patient to readily hear speech). He also correctly predicted that women would one day join the Society, which he considered “...an improvement on the sad, bored, and helpless decorum of the countenances worn late in the afternoon sessions by some of our male audiences.”

As noted, Dr. Fowler died during the creation of this volume, and thus the publication was dedicated to him: “An active member of the American Otological Society for forty-eight of its one hundred years, Dr. Fowler’s

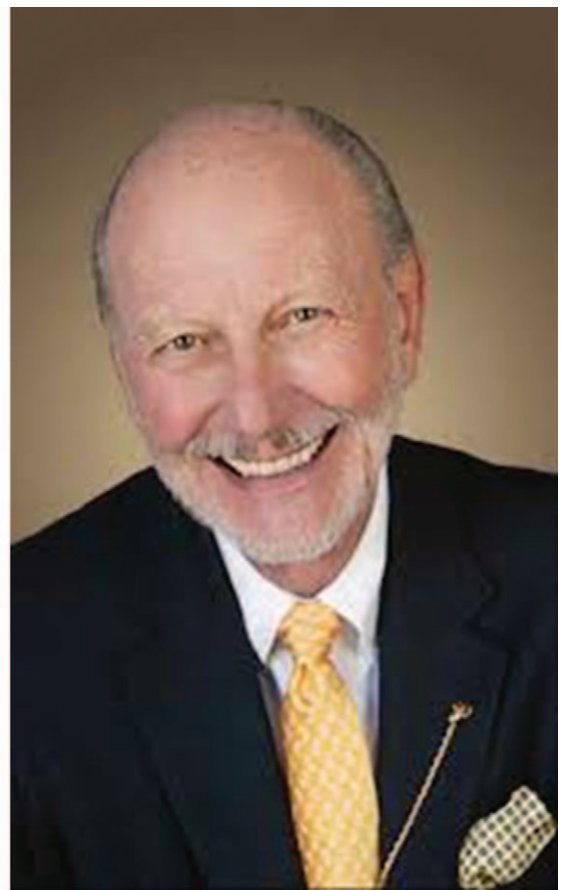
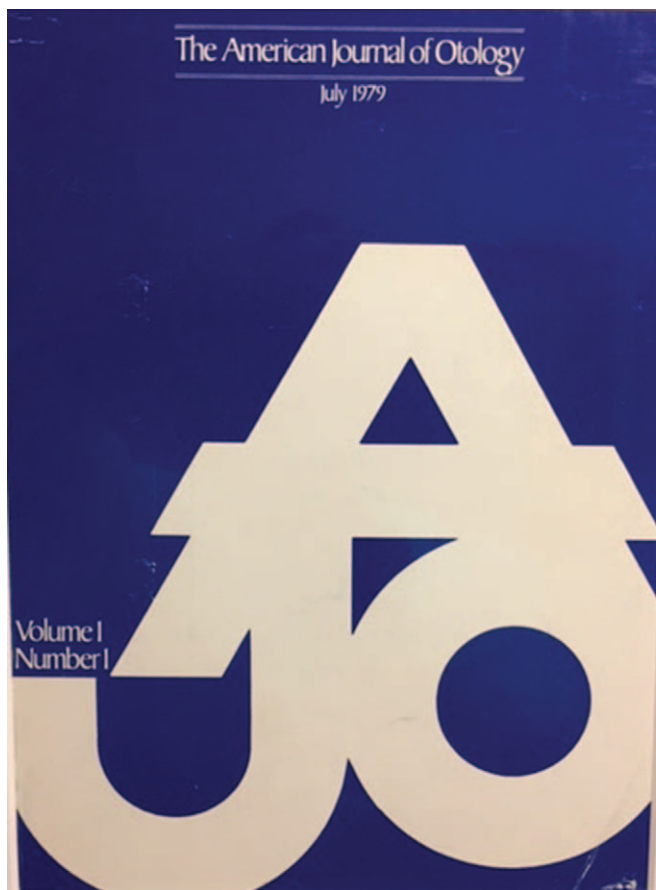


FIG. 10. The contemporary *American Journal of Otology*, the forerunner to *Otology & Neurotology*, was founded by Dr. Michael Glasscock, III (right panel) in 1979. The cover of the inaugural edition (left panel) is shown (courtesy of David Haynes, M.D.). Dr. Glasscock was the Editor-in-Chief from 1979 through 1989.



FIG. 11. Dr. Gary Jackson was another of the founding members of the *American Journal of Otolaryngology*, and took over as Editor-in-Chief of the journal in 1989.

energy and enthusiasm were instrumental in making possible this History of the Society.”

The volume was a great success, and tradition dictated that following its publication, each new member of the Society received a copy of the History (27). Furthermore, there were ongoing requests from libraries and other societies for copies. As a result, during the Council meeting in 1988, the Editor-Librarian reported that the supply was depleted and requested the Council approve funds for a new printing. As noted by Wesley Bradley, M.D., in the ensuing discussion a number of options were proposed, and eventually a committee was appointed to revise the history into a second edition, that would coincide with the Society’s 125th year anniversary (27). This new committee, chaired by Wesley Bradley, also included Dr.’s Thane Cody, Joseph Farmer Jr, Robert Kohut, Brian McCabe (asked to join because of his editorial experience), Cary Moon Jr, and Dekle Taylor. The 125th year anniversary second edition was published in 1993, also by the American Otological Society Inc (Fig. 9) (27). The structure of the text mirrored that of the 100 year Anniversary publication, including all of its original text. In addition, several sections were folded in, including the years 1968–1992, and additional sections labeled “Acoustic Neuroma and Skull Base Surgery, Electrical Stimulation of the Auditory System, Molecular Basis of Genetic Deafness, Beginnings of Otolaryngology-Neurotology as a Separate

Specialty Under the Board” by Brian McCabe; an Overview of the American Otological Society 1968–1993 by Wesley Bradley, M.D.; and updated lists of the Guests of Honor, Members of the Society, deceased members, and past officers and presidents, and sites of the annual meetings. Today, both the 100 and 125 year histories can be found on the website of the AOS as a downloadable portable document format (PDF).

OTOSCLEROSIS

One of the defining diagnoses within otology is otosclerosis. It is thus not surprising that the AOS produced two publications reviewing this important topic. The reader is referred elsewhere for the complex and fascinating history of the treatment of otosclerosis, from the original description of the pathologic lesion to Shea’s successful stapedectomy (28–32). However, while the treatment of otosclerosis today is a relatively straightforward operation, in the 1920s it was considered one of the foremost challenges to solve by the Society. At the 57th meeting of the AOS in June 1924, Dr. Arthur Duel set forth a plan for the “. . .solution to the problem of Otosclerosis” (33). This plan involved the development of a scientific committee to create a perpetual fund for otosclerosis research, under the direction of a permanent “Central Bureau,” and was seeded by a grant from the Carnegie Corporation with \$90,000. One of the first actions of the otosclerosis committee involved completing a complete “résumé” of the literature on otosclerosis up through 1928. The two volume set was edited by Dr. Duel, along with the following members of the otosclerosis committee: Norval H. Pierce, M.D., Eugene A. Crockett, M.D., James F. McKernon, M.D., and J. Gordon Wilson, M.D. (33,34). The volumes were subdivided into four sections: volume I, containing sections I and II, included a summary of the literature on pathology and etiology of otosclerosis. Sections 3 and 4 from volume two included symptoms and diagnoses and treatment of the disease. Eight years later, in 1936, a third volume was produced by the Central Bureau, and edited by Arthur Duel and Edmund P. Fowler (35). This third volume reviewed the otosclerosis scientific literature from the end of volumes 1 and 2 in 1928 through 1935. The volume was published in cooperation with the journal *Annals of Otolaryngology, Rhinology and Laryngology* that same year in the hopes it would achieve a wider circulation than the printed book alone (36). Furthermore, the number of subject headings was greatly increased, reflecting the growing scientific literature on the topic. A 4th volume of the AOS—Central Bureau of Research Otosclerosis series was published in 1946. This thin folio was much shorter than the earlier ones and summarized 20 years of progress.

THE AMERICAN JOURNAL OF OTOLARYNGOLOGY: 1979-PRESENT

In 1979, the *American Journal of Otolaryngology* (AJO) was “reborn,” under the direction of Dr. Michael Glasscock

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June 19, 1990

Michael E. Glasscock III, M.D.
The Otology Group
1811 State Street
Nashville, TN 37203

Dear Dr. Glasscock:

As required by the Agreement governing The American Journal of Otology, I am providing written concurrence with your intention to assign your rights in the publication to the American Otological Society and the American Neurotology Society.

Sincerely,



Brian C. Decker
Chairman, CEO

BCD/em

CC: Robert Kohut, M.D.
Ted Bailey, M.D.

FIG. 12. While under Dr. Jackson's leadership, ownership and rights of the *American Journal of Otology* was transferred jointly to the American Otological Society and the American Neurotology Society, in 1990. This document confirms that arrangement.

(Fig. 10). "Welcome to the *American Journal of Otology*" he wrote in his introductory editorial (37). The editorial noted that the first edition was published exactly 100 years prior. However, when the AJO was conceived, Dr. Glasscock admitted he was unaware of the prior version of the journal, and only learned of its existence from a colleague. Dr. Glasscock originally started the journal to provide a unique voice that also represented the viewpoint of surgeons in private practice, a group that included himself, and whom he felt were largely left out of the academic conversation (ME Glasscock, 3rd., personal communication, 2017). He noted that other journals at the time tended to be dominated by individuals from academic medical centers, and thus he wanted to bridge the "town-gown" academic and private practice divide with a new publication where he could have control over content and direction. The journal started as a quarterly publication from B.C. Decker Publishers, chosen because Dr. Glasscock knew the publisher personally and had worked with him on

some prior projects, and included such features as a "Forum" sounding board for anyone who wished to express an opinion on any aspect of otology. He also set aside a regular section for history, and included a "how I do it" feature. He concluded his editorial, "It is our desire to make the America Journal of Otology an informative and enjoyable publication" (37).

The first edition also contained seven manuscripts, including such diverse topics as the fenestration operation (Shambaugh), glomus tumors (Fisch), ossicular chain reconstruction (Austin), stapes surgery (Sheehy, Nelson, and House), basic auditory physiology (Bess, Forrest and Humes), vestibular schwannoma versus vascular loops (Brookler and Hoffman), and endolymphatic sac surgery for Menière's (Belal and House). Interestingly, there were several letters to the editor in this first edition. While most were congratulatory, one prominent head and neck surgeon wrote to question "...the need for a new journal devoted solely to Otology" (38). According to Dr. Glasscock, this

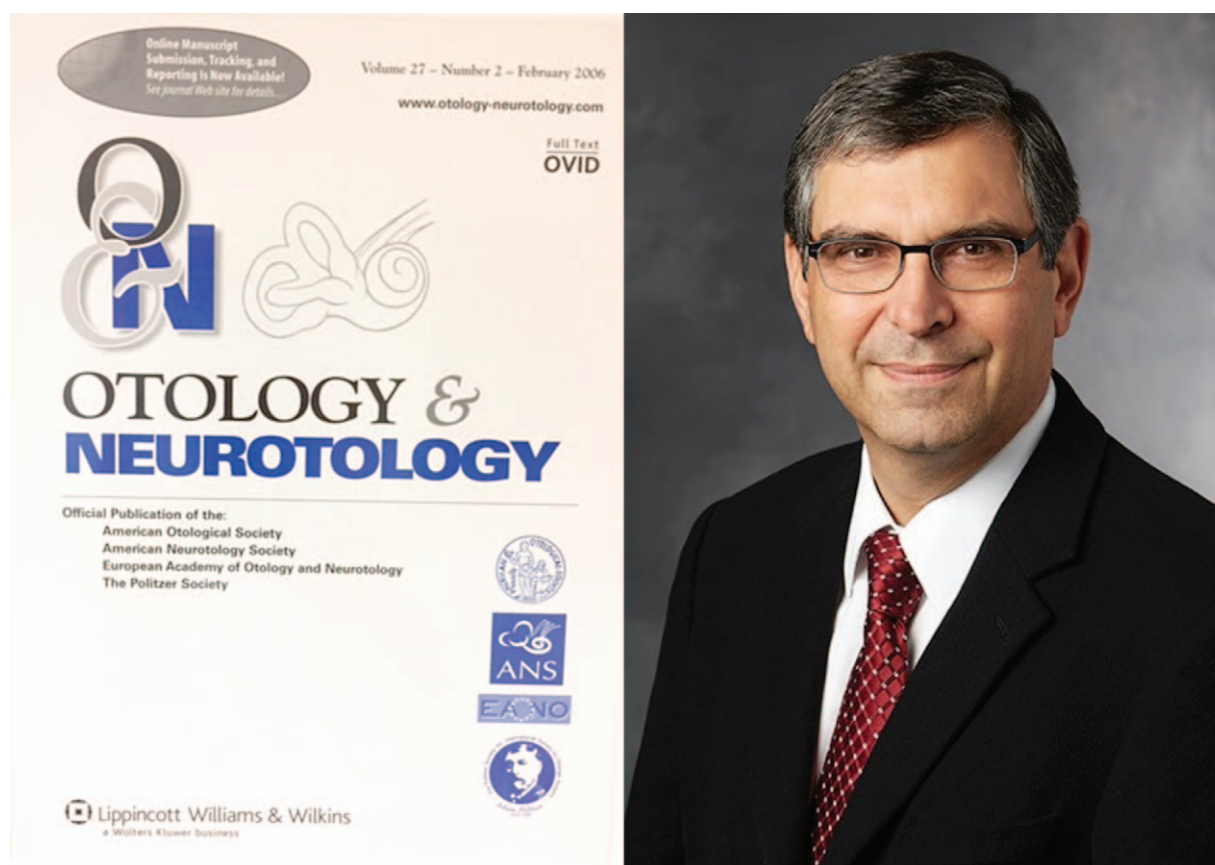


FIG. 13. Dr. Robert K. Jackler (*right panel*) took over as Editor-in-Chief of the *American Journal of Otology* in 1996. Dr. Jackler made a number of critically important changes to the journal, including the implementation of an electronic manuscript submission system, a more rigorous peer-review process, and expanded the editorial board to reflect the growing international contributions to the journal. Additionally he oversaw a change in the journal cover and a change to its present name-*Otolology & Neurotology*, to represent the importance of neurotology as a journal focus (*left panel*).

was a sentiment shared by many academic physicians at the time (ME Glasscock, 3rd., personal communication, 2017). Fortunately this one letter writer was incorrect of his assessment of the potential future success of the journal, which flourished over the following decade.

In 1989, Dr. Glasscock stepped down as the Editor-in-Chief, and appointed his partner in the Otology Group in Nashville, C. Gary Jackson, M.D. (Fig. 11) as his successor (39). Dr. Jackson was one of the founders of the journal and an early, active contributor. Under Dr. Jackson's stewardship, the journal continued to thrive and grow. In 1990, Dr. Glasscock generously transferred ownership of the journal jointly and equally to the AOS and the American Neurotology Society (Fig. 12).

After 7 years at the helm of the journal, Dr. Jackson stepped down, and after a national search conducted by the ownership societies, Robert K. Jackler, M.D. (Fig. 13) was selected as the new Editor-in-Chief, in 1996 (40,41). Under Dr. Jackler's stewardship, the journal made a number of important and transformative changes. A new publisher, Lippincott-Raven was chosen to further

the mission of the journal. In 1996, the AJO had one of the first websites of any medical journal, with the original HTML programming done by Dr. Jackler himself. Furthermore, a new electronic-based submission system was implemented, along with the requirement for a structured abstract. Dr. Jackler also brought a new, more rigorous scientific peer-review process to ensure higher quality manuscripts, and expanded the Editorial Board to reflect the growing international appeal of the journal. In 2001, to reflect the growing importance of Neurotology within the subspecialty, the journal officially changed its name to *Otolology & Neurotology*, while the journal cover itself underwent a change to a more contemporary look (Fig. 13). During this time the journal's cover also acknowledged the growing relationships with international societies, including the Politzer Society, and the European Academy of Otology & Neuro-Otology (EAONO).

After a decade of transformative changes, Dr. Jackler stepped down as Editor-in-Chief, and was replaced by John Niparko, M.D., in 2006 (Fig. 14) (42,43). In is

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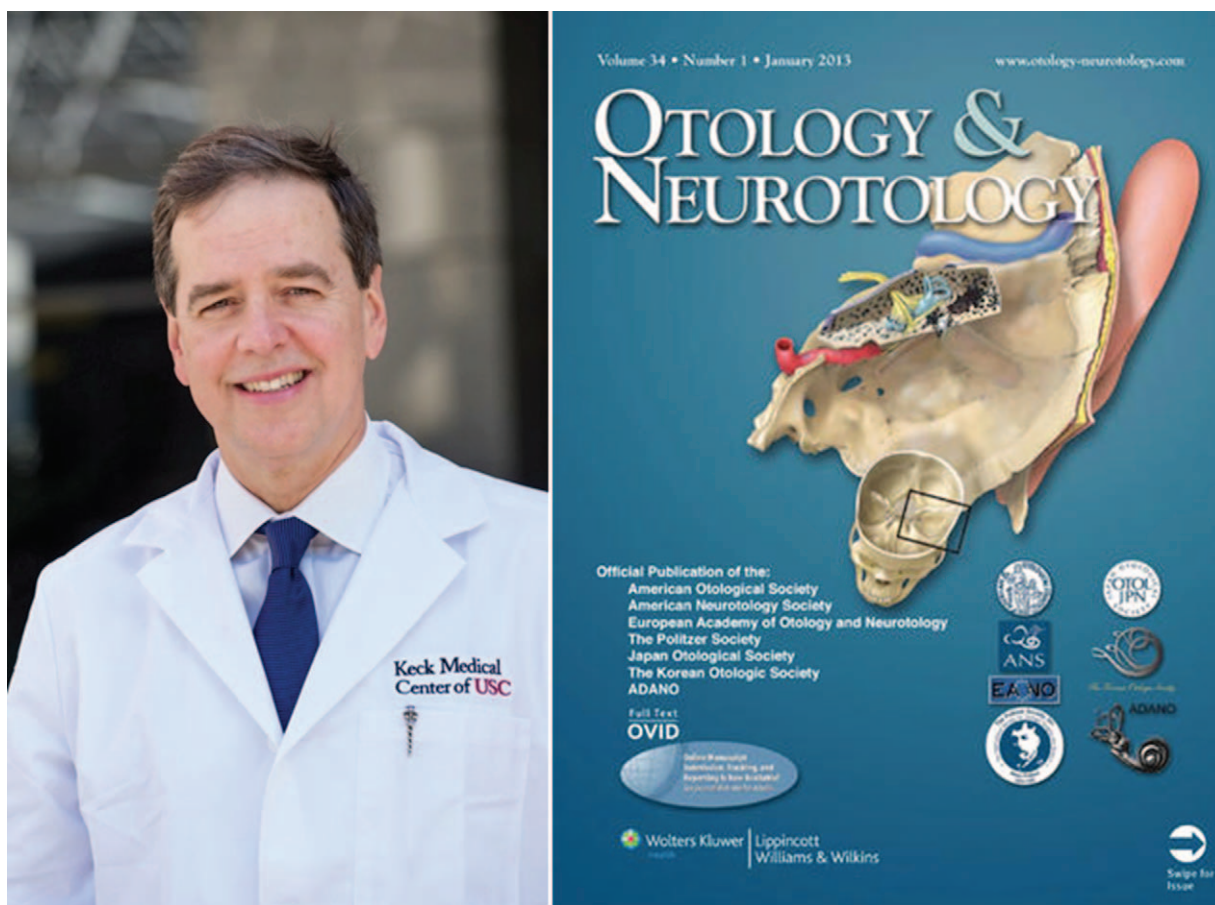


FIG. 14. In 2006 Dr. John K. Niparko was named as the new Editor-in-Chief. Under Dr. Niparko's leadership, a series of important changes occurred, most notably an emphasis on quality reviews and a rigorous peer-review process that enabled the journal to reach new citation index highs. Under Dr. Niparko's leadership, the journal cover also underwent another change to reflect the importance of skull base surgery as a core part of the journal's mission.

introductory Editorial, Dr. Niparko emphasized the importance of the peer-review process (43). As noted by Dr. Niparko, "You and I are charged with building on a legacy through our own inventiveness and refining the creative ideas offered by our peers." This emphasis on quality reviews would help shape his exemplary leadership, which was instrumental in bringing the journal into our current era, with the journal reaching new citation index highs. During his legacy, he modernized the peer-review process for the journal, and personally oversaw many of the manuscripts that came through *O&N*. Under Dr. Niparko's leadership, the journal cover also underwent another "facelift" in 2011 (Fig. 14), to reflect the importance of skull base surgery as a core part of the journal's academic mission. After a decade of outstanding leadership, Dr. Niparko announced his desire to step down as the Editor-in-Chief in 2016, and shortly afterward, unexpectedly passed away (44). In 2016, I was honored to follow in the footsteps of my mentors and predecessors in assuming this role.

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Today, the success of the journal continues, with an ever-increasing number of publications since 1979. Since its inception, *Otolology & Neurotology* has approximately 6,800 unique citable manuscripts and publications (Fig. 15). Yet through all the years of success and growth, the core mission of the journal has remained the same as when Dr. Glasscock founded it nearly 40 years ago, to keep it a publication that is both "informative and enjoyable" (37).

SUMMARY

The AOS has been on the forefront of advancing the science of auditory and vestibular physiology, and art of ear medicine since its founding in 1868. Its members have propelled the specialty to places the founders of the AOS could only dream. For 150 years, through its publications, the AOS has provided a critical forum to debate these advances, highlighting treatment successes and failures, and served a place to celebrate its history. Dr. Edmund Fowler summed up the outlook of the future

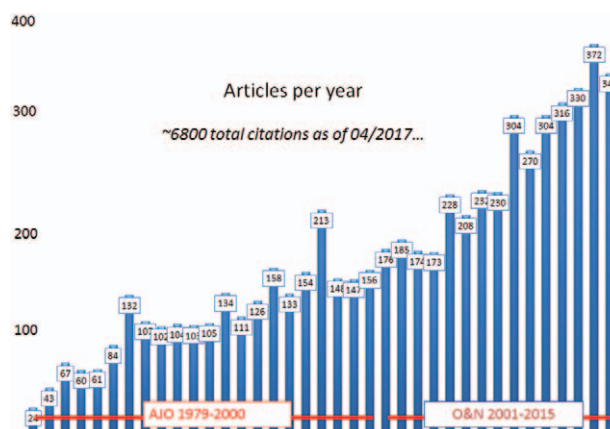


FIG. 15. The journal has shown outstanding growth since 1979. Each bar represents the number of citable manuscripts within PubMed in a given year, beginning in 1979 and going through 2015. The y-axis represents the number of citations for that year. The absolute number is listed at the top of each bar. Data are compiled through April 2015, and thus the complete 2015 numbers are not as high as 2014 in the graph, though in reality 2015 exceeded the number of citations as compared to 2014.

of our specialty most presciently in his forward to the 100-year anniversary history:

We are on the threshold of great strides into the unknown; let us not hesitate in our search for the truth (for the cause of the cause), hoping to get closer and closer, always realizing that we will never know it all. If we ever presume to be omniscient, we will be putting ourselves on the level of whatever gods man has believed there be.

Edmund P. Fowler, M.D. 1968 (26)

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Assessment of Hearing During the Early Years of the American Otological Society

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Objective: To describe the manner in which hearing was evaluated in American Otological Practice during the late 19th and early 20th centuries before introduction of the electric audiometer.

Methods: Primary sources were the Transactions of the American Otological Society and American textbooks, especially those authored by Presidents of the Society.

Results: In the era before electric audiometry multiple methods were used for evaluating the thresholds of different frequencies. Tuning forks were important for lower frequencies, whisper, and speech for mid-frequencies, and Galton's whistle and Konig's rod evaluated high frequencies. Hearing threshold was often recorded as in terms of duration of a sound, or distance from the source, rather than intensity. Hearing ability was often recorded a fraction, for example,

with the distance a watch tick could be heard over the distance of a normal hearing individual. A variety of devices, such as Politzer's Acoumeter, attempted to deliver sound in a calibrated manner, thus enhancing the accuracy and reproducibility of test results.

Conclusion: The early years of the American Otological Society were marked by a number of ingenious efforts to standardize hearing assessment despite the technical limitations. These efforts facilitated the development of the audiometer, and continue to influence clinical practice even today. **Key Words:** American Otological Society—Hearing assessment—History of otology.

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The diagnosis and management of hearing disorders has a long history, predating the onset of the American Otological Society (AOS) by centuries. For example, Hippocrates (460–337 BC) is widely regarded as “The Father of Medicine,” due to his introduction of key concepts such as the power of observation, the importance of the case history, and for developing the ethical code that underlies many facets of medicine even today (e.g., the Hippocratic Oath). Less known, however, was that he was among the first to investigate hearing disorders (1–3). While his belief that hearing loss was related to the direction of winds or weather changes have not held up to modern scrutiny, his reports that hearing loss is often associated with tinnitus or skull-based trauma reverberate into today's medical practice as part of our modern case history.

Over 2000 years later, the AOS was created, and has played a significant role in the diagnosis and management of hearing disorders over the last 150 years. In modern otological practice, assessment of hearing is a routine and crucial part of patient care. In the early days

of the AOS, however, obtaining an accurate measure of hearing was a challenging endeavor, and virtually impossible in many respects. For example, in 1877, Charles Burnett (AOS President 1884–1885) wrote that “No precise standard of normal hearing has ever been defined. The normal ear hears all sounds that fall on it; but it cannot be said, a priori, where good hearing patients and defective hearing begins, for in many senses these are relative terms (4).” Similarly, J. S. Prout (AOS President 1886–1889) noted that accuracy of hearing assessment would remain challenging until “an instrument can be made which shall always produce uniform tones.” Until the advent of the audiometer, Prout's comment proved largely prescient. Nonetheless, several methods were used to estimate hearing with remarkable degrees of ingenuity; the principles of some of these approaches underlie clinical practice even today. The purpose of this manuscript is to highlight techniques used to assess hearing before the advent of the audiometer, which irrevocably changed hearing assessment for the better shortly after entering into widespread use.

METHODS

The primary resource for determining hearing testing in American Otological Practice during the early years of the AOS was the Transactions of the AOS over its initial decades (5). Additional sources include the otology textbooks and paper

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authored by the founder generation of the AOS including those of Roosa (5), Blake (6), Buck (7), and Burnett (8) as well as publications by others describing hearing test methods in the late 19th and early 20th century America.

The Voice Test

In 1887, An AOS Committee on “The examination of the power of hearing” chaired by H. Knapp concluded that: “The human voice is generally acknowledged to be the most important test of hearing (9).” This statement is consistent with the idea that perhaps the most common measurement of hearing used in the first 25 years of the AOS was the “voice test” or the “whisper test,” in which the human voice is used to infer the hearing status of the patient. Variants of this test are used in current audiologic practice with measurement of the speech reception threshold, which is widely used to cross-check pure-tone thresholds. Remarkably, the implementation of “the voice test” changed little during the early years of the AOS. In 1869, Anton von Troltsch recommended, “. . . you must make a closer examination, by testing the power of hearing the voice and conversation. While one ear is being examined to this, the other should be closed by the finger of the patient, and you should speak slowly and distinctly, at first in a whisper. . . You must guard against deception, by seeing that the patient does not practice the habit of watching the mouth of the speaker. . . thus you will often be informed by a patient. . . that he hears much worse by twilight and at night in bed, than when it is light around him (10).” In 1882, Winslow recommended, “It is best to stand a few feet away from the patient upon the side of the ear to be tested, so that he cannot see the lips move, then ask him questions in a low voice. If he cannot hear, address him in a medium tone, and if he is still unable to hear what is said, raise the voice to even a shout if necessary. There are varying degrees of hearing for each tone, but low, medium, and high will be sufficiently exact for all practical purposes (11).” Thirty years later, Barr provided a similar set of instructions, “The patient and physician stand at opposite ends of the room, the ear to be examined turned towards the physician. The opposite ear is closed firmly by a finger to the meatus. Standing thus sideways to the physician, the patient cannot see his lips, and the element of lip-reading is eliminated. The physician now repeats the words or numbers which he chooses to employ, the patient having been instructed to repeat after him. If the patient cannot hear, or hesitates, or calls the word out incorrectly, the physician at once moves nearer and repeats the experiment, but using different words, but those having as nearly as possible the same sound values. The distance between patient and physician is thus reduced until one is reached at which the words are repeated promptly and correctly (12).” The same author noted that differences in pitch, timbre, volume, etc., of different voices make it impossible to determine an exact level of hearing, but reported consensus that conversational speech can be heard at 60 to 70 feet.

Also noteworthy during this time was the awareness that some speech sounds may be audible, while others are inaudible. This point was illustrated in 1877 by Burnett, who articulated, “The distance at which separate vowels can be heard has not yet been established, but they are endowed with the greatest strength of tone, being heard and understood at a distance at which all the consonants are inaudible (4).” In his manual, Burnett subsequently provided distances at which various consonants could be heard, noting that “H is the weakest of all consonants when not followed by a vowel. It is lost at a distance of a few paces. . . Next in strength is B, Ba being heard further than Ha (4),” and so on. Such comments are similar in spirit to

the early studies of acoustic phonetics, which began in earnest during a similar time frame as to the beginning of the AOS, and were later reiterated by Politzer (13).

Because it was widely understood that the voice can vary tremendously between different individuals, some physicians attempted to standardize presentation of speech of these early attempts, the phonograph was perhaps the most widely used. In 1904, Bentley proposed, “Instead of employing directly the voice of the investigator, and instead of relying upon acoustic and organic conditions which vary from experimenter to experimenter and from place to place, it proposes to use permanent phonographic records, which can be copied an indefinite number of times and can be reproduced independently of local conditions (14).” Similarly, in 1890 Fiske noted, “to sum up briefly we need a method of testing the hearing which shall 1, make use of human speech; 2, which shall be accurate and independent of the examiner; 3, which shall make a record capable of interpretation and use by other aurists (15).” Fiske proposed using the “phonometer” developed by Lucae which would enable a recording of the assessment; this would allow for a record of each appointment, which could then be shared with other physicians as needed. Ultimately, however, the cost of the device, and difficulties with reliability meant that widespread use of the phonometer never occurred. The principles of standardized speech materials, presentation levels, and recording of the responses, however, reverberate through audiologic practice even today.

The Watch Test

In addition to the voice test, one of the most widely used measures of hearing assessment during the early years of the AOS was the “watch test” (Fig. 1 (16)). Indeed, it was often stated that, “Thus far, the ticking of the watch has been found to afford the

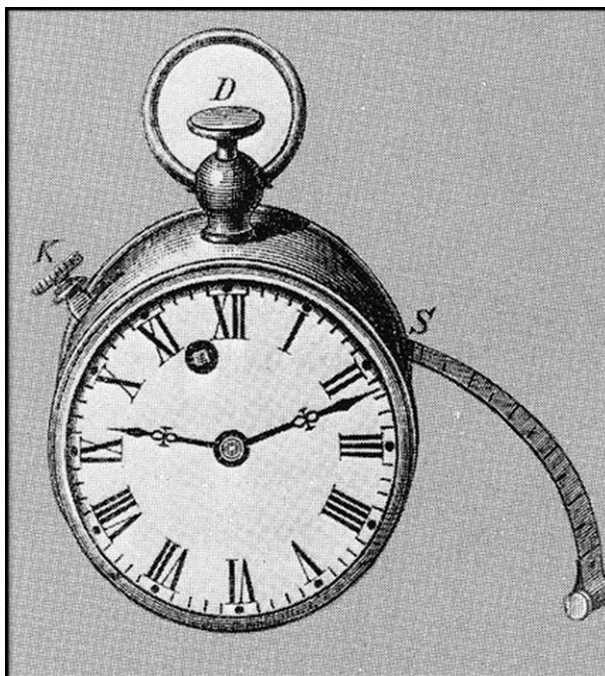


FIG. 1. A specialized watch for use in hearing testing from Bing 1890 (16). Hearing ability was recorded as the distance at which the watch tick could be heard. Note the attached tape measure used for this purpose.

Table showing the Disproportion between the Power of Hearing the Tick of a Watch and the Human Voice.¹

No.	Sex and age.	Hearing distance for the watch.	Hearing distance for conversation, the patient being with the back to the speaker.
1	Female, 17.	R. $\frac{\text{laid}}{40}$, L. $\frac{0}{40}$.	Words spoken loudly at 10 feet with difficulty.
2	Male, 45.	R. $\frac{4}{40}$, L. $\frac{0}{40}$. R. $\frac{0}{40}$, L. $\frac{8}{40}$.	Loud conversation at 20 feet. Voice at 30 feet; cannot tell the direction from which sound comes.
3	Female, 28.	R. $\frac{7}{40}$, L. $\frac{4}{40}$.	Conversation at 20 feet.
4	Male, 56.	R. laid, L. laid.	Conversation at 20 feet.
5	Male, 62.	R. pressed, L. pressed.	Loud conversation at 20 feet.
6	Female, 23.	R. $\frac{5}{40}$, L. $\frac{3}{40}$.	Loud conversation at 6 feet.
7	Male, 9½.	R. $\frac{1}{40}$, L. $\frac{3}{40}$.	Loud conversation at 30 feet.
8	Male, 16.	R. $\frac{\text{laid}}{40}$, L. $\frac{\text{laid}}{40}$.	Conversation at 20 feet.
9	Male, 18.	R. $\frac{40}{40}$, L. $\frac{30}{40}$. R. $\frac{40}{40}$, L. $\frac{40}{40}$.	Conversation at 12 feet. Conversation at 30 feet.
10	Female, 15.	R. $\frac{4}{40}$, L. $\frac{8}{40}$.	Conversation at 20 feet.
11	Male, 19.	R. $\frac{5}{40}$, L. $\frac{10}{40}$.	Conversation at 20 feet.
12	Female, 29.	R. $\frac{\text{laid}}{40}$, L. $\frac{\text{laid}}{40}$.	Conversation at 20 feet.
13	Male, 40.	H. D. R. $\frac{1}{40}$, L. $\frac{\text{laid}}{40}$.	Ordinary conversation with great ease at 30 feet.
14	Female, 25.	R. $\frac{12}{40}$, L. $\frac{6}{40}$.	Ordinary conversation with difficulty at 20 feet.
15	Male, 32.	R. $\frac{0}{40}$, L. $\frac{1\frac{1}{2}}{40}$.	Conversation at 16 feet.
16	Male, 15.	R. $\frac{6}{40}$, L. mastoid.	Conversation at 20 feet.
17	Male, 41.	R. $\frac{8}{40}$, L. $\frac{0}{40}$.	Conversation with ease at 40 feet.

FIG. 2. Table of hearing ability from Roosa 1885 (18) for watch tick compared with spoken voice both expressed in terms of distance from the sound source. The fraction 4/40 refers to perception of the watch tick in inches from the ear (4) over the distance with which a tick was heard for a normal ear (40).

best practical means of testing the capacity of the ear for distinguishing delicate sounds (7).” The basic premise of this approach was to determine whether a patient could detect the ticking of a watch, and if so, then to determine the distance at which the patient could no longer hear the watch. A detailed and widely cited utilization of this approach was described in 1872 by Prout (17) (Fig. 2 (18)). In his report, he recommended the use of distance to estimate hearing acuity in much the same manner as the Snellen chart is used in the visual system. In his system, hearing acuity was recorded as a fraction. “The numerator of which is the distance at which the particular sound is heard, the denominator the distance at which it should be heard by an ear of good average hearing power. This denominator must vary according to the sonofactor used, and should generally be expressed in inches (17).” Thus, 12/36 would indicate that the ticking of a watch was heard at 12 inches, when it should have been heard at 36 inches. According to Prout, one advantage of using fractional distances was its potential applicability to any signal, whether a watch or a whispered voice. In retrospect, it is interesting to consider the use of distance to assess hearing acuity given that the American Otological Society initially began as an offshoot of the American Ophthalmological Society (see Jackler et al., elsewhere in this issue), and visual acuity as a function of distance is a key aspect of the testing of vision.

During the early years of the AOS, several recommendations were given to physicians to increase the accuracy of their measures or the diagnostic power of the watch test. For example, it was generally accepted that “the distance at which the watch used is heard by the normal ear should be known by the examiner (11).” Internal consistency in the testing approach was also reported to be a key step, as “it makes considerable difference whether one hangs the watch by the finger, or holds it in the palm of the hand with the whole hand as a resonator (11).” The watch was also used to assess hearing via bone conduction, “The watch may be placed on the vertex or the forehead to determine roughly the condition of the middle ear and auditory nerve. . . If the watch is not heard when applied thus, it is pretty sure evidence that there is disease of the labyrinth or nerve (11).” Finally, use of a stopwatch was widely recommended as well; the rationale behind this recommendation was that with a stopwatch, the ticking can be stopped or started, and in this way false positives (e.g., reporting hearing the watch when no ticking is present). In other words, use of the stop watch was a “means of finding out whether the patient really hears the sound of the watch, or whether he thinks he does because he knows a watch is being held before his ear.” This approach was reported to be particularly useful with children who “as a rule, give erroneous statements as to their ability to hear a watch (11).”

While the watch was widely used, its limitations were evident from the beginning. First and foremost, watches regularly differed with regard to the intensity and pitch of the ticking; for obvious reasons, this meant that the replicability of hearing tests across institutions was virtually nonexistent. Such concerns were articulated effectively by Albert Buck (AOS President 1879–80) in 1880. “If measurements of the hearing distance could be universally made with some standard source of fixed intensity, the necessity for recording our measurements in fractions (Prout’s method) would be done away with; it would be sufficient to merely state the actual distance measured, and every physician who was familiar with such tests would appreciate at once the degree of impairment of the hearing reported (7).” Another significant limitation was the relationship between hearing a watch and the ability of the patient to communicate with others. Such concerns were noted as early as 1853, “The degree of hearing with a watch is sometimes deceptive; some patients who cannot hear a watch, or even a clock, will hear the voice even in a low tone (19).” Such concerns were repeatedly articulated in different textbooks of Otology, “The watch alone does not afford a sufficient means of determining the amount of hearing examined, because the distance at which it can be heard does not always stand in proper proportion to the power of understanding conversation (11).” Nonetheless, use of the watch to assess hearing status continued until widespread adoption of the audiometer took place. For example, more than 50 years later, general guidelines were provided to physicians as to its use, “Naturally, this sound (the watch tick) varies considerably in intensity with the size, form, thickness of covers, etc. of different watches. Taking, however, a man’s watch of average size, its tick will be heard by the normal ear of a young adult. . . at a distance of 40 to 50 inches. . . As age advances, the hearing distance for the watch is gradually diminished. . . (20).”

POLITZER’S ACOUMETER

As noted by Buck and many others, there was an understanding that accurate assessment of hearing would require a signal of a given intensity which could be reliably delivered. Early attempts in this regard were often classified as “Mechanical Acuity Meters.” Among the earliest of such devices was reported by Wolke in 1802. His device was comprised of a pendulum-like hammer that could be dropped onto a wooden board approximately 1.5 m high. The height of the pendulum swing could be varied, and by doing so, different intensities of sound could be produced. This sort of device was improved upon approximately 20 years later by Itard with the development of the “accumeter (21).” In this device, a ring of copper was used as the sound source; the ring was suspended by a string, and struck by a ball at the end of a pendulum. The strength of the strike, and thus the intensity of the signal, depended on the height from which the ball was dropped. This instrument was widely used in the early half of the 1800s, as Itard was the Director of the Paris Institute for the Deaf. [See Feldman’s *History of Audiology* for a more detailed summary of these early mechanical acuity meters (1)].

The most well known and widely used of these devices was the acoumeter developed by the legendary otolaryngologist Adam Politzer of Vienna in 1877 during the

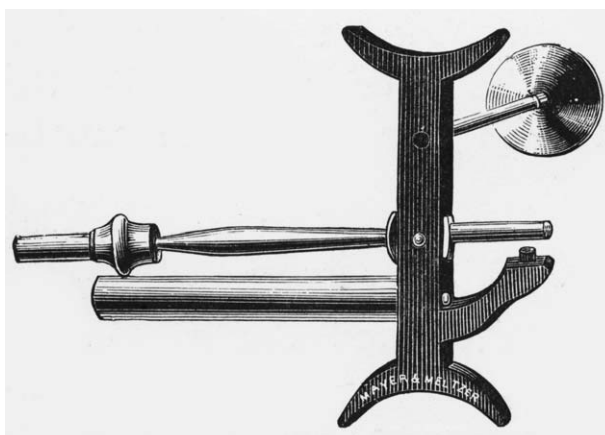


FIG. 3. Politzer’s Acoumeter from Love 1904 (22). Sound was generated by a small mallet struck by a metal rod with calibrated force not as readily obtained with tuning forks. An attached metal disk was used for bone conduction.

beginning stages of the AOS (Figs. 3 and 4) (11,22). One key advancement of Politzer’s acoumeter was that it was hand-held between the middle finger and the thumb. When the middle finger was depressed, it would raise a small mallet; when released, the mallet would fall to strike a small iron cylinder. The primary advantage of this approach was that the mallet was always dropped at a constant height, unlike the aforementioned devices in which the height was generally estimated. Hearing was then measured at known distances at which individuals with normal hearing could detect the sound of the mallet. This provided for a more consistent measure of hearing assessment than the widely used “watch test.” A key advantage of Politzer’s acoumeter was that, by attaching a small metal disk to the acoumeter, bone-conduction hearing could also be measured using this device.

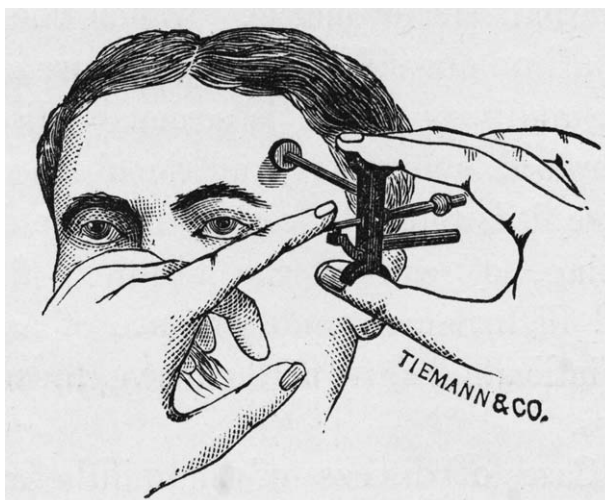


FIG. 4. Illustration of Politzer’s Acoumeter in use for bone conduction from Winslow 1882 (11).

While Politzer's acoumeter resolved some of the concerns surrounding hearing testing at the time, it also presented with a number of limitations. For example, as with the watch test, the relationship between hearing acuity measured with the acoumeter and the ability to understand speech was poorly understood at best. More problematic for some physicians was the fact that early acoumeters were "being nothing more than loud watches (1)," and Politzer's acoumeter was plagued by a similar issue. Politzer himself noted that "The acuteness of hearing for the acoumeter, or for the watch, frequently shows marked differences..." with an average normal hearing distance for Politzer's acoumeter being 15 m (13). Ultimately though, the factors that may have hindered greater acceptance of Politzer's acoumeter were described succinctly by Buck in 1880, "Politzer's idea in producing the 'acoumeter' undoubtedly was to furnish a standard test of hearing. Unfortunately, in its present shape this instrument costs too much, is likely to get out of order too easily, and cannot be manipulated with comfort (7)." Others held similar views, which persisted for over 30 years, "Use the stop watch with a fairly sharp

tick; this will take the place of the Politzer acoumeter, which can be discarded (12)."

TUNING FORKS

The use of tuning forks to evaluate hearing began early in the 19th century (23–25) They were originally developed to assist in tuning musical instruments. By the late 19th century, their use had become routine, but not necessarily universal. In an 1887 position statement in the AOS Transactions titled "The examination of the power of hearing, and how to record its results" opined that tuning forks should be part of the standard hearing evaluation: "They should, in every case of impairment of hearing, be used as regularly as the watch and voice tests. (9)" By contrast, in his 1880 textbook, Buck in his chapter on "Test of the Hearing-Power" did not even mention tuning forks, emphasizing instead perception of the spoken voice and watch ticking (7).

There was a wide diversity of tuning fork design (Fig. 5 (22)). Typically, forks were available in C-tones one octave apart: 64, 128, 265, 1024, and 2048 Hertz. To



FIG. 5. A collection of tuning forks and whistles used in clinical otology from Love 1904 (22).

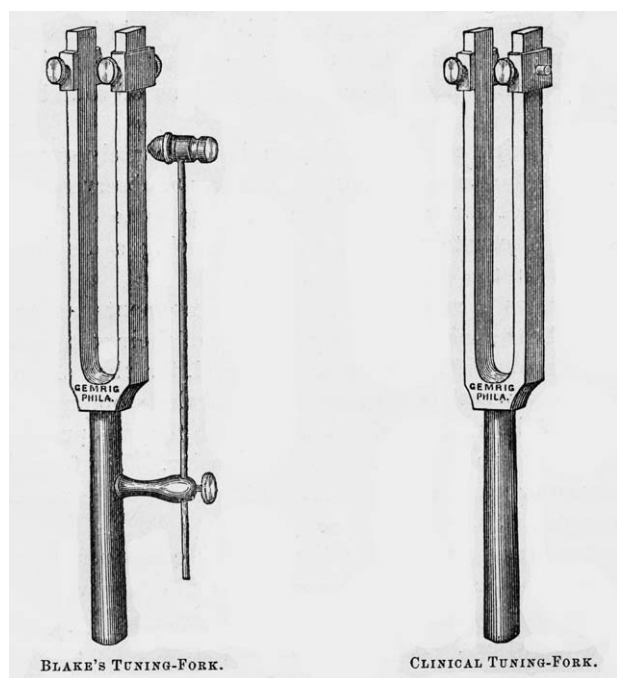


FIG. 6. Modified tuning forks from Burnett 1877 (4). The Blake modified tuning fork had an attached hammer in an effort to calibrate the strike force. The adjustable weights at the end of the tuning fork served two purposes: dampening overtones and adjusting the pitch of the fork's ring.

mitigate the potential for excessive strike force to generate overtones, some had small attached hammers to help calibrate the amount of force to the tine. Burnett in 1877 lauded: "A very beautiful instrument is the tuning fork devised by Dr. C. J. Blake, in which the force setting in vibration is obtained by means of a steel hammer padded with rubber. The handle of the hammer is adjustable at any point along its length, but which means the blow can be weakened or strengthened as desired (4)" (Fig. 6 (4)). Charles H. Burnett was AOS President 1884–5 while Blake served in this role 1877–78. Other tuning fork designs had clamps attached to dampen overtones, but these tended to shorten the vibration period. Forks with an attached weight which could be slid along the tine allowed tests multiple frequencies without the need to carry a large supply of individual frequency forks. Others had resonating chambers to enhance the sound for patients with severe losses (Fig. 7 (26)). Tuning forks with a rubber tube attached were facilitated comparison of the physician's hearing with that of the patient (Fig. 8 (27)).

Today only two tests introduced in the mid-19th century, Weber (1845) and Rinne (1855), remain in widespread use. Over 20 different tests were in use during the late 19th and early 20th centuries before the introduction of the electric audiometer. In 1887, Knapp and his co-authors emphasized the central importance of the Rinne test: "Rinne's method, gentlemen, is the most expeditious and practically the most important (9)." In

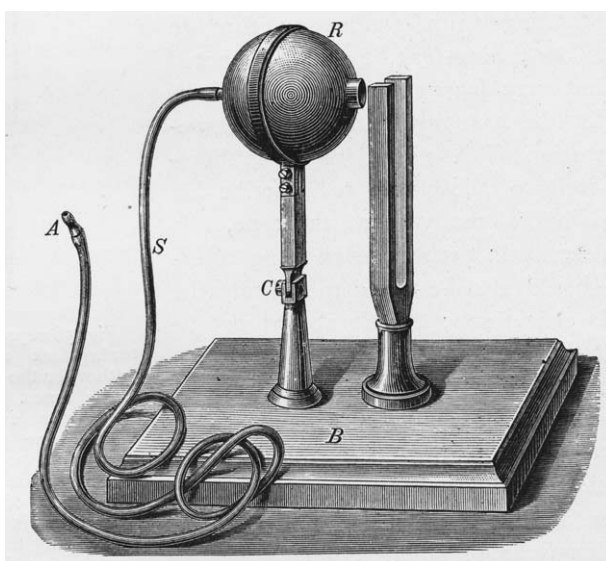


FIG. 7. Tuning fork with resonating chamber from Gruber 1890 to enhance audibility for those with severe hearing losses (26).

1881, DB St. John Roosa (AOS President 1874–76) explained the use of the Rinne test: "If the vibrating tuning-fork be heard better on the mastoid than when placed in front of the meatus, there is disease predominantly of the middle ear (28)." Roosa also explained the Weber test: "If one ear be normal as to the hearing power, and the other abnormal, and a vibrating tuning-fork "C" be placed upon the vertex or the teeth, if its sound be intensified in the ear whose hearing power is diminished, there is disease of the external or middle ear, but no lesion of the labyrinth or nerve (28)."

Other tuning fork tests were developed to discriminate sensory from conductive losses. In the Bing test, a tuning fork is placed on the mastoid and when it is no longer

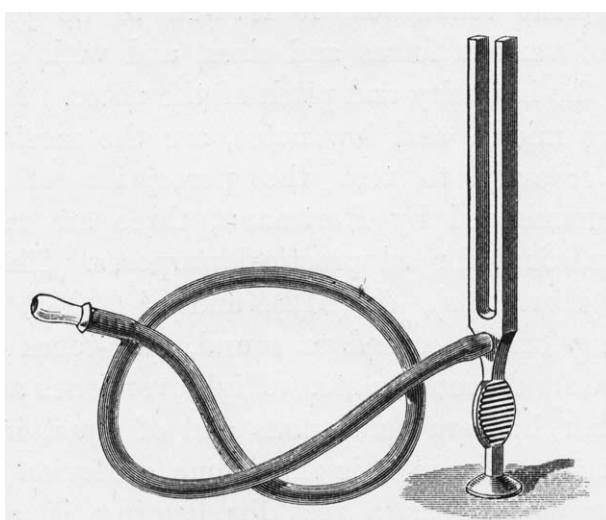


FIG. 8. Tuning fork with a listening tube by Hovell 1894 allowing comparison of the examiner's perception with the patient's during bone conduction testing (27).

heard the patient’s meatus is occluded with a finger. In sensory losses, perception of the tone returned whereas in conductive losses it did not. The Gelle Test was intended to evaluate severe hearing loss for stapes fixation. With the fork on the mastoid compressed air was delivered to the ear canal via a Politzer bag. If the stapes was mobile, it was compressed inward thus diminishing hearing. If fixed, the added pressure did not alter hearing.

While tuning forks are now used principally to discern sensory from conductive loss, in the 19th century they were also a primary means of assessing hearing ability at different frequencies. Use of the tuning fork for threshold testing is somewhat of a lost art today. For threshold testing, tuning forks were especially important for the lower frequencies, speech for the mid-frequencies, while Galton’s whistle and Konig’s rod evaluated the high frequencies (6). In Schwabach’s Test the duration by which the tuning fork is heard when applied to the cranial bones and compared with the duration of a patient of similar age with normal hearing. Measuring the duration of hearing with a variety of tuning forks, struck in a consistent manner, could provide an estimate of threshold not dissimilar to an audiogram (Fig. 9 (29)). Criticism of the Schwabach test was that it was laborious and time consuming and required repetition at each frequency to enhance accuracy. An early form of audiometer consisted of a rotating turret of tuning forks of various frequencies struck in a calibrated manner with a hammer connected to a stop watch (30). The tuning fork audiometer charted the number of seconds perceived at each frequency.

An awareness that the diagnostic reliability of tuning forks is imperfect was recognized in the 19th century. Striking the fork with an excessive force results in overtones at higher frequencies that intended (31). The difficulty in assessing one conduction at low frequencies due to vibrotactile perception was understood: ‘In testing bone conduction for lower tones, it is difficult to determine

whether the patient hears the fork or feels the jar transmitted to the head. Some patients can differentiate between the two sensations, while others admit that they cannot be sure whether they feel the vibrations or hear the sound (31).’ In 1887, Theobald noted regarding the Weber test: ‘It is by no means an uncommon experience with me, when testing with the tuning-fork, that when I place it on the vertex it is heard louder, we will say, in the right ear. Then I will strike it again and place it on the forehead, and it will be heard louder in the left ear. This observation has given me less confidence in the tuning-fork as a differential test between middle ear and labyrinthine troubles than I before had (9).’ Regarding the Rinne test, the nomenclature that designates a negative test to be abnormal and a positive test normal has been a source of confusion since the test was first described. Many contemporary otologists use the terms AC > BC (air conduction > bone conduction) or BC > AC to avoid confusion. In his 1902 contribution titled ‘Sources of error in functional tests of hearing’ A.H. Andrews descried: ‘In the Schwabach test there are two objections to forks which can be heard longer than the time mentioned: 1. In making repeated tests in order to secure accuracy, much valuable time is lost waiting for the fork to run down. 2. Repeated tests with forks which vibrate along time are apt to wear out the patient’s attention, so that after a few trials his replies are found to be uncertain (31).’

In the 21st century, tuning forks are hardly a quaint anachronism and remain relevant in contemporary otological practice. Their use is both art and science, with results varying, and the clinician needs to exercise judgement in interpreting results. In today’s practice, tuning forks are an important check of the audiogram in cases of apparent conductive losses. Insufficient masking can make a deaf ear appear to have a conductive hearing loss, with the potential for misdiagnosis leading to improper therapeutic intervention. Use of the Rinne and Weber tests can clarify this situation. James Sheehy (1926–2006) of the House Group routinely inquired of his neurotology fellows about whether or not they completed the ‘DFTF test.’ New fellows soon became initiated in his meaning: ‘don’t forget tuning forks.’

OTHER METHODS FOR ASSESSING TONAL HEARING: THE GALTON WHISTLE, KONIG RODS, AND SCHULZ’S MONOCHORD

One widely known limitation of hearing assessment in the 19th century was the inability to reliably test hearing for higher frequencies. The importance of the use of high-frequency tonal stimuli was articulated clearly by Blake in 1879, when he wrote ‘that the upper limit of audibility of high musical tones by the normal ear being taken as the standard, any considerable deviation from this standard, within certain limits, may be taken as evidence of an abnormal condition – a. of the sound-transmitting apparatus of the middle ear; b. of the sound-transmitting structures of the labyrinth; c. of the auditory nerve and the ultimate organ of perception (6).’ To address the

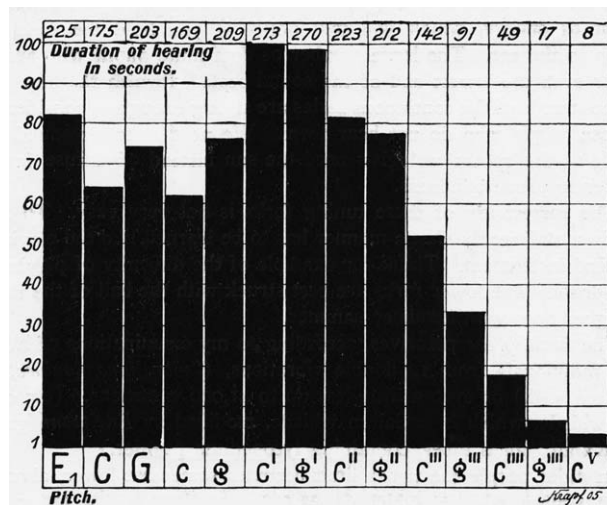


FIG. 9. An ‘audiogram’ from Bezold 1908 created by charting the duration which the patient heard a tuning fork as its vibrations abated (29).

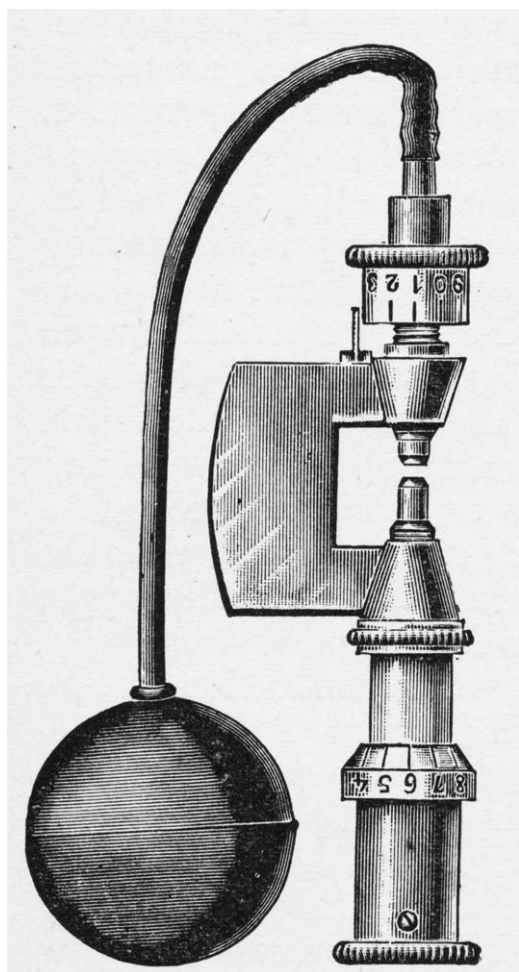
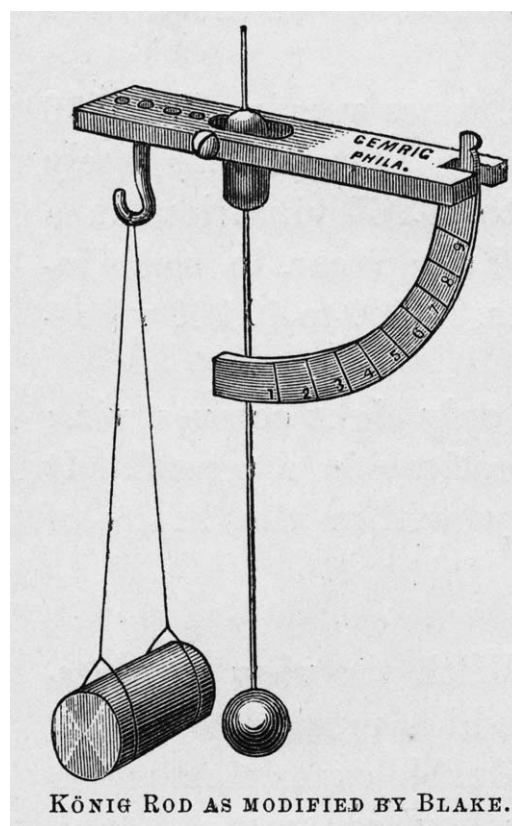


FIG. 10. Galton whistle from Bruhl 1906 produced a variety of high pitched sounds by varying its aperture.

limitation of tools for assessing high-frequency hearing, Sir Frances Galton (1822–1911) invented the “Galton Whistle” in 1876 (Fig. 10). This device consists of a small whistle, which has an obturator controlled by a slider. By varying the aperture, the frequency produced by the whistle can be varied. Some variants of the Galton Whistle produced sounds ranging from 5 to 42 kHz. Galton successfully used this device to estimate the hearing acuity in both humans and animals; much of this work is described in his 1883 book, “Inquiries into Human Faculty and Its Development.” Most notably, through the use of this device, Galton estimated that the upper limit of normal human hearing was approximately 18 kHz, and that the ability to hear high frequencies deteriorated with age. Thus, Galton’s research provided some of the earliest characterization of presbycusis in humans. After the audiometer entered widespread use in the 20th century, Galton’s whistle continued to be used to assess hearing in animals. Notably, use of this device continues even today, but is widely referred to as the “dog whistle.”

König’s rods were similar in principle to tuning forks, and like the Galton whistle, were used to assess high-



KÖNIG ROD AS MODIFIED BY BLAKE.

FIG. 11. König’s rod used in testing high frequencies from Burnett 1877 (4). Intensity was determined by the height to which the ball bearing was lifted before release.

frequency hearing sensitivity (Fig. 11 (4)). The König rods consisted of steel cylinders suspended by cords that produced high-frequency tones when struck by a small hammer. While similar in their use to Galton’s whistle, they differed in some key respects. For example, “the intensity of the tone of a König’s rod diminishes regularly from the moment that it is set in vibration, while the intensity of the tone of the whistle evidently can be maintained. The auditory impression produced by the latter is therefore proportionately greater, and of two tones of the same pitch, sounded at the same distance, by König’s rod and a whistle, the latter will be more distinctly heard (6).” While Blake favored the use of the König rods, they ultimately fell out of favor because of the factors described above, leading some to conclude that they “provide notes of constant pitch, but with variable intensity. They are inconvenient, and not of general utility (32).”

Schulz’ monochord was another tool developed to deliver high-frequency tonal stimuli to the patient, and to determine the highest frequency that could be heard by a given individual. This consisted of a metal wire akin to those used in string instruments. When vibrated, the string would elicit a high-frequency tone, and the patient would indicate whether the tone was heard. The monochord was not as widely adopted, but its adherents noted

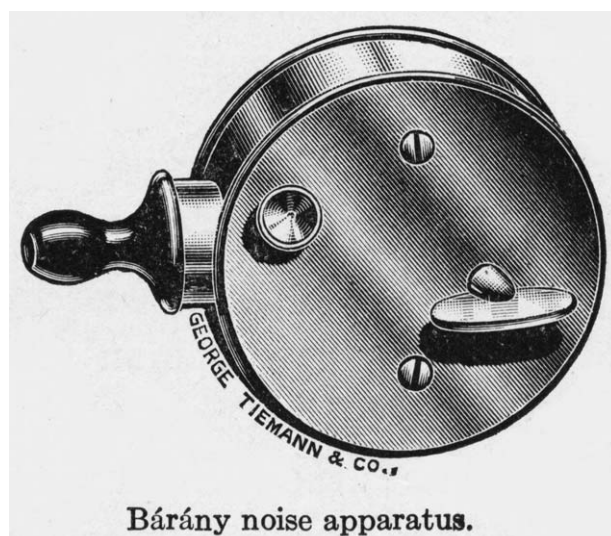


FIG. 12. Barány noise apparatus also known as Barány noise Box from Gorham Bacon (AOS President 1891–4) 1918 (33). The device, still in use today in many centers, is used to mask the better ear in unilateral or asymmetrical hearing loss.

some advantages over the Galton Whistle or König's Rods. Notably, "the limits (of high-frequency hearing) when tested by the whistle is lower... a finding which may be due to the whistle giving less intensity of sound at these high pitches (32)."

EARLY ATTEMPTS AT MASKING: THE BARÁNY NOISE BOX

Another widely known constraint on hearing assessment in the early years of the AOS was the inability to reliably test hearing in one ear without the contralateral ear contributing in some capacity. Most attempts involved closure of the contralateral ear canal by some means; basic forms of plugging the ear were widely used in the various voice tests. However, it was clear that such approaches were likely insufficient to achieve their desired goal, particularly when trying to identify or rule out unilateral deafness. Thus, in 1908, Barány introduced his "noise box" or "noise apparatus," as it became widely known (Fig. 12 (33)). To use this device, it would first be wound up similar to that of a watch. It was then inserted into the ear to be masked, and when turned on, would create a loud buzzing sound while the examiner speaks or shouts into the contralateral ear. If the patient failed to respond, the ear was considered "Barány deaf." Around this time, other approaches were developed with the intent of achieving the same goal as described in Feldman's History of Audiology (1). For example, Voss blew compressed air into the ear to be masked (1908–1909), while Luc advocated caloric irrigation (1910). Lucae (1908) and Davidson (1910) both attempted to mask one ear through use of an electrical vibrator. Nonetheless, the Barány noise box was likely the most widely used of these approaches, although some

physicians noted limitations of this device, "In my experience this apparatus has proved useful, but it has seemed sometimes to so confuse the individual as to prevent an accurate test of the ear under examination, the ear hearing both the noise machine and the fork or voice, as the case may be, but both with less accuracy (12)." Such comments are interesting as they reflect the experiences of many modern-day audiologists, either with regard to over-masking, or with "central masking" (e.g., decrease in ipsilateral hearing threshold when the noise is presented to the contralateral ear, presumably due to a central mechanism).

TESTING OF CHILDREN

With the limited (by today's standards) tools for hearing assessment, it is perhaps no surprise that even fewer options were available for "hard-to-test" populations such as children. For example, the limited reports on hearing assessment in children generally noted that children are often unreliable in their responses, and that caution should be taken when assessing hearing in this population. Representative comments are found in the chapter from Barr, who stated that, "we contend with two principal difficulties: the unwillingness or the inability of the child to answer correctly... The little patients tire easily... Prolonged examinations of children under 10 years are apt to be unsatisfactory... Many children cannot be accurately tested until the third or fourth year in school... (12)."

One unique report during the early years of the AOS, however, came from Harold Walker in 1907 (34). He reported data on 289 children who were tested in their school in a quiet room. The session began with examining the eardrum, nose and throat. Then, "the hearing was tested by a whispered voice which could be heard by the average normal ear at a distance of twenty-five feet, and a spoken voice with thirty-five feet as the normal limit. Numbers from one to one hundred, words, and short sentences were used, and the distance at which the child could repeat what was heard was recorded (34)." Prout's ratio approach was then used to determine the hearing ratio, and these results were compared with the presence of adenoids, abnormal otoscopic results, and "the general facial expression." Using this technique, 2/3 of children were reported to have normal hearing, with 23% having "hypertrophied turbinates," 21% showing "chronic suppurative of the middle ear," and so on. Finally, he reported what may be perhaps the first relationship between hearing acuity and academic performance, as "of the pupils marked with the grade of 'excellent' 17% showed diminished hearing. Of those marked 'good', 20% showed diminished hearing. Of those marked 'fair' 30% showed diminished hearing. Of those marked 'poor' 42% showed diminished hearing... (34)." Such work was prescient in many regards, as the relationship between untreated hearing loss and decreased academic outcomes has been replicated on numerous occasions.

TESTS TO DETECT MALINGERERS

Malingering was well known and tests were devised to reveal it. According to Kerrison in 1922: “Pretended deafness is said to be comparatively common in countries where army service is compulsory (20).” He went on to remark that: “In America it is met with chiefly in the case of imposters seeking indemnity on account of pretended injury to one or both ears (20).” Regarding the identification of malingerers, several approaches were used, some of which continue to be used today in various forms. Among the first tests, and one that continues to be widely used is the Stenger test. This test is based on the Stenger principle, which stipulates that when a signal of two intensities is presented to two ears of similar hearing, the patient will only report hearing in the ear that receives the more intense signal. This test can be performed with two tuning forks held at the same distance from each ear. In the case of feigned unilateral deafness, as one tuning fork is brought closer to the “impaired” ear, the malingerer will report hearing nothing. However, given that the other tuning fork has not moved, and remains audible, the physician can then determine that the patient is malingering. Feigned bilateral deafness was reported to be more challenging to identify however, with sample approaches being “to wake the patient from his sleep by a moderately loud call (13)” or “by making disparaging remarks about him in the presence of a third party, one may be able to determine by changes in his facial expression his ability to hear the conversational voice. Usually, however, the pretense of complete bilateral deafness is too difficult to maintain. . . (35).”

THE ADVENT OF THE AUDIOMETER

Perhaps the most significant development in the assessment of hearing was the audiometer. This device not only revolutionized hearing assessment, but the practice of Otolology, and paved the way for the birth of Audiology to come in subsequent years. Shortly after Alexander Graham Bell invented the telephone in 1876, the electric audiometer began to be developed, and these efforts were led by A. Hartmann and D.E. Hughes. In 1878, Hartmann developed an instrument for hearing assessment in which electric current was used to vibrate a tuning fork, and the resulting signal was then passed through a telephone receiver (36). In 1879, Hughes developed what he termed an “electric sonometer,” which also used electric current to vibrate a tuning fork. In his device, the electric current could be increased or decreased by sliding a movable induction coil, and by this process hearing acuity could be assessed (37). Both devices were limited, however, by several factors, including that “Different fundamental tones can be secured only by installing forks of different pitch. This tends to make the apparatus complicated, unstable, cumbersome, and difficult to standardize (38).” These attempts were followed by several others until the first commercially available audiometer was patented in the United States in

1914. This audiometer was the Western Electric 1A, which was limited by its size and prohibitive price. However, it was followed closely by the Western Electric 2A in 1923, which was considerably smaller and designed for clinical use. This device rapidly gained acceptance by many otologists. The history of these audiometers, and their predecessors were described in great detail by CC Bunch in 1941 (38), and by Feldmann in 1970 (1), and will not be discussed in greater detail here.

Of historical interest are the thoughts of some AOS members during the advent of the audiometer. For example, in 1930, Keeler stated, “The greatest value of the audiometer is the possibility of a uniform standard of measuring hearing loss which it presents. At present, every otologist has his own method of testing, and of estimating the loss of hearing in the subjects of aural impairment whom he examines. There is no uniform standard, and the examiner in California whose patient travels to New York cannot send his records to his colleague on the Atlantic coast into whose hands the patient goes, with any certainty that they will coincide with the records and standards of the New York otologist (39).” Similarly, when describing the existing test battery (e.g., voice, watch, and tuning forks), Clarke noted that “these tests form the backbone of our functional diagnosis, and I believe that the lack of otological progress in the last thirty years is largely due to their inherent inaccuracy (32).” Ultimately, the development and widespread adoption of the audiometer led to a significant change in hearing assessment, and virtually obviated the previous forms of hearing assessment other than tuning forks.

EARLY ATTEMPTS TO PLOT HEARING—AND WHY IS THE AUDIOGRAM UPSIDE DOWN?

In modern otology practice, the audiogram is virtually ubiquitous. However, in the early years of the AOS, attempts to plot hearing ability varied tremendously depending on the approach utilized. For example, in 1885, Dr. Hartmann created the “Auditory Chart” to record results from tuning-fork testing. This chart indicated the length of time that a given tuning fork could be heard; seven tuning forks ranging from 64 to 4096 Hz were included in this graph. To facilitate interpretation, Hartmann even provided “norms” for the duration that each tuning fork could be heard via air and bone conduction (1). Similar tables existed to report hearing for the voice, or the watch tick. Hartmann’s normative data for tuning forks were eventually called into question. Nonetheless, the desire to have true normative data for hearing persisted, and eventually led to the creation of the audiogram.

While the history of the audiogram itself extends far beyond the first sesquicentennial of the AOS, it may be of interest for the AOS members to know why the audiogram is plotted “upside down,” with regard to hearing thresholds. A more detailed accounting of how this came

to pass was provided by Dr. James Jerger in 2013 (40), and is well worth reading. An abridged version of his article is as follows.

Dr. Edmund Fowler (AOS President 1930), a legendary otologist from the first half of the 20th century, came to work closely with Dr. Harvey Fletcher and RL Wegel. Fletcher was one of the early pioneers in the field of speech and hearing sciences, while Wegel was a physicist who worked predominately with telephones. Fletcher and Wegel designed the first commercially available audiometer in the United States, the Western Electric Model 1-A; this device was subsequently used in the practice of Dr. Fowler. The question then became how to represent the data obtained from the audiometer.

In 1922, Wegel (41) published research demonstrating the range between audibility and the sensation of “feeling.” From data of this sort, Fowler derived that, when intensity was plotted in a logarithmic manner, hearing could be plotted in terms of “sensation units” relative to normal hearing. In this manner, for each frequency the number of “sensation units” could be determined. Then, based on the intensity required to obtain the threshold of audibility, one could determine the percentage loss of sensation units. Thus, this approach gave the physician and the patient the “percentage of hearing remaining” at a given frequency. Notably, early attempts to plot this graphically had 100% at the top, and 0% at the bottom; in other words, better hearing was depicted at the top, and worse hearing at the bottom of the graph, akin to what we see in today’s audiogram. Fowler favored such an approach, as he thought that a percentage of remaining hearing at a given frequency made for an excellent counseling tool with patients. Based on comments from patients even today who ask questions such as “What percentage of hearing loss do I have?”, many audiologists and physicians might concur that such an approach would be useful!

However, Fletcher was a physicist, and argued that a more accurate representation of hearing should convey the units of hearing loss (e.g., pressure levels needed to elicit a response) rather than a percentage. His early presentations on representing hearing levels in this way plotted these pressure levels in a conventional manner (e.g., more intense signals toward the top of the graph, rather than at the bottom). In today’s clinical practice, many audiologists fitting hearing aids would agree that this would be a logical way to plot hearing thresholds, because plotting SPL as a function of frequency is precisely how hearing aids are fit today!

Eventually, Fletcher convinced Fowler to abandon the “percentage of hearing loss” approach to plotting hearing thresholds. Upon doing so, however, he surprisingly did not change the scale along the *y* axis. Rather, he simply shifted the “percentage loss” to “sensation units” and left the zero line at the top of the graph, while renumbering the *y* axis so that increasing amounts of hearing loss were lower. Ultimately, this had the effect of ensuring that the audiogram would forever be “upside down,” with the inverted *y* axis to which we have

become accustomed. Eventually, the concept of sensation units was modified to a decibel notation, which was later converted to the “dB HL” (Hearing Level in dB) that we know today, and the audiogram has since remained unchanged for decades.

Dr. Jerger wisely notes that either Fowler’s original suggestion of “percentage loss” as a function of frequency, or Fletcher’s revision which plotted intensity for hearing threshold in a conventional manner (e.g., more intense signals at the top of the graph) would be preferable to the current plotting of the audiogram. First and perhaps most important, both would preserve traditional plotting of data in which larger values are at the top of the graph, and smaller values at the bottom. Moreover, Fowler’s “percentage loss” approach has great counseling utility for the layperson, while the plotting of SPL as a function of frequency would align hearing thresholds with procedures for fitting hearing aids. The latter approach would also have counseling benefits during the fitting process itself, as it would help both audiologists and patients avoid the “mental gymnastics” sometimes necessary to convert from the existing dB HL graph to a traditional plot of sound pressure as a function of frequency. Given its ubiquity of the audiogram in today’s practice, it is highly unlikely to ever be changed, but it is interesting to consider the possibilities had different decisions been made by Fowler and Fletcher over 80 years ago.

DISCUSSION

Mark Twain was a contemporary of many of the early AOS members, and in a letter to Helen Keller, he wrote, “. . . all ideas are second-hand. . .” In his own autobiography, he expanded on this concept stating, “There is no such thing as a new idea. It is impossible. We simply take a lot of old ideas and put them in a sort of mental kaleidoscope. We give them a turn and they make new and curious combinations. We keep on turning and making new combinations indefinitely; but they are the same old pieces of colored glass that have been in use through all the ages.” When one considers how hearing assessment has evolved since the first 25 years of the AOS, one could readily agree with Twain that “there are no new ideas.” The otologists of that time knew the limitations of their chosen approaches, whether the watch, the voice, or the tuning fork. Leaders of the founder generation of the AOS including Roosa, Buck, Burnett, and Blake each knew that a reproducible signal with true normative data was required to obtain a truly accurate measure of hearing, and they strove to create those norms using the best available tools at that time. Many of the lessons learned from their efforts are still in use today. Ultimately, they were limited by the available technology, and not by their ideas. Rapid technical advancements in the first half of the 20th century ultimately led to significant changes in how hearing was measured. At the same time, however, the goals of those assessments remained unchanged from those of the 19th

century, which are reliable methods for determining hearing acuity via air and bone-conduction, and assessing the ability of the patient to communicate with others.

In many regards, hearing assessment has changed little in the last 60 years. Air- and bone-conduction thresholds, along with word-recognition in quiet, make up the majority of audiologic evaluations, just as they did shortly after widespread implementation of the audiometer. While useful, one could argue that new advancements in technology could again yield to sizable revisions in clinical practice, and frankly, that such revisions are long overdue. One likely shift will involve the desire to better understand the ability of patients to communicate in their everyday environment. Such advancements could come from the simple introduction of speech-in-noise assessment as part of the basic audiologic test battery. However, given improvements in signal processing, such measures may be needlessly simple. For example, it is possible to digitally create virtual auditory environments; this could enable the testing of patients in increasingly realistic environments in an extremely controlled manner. Such assessments could occur within the clinic, or even outside the clinic with improvements in data logging and auditory environment recognition algorithms in both hearing aids, cochlear implants, or perhaps even smartphones.

Such potential advancements in patient assessment are potentially compelling, but it is also possible that there may be a period of time in which hearing assessment outside the sound booth could become as fragmented as the varied approaches used in the 19th century. For example, there are a myriad of smartphone and tablet apps from hundreds of sources, all purporting to provide some measure of hearing acuity. These devices use different approaches, often with little normative data, and unreliable equipment due to different types of headphones in different acoustic environments. Moreover, the proliferation of such apps may well increase given the deregulation and seismic changes about to take place within the hearing aid and “hearables” marketplace. Taken together, audiologists and physicians may need to engage in the realm of hearing assessments not only within, but outside of the sound booth, to provide some order in what looks to be an increasingly chaotic marketplace. Ultimately, our current approaches may seem primitive relative to those in use 150 years from now, particularly with regard to those procedures implemented outside of the physician’s or audiologists’ office. However, Twain’s “kaleidoscope of ideas” that will underlie the new testing procedures are likely to remain unchanged, in much the same way that the principles underlying our current testing procedures echo those from 150 years ago at the beginning of the AOS.

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Women of the American Otological Society

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Objective: To describe the history of women in the American Otological Society (AOS).

Methods: Biographies of the early women of the AOS were compiled through review of the AOS transactions, their published scholarship, newspaper articles, and memorials. Interviews were conducted with the only two women to have led the society and also with former colleagues and family members of pioneering AOS women members who are no longer with us. The evolving gender composition of the society over time was researched from AOS membership lists and compared with data on surgical workforce composition from multiple sources such as the Association of American Medical Colleges, Accreditation Council for Graduate Medical Education, American Medical Association, and the American Academy of Otolaryngology—Head and Neck Surgery.

Results: Although American women specialized in otology as far back as 1895, the first woman to be invited to join the AOS as Associate member in 1961 was Dorothy Wolff, PhD. The first female full member was otologic surgeon LaVonne

Bergstrom, M.D., who was elected in 1977, 109 years after the foundation of the Society. As of 2017, only two women have served as AOS President. The first was Aina Julianna Gulya, M.D., who took office during the 133rd year in 2001. At the time of the sesquicentennial (2017), 7.5% of AOS members are women including three of eight who serve on the AOS Council. This compares with 15.8% of women among the otolaryngology workforce and a growing 10.9% representation among those who have earned subcertification in neurotology.

Conclusion: Gender disparities remain in the AOS, but both participation and scholarly contributions by women in otology have grown substantially since the society's inception 150 years ago, and particularly in the 21st century. Increasing the presence of women in leadership provides role models and mentorship for the future. **Key Words:** American Otological Society—Female surgeon—History of otology—Women.

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In honor of the American Otological Society's (AOS's) 150th anniversary, this article recollects the stories of the earliest women members, and tracks the progress of women in the society. Unlike the American Medical Association (AMA), which was founded in 1847 and admitted women by 1909, and the American College of Surgeons, which both was founded and admitted women in 1913, the AOS remained an all-male institution for nearly a century. In recent times, it has accepted and occasionally promoted female members, paralleling the slow increase in women across numerous surgical subspecialties. We found it interesting to trace the stories of pioneering women in the AOS and otology as a field, reflecting on where we are today, and how we got there.

METHODS

Primary sources for this article include the meeting minutes and Transactions of the American Otological Society, publications written by or about AOS women, obituaries from the medical literature, and newspaper articles. Contemporaneous journal articles as well as archives from the Drexel University Legacy Center (available at <http://archives.drexelmed.edu/>), which houses collections from the historical Women's Medical College of Pennsylvania, were used to detail Dr. Musson's life.

The authors are also grateful to the friends and family of AOS women who provided remembrances and photographs, including: Dr. Dennis Trune (colleague of Dr. Catherine Smith), Suzanne Linde (niece of Dr. Catherine Smith), Dr. Elliot Abemayor (student of Dr. LaVonne Bergstrom and of Dr. Ruth Gussen), Timothy and Leticia Johnson (nephew and sister of Dr. LaVonne Bergstrom, respectively), and Jim Gussen (son of Dr. Ruth Gussen). Interviews were conducted with the two women who have had the honor of serving as AOS President: Dr. Aina Julianna Gulya (2001) and Dr. Debara Lyn Tucci (2016).

Statistics regarding the gender composition of the society were tabulated from historical AOS membership lists. Information about medical student, otolaryngology trainee, and current physician gender distributions were compiled from resources from the Association of American Medical Colleges,

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the Accreditation Council for Graduate Medical Education, the AMA, the American Board of Otolaryngology, and US Department of Education National Center for Education Statistics. The American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) provided current membership statistics.

Attitudes Toward Women Entering Medicine During the 19th and Early 20th Century America

In the late 19th century, women were often relegated to working at women's or children's hospitals, or as medical assistants. The few who did complete medical training faced significant hardship and were often looked down upon. Dr. Eduard Hofrath, Professor of Surgery in Vienna, published a monograph that reflected many views from that time: "Medical practice requires power of thought and the capacity for work. Few male students unite both gifts, and how much fewer, the Professor asserts, the female students, in whom thought is so inextricably mixed with emotion (1)."

The earliest formally trained American female physicians, such as Dr. Elizabeth Blackwell, attended otherwise exclusively male medical schools (2). Blackwell was rejected from 20 medical schools before acceptance to one in New York, Geneva Medical College, which allowed her entrance after a vote by the students (3). It was not until the mid-1800s that the first medical schools for women were founded: the New England Female Medical College in 1848, and the Woman's Medical College (WMC) of Pennsylvania in 1850 (4,5). Many prominent American medical schools were reluctant to admit women. In 1893, Johns Hopkins included three women in its first medical school class, but only because of financial need: in donating the \$500,000 requisite to open the school, four of the original University trustees' daughters—Martha Carey Thomas, Mary Elizabeth Garrett, Elizabeth King, and Mary Gwinn—stipulated that qualified women must be admitted (6). Harvard Medical School did not admit women until 1945 (7). Jefferson Medical College (now known as Sidney Kimmel Medical College) had its first class with women only in 1961 (8).

The Corporation of Harvard College and its Professors in the Medical Department almost admitted their first woman in 1850; however, the students petitioned the faculty:

Resolved, That no woman of true delicacy would be willing, in the presence of men, to listen to the discussion of the subjects that necessarily come under the consideration of the student of medicine.

Resolved, That we are not opposed to allowing woman her rights, but do protest against her appearing in places where her presence is calculated to destroy our respect for the modesty and delicacy of her sex (9)."

First American Female Professor of Otolaryngology: Dr. Emma Elizabeth Musson (1861–1913)

A handful of women specialized in otology nearly a century before the first female AOS inductee. Dr. Emma Elizabeth Musson was recognized as the nation's first female Professor of Otolaryngology in her memorial published in the *Journal of the American Medical Association* (see Fig. 1) (10). Born in Coburg, Canada, she graduated with honors from the WMC in 1883. After a general internship, she spent several years study in the anatomy and physiology labs before her appointment as Clinical Professor of Laryngology and Rhinology in 1893. In 1895, she succeeded Dr. Charles H. Burnett (AOS President 1884–1885) as Professor



FIG. 1. First female Professor of Otolaryngology. Dr. Emma Musson became the first female Professor of Otolaryngology in 1895, serving at the Woman's Medical College of Pennsylvania. Photo courtesy of Drexel University Legacy Center.

of Otolaryngology, and subsequently resigned her other two posts, indicating her dedication to otology (11).

Musson was known for her devotion to her craft and to her students. Dr. A. Helena Goodwin wrote, "She spent hours in study, hours in the dissecting room, her clinics were her laboratory, her surgical methods were developed under keen criticism. . . . Among the students at the College her work was a sacred duty to her. . . and through weariness and weakness often, but with cheerful courage, she gave them of her all (12)."

"She was one of those quiet, hardworking, modest woman [*sic*] whose entire pleasure lies in doing. . . . Dr. Clarence J. Blake [AOS President 1877–1878], the leading Boston aurist, and other physicians sent her many patients. . . . She had reached the age of 52 years, and had won the respect of all the men of her profession, and clearly demonstrated what lies in the power of women. There was no aggressiveness about her, no undue desire for fame, no self-seeking effort, no forging ahead to reach the limelight; but she seemed to be consumed with a yearning to serve, and serve she did to the very last," wrote Sallie Wistar, a regular author in the local newspaper (13).

Dr. Musson was a member of the AMA and Medical Society of the State of Pennsylvania. She held leadership positions in the Philadelphia Clinical Society and Philadelphia County Medical Society. She presented and wrote numerous articles, covering topics from "The Deaf Child," (14) to "Anomalies of Lateral Sinus, Mastoid Emissary Veins and Internal Jugular Veins," (15) to "Labyrinthine Deafness" (16) to "The Endoscopic Treatment of Bronchiectasis" (17). She was known to

have operated on children as young as 6 months (18), and performed surgery up until the week before she died: “Just 1 week before she died, already feeling most ill, she performed a radical mastoid operation on a patient, who is recovering while she lies dead.” (13)

Musson was not known to have married or have children. After her passing from pneumonia in December 1913, an operating room dedicated to surgeries of the ear, nose, and throat was named in her honor at the WMC (10). The WMC alumnae association also established the Emma E. Musson Scholarship in Otolaryngology for \$700 (nearly \$17,000 in today’s dollar) (19). Even though she was one of but a few American surgeons to hold the title of Professor of Otolaryngology, was a productive otological scholar, and was well known to AOS Presidents Blake and Burnett, Musson never became a member of the AOS. This was not likely a circumstance of her choosing, but rather reflected the bias of her time.

Biographies of the Pioneer Women in the AOS and Their Contributions to Otolaryngology

1961: First Associate Member—Dorothy Wolff, PhD (1895–1980)

Dr. Dorothy Wolff was the first woman admitted into the AOS, albeit as an Associate Member (see Fig. 2A). Noted temporal bone anatomist and pathologist, she instructed scores of budding otologists through her work at the Lempert Institute of Endaural Surgery, a private hospital and research institution in New York City. Born in Pueblo, Colorado in 1895, Wolff was reared in Pennsylvania. She completed her undergraduate studies at Smith College, and her master’s degree at the University of Michigan. She conducted temporal bone research for her PhD thesis at Washington University, St. Louis under the direction of Dr. L.W. Dean (AOS President 1932). She also had an honorary doctorate of science from the University of North Carolina.

Wolff worked at the Johns Hopkins temporal bone laboratory before accepting a position at the Lempert Institute. There she gave lectures on ear histopathology to all those learning the fenestration operation from Dr. Julius Lempert. In 1955, she moved to the Manhattan Eye, Ear, and Throat Hospital where she continued her research on otosclerosis, at times in partnership with otologist Dr. Richard Belluci (AOS President 1981). In a memorial he wrote for her, Belluci was effusive in his praise: “Dr. Wolff became a very important figure in American otology... Her scientific expertise was widely acknowledged and her research was well received as it was

always honest and well done. Above all she will be remembered for her kindness to her students, her eagerness to provide tutelage, and the demonstration of her tireless enthusiasm which was inspiring to all who knew her.” (20)

In his 1978 Guest of Honor speech, Dr. Howard House (AOS President 1966) remarked that his “first exposure to basic research was provided in 1938, by Dr. Dorothy Wolff... It was there that I saw my first microscopic section of a human temporal bone.” (21) In her 1961 AOS nomination, Dr. Philip Meltzer (AOS President 1950) confirmed her widespread renown: “I would like to present Dr. Dorothy Wolff, whom you all know, and who needs no further introduction or words from me.”

She and Dr. Lempert were awarded a gold medal by the AMA for their teaching exhibit on the fenestration operation. Wolff wrote and coauthored numerous textbooks on the anatomy of the temporal bone, including *Microscopic Anatomy of the Temporal Bone: A Photographic Survey* (22), *Surgical and Microscopic Anatomy of the Temporal Bone* with Belluci and Dr. Andrew Eggston (23), and *Histopathology of the Ear, Nose, and Throat* with Eggston (24).

Wolff passed away in January 1980 at the age of 84. Belluci wrote of her, “In the course of the many years devoted to study and teaching of ear anatomy and pathology, she received great respect and became close friends with many otologists in this country and abroad. Her friendly, cheerful, and energetic personality won her great admiration and inspired all who knew her to higher achievement.” (20)

1962: Second Associate Member—Catherine Smith, Ph.D. (1914–2005)

Dr. Catherine Agnes Smith was a renowned inner ear researcher, known especially for her expertise in electron microscopy and cochlear electrophysiology (see Fig. 2B). She was born in 1914 in St. Louis, Missouri to S.P. Smith, a grocer, and his wife Rosa.

She originally aspired to be a social worker, but during a home visit with a fellow student, she was told she missed much of the conversation, and might be suffering from hearing loss. Smith was recommended to see an otolaryngologist, and consulted with Dr. Max Goldstein (AOS President 1928 and founder of the journal *Laryngoscope* 1896), who diagnosed otosclerosis. At the time, around 1933, surgery was not recommended due to the risk of lethal infection. Goldstein counseled that she might consider a career that relied less on communication. As her best grades were in science, he



FIG. 2. Pioneering Associate Members. A, Dorothy Wolff, Ph.D., was the first female associate member, joining in 1961. B, Catherine Smith, Ph.D., was the second female associate member, and joined in 1962. C, Pathologist Ruth Gussen, M.D., was the third female associate member, and joined in 1977.



FIG. 3. American Otological Society group photograph from the 1971 annual meeting held in San Francisco. Dr. Catherine Smith (associate member) was the only woman. (Seated in the fourth row.) This image well illustrates the lack of gender and ethnic diversity typical of the Society a few years after its centennial. (Photo courtesy of Dr. Dennis Trune.)

recommended she become a laboratory technician, which she did following her graduation from college from Washington University in St. Louis in 1935.

After World War II and the development of antibiotics, Smith consulted with Dr. Theodore Walsh (AOS President 1964, Otolaryngology Chair at Washington University St. Louis, and Laryngoscope editor). She underwent a unilateral one-step fenestration operation, which significantly improved her hearing. She subsequently completed her Master of Science (1948) and Ph.D. (1951) in anatomy at Washington University St. Louis, working in the Department of Otolaryngology. After her graduation she joined the faculty there, as well as at the Central Institute for the Deaf, researching cochlear electrophysiology. In addition to her pioneering work on the anatomy of the inner ear, she was the first to discover and describe the electrolytic characteristics of the endolymph: that its ionic composition resembled that of intracellular fluid, and not of interstitial fluid or cerebrospinal fluid (25).

In 1958, Smith received a foreign research travel grant from the National Institutes of Health, and spent 2 years at the Karolinska Institute in Stockholm, Sweden. There she adapted electron microscopy techniques to the study of the ear. She was later recruited to Oregon Health and Science University in 1969 as part of the burgeoning Kresge Hearing Research Laboratory (now known as the Oregon Hearing Research Center).

In 1962, Smith was nominated by Walsh (her surgeon and Chair) to associate membership in the AOS. After the reading of all the nominated candidates for the year, Secretary-Treasurer Dr. James A. Moore (AOS President 1967) announced, "The Council recommends, on the basis of your vote, the election of

these men to membership in our Society." The AOS transactions then records a voice from the gallery interjecting, "And one lady." Moore then confirmed, "And one lady." (see Fig. 3) (26)

In 1975, Smith received the society's highest honor, the AOS Award of Merit. When presented by Dr. John Bordley (AOS President 1971), he said that the Committee's "choice was not made on the awardee's superb research alone... During her career she has inspired countless young doctors to explore the delights of research. She has been a gentle and wise counselor, listening patiently and speaking softly with words of great wisdom to many of us facing perplexing questions in Otolaryngology." Acknowledging that she was the first woman to receive the award, Bordley quipped that all previous recipients had been bald with an average waist size of "52 inches" (27). She was also awarded the Shambaugh Prize by the Collegium Oto-Rhino-Laryngology in 1977, and the Association for Research in Otolaryngology Award of Merit in 1980.

Smith had numerous interests outside of her work, including bird-watching, wild flowers, and travel. She did not marry or have children. She passed away September 27, 2005 in Lake Oswego, Oregon at the age of 91.

1977: First Active Member—LaVonne Bergstrom, M.D. (1928–2001)

Dr. LaVonne Bernadene Bergstrom was an otolaryngologist who took special interest in pediatric disease and genetic malformations (see Figs. 4 and 5). As an otologic surgeon, she became the AOS's first female Active Member in 1977. Born in 1928 in Erskine, Minnesota, she was the oldest of four



FIG. 4. The first female active member of the AOS, LaVonne Bergstrom, was inducted in 1977. Photo courtesy of Timothy Johnson. AOS indicates American Otological Society.

children. She graduated as valedictorian from Wadena, Minnesota High School. At the University of Minnesota she studied journalism before completing her medical degree at the University of Minnesota Medical School in 1953.

Before specializing in otolaryngology, Bergstrom spent several years after internship working as a general practitioner in Embudo, New Mexico (1958–1961), then as Medical Director of the Sangre de Cristo Medical Unit in San Luis, Colorado (1961–1965). Bergstrom served as the single physician in the 1215 square miles that was Costilla County, Colorado, an impoverished, underserved area. Her clinic waiting room was often standing room only. As the only doctor in town, she served multiple unconventional roles: draft board examiner, coroner, and ringside physician at local prize fights. Her schedule was so demanding that she would dictate her notes while driving in her Rambler on her way to the hospital or house calls.

Bergstrom then pursued residency in otolaryngology at the University of Colorado, Denver (1965–1969). Following the completion of her training she joined the faculty there until 1975 when she was recruited to the University of California, Los Angeles (UCLA). With her experience as a family practice doctor, Bergstrom understood the importance of coordinated care and treating families, not just diseases. “Dr. Bergstrom taught you to be a doctor. And by that I mean a healer—she did it in the sense of treating the family. She taught you to understand and appreciate that your nonsurgical intervention can be just as curative, just as empowering, and just as important as doing a neck dissection and curing a patient that way,” said UCLA Professor of Head

and Neck Surgery Dr. Elliot Abemayor, who trained as Bergstrom’s resident. At UCLA she started one of the first unified craniofacial clinics on the west coast. Her experience treating Spanish speaking families in San Luis was an asset: she volunteered with the Hope for Hearing Foundation in Los Angeles, even translating pamphlets for parents of hearing impaired children into Spanish.

In addition to her charitable work, Bergstrom was an academic pioneer. She authored numerous articles and chapters on the otologic manifestations of congenital disorders. Her work at the University of Colorado with rheumatologist Dr. Alan Rosenberg studying a family with autosomal recessive renal insufficiency, ataxia, and sensorineural deafness, was eponymized as the Rosenberg–Bergstrom syndrome (28).

Bergstrom served as vice president of the American Bronchoesophagological Association and president of the American Auditory Society. She won the Fowler Award in 1977 for best Triological Society thesis for her work, “Osteogenesis Imperfecta, Otologic and Maxillofacial Aspects.” (29) That same year she was elected to the AOS, nominated by Dr. Irwin Harris and seconded by Dr. William Hemenway, both also affiliated with UCLA. She became an Emeritus AOS member in 1992. Other professional memberships included the American Academy of Pediatrics, the AAO-HNS, and the American Neurotology Society.

Bergstrom was known not only for her encyclopedic knowledge, but also for her inquisitive nature. Her nephew Timothy Johnson, special collections and rare books curator for the University of Minnesota Libraries, reminisced, “She had an excitement about research and higher education, a natural curiosity with a sense of playful adventure that was contagious.” Bergstrom prioritized spending time with her family despite her busy work life. Known as “Dene” to close friends and family, she loved taking her nephew and friends on camping trips, hiking, biking and “big adventures,” as her sister Leticia Johnson recalled. She had a fine soloist’s singing voice, and always a recommendation for something to read.

Bergstrom retired as Professor from UCLA in 1989. She did not marry or have children. She was diagnosed with Pick’s Disease (frontotemporal lobe dementia), and passed away in January 2001 at the age of 72.

1977: Third Associate Member—Ruth Gussen, M.D. (1925–2003)

Dr. Ruth Gussen was a temporal bone pathologist who joined the AOS in 1977 (see Fig. 2C). Born and raised in New York City, her parents were both Jewish immigrants from Eastern Europe. As a child, she greatly admired her older brother, Raymond Marcus, who went on to become an internist. She attended Cornell University for her undergraduate degree, and also completed medical school there in 1950. She subsequently moved to Los Angeles, California with her husband, Dr. John Gussen, a psychiatrist at the University of Southern California. She was recruited in 1966 by Dr. Victor Goodhill (AOS President 1976) to direct the UCLA Temporal Bone Laboratory, and attained the rank of Professor in the Departments of Pathology and Surgery.

Gussen’s favorite book as a youngster was *Microbe Hunters*—and indeed, she spent a prolific career hunting ear disease on the microscopic level (30). She published on a variety of otologic processes, from otosclerosis to sudden deafness, endolymphatic hydrops to congenital abnormalities. Ever rigorous in her studies, she was quoted as saying, “I enjoyed more working with problems than dealing with people.” (31) One of few



FIG. 5. A, Dr. LaVonne Bergstrom and her dog, Chico, taken at the Sangre de Cristo Medical Unit at San Luis, Colorado, where Dr. Bergstrom served as Medical Director. Photo taken by Mary Ann Gehres, courtesy of Timothy Johnson. B, Dr. Ruth Gussen examining a pathology slide in her office at the University of California, Los Angeles. Photo courtesy of Jim Gussen. C, Dr. A. Julianna Gulya with Dr. Gene Derlacki and Dr. Howard House. Photo courtesy of Dr. Gulya. D, Catherine Smith receiving the award of merit in 1981 from the Association for Research in Otolaryngology, pictured with Hallowell Davis, Harold Schuknecht and Ben Senturia. Photo courtesy of Dr. Dennis Trune. E, Dr. Debara Tucci operating under the microscope. Photo courtesy of Dr. Tucci. F, Dr. Emma Musson. Photo courtesy of Drexel University Legacy Center.

women in the field, and of the even fewer professional women to have had children at the time, Gussen often brought her son, Jim, to her laboratory. Jim recalls being fascinated by her microtome as a child, once finding himself in the back of the room during an autopsy course at only age 10. Abemayor, who first met Gussen when he was a resident, remembers her as “an incredible teacher. She was incredibly generous with her time and with her effort—even as a senior member of the faculty.”

Following her retirement at age 59, she became the president of UCLA’s PLATO society, an organization of retirees who gathered to share their interests in life-long learning. In particular, Gussen was known for imparting her love of reading, opera, and travel. She even combined her interests with a trip to Bayreuth, Germany to see operas from one of her favourite composers, Richard Wagner. She developed many deep friendships, and it was said that she “radiates a natural warmth that reels people into her circle with only a smile as her lure.” (31) Gussen died in 2003 from cancer.

2001: First AOS President—Aina Julianna Gulya, M.D.

Dr. Aina Julianna Gulya was inducted into the AOS in 1991 as its second female Active Member (see Fig. 6A). She was born in Syracuse, New York in 1953. Gulya’s father, Aladar, had been a thoracic surgeon in Hungary before immigrating to the

United States. He invented several procedures and devices for tuberculosis surgery, which was common in the 1930s before the advent of antibiotic therapy. Gulya’s mother, Sylvia, had worked in rocket circuitry with Wernher von Braun, which prompted Gulya to recall: “Perhaps I got my fine motor manipulation skills from her.”

Gulya completed her undergraduate degree at Yale in 1974 *cum laude*, and her medical degree at the University of Rochester with Distinction in Research in 1978. She initially aspired to be a surgical oncologist, and began internship in general surgery at Beth Israel Hospital in Boston. While there, she gained her first exposure to otolaryngology from trainees from the Massachusetts Eye and Ear Infirmary (MEEI), and was impressed by their joy and love of their craft. She subsequently switched tracks and entered otolaryngology residency at MEEI. At the time, she was the single female resident out of 18, and only the third woman ever to have entered residency at MEEI. She found fascinating the temporal bone histology work of Dr. Harold Schuknecht (AOS President 1977), then Chair of the department. In 1983, she became Dr. Michael Glasscock’s (AOS President 1992) first female otology-neurotology fellow, in Nashville, Tennessee.

Following her fellowship, Gulya and her husband, otolaryngologist Dr. William Rosser Wilson, became founding members of the newly formed Division of Otolaryngology at George Washington University. Gulya later joined the faculty at



FIG. 6. The two women Presidents of the AOS: (A) Dr. A. Julianna Gulya (2001) and (B) Dr. Debara Tucci (2016). AOS indicates American Otological Society.

Georgetown University before becoming the first chief of the National Institute on Deafness and Other Communication Disorders' new Clinical Trials branch in 1996.

Gulya recalls sitting in the audience at the AOS before her induction into the society: "I barely thought I would be a member of the Otological, let alone be the President. It was beyond my wildest dreams. I was delighted." Shortly after she was nominated in 1991, she was inducted into the AOS council in 1994. She then was appointed Editor-Librarian, and rose to President in 2001. During her stewardship of the society, she championed research in the field, and integrated the research fund more closely into the operations of the AOS. Gulya was honored with the Triological Society's Presidential Citation in 1999, the AAO-HNS's Distinguished Service Award in 2001, and the NIH Merit Award in 2004. She served as Associate Editor of *Otology & Neurotology* (previously known as *American Journal of Otology*) and as a member of the executive editorial board of the *Otolaryngology-Head and Neck Surgery*.

Perhaps her best-known publication is *Anatomy of the Temporal Bone with Surgical Implications*, published in three editions between 1986 and 2007 with Schuknecht and Gulya (32). When she initially proposed the idea for this text to Schuknecht, she was told "No, not at all, not a good idea." However, through her own determination and hard work, she put together a pamphlet to teach her fellow residents, organizing the plethora of temporal bone (histo)photomicrographs in the MEEI collection. She went back to Schuknecht, who then agreed to come on board; and her pamphlet would later become a seminal text in otologic training.

Gulya offers advice to the budding otolaryngologist: "The one thing is—and it's really corny but true—it's do what you say, and say what you do. Excuses don't get the job done." She is now enjoying retirement with her husband, step-children, and grandchildren.

2016: Second AOS President—Debara Lyn Tucci, M.D., M.B.A., M.S.

Dr. Debara Lyn Tucci is the fourth female Active Member of the AOS, and the Society's second woman President (see Fig. 6B). Having started her career as a clinical audiologist, she completed medical school at the University of Virginia in 1985, already knowing her goal was to be an otologist. She pursued otolaryngology residency at the University of Virginia and did her fellowship in otology-neurotology at the University of Michigan. Later in her career, she obtained her Master of Business Administration at the Duke University Fuqua School of Business in 2013.

Tucci served on the AOS Research Grants Board of Trustees from 2001 to 2008. She was AOS Editor-Librarian from 2010 to 2012, and AOS Education Director from 2013 to 2015 before rising to President in 2015 to 2016. She was also President of the American Neurotology Society from 2005 to 2006, and President of the Association for Research in Otolaryngology from 2011 to 2012. She has served on the US President's Council, advising on Hearing Devices, and advises the US Food and Drug Administration. She was awarded the AAO-HNS Foundation's prestigious Jerome Goldstein Public Service Award in 2017.

Her Triological Society thesis, "Conductive hearing loss results in a decrease in central auditory system activity in the gerbil," won the Edmund Prince Fowler Award in 1998. She is Professor of Otolaryngology Head and Neck Surgery at Duke University, and continues her leadership as part of the AOS council as Past President. She and her husband, neurologist Kevan VanLandingham, M.D., Ph.D., have three children.

In advising young physicians she notes: "I would advise them to do what they love, and to find a way to devote as much

TABLE 1. Female membership in the American Otological Society

#Women/Total Members	Active or Senior	Emeritus	Associate
2017 (150th yr)	13/174	1/58	5/27
1992 (125th yr)	1/192	1/3	4/38
1967 (100th yr)	0/126	0/1	2/15

time to do that as they want, and to still have time for their family life and personal life. It’s a hard thing to do, but I think that people who are happy find a way to balance the two. I’ve always said “yes,” maybe more often than I should of. I think that if you say “yes” to things, that it opens more doors that would not have been open otherwise. Be as involved as you can possibly be. Be as aggressive as you can be in pursuing things that make you happy.”

Progression of Women in the AOS Over the Last 40 Years (1977–2017)

Female membership has slowly been increasing since the first female Active member was admitted to the AOS in 1977. While only 0.05% (1/192) of Active or Senior members were female at the AOS’s 125th anniversary, this has risen to 7.5% (13/174) at its 150th anniversary (see Tables 1 and 2). Meanwhile, in recent years, women have increasingly participated in AOS leadership. As of 2017, three of eight council members are female: Dr. Carol Bauer (Education Director), Dr. Sujana Chandrasekhar (Secretary-Treasurer elect and Past President of the AAO-HNS), and Dr. Tucci (Past President) (see Fig. 6B).

Trends of Women in Otolaryngology—Neurotology Workforce and Training Pipeline

According to the AMA, 34.0% of all practicing physicians in 2015 were women. Their distribution in various specialties has been skewed: women are more likely to practice primary care, and the fields of pediatrics and obstetrics/gynecology have the highest proportions of women (see Fig. 7). In 2015, 15.8% of practicing otolaryngologists were women, with a similar percentage (17.4% in 2017) comprising the membership of the

TABLE 2. Proportions of females in medical, otolaryngological, and otological training and practice

	Women/ Total	(Percentage)
Medical school ¹	10,474/21,030	(49.8%)
Otolaryngology residency ²	534/1,472	(36.3%)
Otolaryngology practicing physicians ³	1,485/9,405	(15.8%)
AAO-HNSF US members ⁴	1,712/9,852	(17.4%)
Neurotology subspecialty certification ⁵	34/313	(10.9%)
AOS membership (active, senior, emeritus, associate) ⁶	19/259	(7.3%)
AOS membership (active, senior) ⁶	13/174	(7.5%)

Sources: 1. 2016 Association of American Medical Colleges, 2. 2015 Accreditation Council for Graduate Medical Education, 3. 2015 American Medical Association, 4. 2017 American Academy of Otolaryngology—Head and Neck Surgery, 5. 2016 American Board of Otolaryngology, 6. 2017 American Otological Society.

AAO-HNSF indicates American Academy of Otolaryngology—Head and Neck Surgery; AOS, American Otological Society.

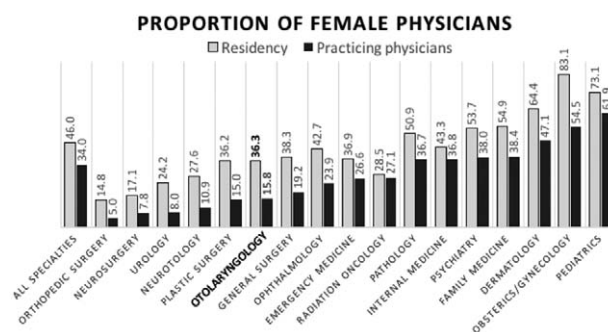


FIG. 7. Proportion of female physicians in residency and clinical practice, by specialty.

AAO-HNS (see Fig. 7, Table 2). In comparison, in 1980, less than 1% of practicing otolaryngologists and 23% of medical graduates were women (33).

An even lower percentage of female otolaryngologists represent those with neurotology subcertification. As of 2017, 34 of 313 diplomats, or 10.9%, were women (see Table 2, Fig. 8A). This proportion has been steadily increasing since the first-year neurotology certificates were granted, in 2004, when it was 2.6%.

Gender parity in neurotology training lags behind that in otolaryngology residency, and far behind what is observed among medical students. As of 2017, 49.8% of all medical students are women (34). The increase in female medical students, especially marked since the 1970s, parallels the rise of women in other professional fields such as law and dentistry, as tracked by the US Department of Education (see Fig. 8B) (35). The proportion of females comprising otolaryngology residents in 2016 was 36.3% (36). Additional data on neurotology and pediatric otolaryngology trainees is available, as these are the only two Accreditation Council for Graduate Medical Education regulated fellowships. Since 2008, the proportion pursuing pediatric fellowship has on average been higher than that in residency. In contrast, the proportion pursuing neurotology training has on average been lower, at 16.7 and 27.6% in 2016 and 2017, respectively (see Fig. 8C) (36).

DISCUSSION

Founded in 1868 by nine men, it took nearly 100 years before the first woman was elected into the AOS. The first women were preeminent researchers in the anatomy and physiology of the ear, and were allowed to join only in a limited capacity as associate members who could neither vote nor propose new members. This is in contrast to the American College of Surgeons, which admitted women in its founding year, in 1913. The first female otological surgeon to be invited as a full member was Dr. LaVonne Bergstrom in 1977 during the Society’s 109th year. Dr. A. Julianna Gulya became the first woman to serve as AOS President in 2001, the Society’s 133rd year. Although only 7.5% of AOS members are women, during this sesquicentennial year 10.9% of those with subcertification in Neurotology are women, and a more robust 27.6% of neurotology fellows training in 2017 are female.

To help understand the progression of women entering otology, it is of interest to explore the patterns of women

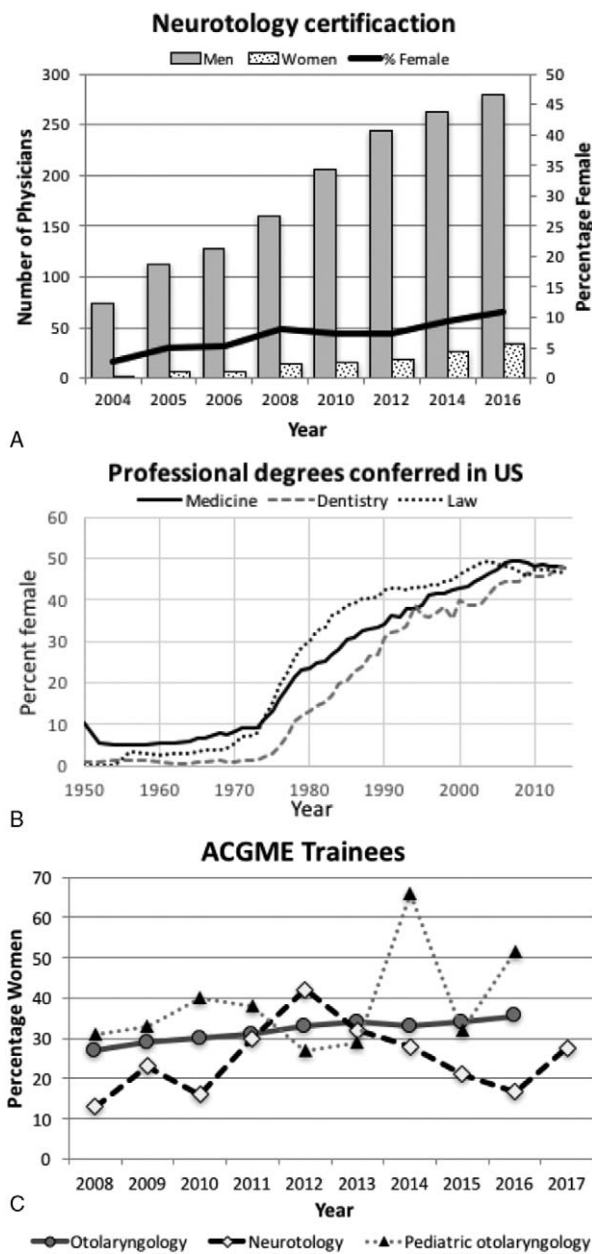


FIG. 8. A, Number of men and women with neurotology sub-certification through the American Board of Otolaryngology. B, Proportion of professional degrees attained by women in the United States over time. C, Proportion of Accreditation Council for Graduate Medical Education (ACGME) otolaryngology trainees over time.

entering surgical fields and the factors influencing their career choices. Contrary to commonly held beliefs, the historical record shows that women held prominent roles as surgeons from ancient times through the middle ages (2). In the 15th century, it was said that a surgeon needed: “the mind of Aesculapius, the eye of an eagle, the heart of a lion, and the hands of a woman.” (37) Nevertheless, in 1540 Henry VIIIth proclaimed that: “no carpenters, smiths, weavers, or women should practice medicine.”

(38) This led to the exclusion of women from the Guild of Surgeons. From colonial times through the early 19th century, few women in America were trained in surgery. With the opening of women’s medical colleges in the mid-19th century, a handful of women entered surgical professions.

Beginning in the last quarter of the 20th century, and continuing into the 21st, as the number of women in medical school classes has approached parity with men, representation of women in surgical fields has steadily risen. Representation among surgical specialties is maldistributed, however, with a greater fraction among obstetrics and gynecology and ophthalmology, and fewer in urology, orthopedics, otolaryngology, cardiothoracic, and neurological surgery (37). The challenges of being accepted as a woman in a male-dominated profession were well articulated by Dr. Jo Buyske, Associate Executive Director of the American Board of Surgery in her 2005 editorial: “Most women surgeons of my era, and certainly those before, have spent our careers being as sexually invisible as possible while attending to the business of learning and practicing surgery. The goal was to be accepted as a surgeon, not a woman surgeon. Now, to be a surgeon and thrown into the spotlight as *women* is blinding. Being asked to write this editorial made me both proud and uneasy. Talking about it with my colleagues, friends and husband (a male surgeon) has been uncomfortable. Are there issues? Is discussing them not just a form of whining? And yet, as I review the literature and ponder my assignment, it is obvious that there are deep and complicated issues that have very real implications for the future of our field.” (39)

Some of the issues that remain include under-representation in surgical specialties such as otolaryngology, which is especially noteworthy in otology-neurotology. Disparities in compensation and academic faculty rank between men and women are certainly factors, and these are, regrettably, prevalent in most medical specialties. Trying to understand the drivers of these differences is important to developing female role models for future generations. In addition, addressing matters traditionally thought of as “women’s issues,” such as cultural and institutional barriers to work-life balance or child care, will benefit both men and women. Examples include availability of parental leave, on-site daycare with hours amenable to a surgeon’s schedule, and flexibility for what Borman in 2007 characterized as: “personal or family serious illness (including complicated pregnancies and neonatal crises), divorce, and death [which are] stressors that defy gender.” (40) Tucci notes, “It’s probably been a culture change for both sexes that parents want to be at their kids’ events after school more, or want to be able to contribute to their kids’ lives in a way that people may not have done in the past.”

Just as one’s personal reasons for choosing a specialty may be myriad, pinpointing the reasons why women disproportionately enter some fields over others is complex. Dr. Jeffrey Flier, former Dean of the Faculty of Medicine at Harvard posited whether lifestyle

considerations might be a contributor: “Over the past 70 years, the previously dominant role of women in child care and family matters has evolved to reflect greater equality, but still differences persist. These ongoing, but highly variable, disparities of external responsibility may explain in part why women physicians gravitate toward fields seen as hospitable to work-family and work-life balance with shorter workweeks, more predictable schedules and greater potential for part-time status.” (7) Work hours alone, however, cannot explain why fewer female medical students pursue otolaryngology. A 2011 study found that over an entire year, otolaryngologists worked an average of only 24 hours more than family practitioners and an average of 85 hours less than medical internists (41). Arguably, the field of otology-neurotology might expect more favorable work/life balance, and thus *more* women than otolaryngology, as there are fewer emergencies and more outpatient procedures, compared with other subspecialties.

Financial compensation for female physicians continues to trail behind that for male counterparts, even in studies that adjust for age, academic rank, specialty, work hours, spousal employment, years of experience, NIH funding, publication count, and total Medicare payments (42,43). Jena et al. (43) found that among physicians at public universities, women earned \$51,315 less than men annually. After multivariate adjustment, this difference persisted, with a difference of \$19,878 (43). While they did not calculate salary differences specifically in otolaryngology, surgical subspecialties demonstrated the largest salary difference of \$76,457, which persisted after multivariate adjustment at \$43,728. In contrast, in radiology, men’s salary only exceeded that of women by \$863. After adjustment, radiology was the only field in which women earned more than men, by \$2,378. Tucci noted that one way to address wage differences is to arm oneself with information. In addition to departmental transparency and having models of compensation that are not subjective, she notes that: “the AAMC publishes information about average salaries for academic and private practice by area of the country. It’s important to have that information, and it’s important to stick up for yourself. It could be if there’s a discrepancy, men are asking for raises and women aren’t. Women have a tendency to undervalue their contribution.”

A key factor which inspires women to enter surgical fields is the availability of women at senior levels to serve as role models and mentors. The ascent of women to senior leadership roles in surgical fields has been notably slow paced. The first woman Chair of the American Board of Surgery was not until 1994 (Patricia Numann, M.D.) and the first woman to lead the AAO-HNS was in 2003 (Jennifer Derebery, M.D.). In the US, regional differences may play a role; the first woman member of the Southern Surgical Society was not inducted until 2011. Presently in otolaryngology many perceive an imbalance between women in residency and junior faculty positions, and those in leadership roles. As noted by Johnson, while there might not be a “glass ceiling” in

otolaryngology, “organizational cultures favor men through mentoring and networking.” (44) In 1980, less than 1% of practicing otolaryngologists were women and virtually none were in senior academic ranks (33). By 2010, women represented 11% of otolaryngologists (13% including residents) and generally had achieved proportionate representation in leadership positions when adjusted for age distribution (45). Nevertheless, without compensating for age to adjust for the higher fraction of women in otolaryngology who are earlier in their careers, representation of women in leadership roles remains relatively low. For example, in 2017, only 2 of the 17 (11.7%) Directors of the American Board of Otolaryngology are women. With 36.3% of women in otolaryngology residency in 2016, engagement of women in leadership development programs and active recruitment of women to specialty leadership roles should be a policy priority for incumbent leaders.

In academia, women have been at a disadvantage in career progression. Among physicians with academic appointments, women are less likely to be promoted to full professorship, even when accounting for age, experience, specialty, and research productivity (46). One reason for this may be that while male and female faculty publish similar numbers of articles over their careers, men have been found to be more productive early on, while women more productive at more senior levels (47). Eloy et al. (48) found this to be true among otolaryngologists: in their study of 20 academic otolaryngology departments, male otolaryngologists had higher research productivity at junior academic ranks, while women were higher at senior ranks, as measured by the *h-index*, calculated from an individual’s number of published articles and citations. A second reason may be relative geographic (im)mobility. Sociological studies of dual-career households suggest that relocation decisions are more often based on a husband’s career than a wife’s (49–53). In corollary, surveys of surgeons show women are more likely than men to report geography and family considerations as primary reasons for choosing a job, or that their spouse’s career was most important in the family (54,55). At the same time, geographic relocation has been found to be positively associated with career advancement in academic medicine (56).

Another factor may be implicit bias, also referred to as unconscious bias. In 2012, Moss-Racusin et al. (57) performed a randomized, double-blind study of 127 science faculty from “research-intensive” universities. Faculty were sent application materials for a laboratory manager position with a randomly assigned male or female name. Despite otherwise identical resumes, faculty rated the male applicant as significantly more “competent,” more “hirable,” and more “deserving of faculty mentoring” than the female applicant. In addition, on average, the male applicant was offered a significantly higher starting salary (\$30,238.10) compared with the female applicant (\$26,507.94). Encouragingly, educational interventions to address unconscious bias can be effective, and can be implemented across

departments, especially in recruitment and promotion committees (58–61). Faculty diversity programs to increase representation of women and under-represented minorities (URMs) have also been beneficial (62). In otolaryngology, Johns Hopkins University published their 10-year experience with a diversity and inclusion program (63). Their multifaceted approach included supporting the pipeline of women and URMs in the form of mentored clerkships with financial support, creation of a climate of diversity and inclusion, recruitment of qualified female and URM faculty, achievement of salary parity based on academic rank, and a faculty mentorship program. As noted by Flier, “There is nothing that a woman in medicine cannot do. It is our responsibility, however, to identify remaining barriers to full gender equality, so that medicine will be an exemplar for all field of human endeavor, as it certainly should be.” (7)

Until 2017, requirements for membership in the AOS included having completed the final level of otological training at least 5 years previous, being nominated and seconded by AOS members in good standing, having a practice primarily limited to otology (and/or neurotology), possessing a sizeable body of meaningful otologic literature to one’s credit, and having attended previous AOS meetings. In 2017, the years of post-training practice were increased to 8 years. Once all of the requirements are met, the Council reviews the membership applications and those passed for membership by the Council are then put up for a vote by the entire AOS membership before they are admitted.

The route to leadership in the AOS involves selection for service on the AOS Council for a number of years, which then leads to President. Council service can be in a number of positions, including Education Director or Secretary-Treasurer. The AOS Award of Merit is granted annually to a particularly deserving member of the society, and reflects their lifetime body of work in Otology including service to the AOS. In the history of the AOS, only one woman (Catherine Smith, Ph.D.) has been awarded this prestigious honor.

Both the processes of entering into membership and moving up into leadership rely on nominations and selections, and can be inherently biased against members of a different group, such as women, underrepresented minorities, or individuals not privileged to have trained under AOS leaders. It requires active recruitment and promotion of these individuals, to allow any society that uses this type of system to progress to better representation of the source group.

While the number of women in otolaryngology is rising, it still lags well behind that of many medical specialties. The proportion of women in the subspecialty of otology-neurotology notably lags behind the mother specialty. The number of women in otology-neurotology is steadily rising, albeit at a measured pace. While disparities remain, it is clear that both the participation in the AOS and scientific contributions of women in otology have steadily increased over the past 40 years. As a senior society, membership in the AOS is generally

awarded only after having a substantial track record of achievement in the field. Because of the reliance on nominations, it is exceptionally important that current AOS members are encouraged to actively pursue women and other URM individuals for membership, speaking roles at meetings, and leadership. With the rising cohort of women obtaining specialized training in neurotology, the membership composition of the AOS should become more balanced in coming years. There is good reason to hope that the increasing number of women being invited to join the AOS will serve as role models and thus further catalyze this rise. It should be acknowledged that the Society has made a laudable effort to engage women into leadership positions with 37.5% (3/8) of the 2017 AOS Council members women. Nevertheless, only with a sustained and purposeful effort to increase gender and ethnic diversity will the Society succeed in its efforts to become more diverse in ways which better reflect the population of patients we serve.

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Reflections on the Last 25 Years of the American Otological Society and Thoughts on its Future

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Purpose: To review contributions of the American Otological Society (AOS) over the most recent quarter century (1993–2018) and to comment on possible future evolution of the field during the quarter century to come.

Methods: Retrospective review of selected topics from the AOS transactions, distinguished lectureships over the past 25 years, and selective reflection by the authors. Speculation on potential advances of the next quarter century derived from emerging topics in the current literature and foreseeable trends in science and technology are also proffered for consideration (and possible future ridicule).

Results: Integration of multiple disciplines including bioengineering, medical imaging, genetics, molecular biology,

physics, and evidence based medicine have substantially benefitted the practice of otology over the past quarter century. The impact of the contributions of members of the AOS in these developments cannot be over estimated.

Conclusions: Further scientific advancement will certainly accelerate change in the practice of otologic surgery and medicine over the coming decade in ways that will be marvelous to behold. **Key Words:** Future—History of otology—Sesquicentennial.

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On the occasion the 150th anniversary of the American Otological Society (AOS), it is appropriate to reflect on the changes to the field of otology. This manuscript focuses on the most recent quarter of a century. Much has changed in the practice of otology since eight inaugural members gathered in the beautiful new Ocean House Hotel in Newport, Rhode Island on July 22, 1868 to establish the American Otological Society and, in fact, a great deal of that change has occurred in the past 25 years. Much of the progress in otology has been made possible by the application of basic science discovery to clinical medicine. Although by no means a comprehensive review, a few of the important advances in otology for the last quarter century from the authors' opinions are highlighted. The programs from the Annual AOS meetings were reviewed for trends and progress, with particular attention paid to lectures from the Guests of Honor and our Scientific Lectures at the annual meetings such as the Saumil Nalin Merchant Memorial Scientific Lecturers (Table 1).

ADVANCES IN OTOTOLOGY OVER THE QUARTER CENTURY

First, a few cursory observations in reviewing the programs from the Annual Meeting of the AOS from 1993 to 2017 are preferred. Remarkably, the earlier programs from 1993 to 2004 have no financial disclosures in the program whatsoever. These have certainly proliferated in recent years. Financial disclosures first appeared in 2005. Soon they occupied more space in the program than the program itself along with “Identification of Professional Practice Gaps,” “Goals & Objectives,” “Learning Objectives,” “Desired Results,” and “Full Disclosures” from all authors on all presentations. The growing administrative burden of meeting the regulatory requirements is clearly evident and emblematic of many similar encumbrances on the time of the members of the AOS which detract from time spent in patient care, research, and teaching. It also burdens those who administer the AOS educational programs.

Certainly of much greater significance, through the past 25 years there is strong evidence of increasing intersections of clinical and basic science at the Annual AOS meeting (Table 1). Such collaborations have greatly accelerated the acquisition of key knowledge to push clinical treatments forward. The Guest of Honor in 1993, Cesar Fernandez, spoke on “The Need for Research in

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TABLE 1. *Twenty five years of special lectures at the American Society of Otological Society*

Year	Guest of Honor	Lecture Title	Scientific/Merchant Lecture	Lecture Title
1993	D. Thane R. Cody, M.D.	Remarks	None	
1994	Cesar Fernandez, M.D.	The need for research in Otology	None	
1995	Richard R. Gacek, M.D.	The periodicity of the professional career	None	
1996	James L. Sheehy, M.D.	Tinnitus: a few thoughts	None	
1997	Mansfield F. W. Smith, M.D.	The heritage and duty of the American Otological Society	None	
1998	Robert A. Jahrsdoerfer, M.D.	You've come a long way baby	None	
1999	Barbara A. Bohne, Ph.D.	Degeneration of the Cochlea after noise damage: primary versus secondary events	None	
2000	Dearld E. Brackmann, M.D.	Balancing the satisfaction of the practice of medicine with personal and family life	None	
2001	James B. Snow, Jr., M.D.	Progress in the prevention of otitis media through immunization	NONE	
2002	David J. Lim, M.D.		None	
2003	James F. Battey, Jr., M.D., Ph.D.	Remarks	None	
2004	Ugo Fisch, M.D.	Surgical management of temporal paragangliomas: a long-term review	None	
2005	George A. Gates, M.D.	Science in Otology: past, present and future	None	
2006	Richard A. Chole, M.D., Ph.D.	Bacterial biofilms: the source of tissue destruction in cholesteatomas?	Bradford J. May, Ph.D. Beverly Wright, Ph.D. Charles Limb, M.D.	Basic science seminar how we hear, how we listen
2007	Fred H. Linthicum, Jr., M.D.		Bob Shannon, Ph.D.	Speech understanding from implants: cochlear, brainstem and midbrain
2008	H. Richard Harnsberger, M.D.	Decision support in the 21st century	Richard D. Rabbitt, Ph.D.	Pathological semicircular canal afferent signals transmitted to the brain during benign positional vertigo and their biomechanical origins
2009	Robert J. Ruben, M.D.	The Promise of Otology	Alec N. Salt, Ph.D. Scott Plotkin, M.D., Ph.D.	Opportunities and techniques for local drug delivery to the inner ear The new frontier: targeted therapies for NF2-related vestibular schwannomas
2010	Edwin W. Rubel, Ph.D.	Toward a new era of hearing Habilitation	Jay T. Rubinstein, M.D., Ph.D.	Characterization of the electrically-evoked compound action potential of the vestibular nerve
2011	Richard A. Miyamoto, M.D.	Cochlear implants: past, present and future?	Kirk Aleck, M.D.	Patterns of inheritance as illustrated by disorders of hearing
2012	Vincente Honrubia, M.D.	Vestibular testing, after 50 years still a challenge	Carol Bauer, M.D.	The neuroscience of tinnitus- implications for treatment
2013	Bruce J. Gantz, M.D.	Electric + acoustic speech processing: what have we learned about the auditory system	Neil Segil, Ph.D.	Can we restore lost hearing? Molecular control of cell fate and cell division in the development and regeneration of the inner ear
2014	David A. Moffat, Ph.D.	Ethical dilemmas in otology	Josef P. Rauschecker, Ph.D.	The gray area—tinnitus and the brain
2015	Joseph B. Nadol, Jr., M.D.	An imperative for otology	M. Charles Liberman, Ph.D. ^a	Hidden hearing loss: permanent cochlear nerve loss after temporary noise-induced threshold shift

TABLE 1 (Continued)

Year	Guest of Honor	Lecture Title	Scientific/Merchant Lecture	Lecture Title
2016	Blake Wilson, Ph.D.	The development of the modern cochlear implant and the first substantial restoration of a human sense using a medical intervention	Andy Groves, Ph.D.	30 years of hair cell regeneration: promising progress or pie in the sky?
2017	John W. House	Otosclerosis treatment: a journey through the last century and a half	A. James Hudspeth, Ph.D.	The active ear: how hair cells provide a biological hearing aid

^aSaumil Nalin Merchant Memorial Lectureship began 2015.

Otology.” Subsequent Guests of Honor noted for their contributions to basic science of otology included Barbara Bohne (1999), David Lim (2001), James Battey, Jr. (2002) and Edwin Rubel (2010).

The first basic science seminar was introduced in 2006 when a panel discussed “How We Hear, How We Listen” with Bradford May, Beverly Wright, and Charles Limb. In 2007, a “Basic Science” lecture was formally added to the AOS annual program, a trend that has continued to the present. The Basic Science Lecturer was renamed the Saumil Nalin Merchant Memorial Lecture in 2015 in honor of Dr. Merchant, a gifted clinician-scientist who made great contributions in many areas including temporal bone histopathology.

The AOS Research Grant Program to fund the mission of advancing the science and practice of otology underwent marked change in scope and magnitude. The AOS Council approved over \$5.6 million in research grants to early stage clinicians and scientist for basic and clinical research. Initially funding was limited to the study of otosclerosis and Menière’s disease, but this restriction was recently released and now research relevant to any aspects of the ear, hearing, and balance disorders are invited. AOS Research Fund awardees have been highly successful in recent years in obtaining substantial extramural peer-reviewed grants to advance their contributions to the field.

The following observations highlight a few of the specific areas where important progress has been made and is ongoing.

Genetics of Hearing Loss

As described by medical geneticist Kirk Aleck in the 2011 AOS Scientific lecture, “Patterns of Inheritance as Illustrated by Disorders of Hearing,” our understanding of the genetic basis of hearing loss has expanded geometrically over the last quarter century, perhaps realizing more progress than in any other area of otology. Approximately 80% of prelingual deafness is genetic, most often autosomal recessive and nonsyndromic (1). As of 2017, among patients with nonsyndromic genetic hearing loss 70 autosomal recessive, 25 dominant, and five X-linked genes have been identified (2). A series of mitochondrial mutations have also been associated with hearing loss. In recent times genetic studies, initially single gene testing,

now increasingly supplanted by multi-gene panels, have become available. Widespread clinical use is hampered by lack of insurance funding. Connexin mutations, which impair a gap junction protein, are the most common among nonsyndromic hearing loss having been identified in 24% of patients with congenital hearing loss when screening 660 hearing impaired patients. Ushers and Waardenbergs were the most common causes of syndromic hearing loss. With the steadily lowering costs of DNA sequencing, routine screening for highly prevalent types of acquired hearing loss such as vulnerability to noise and aging related hearing loss may be developed. While the primary value of genetic studies at present is to establish prognosis and to advise concerning the risk to subsequent generations, gene therapy has commenced and will be refined in the coming years (3).

Imaging

Innovation in medical imaging has greatly clarified and illuminated the practice of otology. H. Richard Harnsberger highlighted these advances in a talk as the Guest of Honor at the annual meeting in 2008 entitled “Decision Support in the 21st Century.” Refinement of magnetic resonance imaging (MRI) and high-resolution computerized tomography (CT) have made precise anatomical diagnosis possible and opened the way for the detection of new disease processes. For example, air contrast CT was the most sensitive and specific method for detecting intracanalicular lesions before the introduction of gadolinium enhanced MR (Fig. 1). Air contrast CT, popularized in the early 1980s, provided excellent resolution and became the procedure of choice for imaging tumors of the internal auditory canal (4). Injection of intrathecal air was not without its attendant discomfort and risk including headache, back pain, nausea, and neck stiffness (5). With high-resolution MRI, far more vestibular schwannomas were detected than with CT. This likely led to an increase in the number of patients having tumors removed that previously went undiagnosed and untreated.

Another recent advance in MRI is the ability to image protein deposition in the cochlea which helps clarify the cause of hearing loss associated with vestibular schwannomas (VS). It has been known for some time that the

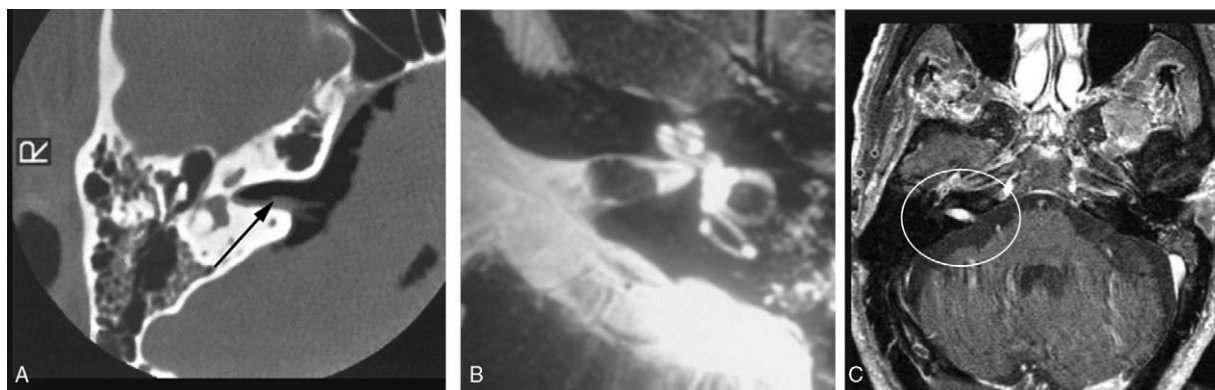


FIG. 1. A, Air-contrast CT demonstrating a small mass in the right internal auditory canal (IAC) (black arrow). B, T2-weighted magnetic resonance image of a small intracanalicular vestibular schwannoma in the left IAC. C, T1-weighted image with contrast with clear enhancement in the right IAC. CT indicates computerized tomography.

size of VS was not directly correlated with the hearing loss. Holliday et al. (6) confirmed this finding and observed that elevated intralabyrinthine protein demonstrated on MRI FLAIR (fluid-attenuated inversion recovery sequences) images were correlated decreased pure-tone audiometric averages (Fig. 2). Increased protein in the cochlea likely correlates with histopathologic findings which showed an acidophilic precipitate in the scala media of patients with VS (Fig. 3). Characterizing these proteins may help explain why some tumors cause hearing loss and others don't, regardless of size. To this end Dilwali et al. (7) have identified secreted proteins from VS, some which are otoprotective of hearing (FGF2) and some which are associated with poorer hearing (TNF- α). Their direct link to the scala media protein imaged, if any, is yet to be discovered.

Further refinement of MRI has led to diffusion tensor imaging, which can differentiate cranial nerves from the adjacent and compressing tumors (8) (Fig. 4). Looking forward, nuclear magnetic resonance (NMR) in combination with MRI may allow the detection of the chemical composition of tumors, thus reducing the need for surgical biopsy to make a certain pathologic diagnosis. Furthermore, precise knowledge of the molecular makeup of discrete tumors in the future may allow prediction of

tumor growth and thus guide treatment timing and options.

More Selective Treatment of Cranial-base Tumors

In the past 25 years, there has been a shift in the treatment of vestibular schwannomas (VS). Combining stereotactic localization for radiation and better imaging techniques has allowed the inclusion of radiation or observation as treatment options. Clearly a higher percentage of patients with VS are being observed for tumor growth before intervention than two decades ago (9). Stereotactic radiation has increasingly been selected as a treatment option in the same period. Stereotactic radiation is more likely to be recommended to the elderly or medically infirm with documented tumor growth, but patients of all ages are considering the relative merits of each approach. Why are patients and practitioners selecting a conservative observational approach in recent years? MRI can accurately detect growth, therefore, observing for non-growth is the least aggressive initial treatment option. One argument for early intervention in smaller tumors has been pointed toward the possibility of hearing preservation. Success may be in part dependent upon a distinct cleavage plane between the VS and the cochlear nerve (Fig. 5), but some VS invade the cochlear

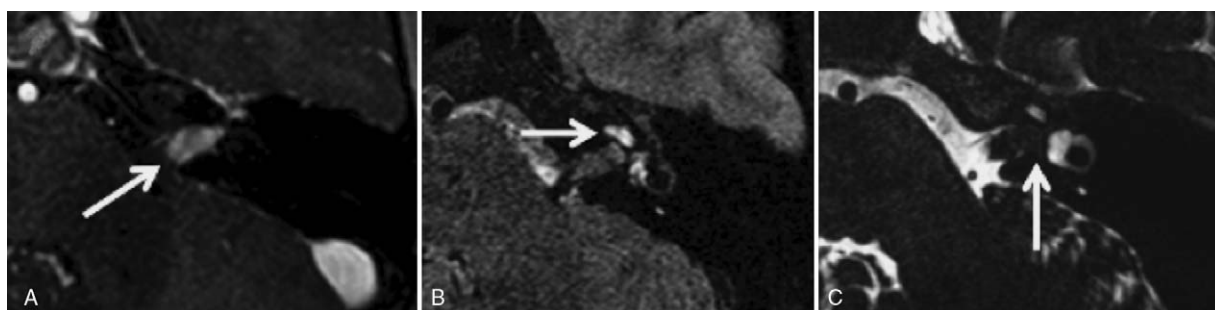


FIG. 2. A, MRI of an intracanalicular vestibular schwannoma on T1-weighted image with contrast. B, FLAIR sequence imaging showing bright signal in the cochlea likely representing protein deposition. C, T2-weighted image showing loss of CSF bright signal where tumor displaces it in the lateral internal auditory canal. From Holliday et al. (6). FLAIR indicates fluid-attenuated inversion recovery; MRI, magnetic resonance imaging.

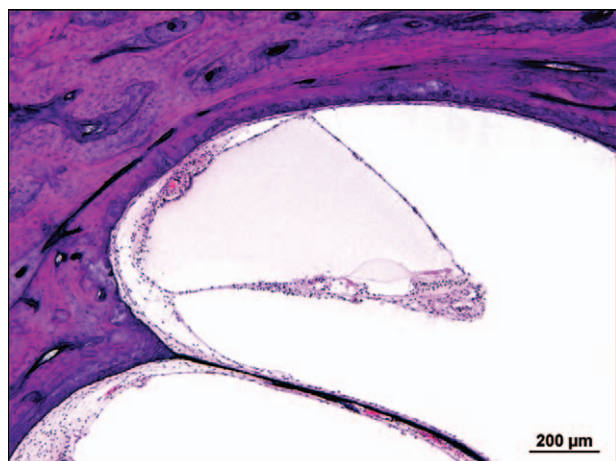


FIG. 3. Acidophilic protein filling the scala media of a patient with neurofibromatosis type 2. Photo courtesy of Dr. Alicia Quesnel.

nerve and have a poor cleavage plane as pointed out in 1984 by AOS member, Neely (10). Figure 6 shows gross infiltration of the 8th cranial nerve with no distinct cleavage plane in one tumor and a clearly defined separation in another. Hearing preservation operations have not been as successful as would be desired, leading patients to a more conservative initial approach in tumors where brainstem compression is not an immediate concern.

The first successful medical intervention for VS was presented by Plotkin et al. (11), the Basic Science Lecture in 2009. Surprisingly, he and his colleagues demonstrated improved sensorineural hearing in 50% of neurofibromatosis type 2 (NF2) patients treated with the vascular endothelial growth factor inhibitor bevacizumab (Fig. 7). Additionally, over 50% of NF2 associated VS showed a decline in tumor volume when so treated (Fig. 8). Clarification of the tumor biology leads patients ever closer to targeted drug options.

Another major shift has been in the treatment of glomus jugulare tumors. Twenty-five years ago the majority of patients were treated surgically, but now surgical resection is seldom employed, as stereotactic radiation has greatly decreased the number of tumors that

require surgery. Cranial nerve sparing with radiation represents a significant advantage over surgical resection in many cases (13–15).

Menière's Syndrome

The treatment of Menière's syndrome has also shifted. When conservative measures such as diuretics and diet fail, otologists have largely adopted intratympanic treatment including intratympanic steroids or intratympanic aminoglycosides, at least as a second line therapy. The latter have been shown effective in limiting Tumarkin crisis and both have resulted in significant control of vertigo. Hearing preservation is still problematic however (16–19).

Inner ear imaging can now demonstrate endolymphatic hydrops (20). Dilute gadolinium in the middle ear via transtympanic injection has shown apparent hydrops on T2-FLAIR weighted images in the scala media. This may eventually play a role in more precise understanding of the underlying causes of Menière's syndrome, and may be useful for determining treatment options as we go forward, although the exact relationship of hydrops and the symptom complex is not completely understood yet. The genetics of familial Menière's disease is also not yet elucidated, but segregation in different populations and various potential genes have been implicated. When identified, it will hopefully help unlock the mystery of its pathogenesis.

The ability to measure vestibular function has evolved from the measurement of only one of the five sensory elements of the vestibular system, typically the horizontal semicircular canal with caloric stimulation, to the addition of measurements of the saccule and utricle with vestibular evoked myogenic potentials (VEMP) (21,22). The presence of cervical VEMP response in Menière's syndrome patients has been associated with Tumarkin crisis and may predict the onset of Menière's in the second ear (23).

In the 1980s and 1990s surgical procedures for the relief of vertigo were undertaken much more frequently than today. Procedures such as endolymphatic sac decompression or shunting and vestibular neurectomy were major topics during AOS meetings both in presentations and the subject of innumerable panel discussions.

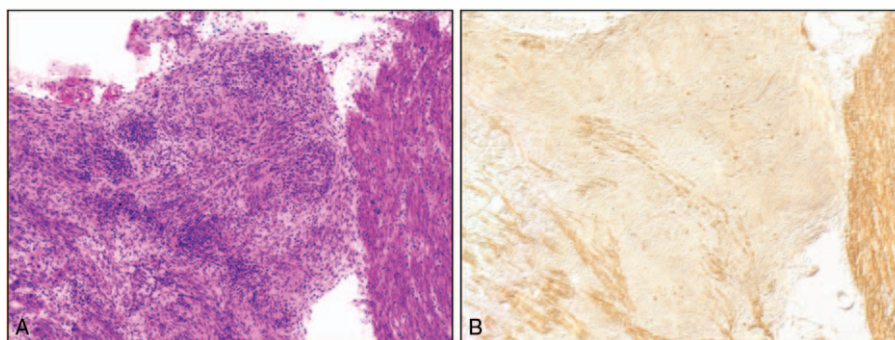


FIG. 4. Cleavage plane between vestibular schwannoma and cochlear nerve A, H&E Stain, B, anti-neurofilament stain. Image courtesy of Jennifer O'Malley.

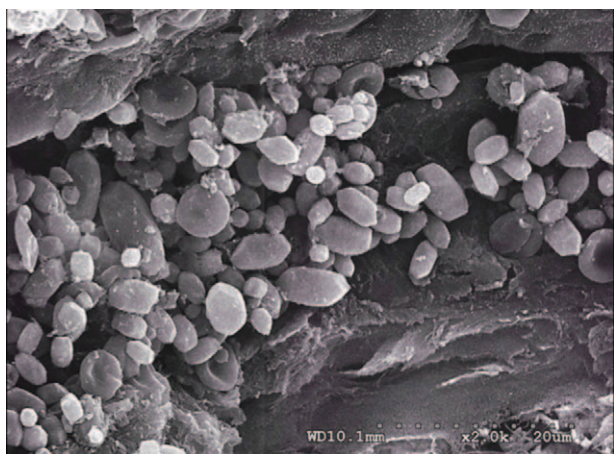


FIG. 8. Otoconia demonstrated in the posterior semicircular canal on scanning electron microscopy in a patient with intractable BPPV. Scale bar 2.5 μ m. Images courtesy of Parnes and Chole (12). BPPV indicates benign paroxysmal positional vertigo.

was poorly understood. Symptoms are frequently improved with canal plugging or resurfacing techniques, but the underlying pathogenesis of the dehiscence is still unknown. Even with plugging techniques all symptoms are not yet completely resolved and BPPV may occur posttreatment, however, overall serious complications have been few with plugging techniques (33). Interestingly, recent data suggest that near-dehiscence of the superior semicircular canal is associated with symptoms similar to complete dehiscence and that plugging a nearly dehiscent canal also results in improved symptoms (34).

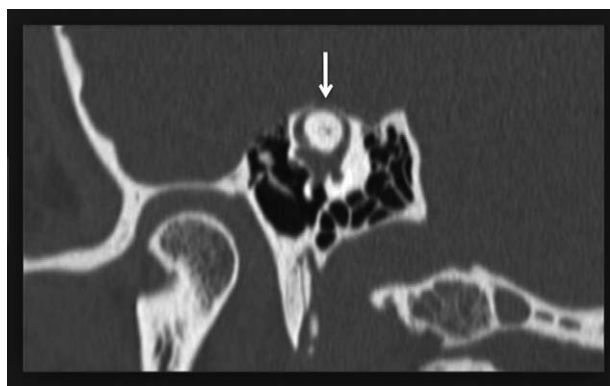


FIG. 10. Dehiscence (arrow) of the superior semicircular canal on CT as initially described by Minor et al. (32). CT indicates computerized tomography.

Cochlear Implants

Throughout the past 25 years, the program for the Annual AOS meeting has been filled with advances in cochlear implant technology and application. Most recently, Wilson (35), was the 2016 Guest of Honor at the 149th Annual AOS annual meeting and spoke on the topic “The Development of the Modern Cochlear Implant and the First Substantial Restoration of a Human Sense Using a Medical Intervention.” Cochlear implants are a product of the merger of bioengineering and clinical otology. Many key contributors have been leaders of the AOS over the years. Wilson proposed that of all positive changes to the field of otology over the past quarter century, the greatest accomplishment is the cochlear

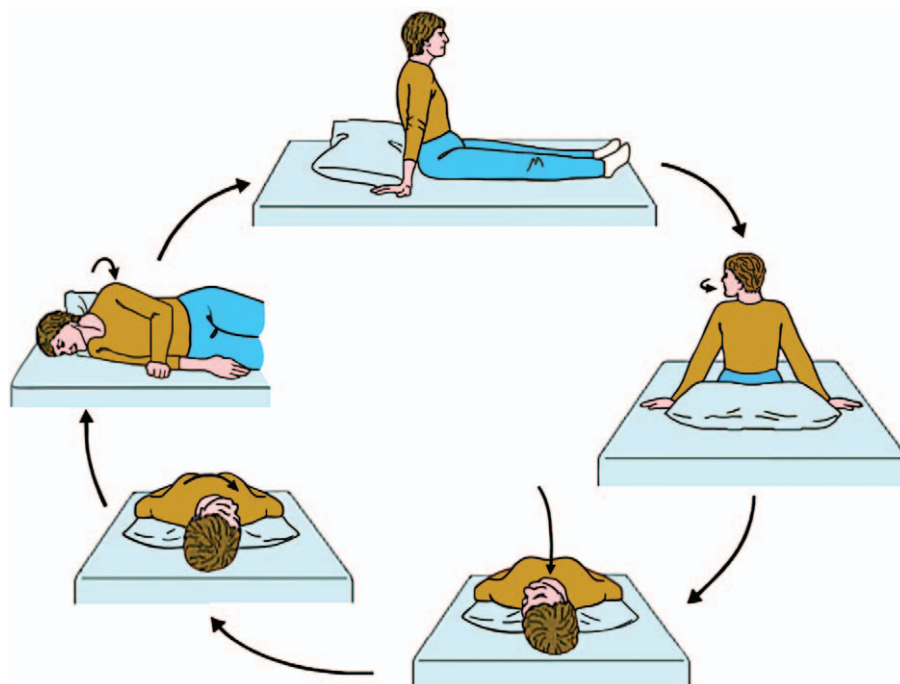


FIG. 9. Particle repositioning maneuver described by Epley in 1980. (Image Courtesy of Chicago Dizzy Clinic as shown in Welling and Barnes (30)).

implant. The ability of a profoundly deaf patient to gain open-set speech discrimination is a modern medical accomplishment unparalleled in bioengineering to date. The impact this has on deaf patients is transforming, especially for deaf children who had poor prospects of gaining communication skills which would allow interaction with the hearing world. There have been over 12,000 articles published on cochlear implants in the past 25 years. To date, approximately 220,000 patients worldwide have received cochlear implants.

Ongoing areas of CI study include modification and relaxation of eligibility requirements, hearing sparing electrodes to allow potential electric-acoustic hybrid stimulation and optimizing fitting paradigms. Bruce J. Gantz (AOS president 2010) was the guest of honor for the annual AOS meeting in 2013 where he summarized this ongoing work in a talk entitled "Acoustic + Electric Speech Processing: What Have We Learned about the Auditory System." He noted that basic science questions are being answered through clinical applications, such as the gradual shift in frequency response to shorter hybrid implants (36,37).

Whether or not cochlear implants should be employed for single-sided deafness and tinnitus suppression is actively being studied in a number of institutions (38,39). The optimal timing of bilateral cochlear implantation as contrasted with a period of bimodal stimulation is an ongoing debate with solid data needed to further clarify these options (40).

Future understanding of auditory cortex plasticity may allow pharmacologic intervention to habilitate the congenitally deafened adult who did not receive early auditory stimulation (41,42). The ability to process sound signals into speech understanding may be followed by further voice development and integration into the hearing world.

The field of optogenetics allows for selective nerve stimulation with optical sources may further refine our ability to discretely stimulate the auditory and vestibular pathways in the future or even the auditory cortex directly (43,44).

Implantable Hearing Aids

Much excitement was generated around active implantable middle ear hearing aids in the past quarter century. Fully implantable and partially implantable devices have been studied. Patient's rationalizations for avoiding conventional hearing aids are well known including cosmesis, irritation of the ear canal, activity limitation, and poor sound quality, particularly in noise. On the other side of the ledger, challenges have been many including battery technology, implantable microphone fibrosis, unreimbursed cost in excess of conventional aids, long-term viability of the mechanical devices in the biologic environment leading to device failure and removal or replacement, decline in unaided hearing as a result of implantation, and MR incompatibility. Failure to clearly demonstrate objective improvement in performance when compared with appropriately fit

conventional hearing aids on a variety of audiologic tests has perhaps been the major deterrent to wide-spread acceptance of these devices (45,46).

Osseointegrated Implantable Hearing Devices

Another area of marked progress has been in osseointegrated bone conduction hearing devices, particularly for applications in congenital aural atresias and patients with severe eczema of the external auditory canal. The patient with a chronically draining middle ear is also a candidate. Implantation procedures have been simplified, but irritation and granulation around transcutaneously implanted devices has not been completely overcome. Osseo-integrated devices for single-sided deafness, when compared with conventional CROS aids, have not been shown to be clearly superior (47).

Endoscopic Ear Surgery

Within a few decades following the introduction of the operating microscope in the 1920s, nearly all ear surgery involved microsurgery. While endoscopes have been used as adjuncts to the microscope in ear surgery for quite some time, in recent years fully endoscopic ear surgery is increasingly popular (48). Even the most delicate of ear surgery, stapedectomy, has been performed endoscopically in a few centers (49). Advantages are greater visualization and illumination of recesses such as the sinus tympani and the ability to peer into the epitympanum without removal of the scutum. Disadvantages which have deterred many otologists include the need for one handed surgery, a limitation likely to be overcome by future technological advances.

WHAT WAS IN VOGUE 25 YEARS AGO?

Perilymphatic Fistulae

A number of years ago a presentation was given in a national meeting on the topic of perilymphatic fistulae (PLF) in which a map of the prevalence of PLF in the United States was flashed briefly. The speaker stated that the prevalence of spontaneous PLF seemed to segregate much like religion in the country with strong geographic predilection. The speaker then quickly proceeded to the body of the presentation. A recent retrospective survey of over 1,000 patients evaluated for vertigo concluded that less than 1% of cases were attributed to PLF (50). It is the author's suspicion that the discovery of dehiscent superior semicircular canals resulted in fewer explorations of the middle ear for PLF. It is conceivable that patching the round and oval windows did help decrease the symptoms associated with the third window effect created by DSSC. Recent modeling indicates otherwise however (51). There appears to be a good deal of interest on the topic from Japan as a recent national study examined for the presence of an inner ear specific, Cochlin tomo-protein (CTP), in middle ear lavage from suspected PLF patients. Only 20% of patients with suspected PLF showed CTP, if there was no associated physical trauma, lesion of the middle ear, or recent stapes surgery. Patients with acute

trauma who waited longer than 30 days for middle ear exploration were significantly less likely to find positive CTP presence (52). The usefulness of CTP may help clarify the true incidence of PLF going forward.

Decompression of Vascular Loops for Disequilibrium

McCabe and Harker (53) proposed vascular loops as a cause of incapacitating disequilibrium in 1983 and decompression of the same was recommended for the control of disabling positional vertigo in 1984 by Jannetta (54). A prolonged I–III interval on ABR was proposed as a result of significant vascular compression of the cochlear nerve. Several case series presented good outcomes from various decompression techniques (55,56). Although this condition may still occur, in the author's experience, lack of symptoms in patients with vascular loops found contacting the 8th nerve complex on routine MRI are so prevalent, it has led to a substantial decline in decompressions for vascular loops. A detailed investigation of the relationship between cochleovestibular symptoms and the type of vascular compression showed no relationship. Sirikci et al. (57) concluded that diagnosis of vascular conflict should not be based on imaging findings alone.

SPECULATIONS ON FUTURE ADVANCES IN OTOLOGY OVER THE NEXT QUARTER CENTURY

Application of Molecular Biological Techniques

Looking forward to the next decades in our field brings a great deal of excitement and anticipation. This will occur in many ways, but most likely through continued merger of scientific disciplines. In the inaugural Saumil Nalin Merchant Memorial Lectureship, M. Charles Liberman delivered a talk which gave an example of the advances being seen today entitled "Hidden Hearing Loss: Permanent Cochlear Nerve Loss after Temporary Noise-Induced Threshold Shift." Cochlear synaptopathy resulted from cochlear nerve degeneration after "temporary" noise induced hearing loss (58). This condition is characterized by pure-tone thresholds returned to normal, but synapses with the inner ear hair cells were lost at levels of acoustic trauma below those necessary to induce permanent hair cell damage and permanent sensorineural loss. Kujawa and Liberman (59) demonstrated further that Neurotrophin-3, when applied to animal models of cochlear synaptopathy demonstrate the regeneration of neurite outgrowth to reconnect with the inner hair cells with concomitant improved hearing thresholds.

The 2016 Merchant lecturer was Andy Groves who spoke on the topic of hair cell regeneration in his scholarly presentation "30 Years of Hair Cell Regeneration: Promising Progress or Pie in the Sky?" He related characterization of the changes in the transcriptome of neonatal mouse cochlear supporting hair cells between 1- and 6-day old mice (60). The importance of the Notch pathway inhibition was demonstrated corroborating the work of Edge and others in

unlocking the insights in the mechanism of regeneration of mammalian hair cells (61).

Lustig led a panel of experts at the 2016 meeting on "Hurdles to Human Gene Therapy." He previously showed restoration of hearing in the VGLUT3 knockout mouse using virally mediated gene therapy (62). Staecker, another distinguished panelist discussed how his team knocked down a significant hurdle by delivering atonal (CGF166) via an adenoviral vector to the live human inner ear with the intent of regeneration (63). This study is ongoing in phase I/II. An ophthalmologist on the panel, Pierce, described their work in vision restoration using adeno-associated viral (AAV2) mediated correction of an inherited retinal dystrophy in children which showed efficacy in both eyes out to 3-year follow up (64).

The high interest and importance of this areas of study was highlighted by the address of Neil Segil at the 146th annual meeting entitled "Can We Restore Lost Hearing? Molecular Control of Cell Fate and Cell Division in the Development and Regeneration of the Inner Ear" (65). Other important advances demonstrating restoration of hearing in young mouse models such as TMC1 and Usher Type 2c (66,67). Shibata et al. (68) demonstrated the feasibility of RNA-interference-mediated suppression delivered via a viral vector to slow progression of hearing loss in autosomal-dominant nonsyndromic hearing loss.

As gene editing becomes more widely applicable, specific defects may be selectively corrected in various mutation affecting hearing. Major challenges with translating gene therapy from bench to bedside are improving efficiency of targeted delivery without causing further trauma or off-target editing. Specialized viral vectors such as Ancestral 80 have beautiful distribution throughout the inner and outer hair cells from base to apex in the mouse model while minimizing immunogenicity (69).

Many congenital lesions causing pediatric hearing loss are present at birth with the absence of normal anatomic structure development. Very early intervention, even prenatal intrauterine intervention, may be necessary to allow critical structural development. Recent delivery to the amniotic fluid in utero of antisense oligonucleotides (ASO), with subsequent rescue of hearing and balance phenotypes in a mouse model of Ushers syndrome (type 1), was shown by the Brigande lab (70). The delivered ASO targeted a causal splice site mutation and showed it corrected gene expression in the therapeutically relevant inner ear target tissues. Recent major advances in ASO therapies include "improved specificity, potency, stability, delivery, and biodistribution and toxic effects have been minimized" according to the authors. This may bring a whole new realm of intervention.

As with ASOs, other gene editing systems are dramatically increasing genome engineering activities for research and eventually therapeutic purposes. Clustered regularly interspaced short palindromic repeats (CRISPR)-associated Cas9 endonucleases have made genome editing much more directed and efficient than older homologous recombination techniques, potentially revolutionizing gene editing. Improved specificity

limiting off-target activity is crucial but seems to be advancing (71–73). The application to otologic disease is eminent and very exciting.

Tissue Regeneration

Growth factor stimulated repair of tympanic membrane (TM) perforations has been successfully explored in animal models as early as the 1980s (74–76). Recent manufacturing of clinical grade growth factors led to successful human trials in Japan (77,78). Tissue engineering for TM repair is evolving quickly and will lead to a significant change in the way that perforated TMs are treated in the near future—opined that “a regenerative method of tympanic membrane repair could be the greatest advance in otology since the cochlear implant” (79). It could simplify the traditional myringoplasty and tympanoplasty by making it an office procedure.

Precision Diagnostics

It is most probable that future members of the AOS will not speak of “sensorineural hearing loss” as generality covering lesions from the cochlea to the cortex. More discrete diagnostic testing will become commonplace allowing discrete treatment paradigms. We will speak of inner or outer hair cell dysfunction, cochlear synaptopathy, cochlear nerve dyssynchrony, brainstem lesions of the dorsal cochlear nucleus afferents, or failure of efferent feedback. Importantly human temporal bone histologic findings will be necessary in deciphering the discrete underlying pathology necessary and cannot be neglected, as was so elegantly described by the Guest of Honor in 2016, Joseph Nadol (AOS president 2009). Diagnostic imaging will help us decipher delayed auditory cortex development and methods then devised to improve the natural language development of the deaf.

The need for similarly improved diagnostic testing of the vestibular system was highlighted by Vincente Honrubia in 2013, when as the Guest of Honor he presented his thesis on “Vestibular Testing, after 50 Years Still a Challenge.” We might predict that in the near future we will have access to a simplified clinical “vestibulogram” which will give discrete information from all 10 vestibular sensory end organs. The central nervous system advances will also be additive.

Vestibular Prosthesis

Another exciting development which follows from the highly successful cochlear implant is the development of the vestibular implant for patients impaired by severe bilateral vestibular dysfunction. Della Santina, Lewis, Rubinstein, and others have made important progress on the development of a device to will resupply vestibular afferent function to the profoundly vestibulopathic system (80–83). Further refinement of multichannel stimulating paradigms, reduction of post implantation variation, and channel interference will likely lead to a successful human vestibular prosthesis within the relatively near future. Given the aging of the population and the high cost of falls among the elderly, sensor based fall

reduction technologies are likely to enter widespread use in the coming years (84).

Tinnitus Intervention

Several decades ago when a patient would ask “what shall I do about the ringing in my ear, doctor? A well-respected otologist (Harold Schuknecht, AOS President 1977) would answer, “what size shoe do you wear.” When informed, he would instruct the patient to buy a pair two sizes smaller, and then their tinnitus would not bother them so much. He would promptly exit the room.

What strides have we made in understanding and treating tinnitus in the last quarter century? Other than being more capable of ruling out tumors of the cerebellopontine angle, vascular malformations, and intracranial hypertension, it could be argued that we have not made substantial progress in terms of treatments. Masking is not a new concept, but still useful. Tinnitus retraining has been shown to be more effective than standard supportive therapy in a recent blinded controlled study by Bauer et al. (85) when combined with hearing aids. Effective pharmacologic agents are yet to be proven.

Auditory neuroscience, however, has progressed substantially recently in understanding the pathophysiology of tinnitus. Carol Bauer’s Basic Science Lecture in 2012 “The Neuroscience of Tinnitus-Implications for Treatment” was outstanding (86). Rauschecker et al. (87), the scientific lecturer in 2014, presented “The Gray Area – Tinnitus and the Brain” to bring us a look at the advances in understanding of tinnitus. Advancing neuroscience certainly gives hope that understanding the generators of abnormal spontaneous activity in the auditory pathways (dorsal cochlear and ventral cochlear nucleus, the inferior colliculus, and the auditory cortex) or a lack of suppression of spontaneous activity may lead to the eventual successful treatment of this symptom. Modulation of the auditory cortex which appears to be hyperactive in tinnitus, may be another treatment option. While auditory input is decreased from the damaged cochlea in the region of the auditory cortex due to hearing impairment, the output from the cortex remains intact to communicate with other parts of the brain. This persistent output which does not correlate with input may be interpreted as the presence of tinnitus. (See Roberts et al. (88) for an excellent review).

Keeping the hyper-excitability theories in mind, a top-down approach to cortical or deep brain stimulation for tinnitus suppression may provide new treatment options (89,90). Pharmacologic control becomes possible with better understanding of the neural modulation of these hyper-excitability-related signals (91).

Deep brain or cortical stimulation directly may also play a role. Early application in human tinnitus sufferers is equivocal (92,93). The usefulness of transcranial magnetic stimulation is also not clearly determined and may be further explored (94). Directed extracranial electrical suppression is being developed now and may become relevant.

Surely with excellent collaborative efforts, tinnitus treatments should advance significantly past the “smaller shoe-size” paradigm.

Eustachian Tuboplasty

Chronic Eustachian tube (ET) dysfunction has been treated with tympanostomy tubes for decades. The results from a recent multicenter controlled study evaluating balloon dilation of the ET for chronic ET dysfunction by Poe (95) may change the way we intervene in the future. The study compared tympanogram normalization in patients treated with topical steroids alone to patients with steroids and eustachian tuboplasty. The favorable results for the eustachian tuboplasty group caused the FDA to recommend early termination of the study and the procedure was FDA approved for adults. Pediatric studies will soon follow. Replacement of tympanostomy tubes with ET dilation would be a major paradigm shift. Long-term sustainability is yet unknowns. Likewise, the applicability to the pediatric population, and ultimately the cost/benefit ratio need to be clarified, but this could be a great paradigm shift in the field of a very common problem.

Hearing Aids

Disruptive innovation is upon us in the hearing aid versus personal sound amplification units (PSAPs) arena as comparative studies and devices appear in greater numbers. A recent report tested hearing in noise with nine PSAPs against a conventional hearing aid, at about 1/10th the cost. Of the nine, the best five were selected and three showed similar benefit to the more expensive traditional hearing aid. At least one device showed worse discrimination than no device at all (96). The audiologist’s professional role in guiding patients through this maze of new devices will accelerate quickly from this point. As only 20% of patients with mild to moderate hearing loss currently use hearing devices, there should be an increased role for the audiology professional in counseling patients regarding hearing devices with a model where the professional counseling is unbundled from the sale of a hearing device. This will benefit both our colleagues in audiology and a growing number of patients.

There has long been an unjustified stigma associated with wearing a hearing aid. The widespread cultural bias that the wearer is older and less intellectually acute (i.e., “deaf and dumb”) has in the past limited adoption of these devices among the hearing impaired. This is in marked contrast to eye glasses which culturally are accepted as stylish and a mark of intelligence. In the future, wearing of an ear device may be as universal as using a cell phone is today. Led by youth proud to adopt the latest devices, the current Bluetooth ear-piece revolution is a forerunner of what is likely to come. These devices will interface with computers and phones, be a conveyer of information and entertainment, and serve as a telemetry system for continuous biometric monitoring of health. Future digital ear devices may enhance signal

to noise ratios in adverse listening situations, such as noisy restaurants, thereby improving the sense of hearing even among the normal hearing population. Connected with high-speed cloud based computers, they will translate across all languages in real time. Such highly capable devices can readily incorporate an ability to adjust their output to accommodate for hearing loss. Importantly, as hearing devices become widely used, consumer electronic devices cost will plummet from their unreasonably high cost of today just as technological capabilities soar. As this transition occurs, the stigma associated with hearing devices can be expected to fade and a much higher fraction of hearing loss patients will adopt their use (97).

Surgery Within the Living Cochlea

Early 21st Century surgeons can operate within the brain, heart, liver, kidney, and eye while sustaining or even improving the organ’s native function. The ability to perform procedures within a functioning, but diseased cochlea remains impossible with today’s technology. It is the only organ in the body which remains inaccessible to surgical intervention for functional gain of its ordinary physiological function. Because of the organ’s extreme fragility, new methods need to be developed which enable intervention while preserving Organ of Corti homeostasis. Fundamental is atraumatic creation of a “cochleaport” which affords temporary access and can be effectively resealed to restore cochlear wall integrity. As the cochlea is both minute and mechanically delicate, internal procedures are beyond the ability of the unaided human hand. Robotic micromanipulators of the type used in basic research which step down larger hand motions into microscopic scale and extinguish tremor will be needed. Miniature, steerable endoscopes, and light sources will also be needed to assist therapies such as targeted placement of cells and drugs or, e.g., use of a laser to reduce endolymph production in hydrops.

Hearing Testing

In the 20th century, automation alleviated workers of repetitive mechanical tasks in factories. In the 21st century, any process which can be explained as an algorithm can potentially be automated, even complex and sophisticated tasks typically done by highly educated workers (98,99). The impact of advances in artificial intelligence and computer image analysis are just now being felt in medicine. It can be foreseen that advanced computer image analysis may 1 day greatly enhance the diagnostic ability of radiologists to interpret images (e.g., CT, MRI) and for pathologists to be supplanted in the microscopic diagnosis and molecular diagnosis of disease. In hearing health care it seems inevitable that artificial intelligence systems should be able to readily replace human audiologists for most routine hearing testing. With the reduced burden of diagnostic studies, audiologist will evolve to have a greater emphasis upon the rehabilitative aspects such as counseling and hearing device fitting. With regard to oto-surgical practice,

robotic and image guided surgery is likely to be an adjunct to surgical craft for the foreseeable future rather than a replacement. Office practice of otology, with its human interaction is likely to be less impacted by automation. It will be a long time before computers will be able to communicate empathy and show compassion (98,99).

Otologic Education

Finally, just a word about where otologic education may head in the near future. Immediate access to the world's body of published science makes our trainees today light years ahead of our where our senior membership was at the same level of training (at least in the present authors' case). Surgical training is moving to a virtual world with very realistic simulators that will shape the skills of our young surgeons before they engage in the surgical theater (100,101). This has been enabled by technological advances in immersive learning and is especially important due to the increasing difficulty of obtaining sufficient anatomical material for traditional temporal bone dissection courses. Automated testing for board certification of surgical skills may be administered virtually in the future. It may be anticipated that fellowship-trained neurotologists, who focus their clinical practice on diseases of the ear and lateral cranial base, will be increasingly called on to provide inner ear surgery and medicine including stapedectomies, cochlear implants, and gene infusions. The team approach to science and patient care is evolving which improves the results for all.

SUMMARY

Predicting the future is always fraught with danger, but it is not inconceivable that in the next decade the discipline of otology will see application of molecular and gene transfer techniques to significantly change the way we deal with various maladies including sensorineural hearing loss and tinnitus. Specific targets and ideal delivery mechanisms are the subjects of intense interest. The biotechnology industry's interest and investment is rising with the growing population of baby boomers world-wide who need hearing restoration, balance rehabilitation, and tinnitus suppression.

In the 1950s, it was said that otology was a declining as a field because most surgeries were done to drain infections and antibiotics were greatly reducing these. Stapedectomy was the major innovation of this time and it reinvigorated the field. Looking forward, a 0.5 to 1% deafness rate with this procedure should no longer be acceptable as it was in the era of analog hearing aids. Stapes footplate surgery is conducted right at the margin of what a human surgeon's hand-eye coordination can safely perform. Technical refinements such as use of highly precise robotic tools may reduce the incidence of sensory loss to that of refractive eye surgery or, with advances in hearing aid technology, indications for this procedure may decline. As biological therapies and technological advances provide safer alternatives to

surgery, otologic surgeons may well become much more focused on the implantation of devices.

Advances in wearable digital technology will almost certainly lead to routine coupling of man and machine in the population at large with the ear likely to feature prominently in placement of biosensors as well as communication devices. As leading experts in this interface, future otologists may be occupied with designing and managing these connections and adopting their use to accommodate for hearing impairment.

The future contributions of the members of the AOS in team-science with our colleagues from many disciplines will surely see even more rapid advances for the welfare of our patients in the coming decades. The growth of international science opens new avenues of collaboration as does the rapid sharing of knowledge. A whole new story will surely be told when the bicentennial is celebrated in 2068. Perhaps the larger question then will be when scientific advances allow all to hear, will we have made any significant progress in the human ability to listen. Brian F. McCabe (AOS President, 1986) would often say "the proof is in the pudding." The scientific future is indeed bright!

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Perspectives From American Otological Society Past Presidents Since the 125th American Otological Society Anniversary Publication

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Monographs chronicling the history of the American Otological Society (AOS) were produced in honor of the 100th and the 125th anniversaries of the society. At this writing of the 150th anniversary of the AOS, the past 25 years have, to date, gone unchronicled. In an attempt to address this gap, a number of options were available. One was to examine the publications of the past 25 years to gain a sense of what key developments have arisen. While valid, this method does not capture those important developments that did not result in a publication, such as the formal adoption of the newly minted neurotology fellowship. For this reason, and to gain the personal reflections of many of the individuals who were involved in making the history over this period, I polled a group of otologists who were there when events happened and who had insights into those events. A logical choice are the Past Presidents (PPs) of the AOS. This group of individuals have diverse specific interests within the field of otology. Some had primary interests in hearing, others in vestibular function. Some had particular expertise in basic science research, others made their mark as clinicians. All are leaders in the field.

The 21 living PPs of the AOS were contacted. The earliest PP presided over the 1988 annual meeting and the most recent presided in 2016. Each were asked several questions. PPs responded to none, some, or all of the questions posed to them. What follows is a synopsis of their replies.

QUESTION #1: WHAT WAS THE GREATEST DEVELOPMENT OF THE PAST 25 YEARS?

As would be expected, there were a range of responses. Some PPs noted, not one, but several developments

of great importance. In general, responses fell into a number of groups. These groups included: Diagnostic Innovations, Disease Entities, Education, and Surgical Technologies.

Diagnostic Innovations

In the last 25 years, a revolution in diagnostic imaging took place. As stated by Jeffrey P. Harris, M.D., Ph.D., President of the AOS in 2004: “The use of CT then MRI for diagnosis of acoustic neuromas (AN) (was a) huge advance over tomography and pneumoencephalography.” The development of the modern MRI scan makes the identification of 3 mm acoustic neuromas, vascular loops and an enlarged vestibular aqueduct routine.

Several respondents noted, from a basic science perspective, that clinicians are now able to confidently diagnose genetic mutations, resulting in precise clinical diagnoses, such as the identification of the neurofibromatosis type II defect on chromosome 22 or the connexin 26 defect resulting in genetically transmitted sensorineural hearing loss.

Disease Entities

Several replies noted the discovery by Lloyd Minor, M.D., of Superior Semicircular Canal Dehiscence. Superior Semicircular Canal Dehiscence became a frequently recognized diagnosis, treatable by a reliable surgical procedure.

Numerous respondents also described the role of the otologist/neurotologist in the care of patients with acoustic neuromas. Acoustic neuroma surgery and specifically breaking the barrier of the dura, changed the surgical practice of otologists in the past 25 years. In addition, the role of nonsurgical treatment of acoustic tumors was brought to the fore. Expanding on this Herman A. Jenkins, M.D., President of the AOS in 2012, stated that “Probably leading the list (of developments in this time period) would be acoustic neuroma management with watchful waiting versus surgery versus radiation.” The efficacy of stereotactic radiosurgery (SRS) was debated

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at length at the AOS. A contentious issue, it is unclear how much SRS changes the natural history of these slow growing and, at times, nongrowing tumors. In addition, it is yet to be determined if late postradiation recurrences will develop into a significant clinical problem.

Education

Innovations in the running of the AOS were noted by several respondents, including the noteworthy election of Juliana Gulya, M.D., in 2001 as the first female President. Further, an important new feature of the AOS annual meeting during the past 25 years was the introduction of a basic science lecturer as a key component.

One of the areas of greatest agreement was the importance of the advent of the standardization of a high quality, university-affiliated comprehensive training program for neurotology. This was a contentious issue as well. Before this point, otologic and neurotologic fellowships were not regulated in terms of length, curriculum, surgical experience, and additional resources provided. With that said, there were some excellent fellowship programs offered in nonuniversity settings, and many AOS members did not think that there was a value in changing the entrenched system. Bruce J. Gantz, President of the AOS in 2010 wrote the following: “Undoubtedly the evolution of the Neurotology Fellowship and ABOto certification was the most controversial issue (over the past 25 years) and I unfortunately was in the middle of the fray! There were many contentious encounters during meetings when we went to a 2 year fellowship and then the certification exam several years later. Looking back I am glad that we were able to move this forward and have a significant impact on our field. The interaction with neurosurgery dramatically changed when we had board certification. We became colleagues instead of combatants. I will say that I learned a lot during these meetings and am certain that I would do it all again.”

Surgical Technologies

The past 25 years may be best characterized by the astounding changes brought on by technology resulting from the increasing speed and capacity of devices created to process and share information. This miniaturization led to the development of smartphones, and lightweight and powerful laptop computers and also resulted in a quantum leap in the technologies used to treat hearing loss.

But the real innovations took place in the minds of the pioneers who dared to consider new ways to treat old problems. This was most true when considering the father of modern otology and neurotology, Dr. William House. Dr. House pioneered acoustic neuroma surgery and cochlear implantation. With regards to both, but especially cochlear implantation, there was tremendous resistance to his new ideas by basic scientists and clinicians alike at AOS meetings. Dr. Michael Glasscock III was the AOS President in 1992. Along with Dr. William House, Dr. Glasscock was one of the two most influential otologists in the United States. The House fellowship and the

Glasscock fellowship trained the bulk of the otologists/neurotologists of the present generation, and as a colleague of Dr. House, Dr. Glasscock had a unique perspective on the struggles in the development of the cochlear implant. He wrote: “The cochlear implant was one of the greatest controversies. Dr. House faced great opposition at meetings to this idea, over a period of many years. His tenacity and attitude of never giving up led to this accomplishment of the century. Dr. House’s achievements help illustrate why the most important key attitude to bring to meetings is an open mind. Vigorous discussions are important, while an overly negative approach can limit new ideas. Galileo is often cited as an example of new science being threatened—in his case, by the Inquisition. A later classic example is the story of Ignaz Semmelweiss, who proposed antiseptic theory 20 years before germ theory was proposed. Simply, he asked doctors delivering babies to wash their hands. He cut the mortality rate at his hospital by 90 percent. In spite of this, his ideas were rejected and dismissed, and he met a tragic end, ostracized by his community. “Belief perseverance” is the tendency to stick to what one knows vs being open to new ideas. Hopefully, when professionals gather in the modern era, as the AOS does, we will continue to advance in our ability to consider and share creative new ideas.” Sam E. Kinney, M.D., President in 2005 shared in the pride of working with Dr. House writing: “The most important new technology presented to AOS is cochlear implants. I was privileged to be on Bill House’s first group of clinicians to do Cochlear implants.”

Harkening back to Dr. William House and acoustic neuromas, Gregory Matz, President in 1999 wrote: “In 1964 I met Bill House and saw how he approached acoustic neuromas, he changed everything and really started the field of otoneurology.”

QUESTION #2: WHAT WAS THE GREATEST CONTROVERSY OF THE PAST 25 YEARS?

As noted above, some of the great developments over the past 25 years were controversial, especially the advent of the cochlear implant and the development of the neurotology fellowship. However many responses to presented articles and panel discussions evolved into debate, dealing with issues that had been around for decades, if not longer. In fact, some of these discussions took place over years and held prominent positions in AOS programs. One such topic was the role of endolymphatic sac surgery for **Menière’s** disease. Another controversy was noted by AOS President in 2008, Clough Shelton. He stated: “Probably the biggest controversy that I heard debated at meetings was that about perilymphatic fistulas. People were divided into camps of believers and nonbelievers.” Other disagreements have mostly faded with time including the role of surgical decompression for Bell’s palsy, while yet others are active such as the role for canal wall up and canal wall down surgeries in the treatment of cholesteatoma.

QUESTION #3: WHAT ARE YOUR REFLECTIONS ON THE MEANING OF BEING ELECTED TO THE AOS?

Not surprisingly there were some excellent responses to this query. The responses fell into five groups: the impact on aspiring otologists, AOS support of research, AOS as a forum for presentation of one's best work, collegiality and relationships, and the honor of membership.

The Impact on Aspiring Otologists

Derald Brackmann, M.D., President, in 1996 focused on the importance of the AOS for young otologists writing: "I think that the AOS is very important to our field in that it stimulates young physicians to work hard, do research and publish so that they can become members of the AOS." Charles Luetje, M.D., President in 1998 echoed these sentiments: "Membership in the AOS is a goal and an honor toward which younger Otologists & Neurotologists aspire because of its rich history and opportunities to perhaps learn of unwritten clinical occurrences."

AOS Support of Research

Joseph B. Nadol Jr., M.D., President in 2009 is one of several voices expressing thanks to the AOS for the support research, writing: "The long tradition of peer review and support for research efforts in the field of otology, particularly research by our younger members has resulted in the well-earned reputation of the AOS as a highly valued senior society in otolaryngology. The AOS has not only been a venue for hearing the best in research across a broad array of subjects related to otology, including deafness, vestibular disease, vestibular schwannoma, otosclerosis, to name a few, but also its support of research has positively influenced the growth of the field." C. Phillip Dasput, M.D., President in 2011 agrees: "The AOS has had a significant impact on the practice of otology/neurotology. I think our research arm reviewing grant applications and awarding money to young investigators has been the linchpin in our reputation." Horst R. Konrad M.D., President in 2003 echoes this sentiment, writing: "The greatest AOS contributions are the mentorship and research funding by our society."

Debara L. Tucci, M.D., President in 2016 was able to review AOS original documents dating back many years and wrote: "I write these reflections having recently spent a day with Kristen Bordignon and Bob Cueva going through a storage room full of boxes dating back to the earliest days of the AOS. This exercise made me grateful for those who made the effort to acquire and preserve the documents and photographs from the earliest time of our subspecialty. What struck me about these materials is how dedicated the members were to advancing care of

our patients with otologic diseases and disorders. Early records from the AOS Research Fund (originally named the "Central Bureau of Research!") reveal their dedication to these principles. Some of the best minds in our field have been funded by the AOS Research fund, and their work has led to significant advances over these many years."

AOS as a Forum for Presentation of One's Best Work

Paul R. Lambert, M.D., President in 2013 writes: "The AOS podium presentations and panel discussions have been the premiere forum for discussing the latest otologic advancements, and the guest lectureships represent the best minds presenting the best science." John W. House, M.D., President in 2013 succinctly adds: "(there were) many great articles and lively discussion."

Collegiality and Relationships

D. Bradley Welling, M.D., Ph.D., President in 2015 underscores a point made by others as well: "the collegiality of the Senior Society (the AOS) and the great mentors and friends are unparalleled in our specialty in my opinion. It is a tremendously enriching association."

The Honor of Membership

Richard A Chole, M.D., Ph.D., President in 2002 wrote: "I feel it is an honor to be a member of the Society. I remember well the day that I was accepted into the Society in 1984 (yikes!)—it was truly one of the highlights of my career. . .—the AOS has been my academic home for over 3 decades. On a personal note, I cherish the friendships that I have been blessed with among the many distinguished members of the AOS." Dr. Julianna Gulya President in 2001 wrote: "Membership in the AOS was a great honor and I felt it represented recognition by my peers of having achieved an outstanding level of performance in the practice of otology. I was fortunate to be able to socialize and learn from the greats in the field and so membership served as a vehicle for both professional and personal growth."

One response that captured the essence of this question was submitted by C. Gary Jackson, M.D., President in 2000, who wrote: "The AOS represents the field's Hall of Fame. However, unlike other Halls of Fame, the achievement of meeting the lofty standards for AOS induction is not traditionally enjoyed at the time of a well-deserved retirement. AOS membership is awarded to those from whom much more is expected. Membership is dynamic. It is, in fact, assumed that one will continue to serve and produce special contribution to our field and to embellish the credentials which afforded them admission to the oldest and greatest medical society on the planet. There can be no higher honor than its membership."