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GERIATRIC OTOLARYNGOLOGY

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Otolaryngology deals with a wide variety of disorders, from communication disorders, allergies, and sinusitis to complex head and neck malignancies. Up to one third of patients seen by the average otolaryngologist are aged 65 or over. With an aging population, health care of the elderly population is becoming increasingly important, but the importance of the older patient has been only partially recognized. Otolaryngology textbooks typically feature a section devoted to the care of the elderly patient; however, the principles of geriatric medicine and issues of concern specific to geriatric otolaryngologic patients have not been widely applied. Furthermore, a significant portion of the literature dealing with geriatric issues in otolaryngology consists of case reports and uncontrolled case series. The purpose of this review is to assess the current knowledge in geriatric otolaryngology and to define important areas for future development.

METHODS

The search was conducted on the National Library of Medicine's PubMed database. The time period covered was from 1980 to April 2001. The search strategy combined various terms for otolaryngology, hearing, balance, head and neck cancer, swallowing, allergy, sinusitis, voice, larynx, smell, and olfaction. Individual hits were refined by using the "related articles" button. Otolaryngology textbooks with chapters on geriatrics were reviewed, and their bibliographies were added to the database. Additional requirements were either that the publication be a review, clinical trial, randomized controlled trial, or meta-analysis, or that terms for risk or age factors be present as title words or MeSH headings. Terms denoting age were *age factors, age, aging, elderly, geriatric, gerontologic, older,* or *octogenarian, nonagenarian,* or *centenarian.*

THE AUDITORY SYSTEM

EPIDEMIOLOGY

Hearing loss is the most common otolaryngologic disability affecting elderly persons. Our understanding of age-related hearing degeneration has increased significantly through several large population-based studies. A wide variety of age-specific changes as well as common otologic diseases occur in elderly persons. Among the best-characterized longitudinally studied populations is the Framingham cohort. A study of 1662 patients from the cohort aged 60 to 90 showed an age-related increase in pure-tone thresholds and a concurrent decrease in speech discrimination. The rate of hearing decline was found to be equal in men and women, but on average, men started with worse hearing. Interestingly, there was also a slight change in contralateral acoustic reflex thresholds in both the men and the women. A further observation of the study was that only 10% of patients who were

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candidates for hearing aids used them. [1] The rate of hearing decline has also been estimated by following a clinic population over a 6-year period. Having the measurements taken by the same audiologist reduced variability in results. In a study of 1475 patients over 6 years, an average decline in hearing of 1 to 8 dB was seen at 250 Hz, and a 10- to 15-dB decline in hearing was noted at 8 kHz. There appeared to be two main patterns of hearing degeneration. The low-frequency pattern of hearing loss appeared to be age dependent, and women had worse thresholds than men. The high-frequency pattern of hearing loss had a different pattern of progression; the rate of threshold change decreased with age. This difference in pattern is interpreted as possibly representing a disorder of the stria vascularis (the organ that generates the endocochlear potential) for the low-frequency loss and a hair cell disorder for the high-frequency loss. [2]

The Baltimore Longitudinal Study of Aging examined 681 men and 416 women from 1965 to 1995 using standard pure-tone audiometry. The individuals were screened for prior otologic disease and noise exposure. This study demonstrated that the rate of loss in hearing sensitivity is greater in women than in men. In men, a decrease in hearing sensitivity is detectable from age 30 on. Women tend to have better high-frequency hearing than men do, and men have better low-frequency hearing. Overall, there was significant variation within the study group. A conclusion of this study was that age-related declines in hearing (with the aforementioned gender factors) occur in persons with no history of noise exposure or evidence of noise exposure on their audiograms. [3] This differs somewhat from the interpretation of the Framingham data, which suggested that the preponderance of male high-frequency hearing loss is related to occupational noise exposure. Epidemiologic studies have consistently shown a 30% to 70% incidence of age-related hearing loss but widely variable assessment of the degree of impairment induced by the hearing loss. Overall, the degree of hearing loss increases with increasing age and is more prevalent in geriatric patients who are institutionalized. [4,5]

Diseases of the Pinna and External Auditory Canal

Cerumen impaction can have a significant effect on the hearing of elderly patients. In a random sampling of hospitalized elderly patients over a 1-year period, 30% were found to have cerumen impaction. Improved hearing was obtained in 75% of ears that underwent removal of cerumen. [6]

Diseases of the Tympanic Membrane and Middle Ear

Numerous studies have examined the age-related risk of otologic surgery for tympanic membrane perforations, both in terms of complications and surgical outcome. Age over 65 has no impact on graft success rate in tympanoplasty. [7] In a study comparing 42 elderly otosclerosis patients (age $>$ 65) with 275 younger adult patients with otosclerosis, Vartiainen [8] determined that there was no significant increase in surgical complications in the older patients and that recovery of hearing was similar in the two groups. The conclusion was that age is not a contraindication to middle ear surgery. There have been no controlled intervention trials comparing quality of life after surgery with hearing aid placement in older patients with otosclerosis.

Eustachian tube dysfunction has been described in the elderly population, but few studies have attempted to establish a clear etiology. When 36 temporal bones of younger adult and elderly patients were examined, calcifications of the eustachian tube cartilage and atrophy of the tensor veli palatini were found to increase in prevalence and severity with age. [9] Another study also found functional compliance to change with aging, which affects the overall function of the eustachian tube. [10] No studies have examined the prevalence of serous otitis media in elderly persons, and the contribution of eustachian tube dysfunction to hearing loss in older people has not been defined.

Otolaryn 1 (Levels B, A): **Randomized controlled trials or prospective cohort studies of otosclerosis patients are needed to compare the effects of surgery or amplification on function and quality of life.**

Otolaryn 2 (Level B): **Patients with unilateral hearing loss of any cause should be compared with those who have bilateral hearing loss in an observational study, either at a single time or longitudinally to assess functional and quality-of-life outcomes.**

Otolaryn 3 (Level A): **The effects of bilateral surgery should be compared with those of unilateral surgery in randomized controlled trials or prospective cohort studies of elderly patients with otosclerosis.**

Otolaryn 4 (Level B): **In order to better define the contribution in older people of eustachian tube dysfunction to hearing loss, an observational study, at a single time or longitudinally, should be carried out in which audiogram and tympanogram findings are correlated with symptoms and signs of eustachian tube dysfunction.**

Otolaryn 5 (Levels, B, A): **If a strong correlation between eustachian tube dysfunction and hearing loss is found (see Otolaryn 4), interventions to improve eustachian tube dysfunction should be tested in preliminary studies and ultimately in a randomized controlled trial to determine if improving eustachian tube function improves hearing in older people with and without presbycusis.**

PRESBYCUSIS OR SENSORINEURAL HEARING LOSS

The incidence and impact of age-related sensorineural hearing loss is well established. Recent studies are beginning to define deficits in addition to the previously described degeneration of the auditory hair cells, auditory neurons, and stria vascularis. Schuknecht and Gacek [11] classified presbycusis on the basis of histologic criteria. In this review of the subject, they reported that the four diagnostic criteria of age-related hearing loss (sensory cell degeneration, neural degeneration, strial atrophy, and cochlear conductive loss) held up in a review of 21 cases that met the clinical diagnosis of presbycusis. Of note was the observation that most cases seemed to have a mixed pathologic pattern. More recent analysis of temporal bone specimens has shown a high incidence of mutations of mitochondrial DNA within the peripheral auditory system. [12]

Age-related changes in the central nervous system (central presbycusis) also play an important role in hearing deficits in older patients. Clearly documented auditory

brain-stem response (ABR) changes occur with aging. Standard testing of ABR examines the auditory pathway from the cochlea to the inferior colliculus. In a study of 92 persons aged 50 to 90 and 30 control persons aged 20 to 29, a progressive delay in wave l, wave III, and wave V of the ABR was found. Interestingly, there was a lengthening in I–V and II–V interpeak intervals observed in the cohort aged 70 to 79 years old that was not present in the oldest subjects. [13] This suggests that there is a cohort of the very aged that has better than average central (brain-stem level) auditory processing. ABR and a central auditory test battery were used to study patients matched for peripheral hearing loss. Patients classified as having a retrocochlear loss (by ABR criteria) overall were found to be poorer performers on the central auditory test battery. [14]

A number of significant changes occur in central processing of auditory information in elderly patients. In a study that compared a cohort of young (average age of 26) with a group of older (average age of 70) men, monaural and binaural temporal thresholds were measured. The elderly group showed poorer performance on both monaural and binaural processing tasks. These measurements were independent of peripheral system disease. [15]

Stach et al [16] investigated the prevalence of central presbycusis in a study of 700 patients aged 50 and older. From each 5-year cohort, 100 consecutive patients with a complaint of hearing loss were enrolled and studied for the effects of central auditory processing on hearing. An age-related increase in central presbycusis that reached an incidence of 95% by the 70s was found. The results were controlled for absolute hearing threshold. This study also examined an age-matched group of persons without complaints of hearing loss. This population also demonstrated the presence of central auditory processing disorders, but at a lower rate. A study of 25 cognitively intact adults with normal hearing revealed central auditory processing declines despite normal cognition, peripheral hearing sensitivity, and linguistic capability. The synthetic sentence identification–ipsilateral competing message test appeared to be the most sensitive measure of central auditory dysfunction. [17] There are no clear data on the significance or the functional impact of these findings.

Impact of Presbycusis on Quality of Life

A number of studies have examined the impact of hearing loss on elderly persons. [5,18–26] A patient-based outcomes study was carried out on 2466 patients between the ages of 17 and 80. Patients were tested with standard audiologic measures as well as with sentences in noise. The researchers found an age-related decrease in performance of auditory tasks such as sentence identification that correlated with increasing hearing thresholds. They also found a matched increase in disability outcomes as measured by validated subjective outcomes tools that identified features of communication disability that led to feelings of isolation and depression. [18] In a study of more than 18,000 nursing-home residents, sensory deprivation due to hearing loss was found to have a significant impact on social interaction. This was compounded when there was associated visual loss. [19] Studies carried out on a cohort of 472 patients with mild to moderate hearing loss with disease-specific outcome measures revealed that even mild hearing losses have a significant impact on perceived emotional, social, and communication function. Sixty-six percent of individuals tested found that this represented a severe handicap for them despite hearing losses starting from only 27 to 55 dB. [20] In a follow-up study, 194 elderly patients were randomized into two groups, one receiving hearing aids immediately and one being placed

on a waiting list. The effect of hearing aid use on quality of life was documented by a variety of outcome tools. A statistically significant effect on quality of life and cognitive function was demonstrated in the patients who received treatment immediately. [21]

Several studies have explored the association of hearing loss and depression or cognitive impairment. [22–26] A study on a population of more than 1100 elderly persons found that hearing loss is correlated with depression and decreased independence. [22] A small (N = 100) case-control study of normal persons and patients with Alzheimer's disease did show an increase in the odds of having dementia with increasing hearing loss. Increasing degree of hearing loss correlated with increased cognitive impairment in this population. [24] There is some evidence to suggest that more accurate assessments of impairment can be derived from the patient's spouse and that discrepancies between hearing level and perceived deficit may be explained by the presence of central auditory processing deficits. [25] Another interesting observation is that hearing loss in the elderly person may be associated with depression. In a study of 43 geriatric patients with major depression, the age of onset of depression correlated with decreased acuity of hearing. It was unclear from this study if the associated hearing loss could be purely related to greater age of the patient, but it does suggest that the association between hearing loss and depression in the elderly population should be investigated. [26]

Inheritance of Presbycusis

The inheritance patterns of presbycusis were studied in the Framingham cohort. Hearing levels in unrelated spouse pairs were compared with those of sibling pairs and parent-child pairs. Pure-tone averages for low-, middle-, and high-frequency hearing were calculated to generate an audiometric pattern that was graded as normal, flat loss (consistent with strial atrophy), or high-frequency loss (consistent with sensory pathology). Hearing levels were correlated between the aforementioned groups. A grouping of hearing threshold changes within parent-child groups and within sibling groups was found. Sisters and mother-daughter and mother-son pairs showed an association of hearing threshold changes at all three frequency sets. The strial pattern of loss showed stronger aggregation and association among female relatives. The sensory pattern of hearing loss was found to aggregate in all related pairs except father-child pairs. This was interpreted as showing that there is a stronger heritable component to the strial pattern of sensory loss and that the inheritance of presbycusis has a genetic component in women and mixed causes in men. [27] The Framingham study also suggested that patients with a history of noise exposure continue to be at greater risk of progressive hearing loss. This may offer an opportunity for intervention. [28]

The Impact of Hearing Loss on Dementia

A number of studies have suggested that there is link or at least an association between hearing loss and dementia. [29] In a study of 30 patients with Alzheimer's disease and 22 patients with generalized cognitive impairment who presented to a memory disorders clinic, 98% of patients failed a pure-tone hearing test. [30] This indicates that certain populations may have extremely high rates of hearing loss. Gates et al [31] examined hearing in a cohort of 82 elderly patients enrolled in a prospective Alzheimer's disease research program. Forty patients were judged to be nondemented (on the basis of the clinical dementia rating scale scores), and 42 were judged to have probable Alzheimer's disease, also on the

basis of dementia rating scores. Pure-tone testing showed no difference in the incidence of hearing loss in the two groups, but the probable Alzheimer's disease group had a much higher incidence of central auditory processing abnormalities. In a follow-up study Gates et al [32] examined patients from the Framingham study and found that hearing loss significantly lowers performance on the verbal portions of the Mini–Mental State Examination. Patients were also tested with synthetic sentence identification with ipsilateral competing message (a test for central auditory dysfunction). A poor score in both ears was associated with a high relative risk of subsequent clinical dementia. This finding suggests that central auditory processing dysfunction may precede or be an early sign of some dementia.

Treatment of Presbycusis

It is well accepted that hearing aids are the treatment of choice for those with moderate hearing impairment. The choice of hearing aids for the elderly patient needs careful consideration. A study of in-the-canal (ITC) hearing aid use in 220 patients with an average age of 69 found significant benefit from amplification. Yet elderly patients found ITC aids difficult to manipulate. [33] It is important to take into account central processing as well as cognitive impairment in assessing the impact of these devices on the aging listener. Currently, no hearing aids provide clear transmission of sound in a noisy background, and furthermore, they do little to improve the function of persons with poor speech discrimination.

Despite the demonstrated impact of hearing loss on quality of life, only 14 % of older persons with hearing loss are fitted with and use hearing aids. No clearly identifiable variables (eg, age, degree of hearing loss, educational status, financial status) have been found to consistently correlate with hearing aid use. [20,21] The newer implantable hearing aids may help with problems of high-frequency gain and feedback, and cochlear implantation is beneficial for patients with very poor speech discrimination. Additional ways of improving the function of those with hearing impairment is the use of assistive listening devices. Amplified doorbells and phones and headphones for television viewing can improve the function of both the independent and dependent older person. For patients with profound hearing loss, cochlear implantation has become the treatment of choice. Shin et al [34] compared the complication rates and outcomes of 27 patients older than 60 with those of a group of younger adult patients. This retrospective study showed no increased incidence of complications in the older group and no significantly different outcome in auditory function between the two groups. Recent studies have begun to examine the cost-effectiveness of cochlear implantation in elderly patients. Francis et al examined the improvement in quality of life in a cohort of adults aged 50 to 80. Using the Ontario Health Utilities Index, this study determined that cochlear implantation improves quality of life and is cost-effective. [35]

Neurotology

A limited number of papers are devoted to neurotologic surgery for the elderly patient. Age was not found to be predictive of return to premorbid function in a series of Ménière's patients treated with labyrinthectomy. [36] There are no large studies of elderly patients treated with gentamicin for Ménière's disease. Treatment of acoustic neuroma has been rapidly evolving over the past 10 years. Currently, age is not considered a contraindication for surgical management of the tumor. Some studies do, however, suggest

that patient age may affect postoperative complications to some degree. Age over 55 was found to be a statistically significant risk factor for the development of postoperative disequilibrium. [37] One series of papers has examined the growth rate of acoustic neuroma and has concluded that a selected group of patients may be candidates for observation rather than surgical excision or radiation. Studies suggest that in growing tumors (30% to 40%), the average growth rate is 1 mm per year, making no treatment other than observation with serial magnetic resonance imaging possible in a selected patient population. [38,39] da Cruz et al [40] examined the quality of life in postoperative acoustic neuroma patients and found no statistically significant effect of age on patient-based outcome data.

Summary

Hearing loss, especially age-related hearing loss, is probably the most common otolaryngologic disorder afflicting the elderly age group. Treatment of presbycusis is currently limited to amplification. The overall low level of use and dissatisfaction with hearing aids is not thoroughly addressed in the literature.

Review of the literature reveals that there are no age-related contraindications to middle-ear surgery. No significant data are available for neurotologic surgery. Recent developments in treating acoustic neuroma have shown that observation may be a reasonable treatment choice for nongrowing or slow-growing tumors in elderly patients.

The past 10 years have shown that central auditory processing disorder, as distinguished from peripheral auditory degeneration, affects the hearing of elderly persons. It is unclear what the impact of this disorder is on communication by older persons. Advances are being made in the understanding of peripheral age-related auditory dysfunction, with large cohort studies identifying both genetic and environmental factors. Thus far, even though there have been tremendous advances in molecular biology of presbycusis in animal models, no human "presbycusis" genes have been identified.

Otolaryn 6 (Level B): **An instrument that would test hearing in small groups set in a noisy environment needs to be developed and validated. Such an instrument would be helpful in all the following recommended studies.**

Otolaryn 7 (Levels B, A): **There is a need for a definitive test of the widely accepted belief that bilateral hearing aids are better than unilateral aids. This could be done by prospective cohort study or by randomized controlled trial. Such studies are needed both for implantable and external-ear hearing aids. Outcome measures should include hearing, speech discrimination, quality of life, and cost-benefit analysis. In the case of unilateral implantation, the unoperated ear can serve as an additional control regarding hearing.**

Otolaryn 8 (Level B): **The value of unilateral and bilateral implantable hearing aids needs to be assessed. A preliminary evaluation would require only measures of hearing and quality of life in the preoperative period with removable hearing aids in use, comparing these with similar measures taken after unilateral or bilateral implantation.**

Otolaryn 9 (Level B): **Studies of elderly patients with profound sensorineural hearing loss are needed that resemble trials for moderate to severe hearing loss in the same age group. The economic benefits of cochlear implantation in the geriatric population is beginning to be defined. Prospective observational studies are now needed that will take into account issues such as loss of independence and cost-benefit ratios.**

Otolaryn 10 (Level B): **An observational study comparing temporal bone pathology, pertinent molecular markers, and audiometric data would significantly aid our understanding of age-related hearing loss.**

Otolaryn 11 (Level B): **Research has linked hearing loss with reduced quality of life, loss of independence, and depression. Observational studies are needed that would correlate patient-based outcome measures and degree of hearing loss. These data should be used to develop guidelines for otolaryngologists to consider in obtaining geriatric consultation for at-risk patients.**

Otolaryn 12 (Level B): **Studies have defined impaired central auditory processing and identified its importance in aging. Central auditory testing is currently performed only in tertiary care centers and takes up to half a day for a single patient. Briefer test panels need to be developed and validated to aid the screening of older patients. This can be carried out as an observational trial for hypothesis generation.**

VESTIBULAR SYSTEM

Balance disorders, though probably as common as auditory problems in elderly persons, are complex and have not been as fully studied. A large percentage of balance disorders can be attributed to cardiovascular disease, neurologic disease, or medication effects, but a significant number can nonetheless be ascribed to disorders of the peripheral vestibular system.

HISTOLOGIC STUDIES

Recent temporal bone studies have shown that there is an age-related decline in both vestibular sensory and ganglion cells. Type I hair cells show a significant decline in the cristae, whereas type II hair cells are lost in both the cristae and the macular organs. [41] There is also a decline of vestibular ganglion cells with age. [42] In a histologic study of human brain stems, Alvarez et al [43] demonstrated that there is an age-related loss of neurons in the descending medial and lateral vestibular nuclei but that the neurons of the superior vestibular nucleus are preserved.

ETIOLOGY OF DIZZINESS

A study by Davis [44] determined the cause of dizziness in 117 consecutive older men aged 50 and over. The average duration of the complaint was 45 weeks. Seventy-one percent of

patients had peripheral vestibular system dysfunction, and benign paroxysmal positional vertigo (BPPV) was the cause of vertigo in one third of these patients. Visual system disturbances were the primary diagnosis in 1%, and proprioceptive disorders the primary diagnosis in 7%. Metabolic or structural lesions of the brain stem were found in 22% of the patients. Psychiatric causes of dizziness were rare. [44]

A study of 50 consecutive patients aged 60 and over found symptoms of lightheadedness and syncope to be associated with cardiovascular causes of dizziness but the symptom of vertigo to be associated with peripheral vestibular disorders. [45] Most patients in this study complained of their presenting symptoms for more than 1 year, suggesting that diagnosis and treatment of many of these complaints is ineffective.

Among the most common peripheral vestibular system pathologies is BPPV. In a cross-sectional study of patients complaining either of dizziness or balance disorders, unrecognized BPPV was found in 9% of patients. This diagnosis was associated with a history of prior falls, depression, and low activities of daily living scores. [46] In a retrospective study from a balance disorder clinic of 1194 patients aged 70 years or older, 39% of patients were found to have BPPV. [47] This combination of findings suggests that all elderly patients complaining of dizziness, even when not complaining of the classic signs of BPPV, should be examined with a Dix-Hallpike maneuver. BPPV is easily treatable with either an Epley maneuver or a variety of home exercises. Comparisons of outcomes of the use of the Epley maneuver versus more conservative treatment for elderly patients have not been conducted.

DEVELOPMENTS IN VESTIBULAR TESTING

Changes in vestibular test results with age are well documented. This would be expected, given the histologic data cited above. Posturography has recently been used to investigate functional balance in elderly persons. Wolfson et al [48] examined 234 elderly persons (average age 76) and compared them with 34 young control persons. The response to conflicting balance information of the two groups was found to differ significantly. Cohen et al [49] evaluated four age cohorts ($<$ 44, 45 to 69, 70 to 79, and 80 to 89); these researchers found a continual age-related decline in sensory organization test scores that persisted into the 80s. These changes were not, however, directly associated with decrease in independence. Baloh et al [50] prospectively examined 72 subjects (aged 79 to 91) with normal neurologic examinations and followed repeated posturography examinations yearly; these researchers found that over time there is a significant increase in sway velocity and degree of sway with dynamic stimulation of balance. Borger et al [51] found that a standardized movement in the visual surround appears to increase sway and perturb balance to a greater degree in elderly subjects. Specific testing needs to be developed to diagnose neurovestibular causes of dizziness and to determine fall risk.

TREATMENT OF AGE-RELATED BALANCE PROBLEMS

Few studies have rigorously looked at methods to improve balance in elderly persons. Generally, balance disorders have been treated with physical therapy. The effect of Tai Chi was recently evaluated by the use of posturography. Twenty-five test persons who practiced Tai Chi were compared with 14 control persons and were found to have statistically better outcomes on dynamic posturography. [52] No long-term studies have correlated diag-

nosed peripheral vestibular system disease with treatment modality and outcome. Also, no prospective studies have been performed to evaluate the pharmacologic treatment of vertigo.

SUMMARY

Balance disorders are common and have a complex etiology. Even though balance disorders in elderly persons can be related to many causes, histologic and epidemiologic data suggest that a significant portion of balance disorders can be ascribed to disorders of the peripheral auditory system. No long-term prospective studies have combined the improvements in diagnostic techniques seen in the past 10 years with patient-based outcome measures. Also, little to no data are available on the correlation between histologic patterns of degeneration and changes seen in vestibular testing.

Otolaryn 13 (Level B): **The available literature supports the idea that vestibular disease is commonly misdiagnosed. An observational study is needed to determine how different practitioners evaluate and treat the chief complaint of dizziness that is assumed to be of vestibular or undefined origin. This study should also determine the prevalence of the use of medications such as meclizine and the prevalence of physical therapy referral. Findings should then be used to develop best practice guidelines.**

Otolaryn 14 (Level A): **Currently, several patient-based outcomes questionnaires for vestibular disorders are available. Vestibular testing can consist of a combination of very different test modalities, including electronystagmography, rotary chair testing, testing of positional nystagmus, and posturography. A prospective randomized controlled study is needed to define which modality or combination of modalities is optimal for evaluating the elderly patient and determining level of vestibular system impairment and impact on quality of life.**

Otolaryn 15 (Level B): **Currently, no data exist correlating aging, vestibular function, and vestibular system histopathology. A collection of temporal bones of different aged patients with vestibular test results is needed to achieve a level of understanding similar to that we have for the auditory system.**

THE NOSE AND SINUSES

SMELL

There has been little recent specific study of sinonasal disease in elderly persons. Olfactory sensitivity has been found to decline with aging. [53,54] This may potentially be related to degeneration of both peripheral and central olfactory pathways. [55,56] One recent study has examined the smell sensitivity in normal elderly persons and patients with Alzheimer's disease. [57]The 80 patients with Alzheimer's disease who were examined had awareness of olfactory sensitivity that was similar to that of chronic sinusitis patients (ninefold less than

that of normal elderly persons). Interestingly, 74% of the Alzheimer's disease patients and 77% of the normal elderly persons who were found to have abnormal smell sensitivity rated themselves as having normal smell sensitivity on a questionnaire.

SINUSITIS AND NASAL DISCHARGE

A common symptom among elderly patients is postnasal drip, which may be constant or induced by food (gustatory rhinitis). It is thought that this may be due to loss of autonomic control, [58] but it is more commonly the result of dehydration from poor fluid intake or a side effect of medications. Few studies have specifically examined the incidence or prevalence of sinusitis in the elderly population. Knutson et al noted that sinusitis is common in elderly persons and may have more subtle presenting signs and that when sinusitis is properly treated, the management of asthma can be improved. [59] The results of sinus surgery for chronic sinusitis has been examined. In a study of 1112 patients who underwent endoscopic sinus surgery, patients older than 65 made up 15% of the patient population. This group had a higher incidence of minor complications but final outcomes that were similar to those for the other age groups. [60]

Otolaryn 16 (Level B): **An observational study is needed to define the incidence of sinusitis in older people and to learn whether diagnostic and treatment approaches to the elderly patient are different. Most studies of sinusitis give an average age but have not assessed their data in terms of age cohorts. If age-related differences are identified, risk-factor assessment (elderly versus nonelderly) will have to be carried out by means of prospective cohort studies.**

Otolaryn 17 (Level B): **Depending on the outcome of the research recommended in Otolaryn 16, a prospective study on the risk factors for sinusitis in the elderly person is needed. This would examine the incidence of allergic and nonallergic rhinitis, as well as the environmental factors that predispose the older person to sinusitis.**

SWALLOWING

In a study of normal volunteers (N = 80) divided into four age cohorts, liquid and semisolid swallows were studied with manometry and videofluoroscopy. Total swallowing time and time to initiation of oropharyngeal swallowing was found to be prolonged in advanced age. Upper esophageal sphincter pressure, peak pressure, and rate of bolus propagation did not appear to be affected by age above 65. [61] Other studies at least partially contradict these data, showing an overall slowing of pharyngeal swallowing time but also confirming an impairment in the opening of the upper esophageal sphincter. [62] In a study of 53 asymptomatic persons with an average age of 75, the repetitive oral suction test was applied to noninvasively evaluate swallowing function. Significant abnormalities in peak suction pressure, frequency of multiple swallows after one ingestion, frequency of polyphasic laryngeal movements, frequency of inspiration after swallowing, and frequency of coughing during or after swallowing were demonstrated. [63] This suggests that a normal (nondysphagic) population of patients has an increased incidence of a variety of physiologic abnormalities in the swallowing process and that concomitant disease may be more

likely to result in pathologic dysphagia in older individuals who develop additional neurologic diseases. [63–65] A series of elderly volunteers without symptoms of dysphagia were examined by endoscopy and fluoroscopy and were found to require a much larger pharyngeal bolus to initiate swallowing. [66] Other researchers have shown that with age there is an increase in pharyngeal swallow delay, a decrease in the duration of swallow, decreased cricopharyngeal swallowing, and decreased peristaltic amplitude and velocity. [67] No studies have linked these changes or targeted treatment of these changes to improved nutritional status and quality of life in elderly persons.

Despite the fact that swallowing pressure remains constant across aging, the reserve capacity of pressure generation within the oral cavity is reduced. It has been argued that concomitant illness might thus put elderly patients more at risk of dysphagia because of reduced reserves. [68] Normal aging does not appear to result in problems with the coordination of swallowing and protective deglutitive vocal cord closure. [69] However, pressure sensitivity in the supraglottis of normal aging volunteers appears to decrease with age. [70] This loss of sensory function may contribute both to dysphagia and aspiration in elderly persons. More recent studies have looked at healthy persons between the ages of 80 and 94. Again, increases in pharyngeal delay as well as a decrease in muscular reserve were demonstrated. Researchers conclude that there may be a role for exercise to improve reserve and possibly prevent later swallowing disorders. [71]

In the population aged 65 and older, 10% to 30% are estimated to have dysphagia, although this number is largely unsubstantiated. [72] Some studies are beginning to address components of the swallowing system in a prospective fashion, allowing the establishment of measurement norms. Using four age cohorts (< 50, 51 to 70, 71 to 85, and > 85) with a sample of 30 in each, Jego et al [73] studied by electromyography the activity of the mylohyoid muscle during swallowing. No significant differences among the groups were found. Rehabilitation of swallowing after head and neck cancer is vital for restoring the patient to a satisfactory functional state. A study of 32 patients with moderate to severe aspiration after resection of a head and neck malignancy showed that prognosis for restoration of function was related to initial tumor size, but age was not a statistically significant variable. [74]

Xerostomia may significantly contribute to dysphagia and is common among elderly persons. The incidence of this problem is estimated to be as high as 1 in 5 elderly noninstitutionalized adults. A study of 67 randomly selected elderly persons (institutionalized and noninstitutionalized) showed that there is a statistically significant ($P < .001$) association between xerostomia (measured by sialometry and questionnaire) and inadequacy of nutritional intake. [75] There is evidence that there is a normal degeneration in salivary gland function with age. [76] However, several studies based on actual measurements of salivary flow suggest that, despite this histologic evidence of loss of salivary acinar structure, flow rates do not decrease with age. Fischer and Ship [77] examined unstimulated and stimulated salivary flow rates in healthy persons (no xerostomia) aged 20 to 40 and 60 to 80 years old. No differences in unstimulated or stimulated parotid flow rates were seen between the two groups. The same researchers have found that dehydration and recovery from dehydration do not have an age-related differential effect on salivary flow. [78] The largest study completed examined 1493 persons between ages 5 and 88 using the whole saliva test rather than just isolating parotid salivary flows. Resting sali-

vary flow was demonstrated to decline in an age-related fashion, thus contradicting studies based on parotid salivary flow alone. [79]

Besides functioning in lubrication during mastication, saliva also produces substances that are important for protecting the mucosal and dental surfaces of the mouth from infection. A recent study of 45 nonhospitalized dentate elderly persons (aged 79 to 89) and 22 nonelderly persons (aged 21 to 51) demonstrated that there is an age-related decline in secretory leukocyte protease inhibitor and lysozyme (antimicrobial proteins found in saliva). Overall, protein levels and electrolytes in the saliva have been shown not to change with age. [80,81] Astor et al [82] observed that medication (particularly anticholinergics and antipsychotics) and systemic illness are probably the most common causes of xerostomia. In an analysis of 100 consecutive patients aged $>$ 60 presenting at a xerostomia clinic, 60% were found to have salivary gland hypofunction. Of these, two thirds were found to suffer from Sjögren's syndrome. [83]

There are clear age-related changes in the physiology of swallowing. Yet for the most part this does not appear to result in clinically significant dysphagia.

Otolaryn 18 (Level B): **Currently, there is no consensus on the optimal evaluation of the dysphagia patient. A comparison of functional endoscopic evaluation of swallowing with modified barium swallow is needed to evaluate swallowing function and outcome of therapy in patients with dysphagia. Specificity and sensitivity should be determined, and cost-benefit analysis should be carried out.**

LARYNX

VOICE

Many studies have looked at the effect of aging on voice quality. [84] A basic description of age-related voice changes includes any alteration in voice pitch and increased variability in pitch. With age, the fundamental frequency of the male voice increases and of the female voice decreases. Estimated subglottic pressure increases with increasing age. Overall, for unclear reasons, women have fewer age-related degeneration effects. [85] In a longitudinal study of 20 patients, voice onset time and spectral features of the voice over 30 years were compared. The men tested showed a decrease in output in the 2- to 4-kHz part of the vocal spectrum. The voice onset time also was found to become prolonged with age. [86]

The histologic changes in aging vocal cords have been studied. Fatty degeneration of the laryngeal muscles increases, and fiber density and elastin fibers in the vocal folds decrease. [87] Increasing ossification of the larynx with aging alters the elastic and biomechanical properties of the insertion points of the vocal cords. A concomitant loss of sulfated glycosaminoglycans in the vocal ligament tendon results in stiffening of the insertion zones. [88]

Several studies suggest that it is important to exclude a variety of disorders prior to making the diagnosis of presbylarynges. Woo et al [89] retrospectively reviewed 151 patients over the age of 60 presenting for evaluation at a voice clinic with a complaint of dysphonia. Only 6 patients were found to fit the diagnosis of presbylarynges, with vocal fold bowing and breathiness. The remaining patients were found to have voice changes

related to central nervous system dysfunction (eg, stroke, Parkinson's disease), benign vocal cord lesions, inflammatory disorders, neoplasia, or vocal cord paralysis. In contrast, Hagen et al [90] retrospectively reviewed 47 patients over the age of 60 presenting with dysphonia. This study found that up to 30% of these patients could be diagnosed with presbylarynges. Treatment for this disorder was speech therapy; phonosurgery was reserved for failures of speech therapy.

Tucker [91] reported the results of vocal fold medialization using a modification of the Isshiki technique in 6 patients with the diagnosis of presbylarynges. The report claims that there are significant short-term benefits in terms of voice improvement; however, progressive relaxation of laryngeal tissues makes the long-term results of this procedure unsatisfactory. No studies using more current concepts of laryngeal framework surgery have focused on the elderly voice.

> ***Otolaryn 19 (Levels B, A)***: **An epidemiologic study of the true incidence and etiology of age-related voice disorders is needed. For this purpose, a normal population (ie, not referred or otherwise selected patients) needs to be identified and screened for voice disorders. New surgical methods of treatment should be explored. Prospective randomized studies comparing conservative with surgical treatment for presbylarynges would follow.**

MALIGNANCIES

In a retrospective study of 414 patients who underwent total laryngectomy, age greater than 65 or even age greater than 80 was found not to be a variable contributing to medical or surgical complications. [92] Pera et al [93]as well as other retrospective studies have confirmed these findings. In a study of 371 patients, Huygen et al [94] also showed no increase in complication with age; however, age above 70 was found to be significantly predictive of death within 3 years after treatment. Patients older than 70 have also been found to have a higher incidence of developing a second primary neoplasm after surgical or radiotherapeutic treatment of laryngeal cancer. [95] Laryngectomy, though safe for elderly patients, may have different long-term consequences. In a study of 58 patients following laryngectomy, a decrease in long-term expiratory function was found. This was more pronounced in patients over age 65, even when age-related decrease in pulmonary function was considered. Treatment with bronchodilators reversed this trend. [96]

HEAD AND NECK CANCER

The effect of aging on head and neck cancer has been assessed in a number of retrospective studies. The most common complications surveyed in these studies were mortality, myocardial infarction, pneumonia, pulmonary embolus, wound infection, postoperative urinary tract infection, and postoperative bleeding. Generally not examined were change in mental status, percentage of patients who were converted from an independence to an institutionalized status, and the incidence of decubitus ulcers.

The management of cancers of the oral cavity is challenging from both an oncologic and a rehabilitative standpoint. A retrospective study in the *British Journal of Cancer* examined prognostic factors in the treatment of squamous cell carcinoma of the tongue. In stage I and II cancers, age above 65 was found to be a significant negative prognostic

factor for survival. Age was not found to influence the prognosis of stage III and IV cancers. [97] In a series of 187 poor-prognosis patients (recurrence of tongue cancer after radiotherapy), age at tumor presentation was found to be significant in determining outcome in men. Older men (age range 50 to 80) were statistically more likely to have shorter survival than age-matched women or younger persons. [98] Barzan et al [99] examined prognostic factors in 438 patients with a variety of head and neck malignancies. Patients were divided into three groups by age. Age was not found to be correlated with outcome. In a comparative study of major head and neck surgery in 115 patients older than 70, Kowalski et al [100] demonstrated that there is no age-related effect on surgical mortality. This was interpreted as an indication to treat elderly patients with standard oncologic protocols. McGuirt and Davis [101] found an increased incidence of complications in head and neck cancer patients aged over 80 but also found that this group and younger patients had a similar prognosis for survival and function. In a retrospective cohort study, age over 65 or age over 80 was not found to be a risk factor for the development of distant metastasis after resection of stage III or IV head and neck cancer. Screening for distant metastasis in geriatric patients should therefore depend on disease-based risk factors rather than age. [102] Janot et al [103] prospectively compared the predictive effects of clinical information and pathologic information in 108 patients presenting with head and neck cancer. Multivariate analysis showed that age and nodal status are prognostic for survival. Age, tumor status, and histologic differentiation are predictive of metastatic disease. In a retrospective study of 207 patients, Magnano et al [104] found no effect of age on the incidence of metastatic disease. Age also does not appear to have an effect on the radiosensitivity of tumors. [105] Recent attempts at curative radiotherapy for head and neck cancer have used an accelerated dosing schedule. Age above 70 years as an independent variable was not found to be associated with an increased incidence of radiotherapy complications such as mucositis and weight loss. [106]

Age does not appear to play a role in the defects and physical disabilities induced by aggressive resection of head and neck cancer. The development of microvascular techniques for reconstruction of defects of the oral cavity, pharynx, and hypopharynx has significantly improved the rehabilitation of these patients. Bridger et al [107] retrospectively studied 26 patients older than 70 years and 91 patients younger than 70 years and found no differences in the postoperative complication rates for these two groups. Distribution of the type of cancer resected and the size of the defect were similar in the two groups. Shestak et al [108] studied 72 patients in 10-year age cohorts ranging from 50 to 80 years old who underwent microvascular free-flap reconstruction; they found no statistically significant difference in complication rates in the patients ranging from age 70 to 79. Some older studies suggested that poor nutritional status may have more of an adverse affect on surgical outcome in older than in young patients. A retrospective study also demonstrated a significant difference in evaluation and preoperative treatment of malnutrition in elderly and younger patients. Elderly patients were found to have a higher complication rate when in poor nutritional status, but younger patients were found to be more likely to receive pre- and perioperative nutrition treatment. [109] For further discussion, see the section on preoperative nutrition in Chapter 13, Cross-Cutting Issues.

From retrospective studies there appears to be no contraindication to standard oncologic treatment for head and neck cancer in older patients. Prospective studies are needed to

confirm this. There is also little information on surgical decision making with regard to age.

Otolaryn 20 (Level B): **We need to understand better the present practice regarding head and neck cancer care. For this purpose, we recommend a prospective, multi-institutional study of a cohort of older patients with head and neck cancer. Observations would include comorbidity, functional status, advance directives, and physician recommendations, followed by description of the perioperative and postoperative course, complications, recovery, and rehabilitation. The outcome would be a regression-based model of preoperative, perioperative, and postoperative risk factors predicting outcomes, as well as a description of present practice.**

Otolaryn 21 (Level B): **We need to know the outcomes to be expected in older patients with head and neck cancer who are surgical candidates. A prospective multi-institutional study is needed that measures functional status, quality of life, social functioning, and depression as outcomes. Preoperative data should be compared with follow-up data for 1 to 3 years. Observations should be stratified by the scope of the surgery performed.**

Otolaryn 22 (Level A): **Depending on the outcome of the study recommended in Otolaryn 21, a prospective, possibly randomized controlled study comparing different surgical approaches for individual cancers (eg, tongue, pharynx) should be designed and performed.**

Otolaryn 23 (Level B): **The wealth of data emerging from molecular biology studies of head and neck cancer needs to be explored in terms of age. Prospective observational studies are needed to determine if the markers and molecular genetics of head and neck cancer are different in the elderly person and if this impacts treatment decisions.**

KEY RESEARCH QUESTIONS IN GERIATRIC OTOLARYNGOLOGY

Otolaryn KQ1: **How can research be used to improve hearing-related quality of life for elderly persons?**

Hypothesis-testing: There is a need for a definitive test of the widely held belief that bilateral hearing aids are better than unilateral. This can be done by a well-designed prospective cohort study or by a randomized controlled trial. The quality-of-life impact and cost-benefit ratios of hearing rehabilitation should be studied for new hearing aids, implantable hearing aids, and cochlear implants. Outcome measures should include hearing, speech discrimination, quality of life, and cost-benefit analysis. The design could be a targeted cohort study or a randomized controlled trial.

Otolaryn KQ2: Can disorders of the peripheral vestibular system be accurately recognized and their causes determined, and does targeted treatment benefit elderly patients with balance disorders or dizziness?

Hypothesis-generating: Diagnostic techniques have improved in the past 10 years. We now need large prospective cohort studies to determine the prevalence of the various major causes of dizziness and balance disorders and the prevalence of the use of nonspecific drugs like meclizine and of physical therapy.

Hypothesis-testing: Subsequently, researchers should identify patients suffering dizziness or balance disorders due to particular causes and run randomized controlled trials on each type of patient, comparing outcomes after various treatment regimens. Quality of life would be an important outcome measure in these randomized controlled trials. Thus, a comprehensive set of guidelines could be developed for classification of patients by cause and for treatment of each class.

Otolaryn KQ3: **Does standard management of head and neck cancer compromise quality of life in the elderly patient to a greater degree than in the younger patient?**

Hypothesis-generating: From retrospective studies there appears to be no contraindication to standard oncologic treatment for head and neck cancer on the basis of incidence of complications. Prospective studies are needed to confirm this. There is also little information on surgical decision making with regard to age. A prospective multicenter study is needed to determine if young and old patients are treated differently.

There is little or no information on the impact of head and neck surgery on independence. For this purpose, we recommend a prospective, multi-institutional cohort study of patients with head and neck cancer. Observations would include age, comorbidity, functional status, advance directives, and physician recommendations, followed by description of the perioperative and postoperative course, complications, recovery, and rehabilitation. The outcome would be a regression-based model of preoperative factors predicting outcomes, as well as a description of present practice.

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