IAPO-Interamerican Association of
Pediatric Otorhinolaryngology

Optimizing Learning – the Vital Role of the Otolaryngologist

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Introduction

Optimal learning is dependent upon optimal communication, and this depends upon the function of the pupil's communication abilities – hearing, voice, speech and language. All of these functions are the medical responsibility of Otolaryngology.

Over the past century, the world-wide economic basis of society has undergone a dramatic evolution. A hundred years ago , manual labor, muscle power, was the mainstay of each society's economic s[1]. Today, it is communication, for almost all productivity is based on the worker's ability to communicate, i.e., the ability to use and understand language; this includes person-to-person communication, as in the service industries, but increasingly communication with and through computers as in all sectors of the modern economy. This economic transformation has a medical consequence. When manual labor was the economic engine, medicine under the banner of public health, researched and carried out programs and interventions, for prevention of malnutrition and infection. This was done chiefly through the provision of optimal nutrition and sanitation, which were necessary for the optimization of physical health in a manual labor economy. Today, Medicine, and in particular Otolaryngology, must provide the research and carryout interventions to prevent communication disorders so as to optimize communication abilities. Communication disorders in hearing, voice, speech and language are major consequences of the diseases of the ENT organ systems.

Communication disorders all greatly impair learning, the acquisition of new knowledge, behaviors, skills, values, preferences, understanding, and the synthesis of different types of information. Learning as a process is characterized by the increase of knowledge over time and is dependent on the expression and reception of language. Built into the biological basis of language is the phenomenon of the critical — maximally sensitive — period, a time when there is optimal ability to acquire the basic principles of language so that a complete language can develop from these[2]. One of the first investigators to appreciate and document the phenomenon of a 'sensitive period' was an otolaryngologist, Jean-Marc Gaspard Itard, in his reports of 1801 and 1807 about an abandoned child whom he named Victor[3;4]. Itard's report and many since have provided evidence for the principle that early deprivation of language inputs results in decreased linguistic function and consequently impaired communication and cognitive ability[5;6] .

How common prevalence

The prevalence of childhood communication – hearing, voice, speech and language – disorders have been documented during the past half century. There is no single worldwide rate as definitions vary. Additionally, reports differ in how the data were gathered and the social structure within which they were gathered. Hearing loss is the communication disorder with the most information available, and can serve as a model to examine these three variables, which for hearing are the particular defined thresholds, the nature of the population sample, and the society from which it was obtained. Permanent childhood hearing loss in post industrialized nations has a prevalence from 3.1 per 1000[7] to 3.4 per 1000[8] with significant differences between ethnic, social , and geographic groups with in each country. The children in the developing nations have a prevalence of permanent hearing loss on the average of 7.6 per 1000[9] or twice the rate of those in post industrialized societies. These numbers do not include unilateral hearing loss, hearing loss from 20 to 30 or 40dB loss and fluctuating losses from otitis media with effusion. Hearing loss from otitis media with effusion has been well studied. Two reports of hearing loss from otitis media with effusion from different societies , Nigeria[10] and India[11] give a prevalence of a hearing loss of >20dB as 109/1000 (10.9%) and 119/1000 (11.9%). The Nigerian report shows the great disparity in prevalence of otitis media with effusion between the rich and poor with the prevalence 2.7 times greater in the poor children than in those from a more wealthy community. The hearing loses were also correlated with economic status: the poorer the community the worse the hearing loss. As a generalization the prevalence of hearing loss is approximately 3 to 8 children per 1000 with a permanent hearing (0.3 to 0.8%) loss and another 100 to 200 per 1000 (10-20%) with a non permanent hearing loss from otitis media with effusion, depending on the society in which that child lives.

The same methodological variables are present in the prevalence data for voice, speech and language disorders. There is an estimated childhood prevalence for voice disorders is in the rage of 60 to70 per 1000 (6% to7 %)[11-14]; speech disorders from 70 to 90 per 1000(7 to9%) [15-17] and language disorders from 20 per 1000 to 80 per 1000 (2% to8%) with a mean prevalence of 59.5 per 1000 (5.95%)[18]. It appears that between 130 to 140 per 1000 (13 to 14%) of children have at least one communication disorder[19]. The disease burden is greater in the developing world and in children living in poverty.

Effects of diseases of hearing, voice, speech and language on communication

These communication disorders have a very deleterious effect on the child's learning, socialization and eventual economic productivity[1;20-23]. Preschool children with speech and/or language delays are at increased risk for learning disabilities [24]as exemplified by reading skills[25;26], written language[27], academic underachievement[28;29] and lower IQ scores[26]. Children with permanent hearing losses have language deficiencies proportional to their loss[30-34]. Children with losses PTA between 40 to 80db were found to have a language quotients of 40%[30] and with losses from 20 to 40 db a language quotients of 80%[33;35;36]. Learning is also diminished from the hearing losses associated with otitis media with

effusion[10;37;38 39;40]and unilateral hearing losses[41;42]. These learning deficiencies are exacerbated by the extrinsic factors of poverty[43-45] and /or inadequate linguistic input[46;47].

Case Finding — Screening

There is ample evidence that the earlier a communication disorder is identified, the better the outcome. This is well documented in numerous studies of early and late intervention of children with hearing impairments such as the 1998 report of Yoshinaga-Itano et al [48], the 2000 report of Moeller et al [49] and the 2007 report of Bubbico et al [50] for severe to profound hearing losses and the reports of Wake et al [33;34] for hearing loss which are moderate to severe.

The need for early detection of hearing loss was recognized in the first quarter of the 20th century and childhood hearing impartment has been the major focus of otolaryngology for screening. There was, from the beginning of the 20th century, a concern for the hearing of school children but there was no accurate method for hearing assessment. The major advance in the diagnosis and care of children's' hearing was the development of the first commercial vacuum tube audiometer, the Western Electric 1A by Fletcher [51;52] and introduced as a clinical tool by E.P. Fowler Jr. and R.L. Wengel in 1922 [53]. This was used to objectively test the hearing of school children and resulted in the 1928 article entitled ''Three million deafened school children'' [54] which was a major stimulus to the establishment of hearing screening programs for young school children in the middle of the 20th Century.

The first experimental screening of a large population cohort of newborns (n = 1,388) for hearing loss was carried out at the Johns Hopkins Medical Hospital, Baltimore from 1959 to 1962 [55]. J. Hardy, in 1965[56] suggested, apparently for the first time, the use of a high-risk register for detecting infants with hearing loss. This low-technology approach not carried out at the time but with a significant subsequent history, was to consist of a form that could be filled out and compiled by a clerk. Downs and Sterritt [57], realizing that the newborn nursery allowed almost universal accessibility, carried out in one Colorado hospital a newborn hearing screen pilot study using an auditory stimulus and observation of the infant's response. While Downs' study demonstrated that screening with the audiometer and observation might be feasible, the use of subjective assessments of infant reaction to sound lacked both sensitivity and specificity. This approach was little used, as noted in the report of the 1971 Committee on Fetus and Newborn Joint Statement on neonatal screening for hearing impairment [58]. Following this report, the strategy for early detection shifted from the technologically and professionally intensive protocol to the high risk register, based on the etiologies of congenital and early onset hearing loss as were understood at the time [59]. The use of the high risk registry identified about half of the affected newborns[60] . During the late 1980s and early 1990s, there was developed an efficient technology- otoacoustic emissions - for newborn hearing screening. In a large study with comprehensive follow-up in the transient evoked otoacoustic emissions test (TEOAE) was used to screen 1,850 newborns. It was found to be both sensitive and specific [61]. These and other studies led to world wide establishment of physiologically-based universal

newborn infant screening programs. Since then, the development of genetic testing for hearing loss has provided the potential for an etiological diagnosis at time of audiometric detection and the possibility to predict delayed onset of the disorder[62]. The hearing-impaired child is identified by differing administrative, professional and technical systems in different countries, but is primarily cared for by the otolaryngologist.

Presently there are no universal screening programs for voice, speech and/or language. The identification of these children is not organized and relies on the awareness of parents, medical providers, teachers and others. As many of these children are seen by otolaryngologists to determine if the child's speech delay and/or unintelligible speech are due to a hearing loss, the otolaryngologist can and should also use one of a number of accurate and efficient language and speech screening tools[17;63-65] such as the Early Language Milestones Screen© [66-68] to identify such a child. These screening instruments are applicable from birth until 3 years or older. They are also used to monitor the outcomes of interventions to aid the child's language development.

Interventions and Outcomes

The otolaryngologist can institute interventions once a disorder is recognized so as to ameliorate the condition, and so optimize learning. Each communication disorder has a variety of effective care or cure modalities, all of which can help reduce language and learning deficits. Once a hearing loss is diagnosed by either an auditory or physiological audiometric evaluation and/or otoscopic examination, it can be effectively cared for by tympanostomy tubes, adenoidectomy, tympanoplasty, cochlear implants, bone-anchored hearing aids, traditional hearing aids, FM classroom amplification systems, etc.

Voice disorders are diagnosed though direct observation with a fiber optic nasopharyngoscope and/or a computerized voice analysis. Once the diagnosis is made, appropriate therapy, either voice therapy and/or micro laryngeal surgery is carried out. Speech disorders are diagnosed by computerized speech analysis, nasopharyngoscopy, especially for velopharyngeal insufficiency — hypo nasal speech - and are corrected with speech therapy and/or appropriate surgery. All of this medical care is the province of the otolaryngologist.

The optimization of learning requires much more than just the providing of the appropriate physical care. The effectiveness of the intervention in assisting learning must be measured, documented and reported to the otolaryngologist so that the effectiveness of the intervention can be accessed and modified if necessary. There needs to be a communication between the school and the otolaryngologist — between education and Medicine. Presently these are two very distinct domains with almost no permanent structure for exchange of information. For the 21st century — the communication age — change is essential in the exhausted paradigm of professional isolation. There must be the transfer of appropriate information from the school (from classroom level) for each child with a communication disorder to the otolaryngologist who is caring for that child, and vice versa. The school would report to the educational progress of each pupil with a communication disorder. If this appears to be inadequate, then the

otolaryngologist would review the intervention(s) to determine their effectiveness. An example would be a child with a unilateral hearing loss who has an FM system in the class room. Let us imagine that this child's reading and language skills are below expectations. This is reported to the otolaryngologist. Several possible causes would then be investigated which would include, further hearing loss in the better ear, further loss in the effected ear, lack of compliance by the teacher or the child, faulty FM equipment etc. The defect would be rectified or further cared for and the child continually followed to determine if the reading and language skills did improve. This scenario with multiple feedback loops would optimize the learning for the effected child.

Another example would be a child with severe dysphonia - hoarseness who could not participate in classroom oral actives and consequently was underachieving. Let us imagine that this child has been in voice therapy but the therapy was ineffective. This could be due to a lack of compliance or to laryngeal pathology so extensive that the voice therapy was unable to overcome the problem. The otolaryngologist would have this information, it appears that the compliance is excellent, and thus a mircolaryngoscopy would be carried out to surgically correct the disorder and allow the child to participate in the class's oral activities so as to optimize that child's learning.

Another use of feedback is exemplified in the following scenario. A two year old with a 35dB hearing loss from otitis media with effusion is found upon language screening, to have a marked expressive and receptive language delay. Tympanostomy tubes are placed and the child achieves near-normal hearing for the next few months or so. The child's language is reassessed using the language screen. One possible outcome is that the expressive and receptive language has improved and the child now has age-appropriate linguistic function. In this case the intervention has optimized learning. But there can be and are other outcomes: that the hearing is now normal but the language function only improves slightly or not at all, or even deteriorates. Each one of these outcomes mandates a further investigation to determine the cause of the linguistic deficiency which could be a form of specific language impairment, autism, or some from of developmental delay. This then allows the child to have a correct diagnosis and intervention so as to optimize learning.

Conclusion

The children of today will be the providers of the future communication based economy. There is a world-wide shift in the age of the populations, in that there are fewer young and people live longer. This aging demographic[69] is most pronounced in the post-industrialized societies of Western Europe, North America and Oceania and less so in the developing world. In 2050 there will be fewer workers, age 20-65 to support those aged less than 20 and over 65. Each worker will have to be much more economically efficient so as to insure the same standard of living for that pupation in 2050 as in 2009. As the economy becomes increasingly communication-based, it will be necessary for each worker to have optimal communication skills for learning. The otolaryngologist has the task of optimizing these skills through the care of children's communication disorders.

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