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1 Introduction: On the Treatment of Hearing Loss

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The World Health Organization (WHO) estimates that more than 5% of the global population, 360 million people, suffer from disabling hearing loss, making hearing loss one of our greatest societal disease burdens.[1] In the United States alone, nearly 75% of people aged 70 and older have high-frequency hearing loss of at least moderate severity.[2,3] Over the next three decades, it is expected that the number of individuals in the United States between the ages of 65 and 84 years will double, while those over the age of 85 years will triple.[4] Given the fact that the handicapping nature of hearing loss increases with severity, and severity of hearing loss increases with age, the demand for hearing care services is expected to increase precipitously. Estimates for this demand on hearing care are not available, however, the demand for physician services has been cited as increasing by 60% over the same period of time.[5]

The societal effects of hearing loss have caught the attention of government and professional organizations. In 2017, three reports, one from the WHO and two from the United States' National Academies of Sciences Engineering and Medicine (NAS) summarized *the costs of unaddressed hearing loss and cost-effectiveness of interventions*[6] and *hearing health care for adults, priorities for improving access and affordability*[7] and *the promise of assistive technology to enhance activity and work participation*.[8] The WHO's findings indicate that annually, the global cost of untreated hearing loss falls between $750 and $790 billion USD. This extreme financial burden attempts to capture three dimensions of cost: (1) direct cost: those incurred by health care and educational systems; (2) indirect cost: those incurred as a result of lost productivity or inability to contribute; and (3) intangible/societal costs: those motivated by stigma-induced behavior, withdrawal from social activity or grief.

Pearl ✓

In a 2017 report, the WHO presented a compelling case for the treatment of hearing loss in their financial-minded analysis of the cost of unaddressed hearing loss.

1. The cost of unaddressed hearing loss is estimated at $750 to $790 billion USD, annually.
2. Unemployment and premature retirement, resulting from untreated hearing loss, cost $105 billion USD annually.
3. The annual cost of childhood hearing loss is estimated between 24 and 47 billion USD, with a dependency on a country's GDP and the inclusion of cochlear implantation.

These staggering statistics have motivated action on the part of the WHO. During the 17th World Health Assembly, a resolution was issued that will urge governments to do the following:

- Integrate strategies for hearing care within primary health care systems.
- Establish training programs for ear and hearing health.
- Improve access to affordable, cost-effective, high-quality, assistive hearing products.
- Ensure universal access to hearing loss prev ention and hearing care.

The 2017 NAS consensus report *The Promise of Assistive Technology to Enhance Activity and Work Participation* was prepared with a scope that included and extended to treatment of disabilities beyond hearing loss. The committee preparing this report noted that assistive products and technologies may reduce handicapping effects and increase an individual's

contribution to society. Nine barriers to treatment and benefit were identified in the report; five of which are included below, in the original language. Each of these conclusions present considerations that are addressed in this text book. For the reader new to hearing care and the treatment of hearing loss, these will read as insights that should be the prime interest in reading the chapters of this text book. The reader experienced in the treatment of hearing loss may be surprised that these statements, written in the context of treatment of many different disabilities, resonate strongly as value statements for the rehabilitative services provided by the audiologist.

1. Assistive products and technologies hold promise for partially or completely mitigating the impacts of impairments and enhancing work participation when appropriate products and technologies are available, when they are properly prescribed and fitted, when the user receives proper training in their use and appropriate follow-up, and when societal and environmental barriers are limited.
2. When matching individuals with appropriate assistive products and technologies, it is important to understand the complexity of factors that must be optimized to enhance function. Selecting, designing, or modifying the correct device for an individual and providing training in its use, as well as appropriate follow-up, are complex but necessary elements for maximizing function among users of assistive products and technologies.
3. Education regarding the availability of assistive products and technologies and knowledge and training that empower users to self-advocate or have a significant other (e.g., family member, friend, or professional) advocate for them are important elements in achieving successful access to appropriate assistive products and technologies and related services.
4. Professionals involved in disability determinations cannot assume that because an individual uses an assistive product or technology, this device is always effective for that person, that it mitigates the impact of the person's impairment, or that it enables the person to work. Environmental, societal, and individual factors must also be considered.
5. Additional research is needed to understand how the specifications for and use of assistive technologies and products and related services impact inclusion in society and work participation for individuals with disabilities. Such research may not only enhance knowledge in these areas, but also inform the development of rational resource utilization, including informing cost/benefit analyses and coverage for devices and related services.

Narrowing the focus to treatment of hearing loss, two organizations work to aggregate data on the treatment of hearing loss with hearing aids. The first of these is the United States' Hearing Industries Association (HIA); membership of the HIA consists of corporations that provide products and services for the treatment of hearing loss. The HIA, in partnership with the Better Hearing Institute, developed a periodic MarkeTrak report that documents consumers' (i.e., patients') experience with hearing aids in the United States. The second and similar group, the European Hearing Instruments Manufacturers Association (EHIMA), sponsors ongoing market research to understand the impact of treating hearing loss throughout the European Union and other parts of the world, not including the United States. Both the HIA and EHIMA hold interest in increasing public awareness of hearing loss and ensuring high standards of hearing care. Similar to the MarkeTrak report, EHIMA sponsors a periodic EuroTrak report.

►**Fig. 1.1**[9] combines data from MarkeTrak and EuroTrak. Shown as yellow bars are estimates for the prevalence of self-reported hearing loss across EHIMA-tracked countries. Red bars show the proportion of a country's total population that suffer from hearing difficulty and the yellow bars show the proportion of people, with hearing difficulty who have pursued hearing aids (also described as hearing aid uptake). At 14.1%, Japan reports the lowest uptake of hearing aids with Norway, at 42.5%, reporting the highest. Of the countries assessed, the United States ranks third with uptake of 30.2%. The factors that contribute to hearing aid uptake are complex, including social and societal contributors, as well as the nature of a country's distribution channel, service providers, and health care policies.

When considering the uptake of hearing aids, it would be natural to assume that countries with state organized health care, providing free hearing aids, would have greater rates of hearing aid uptake. While countries with free market health care, in which patients pay for hearing aids, may have comparatively lower rates of hearing aid uptake. Based on data provided in 2016, it's clear that the United Kingdom (state organized health care) ranks higher at 41.1%, when compared to the United States at 30.2%.

Conclusions can be drawn across health care systems and countries. Firstly, patient outcomes and satisfaction are improving over time. This trend

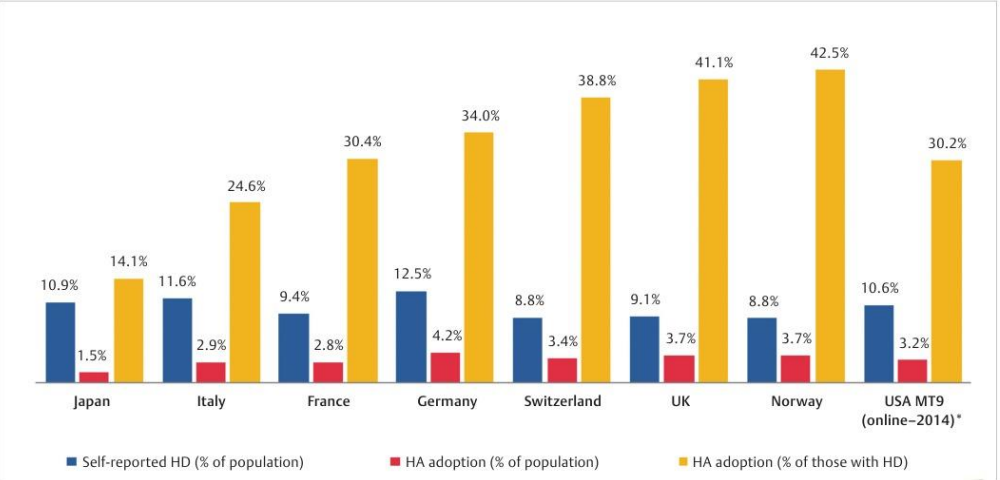

Fig. 1.1 Data from EuroTrak and MarkeTrak 9 reports are shown for countries around the world. Blue bars show estimated proportion of the population that self-reports hearing difficulty (HD). Red bars show estimated proportion of the population that reports hearing aid ownership. Yellow bars show estimated proportion of the population with hearing difficulty who have pursued hearing aids.

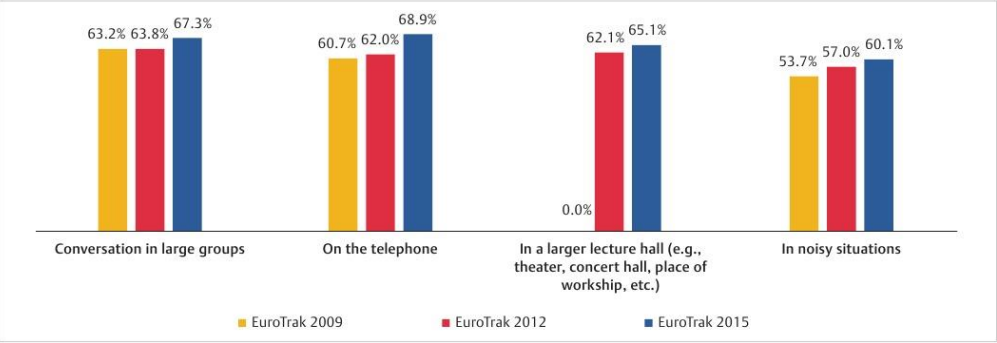

Fig. 1.2 Data from EuroTrak 2009, 2012, and 2015 are shown for four challenging listening conditions. Hearing aid wearers report a small but consistent improvement in satisfaction over time for all assessed conditions: large groups, telephone, lecture hall, and noisy situations.

is observed in both the MarkeTrak and EuroTrak, across a variety of questions intended to probe different domains of interest. ▶ **Fig. 1.2** shows data from EuroTrak 2009, 2012, and 2015, in which 4,133 hearing aid users rated their satisfaction when listening with hearing aids in large groups, telephone, lecture hall, and generally noisy situations. Small but consistent improvements are observed in each category over time. Because many hearing aid technologies are designed to positively affect listening in these and similar listening conditions, these findings stand as testimony for the forward advancement of technological solutions for treating hearing loss.

1.1 Best Practice in the Treatment of Hearing Loss

No single treatment plan will accommodate the needs of every patient, for this reason, the information presented here should be viewed as guidance

and not a literal recipe to be explicitly followed. This is reflected in most best practice documentation that are presented as guidelines and written in a manner that arms the clinician with the information necessary to support evidence-based decision making. Two examples of guidance documents, provided by the American Academy of Audiology are named below. Both of these documents can be freely accessed at http://www.audiology.org

1. Guidelines for the Audiologic Management of Adult Hearing Impairment
2. American Academy of Audiology Clinical Practice Guidelines: Pediatric Amplification

This text book introduces the reader to fundamentals in the treatment of hearing loss, while describing the best practices that should be considered when structuring a rehabilitative treatment plan. A series of general components are common to most treatment plans. By minimally accommodating these components, a logical progression of care is assembled that can be applied to most of the treatment, whether it is hearing aids, cochlear implants, or a bone conduction solution. ▶**Fig. 1.3** shows a series of thematic components that are common to most plans for the treatment of hearing loss.

Every treatment plan begins with the assessment of patient needs, which includes but is not limited to diagnosis of hearing loss and characterization of hearing ability, measurement of speech understanding ability, and collection of pretreatment subjective reports that describe a patient's perception of their own function or expectations from the treatment.

Next, in the case of technological treatment, verification and validation of that treatment is included. Verification describes a type of measurement that objectively documents the manner in which a treatment compensates for the diagnosed hearing loss; Chapters 7 and 8 provide a detailed information on the verification of hearing aids. Following verification, behavioral validation of effectiveness provides evidence that the treatment is beneficial and addresses activity limitations that may be of concern.

Post-treatment patient reports are the most common method of outcomes assessment. A clinician's choice of outcome measure is often discretionary and may be motivated by a multitude of factors that are discussed in Chapter 10.

Finally, the treatment plan should include elements of auditory rehabilitative care and/or therapy. Rehabilitative care often involves one-to-one or group counseling sessions, in which participants focus on the pragmatics of managing their hearing loss. It is also common practice to prescribe regimented auditory training, which often takes the form of a game-like task of speech understanding in noise that patients complete in an effort to improve their listening ability.

Fig. 1.3 Five steps, central to a best practice workflow in the treatment of hearing loss are shown. These provide a high-level framework, within which more detailed protocols and treatment strategies may be developed.

These fundamental steps offer a clear framework around which an individualized treatment plan can be constructed. Options for that treatment are presented throughout this textbook, ranging from technological solutions (i.e., hearing aids or cochlear implants) to rehabilitative tools and strategies that facilitate the success of a technology-based treatment.

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