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Hearing Loss and Dementia in the Aging Population

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Key Words

Health economy · Dementia · Elderly · Cognitive decline ·
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Abstract

For some years, policy makers and medical scientists have both begun to focus more on chronic noncommunicable diseases. It is well known that cardio-cerebrovascular disease, tumors, diabetes, and chronic obstructive pulmonary disease (COPD), are considered areas of major interest in many scientific projects and health programs. The economic impact of cardio-cerebrovascular disease in EU alone is more than EUR 200 billion, while tumors have an impact of EUR 150 billion. The direct and indirect cost of brain disorders exceeds EUR 700 billion a year. Among the brain disorders, the devastating impact of dementia on affected individuals and the burden imposed on their families and society has made prevention and treatment of dementia a public health priority. Interventions that could merely delay the onset of dementia by 1 year would result in a more than 10% decrease in the global prevalence of dementia in 2050. Unfortunately, there are no known interventions that currently have such effectiveness. The manifestations of age-related hearing loss in many older adults are subtle and, thus, hearing loss is often perceived as an unfortunate but inconsequential part of aging. Researchers report that hearing loss seems to speed up age-related cognitive decline. Researchers suggest that treating hearing loss more aggressively could help delay cognitive decline and dementia. Furthermore, there is an increasing interest in better understanding the pathophysiologic correlations between hearing loss and dementia. Hearing loss in older adults, in fact, is associated independently with poorer cognitive functioning, incident dementia, and falls. Further research investigating the basis of this connection as well as the pathomechanism of the two diseases will further our ability to treat dementia.

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2010]. For all studies combined, the incidence of dementia doubles with every 5.9-year increase in age from 3.1 per 1,000 person-years at age 60–64 to 175.0 per 1,000 person-years at age >95 [Duthey, 2013]. Numbers of new cases increase and then decline with increasing age in each region: in Europe and the Americas, peak incidence is among those aged 80–89 years; in Asia, it is among those aged 75–84 years, and in Africa among those aged 70–79 years. Researchers estimated that there are nearly 7.7 million new cases of dementia each year worldwide, implying one new case every 4 s. Some 3.6 million (46%) would occur in Asia, 2.3 million (31%) in Europe, 1.2 million (16%) in the Americas, and 0.5 million (7%) in Africa. In high-income countries, informal care (45%) and formal social care (40%) account for the majority of costs, while the proportionate contribution of direct medical costs (15%) is much lower. In low-income and lower-middle-income countries, direct social care costs are small, and informal care costs (i.e. unpaid care provided by the family) predominate.

The Italian National Institute of Statistics (Istat) estimated that there were approximately 250,000 people suffering from Alzheimer's disease (AD) and similar dementias in Italy in 2005 [Istat, 2008]. However, since AD and various forms of age-related cognitive deterioration have complex diagnoses, their prevalence is likely to be underestimated. AD is known as a 'family illness' because family caregivers of AD patients often represent hidden secondary patients [Chiatti et al., 2013].

Dementia, linked to the use of and expenditure on health and social care in Europe, is estimated to be responsible for 11.2% of the total years of disability in people over 60 years of age, compared with 9.5% for stroke, 5.0% for cardiovascular disease, and 2.4% for cancer. For some time in Europe, the prevalence of AD has increased exponentially with age [Wancata et al., 2003].

Early detection of AD has a number of benefits to patients, their caregivers, and health and social care systems. Patients and caregivers receive timely information on the diagnosis and prognosis of the disease and the available support services from both health and social care and volunteer agencies. Counselling services, lifestyle advice, cognitive training, and pharmacological therapy may all safeguard cognition and function, thereby delaying institutionalization and thereby financially benefitting health and social care systems [Todd and Passmore, 2008]. Many patients and caregivers present early, and are thus able to access pharmacological treatment at an early stage. Other benefits include providing a diagnosis, information and education, counselling and community support, cognitive training, and lifestyle advice.

What about Dementia Today and Tomorrow?

The World Alzheimer Report estimated that there were 35.6 million people living with dementia worldwide in 2010 and, according to forecasts, this figure will reach 65.7 million by 2030 and 115.4 million by 2050 [Reitz and Mayeux, 2014; Wimo and Prince,

Is It Possible to Evaluate the Cost of Dementia?

The estimated annual worldwide cost to society of dementia, USD 604 billion, highlights the enormous impact that dementia has on socioeconomic conditions worldwide. If dementia care were a country, it would be the world's twenty-first largest economy, ranking between Poland and Saudi Arabia. The scale of these

costs is understandable given that the 35.6 million people worldwide comprise 0.5% of the world's total population; a high proportion of people with dementia need some care, ranging from support with instrumental activities of daily living, to full personal care and round-the-clock supervision. Further, in some high-income countries, one third to half of the people with dementia live in resource- and cost-intensive residential or nursing homes [Knapp and Prince, 2007; Macdonald and Cooper, 2007]. In the US alone, AD, the most frequent cause of dementia, characterized by a progressive decline in cognitive function particularly in the memory domain, causes an estimated health care cost of USD 172 billion per year [Reitz and Mayeux, 2014].

Diabetes is also a risk factor and, in longer-term cohort studies, midlife hypertension and raised cholesterol are associated with the onset of AD in later life [Kivipelto et al., 2001; Ott et al., 1999; Skoog et al., 1996]. This has led to the speculation that atherosclerosis and AD are linked disease processes, with common pathophysiological and etiologic underpinnings (e.g. ApoE ϵ 4 polymorphism, hypercholesterolemia, hypertension, hyperhomocysteinemia, diabetes, metabolic syndrome, smoking, systemic inflammation, increased fat intake, and obesity) [Casserly and Topol, 2004].

One of the complicating factors for interventions in this area is that evidence suggests that while hypertension, raised cholesterol, and obesity in midlife increase the risk for later onset of dementia, blood pressure levels, cholesterol, and body mass index fall progressively before the onset of the disease [Skoog et al., 1996; Stewart et al., 2005, 2007].

Future Trends in the Dementia Context?

It is particularly difficult to make confident projections of future economic costs. If we assume that all potential background factors remain unchanged, and we factor in only the forecasted increases in the number of people with dementia, then by 2030 worldwide societal costs will have increased by 85%. In reality, the evaluation of future costs is not simple. Future costs could be influenced by macroeconomic factors and by dementia-specific factors such as: increases in numbers of people with dementia will occur much more rapidly in low- to medium-income countries (LMIC) because of the more rapid demographic ageing in those regions; with economic development, wages will rise rapidly in LMIC, and resources for dementia care, particularly formal medical and social care, are unequally distributed worldwide. With increased awareness will come increased demand for care.

The Alzheimer's Association [2014] underlines that women are the epicenter of AD, representing the majority of both people with the disease and their respective caregivers. Adding to women's Alzheimer's burden, there are 2.5 times as many women as men providing intensive 24-hour 'on-duty' care for someone living with AD. Among caregivers who feel isolated, women are much more likely than men to link isolation with feeling depressed (17% of women vs. 2% of men).

There are currently 15.5 million caregivers providing 17.7 billion hours of unpaid care in the US, often at the detriment of their own health. The physical and emotional impact of dementia caregiving resulted in an estimated USD 9.3 billion in increased health-care costs for Alzheimer's caregivers in 2013. The total national cost of caring for people with Alzheimer's and other dementias is projected to reach USD 214 billion this year, *not* including unpaid caregiving by family and friends valued at more than USD 220 bil-

lion. In 2014, the cost to Medicare and Medicaid of caring for those with Alzheimer's and other dementias will reach a combined USD 150 billion with Medicare spending nearly USD 1 in every USD 5 on people with Alzheimer's or another dementia. Medicare paid approximately USD 11 billion of this cost [Hurd et al., 2013].

It is not easy to evaluate the cost of dementia in Italy. The number of caregivers in Italy and thus indirect support is estimated to exceed 770,000 [Pasquinelli et al., 2008] at an annual cost of more than EUR 13 billion a year.

Key issues for future international cost-effectiveness studies include the following issues: consequences for patients if the diagnosis is shifted from AD-dementia to pre-dementia states; bridging the gap between clinical trial populations and patients treated in clinical practice; translation of clinical trial end points into measures that are meaningful to patients and policymakers/payers and, measurement of long-term effects. Reliable surrogate end points in clinical trials that are sensitive to detect effects even in pre-dementia states are also essential to include, as well as robust and validated modelling methods from pre-dementia states that also take into account comorbidities and age. Finally, the ethical consequences of early diagnosis should be considered [Wimo et al., 2014].

Hearing Loss: A Growing Pathology

Hearing loss is an important public health concern with substantial economic costs and social consequences. Hearing impairment is the most frequent sensory deficit in human populations and affects newborns, children, adults and the elderly [Mathers et al., 2000]. In infants and children, hearing impairment retards the developmental of language and educational progress. In adults, it causes difficulties in both professional and social lives as well as stigmatization. In the US, 26.7 million adults \geq 50 years old suffer from hearing loss, and 3.8 million use hearing aids [Chien and Lin, 2012]. In England and Wales, 8.1 million suffer from hearing loss, of whom 1.4 million use hearing aids [Taylor and Paisley, 2000]. According to the United Nations, the overall global population will grow from 6.9 billion in 2010 to 9.3 billion in 2050. The proportion of the population aged 60 or older will nearly double in the same period, reaching 21% of the total population in 2050, or nearly 2 billion people in that year.

In 2008, the WHO estimated that over 360 million people (5.3% of the global population) have disabling hearing loss, 80% of them in low- or middle-income countries. These figures are expected to rise substantially in the future due to aging of the global population. There may be more than 700 million people with hearing loss worldwide by 2015; in Europe, untreated hearing loss is currently estimated to cost EUR 213 billion a year [Roth et al., 2011; Shield, 2006]. After adjusting for differences in age structure, the prevalence of adult hearing impairment was highest in developing regions and lowest in high-income regions [Roth et al., 2011].

It is estimated that in 2025, 900 million people throughout the world will be hearing impaired; it is expected that around 90 million of these people will be from Europe. In the next 100 years, hearing impairment is projected to affect about 30% of people due to Europe's aging population. In Finland, 1 in 7 people deal with varying degrees of hearing loss, while some form of hearing loss affects 1 in 6 Italians. In Sweden and Denmark, 1 in 10 people suffer from hearing loss. Medical costs (for hearing aids, for example) account for only a small percentage of the overall cost. Untreated

hearing loss costs in Europe are EUR 213 billion per year, about EUR 473 per year for each adult European. Sixteen percent of all adult Europeans, more than 71 million people, suffer from a hearing loss greater than 25 dB hearing level (HL); the definition of hearing loss recognized by the World Health Organization [Shield, 2006]. In the EU alone, more than 55 million people are hearing impaired, and the costs in the EU of unaided hearing impairment of all grades are EUR 168 billion per year. Based on population statistics, it is possible to calculate the yearly costs of untreated hearing loss in some European countries: Germany EUR 30.2 million; France EUR 22.4 million; UK EUR 22.0 million; Italy EUR 21.3 million; Spain EUR 16.3 million; Poland EUR 14.0 million, and the Netherlands EUR 60 million. In the US, hearing loss increases from 5% for 40–49 year-olds to 75% for those >80 years of age. Hearing aid use in adults starts to appear in those people aged 50–59 years; however, only a minority, 15% of people older than 80 use such devices [Chien and Lin, 2012]. Hearing loss is a very common medical condition among adult populations of industrialized countries [National Aging Info, 1998], and it is generally accepted that its impact on communication is largely related to deterioration in quality of life [National Council of Aging, 1999]. As a result of maladaptive communication strategies, people with hearing loss may perceive their social skills to be poor and experience a reduced self-esteem if a combination of hearing impairment and poor coping strategy contributes to failure in their roles [Espmark et al., 2002].

The Economic Evaluation

The economic evaluation of cochlear implants in adult patients requires a common methodological approach among the countries, and within the country among the dedicated institutions. The cost/quality evaluation depends not only on whether there is monolateral or bilateral intervention, but also on the patient's age and duration of deafness, and their commitment during postsurgery recovery. To be able to assess this issue from an economic perspective, studies will be necessary to: support the cost-effectiveness results of cochlear implantation (CIs) in adults; evaluate cost-effectiveness of simultaneous and sequential bilateral implants; evaluate the components of direct and indirect nonmedical costs, as well as direct medical costs, in cost-effectiveness analysis [Turchetti et al., 2011].

The most cost-effective option identified is a one-stage audiometric screen for bilateral hearing loss ≥ 30 dB HL at age 60, repeated at ages 65 and 70. This option has an incremental cost-effectiveness ratio of GBP 1.461 compared to GP referral and would mean an additional 15,437 adults benefit from hearing intervention per 100,000 population at age 60 and above. The cost-effectiveness acceptability curve shows that screening is more cost-effective than GP referral, provided that a quality adjusted life year is valued at GBP 2,000 or more. Adult hearing screening would provide a cost-effective way to improve quality of life for older adults. Piloting an audiometric screen offered to all adults aged 60, 65, and 70 years to identify bilateral hearing loss ≥ 30 dB HL is recommended [Morris et al., 2013].

To evaluate the value of the investment in CI, the non-device-related costs of bilateral, simultaneous CI (BSiCI) versus unilateral were compared, and the dollar amount for potential cost savings in direct costs for BSiCI versus sequential CI was established. The total operating room (OR) time for unilateral CI and BSiCI was 3 h 0 min and 4 h 37 min, respectively, with a mean difference

of 1 h and 36 min (SD = 0 h, 6 min). In Canada the cost of OR and postanesthetic care unit support staff was USD 3,102 and 4,240 for unilateral CI and BSiCI, respectively, with a mean difference of USD 1,138 (SD = 216). Unilateral CI supplies totaled USD 1,348 compared to USD 1,822 for BSiCI supplies with an average difference of USD 438 (SD = 123). The total direct costs for a unilateral CI (excluding implantable device and surgeon fees) were USD 4,362 compared to USD 5,823 for BSiCI. Simultaneous implantation can lead to a potential saving of USD 2,901 compared to sequential implantation [Merdad et al., 2014]. Besides the cost analysis, the CI surgery was found to be well tolerated with few surgical complications. It is reported that patients, also over the age of 79, benefited from the device surgery with improvements in hearing and quality of life [Lundin et al., 2013].

Hearing Loss and Dementia

The association between hearing impairment, the diagnosis of dementia, and the role of sensory therapy in its management has been suggested for some time, and it is now the subject of research and soon the subject of new clinical approaches as well, although further concerted research is needed. Current understanding of the subject requires a large commitment among experts who are able to integrate both experience and research from several areas, including hearing loss and dementia. The clinical aspects and manifestations of age-related hearing loss in many older adults are often perceived as an unfortunate but inconsequential part of aging. Researchers say hearing loss seems to speed up age-related cognitive decline, and think that treating hearing loss more aggressively could help delay cognitive decline and dementia. There is an increasing interest in better understanding the pathophysiologic correlations between hearing loss and dementia. Hearing loss in older adults, in fact, is associated independently with poorer cognitive functioning, incident dementia and falls [Lin, 2012].

Further research is critically needed that investigates the mechanistic basis of these associations and whether hearing rehabilitative therapies could affect these outcomes [Lin et al., 2013]. Broader public health initiatives are needed to inform the public and medical providers of the importance of age-related hearing loss and how to optimally address hearing loss through a combination of concerted counselling, awareness, installation of induction loop systems in public places, and proper fitting of hearing aids and other rehabilitative devices.

Disclosure Statement

The author states that there is no conflict of interest to be disclosed.

References

- Alzheimer's Association: 2014 Alzheimer's disease facts and figures. *Alzheimers Dement* 2014;10:e47–e92.
- Casserly I, Topol E: Convergence of atherosclerosis and Alzheimer disease: inflammation, cholesterol, and misfolded proteins. *Lancet* 2004;363:1139–1146.
- Chiatti C, Masera F, Rimland JM, Cherubini A, Scarpino O, Spazzafumo L, Lattanzio F: The UP-TECH project, an intervention to support caregivers of Alzheimer's disease patients in Italy: study protocol for a randomized controlled trial. *Trials* 2013;14:155.

- Chien W, Lin FR: Prevalence of hearing aid use among older adults in the United States. *Arch Int Med* 2012;172:292–293.
- Duthey B: Priority medicines for Europe and the World 'A Public Health Approach to Innovation'. Geneva, World Health Organization, 2013.
- Espmark AK, Rosenhall U, Erlandsson S, Steen B: The two faces of presbycusis: hearing impairment and psychosocial consequences. *Int J Audiol* 2002;4:125–135.
- Hurd MD, Martorell P, Delavande A, Mullen KJ, Langa KM: Monetary costs of dementia in the United States. *N Engl J Med* 2013;368:1326–1334.
- ISTAT – National Institute of Statistics: Health and Use of Health Services in 2005. Rome, National Institute of Statistics, 2008.
- Kivipelto M, Helkala EL, Laakso MP, Hänninen T, Hallikainen M, Alhainen K, Soininen H, Tuomilehto J, Nissien A: Midlife vascular risk factors and Alzheimer disease in later life: longitudinal, population based study. *BMJ* 2001;322:1447–1451.
- Knapp M, Prince M: Dementia UK – A report into the prevalence and cost of dementia prepared by the Personal Social Services Research Unit (PSSRU) at the London School of Economics and the Institute of Psychiatry at King's College London, for the Alzheimer Society. London, Alzheimer Society, 2007.
- Lin F: Implications of hearing loss for older adults. Aging and Implantable Hearing Solutions Extended Abstracts from the Cochlear™ Science and Research Seminar Paris, France, March 19–20, 2012. *Audiol Neurotol* 2012;17:4–6.
- Lin FR, Yaffe K, Xia J, Xue QL, Harris TB, Purchase-Helzner E, Satterfield S, Ayonayon HN, Ferrucci L, Simonsick EM; Health ABC Study Group: Hearing loss and cognitive decline among older adults. *JAMA Int Med* 2013;173:293–299.
- Lundin K, Näsvall A, Köbler S, Linde G, Rask-Andersen H: Cochlear implantation in the elderly. *Cochlear Implants Int* 2013;14:92–97.
- Macdonald A, Cooper B: Long-term care and dementia services: an impending crisis. *Age Ageing* 2007;36:16–22.
- Mathers C, Smith A, Concha M: Global burden of hearing loss in the year 2000. Geneva, World Health Organization, 2000.
- Merdad M, Wolter NE, Cushing SL, Gordon KA, Papsin BC: Surgical efficiency in bilateral cochlear implantation: a cost analysis. *Cochlear Implants Int* 2014;15:43–47.
- Morris AE, Lutman ME, Cook AJ, Turner D: An economic evaluation of screening 60- to 70-year-old adults for hearing loss. *J Public Health (Oxf)* 2013;35:139–146.
- National Aging Information Center: Profile of older Americans. Washington, Administration on Aging, 1998.
- National Council of Aging: The consequences of untreated hearing loss. *ORL Head Neck Nurs* 1999;41:17–37.
- Ott A, Stolk RP, van Harskamp F, Pols HA, Hofman A, Breteler MM: Diabetes mellitus and the risk of dementia: the Rotterdam Study. *Neurology* 1999;53:1937–1942.
- Pasquinelli S, Rusmini G: Badanti: La nuova generazione – caratteristiche e tendenze del lavoro privato di cura. Milano, Istituto per la Ricerca Sociale, 2008. http://www.qualificare.info/upload/DOSSIER_Badanti_la_nuova_generazione.pdf.
- Reitz C, Mayeux R: Alzheimer disease: epidemiology, diagnostic criteria, risk factors and biomarkers. *Biochem Pharmacol* 2014;88:640–651.
- Roth TN, Hanebuth D, Probst R: Prevalence of age-related hearing loss in Europe: a review. *Arch Otorhinolaryngol* 2011;268:1101–1107.
- Shield B: Evaluation of the social and economic costs of hearing impairment. A report for Hear-It AISBL. 2006. <http://www.hear-it.org/multimedia/>.
- Skoog I, Lernfelt B, Landahl S, Palmertz B, Andreasson LA, Nilsson L, Persson G, Odén A, Svanborg A: 15-year longitudinal study of blood pressure and dementia. *Lancet* 1996;347:1141–1145.
- Stewart R, Masaki K, Xue Q-L, Peila R, Petrovitch H, White LR, Launer LJ: A 32-year prospective study of change in body weight and incident dementia: the Honolulu-Asia Aging Study. *Arch Neurol* 2005;62:55–60.
- Stewart R, White LR, Xue Q-L, Launer LJ: Twenty-six-year change in total cholesterol levels and incident dementia: the Honolulu-Asia Aging Study. *Arch Neurol* 2007;64:103–107.
- Taylor RS, Paisley S: The clinical and cost effectiveness of advances in hearing aid technology 2000. NICE Report. http://www.gserve.nice.org.uk/nicemedia/pdf/hearing_hta_report.pdf.
- Todd S, Passmore P: Alzheimer's disease – the importance of early detection. *Eur Neurol Rev* 2008;3:18–21.
- Turchetti G, Bellelli S, Palla I, Berrettini S: Systematic review of the scientific literature on the economic evaluation of cochlear implants in adult patients. *Acta Otorhinolaryngol Ital* 2011;31:319–327.
- Wancata J, Musalek M, Alexandrowicz R, Krautgartner M: Number of dementia sufferers in Europe between the years 2000 and 2050. *Eur Psychiatry* 2003;18:306–313.
- Wimo A, Ballard C, Brayne C, Gauthier S, Handels R, Jones RW, Jonsson L, Khachaturian AS, Kramberger M: Health economic evaluation of treatments for Alzheimer's disease: impact of new diagnostic criteria. *J Intern Med* 2014;275:304–316.
- Wimo A, Prince M: World Alzheimer Report 2010: The Global Economic Impact of Dementia. London, Alzheimer's Disease International, 2010.

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