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COSTS AND EFFECTIVENESS OF HEARING AID REHABILITATION IN THE ELDERLY

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Abstract

Hearing aid (HA) rehabilitation was studied in northern Finland. The costs of HA fitting were examined at two hospitals, Kainuu Central Hospital and Oulu University Hospital. The patients were visited and interviewed at their home and use of HAs was charted. The benefit of HAs was evaluated using generic and disease-specific questionnaires. The effect of follow-up counselling of HA users on HA use and on the benefit of HAs was studied.

The proportion of all HA possessors that are regular users has clearly increased during the past twenty years, and the number of non-users, in particular, has decreased significantly. Only 5.3% of first fitted HAs were not in use in 2001.

The costs of HA fitting in 2000 were approximately € 900. There was not much difference in the costs between Kainuu Central Hospital and Oulu University Hospital. The price of a HA accounted for somewhat less than half of the total hospital costs, and the costs of the audiology personnel made up roughly a third of the overall costs.

Emotional problems of HA users were significant before HA fitting, but six months after HA fitting the number of patients who felt handicapped by their hearing problems had decreased significantly. This could be seen in the results of both the social and the emotional items of the disease-specific health-related quality-of-life (HRQOL) measure, the short version of the Hearing Handicap Inventory for the Elderly (HHIE-S). The benefit could not, however, be shown with the generic HRQOL instrument, the EuroQol questionnaire (EQ-5D), which apparently lacks sensitivity for measuring changes brought about by audiological intervention.

Follow-up counselling of HA users can significantly increase HA use and decrease the number of non-users. It can also significantly increase the users' handling skills. The cost of follow-up counselling is approximately € 83 per fitted HA, which is an 8.7% increment to the calculated cost of fitting a HA.

Keywords: counselling, disability, handicap, hearing aid fitting, hearing rehabilitation, quality of life

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Abbreviations

ARHI	age-related hearing impairment
BEHL	better ear hearing level
BTE	behind-the-ear
CI	confidence interval
dB	decibel
DSP	digital signal processing type
ENT	ear-nose-throat
EQ-5D	Euro Quality of life questionnaire
EU	European Union
HA	hearing aid
HHIE	hearing handicap inventory for the elderly
HI	hearing impairment
HRQOL	health-related quality of life
ITE	in-the-ear
KCH	Kainuu Central Hospital
kHZ	kilohertz
L_{eq}	equivalent sound level
OUH	Oulu University Hospital
PTA	pure tone average
QALY	quality-adjusted life year
S.D.	standard deviation
SRT	speech reception threshold
VAS	visual analogue scale
WHO	World Health Organisation
WRS	word recognition score

List of original publications

This thesis is based on the following articles, which are referred to in the text by their Roman numerals.

I Vuorialho A, Sorri M, Nuojua I, Muhli A (2006) Changes in Hearing Aid Use over the Past Twenty Years. European Archives of Otorhinolaryngology. 263(4):355-60. Epub 2005 Nov 9. PMID: 16283199.

II Vuorialho A, Sorri M, Nuojua I (2004) Costs of Hearing Aid Rehabilitation in Two Finnish Hearing Centres. Audiological Medicine 2:1-5.

III Vuorialho A, Karinen P, Sorri M (2006) Effect of Hearing Aids on Hearing Disability and Quality of Life in the Elderly. Internal Journal of Audiology. Jul 45(7):400-5.

IV Vuorialho A, Karinen P, Sorri M (2006) Counselling of Hearing Aid Users is Highly Cost-effective. European Archives of Otorhinolaryngology. [Epub ahead of print] PMID: 16799805.

Contents

1 Introduction

Hearing impairment (HI) is one of the most common disabilities in the world, and it is often referred to as a hidden disability. The World Health Organisation (WHO) estimated that in 2005 there were 278 million people in the world with a disabling HI; in 68 million the loss of hearing began in childhood and in 210 million it began in adulthood. A further 364 million people are estimated to have a mild HI. Two thirds of the burden of HI is in developing countries, and these estimates have increased progressively since they were first made in 1986. (WHO 2006)

Approximately 15.0% of the 55 to 75-year-old population in Finland is faced with HI that apparently needs rehabilitation, and the number is increasing (Uimonen *et al.* 1997). Since health care resources are limited and there is a growing need for health care services, choices have to be made regarding what interventions are provided, in what quantities, and to whom. The recent discussion about limited resources in the health care sector in Finland has pointed out the importance of rational arrangement of public health care. As a part of health care, hearing aid (HA) rehabilitation of hearing impaired people and the results and costs of rehabilitation also need to be assessed (Government report to Parliament, 2002).

The Finnish publicly funded health care system provides hearing impaired persons free HAs, including maintenance, and the public health care sector is also obliged to counsel people in the use of their HAs. The provisions on fundamental rights also emphasize that central and local authorities (municipalities) are responsible for ensuring that adequate health care services are available.

In Finland, the process of HA rehabilitation starts from the person's own health centre or private doctor and leads to a central hospital where a HA is fitted. After HA fitting, counselling is given at the hearing centre, or sometimes at home and also by the health centre. The waiting time for HA fitting in hearing centres in Finland has been observed to vary between hospitals, and an inquiry revealed that the mean waiting time in 2002 was 6.7 months (Memorandums of the Ministry of Social Affairs and Health 2003). After the first visit to the hearing centre, hearing impaired have had to wait for HA fitting 0-24 months (Memorandums of the Ministry of Social Affairs and Health 2003). The whole process from health centre to receiving a HA has taken up to three years. Many attempts have been made to make this time shorter. In the beginning of 2005, 6000 hearing

impaired had been waiting for HA fitting over six months (Punnonen, The Association of Finnish Local and Regional Authorities 2005a), and on April 30, 2005, the total number who were waiting was nearly 9000 (Punnonen, The Association of Finnish Local and Regional Authorities 2005b). Upon inquiry half of the hospitals reported that they are able to provide needed HA rehabilitation within an acceptable time, while as many as one fourth reported not being able to do so (Punnonen, The Association of Finnish Local and Regional Authorities 2005a).

In Finland, until 2005 a HI greater than 30 dB averaged over the frequency range of 0.5-2 kHz was considered an indication for a HA. In practice, however, the limit was often set at 40 dB. The proportion of first HAs of all fitted HAs in Finland was 45% in 2002, and binaural fitting was rare (Memorandums of the Ministry of Social Affairs and Health 2003). Since the beginning of April 2005 the indication basis for HA fitting was lowered to 30-40 dB over the frequency range of 0.5-4 kHz (Ministry of Social Affairs and Health 2005). The new aim compared with the former one is also to strive for binaural hearing. In specialized medical care, the joint municipal board of a hospital district must now assess the need for care within a maximum of three weeks of receiving a referral, and any medical care found to be necessary must be provided within three months, or at the very latest, six months. Most HAs are fitted by central hospitals, and only 5% of HA fittings are performed in the private sector (Barton *et al.* 2001).

HA rehabilitation has often been regarded as an expensive treatment. Another common presumption is that delivered HAs are not in use. However, these assumptions are based on out-dated data. In order to arrange hearing rehabilitation for future reference, there is a definite need to examine the costs, use and benefit of HAs in Finnish health care. In addition, means for providing efficient rehabilitation at appropriate cost should be sought.

This investigation was made in order to find out the present status of hearing rehabilitation, its costs, effects and benefits, in Finland. However, a large portion of the results can also be generalized for other countries.

2 Review of the literature

2.1 Hearing impairment

According to the WHO's definitions (International Classification of Impairments, Disabilities and Handicaps (ICIDH), WHO 1980, International Classification of Functioning, Disability and Health, Geneva: World Health Organization 2001), HI is a loss of function due to a physical disorder. To categorise the severity of a HI and to determine the presence of any organic reason for it, clinical audiometric tests, such as pure tone and speech audiometry, are used.

Several classifications have been presented for defining the degree of HI. The World Health Organization's classification (1991, 2006) and the EU work group's classification (1996) are currently in widespread use in Finland (Table 1). The WHO criteria define a person as being at least mildly hearing impaired if the average hearing threshold level over the frequency range of 0.5 to 4 kHz is equal to or exceeds 26 dB in the better ear, measured with standard audiometry (WHO 2006). The more recent EU criteria define this threshold point as "exceeding 20 dB" over the frequency range of 0.5-4 dB (EU Work Group 1996, Martini *et al*. 2001).

Table 1. Classifications of hearing impairment

Grade of HI	WHO (1991, 2006) $BEHL_{0.5\text{-}4\ kHz}$	EU Work Group (1996) $BEHL_{0.5\text{-}4\ kHz}$
Mild	26 - 40 dB	$20\ dB < x < 40\ dB$
Moderate	41 - 60 dB	$40\ dB \leq x < 70\ dB$
Severe	61 - 80 dB	$70\ dB \leq x < 95\ dB$
Profound	$\geq$ 81 dB	$\geq$ 95 dB

$BEHL_{0.5\text{-}4\ kHz}$ = better ear hearing level at the frequencies of 0.5, 1, 2 and 4 kHz

2.1.1 Prevalence of hearing impairment

The prevalence of HI depends on the definitions of HI in terms of the criteria and the age of the population (Table 2). In many studies of the adult population over 18 years of age, prevalence is estimated to be approximately 15–20%.

Table 2. Examples of population-based studies of hearing impairment in the adult population.

Reference	Age	Prevalence (%)		Study style
Davis		BEHL	WEHL	Self-reported and measured HI reported,
1989, 1995	41-50	8.2	20.0	PTA $_{0.5\text{-}4\ kHz}\geq$ 25 dB
	51-60	18.9	33.9	
	61-70	36.8	51.2	
	71-80	60.2	71.2	
Rosenhall *et al.*		Male	Female	Self-reported
1987	70	12	6	
	79	32	27	
Uimonen *et al*.		WHO	EU	Measured.
1997	55-75	15.0	38.4	Better ear PTA $_{0.5\text{-}4\ kHz}\geq$ 20 dB (EU), Better ear PTA $_{0.5\text{-}2\ kHz}\geq$ 26 dB (WHO)
Uimonen *et al.*		WHO	EU	Measured.
1999	45	1.3	6.6	Better ear PTA $_{0.5\text{-}4\ kHz}\geq$ 20 dB (EU), Better
	55	4.3	15.9	ear PTA $_{0.5\text{-}2\ kHz}\geq$ 26 dB (WHO)
	65	10.0	37.2	
	75	32.5	64.5	
Rosenhall *et al.*	45-54	9		Self-reported
1999	55-64	17		
	65-74	23		
	75-84	30		
Karlsmose *et al*.		BEHL	WEHL	At least two threshold levels >25 dB (0.5, 1,
1999	31-50	7.4	15.9	2, and 4 kHz)
Karlsmose *et al*.		Male	Female	Better ear and worse ear PTA $_{0.5\text{-}4\ kHz}\geq$ 25 dB
1999		BEHL 8.5	BEHL 2.5	
		WEHL 21.7	WEHL 10.1	

BEHL= better ear hearing level, WEHL= worse ear hearing level, PTA= pure tone average

Because of differences in study populations and available national population statistics, the studies are not comparable with each other or between countries. HI has been reported to exist in approximately 40% to 50% of people over the age of 75 by many researchers (Moscicki *et al*. 1985, Cruickhanks *et al*. 1998, Sindhusake *et al*. 2001, Smeet *et al*. 2002).

Studies indicate an increase in the prevalence of HI with age (Davis 1989, 1990b, Rosenhall *et al*. 1999, Uimonen *et al*. 1999). The mean hearing level change at ages over 70 years is reported to be over 1 dB a year (Jönsson & Rosenhall 1998, Møller 1981, Pedersen *et al*. 1989). Davis *et al*. (1990) reported that the rate of deterioration is

influenced by age, with people over 55 showing a rate of up to 9 dB/decade and a rate of 3 dB/decade for those under 55. Longitudinal population-based studies report HI increasing with age and being more pronounced in males (Pedersen 1989, Karlsmose 1999), whose HI begins at an earlier age and declines more rapidly (Jerger *et al.* 1995), although the gender difference decreases with age (Abutan *et al.* 1993, Smeeth *et al.* 2002). Traditional men`s work has caused more occupational risk for men than for women (Shilling & Brackbill 1987, Tambs *et al.* 2006). However, Davis (1989) found no clear association between HI and gender.

Excessive noise is a global occupational health hazard leading to noise-induced HI, and in many countries excessive noise is an occupational hazard that costs more money than any other (WHO 1997). Worldwide, 16% of the disabling HIs in adults are attributed to occupational noise (Nelson *et al.* 2005). The WHO is trying to prevent deafness and HI caused by noise with a programme especially targeted to developing countries. In Europe, industrial directives have improved noise levels over the last two decades and reduced the risk of damage to hearing by requiring hearing protection for workers (WHO 1993, European Parliament 2003). However, there is increasing environmental noise, including noise from traffic and recreational activities, especially amongst young people.

Hietanen *et al.* found the prevalence of HI in Denmark, Sweden and Finland to be fairly similar. The prevalence of moderate HI among 75-year-old people varied between 26% and 34% in men, and between 17% and 23% in women (Hietanen *et al.* 2005). This finding may also be generalized more widely.

Because of the ageing of the population, the number of people suffering from a HI has been increasing during the past decades (Sorri *et al.* 2001b). In 1990 Davis predicted that the number of hearing impaired people would increase by approximately 20% over the following 20 years (Davis 1990a), and in 2001 the number was also expected to increase in Finland from today's 15% to 23% within the next 20 years (Sorri *et al.* 2001b). Because of differences in the study populations and in the available national statistics, the studies do not, however, allow reliable comparisons between countries or estimations of the future prevalence of HI (Mäki-Torkko *et al.* 2001a).

2.1.2 Aetiology of hearing impairment

There are two main types of HI: conductive and sensorineural. Any disorder in the transmission of sound waves through the external ear canal and middle ear as far as the footplate of the stapes results in conductive HI (for example, perforation of the eardrum and fixation of the ossicular chain). Sensorineural HI results from a problem in the cochlea, the cochlear nerve or more rarely, in the central neural pathways.

There are many conditions which may contribute to HI (List 1). HI can be acquired or inherited due to a disorder in some part of the ear or the nervous system connected to it. Age-related HI (ARHI) is a term used to describe the progressive, bilateral, and symmetrical HI of sensorineural origin that is associated with increasing age with no obvious external cause. It is believed that genetics plays a role in some cases of ARHI (Pickles 2004), and there are many studies on the genetic aspects of hearing loss (Martini *et al.* 1996, Toriello *et al*. 2004). Structural changes in the inner ear are most contributory

to this: degeneration of hair cells in the cochlea, loss of spiral ganglia and nerve fibres of the cochlear nerve, atrophy of the stria vascularis, which alters the properties of the endolymph, or degeneration of inner ear support components (Schuknecht & Igarski 1964, Schuknecht 1994, Soucek *et al*. 1987, Schuknecht & Gacek 1993, Ohlemiller & Gagnon 2004, Howarth 2006). In addition, there are age-related changes in the auditory brainstem pathways and auditory cortex that can lead to central processing difficulties. Although such distinct pathological varieties and subsequent patterns of sensorineural HI are recognised, the HI of many older patients can be shown to be due to varying degrees of combinations of these types.

Individual susceptibility varies; for example, noise-induced HI is the second most common form of sensorineural hearing deficit, after ARHI. The lower action limit of daily noise exposure has been fixed by the European Parliament (2003) to Leq=80 dB.

HIs after infections have decreased in the last decades due to progress in treatment of infections (Vartiainen 1998).

The most common causes of HIs are mentioned in the following list.

List 1. Common causes of hearing impairment in adults

- Degenerative disease (ARHI)
- Excess noise
- Infection
- Otosclerosis
- Hereditary disorders
- Metabolic disease
- Meniere's disease
- Neoplasm
- Vascular damage
- Sudden deafness
- Ototoxic drugs
- Head trauma

2.1.3 Effect of hearing impairment

HI can clearly affect people's social life and well-being. The role of hearing for the human being is essential, and the inability to perceive sounds and communicate may affect many areas of life. Several studies have shown that an uncorrected HI gives rise to poorer quality of life and has a profound negative effect on the life of any individual. Persons with a moderate to severe HI are more likely than those without a HI to be associated with reduced quality of life also in the elderly (Dalton *et al*. 2003).

The ability to communicate is frequently a deciding factor in determining a person's autonomy, independence, and overall well-being and happiness (Mulrow *et al*. 1990b, Strawbridge *et al*. 2000, Taylor *et al.* 2001, Tomita *et al*. 2001). A HI makes communication with other people difficult and changes family dynamics and results in misunderstandings and conflicts (Smith & Kampfe 1997). The effect of a HI has also

been found to have an effect on self-care and domestic life (Cacciatore *et al*. 1999, Strawbridge *et al*. 2000). Experiences of restricted participation with people around the person may be even more destructive, leading to further isolation (Stephens 1996). Dalton *et al*. (2003) investigated the impact of a HI on quality of life in a large population of elderly adults. The severity of the HI was significantly associated with having hearing problems and with self-reported communication difficulties. Individuals with a moderate to severe HI were more likely than individuals without it to also have impaired activities in daily living. Cacciatore *et al*. (1999) recorded lower scores when they assessed disability with the Activity of Daily Living scale.

HI has an adverse effect on physical, cognitive, emotional, social, and behavioural functions (Mulrow *et al.* 1990b, Dalton *et al*. 2003), and depressive symptoms (Jones e*t al.* 1984, Kampfe & Smith 1998, Tsuruoka *et al.* 2001, Cacciatore *al.* 1999), even paranoid identification, has been reported (Bazargan *et al.* 2001). Cacciatore e*t al.* (1999) found a strong relationship between decreased hearing function and mental decline in elderly people, independent of the effect of age and education. Tambs (2004) reported HI to be associated with substantially reduced mental health ratings among some young and middle-aged persons, but not much effect on mental health among older persons. Poorer quality of life and a higher level of mental distress in the deaf community are demonstrated by Fellinger *et al*. (2005).

The negative influences of HI are, however, found to be amenable to intervention, and functional decline can be decreased by fitting a HA (Mulrow *et al*. 1990b, Weinstein 1996). Cacciatore found the use of HAs reduced the Geriatric Depression Scale score (Cacciatore *et al*. 1999).

These findings indicate the importance of early identification of HI and offers of rehabilitation (Davis 1992, Arlinger 2003). Screening of the elderly and early fitting of HAs to increase the quality of life of the elderly have been proposed (Davis *et al*. 1992, Popelka *et al*. 1998).

Studies concerning hearing rehabilitation have been presented over half a century. Measuring the outcomes of HA intervention has received increasing attention in recent years. Traditionally, HA outcomes are measured by using clinical measurements of hearing, such as changes in functional gain and speech recognition performance. These measures are not influenced by individual biases, such as changes in life experiences. On the other hand, they do not take into account the perspective of the individual with a disability of HI. Pure tone thresholds displayed on an audiogram do not describe the degree of disability. There is also likely to be a difference in the amount and type of impact that the HI has on the quality of life between individuals, even if they have essentially identical audiograms. Several studies have clearly demonstrated that there is no strong relationship between objective measures of HA benefit and self-reported, subjective measures (Johansson *et al.* 1991, Humes *et al*. 1996).

A variety of measures of HA outcome have been developed. Self-assessment of hearing was introduced in the 1930s by the United States Public Health Service (1938), and it was used to select “normal” hearing people. Later the subjective approach of using self-administered questionnaires has been in expanded use in screening for HI in the elderly, and a variety of self-assessment tools have been produced. These have also been used to evaluate the results of rehabilitation.

The disability of HI is frequently measured by using instruments that are specially designed to assess the impairment. Also, in order to assess the relative benefits of interventions on a common metric, people are often asked to complete a questionnaire. By using utility measures, the benefits of audiological interventions can be compared with each other.

2.2 Health-related quality of life

According to the WHO (1948), health is “a state of complete physical, mental, and social well-being and not merely the absence of disease”. This has served the basis for many HRQOL measures.

The term "quality of life" was first mentioned in economic journals in 1920, and it became an issue in North America in the early 1960s. Initially it became accepted in social sciences and later in health sciences. Development of generic quality-of-life measures began in the early 1970s and continues today. Disease-specific measures were introduced in the 1980s and 90s (Maune *et al.* 2005). The quality of life of hearing impaired persons has been examined since the beginning of the 1960s. Social hearing disabilities and rehabilitation were studied already by Ewertsen in the 1960s (Ewertsen 1960). Magilvy studied hearing impaired older women and in 1985 he reported the best predictors of quality of life to be social hearing disability, functional social support and perceived health. Cochrane was the first to clearly point out the vital importance of randomised controlled trials in assessing the effectiveness of treatments, and he has had a profound influence on the practice of medicine and on the evaluation of medical interventions (Cochrane 1972).

HRQOL generally refers to the perception of the effects of a disease and its impact on the patient’s daily functioning. A generic HRQOL instrument measures general health status, including physical symptoms, functioning and the emotional dimension of health. Disease-specific HRQOL measures, however, are tailored to assess the specific physical, mental and social aspects of health affected by the disease in question and to detect small important changes.

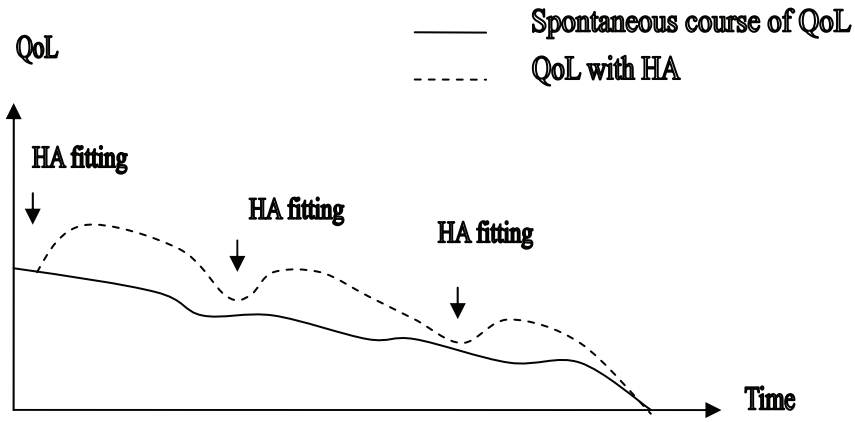

Fig. 1. The imaginary steps in the life span of HA users. The first fitting of a HA is done at the baseline, and in Finland the subsequent fittings are usually done at approximately five-year intervals. QoL = Quality of Life

'Quality-adjusted life years' (QALY) indicate the gain in utility achieved through intervention and the expected time the effect will last. In the case of HA fitting, a reduction in self-perceived disability, and therefore an increase in utility, can be measured after intervention. Using a HA a long time is likely to result in stabilisation and a reduction in perceived gain in utility. The gain in utility is also influenced by a number of factors: variability in the subject's health condition and self-perception, variability in HA performance, decreasing hearing levels and adaptation to benefit.

The utility scores differ across instruments (Bosch & Hunink 2000, Hawthorne *et al.* 2001, Longworth & Bryan 2003, O'Brien *et al.* 2003, Barton *et al.* 2005). Utility differences may be due to differences in the overall quality of life being measured, or different measurement approaches, or both. Caution should be exercised when comparing utility scores derived by different measures (Barton *et al.* 2005).

Since many generic measures lack sensitivity in measuring special health problems, the use of validated disease-specific measures together with generic measures has been recommended (Barton *et al.* 2005, Koivukangas *et al.* 1995).

The reasonable value of a QALY that is generally accepted by researchers has been raised from USD 20,000 in the beginning of the 1990s (Harris *et al.* 1995, Palmer *et al.* 1999, Hay *et al.* 1991, Goldman *et al.* 1991, Tosteson *et al.* 1990) to today's USD 50,000 (Jonsson 2004, Devlin & Parkin 2004, Chumney 2005, Braithwaite 2005, Laufer 2005). These figures as such represent the appraisals of the researchers.

A Disability-Adjusted Life Year, or DALY, is a health gap measure that combines in one measure the time lived with disability and the time lost due to premature mortality. One DALY can be thought of as one lost year of 'healthy' life and the burden of disease as a measurement of the gap between current health status and an ideal situation where everyone reaches old age free of disease and disability. Comparing the percentages of total DALYs of the diseases ranked by the WHO places adult-onset HI in 12th place in

the world in 2005. Thus, hearing loss imposes a huge social and economic burden on society. (WHO 2006)

Cost-effectiveness analysis is a quantitative technique for comparing alternative treatment programmes for the same health condition. It allows elucidation of the economic implications of alternative treatments, i.e. what is achieved and at what cost. The essential measure used in cost-effectiveness research is the incremental cost-effectiveness ratio, or the difference in cost associated with one technology compared with another applied to achieve an incremental gain in health. The analyses provide information that helps decision-makers choose between competing programmes in the allocation of limited resources (Drummond *et al.* 1997, Langley 1995, Willan & O'Brien 1996).

The measures of HA benefit are intended to allow for a comparison of HA intervention outcomes against other health conditions and their interventions. To perform such comparisons, generic measures, as opposed to disease-specific measures, must be used (Crandall 1998).

In cost-utility analyses, the scores can be used as quality weights to calculate quality-adjusted life years. The measure can be used as quality weights in general populations to determine population health expectancy (Torrance *et al.* 1995).

Generic HRQOL measures have also been used to measure the quality of life of hearing impaired and to assess the benefit received from HAs. Until now, the sensitivity of the generic HRQOL measures have failed to show a significant effect of HA use (Joore *et al.* 2003b).

2.2.1 Generic HRQOL instruments

The tools for measuring generic HRQOL have also been used to measure the effects of HI. There are different measures, and the dimensions used to describe a person's state of health and the technique used to assign a value to the state of health in each questionnaire determine the utility score derived from the measure. The following measures represent a few of the most used (Table 3):

The *Nottingham Health Profile* (NHP; Hunt *et al*. 1980) has been developed for use in epidemiological studies of health and disease, but it has also been used with disease-specific measures with hearing impaired people. It consists of two parts. Part I contains 38 yes/no items in 6 dimensions: pain, physical mobility, emotional reactions, energy, social isolation and sleep. Part II contains 7 general yes/no questions concerning daily living problems. Part I is scored using weighted values that give a range of possible scores from zero (no problems at all) to 100 (presence of all the problems within a dimension).

The *15D* is a generic HRQOL instrument developed in 1981 by Sintonen. The present modified (Sintonen 1994) instrument includes 15 dimensions. The 15 dimensions are mobility, vision, hearing, breathing, sleeping, eating, speech, elimination, usual activities, mental functioning, pain, depression, feeling anxious, stressed and nervous, vitality and sexual activities. Each dimension is divided into 5 levels. According to Sintonen, the test

was designed for self-administration, which takes 5-10 minutes. The response rates have been high and its test-retest reliability has been good (Sintonen 1994).

Table 3. Examples of generic health-related quality-of-life instruments. For abbreviations, see the text after the table.

Instrument	Author	Year	Items measured
NHP	Hunt et al.	1980	38 yes/no items in 6 dimensions: pain, physical mobility, emotional reactions, energy, social isolation and sleep, and 7 general yes/no questions concerning daily living problems
15D	Sintonen	1981/1994	15 dimensions divided into 5 levels; mobility, vision, hearing, breathing, sleeping, eating, speech, elimination, usual activities, mental functioning, pain, depression, feeling anxious, stressed and nervous, vitality and sexual activities
EQ-5D	EuroQol group	1990	5 dimensions divided into 3 levels: mobility, self-care, usual activities, pain/discomfort and anxiety/depression
SF-36	Ware & Sherbourne	1992	36 items; bodily pain, physical functioning, role limitations due to physical problems, mental health, vitality, social functioning, role limitations due to emotional problems and general health
HUI3	Feeny et al.	1995	8 dimensions: vision, hearing, speech, ambulation, dexterity, emotion, cognition and pain.

The *EuroQol* (EQ-5D) questionnaire is a generic measure for evaluating health developed by the EuroQol group (1990), an international research network. It aims to serve as a basis for comparing health outcomes by using a basic "common core" of HRQOL characteristics that most people are known to value highly. The EQ-5D is a short, easy-to-use questionnaire and it has a very high response rate (Brazier *et al*. 1993). It has been successfully used in elderly populations and relatively healthy populations, where it seems to be a valid instrument for measuring the quality of life (van Roijen *et al*. 1996).

The EQ-5D defines health in terms of five dimensions (mobility, self-care, usual activities, pain/discomfort, anxiety/depression), and each dimension has 3 levels of "severity", corresponding to "no problems, "some problems" and "extreme problems". As well as yielding a health profile, the EQ-5D can be used to generate a single index score by "valuing" states of health with preferences elicited from the general population. This approach is based on the premise that individuals have quantifiable preferences for states of health and they conceptualise HRQOL as a value for a given state of health. With HRQOL measurements, utility is a number ranging from 0-1, which provides a quantification of an individual's preference for particular states of health or conditions, with 0 typically indicating the least favourable condition (e.g., death or total deafness) and 1 typically indicating the most favourable condition (e.g., perfect health or perfect hearing) (Nease *et al*. 1995). EQ-5D also includes a report of the person's health status on a visual analogue scale (VAS, 0-100).

Preference-based scores permit combination of mortality and morbidity and calculation of QALYs, which allow a comparison of the overall health status in the population and in clinical settings. They are also suitable for economic analyses (Gold *et al*. 1996). A utility measure can be utilized to estimate changes in overall quality of life as

the result of a treatment, including, for example, audiologic intervention (Feeney *et al.* 1990).

The EQ-5D estimates HI to be associated only with a minor loss in utility, so it has poor sensitivity in measuring the sensory quality of life and in detecting small changes (Berlanger *et al*. 2000, Longworth & Bryan 2003, Oostenbrink *et al*. 2002). Studies have revealed only small improvements in the EQ-5D dimension in HA users (Joore *et al*. 2002a, Joore *et al*. 2003a, Joore *et al*. 2003b). Barton *et al*. (2005) have recommended using EQ-5D with another utility measure, Health Utilities Index Mark III (HUI3), when evaluating the benefits of interventions designed to alleviate a person's hearing.

The Short Form *36 Health Survey* (SF-36) was developed by Ware & Sherbourne in 1992, and designed for use in clinical practice and research, health policy evaluations, and general population surveys. It includes 36 items covering eight health concepts: bodily pain, physical functioning, role limitations due to physical problems, mental health, vitality, social functioning, role limitations due to emotional problems and general health. The response format is yes or no or on a three-to-six response scale. For each health concept question the scores are coded, summed and transformed on a scale from zero (worst health) to 100 (best health). This measure was developed to focus on general health, as opposed to specific age, disease, or treatment options. The SF-36 has become one of the most widely used generic measures of subjective health status.

The Health Utilities Index has been developed by researchers in Canada (Feeny *et al*.) in 1995. *The Health Utilities Index Mark III* (HUI3) system contains 8 dimensions: vision, hearing, speech, ambulation, dexterity, emotion, cognition and pain. Each dimension has up to 6 levels of functioning. A combination of levels across the attributes constitutes a state of health. The health status information is then converted into a utility score (Feeny *et al.* 2002).

The relevance of generic HRQOL instruments to hearing disabilities has been found to be poor. Several studies have shown the relevance of 15D and HUI to be greater than that of others due to the nature of their questions, which include hearing as one of the focused items (Brazier *et al.* 1999, Hawthorne *et al*. 2003, Barton *et al*. 2005).

2.2.2 Hearing-specific HRQOL instruments

Hearing-specific measures should facilitate assessing, planning and performing the rehabilitation of hearing impaired. An instrument can be tailored to measure some specific physical, mental and social aspects of health affected by hearing and to detect small important changes due to hearing or overall satisfaction concerning rehabilitation. An open-ended questionnaire followed by subsequent probing of the responses is found to be a good way to define the patient's rehabilitative needs (Stephens 1996). There are many instruments that measure the situation with or without a HA and before and after HA fitting or during fitting, as reviewed by Bentler & Kramer (2000), for example. Table 4 presents some examples from the wide selection of instruments for measuring different aspects. The selection of instruments reported here illustrates the various purposes for which self-assessment tools may be employed. It does not necessarily imply that these

procedures are more or less valid or more widely used than other available self-assessment tests.

Table 4. Examples of tools for measuring disease-specific health-related quality of life. For abbreviations, see the text.

Instrument	Author	Year	Target of measurement
DSCF	Alpiner	1974	Communication attitudes of adults with an acquired HI
HHIE	Ventry & Weinstein	1982/ 1986	Social and situational effects of a hearing handicap
CPHI	Demorest & Erdman	1986	Communication performance, environment, strategies, and personal adjustment in hearing impaired adults
SAC	Schow	1989	Social and emotional impact of HI
GP	Hallberg et al., Arlinger et al.	1992/1998	Hearing speech and sound localization in social settings and personal reactions to the experienced handicap
HDHS	Hetu et al.	1994	Severity of the most common hearing disabilities and handicaps associated with hearing loss

The *Denver Scale of Communication Function* (DSCF; Alpiner 1974) is designed to help the clinician assess communication attitudes of adults with an acquired HI.

In 1982 Ventry & Weinstein developed a new standardized self-assessment tool for assessing hearing impaired people, the *Hearing Handicap Inventory for the Elderly* (HHIE). The inventory is comprised of two subscales: a 13-item subscale explores the emotional consequences of HI and a 12-item subscale explores both social and situational effects. Later, in 1984, Weinstein introduced a short version of this inventory (HHIE-S), which comprises 10 items (5 emotional and 5 social). The answers to each question are scored: "Yes" scores a 4, "Sometimes" scores a 2, and "No" scores a 0. The individual question scores are simply summed to give a total score. Total scores range from zero to 40. A score of zero to eight indicates little trouble with hearing. Scores of 10 or more are indicative of HI that might benefit from an audiologic evaluation. The higher the score is, the greater is the degree of hearing disability.

According to Lichtenstein *et al*. (1988), by using a score greater than 8 as a cutoff point, the HHIE-S had sensitivities ranging from 53 to 72% and specificities ranging from 70 to 84% with the different definitions. The HHIE-S receiver-operating characteristics and likelihood ratios were similar regardless of HI definition used. The HHIE-S was regarded as a valid, robust test for identifying hearing impaired elderly, irrespective of the audiometric definition used to finally diagnose hearing difficulties (Lichtenstein *et al.* 1988). Mulrow *et al*. have reported in 1990 that the HHIE-S is as accurate and sensitive as the long version for detecting change in assessing rehabilitation in elderly individuals.

The purpose of the HHIE-S is to screen hearing impaired persons and to identify the problems HI may be causing. Some studies also support the use of the HHIE-S as an expedient approach for quantifying HA benefit (Weinstein 1986, Mulrow *et al*. 1990, Newman *et al*. 1988, 1991). Compared with long and revised versions of the DSCF and HHIE, Mulrow *et al*. (1990a) have regarded the HHIE-S to be a superior, versatile instrument for screening and assessing rehabilitation in the elderly with HI.

The *Communication Profile* for the Hearing Impaired (CPHI; Demorest & Erdman, 1986) is a self-assessment inventory that measures adjustment in hearing impaired adults. The inventory provides 25 scores describing communication performance, communication environment, communication strategies, and personal adjustment of hearing impaired adults. The CPHI is widely used in research and by rehabilitative audiologists in clinical practice.

The *Self Assessment of Communication* (SAC; Schow 1989) is a 10-item questionnaire for audiologic assessment of elderly adults over 18 years. It samples the social and emotional impact of HI. The purpose of this scale is to identify the problems HI may be causing. It uses a five-point scale (1 = almost never; 5 = practically always) to answer questions such as: "Do you experience communication difficulties while participating in various types of entertainment (e.g., TV, radio, plays)?" and "Do others suggest that you have a hearing problem?" The higher the score is, the greater is the amount of perceived disability on the part of the individual.

The *Gothenburg Profile* (GP; Hallberg *et al*. 1992, Arlinger *et al*. 1998) for measuring experienced hearing disability and handicap was developed with content partly taken from the shortened Hearing Measurement Scale (HMS25; Noble & William 1985). The GP consists of 20 items divided into two subscales. The first subscale measures Experienced Disability in terms of hearing speech (items 1-5) and sound localization (items 6-10). The second subscale targets the Experienced Handicap in social settings (items 11-15) and personal reactions to the experienced handicap (items 16-20).

The *Hearing Disability and Handicap Scale* (HDHS; Hetu *et al*. 1994) is made up of 20 statements, for which there are four possible responses. Half of the statements concern hearing disabilities, and the other half deal with hearing handicaps. The statements on disabilities concern the patient's ability to hear both speech and non-speech sounds. The statements on handicaps deal with the patient's sense of self-worth and quality of life. For each circumstance covered by each statement, the absence of difficulty is reflected by a score of 1 and frequent difficulty is indicated by a score of 4.

The above measures have been used to measure disability derived from HI and also to assess the benefit of a HA. In addition, specific measures for assessing HA benefit have been developed (Table 5).

Table 5. Examples of tools for assessing HA benefit. For abbreviations, see the following text.

Instrument	Author	Year	Target of measurement
HAPI	Walden et al.	1984	Benefit derived from a HA
GHABP	Gatehouse	1999	Auditory disability and handicap, and HA benefit
IOI-HA	Cox et al.	2000	Effectiveness of hearing aid treatments
ADPI	Joore et al.	2002	State of health preferences associated with audiological disabilities needed for clinical decision-making and cost-effectiveness analysis

The *Hearing Aid Performance Inventory* (HAPI; Walden *et al*. 1984) is a subjective, self-report measure for assessing benefit derived from HA amplification. It identifies four types of situations that can be assessed separately: (a) noisy situations; (b) quiet situations with the speaker in proximity; (c) situations with reduced signal information; and (d)

situations with non-speech stimuli. The 64-item questionnaire was later shortened to a 38-item Shortened Hearing Aid Performance Inventory (SHAPI; Schum 1992).

The *Glasgow Hearing Aid Benefit Profile* (GHABP) (Gatehouse 1999) is a self-report questionnaire for assessing aspects of auditory problems and HA benefit. The questions cover scales of initial problems, HA use, HA benefit, satisfaction, and residual disability. It addresses a combination of pre-specified listening situations as well as individual listening difficulties determined by the hearing impaired individual. It can be used as a tool to evaluate the effectiveness and cost-effectiveness of existing services and future developments.

The *International Outcome Inventory for Hearing Aids* (IOI-HA) is a seven-item questionnaire designed to be generally applicable in evaluating the effectiveness of HA treatments. It has been developed as the product of an international workshop on Self-Report Outcome Measures in Audiological Rehabilitation (Cox 2000). The inventory was developed to combine and compare data from different investigations and clinical service models and to facilitate co-operation among researchers and programme evaluators in diverse hearing health care settings, including across national boundaries (Cox *et al*. 2002). The inventory has been translated into many languages.

In 2002 Joore *et al.* developed the *Audiological Disabilities Preference Index* (ADPI), a measure for determining state of health preferences associated with audiological disabilities needed for clinical decision-making and cost-effectiveness analysis (Joore *et al*. 2002b). It consists of a description of hearing-related state of health, valuation of hearing-related state of health, and transformation of the latter to an overall health scale.

In addition to common inquiries, a question like “Do you think you have a hearing problem?” is found to be a very sensitive and specific question (Nondahl *et al*. 2003, Wu H *et al*. 2004). Gates *et al*. (2003) found the global measure of HI to be more effective than the detailed questionnaire in identifying older individuals with unrecognised disability.

Different questionnaires measure different concepts of HI (Brazier *et al.* 2004), and they are not comparable with each other. No single questionnaire has been identified as optimal (Brazier *et al*. 2004, O’Brien *et al*. 2003, Macran *et al*. 2003).

2.3 Hearing aids

HAs fashioned from horns, seashells, or other natural materials probably existed long before the ear trumpet was first manufactured. Ear trumpets were used in the 1800s and were made of various materials, including silver and tortoiseshell. The transition to battery powered HAs began in the early 1900s. Early HAs were expensive, and few people could afford to buy them. Common to all HAs was the analogue technology which makes sounds louder. The development of digital sound treatment allows for fine tuning and customizing the amplified sound ranges to fit the profile of the consumer's hearing loss (www.hear-it.org). The first digital HA was introduced during the mid-1980s, and programmable HAs appeared in 1988, when reports were also made on a completely-in-the-canal instrument. Digital HAs are constructed with a small programmable computer and they are capable of amplifying millions of different sound signals very precisely, thus

improving the hearing ability of hearing-impaired people (Werner & Gottschlich 1997). In 1991 the first fully automatic HA without a volume control and containing dual-channel non-linear sound processing was presented, and in 1994 a programmable completely-in-the-canal HA with two programmes and remotely controlled volume control was introduced. (Central California Ear Nose Throat medical group 2003, www.hear-it.org)

HAs have been developed in recent years, and nowadays they are mostly behind-the-ear (BTE) or in-the-ear (ITE) HAs. Digital signal processing (DSP) HAs are replacing analogue ones. DSP HAs have become more easy to use than earlier HAs and their prices are also approaching those of analogue HAs.

Various studies have confirmed that HI in elderly individuals can be alleviated with the use of a HA (Mulrow *et al*. 1990b, Mulrow *et al*. 1992a). The importance of early identification of HI and HA fitting has also been emphasized by many investigators (Davis *et al*. 1992, Rosenhall 2001, Arlinger 2003).

Jerger *et al*. (1995) estimated that the average time between the onset of a HI and seeking of medical help is about ten years. According to Brooks (1979b), the time lapse between recognition of a HI and application for a HA averages almost ten years. The true delay is probably greater than this, and it must have a substantial bearing on the outcome of HA fitting. Parving *et al*. (1989) found in their investigation that 55% of persons with a HI had had the problem for one to five years, and only 13% had had the problem for one year or less. Twenty-six percent had experienced the hearing problem for more than five years. Fifty-nine percent expected relief of the problem in the form of a HA, while 28% had no expectations about improvement or relief of their problem.

The number of HAs provided annually in Finland has been approximately 14,000, and during the last twenty years it has not changed significantly, despite the increasing number of potential HA users (Sorri *et al*. 2001b). According to a population study by Uimonen *et al.* (1999), the number of citizens needing a HA in Finland was estimated to be twice the figure usually presented, 280,000 in the entire country (population: 5.2 million in 1999). The penetration of HAs was estimated to have been only 41% (Sorri *et al*. 2001b), and according to a joint Nordic-British report, only about 20% (Sorri *et al*. 2001a). Compared with other countries, the annual figures for the number of people receiving at least one HA has been much lower in Finland than in other Western countries. The number of HAs provided has varied from around twelve per one thousand inhabitants in Denmark to 2.7 in Finland (Barton *et al*. 2001). The need for audiologic rehabilitation is estimated at approximately 6% of the Finnish population (Uimonen *et al.* 1997), more than fivefold compared with the present.

In Finland, until 2005 a HI greater than 30 dB averaged over frequency range of 0.5-2 kHz in the better ear has been considered an indication for a HA; in practice, however, the limit has often been set at 40 dB. Now, since the beginning of April 2005 the indication basis has been lowered and set to 30-40 dB, averaged over the frequency range of 0.5-4 kHz. This brings us plenty of potential HA users, because aside from the limit being set to lower frequencies and to both ears, also 4 kHz has been included in the criteria (Ministry of Social Affairs and Health 2005). In all, the indication basis has been lowered, 4 kHz has also been included in the criteria, and binaural hearing is favoured. After this change in the indication basis for HA fitting, the number of HAs provided has

already almost doubled at Oulu University Hospital (Martti Sorri, personal communication).

The benefits of binaural amplification in many listening situations have been reported by Brooks (1984) and Day *et al*. (1988). A significantly greater benefit was gained and it was considered to be due to central summation. Experimental results with normally-hearing listeners and HA users reported by Haggard and Hall (1982) showed that binaural summation is likely to lead to gain settings about 6 dB lower than with otherwise equivalent monaural amplification. It has been concluded that binaural amplification should be attempted in all bilateral, severely hearing impaired subjects (Day *et al.* 1988). However, Walden & and Walden (2005) stated that bilateral amplification may not always be beneficial in every daily listening environment when background noise is present. The value of binaural fitting is now also acknowledged in Finland, and the new aim compared with the former one is to strive for binaural hearing (Ministry of Social Affairs and Health 2005).

2.3.1 Use of hearing aids

There has been plenty of local, national and international discussion about the use of HAs compared with the costs and available resources in Finland (Barton *et al*. 2001, Jauhiainen 2002).

The results of interview surveys concerning the use of HAs have varied much, depending on the methods used. It should be noted that the following findings can not be taken as definitive facts. The methods of investigation differ from each other and also the forms used to present the results affect the results.

Stephens has compared studies concerning HA use between countries in his review article in 1977, which emphasizes that different results clearly depend on the methods of assessment (Stephens 1977). In Finland, Sorri *et al*. reported in 1984 that 57% of HAs were used regularly two years after the HAs had been fitted. Up to 23% of HAs were seldom used, if ever. The figure for non-use among first-time HA users was even higher; 33.3%. Henrichsen *et al*. reported in 1988 that 64% of HA users use their ITE HAs all day, and Parving *et al*. (1991) demonstrated that 51% use them every day 6 months after HA fitting. In 1993 Ward *et al*. (1993) found that only slightly more than a third of those who received a HA wore it regularly, and Overgard & Ramstrom reported in 1994 that about 30% of the hearing impaired use their HA seldom about one year after HA fitting. Tomita *et al*. found in 2001 that two quarters of those who reported that their HI had a large impact on daily life did not use a HA. Davis reported in 2003 that only 6% used a HA, although about 40% of 55-74-year-olds had an impairment of ≥25 dB HL in at least one ear. In studying people aged 80 years at the baseline, Hietanen *et al*. (2004) found that HAs were not used by over 75% of those who had a moderate HI. In 2005 Lupsakko *et al*. reported that only 25% of HAs were non-used.

The use of a HA is highest soon after fitting and use tends to decrease with time. Schumacher (1997) found the main dropout point in HA use was within the first year after fitting. Mulrow *et al*. (1992b) found that at four months, 90% of subjects were using their hearing instruments more than four hours per day. This percentage decreased to 83%

at eight months and 76% at 12 months. There are many factors contributing to adaptation to the use of a HA, such as the degree of the HI, the age and personality of the individual, the duration of the HI, the performance of the HA, and the advice given by the audiologist/dispenser (Brooks 1996).

For many reasons it is natural that, when questioned, HA users may overestimate the time they use a HA. Brooks found (1979a) self-rated HA use to be about two hours per day, on average, whereas an objective measure indicated use of about one hour. Taubman *et al.* (1999) found a significant difference between actual time of use and self-reported time of use. Also, an examination made by Mäki-Torkko *et al*. (2001b) revealed that subjective methods tend to overestimate use; over a third of the Finnish and Norwegian HA candidates used their HA less than 4 hours a day according to an objective assessment (time recorded in the memory of the HA). The results of some studies indicate that relying on a patient's self-reported time of using a HA for documentation of satisfaction or signal processing preference may be misleading (Haggard *et al.* 1981, Taubman *et al.* 1999).

The following factors have been reported to be associated with poor use of a HA: high age, lack of experienced need for a HA, poor health, handling problems, less than ideal matching of the HA to the HI and deficient post-fitting training (Surr *et al*. 1978, Brooks 1985, Parving & Philip 1991, Ward *et al*. 1993, Tomita *et al*. 2001). Wiesner reported in 1996 that actual HA use was observed to be influenced mainly by the intention to use a HA and by normative beliefs of the person. The attitude of the potential HA user has also appeared to be related to the reasons for disuse and under-use (Brooks 1989, van den Brink 1996, Southall *et al.* 2006).

The handling skills of HA users have often been noticed to be poor (Sorri *et al*. 1984, Brooks & Hallam 1998, Parving & Philip 1991, Cohen-Mansfield & Taylor 2004). According to Gimsing's interview in 1995 on the use of HAs and handling skills, only 32% of HA users could handle their HAs. To promote better use of HAs, the need for more help and counselling has been pointed out (Schumacher & Carruth 1997, Brooks 1981).

2.3.2 Costs of hearing aids

Barton *et al*. (2001) estimated in their report comparing HA services between the Nordic countries and the United Kingdom that the current total expenditure on hearing services in Finland is € 33.7 million. The total amount spent annually per person provided with a HA was estimated at € 2669. It was eight times the corresponding figure (annual estimate of the amount spent per person provided with a HA) in the United Kingdom (€ 322). Also the other Nordic countries were estimated to spend less (Sweden € 873, Denmark € 1080 and Norway € 1354). These figures were, however, picked up from rough estimations made by representatives of HA services in the countries**.** Thus, the results are also rough estimations.

According to the comparison of HA services in Denmark, Finland and the United Kingdom by Barton *et al.* 2003, Finland was estimated to spend the most (€ 924) per person fitted a HA in 2000, but to provide the fewest HAs. The figures for the United

Kingdom and Denmark were € 296 and € 670, respectively. These calculations were more reliable than earlier ones, since the figures were gathered from HA centres with more comprehensive questionnaires. However, different choices in spending resources and different systems for arranging HA rehabilitation were found between the countries, so the costs could not be strictly compared with each other.

In Denmark, by making cost analyses Joore *et al*. has calculated the price per fitted HA to be nearly € 800 (Joore *et al.* 2003b).

There has been no detailed reliable data concerning the overall costs of fitting and providing HAs in Finland. Neither can the costs be compared between hospitals, because there is no agreement on the assessment methods or the outcome measures of the costs of HA fitting that would make the studies comparable (Barton *et al.* 2001, Sorri *et al.* 2001a, Barton *et al.* 2003). Also, the systems used to provide HAs differ greatly between countries, making the comparison difficult.

2.3.3 Benefit of hearing aids

The goal of HA fitting is to reduce the perceived limitations of activity and restrictions in participation resulting from the HI. The benefit of a HA has been measured with self-assessment tools used to evaluate hearing disability and handicap, and with specific tools developed for the purpose. In this context, the term "disability" refers to intrapersonal problems and "handicap" to social or interpersonal, respectively. However, these concepts often overlap.

With self-assessment measurements, the experienced effects of a HA have been noticed to be highest soon after provision of the HA. Munro & Lutman (2004) reported by using the GHABP that the benefit and satisfaction of the subjects showed a small but statistically significant improvement over the first 3 months of HA use when the HA users referenced it to their perceived performance 3 weeks before HA fitting (Munro & Lutman 2004). Mulrow has demonstrated with several disease-specific handicap scales that the benefits of a HA is sustained for at least 12 months (Mulrow 1992b). Taylor (1993) measured a significant decrease in perceived handicap after 3 weeks of HA use, and after 3 months of HA use the perceived handicap increased significantly before levelling off at 6 months and one year of HA use. Humes *et al.* (2002a) studied HA users with several objective tests of speech recognition, as well as with the subjective self-reported scales of the HAPI and the HHIE. Although group means changed only slightly over time for all the benefit measures, significant differences were observed, especially among the subjective self-report measures of benefit after HA fitting. In almost all the cases exhibiting significant changes, satisfaction was significantly better at 1 month post-fit compared with the measurements made at both 6 months and 1 year post-fit (Humes *et al*. 2002b).

Valentijn *et al*. (2005) found a strong connection between sensory acuity in auditory and visual domains and cognitive performance measures, both from a cross-sectional and a longitudinal perspective. But in their studies on different aspects of cognitive function, van Hooren *et al*. (2005) suggest that HA use only restores impairments at the level of the

sensory organ, but does not affect the central nervous system and, as a consequence, cognitive functioning.

When unaided, individuals with a conductive HI are more disabled than those with a sensorineural HI and, on the other hand, those with a conductive HI derive more benefit from a HA than those with a sensorineural HI (Carlin & Browning 1990, Verschuure & van Benthem 1992).

Counselling has been observed to improve the benefit of a HA in many studies (Brooks 1979a, Kapteyn 1997, Kemker 2004, Kramer 2005). The findings suggest that subjects given a moderate amount of counselling use their HAs better and achieve better competence in handling. These patients are also considerably more adept at handling their HAs and achieve a greater reduction in their social hearing handicap than non-counselled patients (Brooks 1979a). Norman *et al*. (1994) did not, however, reveal this kind of result. Attendance at rehabilitation has been observed in many examinations to have a positive effect on the impact of disability on patients and also their families (El Refaie *et al*. 2004, Stark & Hickson 2004, Hickson *et al*. 2006). The results also demonstrate the effective role that HAs play in reducing such negative effects for both parties.

Counselling of HA users has also been reported to decrease the HA return rate (DiSarno 1997, Northern & Meadows-Beyer l999). A significantly reduced hearing disability among users who participated in counselling has been measured by Abrams *et al*. (1992) and Beynon *et al*. (1997). There is reasonably good evidence that participation in an adult aural rehabilitation programme provides short-term reduction in self-perception of hearing disability and potentially better use of communication strategies and HAs. The benefits of counselling have been measured to remain essentially stable over the course of one year (Chisolm 2004), but it is less clear whether this advantage over provision of HAs alone persists over time (Hawkins 2005).

3 Aims of the present research

This study was undertaken to find out the use, the costs and the benefit of first HAs and also to study the outcome of follow-up counselling of HA users. The persons who were fitted with their first HAs were a well-defined group who were approach and compared with earlier studies.

The specific aims of the substudies were:

1. To study the use of first-fitted HAs and to find out if there is a change in use in the past decades.
2. To find out the costs of HA rehabilitation and to reveal possible differences between hospitals.
3. To examine the effects of HAs on hearing disability and handicap and the benefit of HAs to HRQOL from the user's point of view.
4. To evaluate the effect of additional counselling on the use of and benefit from HAs.

4 Subjects and methods

4.1 Subjects

The study was conducted at Oulu University Hospital (OUH) and Kainuu Central Hospital (KCH), a secondary health care hospital in sparsely populated mid-eastern Finland. The hospital serves a population of 88,500 inhabitants (Statistics Finland, 31.12.2001) in an area covering 21,567 square kilometres, with approximately 250 HA fittings a year, being one of the smallest of the 20 central hospitals in Finland. The data was collected in 2000-2004. The subjects of the four substudies are indicated in Table 6. There is overlap between the subjects of the substudies.

Table 6. Subjects of the substudies

Study	Use of hearing aids study I	Costs of hearing aid fitting study II	Effect of hearing aids study III	Counselling of hearing aid users study IV
Number of subjects	76	128	98	98
men/women	37/39		49/49	53/45
Age-related hearing impairment, %	85.5		83.7	73.5
Mean age	74.1 (46-91)		76.5 (61-87)	74.9 (47-87)
Behind-the-ear hearing aids, %	86.8		75.0	74.5
DSP hearing aids, %	21.1		52	50
BEHL	41.3*		48.0**	47.3**

* $BEHL_{0.5\text{-}2}$ kHz = Better ear hearing level at the frequencies of 0.5, 1 and 2 kHz. ** $BEHL_{0.5\text{-}4}$ kHz = Better ear hearing level at the frequencies of 0.5, 1, 2 and 4 kHz.

4.2 Methods

4.2.1 Questionnaires, database and statistical methods

Specially selected or designed questionnaires were used to gather the information needed for the purposes of this study in a form that allowed statistical analysis. Most of the data were recorded on questionnaires (Appendices 1, 2, 3, 4) during interviews at the hospital or at home. The data on aetiology and hearing levels were collected by the author from patients' hospital records retrospectively. The data on expenses were collected after realisation of the budget and patient interviews.

Statistical Package for the Social Sciences for Windows software (SPSS 11.5 for Windows/SPSS Tables 11.5) was used for statistical processing and analysis of the collected data. A comparison of the baseline and post-treatment scores was conducted with the Paired samples T-test when the data were normally distributed and with the Wilcoxon Signed Ranks Test and Friedman test when this was not the case. A biostatistician (Mr. Arto Muhli) took part in the studies and he was also the consulting supervisor for the statistical analysis.

The fitting procedure at KCH is similar to that of other Finnish hearing centres. On the first visit to the hearing centre an ear-nose-throat (ENT) surgeon/audiological physician examines the hearing impaired patient using pure tone and speech audiometry. A diagnosis is made along with a plan for treatment. After the decision to fit a HA is made, a model for a custom-made ear mould or a custom-made shell of an ITE HA is prepared. On the second visit the HA is fitted and insertion gain or functional gain measurements are made and the person is given the fitted HA for home adaptation for one month. The third visit is usually the final one, when the HA and its fine tuning is checked and counselling is given. The patient receives an individual rehabilitation plan, and the need for assistive listening devices is also considered. The whole process takes about two months, including one month's trial use of the HA at home between the second and third visits. The HA paid for by the hospital is given to the patient to use, and the hospital is also in charge of its repair and service. Public health care also has to counsel the users in their needs. There are no costs to the patients, except for a normal outpatient fee for the first visit to the ENT surgeon or audiological physician for the diagnosis of a HI and the prescription of a HA and for the second visit for approval of the fitted HA.

The subjects of the study had been fitted with their first HAs. They were interviewed before the fitting and six and twelve months after. The interviews and counselling at home were conducted by an experienced audiology assistant who had not been involved in the HA fitting.

4.2.2 Use of hearing aids (Study I)

To evaluate the use of their first fitted HAs, 78 consecutive patients of KCH were visited and interviewed (Appendix 4) at their homes, starting at the beginning of July 2001, approximately six months after they had been fitted and provided with their first HA. The

results were analyzed with respect to level of HI, handling skills, satisfaction with HAs, etc., and finally compared with an earlier study done in 1984 (Sorri *et al*. 1984) to see if usage had increased over the past decade. Two subjects could not be interviewed, one because of illness and the other because of refusal to participate.

The classification presented by Sorri *et al*. (1984) was used in the present study:

- Group I, "regular users", reported using the HA over 2 hours daily.
- Group II, "occasional users", reported using the HA less than 2 hours daily or 2-6 hours almost every day or at least once a week.
- Group III, "non-users", reported using the HA seldom, if ever.

4.2.3 Costs of hearing aid fitting (Study II)

The study was conducted to find out the direct costs of health care due to HA fitting at two different hospitals, a small central hospital, KCH and a university hospital, OUH. To study all the direct costs, all the expenses of fitting and providing the HAs were recorded, including all the facilities and the personnel. Each step of the process was recorded and the personnel costs were estimated for every professional separately. The prices of the HAs and equipment were taken as the real market prices. The expenses of the general services of the hospitals, such as administration, janitorial service and equipment, were also collected after realisation of the budgets and included in the calculations. The total sums were divided by the number of fittings. The figures quoted here to illustrate these two hospitals are based on the statistics of the year 2000.

The costs of the ear moulds were also calculated after realisation of the budgets. The annual salaries and material costs were calculated and divided by the number of ear moulds. The recorded costs of repairs to the HAs were calculated based on the assumption that the life span of a HA is 5 years.

To find out the time used for fitting, the time used was recorded minute by minute during a period of three weeks by each employee. These calculations included the entire process of HA fitting, from receiving the referral letter to counselling on the last visit. Consequently, the board salaries of the various staff members (secretaries, nurses, ENT surgeon/audiological physician, audiology assistants, etc.) were included. The calculations also comprised the examinations performed; i.e. pure tone and speech audiometry at the beginning of the process, insertion gain or functional gain measurements on the second visit, etc.

Also, a sample of patients had a questionnaire (Appendix 3) about costs due to HA fitting. The direct costs for the patient (travelling costs, etc.) were recorded, and the data were collected from 128 patients, 25 in KCH and 103 in OUH, and analysed.

4.2.4 Effect of hearing aids (Study III)

To evaluate the hearing disabilities and the benefit of HAs, 101 consecutive persons were interviewed at the hearing centre prior to HA fitting, and they were also visited and interviewed in their homes approximately six months after they had had their first HA fitted. The interviews were conducted starting at the beginning of July 2001. The data on one subject were excluded due to death before the second interview, and the data on two subjects were missing, so there were 98 subjects available for the analysis.

The benefit of HA fitting was evaluated at three levels in parallel: 1. clinically, 2. at the disease-specific level and 3. at the general HRQOL level. The interviews prior to HA fitting and on the home visits included the same disease-specific HHIE-S and generic EQ-5D questionnaires. These questionnaires were chosen because the HHIE-S can be applied both to persons without a HA and to those that possess one, and the EQ-5D is currently widely used in health economics. In addition to the HHIE-S (Appendix 1) and EQ-5D (Appendix 2) questionnaires, the home visits were augmented with a questionnaire (Appendix 4) that was modified from the questionnaire used in 1983 at OUH. This home interview questionnaire included 88 items for the users concerning use of the HA, factors contributing to poor use, handling problems and overall satisfaction and skills of using the HAs. The answers were recorded by the interviewer. Furthermore, the interviewer filled out 46 items according her observations about handling skills and the state of the HA (Appendix 4). The HHIE-S and EQ-5D questionnaires were filled out by the patients. HA satisfaction was asked with a simple question: “Have you been satisfied with your hearing aid?”.

4.2.5 Counselling of hearing aid users (Study IV)

Until now, HA users have not been routinely given follow-up counselling in Finland. To evaluate the effect of additional counselling on use and benefit from HAs, a prospective pre-post design study was done. Starting at the beginning of July 2001, 103 consecutive persons were interviewed prior to HA fitting at KCH as part of regular counselling, and they were visited and interviewed at their homes approximately six (visit with follow-up counselling) and twelve months after they had had their first HA fitted. The data on three subjects were excluded because they had returned their HAs before the third interview, and the data on two subjects were missing, leaving a study population of 98 patients.

The interviewer also counselled and instructed the users on how to use their HAs, assessed their skills in handling their HA, and checked the condition of the HA. The counselling given at home was in addition to routine counselling that was included in the HA fitting, and it focused on observed deficiencies in using and handling the HA.

On both home visits the interview questions included the same HHIE-S (Appendix 1) and generic EQ-5D (Appendix 2) questionnaires and also the specified 88 questionnaire (Appendix 4) concerning use of the HA. Handling skills and the state of the HA were also observed by the interviewer on both visits.

Incremental cost-effectiveness analysis was applied. The incremental costs of follow-up counselling were compared with the incremental outcome: the increased number of

regular users after the follow-up counselling. The number of regular users is a robust outcome measure, which indicates that the resources invested in HAs are in use. The audiology assistant made altogether approximately 230 home visits per year, 196 of them due to this examination. There were two visits per patient in this series, the first for counselling and the second for an interview, and the corresponding part of the total cost was included in the calculation. The calculated cost of travel was directly the kilometre allowance (€ 0.38/km) paid to the audiology assistant.

4.3 Ethical considerations

The study protocol was approved by the Ethics Committee of Kainuu Central Hospital. An informed consent was obtained from the participants.

5 Results

5.1 Use of hearing aids (Study I)

The mean $BEHL_{0.5\text{-}2\ kHz}$ was 41.3 dB. The speech reception threshold (SRT) was measured using the word lists of Jauhiainen (Jauhiainen 1974), and it was 38.1 dB. Sixty-six (86.8%) of the HAs were BTE, nine (11.8%) ITE, and one was (1.3%) body-worn. Sixteen (21.1%) HAs were of the DSP type, fifty-eight (76.3%) were analogue HAs, and the data on two HAs were missing. ARHI was the main reason for HI in 65 subjects (85.5%). Seventy-four HAs were (97.4%) fitted unilaterally.

The results were compared with the study done in Oulu in 1983 (Sorri *et al*. 1984), which comprised 150 HA users, 93 of whom were first-time HA users. The mean age of these interviewees was 64 years. The majority of them were retired (77%). The mean $BEHL_{0.5\text{-}2\ kHz}$ of these HA users was between 31-45 dB in 32.7% of the cases and between 46-60 dB in 38.0%. Ninety-seven (64.7%) HAs were BTE HAs, and 53 (35.3%) were body-worn. ARHI accounted for 39.4% and infection accounted for 30.7% of the reasons for the HI. There was no access to the original 1983 data, only the results given in the publication (Sorri *et al*. 1984).

The present study in 2001 showed that 56.6% of the first-time HAs users used their HA regularly (Table 7). Use of the HA did not depend on the number of people living in the household. The number of people living alone was 20 (26.3%), which did not differ from that of the general elderly population (27.1%) (Statistics Finland 2000). Thirty-nine subjects (51.3%) had two persons in their household, 72 (94.7%) were retired, 4 (5.3%) were working, and 2 (2.6%) were unemployed.

*Table 7. Use of hearing aids. Oulu University Hospital (OUH; 1983; Sorri et al. 1984) and Kainuu Central Hospital (KCH; 2001)**

Classification by hearing aid use	1983 (OUH)				2001 (KCH)		Difference	
	All hearing aid users		First-time users		First-time users		First-time users	
	N	%	N	%	N	%	%	95 % CI **
Regular users	86	57.3	38	40.9	43	56.6	15.7	0.8 ; 30.7
Occasional users	29	19.3	24	25.8	28	36.8	11.0	-3.0 ; 25.1
Non-users	35	23.3	31	33.3	4	5.3	-28.1	-38.9 ; -17.3
Missing information					1	1.3	1.3	-1.3 ; 3.9
Total	150	99.9	93	100.0	76	100.0		

* For classification of hearing aid use, see page 36. ** 95 % CI = 95% confidence interval.

With half of the users the initiative for HA fitting was made by the patients themselves, with 22.4% it was made by health care personnel and with the same amount, by relatives or friends. Those who made the initiative for HA fitting by themselves were more satisfied with their HAs than the others.

Over half of the regular users and a third of the occasional users were satisfied with their HAs. The users who used their HAs regularly were more satisfied with their HA than others.

5.1.1 Reasons for non-use

The present study in 2001 showed that the most commonly reported reasons for non-use were associated with the reported lack of conversational situations, (62.5% of the reasons) (Table 8). Background noise amplified by the HA was reported to be the reason in 46.9% of all the reported reasons. Difficulties with the ear mould were reported in 56.2%. The subjects often indicated more than one reason for non-use. The reasons for non-use in 2001 did not differ from those in 1983.

Table 8. Most common reasons for non-use of hearing aids. All hearing aid users in Oulu University Hospital, N=150 (OUH; 1983; Sorri et al. 1984), and first-time hearing aid users in Kainuu Central Hospital, N=76 (KCH; 2001). More than one reason may have been stated by each subject.

Reason for non-use	1983 (OUH; N=64)		2001 (KCH; N=32)	
	N	%	N	%
No opportunity for conversation	45	70.3	20	62.5
Acoustic inconvenience	48	75.1	17	56.43
Handling difficulties	34	53.2	12	32.2
Ear mould unsuitable	12	18.8	9	28.1
Difficulties in hearing despite the hearing aid	25	39.1	5	15.6

5.1.2 Handling skills of hearing aid users

The handling skills of the HA users are shown in Table 9. In 2001 almost half of the users, 45 (59.2%), could clean the ear mould or shell, while 28 (36.8%) could not.

Table 9. Handling skills of hearing aid users. All hearing aid users in Oulu University Hospital (OUH; 1983; Sorri et al. 1984) and first-time hearing aid users in Kainuu Central Hospital (KCH; 2001).

Handling skills	1983 (OUH)		2001 (KCH)		Difference	
	N	%	N	%	%	95%CI
Can place the hearing aid in the ear						
Yes	122	81.3	63	82.9	1.6	-9.0 ; 12.1
No	22	14.7	11	14.5	-0.2	-9.9 ; 9.5
Missing	6	4.0	2	2.6	-0.1	-6.1 ; 3.4
Can replace the battery						
Yes	122	81.3	60	79.0	-2.4	-13.5 ; 8.7
No	22	14.7	13	17.1	2.4	-7.8 ; 12.6
Missing	6	4.0	3	3.9	-0.1	-5.4 ; 5.3
Can use the hearing aid with a telephone						
Yes	50	33.3	14	18.4	-14.9	-26.4 ; -3.4
No	91	60.7	53	69.7	9.1	-3.9 ; 22.0
Missing	9	6.0	9	11.8	5.8	-2.4 ; 14.0
Total	150	100.0	76	99.9		

95%CI = 95% confidence interval

Nearly 70% of the first-time HA users who reported that they could use their HA well were now regular users, and almost all the others were occasional users. The regular users were more able to use their HAs than occasional users and non-users. Of those who reported their abilities to be poor, 30% were non-users. Seventy-two (94.7%) users considered their HAs to work well, while 2 (2.6%) reported theirs to be out of order, and the interviewer agreed with their opinion. Eighteen HA users (23.7%) did not know where to have the HA repaired, if needed. The skills of using a HA had not essentially changed during the past twenty years.

5.1.3 Changes in twenty years

The same classification (Sorri *et al*. 1984) for HA use was applied in the present study, and it can be shown that the number of regular users has increased and the number of non-users has decreased significantly during the past twenty years.

When the interviewer visited the HA users at their homes in the present study, 53 (69.7%) of the users had their HA in use, 21 (27.6%) had it somewhere in the house, and

1 (1.3%) person had lost his HA. Only half of the users had their HA in use when visited in 1983.

Satisfied HA users had increased from 69.3% to 89.5%, and the number of dissatisfied users had decreased.

The initiative for HA fitting was made more often by the HA user him/herself in the current study (50%) compared with the 1983 study (37.3%), and those who had made a personal initiative for HA fitting used their HAs more frequently in both study groups. In both studies, those who had made the initiative for HA fitting by themselves were more satisfied with their HAs than the others.

The most commonly reported reasons for non-use in the present study, and also in 1983, were associated with the subjective experience of a lack of conversational situations.

The skills of using a HA seem to be at the same level now as in 1983 (Table 9). The greatest deterioration was seen in using HAs on the telephone, which was the only statistically significant change. Users who could use their HA well used their HAs more often regularly and were more satisfied with their HAs than those who could not. Difficulties with HA handling were less often (32.2%) a reason for non-use than in 1983 (53.2%). The HA users were now significantly more satisfied with their HA and the sufficiency of counselling than in 1983.

5.1.4 Comment

During the past twenty years the number of regular users has increased and the number of non-users has decreased significantly. The reasons for better use can be explained by many factors: the HAs themselves, the fitting process and counselling, and society.

Since 1984 HAs have been developed as a whole. DSP HAs are replacing analogue HAs, although only 21.1% of the HAs were digital in 2000 when these interviews were made. HAs are now more invisible, but at the same more delicate to use. There are very few body-worn HAs any more, and other models, such as ITE HAs, are common, whereas twenty years ago one third of HAs were body-worn and the rest were BTE. More attention is also paid to the ear moulds and shells of ITE HAs, which are custom-made instead of the former standard ones. Overall, HAs are likely to be better, giving better benefits in communication.

The aetiologies of the HIs have also changed. ARHI is still the most common reason for HI, and most HIs are sensorineural. Patients with chronic otitis are now rarer than twenty years ago (Vartiainen 1998). Because patients with a conductive HI derive more benefit from a HA than those with a sensorineural HI (Carlin & Browning 1990), the change between HA use now and twenty years ago is even more emphasized. The mean age of the interviewees twenty years ago was ten years less than today. The publication from 1983 does not provide the hearing levels of the HA users, but only their ranges. It is obvious, however, that the grade of HI of HA users is nowadays milder than before. Investigations have shown that hearing level is one of the strongest predictors of HA use, so users with a more profound HI use a HA more than those with better hearing (Tomita *et al*. 2001). These factors make the change in use more significant.

Today users are more satisfied with their HAs than twenty years ago, although their skills in using the HAs have not changed. During this period the amount of counselling has increased in Finland, and the fitting process now includes one month's trial use of the HA at home. HA users now also seem to be more satisfied with the counselling than in 1983, although nearly 15 percent of them still report counselling to be insufficient.

The initiative for HA fitting is made more often by the HA user him/herself in the current study compared with the 1983 study, and that may have an impact on the number of regular users and the satisfaction of the users; those who have made an initiative for HA fitting by themselves use their HAs more and are more satisfied than the others.

During the last twenty years many changes have taken place in society, which has become more technical, and wealth in western countries has increased. The fitting procedure has become more individualized and labour-intensive, requiring complicated and specific tools, such as real ear measures and computerised fitting systems. The amount of counselling of HA users has also increased.

Problems from background noise amplified by the HA do not seem to be as usual now as before, which tells us about the development of HAs. Difficulties in placing the ear mold have also decreased, apparently due to an increase in counselling.

The results of interview surveys have varied widely, depending on the methods used and the populations investigated, and they are not directly comparable with each other. On the other hand, the method of this study was identical to that of the survey conducted at OUH in 1983, which makes it possible to compare the results with each other. The results can also be regarded reliable, even though the methods of investigation affect the results concerning the time that HAs are used and self-reported times of use tend to differ from the real times of HA use (Brooks 1981, Taubman *et al*.1999, Mäki-Torkko *et al*. 2001b).

In her study in the city of Kuopio, Lupsakko (2004) found that 25% of HA owners were non-users, and 55% were full-time users. That is the same figure as in 1984. The population of her study consisted of people aged 75 years and over, however, and was entered by 85.9% of those who were invited, probably the healthiest of them. The most common subjective reasons for non-use of HAs were the same as in this study. Ten owners out of 24 did not feel any need for a HA or did not obtain any benefit from it. Other reasons for non-use were a HA out of order (4/24) or it was too complicated to use (5/24).

Stephens *et al*. (2001) did not find a significant change in HA possession and use over the past 18 years in their study of the Welsh population. Neither did they find HA use to depend on whether the HA had been obtained free of charge or purchased privately.

All the reasons for non-use can not be abolished. However, we can try to develop better HAs and fit HAs and ear moulds that are best suited for the hearing impaired persons so that they would like to use them. Kapteyn *et al.* (1997) found that having an effective exchange of information with the general practitioner and counselling HA users at home resulted in a significantly lower level of non-effective HA use than without intervention.

The skills of using a HA have not deteriorated in the past twenty years, but the number of patients who can not handle their HA is still quite notable. When handling problems increase markedly after 75 years of age (Stephens & Meredith 1990), their impact on HA use should be kept in mind. Attitudes towards using HAs can also be improved.

5.2 Costs of hearing aids (Study II)

5.2.1 Costs for the hospital

The costs of HAs were examined for the year 2000 at KCH and at OUH. These two hospitals serve populations of different sizes and provide different volumes of services. In 2001 the population in the area served by KCH was 88,500, and in the area served by OUH, 365,400. The population in the area served by KCH is older than that served by OUH; the percentage of the population aged 65 years and over in KCH was 16.9% and in OUH, 12.9%, and population aged 75 years and over was 6.7% and 5.3%, respectively. KCH had 274 fittings and provided 244 HAs, and OUH figures were 1180 and 1050, respectively. The number of provided HAs /1000 inhabitants was 2.7 and 2.9, respectively, and the number of fittings/1000 people aged over 65 years was 18.1 in KCH and 25.6 in OUH, and over 75 years, 45.7 and 61.0, respectively. The number of fittings was somewhat greater than the number of HAs provided, because some persons refused to have the HA during the fitting process. Eleven percent of all HA trials end without the purchase of a HA. The percentage of DSP HAs provided at KCH and at OUH in 2001, was 17% and 15%, respectively.

The total costs of HA fitting for the two hospitals were very similar, € 897 for KCH and € 919 for OUH (Table 10).

Visits due to hearing rehabilitation made up 19% of the outpatient visits to the Department of Otorhinolaryngology of KCH and 46% of the visits to the Hearing Centre of OUH, which was taken into account when sharing the costs.

In the analysis of the fitting process, the personnel costs were calculated according to the time spent. The time spent by the personnel with a patient in need of HA fitting at the hospital, i.e. the three visits, was 226 minutes in KCH and 187 minutes in OUH.

The equipment comprised audiometers, instruments for real ear gain measurements and computers. The prices of the equipment were the real market prices.

The general hospital costs of these two units comprised telecommunication and computer services, administration, janitorial service and equipment. It was assumed that the manner of recording some costs may have been the reason for the small difference, but it was not possible to obtain more detailed information on these rolled costs to find out the exact reason.

Table 10. Calculated costs of hearing aid rehabilitation per fitted hearing aid (€), (2000) at Kainuu Central Hospital (KCH) and Oulu University Hospital (OUH).

Type of cost	KHC	OUH
Salaries of fitting	349	290
Rolled hospital expenses	82	202
Making an ear mould	68	44
Hearing aid, average price	398	383
Total costs for a hearing aid	897	919
Assistive listening devices	45	30
Total costs of hearing aid rehabilitation	942	949

5.2.2 Costs for the patient

The costs of HA fitting for patients were examined in addition to the results presented in the original article. The cost for the patient was nearly € 200 in both hospitals and, thus, accounted for approximately 15% of the total costs of HA fitting. The main cost factor for a patient was travelling, and it was the only cost component in which a difference between these two hospitals was found. Other expenses include possible costs for a private doctor and for medication. These data have not been published in the original paper (Paper II) dealing with costs of HA fitting.

Table 11. Direct costs of hearing aid fitting (€) per patient, consisting of three visits to Kainuu Central Hospital (KCH) or Oulu University Hospital (OUH), (2000).

Type of cost	KCH(€)	OUH(€)
Travelling costs	85	110
Costs for travelling time*	33	35
Costs of time for examinations*	26	30
Costs for the escort*	30	19
Other expenses	1	1
Total cost for patient	175	195

* Costs are calculated using patients' average wages and salaries and the reported times spent

5.2.3 Comment

The total costs of HA fitting were approximately € 900 at both hospitals, with a slightly higher figure at OUH. The costs for the patients at the two hospitals were also quite similar. The price of the HA accounted for somewhat less than half of the total hospital costs and the costs of the audiology personnel made up roughly a third of the overall costs. Compared, for instance, with ENT operations, fitting a HA does not seem to be very expensive. For example, a tympanostomy done under general anaesthesia cost € 468 at KHC and € 460 at OUH, while a myringoplasty cost € 1,500 at KHC and € 1,438 at OUH, and radical mastoidectomy cost € 1,500 and € 2,928, respectively, according to the price lists for 2000 given by the hospitals.

It can be postulated that the expenditure of hearing services would be higher in small hospitals with fewer fittings. However, the results of this investigation revealed no major difference in the total costs between these two hospitals. A sparsely inhabited country like Finland has long distances, and to make HA service equally available to everyone, even smaller centres in rural areas are needed, and potentially higher expenses are inevitable. The lower travelling expenses for the patients in Kainuu also support the policy of HA fitting near the users.

In the report by Barton *et al*. (2001), the total annual expenses per person provided with a HA, including all rehabilitation services, were estimated to be over € 2,500 in Finland. The present figure, nearly € 950, is not directly comparable with this figure, and the costs of other rehabilitation services, the salaries of rehabilitation counsellors, the

costs of rehabilitation courses, etc., should be added to make the figures comparable with the earlier high figure presented by Barton *et al*. (2001). On the other hand, the estimated figure of € 924, given in the second report by Barton *et al*. (2003), is very close to the present one. Joore *et al*. recently published data from the Netherlands, which reported direct hospital costs 30% higher than the present study (Joore *et al*. 2003b). The difference between the Netherlands and Finland was mainly due to the price of the HA. Abrams *et al*. (2002) have presented the cost per HA fitting in 1999-2001 to be about € 980 in Florida. However, the calculations are not directly comparable with each other due to a different model for calculating, but the order of magnitude is the same.

HAs have developed quickly in the past years, and DSP HAs are widely displacing analogue HAs. This also has an effect on the costs of HAs. In this study the percentage of patients at KCH with DSP HAs was 21.1% in 2000, and the figure had increased to 51% in 2001. It appears that buying HAs in large batches can significantly decrease the costs of HAs. Indeed, recent joint tenders made in the past few years have reduced the prices of HAs in the hospital district of OUH (Heikki Löppönen, personal communication).

5.3 Effect of hearing disability on HRQOL (Study III)

All the patients were retired and in nearly all (83.7%) cases the HI was caused by ARHI. The classification of aetiology was based on audiograms and medical history in the hospital records. The mean age of the interviewees was 76.5 years (min. 61, max. 87), and half of them were women and half were men.

The mean $BEHL_{0.5\text{-}4\ kHz}$ of these HA users was 48.0 dB. The HA improved the mean SRT in this group of HA users by approximately 12 dB and also slightly improved the mean word recognition score (WRS) (Table 12). At six months after HA fitting, 58.2% (N=57) of the patients were regular users, while 31.6% (N= 31) were occasional users, and 10.2% (N=10) used their HA seldom, if ever.

Table 12. Better ear hearing levels ($BEHL_{0.5\text{-}4}$ kHz, dB), speech reception thresholds (SRT, dB) and word reception scores (WRS, %) before (pre) hearing aid fitting and aided with a hearing aid six months after (post) hearing aid fitting. First-time hearing aid fittings, Kainuu Central Hospital, (2002). (N=98)

	$BEHL_{0.5\text{-}4\ kHz}$	SRT pre	WRS pre	SRT post	WRS post
Mean	48.0	37.9	92.2	26.4	95.6
Standard Deviation	7.0	7.8	9.5	5.9	5.1
Median	47.5	40.0	97.0	25.0	97.0
Minimum	33.75	20	60	15	77
Maximum	65.0	55	100	40	100

5.3.1 Effect of hearing disability on disease-specific HRQOL

The mean HHIE-S score was improved and it was 28.7 before HA fitting and 12.7 six months after (Tables 13 and 14). The subscores and the numbers of responses are also shown. The results of the social and emotional items were similar. Emotional problems were significant before HA fitting. Nearly 70% of the subjects felt handicapped because of their HI, and more than half of them reported that the HI limited their lives. Six months after HA fitting, the number of patients who felt handicapped by their hearing problems had decreased significantly ($p<0.01$, Paired samples T-test), and all items of the disease-specific HHIE-S were significantly better compared with the baseline ($p<0.01$, Paired samples T-test). The items least affected by the HA were arguments with family members (emotional items) and difficulty in hearing whispering (social items), but even these changes were statistically significant ($p<0.01$, Paired samples T-test).

There was no difference between the groups classified according to the use of HAs (Table 15). Regular, occasional and non-users brought similar results in all items of the HHIE-S questionnaire, and the changes were statistically significant ($p<0.01$, Paired samples T-test). DSP HAs (N=4) and analogue HAs (N=6) gave similar results. There was no difference between men and women.

Table 13. Hearing Handicap Inventory for the Elderly, short version (HHIE-S), emotional questions. Before and after hearing aid fitting in Kainuu Central Hospital, (2002). N=98

Item	Before hearing aid fitting			6 months after hearing aid fitting		
	N	%	mean score	N	%	mean score
E1, Embarrassed						
yes	57	58.2		11	11.2	
sometimes	30	30.6		35	35.7	
no	11	11.2		52	53.1	
			2,94			1,16
E2, Frustrated						
Yes	38	38.8		5	5.1	
Sometimes	44	44.9		32	32.7	
No	16	16.3		61	62.2	
			2,45			0,86
E3, Handicapped						
Yes	68	69.4		15	15.3	
Sometimes	27	27.6		45	45.9	
No	3	3.1		38	38.8	
			3,33			1,53
E4, Arguments						
Yes	27	27.6		11	11.2	
Sometimes	40	40.8		39	29.6	
No	31	31.6		58	59.2	
			1,92			1,25
E5, Limits life						
Yes	55	56.1		12	12.2	
Sometimes	37	37.8		32	32.7	
No	6	6.1		54	55.1	
			3,00			1,14

Table 14. Hearing Handicap Inventory for the Elderly, short version (HHIE-S), social questions. Before and after hearing aid fitting in Kainuu Central Hospital, (2002). N=98

Item	Before hearing aid fitting			6 months after hearing aid fitting		
	N	%	mean score	N	%	mean score
S1, Whisper						
Yes	91	92.9		59	60.2	
Sometimes	5	5.1		29	29.6	
No	2	2.0		10	10.2	
			3,82			3,00
S2, Visiting						
Yes	65	66.3		16	16.3	
Sometimes	27	27.6		35	35.7	
No	6	6.1		47	48.0	
			3,20			1,37
S3, Religious Services						
Yes	38	38.8		10	10.2	
Sometimes	20	20.4		9	9.2	
No	40	40.8		79	80.6	
			1,96			0,59
S4, Television						
Yes	77	78.6		19	19.4	
Sometimes	13	13.3		27	27.6	
No	8	8.2		52	53.1	
			3,41			1,33
S5, Restaurant						
Yes	56	57.1		15	15.3	
Sometimes	26	26.5		25	25.5	
No	16	16.3		58	59.2	
			2,82			1,12
Mean total score			28,69			12,71

"Yes"=4, "Sometimes"=2 and "No"=0. The individual question scores are summed to give a total score. A score of zero to eight indicates little trouble with hearing. Scores of 10 or more are indicative of HI that might benefit from an audiologic evaluation. The higher the score is, the greater is the degree of hearing disability.

Table 15. Comparison of mean total, emotional and social scores of HHIE-S before and six months after hearing aid fitting classified according to use of the hearing aid. (N=98; Females 49, Males 49). For classification, see page 9.

Classification by hearing aid use	Scores before hearing aid fitting	Scores 6 months after hearing aid fitting	95 % CI of the Difference*
All users, N=98			
HHIE-S	28.7	12.7	14.2 ; 17.8
Emotional Subscale	13.6	5.7	6.8 ; 9.0
Social/Situational Subscale	14.9	7.3	6.5 ; 8.7
Regular users, N=57			
HHIE-S	28.3	11.1	14.9 ; 19.4
Emotional Subscale	13.4	4.8	7.3 ; 9.9
Social/Situational Subscale	14.5	6.5	6.6 ; 9.4
Occasional users, N=31			
HHIE-S	28.4	14.9	9.8 ; 17.2
Emotional Subscale	13.7	7.4	4.1 ; 8.4
Social/Situational Subscale	15.2	7.9	5.3 ; 9.4
Non-users, N=10			
HHIE-S	32.0	15.0	10.8 ; 23.2
Emotional Subscale	14.6	5.4	5.7 ; 12.7
Social/Situational Subscale	16.6	10.2	1.3 ; 11.5

*95 % CI = 95% confidence interval

5.3.2 Effect of hearing disability on generic HRQOL

The generic EQ-5D questionnaire revealed no clear change after HA fitting. The numbers and proportions of patients reporting problems in each EQ-5D dimension as well as the EQ-VAS scores before and six months after HA fitting are shown in Table 16. The number of patients reporting problems increased in the mobility dimension and decreased or was unchanged in the other dimensions. These changes were statistically insignificant.

Table 16. EQ-5D, before and after hearing aid fitting in Kainuu Central Hospital, (KCH), (2002). N=98

Item	Before hearing aid fitting						6 months after hearing aid fitting					
	Total		Men		Women		Total		Men		Women	
	N	%	N	%	N	%	N	%	N	%	N	%
Mobility												
No problems	51	52.0	29	59.2	22	44.9	42	42.9	28	57.1	14	28.6*
Some problems	47	48.0	20	40.8	27	55.1	55	56.1	20	40.8	35	71.4
Confined to bed	0	0.0	0	0.0	0	0.0	1	1.0	1	2.0	0	0.0
Self-care												
No problems	78	79.6	38	77.6	40	81.6	82	83.7	43	87.8*	39	79.6
Some problems	19	19.4	10	20.4	9	18.4	15	15.3	6	12.2	9	18.4
Unable to wash or dress themselves	1	1.0	1	2.0	0	0.0	1	1.0	0	0.0	1	2.0
Usual activities												
No problems	50	51.0	27	55.1	23	46.9	53	54.1	32	65.3	21	42.9
Some problems	43	43.9	20	40.8	23	46.9	38	38.8	14	28.6	24	49.0
Unable to perform usual activities	5	5.1	2	4.1	3	6.1	7	7.1	3	6.1	4	8.2
Pain/discomfort												
No pain or discomfort	26	26.5	11	22.4	15	30.6	33	33.7	19	38.8*	14	28.6
Moderate pain or discomfort	69	70.4	36	73.5	33	67.3	61	62.2	28	57.1	33	67.3
Extreme pain or discomfort	3	3.1	2	4.1	1	2.0	4	4.1	2	4.1	2	4.1
Anxiety/depression												
Not anxious or depressed	81	82.7	40	81.6	41	83.7	79	80.6	40	81.6	39	79.6
Moderately anxious or depressed	17	17.3	9	18.4	8	16.3	17	17.3	8	16.3	9	18.4
Extremely anxious or depressed	0	0.0	0	0.0	0	0.0	2	2.0	1	2.0	1	2.0
VAS Score	61		63		59		65		64		66	
(S.D.)	(17.9)		(18.1)		(17.6)		(16.3)*		(18.1)		(14.4)**	
EQ-5D index	0.70		0.71		0.68		0.70		0.73		0.66	
(S.D.)	(0.19)		(0.20)		(0.17)		(0.18)		(0.19)		(0.17)	

* p<0.05, Wilcoxon Signed Ranks Test. ** p<0.01, Wilcoxon Signed Ranks Test.

The analysis of women and men separately revealed a statistically significant (p<0.05, Paired samples T-test) improvement for men in the self-care and pain/discomfort dimensions, as 39% of the patients reported no problems six months after HA fitting, compared with 22% before fitting. The number of women reporting problems increased statistically significantly (p<0.05, Paired samples T-test) in the mobility dimension, where 71% reported problems six months after HA fitting compared with 55% before fitting. The remaining dimensions did not show any statistically significant changes.

A statistically significant positive improvement was seen, however, in the EQ-VAS score, which reflects a self-report of health status. The change was statistically significant for women ($p<0.01$, Paired samples T-test), which accounts for the change in the total EQ-VAS, and for all users ($p<0.05$), but not for men. The change in the EQ-VAS was statistically significant ($p<0.05$) for regular HA users, but not for occasional and non-users (Table 17).

Table 17. EQ-VAS scores before and six months after hearing aid fitting

Classification by hearing aid use	Before hearing aid fitting		6 months after hearing aid fitting		95 % CI
	VAS score	S.D.	VAS score	S.D.	
All users (N=98)	61	17.9	65*	16.3	-7.1 ; -0.8
Regular users (N=57)	62	19.4	67*	16.3	-9.8 ; -1.4
Occasional users (N=31)	62	16.6	64	15.5	-7.2 ; 3.0
Non-users (N=10)	56	12.6	56	16.5	-13.5 ; 13.5

95 % CI = 95% confidence interval. * $p<0.05$, Paired samples T-test.

5.3.3 Comment

These results show that hearing impaired people benefit significantly from HAs. This can be seen in the results of both the social and the emotional items of the disease-specific HHIE-S questionnaire. Six months after HA fitting, all items of the HHIE-S are significantly better compared with the baseline ($p<0.01$). Also the non-users benefited significantly from HA fitting, which reflects the strong psychological implication of the process itself on hearing impaired people.

This benefit can not, however, be seen with the generic HRQOL instrument, the EQ-5D questionnaire. There is a small improvement in the self-care and pain/discomfort dimensions for men and deterioration in the mobility dimension for women, but it is not possible to identify any clinical parameters that would explain the difference between men and women in these dimensions. One patient was diagnosed with cancer after the HA fitting, but that does not explain the results. These inconsistent results may just reflect random variation.

On the other hand, there is a statistically significant improvement ($p<0.01$) after HA fitting in the EQ-VAS score, which reflects a self-report of health status.

Some studies of different diseases have shown that the EQ-5D questionnaire has poor sensitivity in measuring the sensory aspects of quality of life and in detecting smaller changes (Longworth and Bryan, 2003; Oostenbrink *et al.*, 2002; Belanger *et al.*, 2000, Barton *et al.* 2005). Earlier studies on HI have revealed only small improvements in the generic EQ-5D dimension in HA patients (Joore *et al.*, 2003; Joore *et al.*, 2003; Joore *et al.*, 2002a). It seems that the generic EQ-5D questionnaire lacks sufficient sensitivity to changes brought about by audiological intervention.

Barton *et al.* (2005) found the mean utility score of the EQ-5D to be 0.79 for new referrals to four United Kingdom audiology clinics, and Kind *et al.* (1998) obtained a

mean score of 0.86 from two different samples of people selected from the general population. In our sample, the baseline score was 0.70, which is somewhat lower than the abovementioned ones, but the average hearing level of our subjects was also poorer than in the report by Barton *et al*. (2005). This suggests that according to the EQ-5D, HI is associated with a small reduction in utility.

Gates *et al*. (2003) found a global question "Do you have a hearing problem now" to be more effective than a detailed questionnaire in identifying older individuals with an unrecognised handicapping HI. The global measure was considerably more sensitive (71%) than the HHIE-S (36%) for detecting the HI, but it had more false-positive cases (28%) than the HHIE-S (8%). Thus, primary care physicians are encouraged to ask their patients whether they have a hearing problem and refer patients who do for formal hearing testing (Gates *et al*. 2003). Maybe some simple questions or measures like the EQ-VAS might also work better than a questionnaire in measuring benefits in audiological intervention.

HA satisfaction has been found to be related to experience, expectation, personality and attitude, usage, type of HAs, sound quality, listening situations, and problems in HA use. Many tools have been designed to measure the overall degree of satisfaction, or along the dimensions of cost, appearance, acoustic benefit, comfort, and service. The findings of the various studies are not always consistent across studies. Inconsistent findings across studies and difficulties in evaluating the underlying relationships are probably caused by problems with the tools (e.g., lack of validity) and the methods used to evaluate relationships (e.g., correlation analyses evaluate association and not causal effect). The global question: "Have you been satisfied with your hearing aid?" gives us a good picture of satisfaction as a whole. The question is easy to understand for an interviewee and easy to use.

In this study there was no statistical difference in favour of DSP HAs or analogue HAs, and it may well be that an economical or mid-level HA could provide the same practical assistance to many HA users as a more expensive digital model. The size of the sample does not, however, enable a comparison of adaptive and non-adaptive HAs.

Many different health measures are available for health evaluation studies. Many diseases have also specific tools developed for them. The measure which should be used depends on the topic of the research. Generic measures may capture changes in generic health universally, but does not notice changes in a specific function or feeling. On the other hand, a disease-specific measure can catch even small changes in the disease to which it is dedicated, but it may not note a disadvantage or harm outside its scope. This may lead to wrong conclusions about the studied reactions. This is why many researchers recommend using both generic and disease-specific measures together.

5.4 Counselling of hearing aid users (Study IV)

5.4.1 Hearing aid use

Almost all (95.9%) the subjects were retired. ARHI was the cause of HI in 73.5% of the patients. The diagnosis was based on audiograms and medical history in the hospital records. The mean age of the interviewees was 74.9 years (min. 47, max. 87), and 46 were women and 52 men, who were aged 73 years and 81 years, respectively. The mean $BEHL_{0.5\text{-}4\ kHz}$ of the HA users was 47.3 dB.

Six months after HA fitting, more than 61% of the patients reported using their HA at least 2 hours a day, 30% were occasional users, and 9% used their HA seldom, if ever (Table 18). The users were counselled at six months, and twelve months after HA fitting the number of regular users had increased by 16 patients (26.6%), which change was statistically significant ($p<0.01$, Wilcoxon Signed Ranks Test). Altogether there were 21 new regular users, 18 occasional users and 3 non-users six months after HA fitting. There were also three regular users who became occasional users and two regular users who became non-users. Most (91%) of those who were regular users six months after HA fitting continued to use their HAs regularly at twelve months. Also, over half (62%) of the occasional users and as many as one third (33%) of the non-users had become regular users.

Table 18. Use of hearing aids at 6 and 12 months after hearing aid fitting. Counselling at six months after fitting. N=98.

Classification by hearing aid use	6 months after hearing aid fitting		12 months after hearing aid fitting		Difference1
	N	%	N	%	%
Regular users	60	61.2	76	77.6	16.4
Occasional users	29	29.6	17	17.3	-12.3
Non-users	9	9.0	5	5.1	-3.9
Total	98	100.0	98	100.0	

[1] All items significantly better twelve months after hearing aid fitting ($p<0.01$, Wilcoxon Signed Ranks Test)

Twelve months after HA fitting, the users reported that they felt themselves more able to use the HA and felt less need for counselling compared with the situation at six months. The greatest improvement in handling skills was achieved in cleaning the ear mould and in HA use on the telephone. The HA users were also significantly better able to place the HA in their ear after follow-up counselling (Table 19).

Table 19. Handling skills of hearing aid users. First-time hearing aid users. Follow-up counselling 6 months after fitting and interviews 6 months and 12 months after fitting. N=98.

	6 months after fitting		12 months after fitting	
	N	%	N	%
Can place the hearing aid in the ear[1]	68	69.4	81	82.7*
Can use the hearing aid on the telephone[1]	26	26.5	68	69.4**
Can use the hearing aid well[2]	62	63.3	79	80.6*
Counselling useful[2]	81	82.7	95	96.9**
Counselling sufficient[2]	75	76.5	94	95.9**

[1]Interviewer's opinion. [2]Reported by the subject. * $p<0.05$, Paired samples T-test. ** $p<0.01$, Paired samples T-test.

Nearly 80% of the HA users (79.6%) were satisfied with their HAs after 6 months of use. After 12 months, even more HA users were satisfied (88.8%) with their HAs, and especially the number of dissatisfied users had decreased. However, the difference was not statistically significant ($p>0.05$, Paired samples T-test), maybe because of the small size of the sample.

5.4.2 Disease-specific HRQOL

The HHIE-S (Table 20) shows that the greatest changes in emotional and social problems occurred during the first 6 months after the HA had been provided. The decrease in hearing problems also continued up to twelve months, and the problems with HA use were then milder. The changes from before HA fitting to both 6 months and 12 months after were statistically significant in all items ($p<0.01$, Wilcoxon Signed Ranks Test). Although further improvement was seen in the HHIE-S scores between 6 and 12 months with counselling 6 months after HA fitting, the difference was not statistically significant with the exception of the change in the subscore of the emotional item of all the users, which was statistically significant ($p<0.05$, Wilcoxon Signed Ranks Test).

Table 20. Comparison of mean total emotional and social scores before, six months after, and one year after hearing aid fitting. Statistical analyses were done by comparing results before and six months after hearing aid fitting, and six months and twelve months after hearing aid fitting. (N = 98, Females 45, Males 53).

	Before fitting	6 months after fitting		12 months after fitting	
	Scores	Scores	95 % CI of the difference to before	Scores	95 % CI of the difference to 6 months after
HHIE-S	28.8	12.7	14.4 ; 17.9	11.2	-0.1 ; 3.0
Emotional Subscale	13.7	5.7	6.9 ; 9.1	4.7	0.1 ; 2.0
Social/Situational Subscale	14.8	7.6	6.3 ; 8.3	6.5	0.1 ; 2.0

95 % CI = 95% confidence interval. Paired samples T-test.

5.4.3 Generic HRQOL

Table 21 shows that the EQ-VAS showed improvement in the HRQOL ($p<0.05$, T-test) six months after HA fitting, but it did not change statistically significantly after that. However, the EQ-5D index and the decrease in the number of patients reporting problems in each dimension showed a small but statistically non-significant improvement in the HRQOL between 6 and 12 months. The difference in the EQ-5D index between regular users and other users (occasional users and non-users) at six months (0.71 and 0.63) and at 12 months (0.70 and 0.61) after the HA fitting was not statistically significant.

Table 21. Self-reported health status, percentage of respondents reporting problems in the EQ-5D dimensions, EQ-5D index and EQ-VAS score. Before, 6 and 12 months after hearing aid fitting. Statistical analyses were done by comparing results before and six months after hearing aid fitting, and six months and twelve months after hearing aid fitting. (N=98, Females 45, Males 53)

	Before hearing aid fitting	6 months after hearing aid fitting	12 months after hearing aid fitting
	%	%	%
Mobility, %	44.9	54.1	51.0
Self-care, %	19.4	15.3	15.3
Usual activities, %	45.9	43.9	41.8
Pain/Discomfort, %	71.4	62.2	73.5
Anxiety/Depression, %	17.4	20.4	20.4
EQ-5D index (S.D.)	0.70 (0.18)	0.68 (0.22)	0.68 (0.20)
VAS score (S.D.)	61.4 (16.5)	65.4 (16.5)*	64.7 (15.5)

* $p<0.05$. Wilcoxon Signed Ranks Test.

5.4.4 Cost-effectiveness

The costs of follow-up counselling were approximately € 83/visit. That consisted of the part-time audiology assistant's salary (€ 17,532/year) and travel costs (€ 1,600/year). The audiology assistant made altogether approximately 230 home visits per year, 196 of these due to this examination. There were two visits per patient in this series, the first for counselling and the second for the final interview. The cost of follow-up counselling for the 98 HA users was € 8,134. As a result, regular users increased by 16 patients. The incremental cost-effectiveness ratio is the cost of follow-up counselling per additional number of regular users, i.e. € 508 per additional regular user.

5.4.5 Comment

The benefits must be considered cautiously because there was no non-HA control group. This investigation indicates that follow-up counselling can help a significant number of occasional HA users to become regular users, and decrease the number of non-users. This change into regular users is a clear, robust measure and indicates that occasional users can apparently be trained to become regular users, and that it is also possible to prevent their non-use of a HA. The rate of use of occasional users and regular users presumably also increased as a result of the visit. The results agree with earlier investigations that have shown increased use of HAs after better counselling (Surr *et al.* 1978, Brooks 1981, Brooks 1985, Kapteyn *et al*. 1997, Gianopoulos *et al.* 2002).

In the literature, the use of HAs has been noticed to be highest soon after fitting and the main drop-out point to be within the first year after fitting (Schumacher 1997), but in this study the use of HAs did not decrease, but instead even increased after counselling.

This study also shows that follow-up counselling can also significantly increase the users' handling skills. Improved handling skills may be considered as proof of the real effect of counselling. In the literature, the effect of HA rehabilitation has usually been shown to deteriorate after the first months. Hence, the present improvement in use and disability may rather reliably be attributed to counselling.

Even though use increases from 6 to 12 months, the HHIE-S and EQ-5D do not change any more. At 6 months the HHIE-S had a big change, and there may not be room for additional advancement from 6 to 12 months ("ceiling effect"). However, the general question about satisfaction with the HA shows still more improvement.

The patients in this study also expressed a need for counselling. In their report, Dahl *et al.* (1998) found that a significant proportion of Danish HA users, especially the elderly, did not experience a need for further education and counselling concerning their hearing disability.

Joore *et al*. (2003b) found the fitting of HAs to be a cost-effective health care intervention. Their result was not unambiguously positive, probably because the EQ-5 lacked sensitivity for evaluating HA fitting.

A European study - the Maastricht Report (2000) - shows that the cost per QALY for treating HI in a person aged between 65 and 69 is € 11,500. In comparison, the cost per QALY for breast cancer screening is € 10,300 (Drummond 1993) and for knee replacement, € 46,500 (Drewett 1992). If the hearing impaired person is younger than 65, the cost per QALY will be even lower because of the increased quality of life expectance.

The reasonable value for a QALY that is generally accepted by researchers has been raised from USD 20,000 in the beginning of the 1990s (Harris *et al*. 1995, Palmer *et al*. 1999, Hay *et al*. 1991, Goldman *et al*. 1991, Tosteson *et al*. 1990) to today's USD 50 000 (Jonsson 2004, Devlin & Parkin 2004, Chumney *et al.* 2005, Braithwaite 2005, Laufer 2005).

Abrams *et al*. (1992) stated in their discussed study that HA treatment cost USD 60.00 per QALY gained, while a HA combined with post-fitting counselling cost only USD 31.91 per QALY gained, making it the more cost-effective treatment.

According to this examination, counselling is very cost-effective when considering the use of HAs as a very robust measure. In this study the expenses caused by follow-up

counselling at home were approximately € 83 per fitted HA. This is only an 8.7% increment to the calculated cost of € 949 of fitting a HA, and this can be regarded as highly acceptable. To bring an unused HA into regular use, € 508 per HA was spent. That is half of the whole calculated cost of fitting a HA.

In their study, Chisolm *et al*. (2004) found a counselling-oriented audiological rehabilitation programme, as an adjunct to HA fitting, to result in treatment benefits.

There are only a few earlier reports on the cost of counselling at home. Kapteyn (1997) reported that patients with a counselling visit at home had a significantly lower level of non-effective use (27% versus 37%; $p < 0.05$) than patients who had not been visited.

Brickley *et al*. (1996) found attendance rates at group follow-up counselling for new HA users to be significantly poorer than with individual counselling. In our area, attendance at group counselling can be difficult to arrange for patients, especially due to our long distances. If we want to provide extensive counselling for all users, it is better for us to reach the users at home.

Elderly people easily get tired during HA fitting at a hearing centre, and their lack of attention may hinder good instruction. Counselling comprises many new things at the same time, and reception of new information is better at home, where the elderly person can handle and use the HA at leisure. Our audiology assistant reports that well-performed counselling at home sometimes takes up to two hours per HA user.

6 General Discussion

6.1 Use of hearing aids

The proportion of regular users out of all HA possessors has clearly increased since the 1980s, and the number of non-users has also decreased significantly. During the last twenty years, many changes have taken place in society, and the fitting procedure has also become more individualized and HAs have developed. However, all HAs will never be in regular use and some degree of unuse must be accepted. If the threshold of having a HA is raised, there would be more people who would benefit from having a HA but would not get one. On the other hand, lowering the threshold would increase the number of non-used HAs. The number of non-used HAs in this study was 5.3% of the first HAs, which is a really low figure. Even more non-used HAs could be accepted in order to have a HA in use by all who would benefit from it. Indeed, one might ask whether such a low figure of non-used HAs would imply that there are plenty of people in need of a HA who were never offered one.

The new basis for HA fitting in Finland will apparently increase the number of HA fittings in the direction of fittings in the other western countries and give us new challenges when the number of elderly in need of rehabilitation is also increasing. The real need of HAs can perhaps never be fulfilled. In conclusion, the low percentage of non-used HAs shows that resources have not been wasted. However, the picture may change with the current less strict indications for HA fitting.

6.2 Costs of hearing aids

To study the costs of HA fitting in this study, all the costs of fitting were examined. In addition, to make the results as reliable as possible, the time used for fitting was charted and recorded. Only real costs that were clearly proved to exist, not estimated costs, were taken into account. Comparing the costs of HA fitting calculated in this study, approximately € 900 in the year 2000, with other medical care and considering also the benefit of HAs, these costs are very acceptable.

The real expenses of fitting and providing HAs have not been presented before. The results of this study showed the expenses to be quite the same at KCH and OUH. Recording of expenses differed in these hospitals, but the results were almost the same. Thus, the two paths led to the same result. These two hospitals can be regarded as representing Finnish hospitals in general, one being an ordinary central hospital and the other a bigger university hospital.

Joore *et al*. recently published data from the Netherlands, which reported direct hospital costs 30% higher than the present study (Joore *et al*. 2003b). The costs of HA rehabilitation in Great Britain are considered to be low. However, the use of HAs there is also found to be low (Gianopoulos *et al.* 2002, Davis 2003). Comparing the price of HA rehabilitation per HA in use in Great Britain with ours shows that after all, the costs in Great Britain are not so low. In conclusion, the costs in Finland are not high; one might even argue that the cost per HA in use is low in Finland.

HA fitting is extremely labour-intensive, and qualified personnel are necessary to perform the tasks. Successful fitting of a HA depends as much on the otolaryngologist and the audiology assistant and their rehabilitatory efforts, as on the instrument itself. It takes time to provide the necessary follow-ups to ensure that the HAs are properly fit, both acoustically and for convenient use, and that the user knows how to care for and use them properly. The otolaryngologist and audiology assistant have to interview the person, conduct appropriate audiometric and other tests, take ear impressions, select and fit the aids, reprogramme them when necessary, schedule several follow-up appointments, provide all the necessary information, and deal with extra visits when problems occur. Without all this we could just as easily purchase HAs through the mail or from a supermarket. It is not possible to reduce the amount of work without decreasing quality. To fit HAs as from a conveyor belt would definitely lead to more unused HAs.

A choice has to be made between costs and quality: are we seeking small expenses or good use and benefit of HAs. There are differences in these policies in different countries. More labour is used in Finland than in some other countries. For example, in Great Britain 320, in Denmark 280 and in Finland 60 patients were fitted per audiology person in one year (Barton *et al*. 2003).

The primary goal of HA fitting is to ensure audibility of a speech signal as clearly as possible. Parving (2003) found no difference between the benefits obtained with low- and high-cost DSP HAs. Larson found differences between the benefits provided to patients with sensorineural hearing loss by three commonly used HA circuits to be much less than the differences between the aided vs. unaided conditions (Larson *et al.* 2000).

In this study the results of the HHIE-S were similar in all items with both DSP HAs and analogue HAs, and there was no statistical difference in favour of DSP HAs or analogue HAs. However, the number of digital HAs did not allow a comparison of the results of adaptive and non-adaptive HAs separately. The most expensive, smallest and most modern device is not necessarily the best option for the individual patient. Because of the competitive nature of development in the HA industry, novel technical variations are introduced, but it is not plausible that every newly introduced development results in improved listening technology. Paying more for a HA does not guarantee that someone will hear noticeably better. It may well be that an economical or mid-level HA could provide the same practical assistance to many HA users as a more expensive model. In his study, Kochkin (2003) pointed out that the price of a HA is not significantly related to

the benefit achieved from the HA. Gianopoulos *et al*. (2002) also stated that support, counselling, and small aids are more important than expensive, modern technology in continued use of HAs.

To make costs lower, public service providers are often able to reduce their unit cost by joining a co-operative buying group that purchases HAs in large quantities. This has proved to be true also in Northern Finland, where joint tenders in the past few years have reduced the prices of HAs (Heikki Löppönen, personal communication).

6.3 Effects of hearing aids

This study confirms that HAs are highly beneficial and effective in reversing subjective social, emotional and communication dysfunction caused by a HI and emphasises the importance of HAs for persons with a HI. The results of the disease-specific HRQOL questionnaire, HHIE-S, were significant in all the social and emotional items. The changes in the HHIE-S scores were statistically significant also when considering non-users alone. This change may be due to psychological factors, and it shows that HA fitting also as a process has a strong positive impact on the emotional situation of hearing impaired people. Having their hearing problems dealt with helps the hearing impaired person to cope with them.

On the other hand, the general HRQOL instrument, EQ-5D, revealed no clear improvement in the quality of life of HA users. A generic HRQOL instrument measures general health status and is not sensitive enough to detect small sensory changes. However, the EQ-VAS, which reflects a self-report of health status, proved to be sensitive in this study.

Now, when there is no general HRQOL instrument sensitive enough in measuring audiological intervention to provide the most comprehensive evaluation of treatment effects, it is often useful to include both a disease-specific and a generic health measure (Jackowski & Guyatt 2003). The best accuracy in measuring hearing rehabilitation is achieved with a combination of instruments for both activity limitations and participation restrictions of hearing impaired people. However, it may be that simple measures like the EQ-VAS might work better here than a questionnaire like the one in this study.

The importance of follow-up counselling of HA users has not been recognized until now in Finland. Through counselling the benefits of HAs can be achieved more effectively and by more HA users.

6.4 Cost-benefit in hearing aid rehabilitation

The results of HA rehabilitation can be measured using clinical measurements such as improvement in hearing levels or SRT, or by employing questionnaires to ask patients about HA use or satisfaction with or benefit from their HAs. Successful fitting, which can partly be measured by clinical measures, is needed as a prerequisite for willingness to use the HA and also for improvements in health measures.

Today, quality-of-life assessment is an accepted part of medical research and covers a broad field of issues. When measuring changes in the quality of life in relation to the cost of treatment, it is necessary to know how these changes should be measured and to include all the treatment costs in these measurements. Measuring cost-benefit needs to combine measures and costs. To make comparisons between different diseases, we must use measurements that are comparable between different diseases. With disease-specific questionnaires, a comparison can be made only among similar questionnaires, but the results are not directly comparable with questionnaires developed for assessment of other diseases or impairments. General HRQOL measures can, however, be used as tools within the health sector and for comparing results with different diseases. However, as Barton *et al.* (2005) stated, caution should be exercised when comparing utility scores derived by different measures.

To fit a HA in this study cost less than € 1000 and brought a significant positive change in the lives of their users. The cost-benefit of follow-up counselling was measured in this study using HA use as a robust measure. The expense of follow-up counselling at home was only an 8.8% increment over the calculated cost of fitting a HA. To bring an unused HA into regular use, half of the whole calculated cost of fitting a HA was needed. In addition follow-up counselling increased the benefit of HA use. Taking into account the positive impact of counselling on the lives of HA users, it can be established that follow-up counselling is highly cost-effective. The accepted increment for follow-up might be a cost that is lower than the original cost of HA fitting.

Many medical needs, including hearing health care, are vying for the same insufficient resources. In this competition, hearing rehabilitation must show evidence of being beneficial. The evidence should be shown by studies, but selecting the ways of doing it is not easy. There are some problems associated with interview studies, where patients are recalling a past event, and there might be reasons for over-reporting the time of HA use. For example, the HA was publicly funded and the user does not want to report not using it. They appreciate the fact that someone has taken the time to come to their home and provide individualized instruction and may not want to disappoint the interviewer when he or she returns again. They may simply believe they are wearing their HAs for more hours of the day even though they are not. In this study also, the high figures of satisfied users may reflect the fact that in Finland, HA fitting is done without charge.

Rehabilitators have to verify the utility and cost-effectiveness of HA fitting and thereby have influence on social decisions. It is easier for outsiders to be more concerned with the figures related to dispensing aids rather than measures of their true benefit and seeing the job done properly. Quality in HA fitting includes taking a person as a whole, clarifyng his/hers living circumstances, the kind of need for assistive devices and the fitting itself. None of these can be easily measured.

Drummond (2001) stated that an important obstacle to the use of economic evaluation is inherent in the nature of the health care system itself, being particularly related to the difficulties involved in moving funds from one budget to another. This is important, as several studies have concluded that increased expenditure in one budget will lead to corresponding, or even greater, savings elsewhere. Economic evaluations, like this study, should be taken into account by decision-makers.

7 Recommendations for hearing health care

Screening of hearing impaired adults could best be done at health care centres with a simple general question: "Are you satisfied with your hearing?" or "Do you have a hearing problem?". This has been observed to work as a specific and accurate test for screening hearing impaired people (Gates *et al*. 2003, Nondahl *et al*. 2003, Wu *et al*. 2004). This is also easy to use and does not consume much time. To implement this in practise, everybody working in health care should be made aware of the hearing problems of the elderly and the significant benefits of well-fitted HAs.

Price of a HA. The prevailing practice in Finnish HA fitting is that each hearing impaired patient is fitted with a HA that best and most practically suits him/her considering his/her degree of HI and also the quality and price of the HA. There is no reason to be enchanted by new, modern technology when the new, great technique is not proven to be much more superior to a cheaper alternative.

Joint tenders. Recent joint tenders have reduced the prices of HAs and they should be favoured. Even larger joint tenders could be considered.

Follow-up. Follow-ups of the use of HAs are needed. They can be arranged, for instance, by an audiology assistant or a public health nurse trained for the task or perhaps they can even be done over the telephone. To control the use of HAs, performing a test like the HHIE-S at regular intervals could be attractive. However, there are no long-term studies of the benefits of follow-ups.

Follow-up counselling. This study indicates that follow-up counselling of first-time HA recipients can significantly increase the benefit of HAs. It increased HA use and according to the interviews and the HRQOL measurements, it brought a clearly positive improvement in the life of HA users. Based on this, every hearing impaired who has received a new HA should be counselled a few months after having used the HA. Six months after HA fitting appeared to be an appropriate time.

8 Summary

The results of this prospective study of hearing impaired patients gave a rather reliable picture of HA use in northern Finland, but it can also be regarded as representative of all Finnish hearing rehabilitation due to the similarity of training and practice everywhere in Finland. The patients were interviewed at home, enabling even those in poor physical health to participate in the examinations and allowing charting of the skills in HA use, and there was only a small number of drop-outs. HI in the elderly and also their families is associated with psychological and social difficulties. The difficulties can, however, be diminished with a HA, and the effect can be increased by follow-up counselling.

Study I. To study the use of first-fitted HAs and to examine if there is a change in HA use in the past decades, seventy-six first-time HA users were interviewed in their homes, and the results were compared with those of an earlier study involving both new and experienced HA users that was done in Finland in 1983 using the same method. HA use and handling skills as well as satisfaction with the HA were explored with interviews containing the same questions in both studies.

During the past twenty years the number of regular HA users has increased and the number of non-users has decreased significantly. Regular users were now 56.6% of the first-time HAs users, and the percentage of unused HAs has decreased from 33.3% to 5.3%. The HA users were now significantly more satisfied with their HA and the sufficiency of counselling than in 1983. The most commonly reported reasons for non-use were associated with the reported lack of conversational situations. Compared with the 1983 study, the initiative for HA fitting was made more often by the HA user him/herself. Those who had made the initiative for HA fitting by themselves used their HAs more and were more satisfied than the others.

Study II. To find out the costs associated with HA rehabilitation and to reveal possible local differences, all the direct hospital costs due to fitting and providing HAs in two Finnish hospitals, Kainuu Central Hospital and Oulu University Hospital, were compiled and analysed.

The total costs of HA fitting were almost exactly the same, € 942 in KHC and € 949 in OUH. The price of a HA itself accounts for over 40% and the costs of the audiology personnel make up roughly a third of the total costs of the process of fitting a HA.

Study III. To examine the effects of hearing disability and the benefit of HAs in the quality of life from the users' point of view, ninety-eight first-time HA users were interviewed prior to and six months after the fitting of their first HAs to measure the benefit derived from HA use. Besides audiologic tests, HHIE-S and EQ-5D questionnaires were used. The mean HHIE-S total score obtained was 28.7 before HA fitting and 12.7 six months after, and all the subscores were significantly better compared with the baseline ($p<0.01$, Paired samples T-test).

Hearing impaired people benefit significantly from HAs. This could be seen in the results of both the social and the emotional items of the disease-specific HHIE-S questionnaire at six months after HA fitting.

The generic EQ-5D questionnaire revealed no clear improvement. However, a statistically significant positive improvement ($p<0.01$) was seen in the EQ-VAS score, which reflects a self-report of health status.

Study IV. To evaluate the effect of additional counselling on the use and benefit of HAs, 98 first-time HA users were counselled at six months after the fitting of a HA, and the use of and benefit from HAs were measured by means of an interview and HHIE-S and EQ-5D questionnaires. The results obtained before and six months after counselling were compared and the cost of counselling was calculated.

Counselling significantly increases HA use and the number of regular users. Most (91%) of those who were regular users six months after HA fitting continued to use their HAs regularly at twelve months. Also, over half (62%) of the occasional users and as many as one third (33%) of the non-users had become regular users.

Counselling significantly increases the users' handling skills and satisfaction with the HAs and decreases the number of dissatisfied users.

The greatest changes in emotional and social problems in the disease-specific HHIE-S occurred during the first six months after the HA had been provided, and the decrease in hearing problems also continued up to twelve months.

Lack of a control group is an inevitable deficiency of this study. A control group could have told more clearly whether it was the counselling per se, the additional visit or merely the time interval that resulted in greater HA use at twelve months post-fitting compared with six months.

Counselling is very cost-effective. To bring an unused HA into regular use, € 508 per HA was spent, which is somewhat over half of the total costs of HA fitting.

9 Conclusion

1. HAs are effectively in use. The change from 1983 is significant, and there are few non-used HAs today.
2. The costs of HA fitting in Finland are comparable with other countries. Hospitals in Finland did not show differences in these costs.
3. The disease-specific HHIE-S showed clear improvement after HA fitting. The generic quality-of-life EQ-5D measure revealed a change only in the EQ-VAS, which was statistically significant for regular HA users, but not for occasional users and non-users.
4. The importance of follow-up counselling of HA users should be noticed and recognized. Follow-up counselling is highly cost-effective and brings non-used HAs into use. It also improves the handling skills of HA users.

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Appendices

Appendix 1 HHIE-S questionnaire
Appendix 2 EQ-5D questionnaire
Appendix 3 Questionnaire for patients concerning costs of hearing aid fitting (translated into English)
Appendix 4 Questionnaire for interviewing hearing aid users (translated into English)

Appendix 1

HHIE-S questionnaire

Instructions: Answer yes, sometimes or no for each question. If you are a hearing aid user, answer the questions according to how you hear with the hearing aid. If the question does not apply, enter no as your response.

E-1. Does a hearing problem cause you to feel embarrassed when meeting new people?
yes sometimes no

E-2. Does a hearing problem cause you to feel frustrated when talking to members of your family?
yes sometimes no

S-1 Do you have difficulty hearing when someone speaks in a whisper?
yes sometimes no

E-3. Do you feel handicapped by a hearing problem?
yes sometimes no

S-2. Does a hearing problem cause you difficulty when visiting friends, relatives or neighbours?
yes sometimes no

S-3 Does a hearing problem cause you to attend religious services less often than you would like?
yes sometimes no

E-4 Does a hearing problem cause you to have arguments with family members?
yes sometimes no

S-4. Does a hearing problem cause you difficulty when listening to the TV or radio?
yes sometimes no

E-5. Do you feel that any difficulty with your hearing limits or hampers your personal or social life?
yes sometimes no

S-5. Does a hearing problem cause you difficulty when in a restaurant with relatives or friends?
yes sometimes no

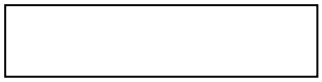
Appendix 2

EQ-5D questionnaire

Please answer the questions by ticking one box in each group. Please indicate which statement best describes your own health today.

1. Mobility:
    () I have no problems walking about
    () I have some problems in walking about
    () I am confined to bed
2. Self care
    () I have no problems with self-care
    () I have some problems washing or dressing myself
    () I am unable to wash or dress myself
3. Usual activities, e.g. work, study, housework, family or leisure activities
    () I have no problems performing my usual activities
    () I have some problems in performing my usual activities
    () I am unable to perform my usual activities
4. Pain/ Discomfort
    () I have no pain or discomfort
    () I have moderate pain or discomfort
    () I have extreme pain or discomfort
5. Anxiety/ Depression
    () I am not anxious or depressed
    () I am moderately anxious or depressed
    () I am extremely anxious or depressed

To help people say how good or bad their state of health is, we have drawn a scale (rather like a thermometer) on which the best state you can imagine is marked 100 and the worst state you could imagine is marked 0.
We would like you to indicate on the scale how good or bad your own health is today, in your opinion. Please do this by drawing a line from the box to whichever point on the scale that indicates how good or bad your current health state is.



My state of health today:

100----------0

Best imaginable state of health Worst imaginable state of health

Appendix 3

Questionnaire for patients concerning costs of hearing aid fitting
(translated into English)

We ask you to answer the following questions. You can circle one choice for each question or write in the empty space.
It is important that you answer every question.

How many kilometres is it from your home to the hospital?
About kilometres
How much time does it take to travel one way?
About hours minutes

How did you travel here?
by bus
by car
by taxi (alone)
by taxi (with someone)
by train
on foot or by bicycle
by ambulance
by a combination of the above, what?

Do you have an escort?
No (proceed to question 6)

Yes, who?

Estimate the time your escort has to use on your visit
hours minutes

If you have an escort, does s/he have to be absent from work?
No
Yes, about hours

Do you currently work
full-time or part-time
out of work or laid off
at home
retired or on sick leave
student

If you are on sick leave, what is the reason for the sick leave
Hearing problem?
Other disease, what?

Do you have other long-lasting diseases?
No
Yes, what?

If you are on sick leave, when did your sick leave start?
Day month year

Did you have to have help at home due to this visit?
No
Yes, for about hours

How much was your gross income last year?
About mk

If you don't know, how much was your gross income last month?
About mk

Do you have private health insurance?
no
yes

How long did you wait after your first troubles with hearing before you contacted a physician?

How many times did you visit the following places because of your hearing problem during the past year? (In case you have visited none of them, mark 0). Notice every item.
health centre times
private doctor times
hearing test laboratory or roentgen times
outpatient department times

How much have you used your own money for your hearing problem during the past year? Notice every item.
medication mk
hospital fee mk
health centre fee mk
private doctor fee mk
other private health centres mk
to pay for domestic help because of your hearing problem mk

Appendix 4

Questionnaire for interviewing hearing aid users (translated into English)

Name _____ date of birth _____-_____

1 Marital status?
- 1 unmarried
- 2 married
- 3 divorced
- 4 widow
- 5 cohabitation
- 9 not known

2 Postal address:

3 Neighbourhood

4 How many children you have?
- 1 no children
- 1-8 number:
- 9 not known

5 How many children live in your apartment?
- 1 1
- 2 2
- 3 3
- 4 4
- 5 5
- 6 6
- 7 7
- 8 more than 7
- 9 not known

6 What is your level of education?
- 0 no schooling
- 1 elementary school
- 2 middle school
- 3 secondary school
- 4 student
- 9 not known

7 What is your professional degree?
- 0 no profession
- 1 vocational course
- 2 vocational school
- 3 college
- 4 academic degree
- 5 some other trade school
- 9 not known

8 What is your professional training?

9 What is your job?
- 1 at home
- 2 unemployed
- 3 studying
- 4 retired, your former job:
- 5 regular full-time job
- 6 regular part-time job
- 7 travelling job
- 8 shift work
- 9 not known

Questions only for those who are working

10 Do you have percussive noise in your work?
- 0 I am not working
- 1 yes
- 2 no
- 9 I cannot say

11 Do you have permanent noise in your work?
- 0 I am not working
- 1 yes
- 2 no
- 9 I cannot say

12 Do you have continuous speech noise in your work?
- 0 I am not working
- 1 yes
- 2 no
- 9 I cannot say

13 Has the level of noise been measured in your work?
- 0 I am not working
- 1 yes
- 2 no
- 9 I cannot say

14 What is the level of noise in your work?
- 0 I am not working
- 1 less than 85 dB
- 2 85-100 dB
- 3 more than 100 dB
- 9 I don’t know

15a Do you use hearing protection?
- 0 I am not working or I do not need any
- 1 cup model
- 2 wad of cotton
- 3 plug
- 4 I do not use any
- 9 no answer

15b Have you had orientation for work at your present work?
- 0 I am not working
- 1 yes
- 2 no
- 9 no answer

16 Do you have discussions with your workmates at work?
- 0 I am not working
- 1 daily
- 2 sometimes
- 3 not at all
- 4 I work alone
- 9 no answer

The following questions ask, how your hearing aid helps you in different situations

17 Can you discriminate speech on the radio?
- 0 I do not have a radio
- 1 well enough without a hearing aid
- 2 well or moderately with a hearing aid
- 3 not well with a hearing aid
- 9 It is difficult to say

18 Can you discriminate speech on TV (TV on at normal loudness?)
- 0 I do not have a TV
- 1 well enough without a hearing aid
- 2 well or moderately with a hearing aid
- 3 not well with a hearing aid
- 9 It is difficult to say

19 Can you hear a normal doorbell ringing?
- 0 I do not have a doorbell
- 1 well enough without a hearing aid
- 2 well or moderately with a hearing aid
- 3 not well with a hearing aid
- 9 It is difficult to say

20 Can you hear a phone ringing?
- 0 I do not have a phone
- 1 well enough without a hearing aid
- 2 well or moderately with a hearing aid
- 3 not well with a hearing aid
- 9 It is difficult to say

21 Can you hear somebody's speech on the phone (normal phone)?
- 0 I do not have a phone
- 1 well enough without a hearing aid
- 2 well or moderately with a hearing aid
- 3 not well with a hearing aid
- 9 It is difficult to say

22 Which ear do you use on the phone?
- 0 I do not use a phone
- 1 right
- 2 left
- 9 not known

23 Do you use a mobile phone?
- 0 I don't have a mobile phone
- 1 yes
- 2 no
- 9 not known

24a Do you have some assistive device when using a phone?
- 1 yes, what?
- 2 no
- 9 not known

***If you use a mobile phone**:*

24b Can you hear the mobile phone ringing?
- 1 yes
- 2 no
- 9 not known

25 Can you discriminate somebody's speech on the mobile phone?
- 1 well enough without a hearing aid
- 2 well or moderately with a hearing aid
- 3 not well with a hearing aid
- 9 difficult to say

26 Do you have some assistive device when using the mobile phone?
- 1 yes, what?
- 2 no
- 9 not known

27 Can you discriminate somebody's speech when talking with a small group (3-6 persons)?
- 1 well enough without a hearing aid
- 2 well or moderately with a hearing aid
- 3 not well with a hearing aid
- 4 I don't talk with a group
- 9 difficult to answer

28 Can you discriminate somebody's speech in a quiet room with somebody?
- 1 well enough without a hearing aid
- 2 well or moderately with a hearing aid
- 3 not well with a hearing aid
- 9 I don't visit such places

29 Can you discriminate somebody's speech in a big echoing room like a church or hall?

- 0 I don't visit such places
- 1 well enough without a hearing aid
- 2 well or moderately with a hearing aid
- 3 not well with a hearing aid
- 9 It is difficult to answer

30 Are you satisfied with your hearing aid?

- 1 yes
- 2 no, I am not
- 9 It is difficult to answer

31 How do you experience the quality of the tone of the hearing aid?

- 1 good and pleasant
- 2 unpleasant
- 9 It is difficult to answer

32 When the interviewer visited the hearing aid user, the hearing aid was

- 1 in the ear
- 2 somewhere at home
- 3 being repaired
- 9 not known where it was

33 How often do you have an opportunity to talk with people?

- 1 every day
- 2 twice a week
- 3 weekends
- 4 twice a month
- 5 maybe once a month
- 6 not so often
- 9 not known

34 Interviewer's opinion about the condition of the hearing aid

- 1 in functioning condition
- 2 broken
- 3 difficult to answer
- 9 not known

How do you use the controls of the hearing aid? What is the state of the controls when using the hearing aid?

35 tone of sound

- 0 no control for tone of sound
- 1 H
- 2 N
- 3 L
- 9 not known

36 Intensity
- 1 minim
- 2 < ½ open
- 3 ½ open
- 4 > ½ open
- 5 maximum
- 9 not known

37 Compressor
- 1 no compressor
- 2 not in use
- 3 < ½ open
- 4 ½ open
- 5 > ½ open
- 6 fully open
- 9 not known

38 Power control
- 1 open
- 2 shut
- 9 not known

39 M-T-control, usual listening
- 1 M-position
- 2 T-position
- 3 M-T-position
- 9 not known

40 Have you tried to change the positions of the controls?
- 1 yes
- 2 no, I haven't
- 9 not known

Next, I would like you to show you how to handle your hearing aid

41 Would you change a new battery in your hearing aid
- 1 can do it
- 2 can do it slowly
- 3 cannot do it
- 4 no need to do it (rechargeable)
- 5 don't want to show
- 9 not known

42 Would you put the hearing aid in your ear
- 1 can do it
- 2 can do it slowly
- 3 cannot do it
- 4 the upper tip stays out
- 9 not known

43 User's motor functions, evaluated by the interviewer
- 1 motor functions of hands, not good
- 2 motor functions of hands, good enough for hearing aid use
- 9 not known

44 Vision, evaluated by the interviewer
- 1 problems of vision do not hinder hearing aid use
- 2 problems of vision hinder hearing aid use to some degree
- 3 problems of vision hinder hearing aid use a lot
- 4 problems of vision prevent hearing aid use

45 Would you show how the hearing aid can be used on the phone
- 1 can use
- 2 can not
- 3 doesn't want to show
- 9 not known

46 If the hearing aid doesn't work, where would you go with it?
- 1 knows, _____ where? _____
- 2 doesn't know
- 9 no answer

47 Where can you buy a battery?
- 1 knows, _____ where? _____
- 2 doesn't know
- 9 no answer

48 Where do you buy a battery?
- 0 doesn't buy
- 1 health centre
- 2 users' associations
- 3 shop
- 4 by post
- 5 federations of the hard of hearing
- 6 free from a health centre
- 7 somewhere else, where
- 9 not known

49 How do you experience your hearing aid's condition?
- 1 good
- 2 the hearing aid is broken
- 9 not known

50 Hearing aid's condition in the interviewer's opinion?
- 1 good
- 2 the hearing aid is broken
- 9 not known

51 Would you show how you clean the ear mould?
- 0 doesn't use the hearing aid
- 1 after every use
- 2 more seldom, but often enough
- 3 doesn't clean
- 9 no answer

52 Would you show how you change the tube?
- 1 can do it, when needed
- 2 cannot
- 9 not known

53 Would you show how you change the wax shelter?
- 1 can do it, when needed
- 2 cannot
- 9 not known

54 When can you use the T-position?
- 1 knows
- 2 doesn't know
- 9 no answer

55 Where can you receive more counselling (the place)?
- 1 knows, _____ where? _____
- 2 doesn't know
- 9 no answer

56 Number of hearing aids in use
- 1 one
- 2 two
- 9 not known

57 Which ear
- 1 right
- 2 left
- 3 both
- 9 not known

The following questions ask in which situations you use the hearing aid

58 How often do you use the hearing aid when watching TV?
- 0 doesn't have a TV
- 1 almost always
- 2 with a certain programmes
- 3 seldom
- 4 never

59 How often do you use the hearing aid when using the phone?
- 0 doesn't have a phone
- 1 almost always
- 2 when it happens to be in the ear
- 3 seldom
- 4 never
- 9 not known

60 How often do you use the hearing aid when at work (school, study)?
- 1 doesn't work or study
- 2 almost always
- 3 seldom
- 4 very seldom
- 5 never
- 9 not known

61 Do you use the hearing aid in the theatre, in church or in some other public place?
- 0 I don't visit such places
- 1 almost always
- 2 seldom
- 3 never
- 9 not known

62 Do you use the hearing aid when at a meeting?
- 0 I don't attend meetings
- 1 almost always
- 2 seldom
- 3 never
- 9 not known

63 How much do you use your hearing aid daily?
- 0 over 6 hours a day
- 1 2-6 hours every day
- 2 less than 2 hours a day
- 3 2-6 hours almost every day
- 4 once a week
- 5 once a month
- 6 seldom
- 7 I don't use the hearing aid
- 9 not known

64 How long did it take you to learn the everyday use of the hearing aid?
- 1 2-3 days
- 2 one week
- 3 about 2 weeks
- 4 a month
- 5 more than a month and I use it every day
- 6 more than a month but I don't use it every day
- 7 I learned at once to use it every day
- 8 I haven't learned everyday use at all
- 9 not known

65 Can you use the hearing aid?
- 0 I don't use the hearing aid
- 1 I can use it quite well, in my opinion
- 2 fairly well
- 3 poorly
- 9 not known

66 Have you had enough counselling, in your opinion?
- 0 enough
- 1 too much
- 2 not enough
- 3 not at all
- 9 not known

67 How many times have you had counselling?
- 1 in the hospital times
- 2 at home times
- 3 in a health centre days
- 4 day courses at the hospital days
- 5 longer rehabilitation periods at the hospital days
- 6 courses of some organisation days
- 7 somewhere else, where?
- 9 not known

68 Did you benefit from counselling?
- 0 I haven't had counselling
- 1 much benefit
- 2 a little benefit
- 3 no benefit
- 4 harm
- 9 not known

69 Would you need more counselling in the use of the hearing aid?
- 1 I don't need more counselling
- 2 I need some more counselling
- 3 I need much more counselling
- 9 not known

70 Have you received information concerning your hearing and hearing decrease in your opinion
- 1 enough
- 2 too much
- 3 too little
- 4 not at all
- 9 not known

71 Whose initiative was it to fit a hearing aid? (Only 1 choice)
- 1 myself
- 2 doctor
- 3 nurse
- 3 relatives
- 4 friends
- 5 social worker
- 6 employee
- 7 other, who?
- 9 not known

Only for patients who do not use a hearing aid or use it only a little

Is the reason for non-use:

72 Background noise amplified by the hearing aid disturbs hearing speech too much
- 0 uses a hearing aid
- 1 is the reason for non-use
- 2 is not the reason for non-use
- 9 not known

73 It is difficult to insert the hearing aid in my ear by myself
- 0 uses a hearing aid
- 1 is the reason for non-use
- 2 is not the reason for non-use
- 9 not known

74 It is difficult to change the battery
- 0 uses a hearing aid
- 1 is the reason for non-use
- 2 is not the reason for non-use
- 9 not known

75 It is difficult to understand speech even with the hearing aid
- 0 uses a hearing aid
- 1 is the reason for non-use
- 2 is not the reason for non-use
- 9 not known

76 The ear mould doesn't fit (presses, falls out easily)
- 0 uses a hearing aid
- 1 is the reason for non-use
- 2 is not the reason for non-use
- 9 not known

77 The hearing aid whistles
- 0 uses a hearing aid
- 1 is the reason for non-use
- 2 is not the reason for non-use
- 9 not known

78 I don't have discussions daily and there is no other need to use a hearing aid
- 0 uses a hearing aid
- 1 is the reason for non-use
- 2 is not the reason for non-use
- 9 not known

79 The hearing aid doesn't always work for some reason
- 0 uses a hearing aid
- 1 is the reason for non-use
- 2 is not the reason for non-use
- 9 not known

80 I don't want others to notice my hearing disability
- 0 uses a hearing aid
- 1 is the reason for non-use
- 2 is not the reason for non-use
- 9 not known

81 Many hearing people shout into the hearing aid and it is inconvenient
- 0 uses a hearing aid
- 1 is the reason for non-use
- 2 is not the reason for non-use
- 9 not known

82 Some other reason for non-use_____

Activities and free time

83 How often do you visit your relatives / friends?
- 1 almost daily
- 2 two times a week
- 3 once a week
- 4 a couple times a month
- 5 once a month
- 6 more seldom
- 9 not known

84 How often do you have visitors?
- 1 almost daily
- 2 every week
- 3 every month
- 4 seldom
- 5 not much
- 9 not known

85 How often do you watch TV?
- 0 I don't have a TV
- 1 every day
- 2 2-3 times a week
- 3 only the programmes which interest me
- 4 not at all
- 9 not known

86 How often do you listen to the radio?
- 0 I don't have a radio
- 1 every day
- 2 a couple days a week
- 3 sporadically, depending on the programme
- 4 not at all
- 9 not known

87 How often do you visit a theatre or a church?
- 1 once a month
- 2 once a year
- 3 more seldom
- 4 never
- 9 not known

88 How often do you attend meetings or clubs?
- 1 once a week or more often
- 2 once a month
- 3 two times a year
- 4 once a year
- 5 more seldom
- 6 never
- 9 not known

89 Are you a member of an association for hard of hearing?
- 1 yes
- 2 no
- 3 not known

90 Type of housing?
- 1 institution
- 2 apartment house
- 3 detached house or row house
- 9 not known

91 Size of housing
- 1 1 room and kitchenette
- 2 1 room and kitchen
- 3 2 rooms and kitchen
- 4 3 rooms and kitchen
- 5 4 rooms and kitchen
- 6 > 5 rooms and kitchen
- 7 institutional housing
- 9 not known

Different situations – hearing

92 Is it difficult for you to distinguish the speech of staff in a shop?
- 0 I don't visit shops
- 1 yes, often
- 2 sometimes
- 3 no, it is not
- 9 not known

93 Is it difficult for you to distinguish the speech of staff in offices?
- 0 I don't visit
- 1 yes, often
- 2 sometimes
- 3 no, it is not
- 9 not known

94 Have you used other hospital services than the hearing centre during the past three years?

1 yes
2 no
9 not known

95 Have you used the services of a health centre?

1 yes
2 no
9 not known

96 Has a parish nurse helped you with some of your affairs?

1 yes
2 no
9 not known

97 Who is your assistant in difficult hearing situations?

1 mate
2 children living at home
3 mate and children
4 other relatives living at home
5 relatives living otherwhere
6 neighbour
7 friend
8 I don't ask anyone
9 not known

98 Have you had difficulties getting a hearing assistant?

1 yes, often
2 yes, sometimes
3 no, I don't have
4 I haven't asked for help
9 not known

99 How often would you need the help of a hearing assistant?

1 every day
2 a couple times a week
3 once a week
4 once a month
5 about five times a year
6 about two times a year
7 more seldom
8 I don't need help
9 not known

100 Type of hearing aid
- 1 1 pocket aid
- 2 2 pocket aids
- 3 1 behind the ear
- 4 2 behind the ear
- 5 bone hearing aid
- 6 communicator
- 9 not known

101 What assistive listening devices do you have?
102 What assistive listening devices would do you need?
103 For what reason would you need them?
104 What assistive listening devices does the interviewer find?
105 What assistive listening devices does the interviewer find are needed?
106 Referral to rehabilitation guidance to check the need for assistive listening devices
107 Referral to rehabilitation guidance for some other social rehabilitation need

Data from hospital records:

110 At what age did a hearing problem appear in the right ear?
- 0 normal hearing
- 1 congenital
- 2 under 1 year
- 3 1-5 years
- 4 5-10 years
- 5 10-20 years
- 6 20-40 years
- 7 40-60 years
- 8 over 60 years
- 9 not known

111 At what age did a hearing problem appear in the left ear?
- 0 normal hearing
- 1 congenital
- 2 under 1 year
- 3 1-5 years
- 4 5-10 years
- 5 10-20 years
- 6 20-40 years
- 7 40-60 years
- 8 over 60 years
- 9 not known

112 Reason for a hearing impairment in the right ear?
- 0 normal hearing
- 1 meningitis
- 2 congenital
- 3 infection, the ear has discharged
- 4 otosclerosis
- 5 inherited degeneration in the inner ear
- 6 age-related hearing impairment
- 7 noise
- 8 accident
- 9 Meniere's disease
- 99 not known

113 Reason for a hearing impairment in the left ear?
- 0 normal hearing
- 1 meningitis
- 2 congenital
- 3 infection, the ear has discharged
- 4 otosclerosis
- 5 inherited degeneration in the inner ear
- 6 age-related hearing impairment
- 7 noise
- 8 accident
- 9 Meniere's disease
- 99 not known

114 Type of hearing impairment in the right ear?
- 0 normal hearing
- 1 perceptive rising
- 2 perceptive even
- 3 perceptive downward
- 4 conductive rising
- 5 conductive even
- 6 conductive downward
- 7 mixed rising
- 8 mixed even
- 9 mixed downward
- 10 deaf
- 99 not known

115 Type of hearing impairment in the left ear?
- 0 normal hearing
- 1 perceptive rising
- 2 perceptive even
- 3 perceptive downward
- 4 conductive rising
- 5 conductive even
- 6 conductive downward
- 7 mixed rising
- 8 mixed even
- 9 mixed downward
- 10 deaf
- 99 not known

116 Thresholds of the right ear, air
117 Thresholds of the left ear, air
118 Thresholds of the right ear, bone
119 Thresholds of the right ear, bone
120 Speech reception thresholds of the right ear
121 Speech reception thresholds of the left ear
122 Word reception scores, right ear
123 Word reception scores, left ear
124 Word reception scores with a hearing aid, right ear
125 Word reception scores with a hearing aid, left ear
126 Speech reception thresholds with a hearing aid, right ear
127 Speech reception thresholds with a hearing aid, left ear
128 Type of hearing aid?
- 1 1 pocket aid
- 2 2 pocket aids
- 3 1 behind the ear
- 4 2 behind the ear
- 5 bone hearing aid
- 6 communicator
- 9 not known

129 Method of producing sound
130 How many hearing aids for the right ear?
131 How many hearing aids for the left ear?
132 Year when hearing aid fitted, right ear?
133 Year when hearing aid fitted, left ear?
134 Recommended positions for regulators
- 1 minim
- 2 ½ way
- 3 maximum
- 9 not known

135 Compressor
- 1 no
- 2 not in use
- 3 < ½
- 4 ½
- 5 maximum
- 9 not known

Original papers

I Vuorialho A, Sorri M, Nuojua I, Muhli A (2006) Changes in Hearing Aid Use over the Past Twenty Years. European Archives of Otorhinolaryngology. 263(4):355-60. Epub 2005 Nov 9. PMID: 16283199.

II Vuorialho A, Sorri M, Nuojua I (2004) Costs of Hearing Aid Rehabilitation in Two Finnish Hearing Centres. Audiological Medicine 2:1-5.

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IV Vuorialho A, Karinen P, Sorri M (2006) Counselling of Hearing Aid Users is Highly Cost-effective. European Archives of Otorhinolaryngology. [Epub ahead of print] PMID: 16799805.

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