Hearing Impairment Among Adults (HIA)

- Report of a joint (Nordic - British) project

DACEHTA

FinOHTA

SBU

SMM

in collaboration with MRC

Hearing Impairment Among Adults

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1. Preface

In May 1999, Health Technology Assessment organisations from four Nordic countries (DIHTA in Denmark, FinOHTA in Finland, SBU in Sweden, and SMM in Norway) met to explore ways of collaboration and decided to initiate as a pilot effort a joint project on hearing impairment in adults. For this purpose a Nordic group of specialists in audiology and health technology assessment was formed, and later complemented with an audiology specialist from the United Kingdom. The Project Group was chaired by Professor Martti Sorri, University of Oulu, Finland. Other members of the Project Group were Associate Professor Bengt Brorsson, SBU, Sweden; Professor Adrian Davis, MRC / IHR, United Kingdom; Professor Iain W.S. Mair, Ullevål Hospital, Norway; Dr. Kurt I. Myhre, SMM, Norway; Professor Agnete Parving, Bispebjerg Hospital, Denmark; Dr. Risto Roine, FinOHTA, Finland; Professor Ulf Rosenhall, Karolinska Hospital, Sweden; and M.Sc. Staffan Stilvén, DIHTA, Denmark.

To monitor and supervise the project, the participating Health Technology Assessment organisations formed a Steering Committee chaired by Professor Pekka Karma, Helsinki University Hospital, Finland. Other members of the Steering Committee were Professor Egon Jonsson, SBU, Sweden; Professor Finn Børlum Kristensen, DIHTA, Denmark; Professor Pekka Laippala, University of Tampere and FinOHTA, Finland; Dr. Berit S. Mørland, SMM, Norway; Dr. Kristian Otto Nielsen, Sønderborg Hospital, Denmark; Professor Tore Schersten, SBU, Sweden; and Professor Odd Spandow, Ullevål Hospital, Norway.

After discussions between the Project Group and the Steering Committee it was agreed that the project should try to answer the following questions: 1) What is the current and predicted prevalence of hearing impairment among adults over 45 years of age in Denmark, Finland, Norway, Sweden and the United Kingdom and how is impairment best defined and assessed; 2) What is the outcome of non-surgical rehabilitation of hearing impairment; and 3) How is non-invasive treatment and rehabilitation of hearing impairment currently organised in the Nordic countries and in the United Kingdom?

The first two questions were addressed in a meticuluos literature search with Dr. Elina Mäki-Torkko (University Hospital of Lund, Sweden, and Oulu, Finland) as the principal author for the Project Group. The issue of

hearing health services was dealt with by Health Economist Garry Barton (Department of Health Sciences, York University, United Kingdom) and Professor Adrian Davis together with the Project Group.

The results are presented in this final report of the project "Hearing Impairment among Adults". The report has been prepared by the Project Group together with Dr. Matti Raivio (Central Hospital of Åland, Finland). It has not been formally reviewed by the participating Health Technology Assessment organisations. The results will also be published in a condensed form as a supplement of the journal Scandinavian Audiology.

The project has been financed by the participating four Nordic Health Technology Assessment Agencies and by the Nordic Council of Ministers.

2. Summary

Hearing impairment in adults over 18 years of age is the most common communication disorder. In some studies it has been estimated to affect approximately 15 % of adults and its prevalence is expected to increase up to 25 % by year 2020 (Rosenhall et al. 1999, Sorri et al. 2001). According to some other estimates, the current proportion of those suffering from hearing impairment is even higher than that comprising up to 18–20 % of the adult population. Within the United Kingdom it has been estimated that 3.5 % of the population have a hearing aid (Taylor 2000).

The total number of inhabitants in Denmark, Finland, Iceland, Norway and Sweden is approximately 24 million and of those aged over 50 years nearly 8 million (Nordic Council of Ministers and the Nordic Council 1999). It can be estimated that several million adults in the Nordic countries suffer from hearing impairment. A substantial, but unknown, part of these could be the target group for effective hearing rehabilitation as it has been estimated that around 60–70 %, maybe even 85 % of those suffering from hearing impairment – depending on the definition of hearing impairment – could benefit from hearing aids.

The current direct costs for rehabilitation of hearing impairment are considerable. It may be estimated that they amount to more than 150 million € per year in the Nordic countries. In the USA, the total costs for communication disorders to the community have been estimated to be not less than 2.5 to 3 % of the gross domestic product, a major part of that being costs for hearing impairment in adults (Ruben 2000). It must, however, be emphasised that the definitions used may have a major impact on prevalence figures and costs of rehabilitation

The ongoing change of the society, for example the fact that much of the workforce is changing from manual to communication work where good hearing ability is a necessity, influences future needs for hearing services. The present way of working requires good communication abilities nearly independently of the profession. In the urban population as high a percentage as 87.5 % of the entire work force is reported to be dependent on communication skills. The challenge presented to the health care services is, with appropriate management, to maintain the hearing disabled at work.

In parallel with the increasing importance of auditory communication in society, the possibilities to manage these disorders have greatly improved during the last few decades. The diagnostic methods are better, and hearing technology has become more reliable and simpler to use, with consequent benefits for the patients. Accurate audiological diagnosis can directly be applied in individual fitting and adjustment of the hearing aid. The new technical solutions offer help for a greater variety of patients than could be treated before. The challenge to the health care system, therefore, is to find the disabled people, to motivate them to seek help, and to provide the right choices for the right persons. However, at the moment we have no "golden standard" method to precisely discriminate different grades of hearing impairment and disability, and to distinguish patients likely to benefit from hearing services. Thus the identification of suitable patients is to a great deal based on clinical experience only. This has resulted in significant differences in the organisation of hearing services among the Western countries.

To be able to define needs for hearing services, reliable information on the prevalence of hearing impairment is essential. Prevalence figures from different studies have, however, been variable depending on the definition of impairment and the methods used to assess impairment. Consequently, exact figures on which planning of future services could be based, are difficult to find.

Precise information on the results of hearing rehabilitation as well as patient satisfaction is also needed. Furthermore, also the organisation, costs and cost-effectiveness of rehabilitation need to be explored to be able to decide how patients with hearing impairment should successfully be rehabilitated and what is the best and the most cost-effective way of organising services.

To fill some of the gaps in knowledge, four Nordic Health Technology Assessment Agencies (DIHTA in Denmark, FinOHTA in Finland, SBU in Sweden, and SMM in Norway) launched in 1999 a joint project with the aim to specifically answer questions on definition, assessment, and prevalence of hearing impairment in adults and to explore the current organisation of hearing services in the Nordic countries and in the United Kingdom.

To meet the aim, a Project Group consisting of one audiologist as well as one Health Technology Assessment expert from each of the participating countries was asked to review the literature and to perform a survey on the

organisation of services. The group was later supplemented with an audiologist from the United Kingdom. Financial support for the task was provided by the participating Health Technology Assessment Agencies and the Nordic Council of Ministers.

To answer issues concerning definition, assessment, and prevalence of hearing impairment, a meticulous literature review was performed. The specific questions of the literature review were: 1) What is the current and predicted prevalence of hearing impairment among adults over 45 years of age in Denmark, Finland, Norway, Sweden and the United Kingdom and how is impairment best defined and assessed; and 2) What is the outcome of non-surgical rehabilitation of hearing impairment.

Three out of the six identified, scientifically valid prevalence studies were nationally representative (Davis 1989, Davis 1995, Rosenhall et al. 1999), while Rosenhall et al. (1987), Uimonen et al. (1999) and Karlsmose et al. (1999) report local population-based prevalence of hearing impairment. These few studies show an increase in prevalence by age, but neither the prevalence studies nor the longitudinal reports on deterioration of hearing thresholds enable reliable calculations of estimated future prevalence of hearing impairment in age groups of 45–65 years and over 65 years, because of differences in study populations and available national population statistics.

Regarding hearing outcome, five studies fulfilling the applied criteria were identified. Three out of the five studies were designed double-blind (Parving et al. 1997, Nilsson et al. 1997, Larson et al. 2000). The remaining two were single-blind (Biering-Sørensen et al. 1995, Bille et al. 1999). All studies included subjects with sensorineural hearing impairment. Studies on hearing aid prescription or outcomes do not provide uniform data in favour of non-linear amplification, but show some subject preference for the newer technology. No conclusions can be drawn regarding the degree of hearing impairment and the effects of amplification, in other words, there is no clear scientific evidence for the association of a predefined degree of hearing impairment and the outcome of rehabilitation. However, there is clear evidence that hearing impaired people benefit from amplification.

The literature review alone thus gives limited information concerning the extent of the problem of hearing impairment in adult populations in the target countries. Likewise, there are only a few studies fulfilling strict scientific criteria on hearing aid outcome, and although many of the

studies excluded in the literature search may have clinical relevance at specific sites, they cannot be generalised into larger populations. Even fewer studies correlate rehabilitation outcome with the degree of hearing impairment, disability or handicap.

To answer the question concerning organisation of services, a survey on hearing health services was performed. This survey indicated striking differences between the countries. The numbers of hearing aids fitted annually per 1000 persons vary from 2.72 in Finland to 12.30 in Denmark. A significant proportion of the hearing impaired in the Nordic countries and in the United Kingdom have not sought help and do not possess or use a hearing aid. About 3.5 % of the population of Denmark and the United Kingdom use a hearing aid; the figures being 2.8 % in Norway and 1.0 % in Finland. None of these approaches the figure of 5 % of the population who are estimated to have ≥ 45 dB hearing impairment in both ears. Also, wide variations in the estimated expenditure per person with a hearing aid exist. In Finland, the expenditure per person with a hearing aid was estimated to be double that of Norway and Denmark and nearly tenfold that of the United Kingdom.

Due to limited scientific evidence, the project was unable to give definite answers to the questions presented and in fact raised many new questions. Based on the current results, a more in-depth study concerning current and predicted prevalence of hearing impairment – to be able to predict the future need of services – seems of utmost importance. To best serve future planning, such a study should preferably be performed in ten-year age bands on as wide a multinational basis as possible and should, among other indicators, exploit also self-assessed disability as a measure of hearing problems.

A more in-depth study using consistent methodology to examine not only differences in the organisation and costs of services, but also the background and reasons for them, between the Nordic countries and the United Kingdom is also clearly needed and is currently being planned by the Project Group.

Other important topics identified by the Project Group comprise the need to reach consensus on outcome measures of hearing aid services, the need to study the effectiveness and cost-effectiveness of hearing rehabilitation not forgetting patient satisfaction, and the need to study the adverse effects of hearing impairment on quality of life.

For planning of future services the size of the workforce needed to meet the predicted future consumer demands for hearing rehabilitation must also be evaluated. Furthermore, as the potential benefits of hearing rehabilitation seem to go largely unrecognised and thus underutilised, there clearly is a call for educating the public as well as the professionals about the opportunities and advantages rehabilitation can provide.

Dansk sammenfatning

Hørenedsættelse hos voksne over 18 år udgør det hyppigste af alle kommunikationshandikap. Nogle studier vurderer, at cirka 15 procent af voksne er ramt af hørenedsættelse, og prævalensen forventes at stige med op til 25 procent før 2020 (Rosenhall et al. 1999, Sorri et al. 2001). Andre vurderinger anslår at helt op til 18 eller 20 procent af den voksne befolkning allerede lider af hørenedsættelse. Det er anslået, at 3,5 procent af befolkningen i UK (Storbritannien og Nordirland) har høreapparat (Taylor 2000).

Det samlede antal indbyggere i Danmark, Finland, Island, Norge og Sverige svarer til cirka 24 millioner mennesker, hvoraf næsten 8 millioner er over 50 år (Nordisk Ministerråd og Nordisk Råd 1999). Det vil sige, at flere millioner mennesker i de nordiske lande lider af hørenedsættelse. En betydelig men ukendt andel af disse kunne udgøre målgruppen for en effektiv rehabiliteringsindsats, da 60–70 procent, måske helt op til 85 procent af mennesker med hørenedsættelse – afhængig af hvordan det defineres – menes at kunne drage nytte af et høreapparat.

De nuværende direkte omkostninger forbundet med behandling af hørenedsættelse er betydelige. De anslås at samlet nå op over 150 millioner € om året i de nordiske lande. I USA vurderes de samlede omkostninger for samfundet af kommunikationshandikap til hele 2,5 til 3 procent af bruttonationalproduktet, hvoraf en væsentlig andel af udgifterne knytter sig til hørenedsættelse hos voksne (Ruben 2000). Dog skal det fremhæves, at tal vedrørende prævalens og omkostninger ved behandling er meget definitionsafhængige.

Samfundsudviklingen, herunder overgangen fra manuelt arbejde til kommunikationsarbejde hvor god hørelse er en forudsætning, får indflydelse på fremtidens behov for behandling af hørenedsættelse. Nutidens arbejde kræver i forvejen gode kommunikationsevner, nærmest uanset profession. Helt op til 87,5 procent af hele arbejdsstyrken blandt bybefolkningen siges at være afhængig af kommunikationsfærdigheder på jobbet. Udfordringen for sundhedsvæsenet er, via passende tiltag, at fastholde de hørehæmmede på arbejdsmarkedet.

Parallelt med hørelsens stigende rolle i samfundet er mulighederne for behandling også vokset signifikant i løbet af de sidste få årtier. De diagnostiske metoder er forbedrede og teknologiske fremskridt har gjort hjælpemidlerne mere pålidelige og enklere at betjene med de deraf

følgende fordele for patienter. Præcise audiologiske diagnoser kan anvendes til at afstemme og tilpasse høreapparater til det pågældende individ. De nye teknologier muliggør behandling af større og varierede grupper af patienter end før. Udfordringen for sundhedsvæsenet er derfor at identificere de hørehæmmede, motivere dem til at søge hjælp og præsentere de rigtige handlemuligheder for de rette grupper. Vi har imidlertid p.t. ingen præcis metode til at skelne mellem forskellige grader af hørenedsættelse og handikap eller til at identificere de patienter, der ville kunne drage nytte af behandling. Identifikationen af den rette patientgruppe hviler i høj grad på klinisk erfaring alene. Resultatet er store forskelle i organiseringen af foranstaltninger for hørehæmmede i de vestlige lande.

Det kræver pålidelig information om prævalens, hvis behovet for ydelser skal defineres nøjagtigt. Tal vedrørende prævalens varierer fra studie til studie, afhængig af definitionen af nedsættelsen og metoderne anvendt til vurdering af nedsættelsen. Derfor er det vanskeligt at finde nøjagtige tal, der kan udgøre basis for en planlægning af fremtidens behandling.

Præcise informationer om resultaterne af rehabilitering af hørenedsættelse såvel som patienttilfredshed er også påkrævet. Ydermere må organiseringen, omkostningerne og omkostningseffektiviteten af rehabilitering undersøges, hvis rehabiliteringsstrategien for hørehæmmede skal tilrettelægges og organiseres til at have størst effekt og omkostningseffektivitet.

For at fylde nogle af videnshullerne igangsatte fire nordiske enheder for MTV (medicinsk teknologivurdering), nemlig MTV-instituttet i Danmark, FinOHTA i Finland, SBU i Sverige, og SMM i Norge et fælles projekt i 1999, hvis mål var at komme med svar på spørgsmålene vedrørende definitioner på, vurdering og prævalensen af hørenedsættelse hos voksne samt at undersøge den eksisterende organisering af behandlingen i de nordiske lande og UK.

Til det formål blev en projektgruppe, der bestod af en audiolog og en MTV-kyndig fra hvert land bedt om at lave et reveiw af litteraturen og lave en undersøgelse af de organisatorisk forhold. Gruppen blev på et senere tidspunkt suppleret af en audiolog fra UK. Opgaven blev finansieret af de pågældende MTV-institutioner og Nordisk Ministerråd.

For at besvare spørgsmålene om definition, vurdering og prævalensen af hørenedsættelse blev der foretaget en grundig litteraturgennemgang.

Litteraturgennemgangen søgte at svare på: 1) Hvad er den nuværende og forventede prævalens af hørenedsættelse blandt de 45-årige og ældre i Danmark, Finland, Norge, Sverige og UK, og hvordan defineres og vurderes nedsættelsen?; samt 2) Hvad er resultaterne af ikke-kirurgisk rehabilitering af hørenedsættelse?

Tre ud af de i alt seks videnskabeligt valide prævalensstudier, der blev fundet, var repræsentative på nationalt niveau (Davis 1989, Davis 1995, Rosenhall et al. 1999), hvorimod Rosenhall et al. (1987), Uimonen et al. (1999) og Karlsmose et al. (1999) afrapporterede tal for lokal populationsbaseret prævalens af hørenedsættelse. Disse få studier viser en stigning i hørenedsættelse knyttet til stigning i alder, men hverken prævalensstudierne eller tidsseriestudiernes konklusioner vedrørende forringelse af hørelse muliggør pålidelige beregninger af estimeret fremtidig prævalens i aldersgrupperne 45–65 år og over 65 år på grund af forskelle mellem studiernes populationer og de tilgængelige nationale befolkningsstatistikker.

Hvad effekten af rehabilitering på hørelse angår opfyldte fem studier de applicerede kriterier. Tre var designet som dobbelt-blindede studier (Parving et al. 1997, Nilsson et al. 1997, Larson et al. 2000). De sidste to var enkelt-blindede studier (Biering-Sørensen et al. 1995, Bille et al. 1999). Alle studier inkluderede patienter med sensorineurale høretab. Studier, der omhandler uddeling af høreapparater og resultatmålinger kan ikke fremvise ensartet data til støtte for non-lineær lydforstærkning men peger på en vis grad af patientpræference for de nye teknologier. Der kan ikke drages konklusioner vedrørende graden af nedsættelse i hørelsen og effekten af lydforstærkning. Med andre ord er der ikke nogen klar videnskabelig evidens for en sammenhæng mellem en foruddefineret grad af hørenedsættelse og et givent resultat af rehabiliteringsindsatsen. Men der var klar evidens for at folk med hørenedsættelse får gavn af lydforstærkning.

Litteraturstudiet alene giver altså begrænset information vedrørende problemets omfang blandt voksne befolkninger i de udvalgte lande. På samme måde er der kun få studier, der vedrører resultaterne af høreapparater, som opfylder de strenge videnskabelige krav. Selvom mange af studierne, der blev ekskluderet i litteratursøgningen måske havde klinisk relevans i begrænsede områder, kunne de ikke generaliseres til større populationer. Endnu færre studier korrelerer rehabiliteringseffekten med graden af hørenedsættelse, nedsat funktionsevne eller handikap.

For at besvare spørgsmålet vedrørende organiseringen af behandling, blev der udført en undersøgelse af sundhedstjenesterne. Denne undersøgelse viste slående forskel landende imellem. Antallet af tilpassede høreapparater pr 1000 personer varierede fra 2,27 i Finland til 12,30 i Danmark. Et betydeligt antal hørehæmmede i de nordiske lande og UK har ikke opsøgt hjælp og ejer eller benytter sig ikke af høreapparater. Omkring 3,5 procent af befolkningen i Danmark og UK bruger høreapparater medens tallene for Norge og Finland er 2,8 og 1,0 procent. Ingen af disse nærmere sig de 5 procent af befolkningen, der menes at have en hørenedsættelse på ≥ 45 dB i begge ører. Endvidere eksisterer der store variationer i de anslåede omkostninger per person med høreapparat. I Finland anslog man omkostningerne per person med høreapparat til at være det dobbelte af det i Norge og Danmark og næsten ti gange niveauet i UK.

På grund af begrænset videnskabeligt materiale kunne projektet ikke give klare entydige svar på de stillede spørgsmål – og det gav faktisk anledning til adskillige nye spørgsmål. På baggrund af de nuværende resultater synes et mere tilbundsgående studie af nuværende og fremtidig prævalens af hørenedsættelse – for at kunne forudsige fremtidige behov – at være yderst vigtigt. For bedst at understøtte en kommende planlægning bør et sådant studie helst udføres med tiårige alderskategorier på et så bredt multinationalt grundlag som muligt. Et sådant studie bør blandt andet også medtage selvrapporteret nedsat funktionsevne som en målvariabel for problemer med hørelsen.

Et mere dybdegående studie, der anvender en konsistent metodologi til undersøgelse af ikke kun forskellig organisering og omkostninger ved behandling i de nordiske lande og UK men også baggrunden og grundene for disse forskel, mangler også og planlægges nu i projektgruppen.

Andre vigtige emner, som projektgruppen identificerede omfatter behovet for at nå en konsensus om resultatmål for høreapparatydelser, behovet for at undersøge virkningen og effektiviteten af rehabiliteringsindsatsen overfor hørehæmmede i et design, der ikke glemmer patienttilfredshedsaspektet og behovet for at undersøge de negative konsekvenser af hørenedsættelse for livskvalitet.

For at kunne planlægge fremtidens ydelser skal det forventede personalebehov til dækning af de forventede forbrugerkrav i forbindelse med rehabilitering også vurderes. Endvidere synes der at være grund til at

oplyse og lære såvel offentligheden som de professionelle vedrørende de muligheder og fordele, rehabilitering kan tilbyde, idet de potentielle fordele af rehabilitering af hørelsen ofte i høj grad synes at blive overset og dermed udnyttes rehabiliteringsmulighederne ikke optimalt.

Norsk sammendrag

Hørselsreduksjon hos personer over 18 år er den hyppigst forekommende kommunikasjonsforstyrrelsen. Noen studier anslår at 15 % den voksne befolkningen er berørt, og forekomsten er beregnet å øke til 25 % i år 2020 (Rosenhall et al. 1999, Sorri et al. 2001). Andre anslag går ut på at 18–20 % av den voksne befolkningen allerede har redusert hørsel. I Storbritannia har omkring 3,5 % av befolkningen høreapparat (Taylor 2000).

Totalt antall innbyggere i Norden utgjør omkring 24 millioner, hvorav 8 millioner over 50 år (Nordisk ministerrråd og Nordisk råd 1999). Følgelig er et stort antall mennesker i Norden rammet av hørselstap. En betydelig – men ukjent – andel av disse kunne være målgruppe for effektiv hørselsrehabilitering. Det har blitt anslått at 60–70 %, kanskje så mange som 85 % av dem som lider av hørselstap (avhengig av definisjonen av hørselstap) kan ha nytte av høreapparat.

Kostnadene for rehabilitering av hørselsskader er betydelige. Det kan beregnes at de utgjør mer enn 150 millioner Euro per år i de nordiske landene. I USA er samfunnets totale kostnader til kommunikasjonsforstyrrelser anslått å utgjøre 2,5–3 % av brutto nasjonalprodukt. En betydelig andel av dette er kostnader til hørselsrehabilitering hos voksne (Ruben 2000). Man må imidlertid være oppmerksom på at definisjonene som brukes har stor betydning både for beregnet forekomst og de økonomiske anslagene.

Samfunnsmessige endringer som redusert behov for manuell arbeidskraft og økt behov for personell i yrker hvor kommunikasjonsevne og god hørsel er nødvendig har også betydning for hørselsomsorgen. I dagens arbeidsmarked er god evne til kommunikasjon nødvendig nesten uavhengig av yrke. I en bybefolkning er det rapportert at så mye som 87,5 % av alle yrkesaktive er avhengige av god kommunikasjonsevne. Det er en utfordring for helsetjenesten å gjøre personer med hørselsreduksjon i stand til å fortsette å være i arbeide.

Parallelt med at betydningen av å kunne kommunisere via hørsel har økt har også mulighetene for å kompensere hørselsreduksjon økt de siste tiår. Diagnostiske metoder har blitt forbedret og kan anvendes direkte ved tilpasning og justering av hørselshjelpemidler. Hørselsteknologi har blitt mer pålitelig og enklere i bruk, og nye løsninger gjør det mulig å hjelpe

flere enn tidligere. Dessverre finnes det ingen "gullstandard" som presist skiller mellom forskjellige grader av hørselsreduksjon, og som gjør det mulig å skille ut de pasientene som mest sannsynlig vil ha nytte av hørselstjenester. Identifiseringen av de mest aktuelle pasienter må i stor grad bygge på klinisk erfaring.

Pålitelig informasjon om forekomsten av hørselsreduksjon er nødvendig for å kunne planlegge behovet for hørselsomsorg. Tall for forekomst fra forskjellige studier har imidlertid vært varierende, avhengig av definisjonen av hørselsreduksjon og metoden som har vært brukt til å vurdere reduksjonen. Det er derfor vanskelig å finne eksakte tall som kan legges til grunn ved planleggingen av fremtidig omsorg.

Det er også behov for presis kunnskap om resultatet av hørselsrehabilitering inklusive pasientenes grad av tilfredshet. I tillegg må organisering, kostnader og kostnadseffektivitet kartlegges for at man skal kunne bestemme hvordan pasienter med hørselsreduksjon best skal rehabiliteres og hvordan tjenestene best kan organiseres.

De nordiske metodevurderingssentra (DIHTA i Danmark, FinOHTA i Finnland, SBU i Sverige og SMM i Norge) startet i 1999 et felles prosjekt om forekomst og vurdering av hørselsreduksjon hos voksne.

En prosjektgruppe som besto av en hørselsspesialist og en metodevurderingsspesialist fra hvert av de samarbeidende landene ble bedt om å utarbeide en litteraturoversikt og kartlegge organiseringen av tjenestene. Gruppen ble senere supplert med en hørselsspesialist fra Storbritannia. Arbeidet ble finansiert av de samarbeidende metodevurderingssentra og Nordisk ministerråd.

Spørsmålene i mandatet var:
1) "Hva er nåværende og sannsynlig fremtidig forekomst av hørselsreduksjon blant personer over 45 år i Danmark, Finnland, Norge, Sverige og Storbritannia og hvordan kan man best definere og vurdere hørselsreduksjon?"
2) "Hva er resultatet av ikke-kirurgisk rehabilitering ved hørselsreduksjon?"

Tre av de seks identifiserte, vitenskapelig gyldige studiene av forekomst var nasjonale (Davis 1989, Davis 1995, Rosenhall et al. 1999), mens de tre øvrige beskrev forekomsten av hørselsreduksjon i lokale befolkningsgrupper (Rosenhall et al. 1987, Uimonen et al. 1999,

Karlsmose et al. 1999). Disse få studiene viste økende forekomst med alder. Men verken studiene av forekomst eller longitudinale studier av fallende høreterskel kan gi et generelt grunnlag for pålitelige beregninger av fremtidig forekomst av hørselsreduksjon i aldersgruppene 45–65 år og over 65 år, dette på grunn av forskjellene i befolkningene som ble studert og ulik nasjonal befolkningsstatistikk.

Med hensyn til resultatet av hørselsrehabilitering ble det funnet fem studier som fylte de metodologiske kravene. Tre var dobbelt-blindet (Parving et al. 1997, Nilsson et al. 1997, Larson et al. 2000), de to andre enkelt-blindet (Biering-Sørensen et al. 1995, Bille et al. 1999). Alle studiene inkluderte personer med lydpersepsjonsforstyrrelser (sykdom i det indre øre eller nervesystemet). Studier av foreskrivning av hørselshjelpemidler og utfall ga ikke entydige data til fordel for ikke-lineær forsterkning, men det var viss tendens til at pasientene foretrakk nyere teknologi.. Det var klar dokumentasjon for at personer med hørselsreduksjon hadde nytte av forsterkning, men ingen klar dokumentasjon for at det var noen sammenheng mellom grad av hørselsreduksjon og utfallet av rehabiliteringen.

For å besvare spørsmål om tjenestenes organisering ble det gjort en kartlegging av hørselsomsorgen. Denne indikerte påfallende forskjeller mellom landene. Antall høreapparater tilpasset per 1000 innbyggere per år varierte fra 2,72 i Finnland til 12,30 i Danmark. En betydelig andel av personene med hørselstap i Norden og i Storbritannia har ikke søkt hjelp og verken har eller bruker høreapparat. Omkring 3,5 % av befolkningen i Danmark og Storbritannia bruker høreapparat, mot 2,8 % i Norge og 1 % i Finnland. Til sammenligning er det antatt at nær 5 % av befolkningen har minst 45dB tosidig hørselstap. Det er også store variasjoner i anslått utgift per person med høreapparat. I Finnland ble utgiftene til hver person med høreapparat anslått å være dobbelt så høye som i Norge og Danmark og ti ganger så høye som i Storbritannia.

På grunn av den begrensede vitenskapelige informasjonen som forelå har dette arbeidet genererte flere nye spørsmål.

Det er behov for en studie som går mer i dybden med hensyn til nåværende og fremtidig forekomst av hørselsreduksjon for å kunne forutsi fremtidig behov for hørselsomsorg. En slik studie bør se på ti-års aldersintervaller i så mange land som mulig og bør inkludere vurdering av selv-vurdert grad av uførhet pga hørselsreduksjon som et av målene.

Det er også behov for en dybdestudie med konsistent metodologi av hørselsomsorgen i de nordiske landene og Storbritannia som ikke bare ser på forskjeller i organisering og utgifter, men også årsakene til disse forskjellene. Prosjektgruppen planlegger å utføre en slik studie.

Videre fant prosjektgruppen at det er behov for konsensus om utfallsmål, behov for å studere effektivitet og kostnadseffektivitet av hørselsomsorg, og behov for å studere hørselsreduksjonens betydning for livskvalitet.

For å kunne tilfredsstille fremtidig etterspørsel etter hørselsrehabilitering må man også anslå behovet for personell og kompetanse i slike tjenester.

Ettersom potensiell nytte av hørselsrehabilitering synes lite påaktet og det antagelig er underforbruk av slike tjenester er det ønskelig at befolkningen og helsepersonell tilføres mer kunnskap om mulighetene og fordelene ved hørselsrehabilitering.

Suomenkielinen yhteenveto

Aikuisten huonokuuloisuus on yleisin kommunikaatiohäiriö. Joissakin tutkimuksissa huonokuuloisiksi on arvioitu 15 % aikuisista ja huonokuuloisuuden yleisyyden on laskettu lisääntyvän aina 25 %:iin vuoteen 2020 mennessä (Rosenhall ym. 1999, Sorri ym. 2001). Eräiden muiden arvioiden mukaan huonokuuloisuudesta kärsivien määrä on jopa edellä mainittua suurempi, aina 18–20 % aikuisväestöstä. Isossa Britanniassa on arvioitu, että 3,5 %:lla väestöstä on kuulokoje (Taylor 2000).

Islannin, Norjan, Ruotsin, Suomen ja Tanskan yhteenlaskettu asukasluku on noin 24 miljoonaa ja yli 50-vuotiaiden määrä lähes 8 miljoonaa (Pohjoismaiden Ministerineuvosto ja Pohjoismaiden Neuvosto 1999). Usean miljoonan aikuisen pohjoismaalaisen voidaan siten arvioida kärsivän huonokuuloisuudesta. Merkittävä, joskin tuntematon osa, heistä voisi hyötyä tehokkaasta kuntoutuksesta, sillä käytetystä huonokuuloisuuden määritelmästä riippuen 60–70 %, ehkä jopa 85 % näistä huonokuuloisista saattaisi hyötyä kuulokojeesta.

Huonokuuloisuuden suorat kuntoutuskustannukset ovat tällä hetkellä huomattavat. On arvioitu, että ne ovat Pohjoismaissa yhteensä yli 150 miljoonaa euroa vuodessa. Yhdysvalloissa kommunikaatiohäiriöiden yhteiskunnalle aiheuttamien kustannusten on arvioitu olevan vähintään 2,5–3 % bruttokansantuotteesta. Valtaosa näistä kustannuksista liittyy aikuisten huonokuuloisuuteen (Ruben 2000). On kuitenkin korostettava, että huonokuuloisuuden määrittelemistavalla on merkittävä vaikutus huonokuuloisuuden yleisyyttä ja kustannuksia koskeviin lukuihin.

Yhteiskunnalliset muutokset vaikuttavat tulevaisuuden kuulonhuollon tarpeisiin. Keskeinen muutos on työvoiman siirtyminen ruumiillisesta työstä sellaisiin kommunikointia vaativiin työtehtäviin, joissa hyvä kuulo on työstä suoriutumisen edellytys. Nykyään kommunikointi on välttämätöntä lähes kaikissa ammateissa, ja onkin arvioitu, että jopa 87,5 % työvoimasta tarvitsee hyviä kommunikointitaitoja. Yksi terveydenhuollon haasteista on pitää huonokuuloiset asianmukaisella tuella työkykyisinä.

Samalla kun kuuloon perustuva kommunikointi on lisääntynyt yhteiskunnassa, ovat myös huonokuuloisuuden hoitomahdollisuudet kehittyneet huomattavasti viime vuosikymmenien aikana. Diagnostiset menetelmät ovat parantuneet, ja kuulonhuollon teknologia on tullut

luotettavammaksi ja aiempaa helppokäyttöisemmäksi. Tarkkaa audiologista diagnoosia voidaan hyödyntää suoraan yksilöllisissä kuulokojesovituksissa ja kojeiden säädöissä. Uusia teknisiä ratkaisuja voidaan käyttää aikaisempaa laajemmille potilasjoukoille. Terveydenhuollon haasteena onkin löytää kuulon alenemasta kärsivät, kannustaa heitä hakemaan apua ja löytää oikeille potilaille oikeat ratkaisut. Valitettavasti tällä hetkellä ei kuitenkaan ole käytettävissä yleispätevää menetelmää huonokuuloisuuden ja siihen liittyvän haitan eri asteiden täsmälliseksi erottelemiseksi saatikka niiden potilaiden tunnistamiseksi, joille kuulonhuoltopalveluista todennäköisesti on hyötyä. Näiden tunnistaminen perustuukin tällä hetkellä pitkälti pelkästään kliiniseen kokemukseen. Niinpä huonokuuloisille tarjolla olevat palvelut vaihtelevat länsimaissa huomattavasti.

Kuulonhuoltopalvelujen tarpeen määrittämiseksi tarvitaan välttämättä tietoa huonokuuloisuuden yleisyydestä. Eri tutkimuksissa huonokuuloisuuden yleisyyttä koskevat luvut vaihtelevat käytetyn huonokuuloisuuden määritelmän ja haitan arvioinnissa käytettyjen menetelmien mukaan. Siten onkin vaikeaa löytää tarkkoja lukuja, joiden perusteella tulevaisuuden palvelutarve voitaisiin arvioida.

Tarkkaa tietoa tarvitaan myös kuulonhuollon tuloksista ja potilastyytyväisyydestä. Myös kuulonhuollon järjestelytapoja, kustannuksia ja kustannusvaikuttavuutta täytyy tutkia. Näiden tutkimusten perusteella saadaan tietoa siitä miten kuulonhuoltopalvelut voidaan järjestää tuloksellisimmin ja miten palvelujen kustannusvaikuttavuus saadaan mahdollisimman hyväksi.

Neljän Pohjoismaan Terveydenhuollon menetelmien arviointiyksiköt (Norjan SMM, Ruotsin SBU, Suomen FinOHTA ja Tanskan DIHTA) käynnistivät vuonna 1999 yhteisen hankkeen, jonka avulla pyrittiin vastaamaan erityisesti aikuisten huonokuuloisuuden määritelmää, arviointia ja yleisyyttä koskeviin kysymyksiin ja selvittämään miten kuulonhuoltopalvelut on tällä hetkellä Pohjoismaissa ja Isossa Britanniassa järjestetty.

Tehtävää varten koottiin projektiryhmä, johon kutsuttiin jokaisesta projektiin osallistuvasta Pohjoismaasta yksi audiologi ja yksi terveydenhuollon menetelmien arvioinnin asiantuntija. Ryhmän tehtävänä oli käydä läpi asiaa koskeva tieteellinen kirjallisuus ja kartoittaa osallistujamaiden palvelujen järjestämistavat. Myöhemmin ryhmään kutsuttiin mukaan vielä englantilainen audiologi. Projekti rahoitettiin

osallistuvien terveydenhuollon menetelmien arviointiyksiköiden ja Pohjoismaiden Ministerineuvoston toimesta.

Huonokuuloisuuden määritelmää, toteamista ja yleisyyttä koskeviin kysymyksiin pyrittiin vastaamaan systemaattisen kirjallisuuskatsauksen avulla. Katsauksen kysymykset määriteltiin seuraavasti: 1) Kuinka yleistä huonokuuloisuus on yli 45-vuotiaiden aikuisten keskuudessa Norjassa, Ruotsissa, Suomessa, Tanskassa ja Isossa Britanniassa ja miten huonokuuloisuus voidaan parhaiten määritellä ja todeta; ja 2) Mitkä ovat huonokuuloisuuden ei-kirurgisen kuntoutuksen tulokset?

Kuudesta tunnistetusta, tieteellisesti pätevästä yleisyyttä koskevasta tutkimuksesta kolme perustui kansalliseen aineistoon (Davis 1989, Davis 1995, Rosenhall ym. 1999), ja kolme muuta raportoi paikallisia, väestöpohjaan suhteutettuja huonokuuloisuuden esiintyvyyslukuja (Rosenhall ym. 1987, Uimonen ym. 1999, Karlsmose ym. 1999). Näiden tutkimusten mukaan huonokuuloisuus yleistyy iän myötä. Tutkimusten kohdepopulaatioiden ja saatavissa olevien väestötilastojen erojen vuoksi on kuitenkin mahdotonta ennustaa luotettavasti tulevaa 45–65 –vuotiaan ja sitä vanhemman väestön kuulovikojen yleisyyttä. Myöskään käytettävissä olevat pitkittäistutkimukset eivät anna vastausta tulevaisuuden kuulovikojen yleisyyteen.

Kuntoutuksen tuloksellisuudesta löytyi viisi tutkimusryhmän asettamat kriteerit täyttävää tutkimusta. Kolme näistä oli kaksoissokkotutkimusta (Parving ym. 1997, Nilsson ym. 1997, Larson ym. 2000), ja kaksi oli yksöissokkotutkimusta (Biering-Sørensen ym. 1995, Bille ym. 1999). Kaikissa oli tutkittu sensorineuraalisesta kuulon alenemasta kärsiviä. Tutkimukset eivät yksiselitteisesti tue epälineaarisen vahvistuksen paremmuutta; potilaat kuitenkin näyttävät olevan tyytyväisempiä uuteen teknologiaan. Huonokuuloisuuden asteen ja kojekuntoutuksen antaman hyödyn suhteesta ei tutkimusten perusteella voi tehdä johtopäätöksiä.

Kirjallisuuskatsaus antaa siis vain rajallisen kuvan huonokuuloisuusongelman yleisyydestä kohdemaiden aikuisväestön keskuudessa. Myös kuulokojeiden tuottamasta hyödystä on vain muutama tiukat tieteelliset vaatimukset täyttävä tutkimus. Vaikka monella tästä kirjallisuuskatsauksesta poissuljetulla tutkimuksella saattaa olla kliinistä merkitystä tietyissä väestöryhmissä, ei niiden tuloksia voida yleistää koskemaan suurempia väestöryhmiä. Vielä harvemmassa ovat tutkimukset, joissa olisi tutkittu kuntoutuksen tuloksellisuuden ja

kuulonaleneman asteen tai siitä johtuvan haitan tai invaliditeetin välistä yhteyttä.

Palvelujen järjestämistä koskevaan kysymyksen pyrittiin vastaamaan kuulonhuoltopalveluja koskevalla kartoituksella. Kartoituksen mukaan tutkittujen maiden välillä on huomattavia eroja. Vuosittain kymmentätuhatta henkeä kohti käyttöön otettavien kuulokojeiden määrä vaihtelee Suomen 2,72:sta Tanskan 12,30:een. Merkittävä osa Pohjoismaiden ja Ison Britannian huonokuuloisista ei ole lainkaan hakenut apua eikä omaa tai käytä kuulokojetta. Ison Britannian ja Tanskan väestöstä noin 3,5 % käyttää kuulokojetta. Vastaava luku on Norjassa 2,8 % ja Suomessa 1,0 %. Missään tämän kartoituksen maassa ei kuulokojetta käyttävien määrä ole edes lähellä sitä 5 %:n osuutta, jonka on väestöstä arvioitu kärsivän yli ≥ 45 dB kuulon alenemasta molemmissa korvissa. Myös kuulokojeiden kustannukset vaihtelevat huomattavasti. Suomessa käytetään yhtä kuulokojeen saavaa henkeä kohti noin kaksinkertainen määrä rahaa Norjaan ja Tanskaan verrattuna. Isoon Britanniaan verrattuna Suomen kustannukset ovat lähes kymmenkertaiset.

Tieteellisen näytön puuttuessa ei esitettyihin kysymyksiin saatu varmoja vastauksia projektin kuluessa. Itse asiassa tehty selvitys herättikin monia uusia kysymyksiä. Tulosten perusteella on ilmeistä, että tulevaisuuden palvelutarjonnan tarpeen arvioimiseksi tarvitaan välttämättä nykyistä perusteellisempia huonokuuloisuuden nykyistä ja tulevaa yleisyyttä koskevia tutkimuksia. Jotta tällaiset tutkimukset parhaiten palvelisivat tulevaisuuden suunnittelua, ne pitäisi tehdä mahdollisimman laajamittaisena kansainvälisenä yhteistyönä jakaen väestö kymmenvuosittaisiin ikäryhmiin. Kuuloon liittyvien ongelmien mittarina tulisi muiden tavallisesti käytettyjen muuttujien lisäksi käyttää myös itsearvioitua haitan astetta.

Perusteellinen, yhdenmukaisia menetelmiä käyttävä tutkimus on tarpeen myös eri Pohjoismaiden ja Ison Britannian palvelutarjonnan järjestelyjä ja kustannuksia koskevien erojen ja erityisesti niihin johtaneiden syiden selvittämiseksi. Projektiryhmä onkin jo aloittanut tällaisen tutkimuksen suunnittelun.

Muita projektiryhmän mielestä tärkeitä tavoitteita ovat pääseminen yhteisymmärrykseen käytettävistä kuulonhuollon tuloksellisuuden mittareista, huonokuuloisuuden kuntoutuksen vaikuttavuuden ja kustannusvaikuttavuuden arviointi, potilastyytyväisyyden arviointi ja kuulonaleneman elämänlaatua huonontavien vaikutusten tutkiminen.

Tulevaisuuden kuulonhuollon palvelujen suunnittelemiseksi täytyy myös arvioida siitä, kuinka paljon työvoimaa tarvitaan ennustetun palvelujen kysynnän tyydyttämiseksi. Koska huonokuuloisuuden kuntoutuksen tuottamat mahdolliset hyödyt näyttävät olevan huonosti tunnettuja ja siten liian vähäisessä käytössä, tarvitaan myös sekä suurelle yleisölle että terveydenhuollon ammattilaisille suunnattua tiedotusta kuntoutuksen mahdollisuuksista ja hyödyistä.

Svenskspråkig sammanfattning

Nedsatt hörsel försvårar ofta kontakter människor emellan. Undersökningar visar att 15 procent i åldrarna 45 år och däröver lider av hörselnedsättning. Enligt andra forskningsresultat kan andelen medelålders och äldre som lider av hörsel-nedsättning vara närmare 20 procent. Nedsatt hörsel är vanligare ju äldre man är. På grund av att andelen äldre förväntas öka, kan så mycket som var fjärde individ i åldrarna över 45 år komma att ha nedsatt hörsel år 2020.

Danmark, Finland, Island, Norge och Sverige har tillsammans ungefär 24 mil-joner invånare varav nästan 8 miljoner är i åldrarna 50 år och däröver. Om 15 procent av dessa lider av hörselnedsättning motsvarar det drygt en miljon av befolkningen i de Nordiska länderna. En avsevärd del av dessa bedöms kunna ha nytta av hörapparat.

Samtidigt som arbetslivet förändras i riktning mot ökande krav på förmåga till språklig kommunikation så har metoderna att diagnosticera hörselnedsättning förbättrats och hörselhjälpmedlen blivit mer tillförlitliga och lättare att använda. Resultaten från audiologisk utredning kan nu direkt tillämpas vid individuell utprovning av hörapparat. Nya tekniska lösningar erbjuder möjligheter för rehabilitering av hörselnedsättningar som tidigare inte kunnat behandlas. Hälso- och sjukvården står därför inför utmaningen att hitta dem som är handikappade av sin hörselnedsättning, motivera dem att söka hjälp och att erbjuda individuellt optimal anpassning. För närvarande finns ingen objektiv metod som kan användas för att urskilja dem som med störst sannolikhet kommer att ha nytta av hörapparat. Detta sker idag till stor del på grundval av klinisk erfarenhet. Detta förhållande förklarar sannolikt de betydande skillnader som finns i hur hörselvården är organiserad inom och mellan olika länder.

För att kunna fastställa behoven av resurser för hörselrehabilitering krävs tillförlitlig information om förekomsten av hörselnedsättning. Uppgifter om hur vanlig hörselnedsättning är har emellertid skiftat beroende på vilka definitioner som använts och de metoder som använts för att värdera/bedöma graden av nedsättning. Följaktligen saknas tillförlitliga uppgifter med vars hjälp man kan planera för att möta de framtida behoven.

För att tillhandahålla beslutsunderlag för god och kostnadseffektiv rehabilitering krävs också tillförlitlig information om resultaten av gjorda rehabiliteringsåtgärder och om hur nöjd man är med sin(a) hörapparat(er).

Sådan information bör kunna ställas i relation till kostnaderna för och organisationen av hörselvården

Därför inledde de fyra Nordiska instituten för medicinsk utvärdering (DIHTA i Danmark, FinOHTA i Finland, SBU i Sverige och SMM i Norge) 1999 ett gemensamt projekt med uppgift att besvara frågor om hur hörselnedsättning bör definieras och beräknas för vuxna samt att kartlägga hörselvårdens organisation i de Nordiska länderna och i Storbritannien.

En arbetsgrupp bestående av en audiolog och en sakkunnig inom medicinsk metodvärdering från vart och ett av de deltagande länderna fick i uppdrag att granska den vetenskapliga litteraturen och att kartlägga hur hörselvården är organiserad. Gruppen utökades senare med en audiolog och en hälsoekonom från Storbritannien. Ekonomiskt stöd förmedlades av de deltagande organisa-tionerna för medicinsk utvärdering och från Nordiska Ministerrådet. Författarna svarar själva för innehållet. Rapporten har inte varit föremål för bedömning av SBU:s vetenskapliga expertgrupp eller av dess styrelse.

Svar på frågor om definitioner, bedömning och förekomst av hörselskador söktes genom systematisk genomgång av den vetenskapliga litteraturen inom området. Mera specifikt formulerades frågorna: (1) Hur vanlig är hörselnedsättning idag och hur kommer dess förekomst att förändras bland personer som är 45 år och däröver; (2) hur definieras och bedöms hörselnedsättning bäst; samt (3) vilka resultat finns dokumenterade från rehabilitering av hörselskadade.

Sex studier avseende förekomst av hörselnedsättning bedömdes som vetenskap-ligt tillförlitliga varav två var nationellt representativa och tre var regionalt avgränsade. Samtliga visar att förekomsten av hörselnedsättning ökar med stigande ålder. Några tillförlitliga beräkningar av förväntad framtida förekomst av hörselskador i åldrarna 45 år och däröver kunde inte genomföras beroende på skillnader i undersökta grupper och i tillgänglig befolkningsstatistik.

Beträffande resultat av rehabiliteringsinsatser återfanns fem undersökningar som motsvarade uppställda kriterier på vetenskaplig kvalitet. Tre av de fem under-sökningarna var genomförda med dubbel-blind metodik. De två övriga var baserade på enkel blindgöring. Samtliga undersökningar avsåg personer med hörselskada i såväl mellan- som inneröra. Resultaten gav inte entydigt stöd för värdet av icke-linjär förstärkning, men tyder på att den nyare och mer avance-ade tekniken

föredras av användarna. Ingen slutsats kunde dras beträffande sambandet mellan grad av hörselnedsättning och effekten av förstärkning med hörapparat, det vill säga att det saknas klar vetenskaplig evidens för sambandet mellan en viss definierad grad av hörselnedsättning och grad av förbättrad hörsel med hjälp av hörapparat.

Litteraturöversikten gav sålunda begränsad information om problemets storleks-ordning i den vuxna befolkningen i de jämförda länderna. Det fanns också bara ett begränsat antal undersökningar av effekter av hörapparat som uppfyllde strikta vetenskapliga kriterier. Även om många av de studier som uteslöts efter granskning kan ha lokalt kliniskt värde så kan resultaten inte generaliseras till andra grupper. Få undersökningar belyser graden av samband mellan resultat av rehabilitering och graden av hörselnedsättning.

Kartläggningen av hörselvårdens organisation och kostnader visade på uttalade skillnader mellan länderna. Antalet utprovade hörapparater per 1000 personer och år varierade mellan 7,2 i Finland och 12.30 i Danmark. Betydande andelar av dem med hörselnedsättning i de Nordiska länderna och i Storbritannien har inte sökt hjälp och saknar hörapparat. Man har uppskattat att 2,8 procent av den norska, 1 procent av den finska och 3,5 procent av befolkningen i Storbritannien har hörapparat. Ingen av dessa uppskattningar kommer i närheten av de 15 procent av befolkningen som är 45 år och däröver och som bedömts kunna ha nytta av hörapparat. Kostnaderna för utprovning uppvisar också kraftiga varia-tioner mellan de jämförda länderna. För Finland uppskattas kostnaderna för utprovning av hörapparat vara dubbelt så höga som i Norge eller Finland och nästan 10 gånger så höga som i Storbritannien. För närvarande beräknas de direkta kostnaderna för hörselrehabilitering i de Nordiska länderna uppgå till mer än €150 miljoner. De indirekta kostnaderna är i stort sett okända.

På grund av att det saknas tillräckligt vetenskapligt underlag kunde projektet inte ge klara svar på de frågor som ställts men i stället väcktes flera nya frågor. Det bedömdes vara av största betydelse att göra en mera djuplodande undersökning av förekomst och framtida utveckling av hörselnedsättning. För att bli till störst möjliga nytta för planeringen bör en sådan undersökning genomföras på en bred multinationell grund och redovisa resultat från såväl audiometriska mätningar som av självuppskattad hörselnedsättning för successiva 10-årsgrupper.

Det finns också ett klart behov av en mer detaljerad undersökning av skillnader i hörselvårdens organisation och dess kostnader, men också av

orsakerna till de observerade skillnaderna mellan de Nordiska länderna och Storbritannien. En sådan undersökning planeras för närvarande.

För att kunna belysa kostnadseffektiviteten i utprovningsverksamheten är det av synnerlig vikt att nå enighet om vilka utfallsmått som bör användas för att värdera resultaten (objektiva mått, i termer av grad av tillfredsställelse bland användarna och effekter på livskvaliteten).

För planeringen av framtida hörselvård måste också personalbehoven beaktas. Det är också väsentligt att öka utnyttjandet av de möjligheter som idag finns för att förbättra hörseln genom att informera allmänhet och profession om de möjligheter och fördelar som rehabilitering kan erbjuda.

3. Introduction

Hearing impairment is a common problem, which increases significantly with age. It may have adverse effects on activities and social participation, and it may also affect the quality of life of affected people (Mulrow et al. 1990a, 1990b). Rudin et al. (1988) reported in a population based sample of 50- and 60-year old men in Gothenburg, Sweden, that 4 % and 11 %, respectively, were candidates for hearing aid fitting when criteria for the better ear hearing level over the frequencies 0.5–2 kHz ($BEHL_{0.5–2\ kHz}$) of $\geq$35 dB and for pure tone threshold at 2 kHz of >50 dB were employed. In a recent Swedish national population-based study Rosenhall et al. (1999) reported an increase from 10 % to 30 % in prevalence of subjective hearing problems from the age of 45–54 years to the age of 75–84. Bech et al. (1996) found in a representative sample of the elderly population aged over 80 years in the Copenhagen City area that hearing aid provision increases from 20 % at the age of 80 to 84 years to 61 % at the age of over 95 years. The extent of the problem discussed is affected by the definitions used to grade hearing impairment, and because of varying definitions the prevalence figures are difficult to compare both between countries and within a country. As the total number of inhabitants in Denmark, Finland, Iceland, Norway and Sweden is approximately 24 million and those aged over 50 years nearly 8 million (Nordic Council of Ministers and the Nordic Council 1999), it is estimated that several million adults in the Nordic countries suffer from hearing impairment.

The prevalence of hearing impairment increases with increasing age and under the coming years the problem is likely to aggravate as the expected life-span of the population increases. Consequently, the prevalence considered in some studies to be now approximately 15 % is expected to increase up to 25 % by the year 2020 (Rosenhall et al. 1999, Sorri et al. 2001). According to some estimates, the current proportion of those suffering from hearing impairment is even higher than that comprising up to 18–20 % of the adult population (Uimonen et al. 1999, Davis 1989, Gates et al. 1990, Parving et al. 1997, Quaranta et al. 1996). Within the United Kingdom it has been estimated that 3.5 % of the population have a hearing aid. This burdens the national economy with remarkable costs (Taylor 2000). In the USA, the total costs for communication disorders to the community have been estimated to be not less than 2.5 to 3 % of the gross domestic product, a major part of that being costs for hearing impairment in adults (Ruben 2000).

As the proportion of elderly citizens increases in developed countries (Vaupel et al. 1998), population-based data on prevalence of hearing impairments are needed for planning of health services in general, and for allocation of resources in audiology, in particular. If resources are to be used efficiently, it is essential to know who can be expected to benefit from rehabilitation, and which are the most efficient forms of rehabilitation for different groups of hearing impaired people. Rehabilitation with hearing aids has faced rapid technological developments during the 1990's. As the new technology is costly, it is in the interest of all parties to obtain evidence on the effectiveness of rehabilitation and to find indicators to assess the benefits of rehabilitation.

In today's industrialised society the requirements for good working place communication ability are in a central position. As high a percentage as 87.5 % of the entire work force has been reported to be dependent on communication skills. The change from the traditional craft peoples' monotone labour in the heavy industry in the era of industrialism to the present team work in the information society has only been possible through communication. The Western societies are predicted to meet a shortage of skilled workers already over the next five years. Successful management of the hearing impaired not only repays the investment but even turns the process profitable when preserving their employability until the ordinary age of retirement, and in the case of the retired, when saving secondary costs for communication disability. The challenge presented to the health care services is thus, with appropriate management, to maintain the hearing disabled at work.

In parallel with the increasing importance of auditory communication in society, the possibilities to manage these disorders have greatly improved during the last few decades. The diagnostic methods are better, and hearing technology has become more reliable and simpler to use, with consequent benefits for the patients. Accurate audiological diagnosis can directly be applied in individual fitting and adjustment of the hearing aid. The new technical solutions offer help for a greater variety of patients than could be treated before. The challenge, therefore, to the health care system is to find the disabled people, to motivate them to seek help, and to provide the right choices for the right persons. However, at the moment there is no "golden standard" method to precisely discriminate different grades of hearing impairment and disability and to distinguish patients likely to benefit from hearing services. Thus the identification of suitable patients is to a great deal based on clinical experience only. This has

resulted in significant differences in the organisation of hearing services among the Western countries.

It is well known that profound hearing impairment can lead to a significant loss of quality of life. A recent meta analysis reported the average quality of life (on a scale of 0 to 1; Walker 1993) of profoundly deaf adults (without cochlear implants) to be 0.54 (Cheng and Niparko 1999). This compares with a representative group of the British population whose mean self-reported quality of life was above 0.85 until the age of 60 (using the visual analogue scale) and did not fall below 0.8 until the age of 70 (Kind 1998). There is little direct evidence but much clinical experience that adults with mild, moderate and severe hearing impairment can benefit substantially from amplification. Some evidence is becoming available concerning the substantial benefit (Humes 1997), but as the present report suggests there are still considerable gaps in our understanding of the extent to which modern hearing aids provide benefit, and are incrementally cost-effective.

To be able to predict future needs for hearing services, reliable information on the prevalence of hearing impairment is essential. As discussed above, prevalence figures from different studies have been variable depending on the definition of impairment and the methods used to assess impairment. Consequently, exact figures on which planning of future services could be based, are difficult to find. The same holds true for the results of hearing rehabilitation as indicators used for assessing the effectiveness of services have been variable. More in-depth and precise information on the results of hearing rehabilitation as well as patient satisfaction but also on the organisation, costs and cost-effectiveness of rehabilitation is thus needed to be able to decide how patients with hearing impairment should be rehabilitated and what is the best and the most cost-effective way of organising services.

To fill some of the gaps in knowledge, four Nordic Health Technology Assessment Agencies launched in 1999 a joint project with the aim to specifically answer questions on definition, assessment, prevalence and non-surgical rehabilitation of hearing impairment in adults and to explore the current organisation of hearing services in the Nordic countries and in the United Kingdom. To answer issues concerning definition, assessment, and prevalence of hearing impairment, a meticulous literature review was performed. The specific questions of the literature review were: What is the current and predicted prevalence of hearing impairment among adults over 45 years of age in Denmark, Finland, Norway, Sweden and the

United Kingdom and how is impairment best defined and assessed; and what is the outcome of non-surgical rehabilitation of hearing impairment? To answer the question concerning organisation of services, a survey on hearing health services was performed.

The results of the project are reported in the following two chapters of this report. The first one (Chapter 4) deals with the meticulous literature review performed by Dr. Elina Mäki-Torkko as the principal author for the Project Group. The issue of hearing health services was dealt with by Health Economist Garry Barton and Professor Adrian Davis together with the Project Group and the results are reported in Chapter 5.

4. Definitions, prevalence and evidence for benefits of non-invasive treatments. A review of the literature.

4.1 Aim

The aim of this part of the project was to retrieve data on the present and predicted prevalence of hearing impairment among adults over 45 years of age in Denmark, Finland, Norway, Sweden and the United Kingdom based on existing literature. Furthermore, to evaluate how hearing problems may be best defined and assessed in adult populations, comparative studies on the outcome of hearing aids (non-invasive treatments) were searched for.

4.2 Present and predicted prevalence

4.2.1 Search protocol and evaluation of searched studies

Taking the available resources into consideration (for example only one reviewer, E.M.-T.), the author used, as recommended in the Cochrane Reviewers' Handbook 4.0 (1999), the Medline and Cochrane libraries as search databases. Within the time-frame of the project it was not possible to extend the search to other databases such as ScitationSearch or Embase. No material was requested directly from researchers and only articles reported in peer reviewed journals were surveyed. At all stages of the project the final decisions regarding the search strategy were made at the Project Group meetings. The searches were performed twice, in spring 2000 and in October 2000.

Regarding the present prevalence of hearing impairment among those over 45 years of age the databases were searched from 1980 to the present. Geographically the studies were required to represent the member countries of the project, i.e. Denmark, Finland, Norway, Sweden and the United Kingdom. Later, it was decided to include also studies reporting population based longitudinal data on hearing threshold levels, even if they do not report prevalence. To estimate the future prevalence, the published figures from epidemiological studies were compared with population statistics.

The primary search from Medline with the terms adult and (deafness or hearing impairment) and prevalence and (Finland or Denmark or Norway or Sweden or Great Britain or United Kingdom) gave 112 possibly relevant studies. In order to check whether the first search had given all

relevant studies from the target countries, a further search without geographical restrictions using the terms adult and (deafness or hearing impairment) and prevalence was made and gave 696 references. Out of these 696 studies 49 were deemed – based on the review of the titles and abstracts – to be possibly relevant population-based studies from all over the world or population based studies from the project countries. The search from the Cochrane library gave 12 references. All of them were either not relevant or were already listed in the earlier searches.

4.2.2 Results

Population-based studies on prevalence of hearing impairment are scanty and the six studies eligible for the review are summarised in Table 4-1. Three out of these six studies were national surveys Davis (1989, 1995), Rosenhall et al. (1999), whereas Rosenhall et al. (1987), Uimonen et al. (1999) and Karlsmose et al. (1999) report local population based prevalences of hearing impairment. All six studies show an increase in prevalence by age and three of the six studies report gender differences with hearing impairment being more prevalent in males than in females. By contrast, Davis (1989, 1995) found no clear association between prevalence of hearing impairment and gender. Based on the average hearing threshold in the better hearing ear over the frequencies 0.5,1, 2 and 4 kHz, $BEHL_{0.5-4\ kHz}$, (Eropean Work Group, 1996) of $\geq$ 25 dB the prevalence of hearing impairment in the 5th decade is 8.2 % in Great Britain (Davis 1989, 1995) and 11 % in Denmark (Karlsmose et al. 1999). In the Finnish population, Uimonen et al. (1999) reported a somewhat lower prevalence of 6.6 % in the age group of 45 years, and the definition used was slightly different, i.e. $BEHL_{0.5-4\ kHz} > 20$ dB. In his comprehensive national epidemiological study on hearing impairment in adults Davis (1995) reported prevalence estimates of $BEHL_{0.5-4\ kHz} \geq 25$ dB of 18.9 %, 36.8 % and 60.3 % in the age groups of 51–60 years, 61–70 years and 71–80 years, respectively. It is not possible to derive fully comparable prevalence data on hearing impairment in age groups of 45–65 years and over 65 years. The studies by Uimonen et al. (1999) and Rosenhall et al. (1999) report prevalences in these particular age groups, but while the former reported measured hearing impairment using two definitions based on the average hearing thresholds in the better hearing ear over the frequencies 0.5,1 and 2 kHz, $BEHL_{0.5-2\ kHz}$, (WHO 1991) and over the frequencies 0.5,1,2 and 4 kHz, $BEHL_{0.5-4\ kHz}$, (European Work Group, 1996) the latter is based on self-reported hearing impairment.

Furthermore, the prevalence data in the study of Rosenhall et al. (1999) are given in bar charts and the exact figures are not reported, but have to be estimated for the present report from the graphics. Uimonen et al. (1999) clearly demonstrate the effect of different definitions of hearing impairment on prevalence figures with prevalence of at least mild hearing impairment being 10.0 % using the WHO (1991) definition and 37.2 % using the European work group (1996) definition in those aged 65 years or more.

Longitudinal studies on changes in hearing thresholds by age are summarised in Table 4-2. Because of differences in study populations and ways of reporting the longitudinal changes, it is impossible to determine whether the differences are real or based on differences in study design.

As indicated in Table 4-3, the proportion of the population aged over 65 years increases in the Nordic countries from the present ca. 15 % (17 % in Sweden) to well over 20 % in 2030. Fully comparable statistics are not available from the United Kingdom, but according to the estimates presented in the internet site of the Government Actuary Department (www.statistics.gov.uk) the proportion of the population aged over 65 years will be about 19.1 % in 2021.

4.3 Definition and assessment

4.3.1 Search protocol and evaluation of searched studies

It is known, based on earlier clinical and scientific experience, that terminology and definitions of hearing impairment and outcome of rehabilitation vary greatly. Regarding the definition of impairment, disability and handicap the Project Group decided to use the definitions proposed by the World Health Organization (WHO, 1980). In this classification three concepts define the consequences of disease and injury: 1) impairment (i.e. the loss of psychological, physiological, or anatomical structure or function), 2) disability (i.e. the limitation in functional performance resulting from an impairment), and 3) handicap (i.e. the disadvantage experienced by a person as a result of impairments and/or disabilities, which limits interaction of the person with the physical and social environment). Concerning outcome in the assessment of hearing impairment both objective and subjective measures should have been used in the studies eligible for review.

The search strategy was formulated to cover studies on outcome of non-invasive rehabilitation (hearing aid and other) of hearing impairment. Based on these results the possibly useful methods of defining and assessing hearing impairment were evaluated. A strategy of an extensive search followed by a more focused one through exclusion in two stages was chosen in this part of the literature review.

The primary search in Medline was performed using the search terms *adult and (deafness or hearing impairment) and rehabilitation not cochlear implant* giving 1200 references from 1966 to search date. Of these, 551 were published in 1990 or later**.**

Additional searches in Medline were performed with the following search terms

1) adult and (deafness or hearing impairment) and definition not cochlear implant (47 references)
2) adult and (deafness or hearing impairment) and (disability or handicap) not cochlear implant not surgery (332 references)
3) adult and (deafness or hearing impairment) and (quality of life or QALY) not cochlear implant not surgery (85 references)
4) adult and (deafness or hearing impairment) and effectiveness not cochlear implant not surgery (83 references).

The search in the Cochrane library with the search term adult and hearing gave 346 references out of which 303 had been published in year 1980 or later and 214 year 1990 or later. Based on the review of the titles only 35 of these studies were deemed to be possibly relevant papers. After excluding studies which already had been derived from earlier searches only 10 out of these 35 studies were left for further evaluation.

The project was targeted to adults, i.e. subjects over 18 years of age and the review was restricted to non-invasive treatments. The scientific evidence was reviewed using a two-stage evaluation protocol described below (Lists 1 and 2). Articles were classified as relevant, not relevant or of questionable relevance based on review of the titles and the abstracts. Full-text articles of all studies deemed relevant or possibly relevant were obtained for further evaluation.

List 1. Stage I inclusion criteria

- adult, i.e. subjects at least 18 years of age
- non invasive (for example excluding cochlear implant, bone-anchored hearing aids, semi-implantable hearing aids, surgery)
- other than vibrotactile aids (no objective assessment methods available for these aids)
- number of subjects at least 20
- all types of studies included except letters, editorials, comments, opinions, catalogues, case studies
- studies primarily dealing with hearing impairment (for example excluding comparisons between American and English sign languages)

List 2. Stage II inclusion criteria

- published in a peer reviewed journal
- regarding hearing aid outcome, all studies published 1990 or later (because of the rapid development in hearing aid technology older studies not included)
- regarding hearing aid outcome, if a clinical cross-over trial with at least 20 subjects or randomised controlled trial with a larger number of subjects (about 40)
- regarding hearing aid outcome, a follow-up time of at least 3 months for inexperienced hearing aid users and at least 6 weeks for experienced hearing aid users
- regarding hearing aid outcome studies based on either validated questionnaire schemes (i.e. high test-retest reliability) or questionnaires indicated in guidelines for clinical testing of hearing aids (Andersen et al. 1998, Arlinger 1998, Hagermann 1999)
- regarding definitions and assessment of hearing impairment, studies published 1980 or later if both objective and subjective outcome measures had been used
- regarding definition and assessment, population-based studies

Each study eligible for review was required to fulfil the inclusion criteria described above. In addition, hearing aid outcome studies were required to be as strictly as possible in accordance with the guidelines for clinical testing of hearing aids summarised in Table 4-4. The criteria applied in this project were stricter than the published guidelines and were used in order to achieve a review of scientific ‘state of art’ studies taking into

account that some clinically relevant and interesting studies might be missed. During the reviewing process the results of the search were compared with related projects, for example the NICE project on hearing aid technology (www.nice.org.uk), the Swedish hearing aid technology assessment project (not published yet), and the Danish audit-project assessing hearing aid outcome based on the users' experiences (Parving and Sibelle 2001).

Based on the review of the titles and abstracts, 12 previously unidentified studies derived from the Cochrane library were rated relevant and obtained for further assessment.

4.3.2 Results

Hearing aid outcome

The five studies fulfilling the applied criteria are summarised in Table 4-5. Three out of the five studies were double-blind by design (Parving et al. 1997, Nilsson et al. 1997, Larson et al. 2000). The remaining two were single-blind (Biering-Sørensen et al. 1995, Bille et al. 1999). All studies included subjects with sensorineural hearing impairment. The outcome of digital versus analogue hearing aid was studied by Bille et al. (1999) while Larson et al. (2000) compared three commonly used hearing aid circuits (linear peak-clipping, compression limiter and wide dynamic range compressor). The other reports dealt with outcome of non-linear versus linear hearing aids. Bille et al. (1999) and Biering-Sørensen et al. (1995) did not find significant differences regarding hearing thresholds between the subjects preferring the test or the reference hearing aid. Parving et al. (1997) did not relate the results to the degree of hearing impairment. Nilsson et al. (1997) dichotomised the study group according to the mean hearing level over the frequencies 0.25, 0.5, 1, 2 and 4 kHz > 40 dB HL and $\leq$ 40 dB and considered that the majority of those preferring the linear amplification mode had significantly worse mean hearing level. Regarding high-frequency hearing impairment the limit was 45 dB at the mean hearing level at 2 and 4 kHz, and the 20 patients preferring linear hearing aid had significantly worse high frequency hearing (Nilsson et al. 1997). All three circuits tested by Larson et al. (2000) improved speech recognition and reduced frequency of problems related to verbal communication. According to their results, 46.1 % of the subjects preferred the compression limiter circuit, 29.8 % the wide

dynamic range circuit and 28.6 % the linear peak-clipping circuit, but they did not study the possible association with the degree of hearing impairment or other background variables.

Definition and assessment of impairment

Population-based studies on definition and assessment of impairment are listed in Table 4-6. Other than population-based studies derived from the definition and assessment searches are grouped according to the study type in Table 4-7. Excluded hearing aid outcome studies are grouped and listed in Tables 4-8 – 4-10, excluded population based studies on definition and assessment in Table 4-11, excluded other than population based studies on definition and assessment in Table 4-12, and excluded prevalence studies in Table 4-13.

4.4 Discussion

Only six population based prevalence studies from the Nordic countries and the United Kingdom were found, and only the works of Davis (1989, 1995) and Rosenhall et al. (1999) reported on nationally representative data, while the others (Rosenhall et al. 1987, Uimonen et al. 1999 and Karlsmose et al. 1999) are local studies. In addition to these, some population based studies are also available from other countries, for example Italy, Australia and USA (Moscicki et al. 1985, Quaranta et al. 1996, Wilson et al. 1999, Cruickshanks et al. 1998). All above-mentioned studies show an increase in the prevalence of hearing impairment with age. However, because of differences in ages of the target populations and slightly different definitions of hearing impairment, comparisons between the studies are not possible. There are no comparable prevalence data available for the age groups of 45–65 years and over 65 years. Both Davis (1989, 1995) and Karslmose et al. (1999) used the same criteria for hearing impairment, $BEHL_{0.5–4\ kHz} \geq 25$ dB, and report fairly similar prevalence figures from Great Britain and Denmark. The British (Davis 1989, 1995), Italian (Quaranta 1996) and Australian (Wilson et al. 1999) studies included subjects over 17 years, over 18 years and over 15 years of age, and reported prevalences of $BEHL_{0.5–4\ kHz} \geq 25$ dB of 16.1 %, 17.1 % and 16.6 %, respectively. The two American studies reported prevalences of $BEHL_{0.5–4\ kHz} \geq 25$ dB of 31.0 % in the age group of 57–89 years (Moscicki et al. 1985) and 32.4 % in the age group of 48–92 years

(Cruickshanks et al. 1998), respectively. Using the same criteria for hearing impairment as above, Davis (1995) gives prevalence estimates of 36.8 % and 60.3 % in respective age groups of 61–70 and 71–80 years.

Population based prevalence studies are difficult to conduct and collaboration with national and international centres with careful planning of the project is warranted. In a recent collaborative study combining prevalence data from Sweden, Denmark and Great Britain the uncertainties regarding slight differences in original projects were discussed (Rosenhall et al. 2000). Furthermore, Parving et al. (1997) especially pointed out the increased risk of biased results because of a high number of drop-outs in very old populations. In their study of a representative Danish urban population aged above 80 years the drop-out rate was 51 %. Comparisons of prevalences based on reported hearing difficulties and measured hearing thresholds should also be regarded with caution. Wilson et al. (1999) found similar overall prevalences for self-reported and measured hearing impairment, but when the results were compared, the false positive rate for the self-report question turned out to be 46 % and the false negative rate 17 %.

The literature survey shows that there are numerous but heterogeneous reports on hearing aid outcome. Only few of the studies fulfil strict scientific criteria and, although many of the other studies may be of relevance at specific sites, they cannot be generalised into larger populations. When considering hearing aid outcome, blinding to avoid possible bias related to a subject's tendency to prefer the new hearing aid, is of utmost importance, as emphasised for example by Biering-Sørensen et al. (1995). However, only three of the five clinical cross-over studies fulfilling our inclusion criteria were double-blind by design. Studies on hearing aid outcome do not provide uniform objective data in favour of non-linear amplification, but show some subject preference for the newer technology. No conclusions can be drawn regarding hearing aid outcome and the degree of hearing impairment, in other words, there is no clear scientific evidence for the association of a predefined degree of hearing impairment and the outcome of rehabilitation.

No consensus concerning outcome measures has been reached in relation to hearing impairment. Nor is there a uniform definition for the benefits related to alleviation of hearing problems. An expert group has recently considered outcome measures in hearing aid use and proposed a questionnaire to be used internationally (Cox et al. 2000).

Limiting the search to two databases (Medline and Cochrane library) increases the risk of both language and publication bias. Likewise, the restriction of using only articles published in peer reviewed journals may have led to the possibility of omitting some relevant articles. However, inclusion of papers published in other than peer reviewed journals or accepting unpublished data directly from researchers, without the possibility to referee them, would have further increased the heterogeneity of the reviewed material. Furthermore, the risk of missing important articles is minimised by the participation of several international experts well acquainted with the field.

Based on the literature review, there is only limited knowledge about current prevalence of hearing impairment in adult populations in the target countries. Similarly, there is only a handful of good quality scientific studies on hearing aid outcome, and even less, on correlation of rehabilitation outcome with the degree of hearing impairment, disability or handicap. Thus, the overall conclusion is that a literature review alone does not give answers to the questions of the project.

5. Adult hearing services: A comparison of service provision in Nordic Countries and the United Kingdom

5.1 Aim

The aim of this part of the project was to provide key descriptors of hearing services in Denmark, Finland, Norway, Sweden and the United Kingdom to firstly provide a baseline description of the services, secondly to identify similarities and differences and thirdly to explain variations in hearing health care provision, if possible.

The questions for this survey were designed at an early meeting of the Project Group, and the answers were researched by the Project Group member responsible for each country. The extent to which information was readily available was very different from country to country, and the gaps in the data are quite clear in the relevant tables.

Data from the countries of Denmark, Finland, Norway, Sweden and the United Kingdom were analysed in an attempt to summarise variations across national hearing services. Particular attention was paid to:
Health care spending levels
Policies on hearing aid provision
The number of people provided with hearing aids
Expenditure on hearing services
The training of health care professionals
The type of hearing aids fitted
The proportion of monaurally and bilaterally fitted hearing aids
Waiting lists
Guidelines and recommendations

5.2 Variations over country in medical practice - data from other specialities

Wide variations in medical practice both within and across countries are not uncommon. For example, Hoyer (1985) provided evidence that the rates of compulsory admissions to psychiatric institutions in Scandinavia varied substantially in 1982 from 248 per 100,000 in Sweden, 109 in Norway and just 26 in Denmark. Variations in rates are also reported for many other procedures such as hysterectomy, hernia operations and tonsillectomy (McPherson 1998).

It is, however, important to investigate the reasons for variations. Andersen (1990) argued that variations are composed of both 'illegitimate' and 'legitimate' reasons for variation. A 'legitimate' variation might arise, for example, because of differences in background morbidity or because of a differing funding priority being attached to certain health care services across countries. Other variations may however be deemed 'illegitimate'. Andersen pointed out that differing rates may be partially explained by some individual clinicians being unaware of existing knowledge on outcomes and thus providing different services from others.

The professional uncertainty hypothesis has similarly attempted to account for variations in practice (Wennerberg 1982). This stated that when geographical variations can not be explained by differences in disease prevalence, access to and availability of services, or enabling factors such as insurance, it reflects differences in physicians' beliefs about the value of the variable procedures and practices for meeting patients' needs. Part of this may be due to some professionals being inefficient, however it may also reflect differences in the evaluations made by different people for the same health outcome. It has further been pointed out that equalising total resources without altering the distribution of physicians may result in missing resources and ineffective use of those available. Thus reducing variations is not straightforward.

A further difficulty in undertaking international comparisons arises because of the limited comparability of data and methodological problems originating from comparing different economic, demographic, cultural and institutional structures (Financing and delivering health care 1987). However once common definitions are established, and error free data collected, variations in medical practice can often be explained by a combination of five factors.

- Need arising from morbidity – (quite often determined by demography)
- Demand: Patient expectations
- Supply and Availability (both resources and health care professionals)
- Clinical practice (different values of the same health outcome or differences in information)
- Random variation

Explanations as to why these might arise, and their applicability to hearing services, will be summarised in section four of this chapter. However

descriptions of the countries from which data have been collected are first summarised.

5.2.1 Country Descriptors

Denmark, Finland, Norway, Sweden and the United Kingdom are all highly industrialised countries, with relatively high gross domestic product per capita. The population density of Finland, Norway and Sweden is however one of the lowest in Europe. The figures in Table 5-1 show that all three have between 5–10 % of the square km population density in the United Kingdom. Moreover, much of the country contains rural areas that are sparsely populated. In Sweden about 90 % of the population is concentrated in the south, with 20 % living in the three largest cities of Stockholm, Malmö and Gothenburg (Hoffmeyer 1994). The situation is similar in Norway and Finland which have high concentrations in the South East and South West of their respective countries.

The population density within countries may have an impact on the uptake of services offered. Hospitals tend to be concentrated close to urban areas, and also benefit (up to a certain point) from economies of scale (average cost per case falls with increased quantity) (NHS Centre for reviews and dissemination 1997). Such concentration may however reduce access to hospitals. Evidence shows that the elderly and those of lower income are particularly likely to be affected, with the uptake of certain services being more likely to diminish. The attendance for screening services and consultations prior to diagnosis fell as the distance needed to travel increased. By implication the greater distances that may have to be traveled in Finland, Norway and Sweden may diminish the number who both seek hearing tests and attend appointments for the fitting of hearing aids.

5.2.2 Economic Descriptors

Although the United Kingdom has a much bigger economy, this is largely explained by it's greater population. Table 5-2 shows that gross domestic product per capita figures are highly comparable with Finland being the lowest at an estimated equivalent of 18,449 EUR (11,114 GBP) in 1997. Norway and Sweden had figures that were approximately 50 % higher.

All have comparably low unemployment rates, with Sweden having a greater percentage of gross domestic product being devoted to government expenditure.

5.3 The organisation of health care

Denmark, Finland, Norway, Sweden and the United Kingdom show great similarity in their organisation of health care funding and provision (Table 5-3). Funds are generally raised directly from tax revenues and there is a tendency for decision making to be decentralised. In Finland and Sweden the state supervises, and contributes to the funding, however the local authorities are responsible for the purchasing and provision of most health care services. Similarly, Denmark is divided into 14 county councils and two municipalities (Copenhagen and Frederiksberg) who have the responsibility of providing health care.

All countries offer universal coverage for catastrophic events. Indeed most like, for example, the United Kingdom offer universal and comprehensive cover. Exceptions include a minority in Denmark who choose to make contributions (in return for extra choice) towards health care provision/accessibility. The Danish health insurance system offers two types of insurance groups, of which more than 95 % choose to receive free care. Under this option people receive tax financed care, and the primary physician has to issue a referral in order for them to be referred to hospital. If they opt for the second option they are free to decide which general practitioner or specialist they go to, however they have to pay for both consultation and hearing test on seeking this second opinion.

5.3.1 Health Care Funding Descriptors

The percentage of gross domestic product devoted to health care is broadly similar across Denmark, Finland, Norway, Sweden and the United Kingdom (the United Kingdom has recently announced it will increase funding levels) (The Government Expenditure plans 2000). Moreover, much of the variation in per capita health care expenditure shows a similar distribution to gross domestic product per capita figures. The private health care expenditure is relatively small within countries, though in Finland private health care expenditure amounts to more than a fifth of total health care expenditure and 1.7 % of gross domestic product. The

United Kingdom had the smallest total health care expenditure as a percentage of gross domestic product.

5.4 The impact of Health Care Policies

Before describing the hearing services within each country it is useful to discuss the theoretical aspects of health care funding. This is important as it may help explain possible causes of any variation in the use of hearing aids that may exist. Indeed there are many factors that can result in a low per capita use of hearing aids; these include the provision of hearing services being deemed a low national priority, or user charges discouraging utilisation or simply fewer hearing impaired people. The reason for such policies being undertaken and the empirical evidence of their existence will now be summarised.

5.4.1 The Funding of Health Care: National Objectives

In all health care systems there is a mix of public and private finance and provision. Health care, public and private, can be funded from some combination of general taxes (income and expenditure taxes), social insurance, payroll taxation (in reality disguised taxation of the income of employees), private insurance and user charges (co-payments and deductibles). The biggest decisions are however often centred around what to purchase, for whom and how these services should be delivered (Drummond 1997). The objectives of most health care systems are however the same and include cost containment (macroeconomic cost control), efficiency (microeconomic resource allocation) and equity (distribution objectives) (Bloor 1999). The relative weights attached to these may affect the resources devoted to hearing services. For example, if equity is deemed important this may translate into relatively high per capita spending on hearing services.

5.4.2 The Allocation of Scarce Resources

All treatment choices involve opportunity costs: a decision to treat Patient A is a decision not to treat Patient B (McGuire et al. 1988). In all health care systems the scarcity of resources means that some patients will not be offered the best care available. Efficiency therefore requires minimisation

of opportunity costs and maximisation of health benefits. If resources are deployed inefficiently, it follows that reallocation could improve the total level of benefit (or health gain) achieved. Costs and benefits of competing health interventions should be compared and resources allocated to maximise health gains. The pursuit of this is referred to as allocative efficiency and involves pursuing programmes only when the benefits outweigh the costs (foregone health benefits).

Despite the objective of maximising social welfare, allocative efficiency can create resource distributions that are uneven and discriminate against certain sections of the society. Allocative efficiency may result in maximum health benefits being obtained from a constrained budget. However, policy makers are also concerned with issues such as 'quality' and 'access', and an efficient allocation of resources may not produce an equitable distribution of resources. Differing access may be associated with differences in time costs for patients. Such time costs may be associated with travel costs and/or the costs associated with absence from work whilst accessing care. Access to care also has a major impact on equity, as geographical distribution of care affects equity across regions, and also time costs may impact more severely on people with low incomes. Policy makers may attempt to equalise access by discriminating in favour of the poor or allocating more money to rural regions, even though such resource reallocation is inefficient.

Particularly relevant to hearing aids is the possible discrimination against elderly people. Whilst it might be efficient to treat the elderly, policy makers may decide that an elderly person has had 'a good innings' (has reached or is approaching the average life expectancy) and consequently that more resources should be diverted to, the relatively inefficient, treatment of young people (Williams 1997). Given the particularly high rate of hearing impairment in the elderly (see section 5 of this chapter), such a policy could have a great impact on the service offered.

5.4.3 Purchasing Power Parity: Salary Levels and Price Levels

If purchasing power parity exists then a given amount of currency in one country, converted into another country at the current market exchange rate, will buy the same quantity of goods in both countries. Focusing on the provision of hearing services it may be that purchasing power parity

does not exist in the cost of goods or labour in respective National Hearing Services. Indeed if one country has higher wage levels for those in the National Hearing Services, then this is likely to result in lower productivity: for each equivalent pound spent they will not be able to fit as many hearing aids. One currency which is particularly high at the moment is the pound, this has risen approximately 20 % since the Euro was introduced on January 1st 1999. This may mean that at present the United Kingdom services are perceived as relatively more expensive than they may be in the long run.

5.4.4 User charges in developed countries

User charges for health care paid by consumers have two main purposes. The first is revenue raising by health care funders – essentially a form of tax in a publicly financed health care system. Secondly, they can be used to discourage use of health services, in public systems or insurance systems. This impacts on revenues and gives patients an incentive to limit use. The presence of user charges therefore reduces the need for decisions about where to allocate scarce resources. Attempts are made to influence patients' behaviour by limiting reimbursement of products or interventions and providing an incentive for patients to reduce their consumption of health care.

5.4.5 Conclusion: Theoretical reasons for Supply and Demand to differ

The above theories about health care objectives and structures have revealed that the utilisation of services may vary because of factors outside the hearing services. The availability of resources is often determined at a national level and purchasing power parity of hearing services may not exist. Both will affect the level of service that is provided. Similarly the existence of differences in ease of access or user charges may alter rates of service use. National priorities will also affect utilisation, especially if the elderly are discriminated against. However, one of the most important influences on the activity of hearing services (and associated expenditure) is the number of hearing impaired people in the population; this is discussed in the next section.

5.5 Epidemiology: How common is Hearing Impairment ?

5.5.1 Variations across countries

Although there are many different causes of hearing impairment a brief literature search revealed no evidence to suggest a difference in prevalence rates of hearing impairment (for the same age and sex) across countries. Indeed comparisons in prevalence between the countries of Denmark and Wales showed that there was no statistical difference in prevalence between the two countries (Parving and Stephens 1997). Two identical 6 year birth cohorts from 1975 to 1980 suffering from a permanent hearing impairment > 90 dB were compared, results showed a prevalence of 0.41/live birth in Wales (N = 34) and 0.45 in Denmark (N = 59).

Even though the prevalence may not vary for people of the same age and sex living in different countries, the overall prevalence may differ because of a differing age structure. Table 5-4 shows the age structure of the population across the five countries in question. Though largely similar it is important to point out that quite small percentage changes can result in large changes in the absolute number of hearing impaired individuals. For example, Sweden has nearly 3 % more people aged over 65 than Finland. Studies have revealed that the rate of hearing impairment (≥ 25 dB loss) to be approximately 50 % in this population. It can be seen that this may translate into 1.5 % more of the population being hearing impaired (≥ 25 dB loss) in Sweden than in Finland, assuming the absolute number is the same in the rest of their respective populations. Although this is perhaps the extreme case, it highlights the importance of not automatically attributing a lower per capita number of hearing aids to a difference in the level of priority that hearing impairment funding commands in different countries, differences can have many causes.

The proportion of people needing and attending for hearing services increases quite substantially with age, especially from 60 years of age. The median age of people attending hearing aid services in Denmark, during a twelve month period, was 71 years (Parving et al. 1992) and it is similar in England. If there were systematic variations in age and sex

distributions between countries this could explain variations in spending, when in fact those of the same age and sex are receiving similar services.

5.5.2 Alleviating Hearing Impairment: Available health technologies and their use

Another factor that may explain differences in the per capita rates of hearing aids is the availability of different types of hearing aids, alternatives and their use. Modern digital hearing aids cost more than single channel analogue linear hearing aids. It is a common perception that most hearing impairments can be helped with a modern hearing aid. Evidence is needed to support this perception. Other service improvements for which there is some evidence of clinical effectiveness are the introduction of smaller hearing aids and of bilateral fittings. With a symmetric hearing impairment, a bilateral fitting provides greater benefit, and some have argued that this should be attempted initially (Klein 1999). In cases of profound deafness, alternatives to hearing aid amplification, such as cochlear implants may be used. The numbers needed are relatively small, for example amounting to approximately 400 adults and children each year in the United Kingdom. Although small in number, the availability of such alternatives can reduce population need substantially , but at a very high cost per patient.

One important factor that affects the use of hearing aids is the preference of individuals. The deterioration of hearing impairment in the elderly is well documented, however, the proportion of elderly people who wear hearing aids is often low. This is highlighted by a British hospital based study in which only 12 out of 30 patients (40 %) who reported difficulties with their hearing had hearing aids (Liston 1995). Only 17 had consulted their doctor (of whom 15 were referred), and 13 had chosen to suffer in silence.

5.5.3 Conclusion: reasons for variation

The evidence obtained so far does not suggest differing rates of hearing impairment across countries. However, there is evidence that elderly people have a very high level of hearing impairment, and account for the majority of visits to hearing aid centres for assessment, fitting, counselling and repairs.

The important question now is what influence there is at the hearing service level collected. The following section summarises the responses to thirteen questions that have been collated in order to discover more about how hearing services vary across the countries of Denmark, Finland, Norway, Sweden and the United Kingdom.

5.6 Description of Hearing Services – Summary of responses to Questions

Within this section the responses from researchers in each of the respective countries of Denmark, Finland, Norway, Sweden and the United Kingdom is presented. Summaries of the responses to each of the questions are now provided, a full list is available from the authors.

5.6.1 Organisation of the national services

The organisation of National Hearing Services across Denmark, Finland, Norway, Sweden and the United Kingdom is broadly similar. The health sector generally has the task of screening, diagnosis, hearing aid fitting and the general planning of rehabilitation. In an attempt to ensure that patients develop hearing to their full potential, the health sector is also supported by the social and the education sectors. For example, in Denmark and the United Kingdom the social sector provides assistive listening devices (ALDs) and interpretation services. Denmark also reported that the educational sector teaches hearing impaired people how to use the hearing instruments, hearing tactics and provides general information on co-morbidities such as tinnitus.

None of the countries seems to provide universal entitlement to all hearing aids fully funded by the public sector. In Denmark and Finland it is reported that up to 5–10 % of the hearing aids and assistive listening devices are purchased from the private sector. Both of these countries also reported that a minority of patients also pay for tests and consultations, thus enabling appointments to be obtained without referral (Raffel 1997). Patients who take up this option have to pay part of their fees. In the United Kingdom it is thought that 20 % of those with hearing aid will have personally purchased these.

5.6.2 Referral to the national hearing services

Again there are similarities in the referral system in Denmark, Finland, Norway, Sweden and the United Kingdom. The most common route to the hearing services for those who have no previous history of hearing impairment is via the primary care physician. In Denmark, Finland and Sweden otolaryngologists refer people with no prior history of hearing impairment. For those who are experienced users (who have already been diagnosed as having a hearing impairment) contact is usually made with the hearing services directly, however, Finland reported that even experienced users should be referred by a GP. On the other hand, the United Kingdom operates a walk-in service or a community based service for those already supplied. However, for complete re-assessment a GP referral is necessary for charging purposes.

5.6.3 Economical implications: Governmental support versus private financing

Preliminary data suggest similarity in the rules concerning availability in Denmark, Finland, Norway, Sweden and the United Kingdom. It seems there is universal entitlement for a hearing aid for those who have a hearing impairment. However, there is variation in the type of hearing aids which are available. Assistive listening devices tend to be universally available, digital hearing aids are however more difficult to obtain.

For example, in Norway a copayment type system operates where the public sector will fund the full cost of hearing aids below a level of 5,400 NKR (661 EUR). For hearing aids which cost more than this (for example digital hearing aids) patients will pay the difference (up to a maximum of 166 EUR, 100 GBP). Similarly within Sweden, although there is generally variation across counties, there is an upper limit on the level of public reimbursement. This means that generally the patient will pay between 400 and 600 SEK (42 – 63 EUR), and even more in those counties where public reimbursement is only available for one aid. In Denmark an Act of Parliament has been enacted, with an upper limit of public reimbursement in the region of 3–4,000 DKR (406 – 542 EUR). However, at present in Denmark, as in the United Kingdom and Finland, if a patient requests a hearing aid that is not provided by the public sector he/she will have to pay the full cost. There are, however, a couple of exceptions to this.

In Finland compensation for hearing impairment is available if an external source is deemed responsible. Relevant groups include occupational hearing impairment, traffic accidents, veterans' war traumas etc; for these the costs are reimbursed from the respective source. In addition, in some rather rare occasions services may also be reimbursed by The National Pensions Institute or labour authorities. If the hearing impairment is compensated, as an occupational hearing impairment etc; (see above), the services are reimbursed also in the private sector.

There is some variation as to whether the patient is expected to pay for batteries. In Denmark they are provided free of charge. However in Norway patients are expected to pay for their batteries.

5.6.4 Annual prescribing ranges in total and per capita

There are quite wide variations in the number of hearing aids purchased each year in Denmark, Finland, Norway, Sweden and the United Kingdom. Table 5-5 shows that in per capita terms annual prescribing ranges from 2.72 per 1,000 in Finland to 12.3 in Denmark. The implications of these figures are discussed in section 7 of this chapter, after the figures relating to the use of bilateral hearing aids have also been discussed.

5.6.5 Annual costs of the national hearing services

Denmark, Finland, Sweden, Norway and the United Kingdom have provided estimates of the annual sum spent on hearing aid services for adults. These are presented in Table 5-6. However, it should be noted that no common definition of what should be included in this was established by the group, there may therefore be small variations which are accounted for by different methods used to calculate costs. At a per capita level it is immediately apparent that there is variation in the level of per capita funding. Even though the value of the United Kingdom pound has increased by 20 % since January 1st 1999, the United Kingdom seems to spend considerably less on hearing services. The full implications of these figures, in terms of what is provided by this money, will be discussed in section 7 of this chapter. However, at an observational level there does seem to be a correlation between per capita expenditure on hearing services and gross domestic product per capita. Denmark and Norway

spend approximately 50 % more per capita on hearing services than Finland, which has 50 % less gross domestic product per capita.

5.6.6 Education and training of persons working within the national hearing service

The evidence collected suggests that, in general, there is a greater level of training in Finland than other countries. A description of their length of education is provided below.

- Medical audiologist/university level: MD 7 yrs
  - Specialist in otolaryngology/phoniatrics: 6 yrs
  - Training in audiology: 2 yrs
  - Total: minimum 14 yrs
- Engineers/university level 6 – 7 yrs university level
- Engineers/polytechnic level 4 yrs
- Speech therapists/university level 6 yrs
- Psychologists/university level 6 yrs
- Audiology assisstants/Polytechnic level
  - Qualified nurse or equivalent 4 yrs
  - Training in audiology: 1 yr
  - Total: minimum 5 yrs
- Social workers/university level 5 – 6 yrs
- Home workers for (re)habilitation guidance/training varies, mainly polytechnic level 3 – 4 yrs (+)

The relative degree of training does seem to be similar in the countries sampled. Physicians and audiologists tend to have at least a degree level qualification and most have a further technical training course as well. However, those who perform diagnostics, hearing aid fitting and speech therapists tend to have less training. The responses from specific countries are shown below.

Denmark

"There is a mixture of persons with academic university background and non-academic background. The academics are physicians, university trained technicians and psychologists. The non-academic personnel is audiology assistants (performing diagnostics and

hearing aid fitting), nurses, ear mould technicians, secretaries, service technicians and cleaning staff."

United Kingdom

"Hearing aid centres: Input from otologists, audiological physicians – degree level medical consultant, registrar, senior houseman level. Input from the audiologists – (1) About 200 audiological scientists with at least a postgraduate MSc and certificate of clinical competence (2) About 1200 audiologists, who are technically trained, they may have first degrees but are more likely to have technical training courses (3) hearing therapists who are usually degree level plus a one year diploma level course (4) assistant audiologists who may be training (5) educational audiologists and teachers of the deaf with postgraduate MSc training at least (6) medical physicists with at least first degree and more likely MSc/PhD who may be in charge of evoked response clinics etc."

5.6.7 Waiting list policies

There seems to be high variation both across countries, and within the countries, with regard to the expected waiting times. Some reported the time for fitting to be less than three months, others up to 2 years. Sweden seems to have the lowest waiting times, where this is reported to be less than 3 months. Indeed in Sweden the government imposed a waiting time guarantee that, after an opinion has been made by a specialist, no patient should wait more than three months for treatment (Hoffmeyer 1994). The United Kingdom reported an average wait of nearly 5 months (range between 1 and 16 months). Denmark reported that the average waiting time was 14–15 months. Norway and Finland reported waiting lists up to 8 to 12 months and 18 months, respectively. There is evidence that the long waiting lists in the United Kingdom have even meant some individuals go to private dispensers – in a recent Government survey 'The General Household Survey', 15 % of hearing aid users reported purchasing a hearing aid privately as it could be obtained more quickly (Office for National Statistics 1998).

5.6.8 Access to technology

Not all hearing aids may be as attractive to users, accessible, comfortable to wear or provide similar benefit. Recent technological developments, have included in the ear (ITE) and completely in the canal (CIC) hearing aids, programming to the individual's needs, and the availability of digital hearing aids which can fine tune frequency responses, control feedback and suppress background noise. Some of the evidence base has been summarised in chapter 4 of this report. Digital hearing aids have been shown to improve speech recognition and reduce hearing impairment in social interactions (Arlinger 1998). Clearness of sound quality was also improved, this was correlated with overall sound quality and 23/33 subjects reported a preference for the new test aid (Boymans et al. 1999). Results also suggested a patient preference for digital hearing aids, however, objective data did not support this subjective preference (Boymans et al. 1999).

In principle it seems that each National Hearing Service has access to all types of hearing aids. However in practice, due to funding constraints, it is often the case that patients are not provided with the hearing aid which is likely to benefit them most. This is well demonstrated by the response from Denmark: "The National Hearing Services have access to all types of hearing aid technology, and all types of hearing aids; only a small proportion of completely in the canal (CIC) hearing aids are fitted." Similarly in the United Kingdom most aids are reported to be behind the ear (BTE), analogue, single channel devices with some output limiting. A paper published in 1996 found similar results, with BTE hearing aids being most often fitted (79 %) against a much lower number of "in the ear" hearing aids (Robillard 1996).

5.6.9 Services to specific subgroups

Generally the services provided to specific subgroups were not reported to differ. However, Denmark and Norway did report that employed people and children are prioritised to receive shorter waiting times. As such there is no evidence to suggest that pensioners or the very old receive an inferior service. Nevertheless the United Kingdom did report that people who were in the armed forces or who were in industry and can prove negligence can possibly get access to more modern aids free of charge.

5.6.10 Unilateral versus bilateral fitting of hearing aid

With respect to hearing aids the collated evidence suggests there is variation in the number of hearing aids prescribed (Table 5-7). Moreover, this may partially explain the higher rates for the number of hearing aids prescribed. For example, Denmark prescribes many more hearing aids, but because a greater proportion are bilateral than in the United Kingdom this may mean a similar number of people each year receives new hearing aid(s). However, the two striking messages from this are that the United Kingdom and Finland provide a lesser proportion of bilateral hearing aids than Denmark and Norway, and that in Finland there is likely to be a lower (per capita) number of people who have a hearing aid. The full implications of these results will be considered in section 5.7 in conjunction with the expenditure figures.

What is apparent from the figures is that the evidence strongly suggests that countries do not provide hearing aids to all those who may benefit. Assuming that this is not due to individual preferences (for example for aesthetic reasons), then this shows that services are being rationed and that, regardless of the type of hearing aid, some method of prioritisation is being used to decide who receives a hearing aid.

5.6.11 Recommendations for renewals / guarantee period

The renewal period for a hearing aid in a patient where there is no evidence of a progressive hearing impairment is as follows, guarantee periods are also stated:

	Guarantee period (years)	Renewal time (years)
Denmark	4	5
Finland	4	5
Norway	Not specified	6
United Kingdom	~1-2	No guideline

There is similarity in the above figures, however the United Kingdom seems to have guarantee periods of half that of other countries.

There is evidence to suggest that components of hearing aids are frequently defective. In Denmark during a two year period prior to 1994 among dispensed hearing aids 11 % were defective at the fitting and 12 % of behind the ear (BTE) hearing aids were defective within the first year of use (Sibelle and Parving 1994). Moreover, after 2 years of use, all in the canal (CIC) hearing aids were defective, while only 33 % of in the ear (ITE) hearing aids remain intact. External components were found to malfunction significantly more after three years of use. This supports earlier work by the same authors, who found that 91.4 % of defective hearing aids had been used for less than four years.

5.6.12 Maintenance

Norway reported that audiology centres and ENT doctors generally organise the maintenance of hearing aids and assistive listening devices. Similarly in the United Kingdom hearing aid centres perform assessment and re-issue a number of product lines where necessary. In Finland maintenance is arranged by municipal hospitals. The larger ones, mainly the university hospitals (5 in the country) take care of the maintenance by themselves. The smaller hospitals buy the services from private firms.

5.6.13 The role of patient organisations

In the United Kingdom there are several patient organisations. The RNID (The Royal National Institute for Deaf People) is both a lobby group and patient representative group. It also runs considerable services for deaf people. Hearing Concern is an organisation of hearing impaired people. The National Deaf Children' s Society is a parent and child organisation which has been responsible for a lot of service development particularly in the area of quality standards.

Finland reported that patient organisations were very political, though peer support and rehabilitation courses and services of home workers are also provided. It was also pointed out that patient organisations receive funding for their (re)habilitative work from RAY (Finland's slot machine association) which is controlled by the Ministry for Social Affairs and Health.

Norway reported that patient organisations take on an advisory role. In Denmark this goes further to include political lobbying, informing people about hearing awareness and to complain about the level of services provided.

5.7 Implications of responses

The main findings of the collated responses are summarised in Table 5-7. Here a new column shows the estimated number of people who have a hearing aid in each respective population. Within the United Kingdom it has been estimated that 3.5 % of the population have a hearing aid (Taylor 2000). Assuming a similar relationship, between the percentage who have a hearing aid and the annual number prescribed an aid, is present in other countries we can also estimate the proportion of the population who are likely to have a hearing aid. These figures should however be regarded with a high degree of caution as there are profile differences in the type of aids (for example digital, ITE, etc) within countries and this may mean there are different repair and renewal times, which may explain differences in the relationship between annual provision and overall provision across countries. Using the assumption that the number of people who have a hearing aid is over four times the annual number provided, then in Denmark, Sweden and Norway it is predicted that the percentage of the population who have a hearing aid is approximately 3.4 %, 2.3 % and 2.4 % respectively. These figures are broadly comparable with the United Kingdom, however, it is noticeable that less than 1 % of the population in Finland is estimated to have a hearing aid. Comparing these figures to the expected number who might benefit from a hearing aid it is apparent that not all are being prescribed one. In section 5.4 figures showed that 16.6 % of the 18–80 year old population are likely to have a hearing impairment of ≥ 25 dB (0.5 – 4 kHz) in both ears rising to 20 % when including the over 80s. It has also been estimated that 4.75 % (2.8 million) of the United Kingdom population has a hearing impairment of ≥ 45 dB (0.5 – 4 kHz). Both figures are significantly larger than the estimated number who have a hearing aid in all of the countries which responded, and therefore reinforces the evidence of others who have argued that not all who may benefit from hearing aids have one.

The per capita spending on those who may have a particular level of need can also be more fully analysed now. Denmark and Norway have similar figures of expenditure, however the figures provided suggest that fewer

people have a hearing aid in Norway. Given the evidence that there is a slightly higher percentage of bilateral hearing aids in the Norway this may suggest that there is a policy of supplying higher quality hearing services (for example a greater amount spent on a providing a hearing aid(s)) to fewer people. This is further corroborated when compared to United Kingdom figures. In the United Kingdom even though there is estimated to be a similar number of people with a hearing aid, per capita spending levels are less than a third of that in Denmark and Norway. The evidence also suggests that this may translate into a lower quality service as the United Kingdom has considerably fewer bilateral aids, hearing aids have a shorter guarantee period, an estimated 43 % report that their hearing aid does not help their hearing and 27 % find it awkward, uncomfortable or badly fitting. However, similar comparable data are not readily available to us for comparison in the Nordic countries.

A new column, which estimates the spending per person with a hearing aid, has also been created in Table 5-8. It is appreciated that hearing centres provide services to many individuals who do not receive a hearing aid (for example assessments, information, ALDs) and consequently these figures are likely to overestimate the annual spending per person with a hearing aid. However, they may act as a good proxy for the relative levels of spending. Moreover they corroborate the earlier findings that Denmark and Norway may spend more on fewer individuals since they provide a greater percentage of bilateral hearing aids.

The figures concerning costs per hearing aid in Finland are considerably higher than in other countries. However, given that this is not explained by more bilateral hearing aids there may be several explanations. It may be that the costs given include elements of service that have not been provided by other countries or it may be that skilled labour costs are higher in Finland. Earlier questions have suggested greater training for workers in hearing services, and this may mean that they earn more later. Certainly the human capital theory suggests that, all other things being equal, people will only undertake greater periods of training (invest in themselves) in the expectation that this will yield future returns (higher earnings) (Schultz 1963, Becker 1962). Coupled with the evidence that fewer people have a hearing aid in Finland, this suggests that a greater amount is spent on those who have a hearing aid. It should however be remembered that this may not be an explicit policy that is being adopted here. Evidence suggests that many in the deaf community do not regard hearing impairment as a disability, and indeed are quite content not to seek services from the health service. This coupled with the earlier

evidence that many of those who report a hearing impairment do not report this to their GP does not rule out the possibility that fewer people may be provided with a hearing aid in Finland because of patient preference.

A converse situation seems to be apparent in the United Kingdom, where less is being spent but more people are actually being given hearing aids. Staff in the same role are therefore likely to be caring for a greater number of people in the United Kingdom than in Finland and this may partially explain some of the possible 'low quality markers' of service that have been reported in the United Kingdom. This may also explain why over 20 % are purchased privately. However, before drawing such a conclusion, further data should be collected to corroborate this. This is the subject of the next section.

5.8 Discussion

Hearing impairment is present in about one in five of the adult population and it can and does lead to a significant loss in quality of life for those affected, their family and others with whom they frequently interact. However the data presented within this report suggest that a significant proportion of the hearing impaired in the Nordic countries and the United Kingdom have not sought help and do not possess or use a hearing aid. Given that 3.5 % of the United Kingdom population has a hearing aid, assuming a similar relationship between the annual number of aids prescribed and the overall number of aids, it is estimated that about 3.4 % of the Denmark population is provided with a hearing aid, 2.3 % in Sweden, 2.4 % in Norway and 1.0 % in Finland. None of these approaches the figure of 20 % of the population predicted to have a ≥ 25 dB (0.5 – 4 kHz) hearing impairment in both ears, or even the 5 % of the population estimated to have ≥ 45 dB (0.5 – 4 kHz) hearing loss in both ears (Richards and Gleeson 1999).

Examining country descriptors has shown that due to their sparse population, different ease of accessibility to hearing aid services in countries such as Finland, Norway and Sweden may occur. With respect to per capita expenditure on hearing services this appears to be correlated with gross domestic product per capita figures, with Norway and Denmark spending 9.61 EUR per capita, approximately 50 % more per capita than Finland. United Kingdom spending is even lower at an

estimated 2.80 EUR per capita. This may partially account for the higher rate of privately purchased hearing aids in the United Kingdom, an estimated 20 % of hearing aids is purchased privately (individuals pay the full cost). This compares to a rate of 5–10 % in Denmark and Finland. In Norway private contributions are made, however, these are only for hearing aids that cost over 661 EUR (maximum contribution 166 EUR). Similar, though more complicated, upper limits of public contribution are found in Denmark where an Act of Parliament has been passed.

Wide variations across the countries of Denmark, Finland, Norway and the United Kingdom in the estimated expenditure per person with a hearing aid also exist. Even though fewer people have hearing aids in Finland, the estimated expenditure per person with a hearing aid is double that of Norway and Denmark and nearly tenfold that of the United Kingdom. Given that this is not accounted for by a greater percentage of provision of bilateral aids, this suggests that service delivery costs may be higher in Finland (possibly as a result of greater emphasis on post-graduate training of personnel or inclusions of elements of service that have not been provided by other countries). However, further investigation of the purchasing power parity is needed to see whether the same amount of currency in one country, converted into another country's currency at the current market exchange rate, will enable the same quantity of hearing services to be bought in other countries.

In most areas that were investigated, there were insufficient data which were also often difficult to interpret. Therefore it has not been possible to explain much of the high inter-country variation seen. One example is the higher cost per person for providing a hearing aid in Finland, where this may be a result of using a highly skilled and trained workforce with an emphasis on rehabilitation rather than on providing amplification per se. However, without further detailed information this can not be verified. Similarly even though the theoretical background suggests that the elderly, who account for the great majority of the hearing impaired, may be discriminated against, little evidence for the influence of patient characteristics has been elicited. The variation in waiting time from approximately 3 months in Sweden, up to 5 or more months in the United Kingdom and over a year in Denmark may, for example, be explained by different case mix strategies in different countries. However, we do not have sufficient accurate data to explain the variation. We suggest that whilst the current data, collected from experts in each country, is highly interesting, there is a high priority case to conduct a more in-depth and

valid study using a consistent methodology for all the Nordic countries and the United Kingdom.

There are two approaches which might complement each other. The first would be to supplement the questions that were asked in this round by others to resolve ambiguity and obtain more in-depth answers. This would be relatively cheap to do and simple, but would have the drawbacks associated with this exercise viz a highly selected and possibly biased description of services. The second approach, for example, would be to carry out individual interviews, collect detailed organisational data and quantitative surveys (as being conducted in the United Kingdom in a sample of clinics). This has the advantage of acquiring less biased, more relevant data, but the drawback is that it takes time and is expensive.

6. General conclusions and recommendations

The literature review and the survey performed in this project aimed at answering the following questions: 1) how is hearing impairment best defined and assessed, and what is its prevalence among adults over 45 years of age; 2) what is the outcome of non-surgical rehabilitation of hearing impairment; and, 3) how is non-invasive treatment and rehabilitation of hearing impairment currently organised in the Nordic countries and in the United Kingdom

Of the six identified, scientifically valid, population based prevalence studies three were nationally representative while three others reported local prevalence figures of hearing impairment. These population based studies generally showed an increase in prevalence by age, but neither the prevalence studies nor the longitudinal reports on deterioration of hearing thresholds enable reliable calculations on estimated future prevalence of hearing impairment in age groups 45–65 years and over 65 years.

Regarding hearing aid outcome, five scientifically valid studies fulfilling the applied criteria were identified. Three out of these were double-blind, and the remaining two single-blind. All studies included subjects with sensorineural hearing impairment. These studies do not provide uniform data in favour of non-linear amplification, but show some subject preference for the newer technology. No conclusions can be drawn regarding the degree of hearing impairment and the effects of amplification.

The literature review alone gives thus only limited information concerning the extent of the problem of hearing impairment in adult populations in the target countries. Likewise, there are only few studies on hearing aid outcome which fulfil strict scientific criteria and, although many of the other studies may have clinical relevance at specific sites, they cannot be generalised into larger populations. Even fewer studies correlate rehabilitation outcome with the degree of hearing impairment, disability or handicap. The overall conclusion is that the literature review alone does not give answers to the questions of the project.

The data obtained during the project suggest that a significant proportion of the hearing impaired in the Nordic countries and the United Kingdom

have not sought help and do not possess or use a hearing aid. It is estimated that about 3.5 % of the United Kingdom population use a hearing aid, 3.4 % in Denmark, 2.4 % in Norway, 2.3 % in Sweden and 1.0 % in Finland. None of these approaches the figure of 20 % of the population who are predicted to have a ≥ 25 dB hearing loss in both ears, or even the 5 % of the population who are estimated to have ≥ 45 dB hearing impairment in both ears.

With respect to per capita expenditure on hearing services this appears to be correlated with gross domestic product per capita figures, with Norway and Denmark spending 9.61 EUR per capita, approximately 50 % more per capita than Finland. The United Kingdom spending is even lower at an estimated 2.81 EUR per capita. This may partially account for the higher rate of privately purchased hearing aids in the United Kingdom, where an estimated 20 % of hearing aids are purchased privately (individuals pay the full cost). This compares to a rate of 5–10 % in Denmark and Finland. In Norway private contributions are made, however these are only for hearing aids that cost over 661 EUR. Similar, though more complicated upper limits of public contribution have been enacted in an Act of Parliament in Denmark.

Wide variations across the countries of Denmark, Finland, Norway and the United Kingdom in the estimated expenditure per person with a hearing aid also exist. Even though fewer people have hearing aids in Finland, their estimated expenditure per person with a hearing aid is double that of Norway and Denmark and nearly ten fold that of the United Kingdom. Given that this is not accounted for by a greater percentage of provision of bilateral aids, this suggests that service delivery costs may be higher in Finland. Further investigation of the purchasing power parity is needed to see whether the same amount of currency in one country, converted into the currency of another country at the current market exchange rate, will enable the same quantity of hearing services to be bought in other countries.

In most areas which were investigated, there were insufficient data which was also often difficult to interpret. Therefore, it has not been possible to explain much of the high inter-country variations seen. One example is the higher rate of spending per person in providing a hearing aid in Finland, where this may be a result of using a highly skilled and trained workforce with an emphasis on rehabilitation rather than on providing amplification per se. However, without further detailed information this cannot be verified. Similarly, even though the theoretical background suggests that

the elderly, who account for the great majority of the hearing impaired, may be discriminated against, little evidence for the influence of patient characteristics has been elicited. The variation in waiting time from approximately 3 months in Sweden, up to 5 or more months in the United Kingdom and over a year in Denmark may, for example, be explained by different case-mix strategies in different countries. However, we do not have sufficient accurate data to explain the variation. We suggest that whilst the current data, collected from experts in each country, are highly interesting there is a high priority case to conduct a more in-depth and valid study that uses a consistent methodology over all the Nordic countries and the United Kingdom.

Due to limited scientific evidence, the project was unable to give definite answers to the questions presented and in fact raised many new questions. Based on the current results, a more in-depth study concerning current and predicted prevalence of hearing impairment – to be able to predict the future need of services – seems of utmost importance. This and some other important issues needing further actions and research are listed below as the recommendations of the Project Group:

1. There is a need to study the prevalence of hearing impairment problems further on a nation-wide basis in ten-year age bands based among other indicators also on self-assessed hearing impairment.

2. There is a need to reach consensus on outcome measures of hearing aid services in the Nordic countries and the United Kingdom.

3. There is a need to launch an in-depth study concerning the organisation of services in relation to economy i.e. effectiveness/efficacy.

4. There is a need to study the adverse effects of hearing impairment on quality of life.

5. There is a need to evaluate the size of the workforce needed to meet predicted future needs in hearing rehabilitation.

6. There is a need to introduce campaigns for better hearing like "Hearing days".

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Tables

Table 4-1. Population based studies on prevalence of hearing impairment in adult populations in the Nordic countries and the United Kingdom

(PTA = pure tone average, EU = European Union, WHO = World Health Organization, BEHL = better ear hearing level, WEHL = worse ear hearing level, CI = confidence interval)

Author/s, journal and title	Study characteristics	Results
Davis AC Int J Epidemiol 1989;18:911–17 The prevalence of hearing impairment and reported hearing disability among adults in Great Britain. AND **Davis A** Prevalence of hearing impairment. In: Hearing in adults. The prevalence and distribution of hearing impairment and reported hearing disability in the MRC Institute of Hearing Research's National Study of Hearing. Chapter 3, pages 46–7.Whurr Publishers Ltd, London 1995.	Self-reported and measured hearing impairment reported, PTA $_{0.5–4\ kHz} \geq 25$ dB HL, adults $\geq$ 18 yr., national, cross-sectional. A 2-stage sample survey, random sample from the electoral register, a detailed sampling description given, N = 2708, Great Britain.	Prevalence % (95 % CI) by age (yr.). Age / BEHL ≥ 25 dB HL / WEHL 41–50 / 8.2 (6.2,10.3) / 20.0 (16.6, 23.5) 51–60 / 18.9 (16.1, 21.7) / 33.9 (30.2, 37.5) 61–70 / 36.8 (32.4, 41.2) / 51.2 (46.3, 56.2) 71–80 / 60.2 (53.0, 67.5) / 71.2 (64.0, 79.3)
Rosenhall U et al. Scand Audiol 1987;16:211–17 Self-assessment of hearing problems in an elderly population. A longitudinal study.	Self-reported hearing problems at age 70 (N = 386), 75 and 79 yr., local, longitudinal, random selection from the Internal Revenue Centre (one-third of the 70-year-old population), Sweden.	Prevalence (%) of at least slight problems in hearing conversation with one person by age (yr.) and sex. Age / male (%) / female (%) 70 / 12 / 6 79 / 32 / 27

Author/s, journal and title	Study characteristics	Results
Uimonen S et al. Br J Audiol 1999;33:53–9 Do we know the real need for hearing rehabilitation at the population level? Hearing impairments in the 5- to 75-year-old cross-sectional Finnish population.	Measured hearing impairment, Better ear PTA $_{0.5–4\ kHz}$ > 20 dB (EU), Better ear PTA $_{0.5–2\ kHz}$ ≥ 26 dB (WHO), age ≥ 5 yr., adults reported separately in 5-year age groups, 45 + yr., local, cross-sectional, random sample from the population register, N = 3518, Finland.	Prevalence (%) by age (yr.) Age — WHO — EU 45 — 1.3 — 6.6 55 — 4.3 — 15.9 65 — 10.0 — 37.2 75 — 32.5 — 64.5
Rosenhall U et al. Audiology 1999;38:328–34 Self-assessed hearing problems in Sweden: a demographic study.	Self-reported hearing problems, ≥ 16–84 yr., national, a systematic sample drawn by age group from the national population register, N = 48680, Sweden.	No direct prevalence figures reported ; following estimates derived from figures (bar charts). Age (yr) — prevalence (%) 45–54 — 9 55–64 — 17 65–74 — 23 75–84 — 30 Gender difference increase build up in the young and the middle-aged (men > women), but remained constant at about 12 % over the age 55–64 yr. Regional differences: higher prevalence in rural areas, difference much greater in men, but observable also in women.
Karlsmose B et al. Br J Audiol 1999;33:395–402 Prevalence of hearing impairment and subjective hearing problems in a rural Danish population aged 31–50 years.	Subjective hearing problems (N = 1392) and measured hearing impairment (N = 905), PTA $_{0.5–4\ kHz}$ ≥ 25 dB better and worse ear, 31–50 yr., local (rural), cross-sectional, random sample from a general practioners' register, Denmark.	Prevalence % (95 % CI) by sex in age group 41–50 yr. old. BEHL — WEHL > 25 dB HL Male — 8.5 (4.7, 12.2) — 21.7 (16.1, 27.2) Female — 2.5 (0.5, 4.5) — 10.1 (6.3, 14.0) Prevalence % (95 % CI) of subjective hearing problems in age group 41–50 yr. old by sex. Problems restricting daily activities Male — 4.0 (1.8, 6,1) Female — 2.8 (1.1, 4.5)

Table 4-2. Longitudinal population based studies which report hearing level changes

(* SRT-SP = speech reception threshold for spondaic words, SRT-PB = speech reception threshold for monosyllabic, phonetically balanced words)

Author/s, journal and title	Study characteristics	Reported results/conclusions
Davis AC et al. Acta Otolaryngol 1991;Suppl. 476:12–22 Longitudinal study of hearing.	National, Great Britain (Davis, 1989), N = 98 at 3 visits (2nd visit on average 2 years after the first, 3rd on average 4.6 yr. after the 1st visit), statistical analysis included.	Average HL 0.5, 1, 2 and 4 kHz ≥ 25 dB HL (bilateral hearing impairment) in a sample of mean age 55 yr. old (range 40–65): incidence of hearing impairment 1.8 % per annum. Rate of deterioration 9dB/decade for subjects > 55 yr. of age and 3 dB/decade for those < 55 yr. High degree of individual variation in deterioration.
Jönsson R & Rosenhall U Audiology 1998;37:207–18 Hearing in advanced age. A study of presbyacusis in 85-, 88- and over 90-year-old people.	Local, urban population, Sweden, audiometry at ages 85 (N = 249), 88 (N = 210) and 90 (N = 133) yr. of age, air conduction at 0.25, 0.5, 1, 2, 4 and 8 kHz, statistical analysis included.	The mean annual threshold decline for men showed decline of approximately 2 dB/yr. between age of 70 and 81 years being most pronounced at 2 kHz and < 1 dB/yr at 81–90 years of age. For women a mean annual deterioration of 1.5 dB/yr at 70–81 yr of age. No more than marginal deterioration of auditory function above the age of 81 yr. Annual threshold decline diminishes to half of the former magnitude in the ninth decade of life in comparison with the eighth.
Karlsmose B et al. Br J Audiol 2000;34:47–55 A five-year longitudinal study of hearing in a Danish rural population aged 31–50 years.	Local, rural, Denmark, 5-year-follow-up, age 31–50 yr., air conduction at 0.5, 1, 2, 3 and 4 kHz (at 1-yr-follow-up 6 and 8 kHz included and at 5-yr-follow-up 0.25 kHz; no masking), N = 705, statistical analysis included.	High degree of individual variation, data presented for left and right ear separately Deterioration mainly at 3–4 kHz the median being 2.5 dB in 5 years. Hearing deterioration increased with age and was more pronounced in males. Deterioration in the hearing sensitivity can be predicted on the basis of findings in cross-sectional study.

Møller MB Am J Otolaryngol 1981;2:22–9 Hearing in 70 and 75 year old people: results from a cross sectional and longitudinal population study.	Local, urban, 5-year-follow-up, at 70 years of age (N = 376), at 75 years of age (N = 261), air conduction at 0.25, 0.5, 1, 2, 4 and 8 kHz, speech reception threshold and discrimination scores measured, no statistical analysis included.	No detectable change in pure tone thresholds for men during follow-up, in women deterioration throughout the entire frequency range and most at 4 and 8 kHz. Mean speech reception threshold for women deteriorated from 26 dB to 31 dB in the right, and from 27 dB to 30 dB in the left ear. Corresponding figures for men were from 28 dB to 31 dB and from 27 dB to 31 dB. Changes in speech discrimination during follow-up were for women: right ear from 93 % to 89 %, left ear from 91 % to 88 %.; for men: 86 % to 82 % and from 84 % to 79 %.
Pedersen KE et al. Audiology 1989;28:194–204 Changes in pure-tone thresholds in individuals aged 70–81: results from a longitudinal study.	Local, urban, Cohort I tested at ages 70, 75,79 and 81 yr (N = 376). Cohort II tested at 70 and 75 yr. of age (N = 297), air conduction at 0.25, 0.5, 1, 2, 4 and 8 kHz, random sample, no statistical analysis included.	Cohort I: Between ages 70–81 years threshold deterioration at 4 kHz 15 dB and at 2 kHz 27 dB; average decline for both genders 1.7 dB/yr., except at 2 kHz 2.5 dB for men.
Pedersen KE et al. Audiology 1991;30:201–11 Longitudinal study of changes in speech perception between 70 and 81 years of age.	Same study populations as above (Pedersen et al. 1989), speech audiometry results (SRT-SP and SRT-PB and discrimination)*, statistical analysis included.	At 70 yr of age median PTA 0.5–2 kHz 20 dB for both sexes, median SRT-SP 23 dB. At 81yr of age SRT-SP 36 dB for females and 37 (right ear) - 40 dB (left ear) for men. Median speech discrimination scores for women were 96 % at 70 yr of age and 88 % at 81 years of age, the corresponding figures for men were 88 % and 79 %. The group (both sexes) with the lowest discrimination scores (< 59 %) had similar pure tone thresholds at 70 and 80 yr of age. At the age of 70 yr 75 % of men had a discrimination score $\geq$ 80 %, at 81 yr of age 68 %. The corresponding figures for women were 90 % and 73 %. For women with discrimination score $\geq$ 90 % the pure-tone deterioration from 70 to 81 yr of age was approximately 10 dB and for men 20–25 dB. A very good correlation between PTA and SRT. With criterion SRT-SP 35 dB 9 % of women and 12 % of men at 70 yr of age likely to benefit from HA, at age 81 yr 50 %.

Table 4-3. Population statistics

Country	Total population Millions Year 2000	Age group	Population by age 2000–2030 % 2000	2010	2030
United Kingdom*	59.5	25–49 50–64 ≥ 65	not available	not available	not available
Denmark **	5.3	25–49 50–64 ≥ 65	36.5 18.7 14.8	33.9 19.9 15.8	30.0 19.5 20.3
Finland **	5.2	25–49 50–64 ≥ 65	35.0 19.2 14.9	32.2 22.0 17.1	30.0 18.0 25.7
Norway **	4.4	25–49 50–64 ≥ 65	36.4 16.2 15.3	33.8 19.1 15.3	31.2 18.5 21.3
Sweden **	8.9	25–49 50–64 ≥ 65	33.9 18.9 17.4	32.1 19.3 19.2	30.1 17.9 22.2

* year 1999, source: www.statistics.gov.uk
** source: Nordic Statistical Yearbook 1999

Table 4-4. Summary of the guidelines for clinical testing of hearing aids

Characteristics	Hagermann, B (1999)	Arlinger, SD (1998)	Andersen T, et al. (1998)
Experimental design and procedure	- double blind (often difficult to conduct) - comparison between T-HA and R-HA* - a real-life field test - single subject cross-over - ≥ 4 weeks for each HA - counterbalanced test sequence	- blind, preferably double-blind (difficult) - cross-over - counterbalanced - manufacturer's guidelines followed - ≥ 1 month test time	- double-blind (often difficult) - preceded by a minor pilot study - comparison between T-HA and suitable R-HA - single subject cross-over - test time ≥ 4 weeks for each HA
Test subjects	- number of subjects depends on the objectives and the sensitivities of the tests, typically 20 and ≥ 10 - selected within the indication range specified by the manufacturer (age, sex, hearing level) - representative of hearing impaired population expected to benefit from the actual type of HA - experienced HA users (≥ 1 yr.), except if the T-HA is specifically meant to first time users - experience from similar evaluations or with ample communicative skills	- ≥ 20 - selected in accordance with the indications specified by the manufacturer for the HA being tested - experienced HA users preferred, first time users if T-HA aimed at this particular group	- ≥ 20, preferably 25, (determined by the quantity under investigation, but also by the sensitivity of the adopted measurement method) - conform to the identification range proposed by the manufacturer (diagnosis, hearing loss, monaural/binaural fitting) - selected randomly, such that they constitute a representative sample (sex, age, ethnic and socio-economic status) - experienced users ≥ 6 months, unless the T-HA specifically designed for first-time users - exclusions accepted: infirmity, decreased mental capacity
Reference hearing aid	- same type for all subjects - user not familiar with the R-HA or with T-HA - R-HA well known, preferably evaluated in an earlier clinical test, 'state of art' - no visible marking on type or manufacturer	- ideally a specific R-HA type - sometimes users old/present aid used	- R-HA matches with the T-HA (style, size, design, earmould) - no manufacturer identification

Characteristics	Hagermann, B (1999)	Arlinger, SD (1998)	Andersen T, et al. (1998)
Outcome measure	- self- assessment questionnaire (subjective reactions, satisfaction and user efficiency in daily life) speech recognition in noise (quasi-free sound field)	- perceived benefit (APHAB, GHABP)** - systematic assessment of perceived sound quality - questionnaire about preference (specific listening situations, aspects of HA function, global preference) - speech recognition in noise (quasi-free sound field preferred)	- speech intelligibility in noise - subjective evaluation (interview or questionnaire)
Manufacturer's role	- information of range and type of hearing loss, fitting procedure, suitable using conditions - specification of the fitting procedure - a person responsible for the fulfilment of the above requirements	- relation well defined - responsible for extra costs	- sponsor - nominates a study monitor
Electroacoustic control	- before and after test	- electroacoustic verification of hearing aid performance on the real ear (real ear insertion gain or real ear aided response)	- before and after test

* T-HA = test hearing aid, R-HA = reference hearing aid
** APHAB = Abbreviated profile of hearing aid benefit, GHABP = Glasgow hearing aid benefit profile

Table 4-5. Clinical hearing aid (HA) outcome studies which fulfil the eligibility criteria of the review

(HI = hearing impairment, BEHL = better ear hearing level, SN = sensorineural, CO = conductive)

Author/s and journal	N	Age yr. (range)	HI HA users	Aim	Study design	Main results
Bille M et al. Scand Audiol 1999;28:127–35	25	median 72 (32–89)	SN experienced	digital and analogue HA compared	- cross-over design - random allocation - single blinded (subject) - follow-up 6–9 weeks - subjective and objective outcome measures: improvement in SRSN, overall preference, overall satisfaction, self-assessment questionnaire - C - statistical analysis described, p-values given	- overall preference for the digital HA (N = 11), for the analogue (N = 10), no preference (N = 4) - the only statistically significant difference in outcome regarding comfort when listening in traffic noise showing better rating for the digital HA - no significant differences between the HAs regarding SRSN in any of the measurements - median $PTA_{0.5–2\ kHz}$ 57 dB HL (range 35–68) and 58 dB HL (range 45–65) for the subjects preferring the digital and analogue HA, respectively

Author/s and journal	N	Age yr. (range)	HI HA users	Aim	Study design	Main results
Biering-Sørensen M et al. Scand Audiol 1995;24:125–32	32	median 74 (60–80)	SN (N = 26), CO (N = 6) experienced	linear and non-linear HA compared	- cross-over design - single-blind (interviewer) - follow-up 6–8 weeks - subjective and objective outcome measures: improvement in SRS and SRSN, questionnaire, distinguishment between the HAs - C - statistical analysis described, p-values given	- 24 (75 %) preferred the non-linear test-HA - test-HA rated significantly better in quiet, regarding brightness of sound quality and traffic noise - no difference in objective parameters - possible bias for preferring something new: no difference in situational and time-related use, in only 58 % of test situations (quiet listening situation) could the subjects recognise the HA they had preferred - no significant difference regarding hearing thresholds
Larson VD et al. JAMA 2000;284:1806–13	360	mean 67.2 (29–91)	SN experienced (53.3 %) new (46.7 %)	three circuits compared (linear peak clipping, compression limiter and WDRC)	- crossover trial (random assigned counter balanced) - multicenter study - double-blind - follow-up 3 months - subejctive and objective outcome measures: speech recognition (NU-6, CST in quiet and noise), category ratings (loudness, noise interference, overall liking) and subjective ratings (PHAP/PHAB and a rank-order rating from memory) - statistical analysis described, p-values given	- each circuit markedly improved speech recognition and reduced the frequency of problems encountered in verbal communication - some test results suggested that compression limiter and WDRC provided better listening experience than linear peak clipping circuits: word recognition, loudness, overall liking, aversiveness of environmental sounds and distorsion - in the rank-order ratings 46.1 % preferred compression limiter circuit 29.8 % WDRC and 28.6 % linear peak clipping circuit

Author/s and journal	N	Age yr. (range)	HI HA users	Aim	Study design	Main results
Nilsson P et al. Audiology 1997;36:325–38	45	(60–80)	SN experienced	non-linear (K-amp) and linear circuit compared	- cross over design - double-blind, - random allocation - follow-up 10 weeks - subjective (structured questionnaire, preference) and objective (SRSN) outcome measures - C - statistical analysis described, p-values given	- 23/45 (51 %) chose non-linear HA, 20/45 (44 %) chose linear HA, 2 chose their old HAs - 18/45 had mean HL at 0.25, 1,2, and 4 kHz of > 40 dB and 11 of these 18 preferred linear mode and they had a significantly worse mean hearing level value than those preferring non-linear mode - regarding high-frequency HI the group was divided according to the mean Hl at 2 and 4 kHz 45 dB: those 20 subjects preferring linear HA had significantly worse hearing
Parving A et al. Scand Audiol 1997;26:231–9	32	median 72 (22–84)	SN experienced	linear and non-linear amplificati on mode compared	- cross-over design - double - blind, - random allocation - follow-up 2 months - subjective (interview) and objective (SRSN) outcome measures - C - statistical analysis described, confidence intervals given	- 23/32 (72 %) preferred the non-linear amplification, 9/32 (28 %) the linear - preference not explained by objective measures - results not reflected to the degree of HI

C = HI consistent with manufacturer's fitting guidelines, possible minor exceptions explained
SRSN = speech recognition score in noise
SRS = speech recognition score
NU-6 = Northwestern University Auditory Test No. 6, CST = Connected Speech Test, SNR = signal to noise ratio
PHAP/PHAB = Profile of Hearing Aid Performance/Profile of Hearing Aid Benefit
WDRC = wide dynamic range compression

Table 4-6. Population-based studies on definition and assessment of hearing impairment

Author/s, journal and title	Study characteristics	Results
Davis A et al. Br J Audiol 1992;26:1–14 Hearing impairments in the middle age: the acceptability, benefit and cost of detection. (ABCD)	Local, representative population sample, N = 662, age 50–65 yr., tests an adult screening programme (domiciliar audiometry or questionnaire) and pure tone audiometry regarding need of a HA.	Questions indicating how well a person can hear another person in a quiet room with each ear could form a basis of a highly efficient paper-and-pencil screening programme.
Gatehouse S Ear Hear 1990;11 Suppl:57–65 Determinants of self-reported disability in older subjects.	Local, stratified random sample, N = 240, sensorineural hearing impairment, age 50–75 yr., assessment: audiometry, admittance tests, questionnaires, IQ. Hearing assessed: mean HL at 0.5, 1,2 and 4 kHz over the both ears.	Personality, age and IQ show significant effects on many aspects of reported disability/handicap.
Gatehouse S Acta Otolaryngol 1991;Suppl 476:249–56 The role of non-auditory factors in measured and self-reported disability.	Same population as in the study above.	Significant age effect exists: for a given hearing level, older subjects are more disabled. Indices of self-reported disability exhibit a trend whereby individuals with a given hearing levels report a lower degree of disability with increasing age.
Gatehouse S Acta Otolaryngol 1991;Suppl 476:182–8 The contribution of central auditory factors to auditory disability.	Same population as in the studies above.	Significant correlation between the derived central variables and measured disability (hearing levels and age controlled).

Author/s, journal and title	Study characteristics	Results
Gates GA et al. Ear Hear 1990;11:247–56 Hearing in the elderly: the Framingham cohort, 1983–1985.	The Framingham cohort, N = 1662, age ≥60 yr., questionnaire, pure tone audiometry (0.25–8 kHz) and word recognition test, cross sectional.	20.2 % of those reporting a hearing loss had BEHL* < 26 dB HL and word recognition in the better ear was > 90 %; 6.2 % of those reporting no hearing problem had BEHL > 26 dB HL and word recognition < 76 %.
Lutman ME Acta Otolaryngol 1991; Suppl 476:239–48 Hearing disability in the elderly.	National, N = 2616, age 17–80 yr. old, self-administered questionnaire and performance based disability tested. Special aim to assess excess disability attributable to ageing, audiometry 0.25, 0.5, 1, 2, 3, 4, 6 and 8 kHz, speech reception in quiet and noise.	There exists an excess disability due to ageing,. Older people tend to underrate their disability.
Lutman ME et al. Br J Audiol 1987;21:45–58 Self-reported disability and handicap in the population in relation to pure-tone threshold, age, sex and type of hearing loss.	National, N = 1691, age 17–89 yr., N = 188 owned a hearing aid, 144/188 used hearing aid, self administered questionnaire, audiometry, all types of hearing impairments.	Questionnaire identified 4 components: 1.disability for everyday speech, 2. disability for speech-in-quiet, 3. localisation and 4. hearing handicap. Strongest components 1 and 4 accounted for 68 % of the variance. Audiometric information well described by a two-parameter model characterised by low-to-mid-frequency loss and high-frequency slope. All components 1–4 increased progressively with increasing low-to-mid-frequency loss, independent of high-frequency. Components 1–4 were best correlated with a binaural average over 0.5, 1 and 2 kHz weighted 4:1 in favour of the better ear. People with similar hearing impairment reported less disability and handicap as age increased.
Nondahl DM et al. Audiology 1998;37:295–301 Accuracy of self-reported hearing loss.	N 3556, local, age 48–92 yr, self-reported (HHIE-S)**and measured hearing.	Most sensitive question was 'Do you feel you have a hearing loss?' having 71 % sensitivity. Using HHIE-S total score > 8 resulted in low sensitivity (34 %).

Author/s, journal and title	Study characteristics	Results
Quaranta A et al. Scand Audiol 1996;25 Suppl 42:7–11 Epidemiology of hearing problems among adults in Italy.	Local, N = 1127, age 18–80 yr., air-conduction 0.25, 0.5, 1,2,and 4 kHz.	22.3 % reported hearing impairment and they had a **BEHL $_{0.5–4\ kHz} \geq$ 30 dB HL.
Wiley TL et al. J Am Acad Audiol 2000; 11: 67–75. Self-reported hearing handicap and audiometric measures in older adults.	Local, N = 3178, age 48–92 years, audiometric thresholds 0.25–20 kHz, HHIE-S, word recognition scores (NU-6***) in quiet and noise.	Higher HHIE-S scores were more prevalent for older age groups and for greater degrees of hearing loss. After adjusting for the degree of hearing loss, the probability of reporting a hearing disability (handicap) decreased with age.
Wilson DH et al. Int J Epidemiol 1999; 28:247–52 The epidemiology of hearing impairment in an Australian adult population.	Local, age $\geq$ 15 yr., a two-stage sample, N = 926, questionnaire (1st stage), air and bone conduction audiometry (2nd stage), self-reported and measured hearing status compared.	False positive rate of the self-report 46 %, false negative rate 17 %.

* BEHL = Better ear hearing level
**HHIE-S = Hearing Handicap Inventory for the Elderly, screening version
*** NU-6 = Northwestern University Auditory Test No. 6

Table 4-7. Excluded studies on definition and assessment of hearing impairment according to study type and topic

Study type	Number of studies (published 1980 ->)
Questionnaire (self-assessment)	23
Perceived disability/handicap/psychological methods in assessment and rehabilitation	26
Self-assessment compared with objective tests	32
Speech tests	22
Quality of life assessment and disability and handicap	10
Reviews, tutorials and discussion papers	10
Various	22
Total	145

Table 4-8. Excluded hearing aid outcome studies (not clinical studies)

Author/s and Journal	Title	Remarks
Byrne D et al. Ear Hear 1998;19:62–71	Open earmold fittings for improving aided auditory localization for sensorineural hearing losses with good high-frequency hearing.	N = 22, compares different ear mold types. Better ear average : better threshold at each frequency, regardless of ear, used.
Chouard C-H et al. Audiology 1997;36:339–53	Auditory performances of a 3–4–7 programmable numeric filter hearing aid.	N = 21, laboratory study.
Cox RM & Taylor IM J Am Acad Audiol 1994;5:317–24	Relationship between in-situ distortion and hearing aid benefit.	N = 33, studied in three groups, each serving in one typical listening environment, total 18 hearing aid models used, laboratory study.
van Dijkhuizen JN et al. J Acoust Soc Am 1991;90:885–94	The effect of frequency-selective attenuation on the speech reception threshold of sentences in conditions of low-frequency noise.	N = 24 (12 normal hearing and 12 hearing impaired subjects).
Dillon H J Speech Hear Res 1993;36:621–33	Hearing aid evaluation: predicting speech gain from insertion gain.	N = 11, experienced HA users (from 3 weeks to 5 years).
Hickson L & Byrne D J Am Acad Audiol 1997;8:322–32	Consonant perception in quiet: effect of increasing the consonant-vowel ratio with compression amplification.	Hearing impairment group (N = 15), normal hearing group (N = 15), both experienced and new HA users, laboratory study.
Keidser G Ear Hear 1995;16:575–86	The relationship between listening conditions and alternative amplification schemes for multiple memory hearing aids.	N = 25, laboratory study.
Leijon A et al. Ear Hear 1991;12:251–60	Sound quality and speech reception for prescribed hearing aid frequency responses.	N = 26, subjects' own HAs (3 different types) used, HA training period at least 2 months.

Author/s and Journal	Title	Remarks
Neuman AC & Eisenberg L J Commun Disord 1991;24:211–21	Evaluation of a dereverberation technique.	N = 17 (10 normal hearing, 7 hearing impaired subjects, experienced HA users).
Neuman AC et al. J Acoust Soc Am 1994;96: 471–78	Effect of compression ratio in a slow-acting compression hearing aid: paired-comparison judgements of quality.	N = 20, experienced HA users, N = 10 with dynamic range ≤30 dB and N = 10, with dynamic range >30 dB.
Neuman AC et al. J Acoust Soc Am 1995;98:3182–7	Effect of release time in compression hearing aids: paired-comparison judgements of quality.	N=20, same group as in Newman AC et.al. (1994).
Peterson ME et al. Ear Hear 1990;11:185–94	The effect of automatic gain control in hearing-impaired listeners with different dynamic ranges.	N = 30 (subgroups 3 x 10) according to their average dynamic range).
Pumford JM et al. J Am Acad Audiol 2000;11:23–35	Speech recognition with in-the-ear and behind-the-ear dual-microphone hearing instruments.	N = 24 sensorineural HI, N = 10 normal hearing, laboratory study.
Ricketts T Ear Hear 2000;21:45–58	Directivity quantification in hearing aids: fitting and measurement effects.	Three groups of HAs (total N = 12) tested with an artificial ear KEMAR, laboratory study.
Stelmachowicz PG et al. Ear Hear 1998;19:131– 8	A comparison of threshold-based fitting strategies for nonlinear hearing aids.	N = 49, HA users fitted with 2-channel wide dynamic range HA, retrospective analysis of use gain settings.
Storey L et al. Ear Hear 1998;19:267–79	The National Acoustic Laboratories' procedure for selecting the saturation sound pressure level of hearing aids: experimental validation.	N = 34, includes a laboratory study and a field experiment (not randomised, not controlled dross-over study).
Versfeld NJ et al. J Acoust Soc Am 1999;106 (3) Pt1:1566–78	Preference judgements of artificial processed and hearing-aid transduced speech.	N = 24 normal hearing and N = 16 hearing impaired subjects (N = 8 experienced HA users), laboratory study.

Table 4-9. Excluded hearing aid outcome studies (not cross-over or randomised controlled trials)

Author/s and journal	Title	Remark
Andersson G et al. Br J Audiol 1996;30:27–35	Predictors of daily assessed hearing aid use and hearing capability using visual analogue scale.	N = 53, no objective follow-up measure.
Arlinger S & Billermark E Br J Audiol 1999;33:223–32	One year follow-up of users of a digital hearing aid.	N = 29, original study Arlinger et al Scand Audiol 1998; 27: 51–61.
Bech B et al. Scand Audiol 1996;25:247–52	The Valby Project. A survey of the hearing in the elderly ≥ 80 years of age-provided with hearing aids.	Immediate benefit of HA assessed: speech recognition score in background noise with and without HA (N = 268 out of total N = 2915).
Brooks DN & Hallam RS Br J Audiol 1998;32:217–26	Attitudes to hearing difficulty and hearing aids and the outcome of audiological rehabilitation.	N = 135, follow-up 3–9 months after HA fitting.
von Buchwald et al. Scand Audiol 1991;20:117–20	High-frequency amplification with ITC-HA and BTE-HA.	N = 22, inexperienced users, no follow-up, two HAs compared at fitting appointment, subjective and objective criteria used, according to preference one type of HA fit – postal questionnaire 1 yr after.
Byrne D et al. J Am Acad Audiol 1992;3:369–82	Effects of long-term bilateral and unilateral fitting of different hearing aid types on the ability to locate sounds.	Total N = 87, in subgroups numbers vary from 4 to 20.
Carlin WV & Browning GG Clin Otolaryngol 1990; 15: 63–7	Hearing disability and hearing aid benefit related to type of hearing impairment.	Subjects with conductive HI (N=28) and with sensorineural HI (N=22).
Chmiel R & Jerger J J Am Acad Audiol 1996;7:190–202	Hearing aid use, central auditory disorder, and hearing handicap in elderly persons.	N = 115, pre-fitting-post-fitting condition.

Author/s and journal	Title	Remark
Chung SM Ann Acad Med Singapore 1991;20:633–44	Management of the hearing-impaired adults in Singapore.	N = 20, pre-fitting post-fitting assessment, only subjective assessment, 3 weeks test time.
Cox RM et al. J Am Acad Audiol 1996;7: 428–41	Benefit acclimatization in elderly hearing aid users.	N = 22 inexperienced HA users, N = 5 experienced HA users and control group.
Crowley HJ & Nabelek IV J Speech Hear Res 1996;39:19–27	Estimation of client-assessed hearing aid performance based upon unaided variables.	No objective assessment, before-after 6 week follow-up.
Davis A et al. Br J Audiol 1992;26:1–14	Hearing impairments in middle age: the acceptability, benefit and cost of detection (ABCD).	Speech test before and after HA fitting measures outcome.
Gatehouse S Acta Otolaryngol 1991;Suppl. 476:262–9	Factors that influence the benefit from amplification in the elderly.	N = 54, a HA simulation used.
Gatehouse S Ear Hear 1994;15:30–49	Components and determinants of hearing aid benefit.	N = 309, first-time users, follow-up.
Gatehouse S & Gordon J Br J Audiol 1990;24:63–8	Response times to speech stimuli as measures of benefit from amplification.	N = 44, experienced HA users, unaided vs aided condition.
Goode RL & Krusemark J Laryngoscope 1999;109:1919–23	Advantages of a new miniature hearing aid for mild to moderate hearing loss.	N = 62, 50/62 inexperienced HA users, non-aided vs. aided condition compared, 4-week trial, no pre-trial assessment, only subjective evaluation.
Hidaka H et al. Scand Audiol 1998;27:225–36	Clinical evaluation of a portable digital hearing aid with narrow-band loudness compensation.	N = 159.

Author/s and journal	Title	Remark
Humes LE et al. J Speech Hear Res 1996;39:923–35	Reliability and stability of various hearing-aid outcome measures in a group of elderly hearing-aid wearers.	N = 20, pre- vs. post fit condition.
Humes LE et al. J Speech Lang Hear Res 1999;42:65–79	A comparison of the aided performance and benefit provided by a linear and a two-channel wide dynamic range compression hearing aid.	N = 55, experienced HA users, sensorineural hearing impairment, follow-up 2 months, no cross-over, T-HA compared to own old HA, subjective and objective outcome methods.
Lamden KH et al. J Public Health Med 1995;17: 445–9	Hearing aids: value for money and health gain.	N = 50, follow-up 3 months.
Lee et al. J Am Acad Audiol 1993;4:91–7	Evaluating performance with high-frequency emphasis amplification.	Two experiments: 1 (N = 18), 2 (N = 13), inexperienced HA users.
Lunner T et al. Ear Hear 1997;18:12–25	A digital filterbank hearing aid: Predicting user preference and performance for two signal processing algorithms.	Pilot and main study reported, N = 26, experienced HA users (10/26 also included in the pilot), subjective and objective evaluation, test time included 2 weeks training with only one of the algorithms usable (1+1 week), after that a 2-week- study time.
Lurquin P & Rafhay S Acta-oto-rhino-laryngologica belg 1996;50:103–9	Intelligibility in noise using multimicrophone hearing aids.	Custom aid group N = 15, multimicrophone aid N = 18.
May AE et al. Br J Audiol 1990;24:301–9	The advantages and disadvantages of ITC, ITE and BTE hearing aids: diary and interview reports from elderly users.	N = 244, only subjective outcome measure, HAs from 7 different manufacturers.
Mulrow CD et al. J Speech Hear Res 1992;35:1402–5	Sustained benefits of hearing aids.	N = 192, assessment at baseline and 4, 8 and 12 months after HA fitting.

Author/s and journal	Title	Remark
Newman CW et al. J Am Acad Audiol 1991;2:70–5	Practical method for quantifying hearing aid benefit in older adults.	N = 91, inexperienced users, follow-up 3 weeks.
Parkinson AJ et al. J Am Acad Audiol 1996;7:305–21	Relationship of aided speech recognition to hearing thresholds and aided speech-peak sensation levels in severely and profoundly hearing-impaired adults.	N = 28, relatively successful HA users who functioned orally, clinical study.
Parving A Scand Audiol 1991;20:159–64	The value of speech audiometry in hearing-aid rehabilitation.	N = 124, pre- post fit evaluation.
Parving A & Boisen G Scand Audiol 1990;19:25–30	In-the-canal hearing aids	N = 256, questionnaire survey, no objective outcome measure, follow up.
Parving A & Philip B Audiology 1991;30:61–9	Use and benefit of hearing aids in the tenth decade and beyond.	N = 138, no objective outcome measure, assessment 4–6 months after HA fitting.
Purdy SC et al. Ear Hear 1998;19:473–80	Investigation of the profile of hearing aid performance in experienced hearing aid users.	N = 102, postal questionnaire.
Ringdahl A et al. Br J Audiol 1990;24:235–42	Clinical trials with a programmable hearing aid set for various listening environments.	N = 22, experienced HA users, test HA compared to own aid, subjective and objective evaluation at the last visit (3–4 weeks).
Ringdahl A ENT Journal 1994;73:192–6	Listening strategies and benefits when using a programmable hearing instrument with eight programs.	Describes 3 studies - 1. N = 15, subjective description of benefit experienced from different programmes - 2. Subjects are children - 3. reported and registered use compared.

Author/s and journal	Title	Remark
Schumacher DU & Carruth JA Clin Otolaryngol 1997;22:430–3	Long-term use of hearing aids in patients with presbyacusis.	N = 240, questionnaire 5 months and 5 years after HA fitting.
Silman S et al. J Rehab Res 1993;30:326–32	Effects of prolonged lack of amplification on speech-recognition performance: preliminary findings.	N = 19, monaurally aided, N = 28 binaurally aided and N = 19 control subjects, before-after assessment, only objective assessment.
Taylor KS Ear Hear 1993;14:390–4	Self-perceived and audiometric evaluations of hearing aid benefit in the elderly.	N = 58 new HA users, assessment before and 3 weeks, 3 months, 6 months and 1 year after HA fitting.
Taylor KS & Jurma WE Psychological Reports 1997;81:735–38	Patients' task-orientation and perceived benefit of amplification in hearing-impaired elderly persons.	N = 50, pre-post HA fit evaluation.
Tesch-Römer C J Gerontol: Psychological Sciences 1997;52B:P127–38	Psychological effects of hearing aid use in older adults.	Follow-up, subjects fitted with HA (N = 70), hearing impaired subjects not fitted with HA (N = 42) and normal hearing subjects with no need of HA (N = 28).
Walden et al. Am J Audiol 1999;8:65–78	A clinical trial of the ReSound IC4 hearing device.	N = 40, experienced HA users, present linear aid used as ref, test time for new aid 7–9 weeks, objective and subjective evaluation used.
Valente M et al. J Am Acad Audiol 1995;6:440–49	Recognition of speech in noise with hearing aids using dual microphone.	N = 50, all subjects fitted with HA and exposed to 4 conditions in counterbalanced order, no follow-up.
Valente M et al. J Am Acad Audiol 1998;9:342–60	Comparing the performance of the Widex SENSO Digital hearing aid with analogue hearing aids.	N = 50, new HA compared with subjects' present HA.

Author/s and journal	Title	Remark
Warland A & Tonning F Scand Audiol 1991;20:101–8	In-the-canal hearing instruments	N = 300, follow-up 1–24 months after HA fitting.
von Wedel H et al. Acta Otolaryngol 1991;Suppl. 476:270–7	Monitoring the efficiency of hearing aid fitting in the aged by the Social Hearing Handicap Index.	
Weinstein BE Acta Otolaryngol 1991;Suppl 476:257–61	The quantification of hearing aid benefit in the elderly: the role of self assessment measures.	Summarises 4 earlier studies.
Weinstein BE J Speech Hear Res 1996;39:S37–45	Treatment efficacy: hearing aids in the management of hearing loss in adults.	Review.
Verschuure J & van Benthem PPG Audiology 1992;31:205–21	Effect of hearing aids on speech perception in noisy situations.	N = 130, pre- and post HA fitting assessment.
Vorwerk U et al. HNO 1993; 41:119–22. German	Akzeptanz und Trage-gewohnheiten von Hörgeräten bei Patienten im Rentenalter (im Versorgungsbereich Magdeburg) [Acceptance and hearing aid use by patients of retirement age (in the Magdeburg clinical area)].	N = 119.

Table 4-10. Excluded hearing aid outcome studies (for various reasons)

Author/s and journal	Title	Study characteristics	Exclusion criteria
Arlinger S et al. Scand Audiol 1998;27:51–61	Clinical trial of a digital hearing aid.	N = 33, experienced users, Cross-over design, follow-up 4 weeks, test aid compared with subjects' own aids (several types).	Follow-up 4 weeks.
Berninger E & Karlsson KK Scand Audiol 1999;28:117–25	Clinical study of widex Senso on first-time hearing aid users.	N = 200, inexperienced HA users randomised.	Several types of (29) ref hearing aids. Follow-up 'at least 3 weeks'.
Boymans M et al. Audiology 1999;38:99–108	Clinical evaluation of a full-digital in-the-ear hearing instrument.	N = 27 in 2 centres, both experienced and new HA users, digital and analogue HAs compared, cross-over design, randomised order, subjective and objective outcome.	Test time 4 weeks for each HA, many different brands of Has used.
Harnack SB & Bentler RA Ear Hear 1998;19:280–89	Comparison of two digital hearing aids.	N = 20, 10 inexperienced and 10 experienced users, cross-over 4 weeks, objective and subjective outcome 'administered at the time of HA fitting or after using each HA for 4 weeks'.	Follow-up 4 weeks.
Harrowven RGC Br J Audiol 1998;32:153–65	Insertion gain versus median ear corrected coupler gain: a comparison of two fitting methods in new NHS hearing aid users.	N = 40, cross-over, counterbalanced, double blind, subjective and objective assessment.	Test time 4 weeks for each system.
Humes LE et al. J Speech Lang Hear Res 1997;40:666–85	A comparison of the benefit provided by well-fit linear hearing aids and instruments with automatic reduction of low-frequency gain.	N = 110, new hearing aid users, cross-over, double-blind, subjective and objective assessment.	Test time 8 weeks and 4 weeks.
Jerger J et al. Ear Hear 1996;17:490–504	Comparison of conventional amplification and an assistive listening device (ALD) in elderly persons.	N = 180 (100 experienced HA users, 80 inexperienced), cross-over, follow-up 6 weeks, 4 conditions compared: HA condition (2 types of HAs), HA + ALD, ALD and non-aided), experimental condition randomised.	Subjective and objective follow-up 6 weeks too short for inexperienced HA users, regarding ALDs no objective assessment method available.

Author/s and journal	Title	Study characteristics	Exclusion criteria
McClymont LG et al. Br J Audiol 1991;25:35–9	Reliability of patient choice between hearing aid systems.	70 inexperienced HA users randomly allocated to study 1 (30) and study 2 (40), 22 and 34 completed the study. Study 1 (N = 22) test aid 2 weeks, ref aid 2 weeks (aids were identical!). Study 2 cross-over test aid and ref aid used 2+2+2+2 weeks in counterbalanced order.	Follow-up 4 weeks.
Moore BCJ et al. Ear Hear 1992;13:349–70	Evaluation of a dual-channel full dynamic range compression system for people with sensorineural hearing loss.	N = 20, both experienced and inexperienced users, questionnaires and objective measures (speech intelligibility and speech reception threshold) used.	Test time 1–2 weeks /condition, not pure cross-over design.
Mulrow CD et al. (a) Ann Int Med 1990;113:188–94	Quality-of-life changes and hearing impairment: a randomised trial.	N = 194, randomised to HA fitting and waiting list groups. Follow-up 4 months.	Only subjective outcome measure, randomisation not described.
MacKenzie K et al. J Laryngol Otol 1991;105:405–8	Randomised, cross over study to assess patient preference for an acoustically modified hearing aid system.	N = 83, inexperienced HA users, test + reference aid used 4 weeks each (2+2+2+2), counterbalanced, subjective outcome measure.	Only subjective preference as outcome measure.
Newman CW & Sandridge SA Am J Audiol 1998;7:115–28	Benefit from, satisfaction with, and cost-effectiveness of three different hearing aid technologies.	N = 25, experienced users, 3 types of test HAs studied, subjects blinded. Cross-over design.	Min follow-up 4 weeks.
Saunders GH & Cienkowski KM Ear Hear 1997;18:129–39	Acclimatisation to hearing aids.	N = 48 (24 experienced and 24 inexperienced HA users), cross-over design, 3 different types of HAs with 6 different configurations compared, follow-up 3 months each aid.	Only objective measures of outcome.

Table 4-11. Excluded population-based studies on definition and assessment of hearing impairment

Author/s and journal	Title	Grounds for exclusion
Cacciatore F et al. Gerontology 1999; 45: 232–28	Quality of life determinants and hearing function in an elderly population: Osservatorio Geriatrico Campano Study Group.	Only subjective assessment of hearing.
Ormel J et al. Psychological Medicine 1997; 27: 1065–77	Chronic medical conditions and mental health in older people: disability and psychosocial resources mediate specific mental health effects.	Only subjective assessment of hearing.
Rudberg MA et al. J Gerontol 1993; 48: M261–65	The relationship of visual and hearing impairments to disability: an analysis using the longitudinal study of aging.	Only subjective assessment of hearing.
Uimonen et al. Br J Audiol 1999; 33: 53–9	Do we know the real need for hearing rehabilitation at the population level? Hearing impairments in the 5- to 75-year-old cross-sectional Finnish population.	Only objective assessment of hearing.
Ward JA et al. Med J Aust 1993; 159: 382–4	Hearing impairment and hearing aid use in women over 65 years of age. Cross-sectional study of women in a large urban community.	Only subjective assessment of hearing.

Table 4-12. Excluded other than population based studies on definition and assessment of hearing impairment, grouped by type and topic

Group	Author/s and journal	Title
Questionnaire (self assessment)	Chermak GD & Miller MC Br J Audiol 1988;22:187–94	Shortcomings of a revised feasibility scale for predicting hearing aid use with older adults.
	Chmiel R & Jerger J J Am Acad Audiol 1993;4:249–57	Some factors affecting assessment of hearing handicap in the elderly.
	Erdman SA & Demorest ME J Speech Lang Hear Res 1998;41:107–22	Adjustment to hearing impairment I: Description of a heterogeneous clinical population.
	Garstecki DC & Erler SF J Speech Lang Hear Res 1998;41:527–37	Hearing loss, control and demographic factors influencing hearing aid use among older adults.
	Garstecki DC & Erler SF J Speech Lang Hear Res 1999;42:785–96	Older adult performance on the Communication Profile for the Hearing Impaired: gender difference.
	Gordon-Salant S et al. Ear Hear 1994;15:262–5	Age effects on measures of hearing disability.
	Hallam RS & Brooks DN Br J Audiol 1996;30:199–213	Development of the Hearing Attitudes in Rehabilitation Questionnaire (HARQ).
	Hallberg LR-M Scand Audiol 1998;27:21–9	Evaluation of a Swedish version of the Hearing Disabilities and Handicaps Scale, based on a clinical sample of 101 men with noise-induced hearing loss.

Group	Author/s and journal	Title
Questionnaire (self assessment)	Jerger J et al. J Am Acad Audiol 1990;1:75–80	Impact of central auditory processing disorder and cognitive deficit on the self-assessment of hearing handicap in the elderly.
	Kaplan H et al. J Am Acad Audiol 1995;6:311–29	Revised Communication self-assessment Scale Inventory for Deaf Adults (CSDA).
	Kramer SE et al. Audiology 1998;37:302–12	The self-reported handicapping effect of hearing disabilities.
	Larmore KA & Stephens SDG Br J Audiol 1994;28:81–9	Use of the open-ended questionnaire with patients and their significant others.
	Magilvy JK Res Nurs Health 1985;8:347–53	Experiencing hearing loss in later life: A comparison of deaf and hearing-impaired older women.
	Mulrow CD et al. Ear Hear 1990;11:176–80	Discriminating and responsiveness abilities of two hearing handicap scales.
	Noble W et al. J Am Acad Audiol 1995;6:129–40	Disabilities and handicaps associated with impaired auditory localisation.
	Purdy SC & Jerram JCK Ear Hear 1998;19:473–80	Investigation of the profile of hearing aid performance in experienced hearing aid users.
	Ringdahl A et al. Br J Audiol 1998;32:375–85	Psychometric evaluation of the Gothenburg Profile for measurement of experienced hearing disability and handicap: applications with new hearing aid candidates and experienced hearing aid users.

Group	Author/s and journal	Title
Questionnaire (self assessment)	Schum DJ J Am Acad Audiol 1993;4:18–21	Test-retest reliability of a shortened version of the hearing aid performance inventory.
	Stewart MG et al. Am J Otol 1997;18:413–20	Development of a new outcomes instrument for conductive hearing loss.
	Tuley MR et al. Ear Hear 1990;11:56–61	A critical re-evaluation of the quantified Denver Scale of Communication Function.
	Ventry IM & Weinstein BE Ear Hear 1982;3:128– 34	The Hearing Handicap Inventory for the Elderly: a new tool.
	Weinstein BE et al. Ear Hear 1986;7:295–9	Test-retest reliability of the Hearing Handicap Inventory for the Elderly.
	Zhao F & Stephens D Br J Audiol 1996;30:397–402	Hearing complaints of patients with King-Kopetzky syndrome (obscure auditory dysfunction).
Psychological methods in assessment and rehabilitation, perceived disability/handicap	Abrams HB et al. Ear Hear 1992;13:371–7	The effects of intervention strategy on self-perception of hearing handicap.
	Andersson G & Green M Perceptual Motor Skills 1995;81:552–5	Anxiety in elderly hearing impaired persons.
	Andersson G et al. Scand Audiol 1994;23:249–56	Behavioural counselling for subjects with acquired hearing loss. A new approach to hearing tactics.

Group	Author/s and journal	Title
Psychological methods in assessment and rehabilitation, perceived disability/handicap	Andersson G et al. Audiology 1995;34:76–84	Dispositional optimism, dysphoria, health, and coping with hearing impairment in elderly adults.
	Andersson G et al. Scand Audiol 1995;24:147–54	Development of a short-scale for self-assessment of experiences of hearing loss. The Hearing Coping Assessment.
	Andersson G et al. Behav Res Ther 1995;33:283–92	An evaluation of a behavioural treatment approach to hearing impairment.
	Andersson G et al. Br J Audiol 1995;29:347–54	A two-year follow-up examination of a behavioural treatment approach to hearing tactics.
	Andersson G et al. Behav Res Ther 1997;35:523–30	Behavioural hearing tactics: a controlled trial of a short treatment programme.
	Bullis M & Reiman J Excep Child 1992;59:12–26	Development and preliminary psychometric properties of the transition competence battery for deaf adolescents and young adults.
	Colletti V et al. Br J Audiol 1988;22:113–8	Investigation of the long-term effects of unilateral hearing loss in adults.
	Erikkson-Mangold M & Carlsson SG J Psychosom Res 1991;35:729–40	Psychological and somatic distress in relation to perceived hearing disability, hearing handicap, and hearing measurements.
	Gilhome Herbst KR et al. Acta otolaryngol 1991;Suppl 476:209–14	Implications of hearing impairment for elderly people in London and in Wales.
	Hallberg LR-M & Barrenäs M-L Br J Audiol 1994;28:71–9	Group rehabilitation of middle-aged males with noise-induced hearing loss and their spouses: evaluation of short- and long-term effects.

Group	Author/s and journal	Title
Psychological methods in assessment and rehabilitation,	Hallberg LR-M & Barrenäs M-L Br J Audiol 1995;29:219–30	Coping with noise-induced hearing loss: experiences from the perspective of middle-aged male victims.
perceived disability/handicap	Hallberg LR-M & Carlsson SG Br J Audiol 1991;25:323–30	Hearing impairment, coping and perceived hearing handicap in middle-aged subjects with acquired hearing loss.
	Hallberg LR-M et al. Audiology 1993;32:137–52	Structure of perceived handicap in middle-aged males with noise-induced hearing loss, with and without tinnitus.
	Herth K Qual Health Res 1998;8:207–23	Integrating hearing loss into one's life.
	Hétu R et al. Audiology 1987;26:141–52	Psychosocial disadvantages associated with occupational hearing loss as experienced in the family.
	Lalande NM et al. Audiology 1988;27:196–206	Quantification of the psychosocial disadvantages experienced by workers in a noisy industry and their nearest relatives: perspectives for rehabilitation.
	Lindberg P et al. Br J Audiol 1993;27:299–301	A behavioural approach to individually designed hearing tactics training.
	Lundborg T et al. Scand Audiol 1982;11:161–70	Rehabilitative procedures in sensorineural hearing loss. Studies on the routine used.
	Naramura H et al. Audiology 1999;38:24–9	Physical and mental correlates of hearing impairment in the elderly in Japan.
	Stephens D et al. Acta Otolaryngol 1995;115:165–7	Effects of hearing impairment on the patient's family and friends.

Group	Author/s and journal	Title
Psychological methods in assessment and rehabilitation, perceived disability/handicap	Tidball K Am Ann Deaf 1990;135:33–40	Application of coping strategies developed by older deaf adults to the ageing process.
	Thomas A & Gilhome Herbst K Br J Audiol 1980;14:76–85	Social and psychological implications of acquired deafness for adults of employment age.
	Vesterager V et al. Audiology 1988;27:179–92	Age-related hearing difficulties II. Psychological and sociological consequences of hearing problems – a controlled study.
Self assessment compared with objective tests	Bertoli S et al. HNO 1996;44:376–84	Das Hörhandicap – Eine Ergänzung zum audiometrischen Hörverlust. Ergebnisse einer explorativen Studie über auditive Kommunikationsstörungen im alter (Hearing handicap- an addition to audiometric hearing loss. Results of an exploratory study of auditory communication disorders in the elderly).
	Bess FH et al. J Speech Hear Res 1989;32:795–802	Comparing criteria of hearing impairment in the elderly: a functional approach.
	Bess FH et al. Acta Otolaryngol 1991;Suppl 476:226–31	Making hearing impairment functionally relevant: Linkages with hearing disability and handicap.
	Brainerd SH & Frankel BG Ear Hear 1985;6:89–92	The relationship between audiometric and self-report measures of hearing handicap.
	Bunce Garahan M et al. J Am Geriatr Soc 1992;40:130–4	Hearing loss prevalence and management in nursing home residents.
	Corbin S et al. J Am Geriatr Soc 1984;32:396–400	Hearing assessment in homes for the aged: A comparison of audiometric and self-report methods.

Group	Author/s and journal	Title
Self assessment compared with objective tests	Corthals P et al. Audiology 1997;36:46–56	Audiovisual speech reception in noise and self-perceived hearing disability in sensorineural hearing loss.
	Corthals P et al. Scand Audiol 1998;27:31–6	Masking effects and tinnitus as explanatory variables in hearing disability.
	Dieroff HG & Meissner W Laryngol Rhinol Otol (Stuttg) 1987;66:338–40	Zur Einschätzung des Sozialgehörs mit Fragebogen in relation zum mittleren Hörverlust (Assessment of social hearing with a questionnaire in relation to average hearing loss).
	Doyle J & Wong LLN J Am Acad Audiol 1996;7:442–6	Mismatch between aspects of hearing impairment and hearing disability/handicap in adult/elderly Cantonese speakers: some hypotheses concerning cultural and linguistic influences.
	Duijvestijn JA et al. Acta Otorlaryngol 1999;119:420–3	Definition of hearing impairment and its effect on prevalence figures.
	Fire KM et al. Am J Otol 1991;12:105–8	Hearing handicap as a function of central auditory abilities in the elderly.
	Garcth J et al. Practitioner 1989;233:1291–4	Predicting who will use a hearing aid.
	Gold M et al. Arch Neurol 1996;53:922–8	Hearing loss in a memory disorder clinic. A specially vulnerable population.
	Goldschmidt Hustedde C & Wiley TL J Speech Hear Res 1991;34:1397–1409	Consonant-recognition patterns and self-assessment of hearing handicap.
	Gutnick HN et al. Ear Hear 1989;10:361–7	Measurement and prediction of hearing loss in a nursing home.

Group	Author/s and journal	Title
Self assessment compared with objective tests	Hawes NA & Niswander PS Ear Hear 1985;6:93–7	Comparison of the revised Hearing Performance Inventory with audiometric measures.
	Jerger J & Chmiel R J Am Acad Audiol 1997;7:269–76	Factor analytic structure of auditory impairment in elderly persons.
	Johansson K et al. Scand Audiol 1991;20:91–9	Contrasting subjective judgement and objective tests in the hearing-impaired.
	Kramer SE et al. Audiology 1996;35:277–87	The relationships between self-reported hearing disability and measures of auditory disability.
	Kricos PB & Holmes AE Am Acad Audiol 1996;7:219–29	Efficacy of audiologic rehabilitation for older adults.
	Lichtenstein MJ et al. J Am Acad Audiol 1990;1:11–22	Deriving criteria for hearing impairment in the elderly: a functional approach.
	Marcus-Bernstein C J Speech Hear Res 1986;29:301–12	Audiologic and non-audiologic correlates of hearing handicap in black elderly.
	Newman CW et al. Ann Otol Rhinol Laryngol 1997; 106:210–4	Perceived hearing handicap of patients with unilateral or mild hearing loss.
	Parving A & Ostri B Scand Audiol 1983;12:165–9	On objective criteria for hearing impairment and hearing disability.
	Salomon G et al. Audiology 1988;27:164–78	Age-related hearing difficulties I. Hearing impairment, disability, and handicap – a controlled study.

Group	Author/s and journal	Title
Self assessment compared with objective tests	Sangster JF et al. Can Med Assoc J 1991;144:981–4	Hearing loss in elderly patients in a family practice.
	Scherer MJ & Frisina DR J Rehab Res and Dev 1998;35:420–6	Characteristics associated with marginal hearing loss and subjective well-being among a sample of older adults.
	Tyler RS & Smith PA Scand Audiol 1983;12:285–92	Sentence identification in noise and hearing-handicap questionnaire.
	Vimpel T et al. Scand Audiol 1986;15:43–9	Hearing in patients in a department for long-term medicine.
	Weinstein BE & Ventry IM J Speech Hear Res 1982;25:593–9	Hearing impairment and social isolation in the elderly.
	Weinstein BE &Ventry IM. J Speech Hear Disord 1983;48:379–84	Audiometric correlates of the hearing handicap inventory for the elderly.
Speech tests	Beattie RC & Warren VG Am J Otol 1982;3:353–8	Relationships among speech threshold, loudness discomfort, comfortable loudness, and PB max in the elderly hearing impaired.
	Ching TYC et al. J Acoust Soc Am 1998;103:1128–40	Speech recognition of hearing-impaired listeners: predictions from audibility and the limited role of high-frequency amplification.
	Danhauer JL et al. Ear Hear 1985;6:191–7	Older persons' performance on auditory, visual, and auditory-visual presentations of the Edgerton and Danhauer Nonsense Syllable Test.
	Duquesnoy AJ J Acoust Soc Am 1983;74:739–43	Effect of a single interfering noise or speech source upon the binaural sentence intelligibility of aged persons.

Group	Author/s and journal	Title
Speech tests	Festen JM & Plomp R J Acoust Soc Am 1990;88:1725–36	Effects of fluctuating noise and interfering speech on the speech reception threshold for impaired and normal hearing.
	Frisina DR & Frisina RD Hear Res 1997;106:95–104	Speech recognition in noise and presbyacusis: relations to possible neural mechanisms.
	Gatehouse S & Haggard MP Ear Hear 1987;8:140–6	The effects of air-bone gap and presentation level on word identification.
	Haggard MP et al. Audiology 1986;25:277–98	Psychoacoustical and audiometric prediction of auditory disability for different frequency responses at listener-adjusted presentation levels.
	Harris RW & Swenson DW Audiology 1990;29:314–21	Effects of reverberation and noise on speech recognition by adults with various amounts of sensorineural hearing impairment.
	Humes LE & Riker S Ear Hear 1992;13:406–9	Evaluation of two clinical versions of the articulation index.
	Jerger J & Jordan C Ear Hear 1992;13:272–7	Age-related asymmetry on a cued-listening task.
	Kaplan H & Pickett JM Audiology 1982;21:325–33	Differences in speech discrimination in the elderly as a function of type of competing noise: speech-babble or cafeteria.
	Larsby B & Arlinger S Audiology 1994;33:165–76	Speech recognition and just-follow-conversation tasks for normal-hearing and hearing-impaired listeners with different maskers.
	Lindeman HE & Platenburg-Gits FA Acta Otolaryngol 1991;Suppl. 476:232–8	Communicative skills of the very old in old people's homes.

Group	Author/s and journal	Title
Speech tests	Noble W et al. J Acoust Soc Am 1997;102:2343–52	Auditory localisation, detection of spatial separateness, and speech hearing in noise by hearing impaired listeners.
	Owens E et al. Ear Hear 1985;6:280–7	Analysis and revision of the Minimal Auditory Capacities (MAC) battery.
	Pichora-Fuller MK et al. J Acoust Soc Am 1995;97:593–608	How young and old adults listen to and remember speech in noise.
	Rubinstein A & Boothroyd A J Speech Hear Res 1987;30:153–60	Effect of two approaches to auditory training on speech recognition by hearing-impaired adults.
	Smoorenburg GF J Acoust Soc Am 1992;91:421–37	Speech reception in quiet and in noisy conditions by individuals with noise-induced hearing loss in relation to their tone audiogram.
	Van Tasell DJ & Yanz JL J Speech Hear Res 1987;30:377–86	Speech recognition threshold in noise: effects of hearing loss, frequency response, and speech materials.
	Walden BE et al. J Speech Hear Res 1981;24:207–16	Some effects of training on speech recognition by hearing-impaired adults.
	Welge-Lüssen et al. Laryngo-Rhino-Otol 1997;76:57–64	Sprachaudiometrie mit Logatomen (Speech audiometry with logatomes).
Quality of life assessment and disability and handicap	Appollonio I et al. Age and Ageing 1996;25:89–96	Effects of sensory aids on the quality of life and mortality of elderly people: a multivariate analysis.
	Bess FH et al. J Am Geriatr Soc 1989;37:123–8	Hearing impairment as a determinant of function in the elderly.

Group	Author/s and journal	Title
Quality of life assessment and disability and handicap	Carabellese C et al. J Am Geriatr Soc 1993;41:401–7	Sensory impairment and quality of life in a community elderly population.
	Dargent-Molina P et al. In J Epidemiol 1996;25:621–9	Sensory impairments and physical disability in aged women living at home.
	Kerr PC & Cowie RID Br J Audiol 1997;31:177–88	Acquired deafness: a multi-dimensional experience.
	Magilvy JK Nurs Res 1985;34:140–4	Quality of life of hearing-impaired older women.
	Mulrow CD et al. J Am Geriatr Soc 1990;38:45–50	Association between hearing impairment and the quality of life of elderly individuals.
	Palagi L et al. Panminerva Med 1997;39:275–9	Factors affecting insufficiency in activity daily living in the elderly.
	Stephens SDG et al. Acta Otolaryngol 1991;Suppl. 476:221–5	Early intervention and rehabilitation: factors influencing outcome.
	Stumer J et al. Disabil Rehabil 1996;18:76–82	Hearing impairment, disability and handicap in elderly people living in residential care and in the community.
Reviews, discussion papers	Gates GA & Rees TS West J Med 1997;167:247–52	Hear ye? Hear ye! Successful auditory aging.
	Hallberg L Vård i Norden 1996;16:39–45. Swedish.	Stigmatisering, coping och handicappupplevelse: intevjuer med medelålders personer med förvärvade höreslskador [Stigmatisation. coping and handicapexperience, interviews with middle-aged persons with inherited hearing disorders].

Group	Author/s and journal	Title
Reviews, discussion papers	Hauser R Therapeutische Umschau 1993;50: 627–32. German.	Presbyakusis.
	Hétu R et al. Audiology 1993;32:363–81	The impact of acquired hearing impairment on intimate relationships: implications for rehabilitation.
	Jerger J et al. J Am Geriatr Soc 1995;43:928–35	Hearing impairment in older adults: new concepts.
	Jones EM & White AJ Br J Audiol 1990;24:3–9	Mental health and acquired hearing impairment: a review.
	Lavizzo-Mourey RJ & Siegler EL J Gen Intern Med 1992;7:191–8	Hearing impairment in the elderly.
	Lichtenstein MJ Clin in Geriatr Med 1992;8:173–82	Hearing and visual impairments.
	Stephens D & Zhao F Folia Phoniatr Logop 1996;48:137–42	Hearing impairment: special needs of the elderly.
	Weinstein BE Geriatrics 1989;44:42–58	Geriatric hearing loss: myths, realities, resources for physicians.
Various	Alberti PW & Blair RL Laryngoscope 1982;92:535–9	Occupational hearing loss: an Ontario perspective.
	Appollonio I et al. Age and Ageing 1995;24:30–6	Sensory impairments and mortality in an elderly community population: a six-year follow-up.

Group	Author/s and journal	Title
Various	BAOL and BSA Br J Audiol 1983;17:203–12	BAOL/BSA method for assessment of hearing disability.
	Beynon GJ et al. Br J Audiol 1997;31:345–51	A randomised , controlled trial of the efficacy of a communication course for first time hearing aid users.
	Dodds E & Harford ER Ear Hear 1982; 3: 160–6.	A community hearing conservation program for senior citizens.
	Franks JR & Beckmann NJ Ear Hear 1985;6:161–6	Rejection of hearing aids attitudes of a geriatric sample.
	Haggard M & Gatehouse S Br J Audiol 1993;27:303–18	Candidature for hearing aids: justification for the concept and a two-part audiometric criterion (OBS! combines population based and clinical data).
	Hart JJ et al. J Laryngol Otol 1989;103:485–8.	A system for accelerated provision of hearing aids to residents of homes for the elderly.
	Hildesheimer M & Muchnik C Audiology 1992;31:222–7	Co-operation of hearing-impaired elderly subjects for participation in a hearing screening program.
	Humphrey C et al. Br J Audiol 1981;15:25–30	Some characteristics of the hearing-impaired elderly who do not present themselves for rehabilitation.
	Lichtenstein MJ et al. JAMA 1988;259:2875–9	Validation of screening tools for identifying hearing-impaired elderly in primary care.
	Lutman ME Br J Audiol 1992;26:307–19	Apportionment of noise-induced hearing disability and its prognosis in a medicolegal context: a modelling study.

Group	Author/s and journal	Title
Various	Macphee GJA et al. Age and Ageing 1988;17:347–51	A simple screening test for hearing impairment in elderly patients.
	Resnick HE et al. J Gerontol: Social Sciences 1997;52B:S135–S44	Windows to their world: the effect of sensory impairments on social engagement and activity time in nursing home residents.
	Reuben DB et al. J Am Geriatr Soc 1999;47:930–5	The prognostic value of sensory impairment in older persons.
	Tolson D & McIntosh J Int J Nurs Stud 1997;34:173–82	Listening in the care enviroment-chaos or clarity for the hearing-impaired elderly person.
	Van den Brink RHS et al. Br J Audiol 1996;30:313–24	Attitude and help-seeking for hearing impairment.
	Vesterager V & Salomon G Acta Otolaryngol 1991;Suppl 476:215–20	Psychosocial aspects of hearing impairment in the elderly.
	Voeks SK et al. JAGS 1990;38:141–5	Hearing loss in the nursing home. An institutional issue.
	Wiesner M & Tesch-Römer C Z Gerontol Geriat 1996;29:273–9. German.	Hörgerätebenutzung im Alter: Der Zusammenhang zwischen intention und verhalten [Hearing aid use in old age: Relationship between intention and actual use].
	Wood PL & Kyle JG Br J Audiol 1983;17:175–81	Hospital referral and family adjustment in acquired deafness.
	Ylikoski ME & Ylikoski JS Scand J Work Environ Health 1994;20:93–100	Hearing loss and handicap of professional soldiers exposed to gunfire noise.

Table 4-13. Excluded prevalence studies

Author/s and journal	Title	Criteria for exclusion
MRC Institute of Hearing Research (prepared by Coles RRA et al. After verbal presentation by Coles RRA) J Royal Soc Med 1981;74:819–27	Population study of hearing disorders in adults: preliminary communication.	Describes a pilot study.
Davis AC Acta Otolaryngol 1991;476:23–31	Epidemiological profile of hearing impairments: the scale and nature of the problem with special reference to the elderly.	Reports prevalence in age groups <60 yr., 60–80 yr. and > 80 yr.
Jönsson R et. al. Scand Audiol 1998; 27: 81–93	Auditory function in 70- and 75-year-olds of four age cohorts. A cross-sectional and time-lag study of presbuacusis.	Not a prevalence atudy.
Karlsson A-K & Rosenhall U Scand Audiol 1998;27:153–60	Aural rehabilitation in the elderly. Supply of hearing aids related to measured need and self-assessed hearing problems.	Not a prevalence study.
Keay DG & Murray JAM Clin Otolaryngol 1988; 13: 31–5.	Hearing loss in the elderly: a 17-year longitudinal study.	Not a prevalence study.
Molvær OI et al. Scand Audiol 1983;12:229–36	Hearing acuity in a Norwegian standard population.	Does not report prevalence, but mean hearing threshold values for each frequency.
Ostri B & Parving A Br J Audiol 1991;25:41–8	A longitudinal study of hearing impairment in male subjects – an 8-year follow-up.	Not a population-based series.
Ostri B et al. Br J Audiol 1986;20:269–75	Epidemiology of hearing impairment in male subjects: a follow-up investigation.	Not a population-based series.

Author/s and journal	Title	Criteria for exclusion
Parving A et al. Scand Audiol 1983;12:191–6	Epidemiology of hearing impairment in male adult subjects at 46–69 years of age.	Not a population-based study.
Parving A et al. Scand Audiol 1993;22:101–07	Epidemiology of hearing disorders. Some factors affecting hearing. The Copenhagen male study.	Not a population-based series.
Parving A et al. Scand Audiol 1997;26:99–106	Hearing in the elderly $\geq$ 80 years of age. prevalence of problems and sensitivity.	Not population-based. Combines clinical series of hearing aid users and an age and gender matched sample in which the proportion of drop-outs is 59 %.
Rahko T et al. Ann Otol Rhinol Laryngol 1985;94:140–4	Hearing loss in an ageing population.	Population-based according to the authors, but sampling not sufficiently described.
Rosenhall U et al. J Aud Med 2000;9:43–52	Hearing in the 'oldest old' – a cross-sectional collaborative study from three European countries.	Not population-based, not totally comparable study samples.
Rudin R et al. Scand Audiol 1988;17:3–10	Hearing capacity in samples of men from the general population.	Does not report prevalence, cross- sectional hearing levels reported.
Wilson PS et. al. Br J General Practice 1993; 43:406–9.	Prevalence of hearing loss among people aged 65 years and over: screening and hearing aid provision.	Not a true prevalence study, concentrates to HA provision.

Table 5-1. Descriptors of country population and gross domestic product (GDP)

Source: OECD Health Database 99, (OECD Health database 1999: Philip's Millennium Encyclopedia 1999; Conversion rates taken from Financial Times 2000, see Table 5-9).

Country	Population 1997	Area (square km)	Capital Population	Average population per square km	GDP (1997) EUR / GBP Millions
Denmark	5,284,000	43,070	Copenhagen (620,970)	122.7	150,768 EUR (90,824 GBP)
Finland	5,140,000	338,130	Helsinki (508,588)	15.2	104,618 EUR (63,023 GBP)
Norway	4,393,000	323,900	Oslo (459,292)	13.5	132,838 EUR (80,023 GBP)
Sweden	8,848,000	449,960	Stockholm (672,594)	19.6	209,215 EUR (126,033 GBP)
United Kingdom	59,009,000	243,368	London (6,966,800)	242.5	1,300,809 EUR (783,620 GBP)

Table 5-2. Key Economic Indicators

Source: OECD Health Database 99, Financial Times.

Country	**GDP per capita EUR / GBP 1997**	Labour Force (% of population) 1997	Total population (% unemployed) 1997	**Public Expenditure (% of GDP) 1997**
Denmark	28,532 EUR 17,188 GBP	53.5	2.9	52.0
Finland	18,449 EUR 11,114 GBP	48.8	6.1	53.0
Norway	30,238 EUR 18,216 GBP	52.3	2.1	45.2
Sweden	23,645 EUR 14,244 GBP	50.0	5.0	62.7
United Kingdom	21,962 EUR 13,230 GBP	48.7	3.4	39.6

Table 5-3. Descriptors of the Health care system

Source: OECD Health Database 99, Financial Times.

Country	Total Expenditure on Health (Per Capita EUR / GBP) 1997	Total Expenditure on Health (% GDP) 1997	Public Expenditure on Health (% of Total) 1997	Public Expenditure on Health (% of GDP) 1997	GDP per capita EUR; GBP (1997)
Denmark	2284 EUR 1376 GBP	8.0	83.8	6.7	28,532 EUR 17,188 GBP
Finland	1515 EUR 913 GBP	7.4	76.0	5.7	18,449 EUR 11,114 GBP
Norway	2273 EUR 1369 GBP	7.5	82.2	6.2	30,238 EUR 18,216 GBP
Sweden	2040 EUR 1229 GBP	8.6	83.3	7.2	23,645 EUR 14,244 GBP
United Kingdom	1501 EUR 904 GBP	6.8	84.6	5.8	21,962 EUR 13,230 GBP

Table 5-4. Population Descriptors. Age Structure.

Source: OECD Health Database 99

Country	Life Expectancy Males		Life Expectancy Females		% Female	0 to 19 (% of total)	20 to 64 (% of total)	Over 65 (% of total)
	1996	*1997*	*1996*	*1997*	1997	1997	1997	1997
Denmark	72.9		78.0		50.6	23.7	61.4	14.9
Finland	73.0	73.4	80.5	80.5	51.3	25.2	60.4	14.3
Norway	75.4	75.4	81.1	81.0	50.6	25.5	58.8	15.6
Sweden	76.5	76.7	81.5	81.8	50.6	24.6	58.3	17.0
United Kingdom	74.3		79.5		50.0	25.3	58.8	15.8

Table 5-5. The number of hearing aids provided in each country

	Estimated number of Hearing Aids provided annually	Average number of hearing aids provided annually per 1.000 people
Denmark	65.000	12.30
Finland	14.000	2.72
Norway	40.000	9.10
Sweden	62.000	7.00
United Kingdom	560.000	9.32

Notes: These figures for Denmark, Finland, Norway and the United Kingdom include those provided to both adults and children. This probably overestimates the number of hearing aids by about ten per cent. Hearing aids dispensed privately are not included in these estimates. If a person has a hearing aid for each ear this will be counted as two in the above figures.

Table 5-6. Summary of Annual Expenditure on Hearing Services

	Total spent on hearing services (own currency, millions)	Total annual Expenditure on Hearing Services Millions EUR (GBP)	Per capita annual expenditure EUR (GBP)	GDP per capita EUR (GBP)
Denmark	375M DKR	50.80 M EUR 30.6M GBP	9.61 EUR 5.79 GBP	28,532 EUR 17,188 GBP
Finland	200M FIM [F]	33.70 M EUR 20.3M GBP	6.54 EUR 3.94 GBP	18,449 EUR 11,114 GBP

[F] The costs of the hearing services have not been calculated. The annual costs of the hearing aids (instruments, personal costs) can be calculated to be approx. FIM 100 000 000 (EUR 16 700 000). Often, an assumed figure of FIM 200 000 000 (EUR 33 300 000) for the annual total costs has been presented.

Table 5-7. Estimated number of hearing aid users and percentage of bilateral hearing aids

	Average number of hearing aids purchased annually (per 1,000 people)	Estimated % of bilateral hearing aids	Average number of people prescribed a hearing aid annually (per 1,000 people)	Estimated % of population who have a hearing aid
Denmark	12.30	50–60	7.7–8.2	3.35 %
Finland	2.72	20	2.27	0.96 %
Norway	9.10	60	5.69	2.40 %
Sweden	7.00	30	5.38	2.27 %
United Kingdom	9.32	10–15	8.1–8.5	3.50 %
Estimated number with hearing impairment greater than 45dB in both ears.				5 %
Estimated number with hearing impairment greater than 25dB in both ears.				20 %

Table 5-8. Estimated expenditure on hearing services per person with a hearing aid

	Total Annual Hearing Services Expenditure	Estimated % of population with hearing aid	Expenditure per person with hearing aid	GDP per capita (1997)
Denmark	50.8M EUR 30.6M GBP	3.42–3.69	260.6–280.5 EUR 157–169 GBP	28,532 EUR 17,188 GBP
Finland	33.7M EUR 20.3M GBP	0.98	667.32 EUR 402 GBP	18,449 EUR 11,114 GBP
Norway	42.3M EUR 25.5M GBP	2.84	338.64 EUR 204 GBP	30,238 EUR 18,216 GBP
United Kingdom	166 M EUR 100.0M GBP	3.45–3.54	81.34 EUR 49 GBP	21,962 EUR 13,230 GBP

Table 5-9. Conversion Rates to GBP. Closing point Friday 14th April 2000.

Source: Financial Times. Monday April 17th 2000.

Country	Conversion rate
Denmark	(DKR) 12.2643
Finland	(FIM) 9.8710
Norway	(NKR) 13.5560
Sweden	(SKK) 13.7969
Euro	(EUR) 1.6602