Horizon Scanning Research & Intelligence Centre

New and emerging technologies for hearing loss

March 2017
About the National Institute for Health Research (NIHR) Horizon Scanning Research & Intelligence Centre (HSRIC)

The NIHR HSRIC is based at the University of Birmingham in the UK. The centre aims to supply timely information to key health policy and decision-makers and research funders within the NHS about emerging health technologies that may have a significant impact on patients or the provision of health services in the near future. The scope of our activity includes pharmaceuticals, medical devices and equipment, diagnostic and screening tests, interventional procedures, therapeutic interventions, rehabilitation and therapy, and public health activities.

NIHR HSRIC reports can be accessed free of charge via our website at: www.hsric.nihr.ac.uk
The centre can be followed on Twitter at: @OfficialNHSC

This review is based on information that was publicly available at the time of research and may include opinions from a small number of clinical experts, patients and the public. It is not intended to be a definitive statement on the safety, efficacy or effectiveness of the health technologies included and should not be used for commercial purposes, the development of clinical trials or commissioning without additional information.

Due to the nature of innovation being driven to answer unknown questions and deliver solutions to unmet clinical needs, it should be noted that the health technologies discussed in this report may not have sufficient clinical exposure and clinical expertise to address the potential benefits and harms of the technologies in detail.

This report presents independent research funded by the National Institute for Health Research.
The views expressed in this publication are those of the authors and not necessarily those of the NIHR, NHS, or the Department of Health

The NIHR Horizon Scanning Research & Intelligence Centre
University of Birmingham, United Kingdom
nihrhsric@contacts.bham.ac.uk
www.hsric.nihr.ac.uk

Copyright © University of Birmingham 2017
# CONTENTS

EXECUTIVE SUMMARY ......................................................................................................................... 5

ACKNOWLEDGEMENTS .......................................................................................................................... 6

ABBREVIATIONS ................................................................................................................................... 7

1. INTRODUCTION ................................................................................................................................ 8

1.1. DEFINITION ................................................................................................................................... 8

1.2. TYPES OF HEARING LOSS ............................................................................................................. 8

1.3. CLINICAL NEED AND BURDEN OF DISEASE ............................................................................. 9

1.4. CURRENT MANAGEMENT OPTIONS .......................................................................................... 9

1.4.1. EDUCATION PROGRAMMES, AUDITORY & COGNITIVE TRAINING .................................... 9

1.4.2. ASSISTIVE LISTENING DEVICES ............................................................................................. 10

1.4.3. HEARING AIDS AND ALTERNATIVE LISTENING DEVICES .............................................. 10

1.4.4. COCHLEAR IMPLANTS ............................................................................................................... 10

1.4.5. DRUG THERAPY ......................................................................................................................... 11

1.4.6. SURGERY .................................................................................................................................. 11

2. AIM .................................................................................................................................................... 11

3. METHODS ......................................................................................................................................... 11

3.1. IDENTIFICATION ............................................................................................................................ 11

3.1.1. IDENTIFICATION SOURCES ................................................................................................... 11

3.2. INVESTIGATION AND FILTRATION .............................................................................................. 12

3.3. VIEWS ON POTENTIAL FOR IMPACT ......................................................................................... 13

3.3.1. CLINICAL AND RESEARCH EXPERTS .................................................................................... 13

3.3.2. PATIENTS .................................................................................................................................... 13

4. RESULTS ........................................................................................................................................... 13

4.1. GENERAL COMMENTS .................................................................................................................. 15

4.2. EDUCATION PROGRAMMES ......................................................................................................... 16

4.3. AUDITORY AND COGNITIVE TRAINING .................................................................................... 16

4.4. ASSISTIVE LISTENING DEVICES .................................................................................................. 17

4.5. HEARING AIDS AND ALTERNATIVE LISTENING DEVICES ................................................... 18
4.6. IMPLANTS AND DEVICES ........................................................................................................19

4.7. DRUGS ..................................................................................................................................19

4.8. REGENERATIVE MEDICINE, CELLULAR & GENE THERAPY ..............................................20

4.9. SURGICAL PROCEDURES ........................................................................................................20

5. DISCUSSION & CONCLUSIONS ..............................................................................................21

6. APPENDICES ............................................................................................................................22
   APPENDIX 1: ELECTRONIC SOURCES USED TO IDENTIFY TECHNOLOGIES .....................22
   APPENDIX 2: STRATEGIES USED TO SEARCH MEDLINE AND EMBASE ..............................23
   APPENDIX 3: SEARCH TERMS USED .......................................................................................24
   APPENDIX 4: NEW AND EMERGING TECHNOLOGIES FOR HEARING LOSS .......................25
   A. EDUCATION PROGRAMMES .............................................................................................26
   B. AUDITORY AND COGNITIVE TRAINING ..........................................................................30
   C. ASSISTIVE LISTENING DEVICES .......................................................................................35
   D. HEARING AIDS AND ALTERNATIVE LISTENING DEVICES .............................................40
   E. IMPLANTS AND DEVICES ..................................................................................................49
   F. DRUGS ..................................................................................................................................54
   G. REGENERATIVE MEDICINE, CELLULAR AND GENE THERAPY ......................................60
   H. SURGICAL PROCEDURES ..................................................................................................61

7. REFERENCES ............................................................................................................................64
EXECUTIVE SUMMARY

The NIHR Horizon Scanning Research and Intelligence Centre (HSRIC) undertook a horizon scanning review to identify technologies in clinical development for the management and reduction of the negative consequences of hearing loss. The review was carried out in response to two prioritised, unanswered questions that arose from the 2015 James Lind Alliance (JLA) Mild to Moderate Hearing Loss Priority Setting Partnership (PSP):

- Can new technologies replace hearing aids (HAs)?
- Can stem cell therapy offer a cure for mild to moderate hearing loss in adults?

More than 11 million, (approximately one in six) people in the UK are affected by hearing loss, the majority (92%) experiencing mild to moderate hearing loss. The likelihood of hearing loss increases with age, with more than 70% of 70 year-olds experiencing some form of hearing loss. Hearing loss is however, not uncommon in children; there are over 45,000 children in the UK who have a profound hearing loss.

This horizon scanning review was carried out between April and December 2016. We searched a wide range of sources of intelligence for new and emerging technologies including bibliographic databases, clinical trial registries, horizon scanning databases, industry news sites, and the Internet. We invited clinical and research experts and patients to provide their views on each technology’s innovation, user acceptability, and any likely benefits and barriers for use by patients, carers and the NHS.

We identified 55 technologies that fitted our search and filtration criteria: five educational programmes, six auditory and cognitive training programmes, five assistive listening devices, eleven hearing aids (HAs) and alternative listening devices, eight implants and devices, twelve drugs, one regenerative medicine approach, and seven surgical procedures. None of the identified technologies helped with the JLA-PSP questions although we did find a stem cell regenerative medicine approach in development for severe to profound hearing loss. Most of the developments were in early or uncertain clinical research and would require additional evaluation before widespread adoption by patients and the NHS.

Experts and patients picked out technologies of interest including: apps for converting speech to text and sign language to speech, hearing aids and alternative listening devices to support listening in different environments, a fully implantable cochlear implant (CI) system, a closed-loop CI system, and three developments to support the tuning and optimisation of HAs. If these were successful they have the potential to change the CI landscape for patients, improve patient experience and use of HAs, and to affect service delivery and provision.

However, as the experts and patients say in their general comments, the greatest benefit to the greatest number of patients will come from identifying and supporting those patients with age-related hearing loss to access and use HAs to their best advantage, overcoming reluctance, poor training, stigma and sometimes poor access to interventions and services.
ACKNOWLEDGEMENTS

NIHR HSRIC Review Team
- Saimma Majothi, Senior Analyst
- Dr Claire Packer, Medical Advisor & Director
- Dr Sue Simpson, Reviews Team Lead

External Involvement
The NIHR Horizon Scanning Research and Intelligence Centre is grateful to all those who helped us to include healthcare professionals’, researchers’ and potential users’ perspective in this report.

The following contributed to the review:
- Professor Trevor Cox, Professor of Acoustic Engineering, University of Salford
- Dr Lorraine Gailey, Chief Executive, Hearing Link
- Dr Melanie Ferguson, Honorary Associate Professor / Consultant Clinical Scientist, NIHR Nottingham Hearing Biomedical Research Unit (BRU), Nottingham University Hospitals NHS Trust.
- Dr David Maidment, Research Fellow, NIHR Nottingham Biomedical Research Centre (BRC), Otology and Hearing Group, Division of Clinical Neuroscience, School of Medicine, University of Nottingham.
- Peter Sydserff, President, British Society of Hearing Aid Audiologists
- Jesal Vishnuram, Technology Research Officer, Action on Hearing Loss
- Dr Chris Wood, Senior Research and Policy Officer, Action on Hearing Loss

We thank Dr Adele Horobin at the NIHR Nottingham Hearing BRU for facilitating involvement of people with experience of hearing loss in the review. We are grateful to people with hearing loss and carers for their time and valuable contributions.
## Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baha</td>
<td>Bone anchored hearing aid</td>
</tr>
<tr>
<td>BRC</td>
<td>NIHR Biomedical Research Centre</td>
</tr>
<tr>
<td>BRU</td>
<td>NIHR Biomedical Research Unit</td>
</tr>
<tr>
<td>Bte</td>
<td>Behind the ear</td>
</tr>
<tr>
<td>Chl</td>
<td>Conductive hearing loss</td>
</tr>
<tr>
<td>CI</td>
<td>Cochlea implant</td>
</tr>
<tr>
<td>CIC</td>
<td>Completely in canal</td>
</tr>
<tr>
<td>dB</td>
<td>Decibels, a measure of loudness of sound</td>
</tr>
<tr>
<td>EMA</td>
<td>European Medicines Agency</td>
</tr>
<tr>
<td>HA</td>
<td>Hearing aid</td>
</tr>
<tr>
<td>HL</td>
<td>Hearing loss</td>
</tr>
<tr>
<td>Hsrict</td>
<td>NIHR Horizon Scanning Research and Intelligence Centre</td>
</tr>
<tr>
<td>Hz</td>
<td>Hertz, a unit of frequency of sound</td>
</tr>
<tr>
<td>Itc</td>
<td>In the canal</td>
</tr>
<tr>
<td>Nice</td>
<td>National Institute for Health and Care Excellence</td>
</tr>
<tr>
<td>Nihl</td>
<td>Noise-induced hearing loss</td>
</tr>
<tr>
<td>Nihr</td>
<td>National Institute for Health Research</td>
</tr>
<tr>
<td>Psap</td>
<td>Personal sound amplification product</td>
</tr>
<tr>
<td>Snhl</td>
<td>Sensorineural hearing loss</td>
</tr>
<tr>
<td>TM</td>
<td>Tympanic Membrane</td>
</tr>
<tr>
<td>Who</td>
<td>World Health Organisation</td>
</tr>
</tbody>
</table>
1. INTRODUCTION

In 2015, the Mild to Moderate Hearing Loss Priority Setting Partnership (PSP)\(^1\)\(^2\), comprising patients, carers and health care professionals, under the direction of The James Lind Alliance (JLA) identified and prioritised unanswered questions about the treatment of mild to moderate hearing loss. Two of the top ten questions and priorities for future research that arose were:

- Can new technologies replace hearing aids (HAs)\(^3\), and
- Can stem cell therapy offer a cure for mild to moderate hearing loss in adults?\(^4\)

This NIHR Horizon Scanning Research and Intelligence Centre (HSRIC) horizon scanning review was undertaken in response to these questions, to determine what technologies are in development for the management and reduction of the negative consequences of hearing loss.

1.1. DEFINITION

There are several different classifications of hearing loss. According to the World Health Organization (WHO), a person who is not able to hear as well as someone with normal hearing – hearing thresholds of 25 decibels (dB) at 0.5, 1, 2, and 4 kHz or better in both ears – is said to have hearing loss\(^5\). Hearing loss can affect one or both ears, and often leads to difficulty in hearing conversational speech and quieter sounds, particularly in background noise. The severity of hearing loss can be defined by the quietest sound (or hearing thresholds) that people are able to hear, measured in decibels\(^6\) (Table1).

Table 1: Levels of Hearing Loss (Source: Action on Hearing Loss)

<table>
<thead>
<tr>
<th>Level of hearing loss</th>
<th>Quietest Sound (dB)</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>25-39</td>
<td>Can sometimes make following speech difficult, particularly in noisy situations</td>
</tr>
<tr>
<td>Moderate</td>
<td>41-69</td>
<td>May have difficulty following speech without hearing aids</td>
</tr>
<tr>
<td>Severe</td>
<td>70-94</td>
<td>Usually need to lip-read or use sign language, even with hearing aids</td>
</tr>
<tr>
<td>Profound</td>
<td>95 or greater</td>
<td>Usually need to lip-read or use sign language</td>
</tr>
</tbody>
</table>

WHO classes hearing loss greater than 40 dB in the better hearing ear in adults as disabling hearing loss\(^5,5\). Hard of hearing refers to people with hearing loss in the range of mild to severe. People who are deaf have profound hearing loss, which implies very little hearing or no hearing\(^4\).

1.2. TYPES OF HEARING LOSS

There are three types of hearing loss:

1. Conductive hearing loss (CHL) is the inability of sound waves to pass freely to the inner auditory canal from the outer and/or middle auditory canal due to mechanical or physical obstruction to air conduction\(^6\). Possible causes of conductive hearing loss include congenital factors, otosclerosis (abnormal bone growth and fused bones of the inner ear), fluid in the middle ear, otitis media, a perforated or punctured eardrum, earwax, dysfunction of the Eustachian tube, the presence of a foreign body, or benign tumours. This form of hearing loss is usually managed medically or surgically\(^6,7\).
2. Sensorineural hearing loss (SNHL) is caused by damage to the hair cells in the cochlea and/or damage to the auditory nerve, both of which are located within the inner auditory canal. It is often difficult to differentiate between the two causes of sensorineural hearing loss and it may be referred to as sensory, cochlear, neural or inner ear hearing loss. Age-related hearing loss (presbycusis) is one of the main causes of sensorineural hearing loss. Other factors include regular and prolonged exposure to loud sounds e.g. music or machinery, ototoxic drugs used in the treatment of cancer, antibiotics, infectious diseases such as rubella or measles (not a common cause since the implementation of successful vaccination), complications at birth, genetic predisposition, benign tumours on the auditory nerve, or injury to the head. At present, there is no cure for damage to the hair cells within the cochlea and therefore sensorineural hearing loss is currently irreversible. Typically hearing loss is managed with HAs or other devices which primarily provide increased amplification of sounds and therefore help reduce the impact of hearing loss.

3. Mixed sensorineural conductive hearing loss is conductive hearing loss coupled with sensorineural hearing loss, i.e. hearing loss that affects both the outer or middle and the cochlea or neural system.

1.3. CLINICAL NEED AND BURDEN OF DISEASE

More than 11 million (approximately one in six) people in the UK are affected by hearing loss with the majority experiencing mild to moderate loss. The likelihood of hearing loss increases with age, with more than 40% of 50 year-olds and 70% of 70 year-olds estimated to experience some form of hearing loss. Hearing loss is however, not uncommon in children; there are over 45,000 children in the UK who are deaf and an increased number who experience temporary hearing loss. As a consequence of the aging population profile, it is estimated that there will be over 14.5 million people in the UK with some degree of hearing loss by 2031, and over 2 million with severe hearing loss. In 2010/11 the cost of managing hearing loss to the NHS was estimated to be £450 million.

The financial burden of an increasing number of people with hearing loss falls not only upon society and the NHS, but upon individuals, who often experience difficulties with interpersonal communications and challenges in day-to-day living and employment. Hearing loss can impact negatively on economic activity, psychological wellbeing and quality of life.

1.4. CURRENT MANAGEMENT OPTIONS

1.4.1. EDUCATION PROGRAMMES, AUDITORY & COGNITIVE TRAINING

Alongside other management options such as HAs, education programmes help people to improve their knowledge and skills about hearing loss and the use of HAs and other assistive devices. These programmes can help people make the most of their HAs and manage their hearing loss effectively.

Auditory and cognitive training can be used to train the brain to listen better and uses the concept of neuroplasticity - the brain's ability to reorganize itself by forming new neural connections. Auditory training can improve speech intelligibility through the development of auditory perceptual skills. Similarly, changing cognitive functioning can offer benefits in listening through improvements in working memory capacity, improved language comprehension and selection attention.
Interventions can only be deemed effective once implemented according to recommended use; this is particularly true of self-management type interventions that are home-based and unsupervised\textsuperscript{16}.

1.4.2. ASSISTIVE LISTENING DEVICES

People with hearing loss and their families and carers may benefit from assistive listening devices, also known as hearing assistive technology. Examples of these devices include amplifiers and streamers for telephones and televisions, vibrating alarm clocks, conversation amplifiers, text phones, flashing doorbells, and baby alarms\textsuperscript{17}. Most assistive listening devices are not funded through the NHS and the economic burden falls upon affected individuals and their family. In some situations social services and specific funding schemes e.g. access to work, may contribute towards the cost of some hearing assistive technology\textsuperscript{18}.

1.4.3. HEARING AIDS AND ALTERNATIVE LISTENING DEVICES

Approximately 1.4 million people in the UK use conventional HAs and it is estimated that a further 6.7 million people could benefit from using them\textsuperscript{11,15}. HAs are medical electronic devices that amplify sounds in order for the sound to be detected by the affected ear. HAs consist of a microphone, amplifier, loudspeaker and a battery. Nowadays, these are most likely to be the analogue programmable type or digital processing type although some analogue devices are still available and used\textsuperscript{6}. There are several types of HAs with the more modern ones becoming increasingly discreet\textsuperscript{19}. Common hearing aid types include behind-the-ear (BTE), in-the-ear, in-the-canal (ITC), and completely in-the-canal (CIC) aids. Other forms of HAs include bone conduction/anchored hearing aids (BAHAs) which may require local surgery to implant and position\textsuperscript{6}.

There is a rapidly developing market for alternative listening devices which include enhancements to conventional HAs such as sound filtering and augmentation, developments in the aids’ ability to wirelessly sync with mobile phones and computers e.g. for access to web applications, direct streaming of music, and audio notifications. Although not yet a recognised category of medical device, alternative listening devices that do not amplify sound are sometimes referred to as ‘hearables’. Examples of enhancements to hearing aids include Starkey Halo, Resound LiNX2, Beltone Legend, and Oticon Opn. These all require a hearing healthcare professional to fit them. However, with the publication of the United States National Academies of Sciences, Engineering and Medicine report in 2016\textsuperscript{20}, over the counter (OTC) devices, such as personal sound amplification products (PSAPs) and self-fitting hearing aids, which do not necessarily require professional healthcare input, are likely to become more commonplace. There is currently no high-level evidence base for these devices nor commonly agreed consensus definitions for these alternative devices to conventional hearing aids\textsuperscript{21}.

1.4.4. COCHLEAR IMPLANTS

Cochlear implants (CIs) have an external component consisting of a microphone and speech processor and an internal receiver that is surgically implanted in the mastoid bone behind the ear, with electrodes inserted into the cochlea\textsuperscript{22}. CIs work on behalf of the damaged parts of the inner auditory canal to provide sound signals to the central nervous system\textsuperscript{23}. The National Institute of Health and Care Excellence (NICE) recommend a CI in one ear, as a possible option for everyone with severe to profound deafness, if no benefit from three-months of HAs\textsuperscript{16}. 
The majority of digital HAs and CIs (within certain criteria) are prescribed through the NHS where the provision of repairs, batteries and services are provided free of charge\textsuperscript{24,25}, although the range of providers has expanded over the years (particularly through the Any Qualified Provider scheme for adult hearing loss) to include: national and regional independent sector providers, charitable organisations; social enterprises and GP – led organisations\textsuperscript{26}.

1.4.5. DRUG THERAPY

Some types of CHL can be managed with drug therapy, depending on the underlying cause. The removal of earwax using medicated ear drops or oil, a cleaning syringe or suction will help clear obstructive earwax in the outer and middle auditory canal\textsuperscript{24}. Antibiotics may be given to alleviate ear infections.

1.4.6. SURGERY

In addition to the surgical implantation of cochlear and other implants, surgery may be indicated to reduce middle ear fluid build-up, to repair perforations of the eardrum or fix malformations of the ossicles\textsuperscript{16}. These methods are not usually indicated for SNHL affecting the inner ear.

2. AIM

The aim of this horizon scanning review was to identify new and emerging technologies in development for the management and reduction of the negative consequences of hearing loss.

3. METHODS

We undertook scoping searches to obtain background information about hearing loss, current management options and to identify the terms and medical subject headings related to this area. We used this information to develop a review protocol that outlined inclusion and exclusion criteria and a search strategy. The protocol was agreed by clinical and research experts in the field (members of Action of Hearing Loss and Hearing Link) and the review advisors from NIHR Nottingham BRC.

3.1. IDENTIFICATION

3.1.1. IDENTIFICATION SOURCES

A wide range of sources of electronic sources were searched including:

1. Horizon scanning databases
2. MedTech industry news sites
3. Clinical trial registries
4. Bibliographical databases
5. Licensing bodies
6. General internet
See Appendix 1 for a complete list of the identification sources searched. See Appendix 2 for the strategy used to search MEDLINE and EMBASE and Appendix 3 for the search terms used on other sites.

3.2. INVESTIGATION AND FILTRATION

Identified technologies were initially filtered using the pre-specified inclusion and exclusion criteria (Table 2). Where there was inadequate information available to enable filtration, we undertook brief online searches for additional publically available information in order to apply the inclusion and exclusion criteria.

**Table 2: Review inclusion and exclusion criteria.**

<table>
<thead>
<tr>
<th>Key filtration points</th>
<th>Inclusion criteria</th>
<th>Exclusion criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical area</td>
<td>• All types of hearing loss (all ages)</td>
<td>• Associated conditions e.g. tinnitus</td>
</tr>
<tr>
<td></td>
<td>• All grades of hearing loss (all ages)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Deafness (all ages)</td>
<td></td>
</tr>
<tr>
<td>Place in pathway</td>
<td>• Management and treatment</td>
<td>• Screening, diagnosis and assessment</td>
</tr>
<tr>
<td></td>
<td>• New patient group for currently available technology</td>
<td>• Prevention</td>
</tr>
<tr>
<td></td>
<td>• Impacts directly on hearing outcomes e.g. not solely on speech intelligibility</td>
<td></td>
</tr>
<tr>
<td>Technology type</td>
<td>All technology types including</td>
<td>• None</td>
</tr>
<tr>
<td></td>
<td>• Drugs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Cellular therapies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Devices and assistive technologies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Surgical interventions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Auditory and cognitive training</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Change to an existing technology e.g. a new approach, a modification or upgrade</td>
<td></td>
</tr>
<tr>
<td>Stage in development</td>
<td>Pharmaceuticals and cellular therapies</td>
<td>• Pre-clinical – lab or animal studies</td>
</tr>
<tr>
<td></td>
<td>• Phase II and III clinical trials (trials updated in the last 2 years)</td>
<td>• Early trials – phase 0 or phase I</td>
</tr>
<tr>
<td></td>
<td>• Pre-registration</td>
<td>• Phase II and III clinical trials with no updating information within the last 2 years</td>
</tr>
<tr>
<td></td>
<td>Devices and surgical interventions</td>
<td>• Late trials – phase IV</td>
</tr>
<tr>
<td></td>
<td>• Pre-CE marking</td>
<td>• Already available and diffused</td>
</tr>
<tr>
<td></td>
<td>• Just received CE marking</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Not yet launched</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Launched but poorly diffused</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Programmes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Not widely implemented</td>
<td></td>
</tr>
</tbody>
</table>
We then compiled a table of technologies that met the review inclusion criteria detailing the developer, technology type, technology description, clinical trial information and stage of development. Duplicates were removed whenever they were recognised during the identification and filtration processes.

3.3. VIEWS ON POTENTIAL FOR IMPACT

We invited clinical and research experts and patients to consider the table of technologies and provide their views on each technology’s potential impact. We asked them to particularly consider the levels of innovation, issues around user acceptability, and any likely benefits and barriers for use by patients, carers and the NHS.

3.3.1. CLINICAL AND RESEARCH EXPERTS

Nine clinical and research experts were approached to provide comments from the following organisations and charities:

- Action on Hearing Loss
- British Academy of Audiology
- British Society of Audiology
- British Society of Hearing Aid Audiologists
- Hearing Link
- NIHR Nottingham BRC
- University of Salford

3.3.2. PATIENTS

Patients were invited to be involved through promotion of this work via the Patient and Public Involvement manager at NIHR Nottingham Hearing BRU. All patients had experience of varying severity of hearing and of different duration, and all patients had experience of using at least one hearing device.

4. RESULTS

A summary of the number of technologies identified and subsequently selected for inclusion in the review is provided in Figure 1. In total, 2,200 (97.5%) of the technologies identified were excluded as they did not meet the review inclusion criteria. A total of 55 technologies were included and categorised according to the type of technology (Table 3). Seven experts commented on the identified technologies either as individuals or on behalf of their organisations with input from colleagues. Four patients commented on the technologies. The full results with comments are presented in tables within Appendix 4.
Figure 1: Flow diagram detailing flow of technologies identified

Identification

Search hits
N = 2,255

Technologies included following primary filtration
N = 403

Technologies excluded based on source information
N = 1,852

Technologies included after second filtration
N = 65

Technologies excluded based on further investigation
N = 344

Technologies included after second filtration
N = 55

Technologies excluded with final filtration
N = 10

Inclusion
Table 3: Identified technologies by technology type

<table>
<thead>
<tr>
<th>Technology type</th>
<th>Number identified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education programmes</td>
<td>5</td>
</tr>
<tr>
<td>Auditory and cognitive training</td>
<td>6</td>
</tr>
<tr>
<td>Assistive listening devices</td>
<td>5</td>
</tr>
<tr>
<td>Hearing aids and alternative listening devices</td>
<td>11</td>
</tr>
<tr>
<td>Implants and devices</td>
<td>8</td>
</tr>
<tr>
<td>Drugs</td>
<td>12</td>
</tr>
<tr>
<td>Regenerative medicine cellular and gene therapy</td>
<td>1</td>
</tr>
<tr>
<td>Surgical procedures</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>55</td>
</tr>
</tbody>
</table>

4.1. GENERAL COMMENTS

Although experts and patients made comments on individual technologies (see tables in Appendix 4), they also gave more general comments about the likely benefits of innovative areas such as alternative listening devices (some are referred to as hearables) compared to the benefits of encouraging more people with hearing loss to use their hearing aids to best effect.

One expert stated:

“In these areas, the emerging technologies that will be of greatest impact to patients and carers and therefore to the NHS, are those with genuine benefits to the 90% plus of the population with straightforward presbycusis hearing loss that will continue to resist existing models of care. Please don’t confuse my lack of enthusiasm for some of the other products that will do so much to enrich the lives of people with profound hearing loss, with a lack of interest in them. It’s just that I believe that the technologies that will have the biggest impact are the ones that have a chance of helping the largest populations”.

This view was supported by another:

“Acoustic amplification provided by hearing aids is currently the primary clinical management strategy for adults with hearing loss. However, 2 out of 3 people that would benefit from using hearing aids do not take them up. For patients that do obtain hearing aids, up to 40% do not wear them all of the time. The stigma associated with hearing loss and hearing aids often stops people seeking help. People with hearing loss report that they are concerned or embarrassed that hearing aids will make them look old and that they will be treated differently by others. There is, therefore, a need to assess alternative service delivery models, which could increase patient choice, accessibility and acceptability of hearing services for people with hearing loss that do not currently access or accept hearing aids”.

This balance between innovation and support for those with hearing loss continued with:

“The specific projects I think [that] were, at least novel, although probably of little help to day to day wearers of HAs, were in no specific order: ReSound LinX (25), UNI (16), Deafalarm (12),
Google Glass App (13), Earcle (26) and Transcence App (15).” This list of innovation refers mainly to assistive listening devices and alternative hearing devices.

4.2. EDUCATION PROGRAMMES

We identified five education programmes, all of which were in ongoing or recently completed research studies. Only one programme was based in the UK (3), the others being developed in the USA, Netherlands and Canada. Two of the programmes appear to combine direct counselling by therapists with multimedia tools, two programmes use multimedia and on-line tools only, and the last incorporates group-based training.

Experts and patients were generally supportive of the concept of education programmes, but expressed concerns about the generalisability and transferability of materials from country to country, and in some cases even between different areas in the UK.

Experts added that barriers to these programmes can include accessibility to on-line materials, literacy if the reading level is pitched too high, and a lack of clarity in the materials if users are not involved in their development.

Patient comments:

“[I am drawn to these programmes] especially where continuous reinforcement of the operating instructions are available.”

“Training in operation and maintenance of HAs is certainly required as a means of improving the uptake and use of HAs. But I think we should do this ourselves in the UK.”

“Note that regional variations – e.g. in the provision of HA tubing – need to be taken account of with local customisation.”

“This kind of further education on the use and control of HA is a neglected area. Audio technicians tend to give very perfunctory details to patients. There could be good benefits for users of HA if more user information given and reinforced at regular intervals.”

“I believe there’s a quick win available here: persuading folk to persevere with their HA would be a major benefit and the cost would be relatively low.”

Additional expert comments:

“[These programmes are] rated as highly useful, enjoyable, improve confidence and are preferable to written information.”

When referring to interactive and multimedia resources:

“These materials have proved to be of benefit to many users, helping them become more familiar with using their hearing aids and encouraging them to develop better communication tactics. They help reduce the need for clinician input. They work best when complemented by volunteer support”.

4.3. AUDITORY AND COGNITIVE TRAINING

We identified six auditory and cognitive training programmes, two of which appear to be already available for use by patients, the rest being in early clinical trials. Four of the programmes are computer based and can be used by patients in their own homes.
A general comment made about these types of training programmes is that you need to look at the evidence that the benefit from the training programme transfers to everyday listening. People may just get good at the training task, but this may not improve their ability to distinguish speech in everyday life.

Experts referred us to a paper that reviewed three training studies incorporating auditory training including i) a randomized controlled trial (RCT) of training for phoneme (individual speech sounds) discrimination in quiet environments for adults with mild hearing loss, ii) a repeated measures study of training in phoneme discrimination in noisy environments in hearing aid users, and iii) a double-blind RCT that directly trained working memory in HA users. A conclusion from this review was “that combined auditory-cognitive training approaches, where cognitive enhancement is embedded within auditory tasks, are most likely to offer generalized benefits to the real-world listening abilities of adults with hearing loss”.

However, there are many barriers to the widespread use of these programmes including the need for a computer and internet connections and the associated costs, and poor compliance in the real world.

### 4.4. ASSISTIVE LISTENING DEVICES

We identified five assistive listening devices, four of which are available:

- two of these are applications (apps) for mobile phones - Deafalarm that relays audio alarms from the environment and Transcense that transcribes conversations in real time,
- three are computer-based or other electronic systems - one using sensors to track hand and finger movements with translation to sound/text, one using Google glass (now withdrawn from sale) to translate speech to text, and a hypersound system to direct sound to specific individuals in a room.

Like many of the alternative hearing devices (see next section), most of the identified assistive listening devices required the use of apps, mobile phones or devices, and/or access to the internet. Experts and patients identify this as a potential barrier for some patients as they will need high computer literacy and competence, access to the hardware and software, and wifi connections to the Internet or between devices.

Both experts and patients expressed concern about benefits over and above currently available systems e.g.

“Technology similar to this exists for public exhibitions but due to price is not suitable for personal use.”

“... converting speech to text would be of interest if it is a significant improvement on current options such as Dragon and Siri, both of which are freely available and perform reasonably well at speech to text options.”

Experts and patients were particularly positive about:

- Transcense (15), which can transcribe multiple conversations in real time into text, and
- UNI (16), a two-way communication tool that converts sign language to speech and speech to text

Cautionary comments on these sign language to text and speech solutions included:
“To be truly sign language friendly, spoken word needs to be translated into sign language not text.”

“Let’s look again once this [translation of speech into BSL] can be done too. What we need are complete solutions. This is only a stepping stone towards one.”

4.5. HEARING AIDS AND ALTERNATIVE LISTENING DEVICES

We identified six advances in hearing aid technology and five alternative listening devices. Of the advances in hearing aids, three were available (although access in the UK could not be confirmed), one was not yet available in the UK and two were in early development. Of the alternative listening devices, three were available or in the approval process (assumed to be within the USA) and two were in early development.

Experts and patients were particularly positive, although with plenty of reservations, about:
- ReSoundLiNX (25), an HA that streams output from iPhones and iPads directly to hearing aids
- Earcle (26), an alternative listening device controlled by mobile phone that improves the audio in different situation e.g. restaurants
- SelfFit (24), an app to support interactive HA tuning
- Abrumed (23), an office based computer support to HA tuning
- iHear (19), an ‘off-the-shelf’ hearing aid that can be customised via computer app

A patient said about our findings:
“Existing hearing aids although improved are still very basic i.e. they amplify all sound and are very directional. I was surprised that there were few projects or proposals to improve the performance of existing HAs, which I think would be very acceptable to wearers of HAs.”

Like many of the assistive listening devices (see previous section), most of the identified alternative listening devices required the use of apps, mobile phones or devices, and/or access to the internet. Experts and patient identify this as a potential barrier for some patients as they will need high computer literacy and competence, access to the hardware and software, and wi-fi connections to the Internet or between devices. However, looking to the future this is likely to become less of a barrier as, for example, the use of the internet in the 55- to 74-year age group shows a year-on-year increase; 2010=61%, 2012=70%, 2014=78%, 2016=85%29,30.

Some of the identified alternative listening devices have the potential to reduce the need to return to audiology for reprogramming of hearing aids, which, as one expert said
“... could lead to a reduction in waiting times and increasing service availability for patients with more complex needs”, and to

“... decreased wastage of scarce healthcare resources; patients may be more satisfied with the amplification provided by an alternative that they could fine-tune themselves, thereby reducing the likelihood that NHS devices are not used once accessed”.

However, as a patient noted,
“... there would be clearly be a strong requirement for high quality documentation and an ergonomic interface for the software. And probably a good quality helpdesk function.”
General expert comments

“Buy-in from clinicians (i.e. audiologists) is also important, as these devices will impact their profession.”

“In general, clinicians are very positive of the benefits that alternatives could provide in terms of self-management, but are also mindful that devices need to be supplemented with additional rehabilitation.”

“Alternative listening devices that link wirelessly to smartphones may be particularly appealing, allowing users to conveniently adjust and personalise their hearing settings in different listening situations.”

A reservation expressed:

“To date, there is no high-quality evidence assessing the effectiveness of self-adjusting alternative listening devices. The need for high-quality evidence in hearing research more generally has also been highlighted in NHS England and the Department of Health’s Action Plan for Hearing loss, and the recently published Commissioning Services for People with Hearing Loss: A Framework for Clinical Commissioning Group.”

4.6. IMPLANTS AND DEVICES

We identified eight implants and devices in development: six relating to cochlea implants, one middle ear implant and a partial ossicular replacement. Three of the CI related developments are known to be in clinical trials.

Experts and patients were particularly positive, although with plenty of reservations, about:

- System-on-chip (28), a fully implantable CI system in very early development
- Closed-loop CI (29), a CI system that automatically optimises stimulation and may have the potential for wireless monitoring and adjustment, also in very early development.

Both these implants appear to be very early proof of concept and feasibility development. They would need to complete these stages prior to being tested in humans.

General expert comments about CIs

“Cochlear implants are a great solution for those with really severe hearing losses. Any advance in this field I’m sure will be welcomed but unless candidacy goes up because the surgery required becomes more accessible, again take up will be limited.”

Patient comments

“Devices and implants especially improvements to cochlear implants. I have 2 friends with cochlear implants and they both found the first 6 months in particular to be quite difficult before they started to feel improvements. There is also the problem of the aerial on the side of the head and now the light box under the skin... surely these can be improved.”

4.7. DRUGS

We identified 12 drugs in development for people with hearing loss: six for sudden idiopathic SNHL, two for noise-induced hearing loss (NIHL), and one each for age related hearing loss, people with less than optimum speech following CI, Meniere’s disease, and corticosteroid resistant autoimmune inner ear disease. Only two drugs were reported to be in phase II/III or III clinical trials: AM-111 (Auris Medical) and high-dose corticosteroids, both for sudden idiopathic SNHL. The majority of the
rest are reported to be in phase II trials (and many in very small trials), with two being at a slightly earlier trial phase.

Many of the products identified are orally administered; the remainder are administered by injection to the tympanic membranes, subcutaneously or intravenously, inhaled or administered locally as part of a surgical procedure.

We have not undertaken searches to find out if any of these products are continuing in commercial or non-commercial development and therefore cannot confirm if any are likely to be considered by the European Medicines Agency (EMA) for a licence to market in the UK or EU.

Experts and patients made general comments that can apply to all the identified products to the effect that an evaluation of a product’s effectiveness, adverse effects, cost and practical delivery to patients is needed before any decision can be made to provide these treatments in the NHS.

4.8. REGENERATIVE MEDICINE, CELLULAR & GENE THERAPY

We identified one regenerative medicine approach: a gene therapy for severe to profound hearing loss that aims to re-generate the sensory hair cells in the inner ear.

This therapy is still in very early research and needs additional evaluation before any statements can be made about its long-term efficacy.

4.9. SURGICAL PROCEDURES

We identified seven surgical procedures: a pre-surgical planning tool for the placement of CIs, three proposed developments in surgical approach, two proposed developments in CI placement, and a proposal that may reduce the time interval between fixation and implantation in BAHA from 8-9 weeks to 2 weeks. All the techniques and approaches had small, case series or non-randomised trials either ongoing or reported. Although, we cannot be certain if all these procedures and techniques are still in active development.

Patient comment

“Surgery would not be an acceptable treatment to me personally unless the procedure was carried out regularly in NHS hospitals in a similar fashion as say cataract operations.”
The original questions set by the Mild to Moderate Hearing Loss Priority Setting Partnership (PSP) were:

- Can new technologies replace hearing aids?, and
- Can stem cell therapy offer a cure for mild to moderate hearing loss in adults?

We decided to include all levels and levels of hearing loss in our review in order to provide a broad picture of emerging technologies. We acknowledge that the methods we used will not identify all products in development and may miss in particular, those that have not been associated with formal clinical trials.

Using the horizon scanning methods set out, we did not identify any technologies that would replace HAs. We do, however, understand from our expert advisers that some alternative listening devices in practice may substantially replace HAs for some people. There are some technologies e.g. smartphone hearing aids, that are designed to enhance the functionality and use of HAs or to increase the ability to quickly personalise a HA to individual needs. Other technologies that experts and patients picked out included apps for converting speech to text and sign language to speech – again not replacements for HAs.

We did identify one stem cell regenerative medicine approach in early phase I/II clinical trials for bilateral severe to profound hearing loss that, if it progresses successfully through the trial stages (and the phase I/II study is due to complete in summer 2017), has the potential to offer a novel treatment for this patient group. However, we did not identify anything in trials for mild to moderate hearing loss.

Experts and patients picked out other technologies for special notice including a fully implantable CI system (28), and a closed-loop CI system (29) that automatically optimises stimulation and has the potential for wireless adjustment. These may, if these were successful in clinical development, change the CI landscape for patients and service provision. Other findings they were positive about included three to support the tuning and optimisation of HAs (15, 23 and 24). Again, if these were successful they have the potential to improve patient experience and use of HAs, but also to affect service provision.

Although, we identified 55 technologies at various stages of development for the management and reduction of negative consequences of hearing loss, many were at an early or uncertain stage of development. In addition, as the experts and patients say in their general comments, the greatest benefit to the greatest number of patients will come from identifying and supporting those patients with age-related hearing loss to access and use HAs to their best advantage, overcoming reluctance, poor training, stigma and sometimes poor access to aids and services.
### APPENDIX 1: ELECTRONIC SOURCES USED TO IDENTIFY TECHNOLOGIES

<table>
<thead>
<tr>
<th>Source</th>
<th>Website</th>
<th>Not publically available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizon scanning websites &amp; databases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HSRIC ‘in-house’ technology database</td>
<td>Not online</td>
<td>√</td>
</tr>
<tr>
<td>ECRI Institute</td>
<td><a href="http://www.ecri.org">http://www.ecri.org</a></td>
<td>√</td>
</tr>
<tr>
<td>EuroScan International Network</td>
<td><a href="http://www.euroscan.org">www.euroscan.org</a></td>
<td>Restricted access for non-members</td>
</tr>
<tr>
<td>CADTH</td>
<td><a href="https://www.cadth.ca">https://www.cadth.ca</a></td>
<td></td>
</tr>
<tr>
<td>Agency for Healthcare Research and Quality (AHRQ)</td>
<td><a href="http://www.effectivehealthcare.ahrq.gov">http://www.effectivehealthcare.ahrq.gov</a></td>
<td></td>
</tr>
<tr>
<td>MedTech industry news sites</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinica MedTech</td>
<td><a href="http://www.clinica.co.uk/">http://www.clinica.co.uk/</a></td>
<td>√</td>
</tr>
<tr>
<td>Clinical trial registries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WHO International Clinical Trials registry platform (ICRTP)</td>
<td><a href="http://apps.who.int/trialsearch/AdvSearch.aspx">http://apps.who.int/trialsearch/AdvSearch.aspx</a></td>
<td></td>
</tr>
<tr>
<td>Bibliographic databases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MEDLINE In-process &amp; Other Non-indexed Citations; MEDLINE; EMBASE (OVID)</td>
<td><a href="http://www.elibrary.bham.ac.uk/">http://www.elibrary.bham.ac.uk/</a></td>
<td></td>
</tr>
<tr>
<td>ZETOC database - British Library Database</td>
<td><a href="http://zetoc.jisc.ac.uk/">http://zetoc.jisc.ac.uk/</a></td>
<td></td>
</tr>
<tr>
<td>Licensing bodies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General internet</td>
<td><a href="https://www.google.co.uk/">https://www.google.co.uk/</a></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX 2: STRATEGIES USED TO SEARCH MEDLINE AND EMBASE

Medline search strategy

<table>
<thead>
<tr>
<th>Step</th>
<th>Search terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Exp Hearing Loss/</td>
</tr>
<tr>
<td>2</td>
<td>New.ti,ab.</td>
</tr>
<tr>
<td>3</td>
<td>Emerging.ti,ab.</td>
</tr>
<tr>
<td>4</td>
<td>Innovate*.ti,ab.</td>
</tr>
<tr>
<td>5</td>
<td>Nover.ti,ab.</td>
</tr>
<tr>
<td>6</td>
<td>Advances.ti,ab.</td>
</tr>
<tr>
<td>7</td>
<td>Developments.ti,ab.</td>
</tr>
<tr>
<td>8</td>
<td>2 or 3 or 4 or 5 or 6 or 7</td>
</tr>
<tr>
<td>9</td>
<td>1 and 8</td>
</tr>
<tr>
<td>10</td>
<td>Limit 9 to (English language and humans and yr=&quot;2014 – 2016&quot;)</td>
</tr>
</tbody>
</table>

Embase search strategy

<table>
<thead>
<tr>
<th>Step</th>
<th>Search terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hearing disorder/</td>
</tr>
<tr>
<td>2</td>
<td>Partial hearing loss/</td>
</tr>
<tr>
<td>3</td>
<td>Hearing</td>
</tr>
<tr>
<td>4</td>
<td>Hearing impairment/</td>
</tr>
<tr>
<td>5</td>
<td>Inner ear hearing loss/</td>
</tr>
<tr>
<td>6</td>
<td>High frequency hearing loss/</td>
</tr>
<tr>
<td>7</td>
<td>Central hearing loss/</td>
</tr>
<tr>
<td>8</td>
<td>Bilateral hearing loss/</td>
</tr>
<tr>
<td>9</td>
<td>Functional hearing loss/</td>
</tr>
<tr>
<td>10</td>
<td>Mixed hearing loss/</td>
</tr>
<tr>
<td>11</td>
<td>Unilateral hearing loss/</td>
</tr>
<tr>
<td>12</td>
<td>1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11</td>
</tr>
<tr>
<td>13</td>
<td>New.ti,ab.</td>
</tr>
<tr>
<td>14</td>
<td>Emerging.ti,ab.</td>
</tr>
<tr>
<td>15</td>
<td>Innovate*.ti,ab.</td>
</tr>
<tr>
<td>16</td>
<td>Novel.ti,ab.</td>
</tr>
<tr>
<td>17</td>
<td>Advances.ti,ab.</td>
</tr>
<tr>
<td>18</td>
<td>Development.ti,ab.</td>
</tr>
<tr>
<td>19</td>
<td>13 or 14 or 15 or 16 or 17 or 18</td>
</tr>
<tr>
<td>20</td>
<td>12 and 19</td>
</tr>
<tr>
<td>21</td>
<td>Limit 20 to (human and English language and yr=&quot;2014-2016&quot;)</td>
</tr>
</tbody>
</table>
## APPENDIX 3: SEARCH TERMS USED

<table>
<thead>
<tr>
<th>Search terms for disease area</th>
<th>Search terms for new and emerging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hearing loss</td>
<td>New</td>
</tr>
<tr>
<td>Hearing</td>
<td>Emerging</td>
</tr>
<tr>
<td>Audiology</td>
<td>Innovat*</td>
</tr>
<tr>
<td>Hearing impair*</td>
<td>Novel</td>
</tr>
<tr>
<td>Hard-of-hearing</td>
<td>Advances</td>
</tr>
<tr>
<td>Deaf*</td>
<td>Development</td>
</tr>
<tr>
<td>Aural</td>
<td></td>
</tr>
<tr>
<td>Listen*</td>
<td></td>
</tr>
</tbody>
</table>

* indicates use of truncation
APPENDIX 4: NEW AND EMERGING TECHNOLOGIES FOR HEARING LOSS

Tables (click on link to go directly to specific tables)

A Education programmes
B Auditory and cognitive training
C Assistive listening devices
D Hearing aids and alternative listening devices
E Implants and devices
F Drugs
G Regenerative medicine, cellular and gene therapy
H Surgical procedures
### A. EDUCATION PROGRAMMES

<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ASPIRE</td>
<td>University of Chicago</td>
<td>Children aged 6 months and older with hearing loss</td>
<td>Parent-directed intervention aiming to increase parental skills and enrich children’s early language environments and outcomes in children with hearing loss.</td>
<td>A longitudinal, multi-institutional study to further test the program’s efficacy is planned</td>
<td>Non-randomised, single blind, multimedia early intervention; n=41; USA; primary completion 2015.</td>
<td><a href="https://clinicaltrials.gov/show/NCT01753661">https://clinicaltrials.gov/show/NCT01753661</a> <a href="http://project-aspire.org/project.html">http://project-aspire.org/project.html</a></td>
</tr>
<tr>
<td>2</td>
<td>Patient-centred education tool</td>
<td>VA Office of Research and Development</td>
<td>Hearing loss</td>
<td>Counselling with the teach-back technique reviewing information on hearing loss. The aim is that the teach-back technique will help patients remember how to correctly use and care for their hearing aids.</td>
<td>Randomised, active controlled, outcomes on handling hearing aids and self-efficacy; n=468; USA; primary completion 30/9/16.</td>
<td><a href="https://clinicaltrials.gov/ct2/show/NCT01940705">https://clinicaltrials.gov/ct2/show/NCT01940705</a></td>
<td></td>
</tr>
</tbody>
</table>

**Patients comments**
- Since the role of the parent is crucial to the upbringing of any child but especially a deaf child, this training is potentially valuable. Maintain a watching brief.
- Limited information on results to be able to assess benefits etc.
- This is beyond my capacity to assess as it appears to require skilled professionals making home visits to low-income families. I don’t understand how this would work in the USA procedurally, i.e. gaining access, targeting families, the sociology.

**Experts**
- Veterans and not civilians were used in this study. Would another study need to be done on civilians to test it? The DVD might be US focussed and a UK version may be required.
- While the concept is promising, generic cognitive development interventions are in my experience less valuable than specific auditory training.

**Patients**
- Training in operation and maintenance of HAs is certainly required as a means of improving the uptake and use of HAs. But I think we should do this ourselves in the UK. Action on Hearing Loss’s volunteers would be up for this, possibly under the guidance of the NHS. Here in Scotland, the charity Deaf Action and the NHS have produced videos showing how to maintain HAs. These could be a starting point then made rigorous and polished. Note
<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Reusable learning objects (RLOs) in addition to information given by audiologists</td>
<td>Nottingham Hearing Biomedical Research Unit</td>
<td>Mild to moderate sensorineural hearing loss in adult first time HA users</td>
<td>Interactive and multimedia resources to help people newly fitted with HAs: inserting and caring for HAs, getting to know your HA, expectations and adaptations, communication tactics, using the phone and other devices, and troubleshooting. RLOs included video clips, illustrations, animations, photos, sounds and testimonials, all with subtitles included.</td>
<td>Randomised controlled trial; n=203; Nottingham; completed and published 2016.</td>
<td>Ferguson et al 2016 [28] <a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4764016/">https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4764016/</a></td>
<td></td>
</tr>
</tbody>
</table>

**Experts**
- I could imagine very useful in NHS and private setting – allows people to take something away and learn aspects in their own time.
- These materials have proved to be of benefit to many users, helping them become more familiar with using their hearing aids and encouraging them to develop better communication tactics. They help reduce the need for clinician input. They work best when complemented by volunteer support.
- Take-up and adherence was very high. Benefits - rated as highly useful, enjoyable, improved confidence and were preferable to written information. Significantly greater hearing aid use in the RLO intervention group for suboptimal users. Also had significantly better knowledge of practical and psychosocial issues, and significantly better practical hearing aid skills.

**Patients**
- Training in operation and maintenance of HA is certainly required as a means of improving the uptake and use of HA. But I think we should do this ourselves in the UK. Action on Hearing Loss's volunteers would be up for this, possibly under the guidance of the NHS. Here in Scotland, the charity Deaf Action and the NHS have produced videos showing how to maintain HA. These could be a starting point and then made rigorous and polished. Note that regional variations – e.g. in the provision of HA tubing – need to be taken account of with local customisation.
- Patient’s acceptance of this programme would be high and certainly beneficial. Costs must be low and would allow re-enforcement at patients own pace even after prolonged use. This kind of further education on the use and control of HA is a neglected area. Audio/technicians tend to give very perfunctory details to patients. There could be good benefits for users of HA if more user information given and reinforced at regular intervals.
<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Support rehabilitation programme (SUPR) in addition to usual hearing aid care</td>
<td>Amsterdam</td>
<td>Hearing impairment</td>
<td>On-line, multimedia support rehabilitation programme to help hearing-impaired individuals use their hearing aid more effectively and to improve successful coping strategies, as compared to usual hearing aid care.</td>
<td>Randomised, active controlled; n=569; &gt;50 years; Netherlands; completion December 2017.</td>
<td><a href="http://www.isrctn.com/ISRCTN77340339">www.isrctn.com/ISRCTN77340339</a></td>
<td></td>
</tr>
</tbody>
</table>

**Experts**
- I could imagine very useful in NHS and private setting – allows people to take something away and learn aspects in their own time.
- These materials have proved to be of benefit to many users, helping them become more familiar with using their hearing aids and encouraging them to develop better communication tactics. They help reduce the need for clinician input. They work best when complemented by volunteer support.

**Patients**
- There might be a business case for a one-time charge for developing or purchasing training courses. But not for external delivery charges. I believe there’s a quick win available here: persuading folk to persevere with their HA would be a major benefit and the cost would be relatively low.
- Patients’ acceptance of this programme would be high and certainly beneficial. Costs must be low and would allow re-enforcement at patients own pace even after prolonged use.
- This so far incomplete programme is attempting to rectify everything, how to manage hearing aids, hearing loss, listening, with a compendium of interventions, an instruction book including exercises, frequent contact by email with a hearing expert, training modules covering short films with instructions for daily life situations and testimonials consisting of experiences from other peer hearing aid users. It’s very labour intensive, so won’t save anybody any time. I don’t know if it can be generalised.

<p>| 5  | Walk, talk and listen for your life, includes auditory rehabilitation programme | British Colombia | Hearing loss | 1-hour group auditory rehabilitation programme delivered weekly alongside balance, resistance and strength training, and health education for 10 weeks. | Randomised, active-controlled; patients aged 65-90 years; n=60; Canada; completion expected December 2016 | <a href="https://clinicaltrials.gov/ct2/show/NCT02662192">https://clinicaltrials.gov/ct2/show/NCT02662192</a> | <a href="https://www.ncbi.nlm.nih.gov/pubmed/28129779?dopt=Abstract">https://www.ncbi.nlm.nih.gov/pubmed/28129779?dopt=Abstract</a> |</p>
<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
</table>

**Experts**

- My main concern in the various studies using training is take-up by people once it isn’t part of a study. Such medical interventions have mixed success because not all patients will be sufficiently diligent in doing the training.
- I could imagine very useful in NHS and private setting – allows people to take something away and learn aspects in their own time. Good that over 10 weeks which is usual in UK for follow up- do people stick to this duration?
- These materials have proved to be of benefit to many users, helping them become more familiar with using their hearing aids and encouraging them to develop better communication tactics. They help reduce the need for clinician input. They work best when complemented by volunteer support.

**Patients**

- I’m interested in the relationship between deafness and lack of functional fitness, isolation etc. I’d like to think this approach would have some value. We’ll see.
- I think the social aspect of this programme would be the most acceptable and beneficial part for patients. Social exclusion through deafness affects many people.
- This came as a surprise. The aural rehab is just something they adapt from existing programmes, while exercise is the main intervention to see how it affects...fitness, psychosocial well-being, hearing? OSFA (one size fits all)? Or genius? I do a lot of walking, and maybe if I didn’t, a programme like this would get me physically active, preventing the falls that can come from being elderly, deaf and demented? Interesting though. I’d really like to know the outcome.
B. AUDITORY AND COGNITIVE TRAINING

General comments on auditory and cognitive training:

- A general comment on auditory training is that you need to look at the evidence that the benefit from training transfers to everyday listening. Often people just get good at the training task.

| 6  | At-home auditory training | Indiana University; National Institute on Deafness and Other Communication Disorders | Age-related hearing loss | Home-based auditory training programme used alongside patients own hearing aids. Patients take home a training system that includes a tablet computer that has the training program loaded onto it, a portable loudspeaker, and some accessories. | Phase I/II | Patients aged 55-79 years with age-related hearing loss and users of binaural hearing aids; n=63; USA; study completed May 2016. | https://clinicaltrials.gov/ct2/show/NCT01950013 |

Experts

- My main concern in the various studies using training is take-up by people once it isn’t part of a study. Such medical interventions have mixed success because not all patients will be sufficiently diligent in doing the training.
- Concept is interesting and shows promise.
- Beneficial on the trained task mainly – see Humes et al papers (e.g. a,b). Great that it is home-based and allows users to this in their own home, however wondered what implications are for training and getting them to use the system on a given tablet etc. Would need to consider insurance for NHS/private if equipment is damaged by user.

Patients

- This sounds encouraging. It would be highly attractive to the patient in that it is home-based and is delivered on familiar devices like an iPad.
- No study results posted. Aims of project not very clear.
- I am for this training based on the evidence of the research. I’m not so clear as to how it would be made available and how you would market it so that people who could profit from it would know about it and also be willing to undertake. In an idealised world, audiologists could provide (free) links. There is no information on results, and one wonders if there will be competing programmes achieving the same purpose, and how to choose which works, and is there a geographical relevance, i.e. I trialled Lace when it was first in the UK and found the voices and accents off-putting and felt...

---

a Burk MH, Humes LE, Amos NE, Strauser LE. Effect of training on word-recognition performance in noise for young normal-hearing and older hearing-impaired listeners. Ear Hear. 2006 Jun;27(3):263-78. DOI: 10.1097/01.aud.0000215980.21158.a2

less engaged as a result. Who would embed it, offer the tablet, monitor, or would it eventually be self-explanatory, something that could be downloaded?

| 7 | Auditory-Verbal Therapy (AVT) via telemedicine | University of Colorado; National Institute on Deafness and Other Communication Disorders | Congenital sensorineural deafness in children | Aural-verbal therapy administered via telemedicine following cochlear implantation surgery to minority groups. | Phase II | Patients 6 months - 6 years with congenital sensorineural deafness and fitted with bilateral or unilateral cochlear implants; n=100; USA; study completion August 2019. | [https://clinicaltrials.gov/ct2/show/NCT02497690](https://clinicaltrials.gov/ct2/show/NCT02497690) |

**Experts**
- Debatable benefits – some strong proponents and critics. Need internet.

**Patients**
- Telemedicine is less relevant in UK (small area, dense population) than in Colorado (opposite). Put it on the back burner.
- Study at early stages. Difficult to assess benefits at this stage.
- The results are not yet in for this one, but I appreciate the possibility, if evidenced later, of aural-verbal therapy delivered at home without requiring a professional’s input. This is everybody’s dream, but on the other hand I suspect children are motivated to learn when they can engage with real people. I can imagine a parent saying “Come on, training time darling”, and a child not wanting to do it, as opposed to, “We’re going to see Irina today”. Again, evidence is essential.

| 8 | Cogmed Working Memory Training (WMT) | Pearson Clinical Assessment Group; Nottingham Hospitals NHS Trust; National Institute for Health Research | Adult hearing aid users | This computer-based solution is an adaptive version of the Cogmed RM working memory training. Working memory is the way that things encountered are delegated to the parts of your brain that can take action. In this way, working memory is necessary for staying focused on a task, blocking out distractions, and keeping you updated and aware about what’s going on around you. | Available | Patients aged 50-74 years with mild to moderate SNHL and a user of a hearing aid; n=62; UK; study completed October 2014. | [https://clinicaltrials.gov/ct2/show/NCT01892007](https://clinicaltrials.gov/ct2/show/NCT01892007) [http://journal.frontiersin.org/article/10.3389/fpsyg.2015.00556/full](http://journal.frontiersin.org/article/10.3389/fpsyg.2015.00556/full) [www.cogmed.com/about-working-memory](http://www.cogmed.com/about-working-memory) |

**Experts**
- While the concept is promising, generic cognitive development interventions are in my experience less valuable than specific auditory training.
- Older adults with hearing loss, report that they do not see the relevance of training on cognitive tasks (i.e. visuo-spatial and verbal WM span and storage) to their condition (Henshaw et al, in review). No benefits – see 2xRCT (Wayne et al 2016; Henshaw et al, in review)⁶.
- Barriers – requires internet access and need to be computer literate. Recommended that training completed with another ‘training aid’ (especially with children).
- Needs to be purchased from Pearson, so also cost a barrier. WMT on its own not beneficial – but could be if embedded in speech tests (see Henshaw grant application submitted) NHBRU project.

**Patients**

- Understanding speech as opposed to perceiving the noise of someone speaking is clearly a key issue, especially in the presence of background noise. This type of auditory training (AT) is therefore potentially very valuable both to the NHS and to the patient. On the face of it, once developed, this AT would be low-cost compared with the sophisticated hearing aid (HA) technology being developed in order to help achieve similar results. Persuading folk with a mild loss of the need to use HA is an ongoing issue. Does Cogmed have a strong requirement for the mildly deaf user to have a HA? If not, AT might be a more acceptable option than a HA for some. And NHS Trusts like North Staffs who threaten to discontinue the provision of HA to mildly deaf patients in order to reduce costs might view AT as at least a partial alternative solution.
- Fairly large time commitment involved. Patient acceptability and potential benefits difficult to assess without further results.
- I am for this training based on the evidence of the research. I’m not so clear as to how it would be made available and how you would market it so that people who could profit from it would know about it and also be willing to undertake. In an idealised world, audiologists could provide (free) links.

| 9 | Cognitive training | Nova Scotia Health Authority | Hearing loss, deafness and auditory perception | Cognitive training will take place 30 minutes per day, five days per week, for eight weeks. Training will be done in the participant’s own home using web-based software | In clinical trial | Randomised, active control; patients >50 years old; n=120; Canada; primary completion Sept 2017. | [https://clinicaltrials.gov/ct2/show/NCT02294812](https://clinicaltrials.gov/ct2/show/NCT02294812) |

**Experts (see Cogmed entry for additional comments)**

- My main concern in the various studies using training is take up by people once it isn’t part of a study. Such medical interventions have mixed success because not all patients will be sufficiently diligent in doing the training.
- As home based may be beneficial. 30 minutes per day sounds do-able, but would we realistically get people doing this over 8 weeks?

**Patients**

- Keep a watching brief. This is potentially a low-cost way of meeting a major requirement - i.e. helping deaf folk hear above background noise. Similar comment to Cogmed Working Memory Training (8).

---

- Study at early stages. Patient acceptance may be difficult with amount of time required. Benefits unable to assess.
- I like the idea of training being game-based, but it appears this is a study trying to ascertain whether cognitive training works, rather than to come up with a package. I believe from Cogmed Working Memory Training (8) that the evidence is already in, so I don’t understand why this is being repeated. But then again I don’t understand scientific research well enough to know if you need many studies to prove the same point, or if what appear to be the same points in two studies are indeed the same.

| 10 | Constraint-induced sound therapy (CIST) | Japan | Sudden sensorineural hearing loss | The canal of the intact ear of patients with sudden sensorineural hearing loss is plugged in order to motivate them to actively use the affected ear and thereby prevent progression of hearing loss. | Protocol stage. | www.ncbi.nlm.nih.gov/pubmed/26863274
http://hearinglosshelp.com/blog/constraint-induced-sound-therapy-for-sudden-sensorineural-hearing-loss/ |

**Experts**
- This sounds intriguing and would worry about the risk of causing an accident by plugging good ear. Would need to check that plugging the good ear doesn’t lead to unwanted cortical reorganisation in itself.
- While the concept is promising, generic cognitive development interventions are in my experience less valuable than specific auditory training.

**Patients**
- This sounds like putting a plaster on a good eye to force the use of a lazy eye. Does it work? I think I’ve read that (at least with sensorineural presbycusis) the use of a hearing aid by a failing ear slows the rate of deterioration.
- From my personal experience I would not consider this programme as realistic.
- If this is technology, then why are they speaking of exposure to music for 6 hours daily during hospitalisation? I’ve never heard of hospitalisation for Sudden Hearing Loss. This programme is innovative, however, treating the affected ear. They force it to hear by shutting down the hearing ear which might then prevent progress of maladaptive cortical reorganization. Is this realistic, however? Who’s going to be on hand to suggest and administer? It is rare to find a GP or even hospital facility that knows enough about the condition to suggest an intervention other than dearie go home and rest
and take these anti-dizzy tablets. Maybe in Japan they handle it differently? But even if this worked, the NHS wouldn’t hospitalise people and give them music. Come on!

| 11 | Listening and Communication Enhancement (LACE) Online | Neurotone, USA | Hearing loss | For HA users, DVD or computer training tool. Aim to retrain the brain to comprehend speech better in difficult situations such as noisy environments, rapid or competing speakers. LACE is to become available online (LACE Online) to replace the LACE home edition. | Launched | LACE Online became available in November 2016. | www.neurotone.com/lace-interactive-listening-program |

**Experts**
- My main concern in the various studies using training is take-up by people once it isn’t part of a study. Such medical interventions have mixed success because not all patients will be sufficiently diligent in doing the training.
- Great that home based and can use on the go – I’m not sure of recommendations though on time and over how long these tools are designed to use.
- Has been used for many years. Generally very positive user response, with measurable improvements. Very glad to see that it will be available online because it’s primary disadvantage to date has been restricted distribution options. Although the best way to use this is with monitoring from an audiologist, I have known a number of people to use this successfully without any professional involvement. The interventions are face-valid, and address situations that cause the greatest difficulty.
- Been around for years. Acceptable?? Compliance in the general population is poor (30%)\(^d\). Benefits – questionable – Sweetow (inventor) 2006 showed benefits but large RCT showed no benefits\(^e\); but still some question marks around where benefit might be shown i.e. right outcome measures. Online? Comes at a cost?

**Patients**
- LACE sounds to be of major interest in that it is a low-cost way of drowning out background noise. I see LACE has already been launched. Does it work?
- The aims to improve listening skills would certainly be acceptable to patients and if success full could be of great benefit. Costs could be a potential stopper for patients.
- I piloted this though only partially but assume it can be effective as it is in existence. It is used by private audiologists. I like the promotional video. Marketing is no doubt a big issue in all these re-educating programmes.

---


### C. ASSISTIVE LISTENING DEVICES

<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Deafalarm</td>
<td>iPhone</td>
<td>Deaf</td>
<td>iPhone app to notify deaf people of audio alarms in their vicinity. The app runs in the background listening for the repetitive signature sounds of alarms. When an alarm goes off, it triggers the phone to vibrate and displays a message on the screen to notify the user. For added safety, the app will also vibrate the phone whenever it is turned off and when the phone itself powers down due to low battery charge.</td>
<td>Available</td>
<td></td>
<td><a href="http://www.medgadget.com/2014/04/deafalarm-keeps-deaf-folks-on-notice-whenever-an-audio-alarm-rings.html">www.medgadget.com/2014/04/deafalarm-keeps-deaf-folks-on-notice-whenever-an-audio-alarm-rings.html</a></td>
</tr>
</tbody>
</table>

**Experts**
- A good example of how apps can make a difference to the lives of those with profound hearing losses.
- This does not comply with Health and Safety regulations of smoke alarms.
- Interesting concept, but only of value to someone with a profound, un-aidable hearing loss.
- Barriers – require compatible iPhone device. Need to be competent in using device also.

**Patients**
- Interesting and potentially useful, although I’m struggling to see its value over and above current alarms for deaf people. The biggest risk is not hearing an alarm at night when you’re asleep. This can be addressed by a vibrating pillow. It’s doubtful whether a vibrating phone would be effective. So... limited value. If I were the developer, I’d make the phone vibrate when it hears a remote phone ringing. I often miss calls that come in on the home phone because I’m in a different room from the home phone although I have my mobile with me.
- Use of existing equipment and technology would make this app very acceptable to patients and beneficial safety improvement.
- Interesting. You download it for $3 if you have an iPhone and are a deaf “folk”. I may be American, but I hate some of this promotional language usage.

<p>| 13 | Google Glass App | Georgia Institute of Technology | Hard-of-hearing | Captioning on Glass uses a companion Android phone app for everyday conversations. A hard-of- | Withdrawn from sale | | <a href="http://www.news.gatech.edu/2014/10/02/researchers-create-software-google-glass.html">www.news.gatech.edu/2014/10/02/researchers-create-software-google-glass.html</a> |</p>
<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>hearing person wears Glass while a second person speaks directly into a Smartphone. The speech is converted to text, sent to Glass and displayed on the heads-up display in real time.</td>
<td></td>
<td></td>
<td>glass-provides-captions-hard-hearing-users</td>
</tr>
</tbody>
</table>

**Experts**
- As google glass has been withdrawn from sale, can’t see the relevance for this specific product. Anything however that could deliver live and accurate subtitling to the spoken word must be of interest.
- Google Glass is no longer made, although in the future they’ll be other AR technologies that could be used. E.g. Microsoft Hololens, but this is currently thousands of dollars to buy.
- Our members have considerable interest in this, but none have had the opportunity to test it.
- Barriers – require compatible Android/Google device. Need to be competent in using device also.

**Patients**
- I’ve read about this before on the deaf forums and I like it. What I especially like is the deaf listener’s ability to listen, lip-read and read the captions at (almost) the same time. This is how moderately and severely deaf people watch TV. My ears do their best to hear the speaker while my eyes flick between the speaker’s lips and the subtitles. I don’t have to do this deliberately - my brain just does it automatically. This new solution sounds similar in that regard.
- Costs allowing this would be very acceptable to patients in one to one situations.
- I think I’ve heard of something like this for theatre-goers too. All this technology is really exciting when available and inexpensive on the open market. It’s also always limited in how much it can be used, where you use it, how many people can access, and the description of it here talks about trying to make out speech without it and then checking up using the app—that’s quite sophisticated multi-tasking.

<p>| 14 | Speaker system | University of Southampton | Hearing loss | A speaker system that can focus high volume audio on one person while letting everyone else in the room hear things at normal levels. The system consists of loudspeakers that are phase-shifted in respect to each other to create a &quot;hot-spot&quot;. Unlike other similar systems, the new technology gets rid of a speaker |                   |                           | <a href="http://www.southampton.ac.uk/news/2014/11/13-tv-sound-system.page#">www.southampton.ac.uk/news/2014/11/13-tv-sound-system.page#</a> |</p>
<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>array placed in the back of the room that has been used to cancel out audio waves that approach the listeners from the rear.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Experts**
- This already exists and is called hypersound. The retail price detracts from its accessibility.
- Technology similar to this exists for public exhibitions but due to price is not suitable for personal use.
- We have no access to test the system, but most respondents were sceptical of its value in public or domestic situations. It is difficult to see in what way this is an improvement on current assistive listening options.
- Similar to FM (personal frequency modulation systems). Our systematic review found that FM systems paired with hearing aids can improve speech intelligibility, listening abilities and hearing-specific QoL, relative to unaided and hearing aid only conditions.

**Patients**
- Interesting development. Does it address the deaf person's need for clarity as well as loudness? It doesn't seem to, in which case the solution is only partially effective. Presumably the deaf person in the family will have to have his own armchair in the hot spot, which would then be known as the "deaf armchair." There will be a vocal lobby complaining that solutions like this only serve to make h/a even less attractive. I look forward to interesting debates on social media! I do high level counselling for deaf people, and even when this new sound system is available, I will continue to press people to get a h/a to enable them to hear the TV better.
- Seems like a gismo to me.
- This sounds like one of those improvements that audiologists, hearing therapists or local authority helpers should know about. Yes, it could be good for a hard of hearing person to be able to turn the volume up without affecting other people in the room. But maybe the same has been affected with the ReSound hearing aid in number 25. And how much would this cost? It doesn’t sound as if it’s been rolled out anyway.

15 Transcense App Ava Deaf and hearing impaired The Transcense app listens for voices and transcribes the conversation it is hearing. It recognises different speakers that are participating in a conversation and colours each person’s transcribed text with a different colour to ensure the person Available www.ava.me/

---

<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>UNI sign to speech and speech to text</td>
<td>MotionSavvy</td>
<td>Deaf and hearing impaired</td>
<td>Two-way communication tool that converts sign language to speech and speech to text. UNI consists of a tablet computer, a smart case and a mobile app. The smart case contains hardware from Leap Motion with cameras to track the user's hands and fingers. The app, powered by the tablet, translates the hand and finger movements into audible speech or text. The app can also translate.</td>
<td>Available</td>
<td><a href="http://www.motionsavvy.com/#learn-more">www.motionsavvy.com/#learn-more</a></td>
<td><a href="https://www.youtube.com/watch?v=Kj51RNZAM9k">https://www.youtube.com/watch?v=Kj51RNZAM9k</a></td>
</tr>
</tbody>
</table>

**Experts**
- Very cool. I downloaded it immediately. The party mode will require everyone to be on the same platform but it seems to work well. Could be part of selection of apps recommended to patients as long as they are happy to install and manage.
- Current speech to text technologies have advanced greatly, but are not so far advanced to deal with the situation described e.g. multiple speakers in conversation.
- Currently accuracy is poor and the microphone needs to be held close to speaker’s mouth in order not to pick up other voices in the room.
- No comment on this device in respect of its ability to translate sign language, but converting speech to text would be of interest if it is a significant improvement on current options such as Dragon and Siri, both of which are freely available and perform reasonably well at speech to text options. We would be extremely interested in seeing the development of this app.
- Barriers – require compatible smartphone/tablet. Need to be competent in using these devices also.

**Patients**
- Looks interesting and useful. Does it mean the deaf person must have two phones - one for the speaker and another for the deaf listener? Do the phones need to be identical? What if there are multiple separate groups in the same room, each group having its own conversation with these phones at the same time. These issues need to be thought through.
- Early stages yet. Concept would be acceptable though and certainly beneficial in group discussions. How will noise interference be filtered?
- So this exists already, it seems, and can be downloaded. It seems a great possibility, although will you really get everybody to download it on their phone when you’re in a group situation? I think it’s only for iphone. But it will succeed on the open market I’m quite confident.
<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>spoken word into written text for the deaf person to read.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Experts**

- A great way to bridge the gap between those who are profoundly deaf and those who still have hearing. Relevant to a small part of the population however.
- For accurate translations, lip patter is required with hand gesture recognition. To be truly sign language friendly, spoken word needs to be translated into sign language not text.
- No comment on this device in respect of its ability to translate sign language, but converting speech to text would be of interest if it is a significant improvement on current options such as Dragon and Siri, both of which are freely available and perform reasonably well at speech to text options.
- Barriers – require compatible smartphone/tablet. Need to be competent in using these devices also.

**Patients**

- There's not a lot of info about this but it sounds as though it hasn't been thought through. It's one thing to translate BSL to speech. But I would have thought there's just as strong a need to translate speech into BSL. Let's look again once this can be done too. What we need are complete solutions. This is only a stepping stone towards one. Other points: what about other sign languages - BSL vs ASL etc? Compatibility with different makes of smartphone? And the speech-text feature looks like a free add-on.
- I would think this very acceptable and beneficial to those patients either profoundly deaf or totally dependent on HA’s. Costs may be a consideration. Blind patients have had text to sound (and vice versa) convertors for many years.
- The link provides a promotion video demonstrating how the tablet translates sign language into text. It’s in America so presumably ASL. Is it here too? Seems impressive. Anyway it’s for sale there it would appear on the open market.
### D. HEARING AIDS AND ALTERNATIVE LISTENING DEVICES

<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>Cartilage conduction hearing aids</td>
<td>Japan</td>
<td>Hearing impairment - not satisfied with traditional hearing aids</td>
<td>A vibration signal delivered to the cartilage in the ear via a transducer; to produce audible sound is referred to as a cartilage conductor. This is different to bone conduction.</td>
<td>Efficacy and safety (phase II)</td>
<td>Single arm, non-randomised; &gt;2 years of age; not satisfied with normal HA; n=50;</td>
<td><a href="https://upload.umin.ac.jp/cgi-open-bin/ctr_e/ctr_view.cgi?recptno=R000023173">https://upload.umin.ac.jp/cgi-open-bin/ctr_e/ctr_view.cgi?recptno=R000023173</a> <a href="http://asa.scitation.org/doi/abs/10.1121/1.4969094">http://asa.scitation.org/doi/abs/10.1121/1.4969094</a></td>
</tr>
<tr>
<td>18</td>
<td>Eargo hearing aids</td>
<td>Eargo</td>
<td>Hearing loss</td>
<td>Eargo is a pre-programmed suspendable hearing aid intended for mild to moderate hearing loss. Designed to provide amplified sound and extended frequency range up to 7750 Hz. Uses flexi fibers of silicone which allow natural bass sounds to pass right through.</td>
<td>Available</td>
<td>Launched June 2015.</td>
<td><a href="http://eargo.com/products">http://eargo.com/products</a></td>
</tr>
</tbody>
</table>

**Experts**
- Can’t see how this adds to the current bone conduction solutions available today.
- Potentially more suitable for bone-conductive losses.

**Patients**
- I don’t understand this. What I would say is that I’m not convinced that there are problems with bone conduction that would justify developing cartilage conduction devices.
- Results of tests not given. Could be of limited benefit and would be acceptable to patients.
- There is so little written about it that it’s impossible to assess. The way it’s written, anybody not satisfied with hearing aids could try this? No, there’s got to be a more specific brief than this.

- Similar in concept to iHear but the price makes it prohibitive. Suspect that they are trying to take advantage of relatively high prices of hearing aids in U.S. market. Rechargeable nature of batteries will appeal to any provider obliged to supply.
<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>iHEAR HD</td>
<td>iHear Medical, Inc.</td>
<td>Hearing loss</td>
<td>Uses digital signal processing (DSP), miniature transducers, directional hearing, wireless interface and rechargeable battery. It is digitalised and programmable for a broad range of hearing loss. Replaceable battery module that lasts for 7-10 days, includes a USB device for individualised programming.</td>
<td>In approval Process</td>
<td>Estimated approval September 2017; estimated launch December 2017.</td>
<td><a href="http://www.ihearmedical.com/">www.ihearmedical.com/</a> ihear-hd/</td>
</tr>
</tbody>
</table>

**Experts**
- One of the most attractive off the shelf solutions I’ve seen. If it delivers on promises of sound quality, fit and ease of use should be really interesting. Any product that can be distributed without the clinician will be of interest to NHS.
- I would want to see measurements on the effectiveness of the devices. I couldn’t see any on the website.
- Needs clear guidelines if it becomes an off the shelf product or is introduced as part of the hearing aid fitting pathway.
- Benefits - allows user to customise hearing aid settings online at a time that suits the user. Barriers – requires internet access and computer literacy.

**Patients**
- I believe this HA will be very popular thanks to its small size, rechargeable batteries and esp the capability of programming it yourself. As the online
Chat rooms demonstrate, a perennial issue is having to go back to audiology to have your HA reprogrammed. There would therefore be great value in being able to do this yourself, although the option of getting it done by audiology would need to be available given the likely computer illiteracy of many deaf (and elderly) people. On the other hand, there would clearly be a strong requirement for high quality documentation and an ergonomic interface for the software. And probably a good quality helpdesk function. This is the sort of HA that could really increase take-up by mildly deaf folk provided the programming function is easy to use, robust & reliable and well supported.

- The seemingly deep insertion of the HA looks like a drawback. Costs may also be unacceptable to patients or NHS. Benefits could be good however and acceptance with younger HA users is likely.
- This is the future of hearing loss, a hearing device you order online and program yourself for only $299. Everybody in the UK says it will never take off.
- You need an audiologist or someone involved in your treatment. I don’t know. They expect it to be approved in the USA. Is it here? I can’t comment without trying it out myself. Should I? I’d better do it soon before the hearing loss dementia sets in because obviously it will require a bit of skill to program myself. With the shutting down of audiology departments here and AQP, I can actually envisage a day when you’re advised that this is the way forward.

<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Lyric</td>
<td>Phonak</td>
<td>Mild to moderately-severe hearing loss</td>
<td>Invisible CIC hearing aid. It can be worn 24 hours a day, seven days a week for months. It can be worn during daily activities such as showering and sleeping. Lyric uses minimal processing and can be used with normal external headsets. Insertion is by a trained hearing professional. A special tool is required for removal and volume adjustment.</td>
<td>Available in UK and EU</td>
<td>Post-marketing trial complete 2014; n=177; USA</td>
<td><a href="https://www.clinicaltrials.gov/ct2/show/NCT01861704?term=NCT01861704&amp;rank=1">https://www.clinicaltrials.gov/ct2/show/NCT01861704?term=NCT01861704&amp;rank=1</a></td>
</tr>
<tr>
<td>21</td>
<td>Earlens</td>
<td>EarLens Corporation</td>
<td>Mild to severe sensorineural hearing impairment</td>
<td>Consists of two parts: a tympanic membrane transducer which is placed on the eardrum, and a behind-the-ear audio processor that is connected to an ear tip in the ear canal. Sounds are converted to electronic signals, digitally processed, amplified and sent to the ear tip, which contains a laser diode</td>
<td>Available in USA</td>
<td>NCT study; open label; n=48; completed Jan 2015</td>
<td><a href="https://clinicaltrials.gov/show/NCT02042404">https://clinicaltrials.gov/show/NCT02042404</a></td>
</tr>
<tr>
<td>ID</td>
<td>Technology name</td>
<td>Developer or place</td>
<td>Indication</td>
<td>Technology description</td>
<td>Development status</td>
<td>Clinical trial information</td>
<td>Further information</td>
</tr>
<tr>
<td>----</td>
<td>-----------------</td>
<td>-------------------</td>
<td>------------</td>
<td>------------------------</td>
<td>-------------------</td>
<td>---------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>sending out pulses of light. A photodetector in the tympanic membrane transducer converts the light back into electronic signals, transmitting sound vibrations directly to the eardrum by direct contact. The light signal wirelessly transmits both signal and power to the TM transducer. The removable transducer is customized for each patient, is placed and removed by a physician, and is designed to reside in the ear for long periods of time.</td>
<td>Early development</td>
<td>Product is currently in early stages of development and testing</td>
<td><a href="http://www.medgadget.com/2015/01/new-device-delivers-sound-through-tongue-to-let-deaf-people-hear-video.html">www.medgadget.com/2015/01/new-device-delivers-sound-through-tongue-to-let-deaf-people-hear-video.html</a></td>
</tr>
<tr>
<td>22</td>
<td>Tongue neuro-stimulator</td>
<td>Colorado State University</td>
<td>Deafness or hearing impairment</td>
<td>A flat shaped stimulator with electrodes in a grid at one end connected wirelessly via Bluetooth to an earpiece that captures sound. The system processes the audio signals received by the earpiece and converts them into electrical pulses that are delivered through the stimulator. The user presses his tongue against the electrodes on the mouthpiece and feels tingling or vibration. The idea is that this sensation (sound interpreted differently) can be translated by the brain into perceived audio if given proper training.</td>
<td>Early development</td>
<td>Product is currently in early stages of development and testing</td>
<td><a href="http://www.medgadget.com/2015/01/new-device-delivers-sound-through-tongue-to-let-deaf-people-hear-video.html">www.medgadget.com/2015/01/new-device-delivers-sound-through-tongue-to-let-deaf-people-hear-video.html</a></td>
</tr>
</tbody>
</table>

**Experts**
- If this makes it to market I'll be impressed.
- Is the device practical? How long is the training time?
- Don’t see this as being widely accepted by people with a hearing loss.
<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>Interactive hearing aid tuner platform, ABRUMED</td>
<td>AudioPlua Concept AS; SINTEF, Norway</td>
<td>Hearing impairment</td>
<td>Touch screen display brings together different sound profiles that a user typically experiences e.g. peripheral voices at the office or cars passing. The system stimulates these audio situations and the patient provides feedback on what is easy or difficult to hear. The audiologist adjusts the settings on the hearing aids. Additional sound sources can be pulled in and out of the visual scenes to create environments of different complexities. There is a Smartphone app that can be used by the patient to record sounds that create particular hearing problems. These can be imported into the in-clinic interface.</td>
<td>Ready to commercialise</td>
<td>Ready to commercialise</td>
<td><a href="http://www.sintef.no/en/latest-news/users-to-fine-tune-hearing-aids-themselves/">www.sintef.no/en/latest-news/users-to-fine-tune-hearing-aids-themselves/</a></td>
</tr>
</tbody>
</table>

**Patients**
- Very interesting but still at the science fiction stage. It’s widely believed that folk with a sensory disability can compensate with a corresponding super-ability in another sense. It’s very early days yet for this device. Surely there’s no case for committing resources to it yet.
- Sounds very experimental.
- At the moment it’s only at the press release stage but one of a number of wild cards to bear in mind as future possibilities.

**Experts**
- Will be interesting to see if a hearing aid manufacturer picks this up. Suspect something like it already in development. Anything that has the potential to improve outcomes for patients should be taken seriously.
- There are quite a few self-tuning applications for hearing aids. My concern is whether amateurs can really do this with an app. There is already a problem of take up with hearing aids, with one issue being the performance of the devices.
- No opportunity for our members to test this directly, but we welcome the trend to involve the hearing aid user more and more in the programming of their own hearing aids. Having an audiologist programming hearing aids in a clinic is by far the least effective way to ensure that the aid delivers sounds in a way that is of greatest benefit to the user. Disagreements between user and clinician about the programming of the hearing aid is one of
<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SelfFit</td>
<td>Two Pi Signal processing Applications; Academic Medical Centre Amsterdam</td>
<td>Hearing loss</td>
<td>SelfFit is a mobile medical app for hearing device adjustment. It is a 3-step procedure for user-driven adjustment of hearing devices i) screening of mild to moderate hearing loss, ii) first-fit and iii) interactive fine-tuning.</td>
<td>Available</td>
<td><a href="http://www.tow-pi.com/?p=472">www.tow-pi.com/?p=472</a></td>
<td></td>
</tr>
</tbody>
</table>

**Experts**

- Will be interesting to see if a hearing aid manufacturer picks this up. Suspect something like it already in development. Anything that has the potential to improve outcomes for patients should be taken seriously.
- There are quite a few self-tuning applications for hearing aids. My concern is whether amateurs can really do this with an app. There is already a problem of take up with hearing aids, with one issue being the performance of the devices.
- If someone is detected as having a more severe loss can they still use the app?
- No opportunity for our members to test this directly, but we welcome the trend to involve the hearing aid user more and more in the programming of

---

<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>ReSound LINX hearing aid</td>
<td>GN ReSound</td>
<td>Hearing loss</td>
<td>Small wireless receiver-in-the-ear hearing aid system intended for direct streaming of sound from iPhone, iPad and iPod touch. It utilises hearing aids like wireless headphones to talk on the phone, listen to movies and music in stereo sound without the need for an additional remote control or intermediate body-worn devices. It has an app that provides volume and equalizer settings. It also features a find function to pinpoint hearing aids if misplaced.</td>
<td>Approved</td>
<td>Available for download. Launched February 2014 (Global)</td>
<td><a href="http://www.resound.com/hearing-aids/linx2">http://www.resound.com/hearing-aids/linx2</a></td>
</tr>
</tbody>
</table>

**Patients**
- Benefits - require limited input from a qualified clinician. Lead to potential NHS cost savings. Barriers – require compatible smartphone/tablet. Need to be competent in using these devices also.

**Experts**
- Smartphones are here to stay and the baby boomers who will contribute to a growing ageing population will take them with them. Any device that can bridge to smartphones will have significant advantages through mobilization of apps but also some interesting challenges for clinicians. However, if smartphones are part of the way ahead then it suggests health inequalities for those who can’t access them.
<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>SM-R790, Earcle</td>
<td>Samsung Electronics Co. Ltd.</td>
<td>Hearing Impairment</td>
<td>Wearable device that wirelessly connects a receiver via a repeater on a Smartphone. The microphones and control button can be used to improve the audio in different scenarios, such as restaurants, and concerts. There is also an automatic mode that changes based on the noise levels of the surroundings.</td>
<td>In approval process</td>
<td></td>
<td><a href="http://www.sammobile.com/2015/12/21/samsung-hearing-aid-sm-r790-bluetooth/">www.sammobile.com/2015/12/21/samsung-hearing-aid-sm-r790-bluetooth/</a></td>
</tr>
</tbody>
</table>

**Patients**
- This technology is still under development as part of an EPSRC project (**S3A – Future Spatial Audio in the Home**).
- In the UK this is only available for a small number of hearing aid users. Need a push to make these technologies available to more patients through the NHS to increase uptake of hearing aids.
- Of the few people we know who have this device, they all find it useful and for some it has enabled them to return to meaningful employment. Of particular value, apart from the high quality sound, is the ability to use an iPhone to control the hearing aid settings. This normalises hearing support.
- Benefits - allow user to customise hearing aid settings at a time that suits the user via smartphone. Barriers – require compatible smartphone/tablet. Need to be competent in using these devices also.

**Patients**
- ReSound looks very attractive, esp. as a means of getting young folk to use hearing aids. More and more young people will become deaf through listening to loud music either on smart phones or at clubs. Ironically, these are the very people that will resist using hearing aids because they are uncool. ReSound addresses the "uncool" issue with its wireless connection to an iPhone etc, allegedly while improving sound quality compared with a traditional HA. The app looks good, esp. the capability to tune your aids. Two downsides: ideally needs to be compatible with ALL makes of smartphone; and the effect is somewhat spoiled by the BTE aids - CIC would have been more acceptable if the technology allows.
- Would be beneficial to patients dependant on HA’s. Acceptance would not be problem especially with younger patients.
- I think you can’t get these on the NHS though everybody would want them, provided the hearing aids they go with work well. I’d like them. I have heard them criticised for only making this software available on the iphone-it’s quite a bias. But I’m saving up.
- The ReSound Multi Mic tool works with ReSound Smart hearing aids to help improve the signal-to-noise ratio, making it easier to understand speech in noisy situations. It was trialled by three people in the latest Action on Hearing Loss Magazine.

**Experts**
- Aside from the potential benefits of the app hinted it, the brand is the biggest potential benefit. Brand power cannot be underestimated and coupled with android platform has to be of interest to the NHS. Smartphone connections are important and android phones are more accessible and popular than Apple.
<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>Binaural spatialization in wireless microphone systems for hearing aids</td>
<td>Sonova Holding AG; Ecole Polytechnique Fédérale de Lausanne; Phonak</td>
<td>Hearing loss in hearing aid users</td>
<td>New feature of existing FM systems which allows localisation of sounds. It is now possible to include binaural spatialization of the speech signal in the Roger product of Phonak hearing devices.</td>
<td>Phase II/III</td>
<td>Adults, normal or moderate to severe hearing loss; non-randomised; n=40; Switzerland; study completed July 2016.</td>
<td>ClinicalTrials.gov/show/NCT02693704</td>
</tr>
</tbody>
</table>

**Experts**
- Take up of wireless peripherals for hearing aids is still disappointing and may be left behind by smartphone technologies. Effectiveness of accessories also presents an interesting challenge for NHS - where does funding end for equipment?
- Use of binaural sounds like a good idea and probably has benefits, but I haven’t seen an independent scientific study demonstrating it works.
- FM systems used largely in education by children under 16. Need trials to support use in this environment.

**Patients**
- The Roger brand is well respected by deaf patients. Drowning out background noise is a top priority for most deaf folk. If it's effective, it's worth taking on. A downside might be compatibility issues with non-Phonak devices.
- Improvement in HA sound system. Benefits difficult to understand from results given. Idea would be highly acceptable to patients especially those using current HA’s.
- I can imagine that this new feature of the Roger product would be a surprise to its users. Until now they’ve been aiming simply to make out speech of the speaker. With this, all of a sudden it won’t just be a microphone but a sense of where the speaker is speaking from. I guess this would make listening feel improved and more natural.
### E. IMPLANTS AND DEVICES

<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
<td>System-on-chip Cochlear Implant</td>
<td>Massachusetts Institute of Technology; Harvard Medical School; Massachusetts Eye and Ear Infirmary</td>
<td>Hearing loss</td>
<td>Unlike traditional cochlear implants, the low-power chip requires no external hardware. The device also uses natural mechanisms in a patient’s middle ear to help increase sound. The chip could be wirelessly recharged and run for 8 hours on each charge.</td>
<td>Feasibility testing, prior to clinical trials.</td>
<td></td>
<td>news.mit.edu/2014/cochlear-implants-with-no-exterior-hardware-0209</td>
</tr>
</tbody>
</table>

**Experts**
- An interesting idea but will this really make CIs more appealing?

**Patients**
- I agree with MIT News: “It’s very cool,” says Lawrence Lustig, director of the Cochlear Implant Center at the University of California at San Francisco. “There’s a much greater stigma of having a hearing loss than there is of having a visual loss. So people would be very keen on losing the externals for that reason alone. But then there’s also the added functional benefit of not having to take it off when you’re near water or worrying about components getting lost or broken or stolen. So there are some important practical considerations as well.” If it works and is cost-justifiable, this could be the future of CIs.
- A CI without the external fitments would be very acceptable to patients. The battery life may be a drawback although it sounds like technicians working on this.
- If MIT is actually coming up with a CI that doesn’t require any external hardware, then obviously when it's affordable, all CI users will want it. Nobody likes a device that shows. People put up with it because they can hear. Fingers crossed.

<p>| 29 | Closed-loop Cochlear Implant | Trinity College Dublin | Hearing Impairment | Measures brain signals to estimate speech perception ability and automatically optimise electrical | Available for commercialisation |  | <a href="http://www.tcd.ie/innovation/exchange/technologies/biomedical/closed-loop-">www.tcd.ie/innovation/exchange/technologies/biomedical/closed-loop-</a> |</p>
<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>759</td>
<td>Cochlear Nucleus Fitting Software</td>
<td>Cochlear, Clinical Care Innovation</td>
<td>Hearing loss - adults, post-lingual deafness</td>
<td>Simplified fitting method with a component of a suite of tools which reduces fitting to simple volume, bass and treble adjustments. Aims to provide CI recipients with the same hearing outcome as the current clinical fitting method.</td>
<td>Randomised, cross-over; patients aged &gt;18 years; n=48; Germany and Switzerland; primary completion December 2017.</td>
<td></td>
<td><a href="https://clinicaltrials.gov/ct2/show/NCT02228148">https://clinicaltrials.gov/ct2/show/NCT02228148</a></td>
</tr>
</tbody>
</table>

**Experts**
- I would like to see data demonstrating the brain signals being used successfully. There are also issues around the adaptation that the brain makes to compensate for the implant signals.

**Patients**
- This is impressive - a useful add-on to improve speech perception by CI users. Given the high cost of the whole CI process and the total reliability on CI by the user, I would have thought this add-on would represent a relatively small percentage uplift in cost while providing a high level of benefit. Worth pursuing, in my view.
- Early stages of project unable to comment. Acceptability likely to be age dependent and results orientated.
- This is just the beginning here as well but anything that optimises the success of CI use has to be a boost to the world. It sounds like a fantastic use of remote technology. Patients often wait a long time for appointments, and it’s a stressful time. Having ongoing treatment via Smartphone and monitoring could be an encouraging development.

- Worth pursuing if it leads to a significant cost reduction with no functional degradation and no additional effort, time or discomfort for the patient.
- Difficult to comment since results not posted. Anything which improves sound quality of CI would be acceptable and beneficial to patients with CI.
- With my limited understanding, this company is suggesting a different method of fitting cochlear implants, which hasn’t been completed. I can’t really...
compare current measures with the ones they are trialling. Good luck, if simple means better.

31  | Firmware - feedback canceller algorithm | Cochlear | Hearing loss - moderate to severe (Carina implant users) | A feedback canceller algorithm for patients with CI or Otologics Carina implant, which evaluates the functional gain and speech understanding benefit for the patient with automatic adaption for feedback cancellation without prior calibration. | Randomised, active control algorithm; n=12; France; primary completion date September 2017. | https://clinicaltrials.gov/ct2/show/NCT02309541 |

**Experts**
- Active noise control is a good idea but data that could show effectiveness not yet collected.
- Algorithm for a CI rather than new device per se.

**Patients**
- Firmware solutions are generally worth pursuing because they are quick wins - i.e. low-cost and easy to install but with high benefit. But first of all we obviously need to make sure the firmware actually does what it sets out to do.
- Difficult to comment since results not posted. Anything which improves sound quality of CI would be acceptable and beneficial to patients with CI.
- Hmmm - again this is just in the offing, attempting to deal with feedback in cochlear implants. I didn’t know there was feedback in CIs, and so wouldn’t be able to analyse the importance of this, if it were successful.

32  | HiRes Fidelity 120 Paediatrics | Advanced Bionics, LLC | Hearing impairment in children | A high resolution CI system with multiple current sources so two or more electrodes can be stimulated at the same time. It allows current to be steered between electrodes giving recipients 120 spectral bands of sound. It will be available only with the Harmony HiResolution Bionic Ear System and the Platinum Series (PSP) Sound Processor. | Available for adults in USA | https://www.advancedbionics.com/com/en/home/products/sound-processing/hires-fidelity-120.html |

**Patients**
- This is a specialist device specifically for paediatric patients, which obviously narrows its scope and therefore its value. Its compatibility is restricted to...
certain types of CI. I can’t comment on how restrictive these characteristics would be in practice. Is it best to provide a deaf patient with a CI at as young an age as possible rather than waiting until they are more mature? If so, this device looks useful.  
- Refinement of Cochlear implant. Targeted at children. Benefits high for children who will gain most out of improved CI.  
- I read somewhere that you can have too many bands of sound. The link says it’s mostly to give children music, which should be thought about as part of listening so this sounds very positive. It’s not something a healthcare system would provide, I expect.

<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
<td>Nucleus Hybrid S12 - short cochlear implant</td>
<td>Cochlear</td>
<td>Children and adolescents with severe sensorineural hearing loss and residual low-pitch hearing</td>
<td>Stimulates the high-frequency, basal region of the cochlea while maintaining some acoustic hearing in the low-frequency, apical region. Uses a short, thin, straight intra-cochlear electrode array attached to a Nucleus CI receiver/stimulator. The array incorporates a collar to prevent over-insertion, or further migration, into the cochlea beyond the point where the basal turn curves into the ascending segment.</td>
<td>In trials</td>
<td>Uncontrolled; patients aged 5 years and older; n=45; USA; primary completion July 2020.</td>
<td><a href="https://clinicaltrials.gov/ct2/show/NCT01975571">https://clinicaltrials.gov/ct2/show/NCT01975571</a></td>
</tr>
</tbody>
</table>

**Patients**
- Does this solution provide a CI that works in joint-harness with residual hearing in the same ear? If so, it sounds worth pursuing provided that the solution is no less effective than the current standard CI implementation. I think protecting (indeed capitalising on) existing hearing ability would make CIs more acceptable to both patient and NHS.  
- Sounds very experimental. Patient benefits and acceptance would depend very much on results.  
- This is in its formative stage but sounds again a great improvement to refine the quality of hearing in the affected group.

<p>| 34 | Electro-Acoustic Transducer | Fraunhofer Institute for Manufacturing Engineering and Automation | Hearing Impairment | Piezoelectric micro-actuator designed to transmit acoustic signals to the inner ear. It is placed between the middle and inner ear at the round window. It is a laminated composite made from piezo-ceramics and silicon. If voltage is | Clinical | Estimated approval October 2017; estimated launch January 2018. |</p>
<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Partial Ossicular Replacement Prosthesis (PORP)</td>
<td>Dastghaib Hospital Shiraz, Iran</td>
<td>Otitis media</td>
<td>Ossicular reconstruction in patients with chronic otitis media has contributed significantly to the improvement of their hearing and because of the variety of prostheses. Polycel and titanium prosthesis have been trialled.</td>
<td>Double-blind, randomised clinical study; patients aged 15-70 years; n=100; Iran; recruitment end date December 2015.</td>
<td><a href="www.irct.ir/searchresult.php?id=15496&amp;number=19">www.irct.ir/searchresult.php?id=15496&amp;number=19</a></td>
<td></td>
</tr>
</tbody>
</table>

**Experts**
- Any device involving this degree of surgery will really limit take up.

**Patients**
- How common is the requirement for this kind of device - i.e. a middle ear implant? And, if common, are there suitable devices available today? If this device is really a break-through, then it deserves monitoring and ongoing evaluation. But presumably the admin and processes around it would be a huge overhead, as with CIs today - eligibility, assessment, preparation, surgery, training, follow-up, etc.
- Unable to comment. Appears to be very early days and quite experimental. Acceptability would be dependent on results.
- This also sounds great, if I really understood.

- Interesting, but not a game changer.

**Patients**
- Ossicular reconstruction appears to be effective and sounds like a worthy component of NHS's toolkit if it isn't already. I think the trials involving polycel, etc should be allowed to complete and some other organisation encouraged to try using it in earnest before the NHS or other UK agencies commit to it. Keep a watching brief.
- Interesting idea but it has to be trialled and then surgeons will decide.
**F. DRUGS**

<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
<td>AM-111 (AM111; XG-102; XG102; D-JNK1-1)</td>
<td>Auris Medical (Licensee), ribOvax Biotechnologies (Collaborator)</td>
<td>Severe to profound idiopathic sudden sensorineural hearing loss (ISSNHL)</td>
<td>XG-102, intra-tympanic membrane injection, selectively blocks JNK MAPK-mediated apoptosis of stress injured hair cells and neurons in the cochlea as a result of acute acoustic trauma, sudden deafness or during middle/inner ear surgery.</td>
<td>Phase III; EU orphan drug status</td>
<td>1. Aged 18-65 years with severe to profound unilateral ISSNHL; n=255; Bulgaria; study completion Sept. 2017. 2. Aged ≥18 years with unilateral ISSNHL; n=300; USA; study completion date June 2018.</td>
<td><a href="https://clinicaltrials.gov/ct2/show/NCT02561091">https://clinicaltrials.gov/ct2/show/NCT02561091</a> clinicaltrials.gov/ct2/show/NCT02809118 <a href="https://clinicaltrials.gov/ct2/show/NCT00802425">https://clinicaltrials.gov/ct2/show/NCT00802425</a></td>
</tr>
</tbody>
</table>

**Experts**
- Is delivered by intra tympanic injection, so may limit uptake/ease of administration. Would need to be an ENT.

**Patients**
- I have always wondered how you recruit participants for a study which requires you to have suddenly lost your hearing within a few hours of the trial. There are no results as yet.
- Drug trial if successful would benefit patients.

| 37 | Ancrod | Nordmark | Sudden SNHL | Ancrod (from the venom of the Malayan Pit Viper) is a fibrinogen splitting enzyme (fibrinogenase). Fibrinogenase works by lowering the level of fibrinogen in blood, leading to a reduction of blood viscosity. It is administered intravenously or subcutaneously. | Phase II | Randomised, placebo-controlled; patients aged 18-70 years; with unilateral idiopathic sudden SNHL; n=115; Czech Republic and Germany; primary completion August 2017. | www.nordmark-pharma.de/en/rd/project-ancrod.html https://clinicaltrials.gov/show/NCT01621256 |

**Patients**
- Snake venom? Yum.
There are a number of treatments of sudden hearing loss in trial phase in these documents. That in itself is reassuring. It is interesting to consider snake venom as a possibility. It would be good to know if it works and then, as before, cost, publicising, embedding issues.

38 | Fludrocortisone | Oregon Health and Science University | Sudden sensorineural hearing loss | Fludrocortisone is an oral mineralocorticoid. Unlike glucocorticoids, which work by reducing inflammation, mineralocorticoids work by changing salt and fluid balance. | Phase I/II | Single arm; 18-89 yrs; n=20; USA; primary completion August 2016. | https://clinicaltrials.gov/show/NCT01186185 |

**Patients**
- Looks like a worthy piece of research. Clearly they need to make sure fludrocortisone is actually more effective than glucocorticoid in preserving hearing rather than “at least as effective”.
- Bring it on! If this works, it would make a huge difference, if only, if only, practitioners were made aware of it in A and E, ENT departments and GPs, but the results aren’t in yet.

39 | High dose glucocorticosteroid | Germany | Idiopathic sudden sensorineural hearing loss | Higher than standard doses of a steroid, which works by reducing inflammation. Administered orally or intravenously. | Phase II/III | 3-arm trial, standard doses compared to high-doses; randomised; n=312; registered 2016. | http://drks-neu.uniklinik-freiburg.de/drks_web/navigate.do?navigationId=trial.HTML&TRIAL_ID=DRKS00010738 |

**Patients**
- Alternative drug trial which would benefit patients dependent on HA following SHL.
- This one is saying that if you increase the steroid dose, the treatment may work, as there are incomplete data re efficacy of current use of steroids. I’d have taken anything to have been appropriately treated, almost irrelevant of side effects.
<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>Hyperbaric oxygen therapy (HBOT)</td>
<td>US Wound Registry</td>
<td>Idiopathic sudden sensorineural hearing loss</td>
<td>Involves breathing pure oxygen at higher than atmospheric pressures in an enclosed chamber. This causes oxygen to be absorbed by all body fluids, cells and tissues, even those with reduced blood flow. This stimulates and restores function to damaged cells and organs.</td>
<td>Observational registry</td>
<td>Observational registry; n=5,000; all ages; range of conditions including idiopathic sudden SNHL; USA; primary completion January 2020.</td>
<td><a href="http://www.hyperbaricoxygentherapy.org.uk/">www.hyperbaricoxygentherapy.org.uk/</a> &lt;br&gt; <a href="https://clinicaltrials.gov/ct2/show/NCT02483650">https://clinicaltrials.gov/ct2/show/NCT02483650</a></td>
</tr>
</tbody>
</table>

**Patients**
- First indications at 8 weeks looked excellent but appeared to drop in following weeks does this mean the procedure has to be repeated. Side effects looked worrying. I personally would not accept this treatment at this stage of development.
- Here is a trial that worked, restoring hearing. Is this the one then? What has happened to it? Please scientists out there, explain what happens next when something is seen to work.

**Experts**
- If this is effective then hearing loss will be a very small part of what it can do.

**Patients**
- HBOT looks like a short-term temporary fix for certain kinds of loss (at best). Hard to see how it would score over hearing aids as any sort of permanent solution.
- Would be a very interesting treatment for sudden SHL, if it is proven to work without major side effects. Side effects would be major personal
consideration for patients.

- This is so new and tentative it almost doesn’t bear thinking about. Except, are they actually considering a possibility of regenerating hair cells in people who’ve had sudden hearing loss? Sounds to me like the HBOT works in some conditions, so maybe it works in a lot more. And that’s about as far as it reads here.

42  Ebselen; SPI-1005  Nattermann (Originator), Sound Pharmaceuticals (Owner)  Acute noise-induced hearing loss (NIHL)  An orally active, organic selenium compound with leukotriene B4 and prostaglandin antagonistic activity. It also mimics glutathione peroxidase. Glutathione peroxidase has a key role in the neutralisation of reactive oxygen species formed in the cochlea during and after loud noise exposure.  Phase IIb  18-50 yrs; acute NIHL; n=180; USA; study completion September 2017.  clinicaltrials.gov/show/NCT02779192

**Experts**
- As is oral, then could be useful, particularly amongst the armed forces who are exposed to loud noise.

**Patients**
- Addressing NIHL is very important. The risks to young people's hearing based on listening to music above 85dB are well documented. Worth pursuing.
- Drug trial for NIHL. If successful would be beneficial to younger patients.
- It will be welcome if it works. Early days.

43  EGb-761 (Gingko biloba extract; Tebonin)  Ipsen; Dr. Willmar Schwabe Pharmaceuticals  Temporary noise-induced hearing loss (NIHL)  EGb-761 is a standardised and patented oral extract of Ginkgo biloba (maidenhair tree) leaves. It is a nitric oxide synthase type-II inhibitor that acts as an antioxidant. It is also a platelet aggregation.  Phase II  Randomised, placebo-controlled; 18-25 yrs; healthy males; n=202; Germany; NIHL with bilateral 110db noise for 5 mins; outcomes at 1-8 mins and 26-30 days; trial completed.  https://www.clinicaltrialregister.eu/ctr-search/trial/2013-000614-38/DE

**Patients**
- I can see this being used by people in the vicinity of bombs, football stadiums, all those jolting noise experiences.
- So now it’s gingko, and will it work?
<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>AUT-00063</td>
<td>Autifony Therapeutics</td>
<td>Age-related hearing loss</td>
<td>Orally active small molecule modulator of Kv3 potassium channels that targets auditory processing in the brain. It also has potential to prevent hearing loss due to noise trauma.</td>
<td>Phase II</td>
<td>CLARITY1 - aged 50-89 years with age-related hearing loss; n=78; USA; study completed June 2016.</td>
<td>clinicaltrials.gov/show/NCT02345031</td>
</tr>
</tbody>
</table>

**Experts**
- Study did not show any benefits, so has been stopped.

**Patients**
- Treatment that addresses two prolific causes of deafness - i.e. both age related loss and noise-related loss (smartphones, clubs etc.) seems worth pursuing.
- If purpose satisfied then it would be acceptable to patients with reasonable costs.
- You take a drug for four weeks and then you hear better in noise and feel an improvement in your tinnitus because the drug is affecting your brain. Sounds like a miracle. Will it work? As ever, cost, risk, publicity?

| 45  | AUT-00063         | Autifony Therapeutics       | Cochlear implant users for post-lingual deafness | Orally active small molecule modulator of Kv3 potassium channels that targets auditory processing in the brain. It also has potential to prevent hearing loss due to noise trauma. Given for 28 days. | Phase II           | Randomised crossover trial; aged ≥18 years; CI within previous 9-36 months; less than optimum speech; n=20; UK; study completion April 2017. | clinicaltrials.gov/show/NCT02832128 |

**Experts**
- Could be useful if shown to be effective.

**Patients**
- If purpose satisfied then it would be acceptable to patients with reasonable costs.
- Drugs for a particular sort of affected cochlear implant users.

<p>| 46  | Ebselen; SPI-1005 | Nattermann (Originator), Sound | Meniere's disease                          | An organic oral selenium compound with leukotriene B4 and prostaglandin antagonistic activity. It | Phase I/II          | 19-70 yrs; Meniere's disease; n=40; USA; study completion                              | clinicaltrials.gov/ct2/show/NCT02603081 |</p>
<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>47</td>
<td>Gevokizuma S-78989; XMA-005.2; XMA-0052; XOMA-052</td>
<td>XOMA; IRIS; National Eye Institute; North Shore-Long Island Jewish Health System; Servier; University of Zurich</td>
<td>Autoimmune inner ear disease – corticosteroid resistant</td>
<td>Anti-inflammatory monoclonal antibody targeting interleukin-1-beta for the treatment of inflammatory conditions administered subcutaneously.</td>
<td>Phase II</td>
<td>18-75 yrs; autoimmune inner ear disease resistant to corticosteroid therapy; n=10; USA; study completed December 2015.</td>
<td><a href="https://clinicaltrials.gov/ct2/show/NCT01950312">https://clinicaltrials.gov/ct2/show/NCT01950312</a></td>
</tr>
</tbody>
</table>

**Patient**
- Finding effective treatments for Meniere’s is very important. I know a person with Meniere’s whose absence-rate from work owing to sickness is 25% on average.
- There’s nothing I can say about this study until it’s finished except to ask again how they can recruit participants who are in the midst of vertigo attacks. But they can clearly and so perhaps this medicine will be shown to work. Hurray.

**Experts**
- Antibody treatments likely to be expensive, which may be a barrier.

**Patients**
- Alternative drug trial.
### G. REGENERATIVE MEDICINE, CELLULAR AND GENE THERAPY

<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Development status</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td>CGF-166, ATOH gene therapy, Hath1 gene therapy, GenVec otological, TherAtoh</td>
<td>Baylor College of Medicine (Originator); GenVec; Novartis (Licensee)</td>
<td>Severe to profound hearing loss</td>
<td>Intra-labyrinthine gene therapy that uses its proprietary recombinant adenovirus 5 vector encoding the atonal gene, math1. The AdenoVerse technology platform is used for the delivery. The math1 gene induces the generation of sensory hair cells in the inner ear.</td>
<td>Phase I/II</td>
<td>21-75 yrs, bilateral severe to profound hearing loss; n=45; USA; study completion date August 2017.</td>
<td><a href="https://clinicaltrials.gov/ct2/show/NCT02132130">https://clinicaltrials.gov/ct2/show/NCT02132130</a></td>
</tr>
</tbody>
</table>

**Patients**

- Even gene therapy is being used to try to regenerate hair cells. No results yet. I thought the closest scientists had come to regeneration was in rats, but it appears we’re closer than we think with all these attempts on going. Nobel Prize anyone?
### H. SURGICAL PROCEDURES

<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>49</td>
<td>Computer-assisted 3D planning for CI surgical placement</td>
<td>Germany</td>
<td>Conductive or mixed hearing loss caused by chronic ear disease, malformation, or single-sided deafness</td>
<td>Pre-operative planning tool, free adjustment of implant in a 3D model of the skull, to evaluate fitting the bone-conduction mass transducer. &quot;Virtual surgery.&quot;</td>
<td>n=6</td>
<td><a href="https://www.ncbi.nlm.nih.gov/pubmed/24770405">www.ncbi.nlm.nih.gov/pubmed/24770405</a> <a href="https://hal.archives-ouvertes.fr/hal-01370185/file/patientSpecific.pdf">https://hal.archives-ouvertes.fr/hal-01370185/file/patientSpecific.pdf</a></td>
</tr>
</tbody>
</table>

**Experts**
- Really niche and any device involving this degree of surgery will really limit take up.
- Suitable for bone conductive losses.

**Patients**
- Sounds like a useful device if it helps reduce the cost and effectiveness of the whole CI process. Would need careful cost justification though.
- Unable to comment on procedure. Numbers involved very low. Benefits yet to be assessed. Surgical procedure.
- This sounds fantastic using 3D models. Simulation rather than aggravation has to be a great tool. But it’s out of my league to evaluate.

<p>| 50 | Manubrio-stapedioplasty | Turkey | Tympanosclerosis with hearing impairment | The incudostapedial joint is disarticulated, tympanosclerotic plaques removed from the incus and malleus. The incudomalleolar joint is then separated and the incus removed. The head of the malleus is cut, close to the neck, and removed. At this point, a mobile manubrium that has a very low possibility of fixation in the future by tympanosclerosis is obtained. Bone cement is applied to reduce the gap between the manubrium mallei and the head of stapes, until a complete bridge has been formed between the two structures. | Case study 5 patients | <a href="http://www.cambridge.org/core/services/aop-cambridge-core/content/view/10C3673E2874C6C36F132B2DDF460928/S002215115000973a.pdf/manubrio-stapedioplasty-new-surgical-technique-for-malleus-and-incus-fixation-due-to-tympanosclerosis.pdf">www.cambridge.org/core/services/aop-cambridge-core/content/view/10C3673E2874C6C36F132B2DDF460928/S002215115000973a.pdf/manubrio-stapedioplasty-new-surgical-technique-for-malleus-and-incus-fixation-due-to-tympanosclerosis.pdf</a> |</p>
<table>
<thead>
<tr>
<th>ID</th>
<th>Technology name</th>
<th>Developer or place</th>
<th>Indication</th>
<th>Technology description</th>
<th>Clinical trial information</th>
<th>Further information</th>
</tr>
</thead>
<tbody>
<tr>
<td>51</td>
<td>Non-fixation sub-periosteal pocket technique for placement of cochlea implant receiver</td>
<td>USA</td>
<td>Young children with hearing impairment</td>
<td>The position of the receiver/stimulator is planned. A small post-auricular incision is designed, in part due to the decreased exposure necessary without a surgical well. A sub-periosteal pocket is raised and sized with a silastic dummy. The implant is put in position.</td>
<td>6 patients with 12 implanted ears</td>
<td><a href="www.sciencedirect.com/science/article/pii/S0165587614003851">www.sciencedirect.com/science/article/pii/S0165587614003851</a></td>
</tr>
<tr>
<td>52</td>
<td>One-stage and two-stage surgery</td>
<td>South Korea</td>
<td>Cochlear implantation</td>
<td>One-stage surgery, cochlear implantation accompanied with the eradication of inflammation. Two-stage surgery: complete eradication of inflammation as first-stage surgery, and cochlear implantation performed as second-stage.</td>
<td>30 patients - 17 with 1-stage surgery, 13 in 2-stage surgery</td>
<td><a href="www.ncbi.nlm.nih.gov/pmc/articles/PMC4278032/">www.ncbi.nlm.nih.gov/pmc/articles/PMC4278032/</a></td>
</tr>
<tr>
<td>53</td>
<td>Oticon Medical Xpress system</td>
<td>Oticon Medical AB</td>
<td>Hearing impairment</td>
<td>Rapid insertion of a bone-anchored hearing system. Patients fitted with processor implant as early as 2 weeks post-surgical implant as opposed to 8 or 9 weeks.</td>
<td>20 implants into 15 patients, Birmingham, UK</td>
<td><a href="www.ncbi.nlm.nih.gov/pubmed/24759297">www.ncbi.nlm.nih.gov/pubmed/24759297</a></td>
</tr>
<tr>
<td>54</td>
<td>Oval window atresia</td>
<td>Turkey</td>
<td>Bilateral hearing loss</td>
<td>The facial nerve usually occupies the oval window area in patients with oval window atresia. During exploration, if the facial nerve is discovered to lie in the oval window area, this is usually regarded as a contraindication for further surgical intervention. A novel surgical approach may overcome this.</td>
<td>Case series; 3 patients with 4 ears</td>
<td><a href="www.sciencedirect.com/science/article/pii/S0165587614009497?np=y">www.sciencedirect.com/science/article/pii/S0165587614009497?np=y</a></td>
</tr>
<tr>
<td>ID</td>
<td>Technology name</td>
<td>Developer or place</td>
<td>Indication</td>
<td>Technology description</td>
<td>Clinical trial information</td>
<td>Further information</td>
</tr>
<tr>
<td>----</td>
<td>--------------------------</td>
<td>-------------------------------------</td>
<td>------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td>55</td>
<td>Surgical rehabilitation</td>
<td>University Hospital, Toulouse</td>
<td>Otosclerosis and conductive hearing loss</td>
<td>Surgical restoration of the columellar effect consists of the intraoperative verification of the stapedo-vestibular ankylosis which provides diagnostic. Then a stapedotomy is performed and partial ossicular prosthesis inserted between stapedotomy and the long process of the incus.</td>
<td>Phase III; aged ≥18 years; unilateral or bilateral asymmetric otosclerosis and conductive hearing loss; n=30; France; study completion July 2017</td>
<td><a href="clinicaltrials.gov/ct2/show/NCT02456272">clinicaltrials.gov/ct2/show/NCT02456272</a></td>
</tr>
</tbody>
</table>

**Experts**

- Interesting, but not a game changer.

**Patients**

- Let’s look again when the questionnaire results are in.... "The questionnaire will be given to the patient at the pre-enrolment visit, after a period of two months of external hearing aid trying and 2 months after the surgery.".... and make a judgment then.
- I can’t really follow the science here, but what is interesting is the idea of measurement based on the “evolution of the quality of life”.
7. REFERENCES

20. The National Academies of Sciences, Engineering and Medicine, Hearing Health Care for Adults: Priorities for Improving Access and Affordability


Ferguson MA, Henshaw H. Auditory training can improve working memory, attention, and communication in adverse conditions for adults with hearing loss, Frontiers in Psychology. 2015;6:556.
