The Future is Hear

What today can tell us about tomorrow's audiology

Presented by:
David Allen – Senior Research Audiologist

Hearing Rehabilitation
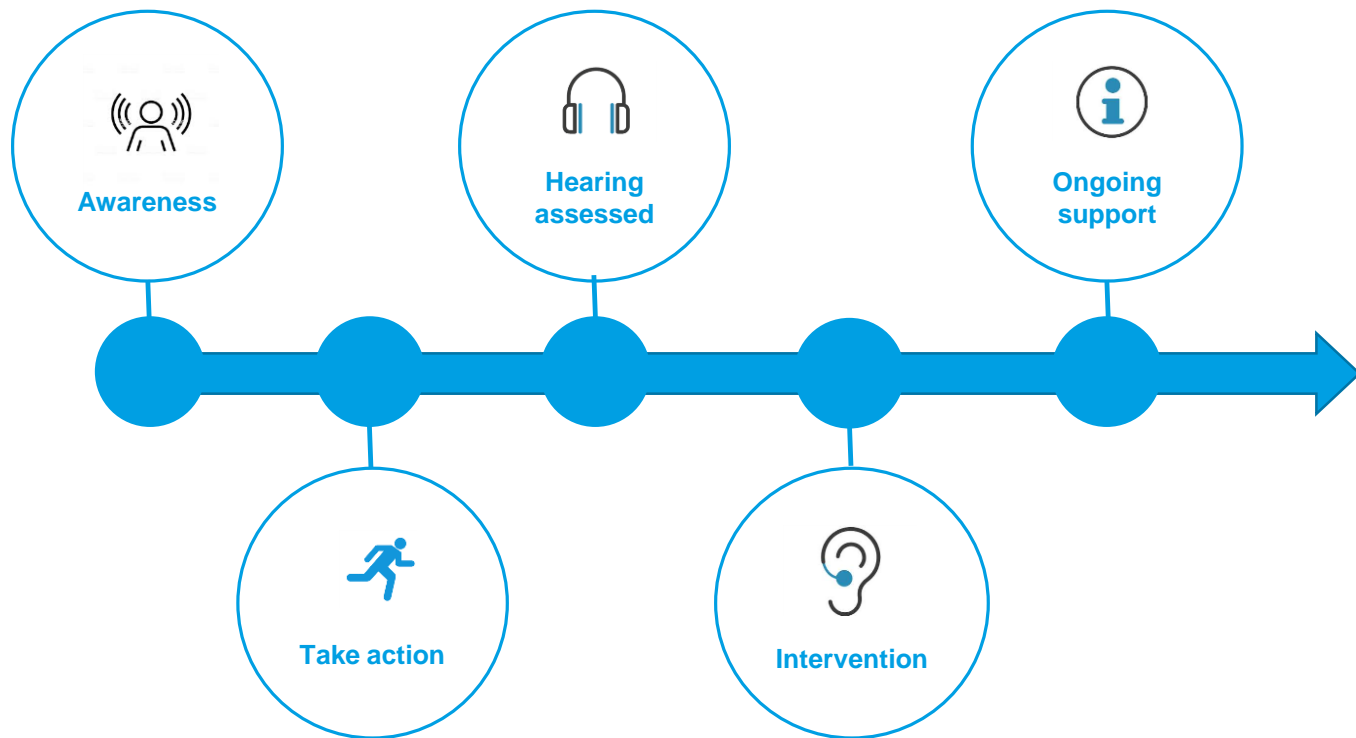
Hearing Rehabilitation

Hearing Rehabilitation

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Hearing Rehabilitation

Awareness

Hearing assessed

Ongoing support

Take action

Intervention

Diagnostics

Diagnostics

Nuheara IQbuds™

- 30 adults with various audiograms
- Built-in automated audiometry
- Tested thresholds at 500Hz, 1kHz, 2kHz, 4kHz

Results within 5dB for 87% of participants

Results within 7.5dB for all participants

(Carter, Pang, Beach, Davis, and Mealings, in preparation)

Ubiquitous Diagnostics

Diagnosis going to the patient

- Integrated into available devices/services
- Integrated into existing data collection systems
- No travel to clinician
- Information not held by the clinician
- Relies on technology giving information to the patient, and the patient seeking support

Ubiquitous Diagnostics

Nura Nuraphone

- Measures otoacoustic emissions
- Data used to adjust sound levels
- Platform not (currently) open – data not available clinically

Ubiquitous Diagnostics

enophone

- Headphone with integrated EEG sensors
- Currently available
- Potential for CER/ABR
- Platform not (currently) open – data not available clinically

EEG data can be used for hearing assessment

Can also be used to identify other hearing conditions:

- ABR recordings of 15 people with tinnitus and 18 controls
- Machine learning applied
- Diagnostic accuracy over 80%

(Monaghan, Liu, Zao, and McAlpine, 2020)

Ubiquitous Diagnostics

Use of consumer electronics to monitor health conditions not new:

Apple Watch

- Monitors environment for dangerous noise levels
- Built-in electrocardiography identifies irregular heart rate
- Fall detection
- Blood oxygen detection for early diagnosis of asthma, COVID-19

Ubiquitous Diagnostics

Use of existing data to identify health conditions also possible:

Recordings of speech can be used to identify kinds of dementia (Jarrold et al., 2014)
- Recordings of speech from 9 people with Alzheimer's Disease, 30 with Fronto-temporal Lobar Deterioration, and 9 healthy controls
- Machine learning techniques identified correct diagnosis in up to 88% of cases

Changes in shopping habits identify pregnancy (Duhigg, 2012)
- Target Guest ID able to identify pregnancy in shoppers based on changes in buying habits
- Not dependent on the person knowing that they are pregnant

Ubiquitous Diagnostics

What could the future hold?

- Consumer devices identifying hearing loss using tests
  - Not just thresholds – otoacoustic emissions, AEPs, &c.
- Identification through patterns of behaviour
  - Anomalous interactions identified through machine learning

- Diagnosis information located with the patient or technology
  - Awareness of profession vital
  - Standards for information interchange can support alternative diagnostics

Rehabilitation
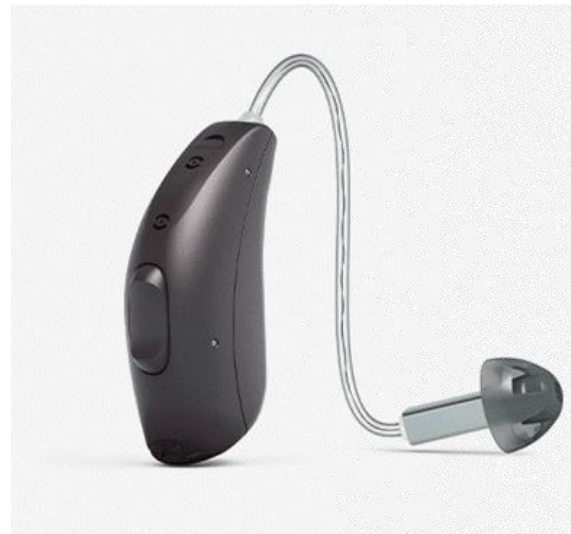
Rehabilitation
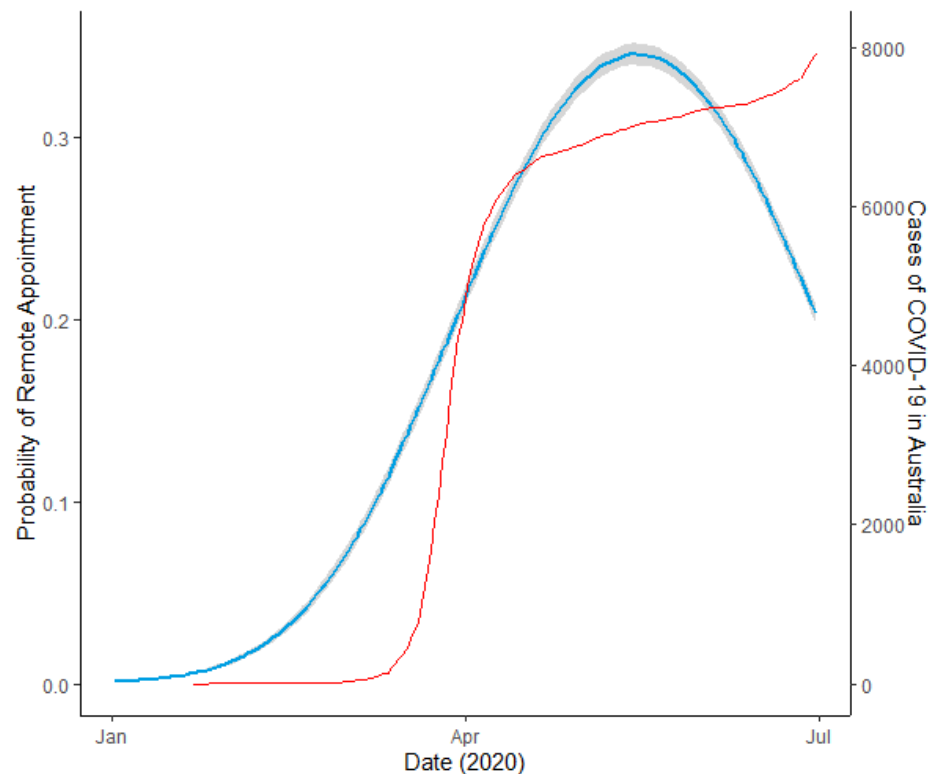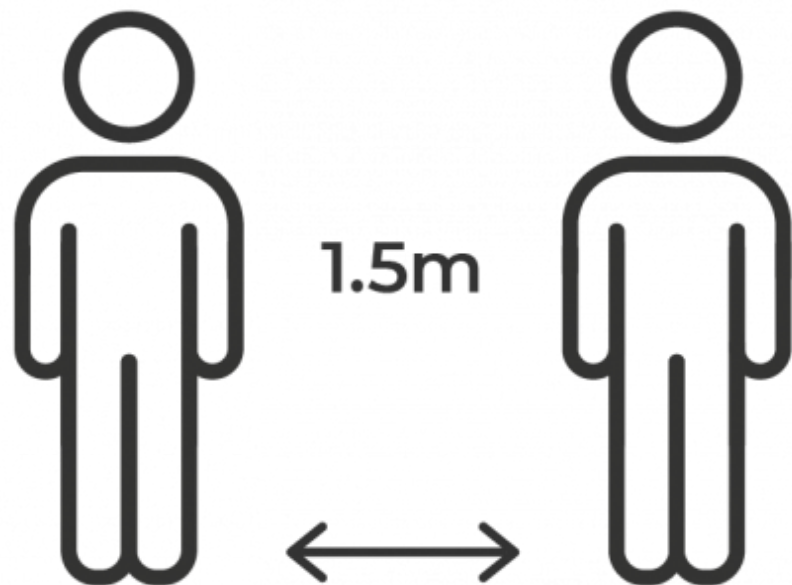
Australian COVID-19 infections (cumulative)
Probability of remote appointment

Connected Rehabilitation: NAL's connected health research program

Smartphone-
connected
hearing aids

Post-fitting
motivational support

Hearing health
education

Hearables
PSAPs

Remote device
adjustment

Pre-assessment/
pre-fitting preparation

Connected Rehabilitation

"What are the factors that determine whether staff choose to use or refuse connected hearing services?"

Survey of 132 hearing centre staff:

- Asked about three different connected hearing health services

- "Does your centre deliver [service]?"
- "What currently works well or would help your centre to use [service]?"
- "What does not work so well or stops your centre from using [service]?"

Responses collated and analysed using thematic analysis

(Allen, Jevelle, Pang & Ferguson, in preparation)

Connected Rehabilitation – what staff need to know

- Training – "Do I have the skills to use this service?"

- Staffing – "Are there enough people with the right skills around me?"

- Time – "Do I have enough time to be able to use this service?"

- Technology – "Does the technology work effectively?"

- Usability – "Does the service work easily for me and for my client?"

- The Right Client – "Will my client be able to benefit from this service?"

- Clear Benefits – "Do I believe that this service will help my client?"

Connected Rehabilitation

- Connected hearing services seen as an alternative to traditional services
- Same kinds of problems arose in different kinds of connected hearing service
- The younger an intervention was, the more and more varied issues were reported
- Many staff felt that most clients were not suitable for telehealth
  - However, ~80% of adults over 65 own a smartphone (Deloitte, 2018)
- Many staff did not feel that clients "needed" the service

"Hasn't been needed"

"No clinical need"

"Insufficient demand in this area"

Connected Rehabilitation: NAL's connected health research program

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Connected Rehabilitation

C2Hear

- Evidence-based, randomised controlled trial (n=203)

| knowledge | handling skills | self-management | hearing aid use | valued by users | self-efficacy |

(Ferguson et al, Ear Hear, 2016; Gomez & Ferguson, Int J Audiol, 2020)

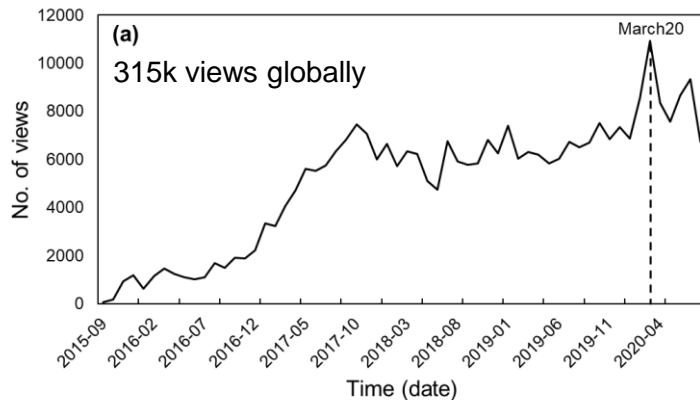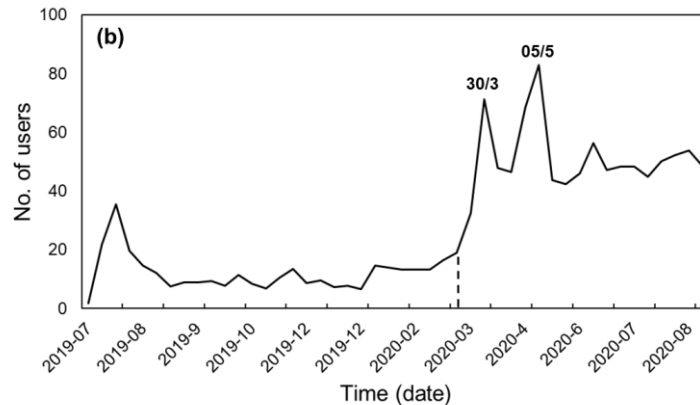m2Hear   https://www.nottingham.ac.uk/helm/dev-test/m2hear

- 42 mRLOs
- Delivered on mhealth platforms
- Tailored to individual needs
- Greater interactivity
- More activities

- Outcomes similar to C2Hear
- Users preferred m2Hear
  - concise and convenient
  - personalised
  - empowered users

NAL

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(Ferguson et al, Sem Hear 2019; Ferguson et al Int J Aud, 2020; Maidment et al J Med Int Res, 2020)

Connected Rehabilitation

C2Hear Online You Tube

315k views globally

C2HearOnline.com

United Kingdom	39%
United States	32%
Canada	6%
India	4%
Australia	3%

US version now developed

Included in UK guidelines including recent COVID19

NICE
National Institute for
Health and Care Excellence

British Society of Audiology
KNOWLEDGE | LEARNING | PRACTICE | IMPACT

Link on >40 UK audiology dept websites

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(Ferguson et al Int J Aud, 2020)

Connected Rehabilitation

Ubiquitous Rehabilitation

Environmental Momentary Assessment

- Collecting patient feedback linked to environmental data

- Developed as research tool, moving into hearing device apps

Internet of Things

- Linkage of devices to each other/the Internet

- Lightbulbs, motion sensors, locks

- Can incorporate additional sensors (e.g. accelerometers, electrical, optical)

Ubiquitous Rehabilitation

Accelerometer

- Allows for fall detection, gait analysis

Ear-EEG

- Ear worn EEG electrode

- Explored by Widex and Oticon
  (Bech Christensen et al., 2018; Jensen, 2018)

- EEG can identify auditory attention, listening effort

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Ubiquitous Rehabilitation

Hearing devices connected to smartphone/Internet

- Continuous environmental monitoring

- Continuous neural monitoring

- Continual user-prompted subjective feedback

- Identification of issues in near real time

- Automated "good enough" adjustments

- Flagging for review by clinicians

- Will we need the clinician?

Ubiquitous Rehabilitation

Analysis of textual patient interactions

- **Signia TeleCare** system – patients can send message to clinician

- **2623 messages** sent and received from 20/12/2018 – 30/4/2020

- **717 conversations** identified by NAL researcher

- **438 conversations** related to a problem with the hearing aids

- **316** had a settings adjustment applied – **309** resolved

- **51** had a counselling conversation – **43** resolved

- **20** had a problem that could not be addressed at all remotely

(Allen, Jevelle, Pang, Cooper & Ferguson, in preparation)

Ubiquitous Rehabilitation

334 conversations initiated by patients

94 conversations used a specific staff member's name in the first message

Messages were personal and friendly

- Language tailored to the client's way of communicating

- Demonstrated a knowledge of the client's history and preferences.
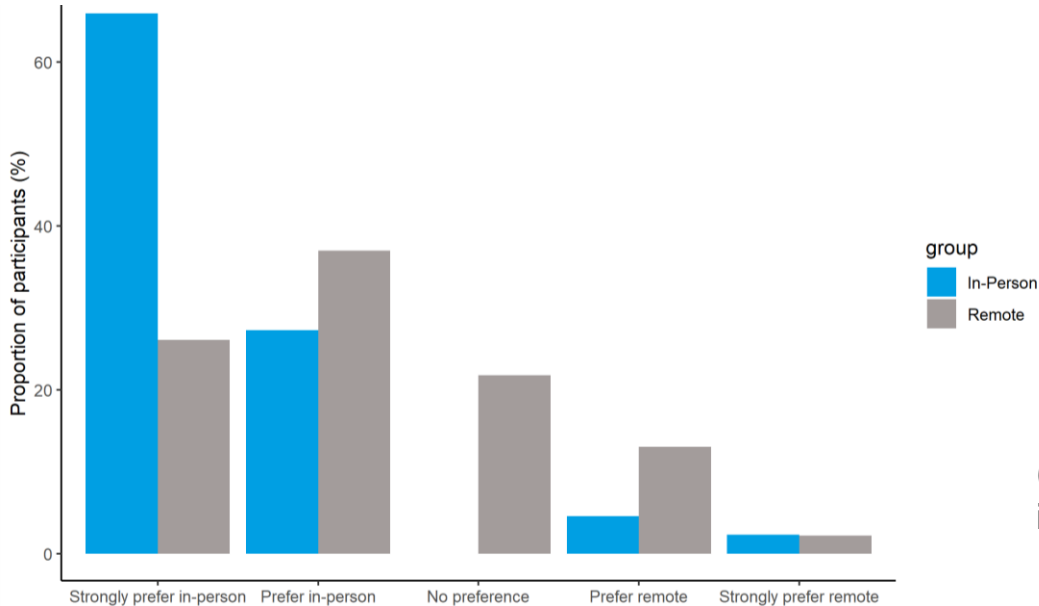
Patient: [name] is in da house

Clinician: Hey [name]

Like text messaging – a direct conduit between client and staff

Ubiquitous Rehabilitation

Patients seen for fitting during COVID-19

- 48 seen remotely; 45 seen in-person

- Still a strong preference for in-person services

(Allen, Pang & Ferguson, in preparation)

Ubiquitous Rehabilitation

Patients seen for fitting during COVID-19

- Qualitative interviews

- Eleven patients

- 6 had had a remote service

- 9 preferred an in-person service

"Well, first of all, I like to see the person I'm talking to"

"Well, I just thought it was like going to the doctor. You just go."

"I have to get somebody to drive me […] But I do prefer to see the consultant."

Ubiquitous Rehabilitation

(Grenness et al., 2014)
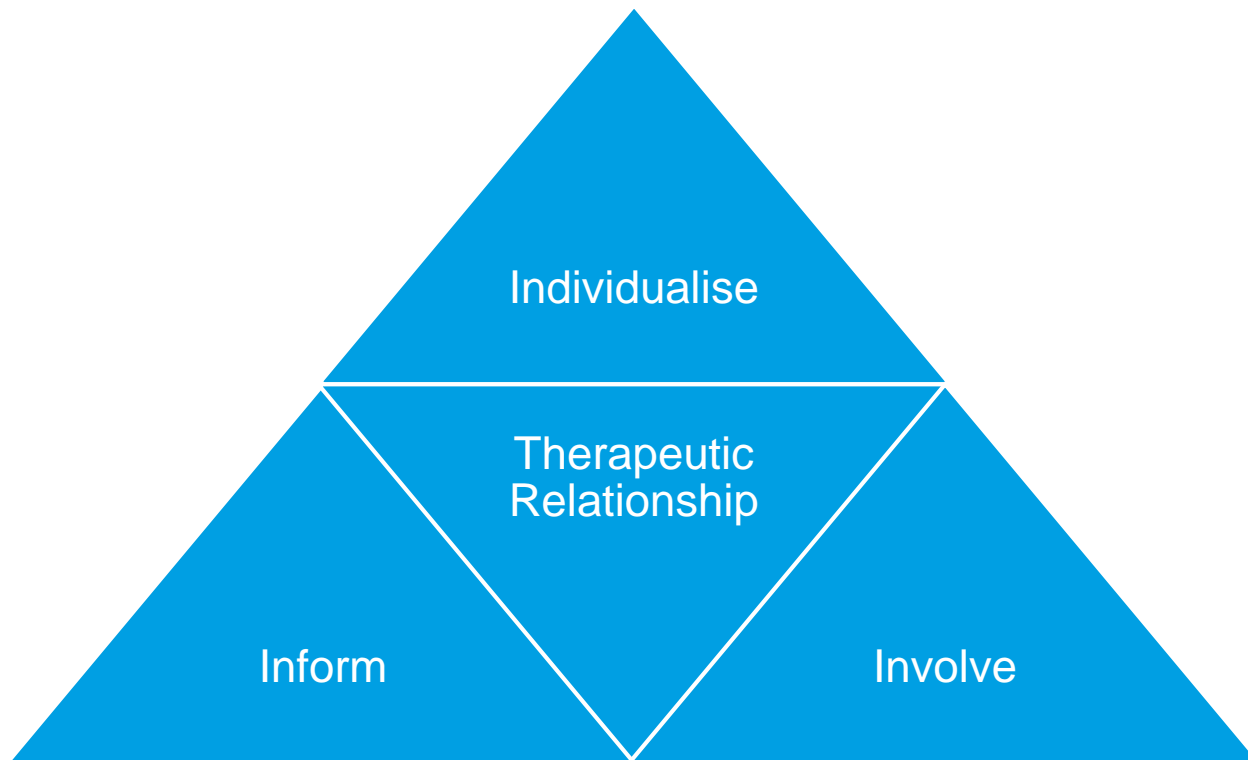
So what does the future hold?

Ubiquitous computing:

"computing anytime and everywhere"

Diagnostics will change:

- We may not be the primary source of a diagnosis

- Need to establish awareness of the profession so that pathways are clear

Rehabilitation will change:

- More data allows for responsive technology

- Allows us as professionals to focus on the personal

Thank you

All the staff at NAL whose work I have spoken about today

Nuheara, Hearing Australia, and all of the people who funded this work

Specsavers for inviting me here to speak today

Mel Ferguson

Elizabeth Beach

Kiri Mealings

Jessica Cooper

Jessica Monaghan

Jermy Pang

References

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