Using mHealth technologies to increase the three I’s: individualisation, interactivity and inclusivity

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MMHL research programme

Aim: to seek new knowledge and clinical strategies to overcome social activity and participation restrictions arising from difficulties in hearing → improve quality of life
What is mhealth?

- Delivers healthcare by mobile technologies
- A subgroup of telehealth, ehealth and telemedicine
Mobile technology use is increasing in older adults

(Prepared by Deloitte, 2017)

**Smartphone ownership in 55+ year olds**

<table>
<thead>
<tr>
<th>Year</th>
<th>Ownership Percentage</th>
</tr>
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<tbody>
<tr>
<td>2012</td>
<td>19%</td>
</tr>
<tr>
<td>2017</td>
<td>71%</td>
</tr>
</tbody>
</table>
Smartphone mode of delivery (mhealth): benefits

- Overcome barriers: time, mobility, geography → Greater accessibility
- Easy access and convenience → Empowerment
- Personalised tailored information to meet individual’s needs → Better knowledge and understanding
- Interactive, enabling self-monitoring and self-evaluation → Greater engagement and self-management
- Social network opportunities → Increase social support
- Limited healthcare resources → Low cost, high volume, new service delivery models
- Training healthcare workers → Increase awareness of hearing loss and more…..
mHealth for hearing care and self-management

Outcome measurement
EMA*

Monitoring*
(e.g. hearing aid use & progress)

Auditory-cognitive training**

Hearing health information**

Pre-assessment/pre-fitting information**

Smartphone-connected hearing aids**

Alternatives: PSAPs, Hearables**

Remote fitting and adjustment*

Auditory-cognitive training**

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Alternatives: PSAPs, Hearables**

Remote fitting and adjustment*

(ENT and Audiology News, special issue on mhealth, Ferguson guest editor, 2017)
mHealth for hearing care and self-management

- Hearing health information**
- Remote fitting and adjustment*
- Smartphone-connected hearing aids**
- Alternatives: PSAPs, Hearables**
- Monitoring* (e.g. hearing aid use & progress)
- Outcome measurement EMA*
- Disruption assessment/monitoring**
- Smartphone-connected hearing aids**
- Remote fitting and adjustment*
- Hearing health information**

(ENT and Audiology News, special issue on mhealth, Ferguson guest editor, 2017)
mHealth enables self-management of long-term conditions

- Provision of education to improve knowledge
- Strategies to support adherence to treatment
- Tailoring of practical support
- Psychological strategies adjustment to life with LTC
- Social support as appropriate
  - Communication partners
  - Peers
  - Professional
  - Online support

(Taylor et al, 2014)
mHealth enables self-management of long-term conditions

• Provision of education to improve knowledge
• Strategies to support adherence to treatment
• Tailoring of practical support
• Psychological strategies to adjust to life with LTC
• Social support to facilitate
  – Communication partners
  – Peers
  – Professional
  – Online support

(Taylor et al, 2014)
Listening devices
Hearing aids are effective

Hearing-related QoL
- Large beneficial effect
- Moderate quality evidence

Listening ability
- Large beneficial effect
- Moderate quality evidence

Health-related QoL
- Small beneficial effect
- Moderate quality evidence

Adverse effects
- None reported
- Very low quality evidence

“The evidence is compatible with the widespread provision of hearing aids as the first-line clinical management in those seeking help for hearing difficulties”

(Ferguson et al, Cochrane Review: Hearing aids for adults with mild to moderate hearing loss, 2017)
Accessibility and use

- Majority (2/3) who would benefit from hearing aids do not have them
  (Davis et al. HTA, 2007)
- Hearing aid non-use variable: 3-24%
  (Ferguson et al, 2017)
- Implement a new FDA device category for over-the-counter (OTC) wearable hearing devices separate from hearing aids
  (National Academies of Sciences, Engineering, and Medicine, 2016)
- “Can new technologies replace hearing aids?” ranked as the 5th research priority by patients and audiologists
  (Henshaw et al. Lancet, 2015)
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Smartphone-connectivity: Individualisation and interactive

Self-fitting

User-adjustment

Remote delivery

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Usability of alternatives in ‘real-world’ health behaviour theory

Q: Views on alternative listening devices: usability, acceptability and adherence?

Factors that affect a particular health behaviour → use of alternative listening device to manage hearing loss

<table>
<thead>
<tr>
<th>Alternative Listening Devices</th>
<th>Visit 1</th>
<th>Visit 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smartphone-connected hearing aids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal sound amplification products (PSAPs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smartphone app &amp; wireless ‘hearable’</td>
<td></td>
<td></td>
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<td>Smartphone app &amp; wired earphones</td>
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COM-B health behaviour change model

(Maidment & Ferguson, 2017)

(Michie et al, 2011; 2014; Coulson et al, 2016)
## Differences between alternative devices

<table>
<thead>
<tr>
<th>Device</th>
<th>Capability</th>
<th>Opportunity</th>
<th>Motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smartphone hearing aid</td>
<td>Easy to use and adjust</td>
<td>Improved listening</td>
<td>Control and confidence</td>
</tr>
<tr>
<td>PSAP</td>
<td>Difficult to use</td>
<td>Sound quality mixed</td>
<td>Discrete/less noticeable</td>
</tr>
<tr>
<td>Hearable</td>
<td>Difficult to use</td>
<td>Delay intolerable</td>
<td>‘Young’ and ‘trendy’</td>
</tr>
<tr>
<td>Smartphone app</td>
<td>Straight forward to use</td>
<td>Helpful in quiet</td>
<td>Self-conscious</td>
</tr>
</tbody>
</table>
Capability Knowledge and skills

- The devices should be **simple and intuitive** to use

  “You want something you take out of the box and it’s ready to go.”

- **Online support** was preferred for troubleshooting

  “YouTube videos would be the first place that I would look to get support. [...] If a video shows me, that’s just as good as someone sat in front of me showing me.”
Opportunity
Social & environmental

- **User-control** to make fine-tune adjustments had an **impact on participation**

  “[the app] gave me a higher possibility of being able to hear what's being said and join in.”

- **Concern about the views of others** when using devices not typically associated with hearing loss

  “People think that you’re listening to something, and that you’re being rude, but you’re not, you’re listening to them.”
Motivation
Identity, beliefs, emotions

- **User-control** to make fine-tune adjustments elicited **positive emotions**

  “It gives me that bit of control, and it’s not other people running my life, it’s me.”

- The devices were viewed as potentially **less stigmatising**

  “If I just look as if I’ve got ear buds in, people will just treat me normally.”

- Greater sense of autonomy and empowerment, less frustration, greater device use
General lack of awareness of alternative devices

- 116 adults with self-reported hearing difficulties
- Little awareness/experience
- ‘Very interested’
- Highest ranking features user-controllability:
  1. volume
  2. sound quality
  3. directionality

(Maidment & Ferguson, 2018)
mtech innovations: evaluation of the 3xIs

eAdjust application

- Benefits of user-set conditions compared to factory presets
- To explore and identify patient preferences and usability
- N=44 new and existing users
- Android vs iPhone!

Remote access delivery model

IT requirements?
Concept
- Audiologists
- Patients
‘How-to’ toolkit
→ new service model

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Take home message

- New and emerging listening devices alongside mobile technologies enables greater
  - opportunities for new service delivery models
  - choice of device
- different pros and cons may be dependent on individual needs

- The potential for improved patient outcomes is evident and could transform adult audiology services

**Pros**
- User-controllability
  - Individualise
  - Interactive

**Pros**
- Greater participation
- Less stigmatising
  - Inclusive

**Cons**
- Lack of knowledge
- Don’t know exist!
- Concerns may look rude
eHealth and self-management
Question

If you are an audiologist

• How confident are you that the information and advice you offer your first-time hearing aid patients is
  • understood
  • absorbed
  • and then acted upon

once they leave the comfort of your clinic room?
Question to audiologists:
I am confident that the information given is remembered and acted upon by my hearing aid patients.

(Hajat, 2016)
Knowledge of all things hearing is poor

- Patients, public, practitioners
  - Experienced hearing aid users
    - hearing aids and how to use them - poor to excellent
    - 60-80% did not know how to use the telephone

Hearing aid non-use

Costs: financial - individual and healthcare systems
person with hearing loss = communication difficulties
→ reduced social interaction → poorer QoL

- Health context
  - better knowledge increases patient satisfaction and treatment compliance

- Hearing aid users have a desire for additional information
  - both before and after the fitting appointments

(Desjardin & Doherty, 2009)
(Goggins & Day, 2003)
(Murray et al, 2005)
(Laplante Levesque et al, 2013; Kelly et al, 2013)
HEAR-IT study

Q: Do video tutorials (or RLOs) *supplement* advice and information provided by audiologists and result in enhanced benefit and use for hearing aid users?

1. To *develop* a series of reusable learning objects (RLOs)
   - range of auditory rehabilitation subjects
   - accessible to hearing aid users and their families

2. To *evaluate* the benefits and cost-effectiveness of the RLOs

   Randomised controlled trial

   RLO+  or  RLO-

Research for Patient Benefit
inspired by patients and practice
Re-usable learning objects

Commonly used in elearning environments

Interactive multimedia clips

- Highly visual illustration of concepts support learning goal
- Self-assessment – a test of mastery of content
- Activity and engagement with the content

• Participatory approach → high quality materials aligned to the user’s needs
• Improve motivation and compliance with health treatments
Participatory design: to identify content

Delphi review → Workshops → RLO content

Consensus
n=33 hearing healthcare professionals

n=33 hearing aid users
n=11 audiologists

(Ferguson et al, Int J Audiol, 2018)
Participatory design: to develop RLOs

(Ferguson et al, Int J Audiol, 2018)

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The end-product: interactive multimedia RLOs for HA users

(Ferguson et al, Ear Hear, 2016)
## Evaluation: Clinically registered RCT (N=203)

### Take-up and adherence
- Take-up = 78%
- 94.3% watched all RLOs

### Self-management
- 2+ times = 49.9%
- Re-use suggested self-management

### HA knowledge & skills
- Better knowledge on HAs and communication & HA handling skills

### HA use
- Greater use (GHABP) suboptimal users

### Valued by users
- Rated RLOs as highly useful (9/10)
- Improved confidence
- Preferable to written info

### Health economics
- RLOs were a very effective and cheap healthcare intervention

*(Ferguson et al, Am J Aud 2015; Ear Hear, 2016)*
‘Active ingredients’ of C2Hear

- Identified which aspects of the Theoretical Domains Framework (TDF) are present in each RLO → mapped onto the COM-B model

(Maidment et al., in prep)
Underlying processes

Contextual factors
- External factors that inform WHY the intervention works

Greater hearing aid self-efficacy predicted:
- Greater use
- Reduced emotional consequences of hearing loss (e.g. anxiety)
- Greater hearing aid handling skills and knowledge

Causal mechanisms
- Mechanisms of impact - HOW the intervention works

Improved hearing aid handling skills and knowledge led to:
- Greater use, benefit and satisfaction
- Reduced emotional consequences of hearing loss (e.g. anxiety)
- Increased patient activation

Early delivery of C2Hear improves self-efficacy

Measure of Audiological Rehabilitation for Self-efficacy for Hearing Aids (MARS-HA):

- Large effect sizes: $d: 0.7-0.91$

RCT, n=47
First-time hearing aid users

➢ Early delivery of C2Hear ‘primes’ patients for their hearing aid fitting

*(Gomez & Ferguson, in prep)*
Question to audiologists:
I am confident that the information given is remembered and acted upon by my hearing aid patients

- Vast majority were more confident (Hajat, 2016)
Research into practice
Getting C2Hear out there: impact

- 4x increase in second year, ~6000/month
- Views from >50 countries: 38% UK  38% N America
- Used in UK audiology departments, on ~30 websites
- Included in national guideline documents
- Research Impact awards; REF potential 4*

>140,000 unique views

Just google ‘C2Hear Online YouTube’
Towards an mhealth self-management system

- Knowledge
- Individualised
- Interactive
- Inclusive
- Shared decision-making
- Monitoring
- Self-evaluation
- Peer support
mRLOs tailored for hearing aid users (m2Hear)
Individualised - tailored to meet user’s specific needs (m2Hear)

(Ferguson, ENT and Audiology News, 2017)

- 42 mRLOs
- Greater interactivity
- Additional activities
Greater interactivity

Mel - You have selected information on Getting used to your hearing aids.

What can I expect when wearing hearing aids for the first time?

How do I get used to wearing my hearing aids?

How can I get used to wearing my hearing aids?

You may wish to become familiar and comfortable with the sounds in your own home at first.
Greater interactivity

Drag and drop

How do I work with others to help me take part in conversations?

Hearing problems and solutions activity

Here are some situations you might recognise with suggested solutions.

Activity: Drag which solution you think would be best to each problem.

- Helps communication
- Doesn't help communication

More activities
Self-efficacy for hearing aids and hearing handicap significantly improved.

Self-efficacy for hearing aids (MARS-HA)

\[
p < .001; \quad d = 2.01
\]

Hearing handicap (HHIE)

\[
p < .001; \quad d = 2.9
\]
What the patients said

• Provides reminders

“[m2Hear] started to change my life. I had… a prop basically... something to fall back onto if there was a problem.”

• Convenient to re-visit

It’s more convenient to use, wherever you are. You just get your phone out.

• Comprehensive content

“I knew which section to go to and there were details in there that would gave me what I needed.“
m2Hear rated higher than C2Hear

<table>
<thead>
<tr>
<th>Mobile Application Rating Scale – user (0-5)</th>
<th>m2Hear</th>
<th>C2Hear</th>
</tr>
</thead>
<tbody>
<tr>
<td>uMARS Overall quality</td>
<td>4.23</td>
<td>3.60</td>
</tr>
<tr>
<td>uMARS Engagement</td>
<td>3.61</td>
<td>3.13</td>
</tr>
<tr>
<td>uMARS Functionality</td>
<td>4.46</td>
<td>3.75</td>
</tr>
<tr>
<td>uMARS Aesthetics</td>
<td>4.22</td>
<td>3.00</td>
</tr>
<tr>
<td>uMARS Information</td>
<td>4.65</td>
<td>4.50</td>
</tr>
<tr>
<td>uMARS Subjective quality</td>
<td>3.60</td>
<td>3.25</td>
</tr>
</tbody>
</table>
Including others
Including communication partners

- Support and involvement from others improved outcomes  
  \[\text{(Scarinci et al, 2008)}\]

- Aligned coping strategies between people with hearing loss and their family and friends → positive effect and improved outcomes  
  \[\text{(Barker et al, Int J Audiol, 2017)}\]

- Focus groups suggested that CPs would value information relevant to them  
  \[\text{(Ferguson et al, Ear Hear, 2016)}\]

- Communication Tactics RLO for ‘others’
  - designed specifically for mobile-technologies (e.g. smartphones, tablets)
  - added more activities
Restaurant activity

Choose the best location to hear conversation as well as possible
Communication tactics for CPs: “active ingredients”

Greater emphasis on the environment
Inclusive: involving others

Think aloud and video analysis

(Ferguson et al, ASHA Perspectives SIG7 In press)
Greatest impact for joint-working

- Increased CP’s hearing-related knowledge, and highlighted difficulties faced by the PHL

  “I expected the hearing aids to bring his hearing back to normal... I understand better now” (CP)

  “It’s rather nice for them to fully appreciate [the challenges]” (PHL)

- CPs would change their behaviour to help improve communication based on their learning

  “That’s what we shall look for [a quiet restaurant table]” (CP)

  “We are both on the same wavelength, we can look for it now” (PHL)

- Prompted novel discussions about challenging everyday communication situations

  (Ferguson et al, ASHA Perspectives SIG7 In press; Henshaw et al, BSA, 2017)
residential carehome staff

n = 25 care home staff
n = 3 homes

• 84% thought correct use of hearing aids was extremely important
  72% assisted all residents with hearing aids and maintenance
  20% “ half or more
  8% “ half or less

• None of the carehomes had sought or reported ever provided any training

(Rocks & Ferguson, 2013)
Training residential care home staff

n = 25 care home staff
n = 3 homes

Knowledge of hearing aids and communication

Significant pre-post improvement \( p < .001 \) \( d = 3.6 \)

“This should be made mandatory at induction with annual refresher sessions”

Practical hearing aid skills

Significant pre-post improvement \( p < .001 \) \( d = 3.3 \)

“Awareness of hearing aids has definitely gone up with all of us”
Take home messages

- Remote technologies provide patient benefit by improving:
  - Knowledge
  - Handling skills
  - Self-management
  - Hearing aid use
  - Self-efficacy

- Knowledge is power – and a mechanism of impact - leading to:
  better hearing aid outcomes, reduced psychosocial effects (e.g. anxiety), and
greater patient activation

- The future is the three I’s – individualisation, interactivity and inclusivity

- Involving partners in ‘joint-working’ with C2Hear prompts novel discussions about
  challenging communication leading to behaviour change in partners

  “technology works best when it brings people together”

(Matt Mullenweg)
Thanks to …..

Patient panels

Mild-moderate hearing loss team
David Maidment  Rachel Gomez

Clinical and academic colleagues

This presentation presents independent research funded by the National Institute for Health Research (NIHR) under its Research for Patient Benefit (RfPB) Programme (Grant Reference Number PB-PG-0909-20294 and PB-PG-0815-20019). The views expressed are those of the author(s) and not necessarily those of the NHS, the NIHR or the Department of Health.