TELEPRACTICE IN PEDIATRIC AUDIOLOGY: EXPANDING AUDIOLOGY HORIZONS FOR CHILDREN WITH HEARING LOSS

International Pediatric Audiology Conference, Shanghai 2014

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ACKNOWLEDGEMENTS

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OUTLINE

• Global Childhood Hearing Health – Challenges
  – Prevalence
  – Access to care

• Exploring Novel Solutions - Telehealth
  – Remote diagnosis of hearing loss in primary health care
  – Remote diagnosis of ear disease in primary health care
PREVALENCE OF CHILDHOOD HL

Global Situation

• Everyday 1753 born with significant permanent SNHL:
  – 1643 born in developing world (5/1000)
  – 110 born in developed countries (3/1000)

• >90% born in developing world

(UNICEF, 2008; Olusanya & Newton, 2007; Olusanya et al. 2008; Smith et al. 2005)
## PREVALENCE OF CHILDHOOD HL

<table>
<thead>
<tr>
<th>Regions</th>
<th>DHL in children (&lt;15 yoa)</th>
<th>Prevalence %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Millions</td>
<td></td>
</tr>
<tr>
<td>High-income</td>
<td>0.8</td>
<td>0.5</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>6.8</td>
<td>1.9</td>
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<tr>
<td>Middle East &amp; North Africa</td>
<td>1.2</td>
<td>0.9</td>
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<tr>
<td>South Asia</td>
<td>12.3</td>
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<tr>
<td>Asia Pacific</td>
<td>3.4</td>
<td>2.0</td>
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<tr>
<td>Latin America &amp; Carribbean</td>
<td>2.6</td>
<td>1.6</td>
</tr>
<tr>
<td>East Asia</td>
<td>3.6</td>
<td>1.3</td>
</tr>
<tr>
<td><strong>World</strong></td>
<td><strong>31.9</strong></td>
<td><strong>1.7</strong></td>
</tr>
</tbody>
</table>

(WHO, 2013)
HEARING HEALTH CARE ACCESS

- Available hearing health service distribution inequality
- Geographical, weather and infrastructure obstacles
  - Large distances & remote communities
  - Poor transport infrastructure
  - Expensive referral pathways
EXPLORING TELEHEALTH

• Telehealth literally means “health care at a distance”.

• Refers to “utilization of information and communication technology in health care”.

• Provision of health services from one location to another using a telecommunications medium. Includes concepts of surveillance, health promotion and public health functions.


• Recent addition – mHealth – provision of health care and public health, supported by mobile devices.
TELEHEALTH - ICT
Concept as old as telecommunication mediums
TELEMEDICINE MODELS

- **Synchronous, real-time**
  - Videoconferencing
  - Desktop sharing software
  - Remote hardware control

- **Asynchronous, store-and-forward**
  - Fax, Email, Server uploads
  - Automation NB component

- **Hybrid model**
ONSITE

Patient

Facilitator

VIRTUAL

ASYNCHRONOUS / STORE & FORWARD

ICT

SYNCHRONOUS / REALTIME

Healthcare professional
MOBILE REVOLUTION
CONNECTIVITY
The number of mobile subscriptions will soon overtake the world’s population

2002
There are over 1 billion mobile subscriptions, passing fixed-line users.

1978
First commercial cellular mobile services established.

1961
85 years later, fixed-line subscriptions reach 100 million.

1876
Alexander Graham Bell holds the first two-way telephone conversation.

GLOBAL POPULATION
FIXED-LINE SUBSCRIPTIONS
MOBILE SUBSCRIPTIONS

World Bank, 2012
The pace at which mobile phones spread globally is unmatched in the history of technology.

- Percent of the world's population with mobile cell signal:
  - 2003: 61%
  - 2010: 90%

Over 6 billion mobile subscriptions worldwide.

75% of the world now has access to a mobile phone.
THE DEVELOPING WORLD IS NOW MORE MOBILE THAN THE DEVELOPED WORLD

MOST PHONES ARE OWNED BY PEOPLE LIVING IN LOW-INCOME REGIONS

GROWTH OF GLOBAL MOBILE SUBSCRIPTIONS

ACCESS TO A RANGE OF MOBILE APPLICATIONS HAS INCREASED DRAMATICALLY THROUGHOUT THE LAST DECADE

World Bank, 2012
EXPLORING NOVEL SOLUTIONS

1. Novel screening technologies
2. Remote hearing and ear diagnosis
3. Tele-intervention

(Swanepoel & Hall, 2010)
WITKOPPEN CLINIC - DIEPSLOOT
WITKOPPEN CLINIC - DIEPSLOOT
TELE-AUDIOLOGY CLINIC
AUDIOMETRY OUTSIDE A BOOTH?

SUBJECTIVE ATTENUATION

- 3A & KW Cup
- 3A
- TDH39
AUDIOMETRY OUTSIDE A BOOTH?
AUDIOMETRY OUTSIDE A BOOTH?

- Validation study
- Within-subject repeated measures design comparing air (250 to 8000 Hz) and bone (250 to 4000 Hz) conduction thresholds in:
  1. Natural school environments
  2. Sound-treated booth
- 149 children (54% female) with an average age of 6.9 years (SD 0.6; Range 5 – 8) from 2 schools.
- Ave time between tests 9.3 days (± 8.4 SD) – tympanometry & otoscopy to confirm no transient middle-ear pathology
Audiometry Outside a Booth?

- **No significant differences** \((p > 0.01)\) between the natural and audiometric booth environments within subjects between:
  
  i. **Thresholds** recorded in natural and booth environments for air- and bone-conduction audiometry
  
  ii. **No of responses** to pure-tone presentations
  
  iii. **Average reaction time**

- Almost all air- (96%) and bone-conduction (97%) threshold comparisons between the natural and booth test environments were within **0 to 5 dB**
Conclusions: Automated audiometry provides reliable, accurate, and time-efficient hearing assessments for normal-hearing and hearing-impaired adults.
Conclusions:
- 29 reports (method of limits and method of adjustment); 1956 - 2011.
- Meta-analysis test-retest and accuracy for automated audiometry was within typical test-retest variability for manual audiometry
- Provides an accurate measure of hearing threshold, but data limited for (i) automated BC audiometry; (ii) children and difficult-to-test populations and; (iii) different types and degrees of hearing loss
TELE-AUDIOLOGY CLINIC
<table>
<thead>
<tr>
<th>View</th>
<th>VTC</th>
<th>Clinic</th>
<th>Test Date</th>
<th>Interpreted</th>
<th>Care Giver</th>
<th>Patient</th>
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REFERRALS FOR SYNCHRONOUS TESTING:

- Complex cases
- Difficult-to-test patients
- Queries regarding validity of results
Conclusions: There were no clinically significant differences between the results obtained by remote intercontinental audiometric testing and conventional face-to-face audiometry.
REMOTE DIAGNOSIS OF EAR DISEASE

Background

• Global burden from chronic OM affect 65 – 330 million

• India & sub-Saharan Africa account for most deaths from OM

• COM – 1) risk of hearing loss and 2) life-threatening complications (e.g. meningitis, brain abscesses)

• Largely preventable and effective medical management

• Early detection and treatment at primary health care can reduce long-term morbidity and mortality

BUT - Poor access to specialist personnel limit diagnosis and appropriate treatment

(WHO, 2013; Acuin, 2004)
REMOTE DIAGNOSIS OF EAR DISEASE

- **Aim:** To evaluate the *effectiveness* and *accuracy* of *video-otoscopy* recordings by a trained *non-professional* for remote *diagnosis* of *ear disease* in children

- **Design:** Within-subject comparative design

- **Subjects:** 140 unselected children (2 – 15 yoa; mean 6.4 ±3.5 yoa; 44.3% female) attending a PHC

- **Context:**
REMOTE DIAGNOSIS OF EAR DISEASE

Equipment and procedures:
# REMOTE DIAGNOSIS OF EAR DISEASE

Concordance of otomicroscopy and remote video-otoscopy

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<th>Onsite diagnosis</th>
<th>Remote diagnosis</th>
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<tbody>
<tr>
<td></td>
<td>n = 272 ears</td>
<td>n = 269 ears</td>
</tr>
<tr>
<td><strong>Otologist (%)</strong></td>
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<td></td>
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<tr>
<td><strong>Review 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>75.8</td>
<td>58.4</td>
</tr>
<tr>
<td>Otitis media:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AOM</td>
<td>16.5</td>
<td>16.7</td>
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<tr>
<td>CSOM</td>
<td>4.8</td>
<td>6.7</td>
</tr>
<tr>
<td>SOM</td>
<td>11.0</td>
<td>10.0</td>
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<tr>
<td>Undetermined</td>
<td>7.7</td>
<td>24.9</td>
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<td><strong>Review 2</strong></td>
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<tr>
<td>Normal</td>
<td>62.1</td>
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<tr>
<td>Otitis media:</td>
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<tr>
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<tr>
<td>Undetermined</td>
<td>23.4</td>
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</table>

R1 Kappa = 0.702
R2 Kappa = 0.740

Substantial agreement

Sens / Spec = 78% / 95%

Intra-rater diagnosis Kappa – 0.773
REMOTE DIAGNOSIS OF EAR DISEASE

CONCLUSIONS

• A non-professional, with no health care training, can be trained to acquire adequate video otoscopic recordings for remote otologic diagnosis

• Remote diagnosis accuracy is similar to inter- and intra-rater agreement previously reported

• Accompanied with audiometric data it can be a valuable diagnostic tool to underserved populations

• Video recordings improved diagnostic utility above images

• More experience may improve quality of recordings

(Biagio, Swanepoel, Lundberg & Laurent, IN PRESS)
CONCLUSION

• Rapidly changing world

• **Hearing loss and ear disorders** prevalent with inadequate human resources to meet **demands**

• Continued **growth in technology and connectivity** will change the way in which we deliver services. E.g.
  
  – *Remote hearing assessment*

  – *Remote ear diagnosis*

• Promise of **reaching** more patients, and especially those in **underserved** areas, **more effectively** (time and cost)