

# The diagnostic accuracy of school hearing screening tests and cost-effectiveness of school entry hearing screening programmes

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# Why assess school hearing screening?

- 1950s Started in UK
- From 2006: Universal Newborn Hearing Screening (England)
  - Very effective (~half of cases identified at birth)
- HTA report 2007 – Bamford, Fortnum et al<sup>1</sup>:
  - Little good evidence for effectiveness of screen
  - Still picks up some permanent losses otherwise missed
  - Troublesome conductive hearing loss can be referred
  - Does it use the best test?

<sup>1</sup>Bamford et al “Current practice, accuracy, effectiveness and cost-effectiveness of the school entry hearing screen” HTA 2007; 11(32)

# History of this project



- Aug 2007 Bamford, Fortnum et al published
- Dec 2009 First HTA call - not awarded
- July 2010 2<sup>nd</sup> HTA call for a further study
- Dec 2010 Submitted outline application
- Jan 2011 Invited to submit full application
- Apr 2011 Submitted full application
- Aug 2011 Awarded funding
- Sep 2011 Began
- Dec 2014 Completed
- 26 Mar 2015 Report submitted

# Publication



- *Jan 2016 scheduled for publication*
- Go to: <http://www.nets.nihr.ac.uk/programmes/hta>
- Search for 10/63/03
- Notified when published
- Download all or part including scientific summary

# The SES Project Team



**University of Nottingham:** Heather Fortnum, Mara Ozolins, Sam Catterick

**University of Exeter:** Rod Taylor, Chris Hyde, Obi Ukoumunne,  
Vasilis Nikolaou, Zhivko Zhelev

**University of Plymouth CTU:** Laura Cocking

**Nottingham University Hospitals NHS Trust:** Claire Benton

**Cambridgeshire Community Services NHS Trust:** Jo Moody

**Nottinghamshire Healthcare NHS Trust:** Ann Allardice , Mary Barks

**Economic modelling (Optimity Advisors):** Clive Pritchard, Sarah Roberts

**Parent representative:** Jules Watson

# Objectives:

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- Update systematic review from 2007 HTA report
- Assess diagnostic accuracy of 2 screening tests
- Assess extent and impact of potential false negative results
- Compare referral data for an area with no school hearing screen (Cambridge) and in an area with a school hearing screen (Nottingham)
- Assess impact of referral from the SES
- Assess resources for implementation of two screening tests in schools
- Evaluate cost-effectiveness

# Systematic review

- Variability in design, methodological quality and results
- Cannot draw robust conclusions
- Reporting different systems of healthcare, may not be generalisable

*Parental questionnaires*

- poorest diagnostic accuracy

*PTS*

- high sensitivity and specificity

*TEOAE*

- variable sensitivity but high specificity

*ABR (one study)*

- high sensitivity and specificity

# Diagnostic Accuracy

- Two methods:

- Pure Tone Screen (PTS)

- 1, 2, 4, 0.5kHz at 20dB HL



- Siemens HearCheck screen (HC)

- 1kHz at 55, 35 & 20 dB HL

- 3kHz at 75, 55 & 35 dB HL



- Compared with Pure Tone Audiogram (PTA) – reference standard



# Participants

- **Children aged 4-6 years**
- **'Cases'**: 75 with known hearing loss
  - Recruited from audiology centres
  - Sensorineural or permanent conductive hearing loss
    - bilaterally (average 20-60dBHL) OR
    - unilaterally (any level  $\geq 20$  dBHL)
  - Tested at home
- **'Controls'**: 160 without hearing loss
  - Recruited from Nottingham schools
  - Thresholds  $< 30$  dBHL at 0.5, 1, 2, and 4kHz
  - Tested in research unit

# Diagnostic Accuracy Estimates

(95% confidence intervals)



**Sensitivity:** Proportion of **hearing impaired** ears correctly identified with a hearing impairment

- PTS: 94.2% (89.0%, 97.0%)
- HC: 89.0% (82.9%, 93.1%)

**Specificity:** Proportion of **non-hearing impaired** ears correctly identified as not having hearing impairment

- PTS: 82.2% (77.7%, 86.0%)
- HC: 86.5% (82.5%, 90.0%)

# False negatives



- Little in the literature
- Diagnostic study
  - 16 ears passed one or both screens but failed PTA
  - 4 confirmed to have hearing loss at diagnostic evaluation
  - All mild

# Service comparison: referral data

	Nottingham (with SES)	Cambridge (no SES)	Ratio / Difference (95% ci)
Referrals (n: 3-7yrs old)	1702	1108	
Base Population	42553	17624	
Referral rate /1000 person-years	21.9	34.4	0.64 (0.59, 0.69)
Yield / 1000 person-years	2.51	3.04	0.82 (0.63, 1.06)
Age of referral (years)	4.7	4.7	
Age of referral for cases (years)	5.0	4.5	0.47 (0.24, 0.70)

# Impact of referral



- Questionnaire survey
- Parents of children referred by SES in Nottingham
- Consequences = minor
- Impact applies in both SES and non-SES systems
- Main issue is concern being raised by the screen

# Practical implementation



- Range of schools
- Throughout the school year
- Minimal difference in time taken in schools between PTS and HearCheck

# Cost-effectiveness

- SES unlikely to be cost-effective
- Dominated by no screening strategy
- Confirms clinical study
  - In the absence of SES, cases of hearing impairment
    - identified in similar numbers
    - but at a younger age
- BUT may be cost-effective if:
  - There are fewer referrals with SES (attributable to the screen) or more referrals without screening
  - Referrals occur more quickly with screening than we observed.

# Conclusions



- PTS & HC both highly sensitive (PTS  $\geq 89\%$ , HC  $\geq 83\%$ ) and specific (PTS  $\geq 78\%$ , HC  $\geq 83\%$ )
- No time savings but nurses prefer PTS
- Referral rate lower in site with SES
- Cases identified in similar numbers but at younger age in absence of screening
- SES unlikely to be cost-effective unless referrals reduce with screening or increase with no screening (modelling)



# Overall



In the context of the UK NHS, and similar health care systems, SES using screening tests like the PTS and HC is unlikely to be effective in increasing the number of cases of hearing impairment identified and lowering the age at which these cases are identified.

SES is unlikely to be judged to be cost-effective when judged against benchmarks used by the National Institute for Health and Care Excellence

## (some of the) Remaining Questions



- Are there other, better screens, perhaps still to be developed?
- Definitions?
- Are our findings representative?
- If we stop screening, what is the best alternative referral system?
- What is the impact on children and families?

# Implications for practice

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- If SES is not cost-effective – withdraw it? BUT
  - Two scenarios in which it could be cost-effective
  - Findings dependent on only two services
  - Crucially dependent on effectiveness of ad-hoc referral

# Implications for research



- On-going systematic review of diagnostic accuracy of screens
- Characterise and measure different approaches to ad-hoc referral
- Further observational studies in different services
- Opportunities for data collection where SES is withdrawn

# Thank you



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SES is unlikely to be judged to be cost-effective when judged against benchmarks used by the National Institute for Health and Care Excellence

## QUESTIONS?