Audiens Interactive

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August 2015

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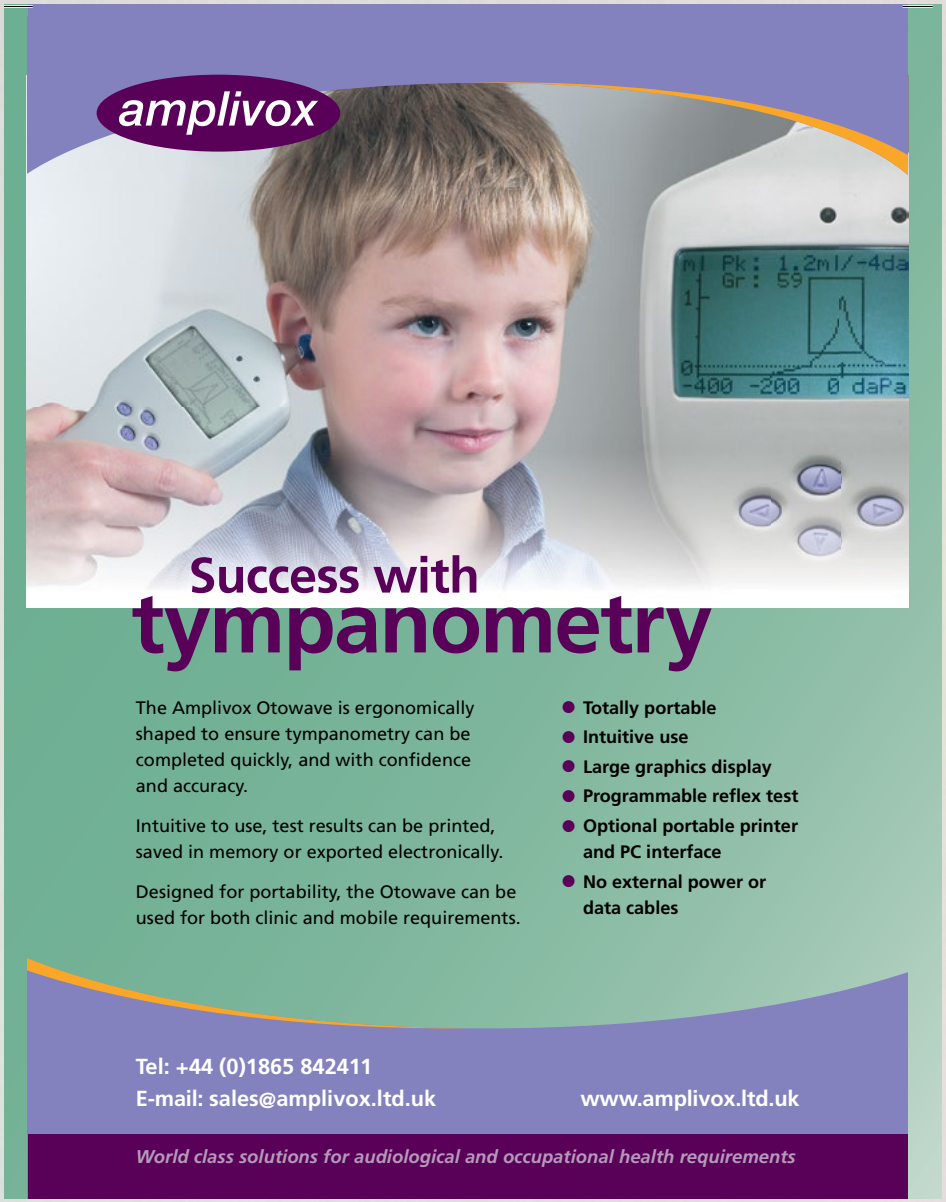

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AUDIENS

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From the Editor

Dear All

Dear All

Although I write this as the summer holidays begin, there is no time to forget about school as this edition has two articles about the school screen. Although unlike the various UK newborn hearing screening programmes, the school screen is no longer universal, both pieces make interesting reading. Heather Fortnum recently retired from the NIHR in Nottingham and her work familiar from her many research papers has written a summary of the diagnostic accuracy and cost effectiveness of the school screening programme. Both questions of interest to commissioners of paediatric audiology now newborn screening is well established. Sebastian Hendricks received the BAPA prize and describes how he used this to support his work on developing a lap top based school screening tool. Regulations for the BAPA prize can be found on the BAPA website. You could be the next recipient of the prize, so tell us about your service development, service improvement, research.....

An evaluation of the BAPA London meeting earlier this year is enclosed and again Ann Large is preparing an exciting programme for next January. Please note the change of day to Thursday 28th January 2015, the day being changed in order to keep the usual venue. My highlight as last year was the audit presentations from members, with an increased number submitted for selection and all very relevant to our practice. As all of us are involved in audit, please consider submitting yours. Again look on the website for details or contact your rep.

Again for information I have enclosed the agenda of the last BAPA exec meeting. Through the exec, BAPA has links to other audiology/paediatric organisations, and BAPA is best informed about the UK wide picture through you the members. If you are aware of any challenges in your area especially workforce issues please let your rep know.

Anne Marsden, anne.marsden.nhs.net

BAPA EXECUTIVE COMMITTEE MEETING
Friday12th June2015 at 10.30am – 4.30pm
Meeting Room 1, on the 5th floor. Venue: - RCPCH
Agenda

1. Housekeeping, Welcome & Apologies for Absence
2. Minutes of last meeting*
3. Matters Arising. - MaxAppeal 22q11, HABUK
4. BAPA Trustees – names
5. BAPA Exec & Trustees
   a. Roles & Responsibilities update*
   b. Guidelines / Protocols for BAPA*
6. AGM 2015 - Draft minutes*
7. Company Information– Membership
8. E-mail communication with members
9. Audiens
10. BAPA website - Any requests to advertise, links, updates –
11. Meeting Secretary*
    a. January 2015- Feedback, etc
    b. Jan 28th 2016 - Programme,etc,

12. BACCH – Training, ASM –2015
13. RCPCH meeting 26 – 28th April 2016, Liverpool
14. Aetiology training course - update
15. BAPA Prize & audit prize
    a. 2016 – Entry criteria*,
16. BAAP
    a. new constitution
    b. audit presentation
    c. Paediatric AVM training / Workforce
17. Rapid Response requests / information circulated since last meeting *
    a. Microtia and Atresia Care Standards*
    b. Unilateral Profound Survey
    c. BSA Lunch & Learn
    d. BSA Early Day Motion
    e. RCPCH Doc 28 – ShoT
    f. Bank Account vote
18. Discussion of circulated reports* from
    a. Chair*
    b. Past Chair
    c. Treasurer*
    d. Regional Representatives**
    e. RCPCH SIG Convenor
    f. UKCoD rep*

19. Liaison with BACCH, BSA, PAIG
20. Other organisations meetings – feedback & future dates – BSA Hallpike,, Lunch & learn.
22. AOB
    a. a…
    b. b
23. Dates / venue of future meetings All meetings at RCPCH
    a. Monday 21st September 2015
    b. Thursday 3rd December 2015
    c. ? March 2016
    d. ? June 2016
    e. ? September 2016
    f. ? December 2016

(Written report in advance please).
*circulated - please read in advance of meeting

British Association of Paediatricians in Audiology (BAPA)

Annual London Conference 2015

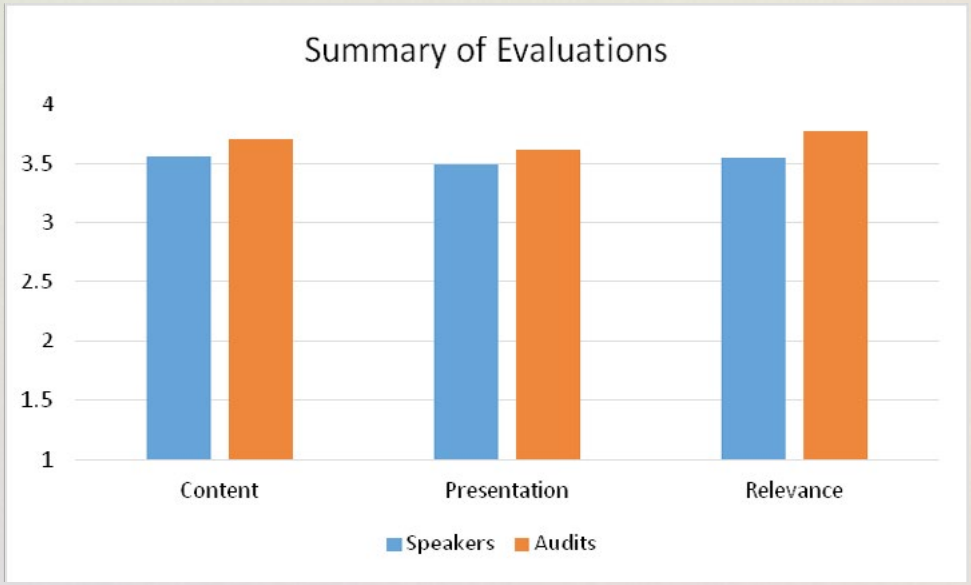
The 2015 BAPA Annual London Conference was held at the School of Oriental and African Studies, University of London on Friday 30th January 2015. There were 66 delegates and 3 exhibitors.

The morning session started with two talks on OME. The first by Mr Mahmood Bhutta of UCL Ear Institute discussed the evidence for genetic involvement in OME and the second by Dr Amanda Hall of the University of Bristol discussed the relationship of OME, hearing loss and IQ, findings of the ALSPAC study. These were followed by talks on neural plasticity in the auditory system by Dr Velia Cardin of University College London and on APD and tinnitus by Professor Tim Griffiths of Newcastle University. The afternoon plenary session was devoted to congenital infections and hearing loss. Dr Nicola Price of Public Health Wales gave an overview of the subject followed by an update on congenital CMV and hearing loss by Dr Simone Walter of St. Helier Hospital. The feedback for the invited speakers was very positive however, the delegates generally found the talks with a clinical message more useful than the scientific presentations.

The Conference concluded with the prize winning audit presentations. The subjects covered were vision care, transition, KPI2 and Down Syndrome. These were very well received by the audience as they were so relevant to our daily practice and delegates went away with ideas for how they may examine and change practice in their departments.

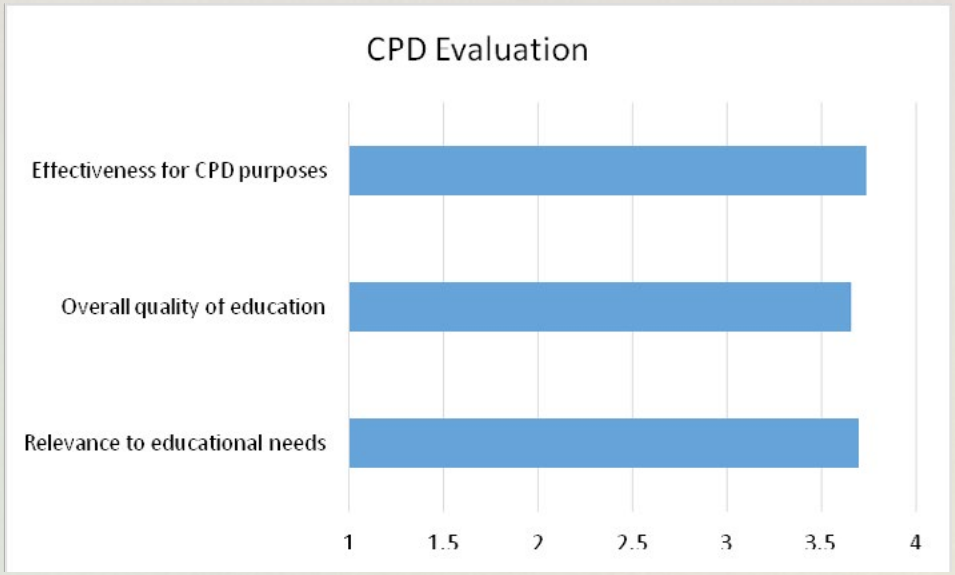
Each talk was scored out of 4 for content, presentation and relevance. A summary of these can be seen in Figure 1.

In addition to the spoken audit presentations, there were 3 poster presentations of audits which were visited by delegates during the breaks. These included one by Medical student, Emily Gaines from Cardiff who found the whole Conference a



great experience. This is an excellent opportunity for trainees, please encourage them to get involved. There was no formal feedback for the posters but comments received suggested that delegates found them informative and it is definitely something which we will endeavour to have at next year's meeting.

Overall, the day was successful in meeting the aim of the conference, to provide an opportunity for learning and discussion on current issues in paediatric audiology. This can be seen in Figure 2.



Plans for next year's Conference are well under way. After many years of the Conference being held on a Friday, next year's Conference is moving to a Thursday. Please put the date in your diary now and book your study leave for THURSDAY 28th JANUARY 2016. The venue will remain the same. More details to follow nearer the ti me. I look forward to seeing you all there!

Ann Large

BAPA Meeting's SecretaryP

Presentation of the Audit Prizes


Jane Audit of
Key Perfor...
Annabel
Down's f...


Jane Audit of
Key Perfor...
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Development of a
School Entry Hearing Screening [SEHS] system
- the schoolscreener -

Dr Sebastian Hendricks

Development of a School Entry Hearing Screening [SEHS] system

- the schoolscreener -

Dr Sebastian Hendricks, Consultant Audiovestibular Physician & Paediatrician.

Clinical Lead for Paediatric Audiology & Audiovestibular Medicine, Royal Free London NHS Foundation Trust

Consultant Paediatric Audiovestibular Medicine, Royal National Throat Nose & Ear Hospital, University College London NHS Foundation Hospitals.

Background:

Our established national newborn hearing screening is well respected and has led to great improvements in the early diagnosis and management of children with hearing loss. However we also know that it only picks up about half of the permanent hearing losses present at around 5 years of age. In order for children to fulfil their potential in education it is important that we identify and manage hearing loss in all these children at this critical age. The school entry hearing screening seems an appropriate system to ensure detection of those hearing losses.

In 2007 the Health Technology Assessment on “Current practice, accuracy, effectiveness and cost-effectiveness of the school entry hearing screen” Vol. 11: No.32 stated that:

- Just over 10% of services are no longer providing hearing screening at school entry.
- Coverage and referral rates are variable.
- Test techniques and protocols were very variable and tests are often done in poor listening conditions.
- There is no national approach to data collection or audit and quality assurance, and there are variable approaches at local level.
- Approx 1.89/1000 children have an acquired or progressive permanent deafness that requires identification after the

newborn screen. 80% of these children could be identified using targeted screening if appropriate protocols, services and professional vigilance are in place. However, 20% (0.37/1000) of all permanent impairments may be missed without SEHS or reactive referral.

- SEHS was found to be cost-effective when compared to not having SEHS or using other types of hearing screen.

The Department of Health published in 2008 “The Child Health Promotion Programme”. On page 56 it stated that, “By five years – to be completed soon after school entry …

- Hearing screening should be carried out using an agreed, quality-assured protocol in appropriate surroundings. Parental concern about hearing should always be noted and acted upon.
- Screen all children for visual impairment between four and five years of age. This should be conducted either by orthoptists or by professionals trained and supported by orthoptists. …”

The National Deaf Children Society published their position statement in response to the above documents in February 2010. They confirmed that, …

in areas of the UK which have school entry screening NDCS shall:

- oppose any proposal to cease school entry screening unless it can be demonstrated that it will be replaced by more effective screening processes
- seek assurances about the quality of the screening programme, including asking for details of the numbers of children identified by school entry screening and what happens to the data
- ask that services should work to improve the quality of their screening programmes and implement audit of screening performance.

… in areas that do not have school entry screening NDCS shall:

- urge for the introduction of an effective way of screening the child population
- ask what processes the health service has in place to ensure children are given prompt hearing assessment – e.g. do they offer open referral for parents concerned about hearing, do they have targeted screening for ‘at risk’ groups
- ask that whenever SES is re-introduced this is done with robust protocols, data

collection and audit processes in place.

In August 2012 another Health Technology Assessment [HTA 10/63/03] was started to look at the “The diagnostic accuracy of school hearing screening tests and cost-effectiveness of school entry hearing screening programmes“. The publication of this is awaited for January 2016. http://www.nets.nihr.ac.uk/projects/hta/106303

In the meantime time many services have tried to maintain and improve their SEHS against dwindling resources and difficulties working across boundaries. Some areas even saw their school entry hearing screening discontinued.

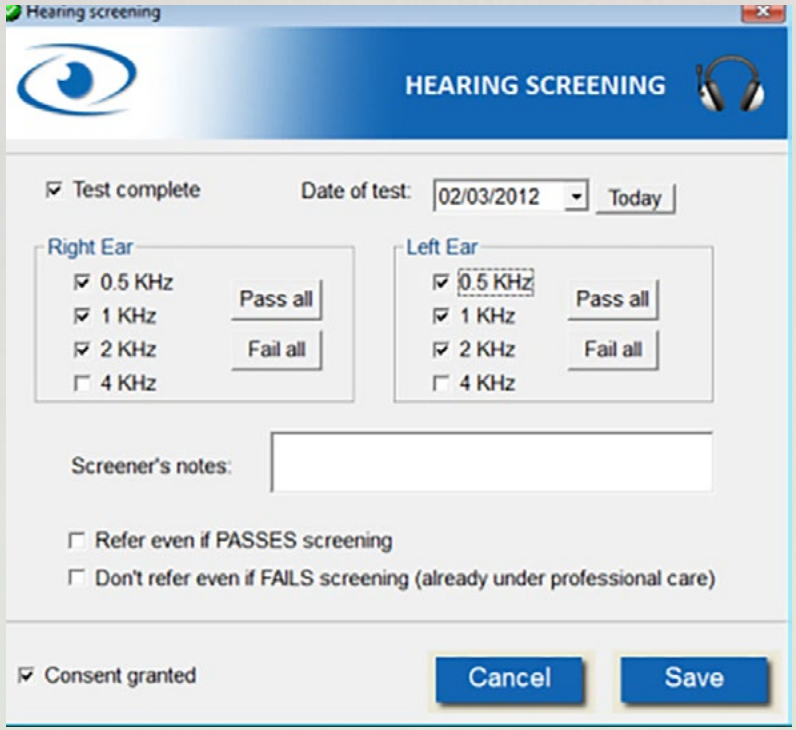
How it Started

In Barnet, North Central London, the paediatric audiology team had been training primary care trust school nurses to perform the school entry hearing screening and provided annual updates to ensure quality training. The workforce was relatively stable and local. However no formal assessment of the screening quality existed and data were not monitored. The quality control was limited.

From 2005 on a school entry vision screening program was planed and a computer based solution for the school entry vision screening considered. The PCT primary care team and the paediatric audiology team being co-located initially met for tea and coffee conversations in the kitchen. Out of this was born a cooperation to combine the vision and hearing screening at school entry. Foremost, so children had to be taken out of class only once for both screenings. We also knew that children with hearing loss are more likely to have some vision problem and vice versa. So we created a common pathway for both.

Professor David Thomson (Department of Optometry and Visual Science, City University) developed and then established with the Barnet community based orthoptists a laptop based vision screening. This allowed data to be collated automatically, stored and converted into computer generated letters.

At the time I considered the significant amount of time required to train and maintain high quality skills in those performing the hearing screening using a standard manual audiometer to be too high and that the requirement for manual recording and transmission of hearing data would not be the best use of resources in the future. I also wanted a hearing screening system that provided more robust, effective and easily auditable data. This meant I needed an automated hearing screening system suitable for children at school entry.



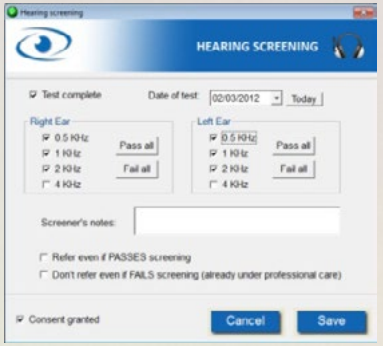
How the SchoolScreener developed:

The first step on the path was to allow the manually obtained hearing screening data to be entered into the laptop database of the school children. We created a manual input screen. As everybody was using standard audiometers performing manual screening this was a useful addition.

When the national school entry height and weight program came into practice I made sure these could be included in the database through a data entry screen. The reason for this was that Professor Marie-Louise Barrenäs just published her findings on weight and sensorineural hearing loss. Having the data sitting alongside each for each pupil would allow to link these two once a large number of data is collected.

What followed was to create a laptop based hearing screening tool. This should remove the need for manual transcription of data, but should transfer any recorded data automatically and to be stored in the database against the pupils data, linked to the vision data as well. So it happened at the time that the Institute for Hearing Research (IHR) in Nottingham had just developed the IMAP for auditory processing disorder testing. A tool that carried the potential to be used for exactly my need. Dr Sally Hind already explored options for the IMAP to be used for hearing assessments and named it PlayMe.

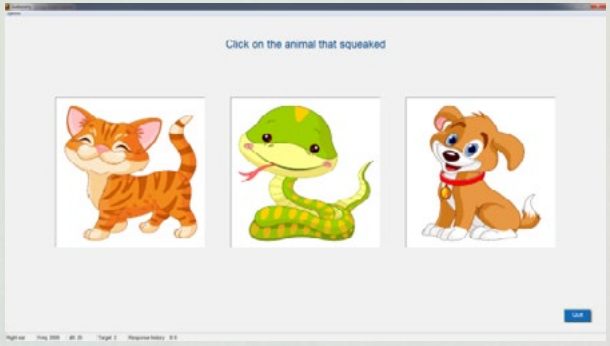
PlayMe used the IMAP screen and response system and sounds were generated through the laptop and presented through headphones. We worked on it further so it could be incorporated with the vision screener, but intellectual property concerns and difficulties with changes to the software became a problem. We decided to use it as a standalone version. From the first prototype some further changes were required and BAPA kindly awarded me with their annual prize the opportunity do further work on it, thus supporting this development. Funding from the British Society of Audiology was successfully obtained to fund the initial testing with children in the clinic situation. Unfortunately reorganisation at Dr Sally Hind's unit at the IHR delayed this progress and when she shortly after retired all IHR researchers were too busy with their projects to progress this work further. Without the IHRs support I could not progress on my own.



All along I had been working with Professor David Thomson (Department of Optometry and Visual Science, City University). He was fully supportive of develop a new custom designed integrated system for hearing screening. The current SchoolScreener (www.schoolscreener.com) was born, offering hearing, vision and BMI screening in one unit.

We already had the manual input screen for the hearing screening data that we designed a couple of years earlier and it worked well for those using their standard audiometers performing manual screening.

It worked well, but it still required screeners trained to perform sweep audiometry. A time consuming task and reliant on highly qualified school nurses rather than Health Care Assistances [HCA] or School Screeners. The only way to move to HCA screening was to develop an automated version that captured the child's attention and collected the responses automatically.

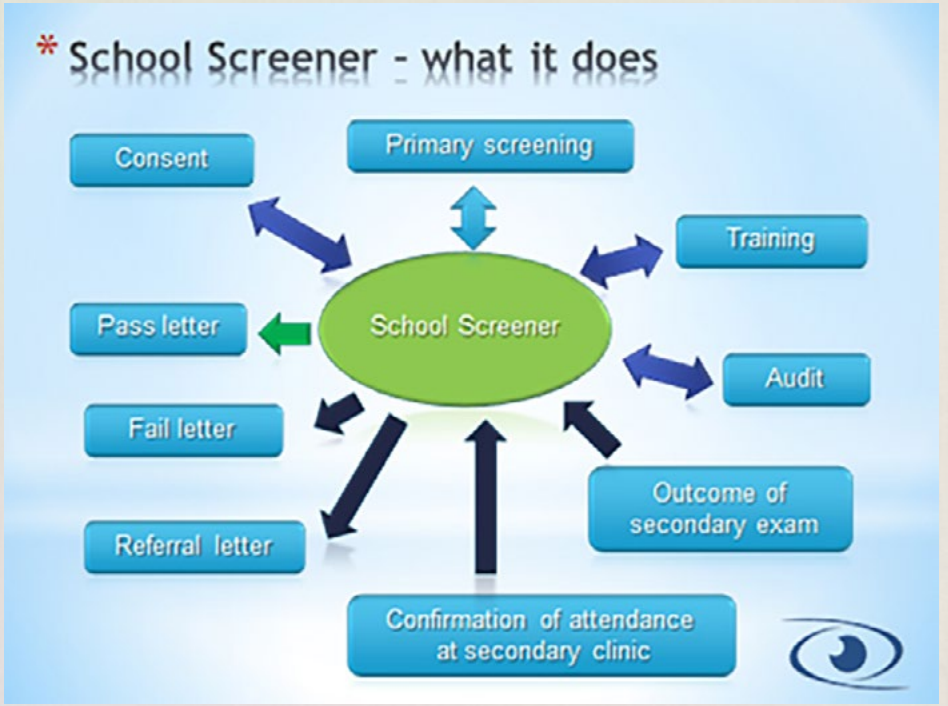


We decided to use three characters appearing one after another. One character would be making a sound, the other two not and the child had to point which one produced the sound. In order to reduce the likelihood of guessing each frequency is presented at least twice per ear. Later on we also introduced intermittent no-sound events with a no-sound symbol on the screen. Counting false positive responses allows us to detect children who guess and need referral to paediatric audiology services for manual paediatric audiometry.

The sound is presented through Sennheiser HD300 (now HD200) headphones which have excellent noise attenuation properties; a very important feature for screening in school environments.

The headphone is hard wired into a small mobile phone-sized audiometer that plugs into the USB-port of the laptop. This is unique to this system and developed for it. The headphones and the audiometer are calibrated as one unit. The whole unit is powered through the USB port of the laptop and can be exchanged against another set within seconds without the need to change the laptop or major calibration. The screener can immediately continue with the screening process.

All screening results are automatically stored with the child's record on the encrypted system. An NHS approved secure wireless transmission to a central server synchronises the data on the press of a button and allows a personalised computer generated letter to be sent to the paediatric audiology department, the parents, GP and others. The second tier clinic can access the screening data and referrals through a web portal or directly imported into AuditBase. The paediatric audiology department can also then input those cases clearly identified with a hearing loss. This closes the audit loop of the process. Summary reports per screener, school, area or part thereof can be generated on request. This gives opportunities to identify problem areas and those that might need further help.



Since the first department went live with this in London in 2014 the program continuously develops further. The early adopters have been able to shape the program and every new borough providing feedback allows me to develop the system such that it is a truly clinically driven tool that helps people to provide better services.

The hearing module is now working well and removes the screener's bias but can take longer than the

conventional manual sweep audiometry. The winning savings are in the time required around it (e.g. pupil data are electronically uploaded if provided by the local authority) and the quality of the data recording and its audit capability. The reduction of training needs is considerable.

The audit loop closes if secondary care enters their data via a web browser and unique ID. All data can also be imported into AuditBase for those services using it.

As the test time takes slightly longer than with conventional sweep audiometry I am now developing a different paradigm that should reduce the required testing time and consider the individuals response delay.

It has been a long time since I have started working on this project, but it is still growing and new ideas are waiting to be worked on.

The BAPA research prize has been very helpful in getting this progressed despite the obstacles encountered. Without small funds like this some work would not be possible.

So, thank you BAPA

Literature:

The Child Health Promotion Programme, DfES & DH, 2008

http://webarchive.nationalarchives.gov.uk/20130401151715/http://www.education.gov.uk/publications/eOrderingDownload/DH-286448.pdf

Current practice, accuracy, effectiveness and cost-effectiveness of the school entry hearing screen, Bamford, J. et al, Health Technology Assessment 2007; Vol. 11: No. 32

http://www.journalslibrary.nihr.ac.uk/__data/assets/pdf_file/0006/64644/FullReport-hta11320.pdf

National Institute for Health Research - Health Technology Assessment Programme HTA no 09/113: Are screening programmes for permanent hearing loss in children at school entry cost effective?

www.nets.nihr.ac.uk/projects/hta/106303

National Deaf Children Society [NDCS] 2010 Position Statement on School entry screening

http://www.ndcs.org.uk/document.rm?id=6256

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3185620/

Professor Marie-Louise Barrenäs:

- High risk of sensorineural hearing loss in men born small for gestational age with and without obesity or height catch-up growth: A prospective longitudinal register study on birth size in 245,000 Swedish conscripts ;

Journal of Clinical Endocrinology & Metabolism 09/2005; 90(8):4452-6. DOI:10.1210/jc.2005-0385

- The association between short stature and sensorineural hearing loss

Hearing Research 07/2005; 205(1-2):123-30. DOI:10.1016/j.heares.2005.03.019

BSA Journal Audacity:

- Audacity issue 2: Dec 2013, page 71-2 http://issuu.com/pinpoint-publishing/docs/audacity_dec13-diged
- Audacity issue 5: Dec 2014, page 50-2 http://issuu.com/pinpoint-publishing/docs/audacity_dec14-diged2/0

The diagnostic accuracy of school hearing screening tests and cost-effectiveness of school entry hearing screening programmes: A summary of a project funded by the National Institute for Health Research,

Health Technology Assessment Programme.

Dr Heather Fortnum, on behalf of the project team*.

Identification of permanent hearing impairment at the earliest possible age is crucial to maximise the development of speech and language and contribute to the best opportunities for educational achievement and quality of life [1]. Approximately one in every 1000 children in the UK is born with a permanent bilateral hearing impairment >40dB (average across four frequencies: 0.5, 1, 2 and 4 kHz) and a further 0.6 per 1000 has a unilateral impairment [2]. This equates to 800 children per year born with a permanent bilateral hearing impairment (moderate or greater) and 500 with a unilateral impairment. The introduction of the highly sensitive and specific universal new-born hearing screen (UNHS) has led to the identification of the vast majority of children born with a hearing impairment who undergo the screen [3,4]. However, not all children who will ultimately have a hearing impairment are identifiable at birth. The adjusted prevalence of permanent hearing impairment >40dB (average of 0.5, 1, 2 and 4kHz) at age 3 years is reported as 1.07 per 1000 and the prevalence for children aged 9-15 years as 2.05 per 1000 [5]. Thus, due to acquisition, progression or late-onset of hearing impairment and/or geographical movement of families, there remain a significant number of children to be identified with a permanent hearing impairment after the new-born period. The onset of hearing impairment in children can occur at any time which means there is no optimum time for a further universal hearing screen. The universal distraction hearing test, established in the UK in the 1950s and undertaken by health visitors at around 8 months of age was abandoned following the introduction of UNHS, based on a lack of robust implementation and a low yield of cases [6,7]. Without formal screening between the new-born period and school entry, identification of hearing impairment in children is achieved through parental and professional awareness and a close follow-up of children who pass the neonatal screen but are considered to be at risk [8]. A universal hearing screen when children start school, the school entry screen (SES), was established in 1955 and remains in place in many parts of the UK. It is considered as a ‘back-stop’ screen to identify children as part of a ‘captive population’ at school entry.

OBJECTIVES AND METHODS

The overarching aims of this project were to evaluate the diagnostic accuracy of hearing screening tests and the cost-effectiveness of screening for hearing impairment at school entry in the United Kingdom.

- We updated the latest systematic review of diagnostic accuracy of tests used for school entry hearing screening, summarising the literature that has been published since the previous review and drew together the evidence from the previous review and the updated review.
- We estimated and compared the diagnostic accuracy of the Pure Tone Screen (PTS) and HearCheck (HC) tests for discriminating between children aged 4-6 years i) with a known hearing impairment (of any type) and ii) assumed to have no hearing impairment. We used Pure Tone Audiometry results as the reference standard.
- We investigated the impact of a potential false negative result by reviewing the literature on the impact of false negative results from screening tests and describing children with false negative screening results in the diagnostic accuracy study.
- We prospectively collected data for children aged between 3 years and 6 years 364 days referred for investigation of suspected hearing impairment in a geographical area which applies a routine school entry hearing screen (SES) (Nottingham) and compared it with those referred in an area with no routine SES (Cambridge) with respect to the number of referrals, the age at referral, the source of referral, the route through assessment to intervention, the number of children ultimately identified to have a hearing impairment (yield) and the nature of hearing impairment identified.
- We surveyed parents of children referred from the SES in Nottingham via a postal questionnaire to assess the impact both psychological and economic, for the child and the family of a positive result from a screen (both true and false positives).
- We determined the time resource in implementing either of the two alternative screening methods (PTS and HC) in primary schools and explored the practical issues involved and the views of nurses conducting the screening tests.
- The component data from each study were used to refine an existing SES economic model, providing robust estimates of key parameters beyond accuracy of SES to be assessed. In particular, the yield and nature of hearing impairment detected in a system with no SES; the yield, consequences and costs of screen positive individuals in an SES system; and the costs of setting up an SES system.

RESULTS

The updated review of diagnostic accuracy studies confirms the conclusion from the 2007 HTA report that research to date demonstrates marked variability in the design, methodological quality, and results. Robust conclusions about the performance of individual test types for use in SES cannot be drawn. We found that parental questionnaires had the poorest diagnostic accuracy compared with all other tests. The findings for sweep pure tone audiometry (PTA) remain unchanged from the 2007 HTA report: “Studies comparing various screen protocols of pure tone sweep audiometry report high sensitivity and specificity….”. Studies evaluating transient evoked oto-acoustic emissions reported variable sensitivity with wide confidence intervals, while specificity estimates were relatively high and more consistent. The study evaluating the automated auditory brainstem response reported high sensitivity and specificity.

The review included studies from countries with and without an established UNHS system and with very different systems of healthcare delivery. The generalisability of the findings to other situations, including the UK NHS system, is likely to be limited.

The findings of our diagnostic accuracy study indicate that the pure tone screen and HearCheck devices have a high level of sensitivity (PTS ≥89%, HC ≥83%) and specificity (PTS ≥78%, HC ≥83%) for identifying hearing impairment at the level of the ear. These conclusions appear robust, the child-level analyses indicating similar levels of sensitivity and specificity.

From our review of the existing literature and data from the diagnostic accuracy study, we are unable to quantify the effect of false negative results from the PTS or HC screening, but were able to confirm that the rate was extremely low. Of the 16 ears in our diagnostic study (total N=630) which passed one or both of the screening tests but were referred by the PTA measure, only four were confirmed to have a hearing impairment at diagnostic evaluation and all were mild.

There was strong evidence that the rate of referral for hearing problems is lower when a school entry screen is present. The referral rate was 36% lower in Nottingham (SES) relative to Cambridge (no SES) (rate ratio 0.64, 95% CI: 0.59 to 0.69).

There was little evidence that the yield of confirmed cases differs between areas with and without a school entry screen (rate ratio 0.82, 95% CI:0.63 to 1.06; p=0.12) but a higher proportion of referred children were subsequently confirmed to be hearing impaired in the area with a school entry screen (17.0% in Nottingham versus 10.6% in Cambridge).

The mean age of referral was nearly identical between areas with and without a school entry screen when looking at all referrals but for children who were subsequently confirmed as having a hearing impairment there was strong evidence that the children in sites with a screen are older at referral (mean age difference 0.47 years, 95% CI: 0.24 to 0.70).

We found from our survey of parents of children referred by the SES in Nottingham that the consequences of the referral process for parents and children, including false positives, are minor. The difference for parents whose child is referred by the SES is that they may have had no concerns prior to the screening test.

We demonstrated minimal differences between the PTS and HC in terms of time taken to conduct each examination and practical issues. Testing covered a range of schools throughout the school year and thus we suggest the findings might be generalisable beyond the Nottingham schools.

Our economic modelling showed that SES is unlikely to be cost-effective and, using base case assumptions, is dominated by a no screening strategy. This is consistent with the observed results of the clinical studies which suggest that cases of hearing impairment are identified in similar numbers but at a younger average age in the absence of SES.

Two situations where SES might be cost-effective were identified. In the first situation, a reduction in the number of referrals associated with SES or, conversely, an increase in referrals without screening, can give a cost-effectiveness

ratio for the no screening option above NICE's £30,000 per QALY benchmark. This is supported by the observation from our clinical study that the referral rate (and by assumption, potential false positives) was lower in the site where SES had been in place for many years. However, in order for this to be the case the reduction in referrals would need to be attributable to SES and there is considerable uncertainty about this. The second situation is subject to still greater uncertainty and requires referrals to happen more quickly with screening than is observed from our study comparing of SES and non-SES sites.

CONCLUSIONS

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 average age at which these cases were identified. SES is also unlikely to be cost-effective when judged against the benchmarks normally used by NICE, relative to a system entirely reliant on ad hoc referral when a suspicion of hearing impairment is raised.

Implications for practice

Although our finding of the lack of cost-effectiveness of SES may be considered as a reason to withdraw SES where it is currently being practiced, we would highlight aspects of the results which suggest caution. First, we have shown that there are at least two scenarios in which it may be cost-effective. Second, our findings are very dependent on findings in the two specific areas (Nottingham and Cambridge) that were used here, and our conclusions from comparing areas with an SES and without an SES may not be generalisable to other areas. Third, the cost-effectiveness of SES depends on how effective (or ineffective) the 'no SES system' is. This in turn is highly dependent on the effectiveness of ad hoc identification and referral for diagnostic evaluation with an audiologist (DEA), which is not only largely unknown, but likely to be variable. It seems plausible that SES might have greater potential to be cost-effective where ad hoc identification and referral is less well developed than in a system where it is well established. If withdrawal of the SES service is to be considered it needs to be carefully managed to ensure that the ad-hoc referral system is working effectively. Health professionals and parents, who would then be responsible for referral of children about whom there were concerns in the school entry year, might need to be reminded to be more vigilant for signs of hearing impairment.

Implications for research

Systematic reviews of the accuracy of devices which might be used to measure hearing in children at around school entry age should continue to be pursued.

Characterising and measuring the cost-effectiveness of different approaches to the ad hoc referral system with a view to optimising it should be undertaken.

Examination of the process by which concern, or referral from SES, is converted into DEAs would be useful to inform further research on what determines programme specificity (as opposed to test specificity).

We should improve understanding of why the referral rate varies across different sites and determine if this is related to

the presence of SES. Further observational studies similar to our comparison between Nottingham and Cambridge could be undertaken, albeit recognising the difficulty of matching the geographical areas.

Further research to better quantify the impact of referral, particularly with respect to anxiety, and whether all referrals are affected to the same degree as respondents in our study may be required, particularly if it appears that overall effectiveness and cost-effectiveness could be critically dependent on the costs and disutilities experienced by false positives.

If withdrawal of SES is contemplated in particular settings, this could be used as an opportunity for further data collection. Particularly where the pattern of referrals and cases was known over many years in the run up to withdrawal, any change in pattern of referrals/cases could be very useful evidence confirming the lack of effectiveness and cost-effectiveness of SES, or challenging it. More formally, if SES cessation is being contemplated in many areas, a randomised trial of withdrawal of SES services could be designed using referrals and hearing impairment cases identified as outcomes.

The draft report of this project has been submitted to the NIHR HTA programme for review. See http://www.nets.nihr.ac.uk/projects/hta/106303 for updates. Final publication is expected to be January 2016.

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