Assessing the Newborn Baby
Intended Learning Outcomes

- Screening
- What is the Auditory Brainstem Response?
- Applying electrodes
- Determining threshold
Screening
Screening Criteria

- The condition
- The test
- The intervention
- The screening programme
- Implementation criteria
Newborn Hearing Screening Aim

“To identify all children born with moderate to profound permanent bilateral deafness within 4-5 weeks of birth”
Permanent Childhood Hearing Impairment (PCHI)
Techniques

• Otoacoustic Emissions
  – Acoustic Response
  – Only as far as the cochlea
  – Baby settled and room quiet

• Auditory Brainstem Response
  – Electrophysiological
  – Baby asleep and room quiet

• At Screen:
  – Neither is frequency specific
  – Both fully automated
Patient Flowchart NICU Babies – OAE Model

- Risk factors requiring ongoing surveillance including bilateral refer on OAEs with a clear response on AABR
  - Yes
    - Clear response in both ears on AABR test
    - No
      - Referral for an audiological assessment
  - No risk factors requiring ongoing surveillance
    - UNHS complete baby is returned to routine child health surveillance
    - Referral made to targeted surveillance programme
Well Babies

If NCR

OAE1

OAE2

If NCR

AABR

NICU Babies

OAE

&

AABR
Excluded from Screen

- **Microtia / external ear canal atresia** - where there is no patent ear canal in one or both ears

- **Neonatal bacterial meningitis or meningococcal septicaemia** – Confirmed or strongly suspected

- **Confirmed Congenital Cytomegalovirus**

- **Presence of a ventriculo-peritoneal shunt**
Definitions

- **Sensitivity** (true positive rate, hit rate): the proportion of cases with the target disease that the test correctly identifies as having the disease.

- **Specificity** (true negative rate): the proportion of cases without the target disease that the test correctly identifies as not having the disease.
Additional Screening?

• 136 children with a unilateral or bilateral PCHI of any degree identified / confirmed at school age (prevalence 3.65/1000).

• Sixty-four (1.79/1000) (49%) had been identified by UNHS.

• The post-neonatal prevalence was attributed to;
  – Congenital PCHI not identified by UNHS
  – Mobility of Population
  – Late-onset or acquired HL
  – Progressive PCHI
Late onset

- “Even with UNHS in place post-neonatal routes to identification need to be maintained and improvements investigated”

(Watkin & Baldwin 2012)
Targeted follow-up

- Syndromes associated with hearing loss
- Cranio-facial abnormalities including cleft palate
- Confirmed congenital infection (toxoplasmosis, rubella or CMV)
- NICU >48 hours and no OAEs despite clear AABR
Newborn Hearing Screening Programme (NHSP): recommendations for changes in targeted follow up procedures

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Sally Wood, Adrian Davis, Graham Sutton</th>
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<td>Date</td>
<td>21/11/11</td>
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<tr>
<td>Audience</td>
<td>NSC, NHSP Programme Centre, Directors of Public Health (SHA and PCT), Screening leads (SHA and PCT), commissioners, NHSP teams (Team Leaders, Screening Managers, Medical Leads, Heads of Paediatric Audiology), Regional teams, NHSP QA board, NHSP Clinical group, RCP, Royal College Midwives, BAAP, Paediatricians in Audiology, NDCS, BSA, BAA</td>
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**Consultation**

This evidence and its associated recommendations are out for consultation until 09/01/12. In order to respond to the consultation please use the dedicated response form on the NHSP website at [http://hearing.screening.nhs.uk](http://hearing.screening.nhs.uk). We plan to produce a response to the consultation and recommendations for future practice in February 2012.

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Risk factor identification

- Family history of hearing loss by questioning of parents is difficult to identify correctly (Wood et al, 1995).
  - Families tend to have poor knowledge of this risk factor
  - Difficult for non specialist staff to distinguish between a likely congenital/early onset hearing loss and later onset/acquired losses due resulting from otitis media with effusion.
Summary of evidence

• Uptake of targeted follow up is 55% for the risk factor group and 17% for the incomplete screen group.

• Incomplete screen group: Positive predictive value for permanent childhood hearing impairment = 0.95/1000
  – Thus a screening programme with 5000 births p.a. could expect one case of PCHI in this group every 15 years.
<table>
<thead>
<tr>
<th>Family History of Hearing Loss (parents/siblings only)</th>
<th>PCHI=NO</th>
<th>PCHI=YES</th>
<th>PPV/1000 if screen refer</th>
<th>PPV/1000 if not refer</th>
<th>NNT if screen refer</th>
<th>NNT if not screen refer</th>
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<tr>
<td>Screen refer</td>
<td>Not screen refer</td>
<td>Sum</td>
<td>Screen refer</td>
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<td>Sum</td>
<td>PPV/1000 if screen refer</td>
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<tr>
<td>-------------------------------------------------------</td>
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<td>--------------------------</td>
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<tr>
<td>Syndrome associated with hearing loss-other than Downs</td>
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<tr>
<td>Screen refer</td>
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<td>NICU with NCR/NCR at OAE and CR/CR at AABR</td>
<td>0</td>
<td>3494</td>
<td>3494</td>
<td>0</td>
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<td>Cranio-facial anomalies</td>
<td>1035</td>
<td>4011</td>
<td>5046</td>
<td>231</td>
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<td>462</td>
<td>1107</td>
<td>1569</td>
<td>43</td>
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<td>Congenital infection</td>
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<td>1120</td>
<td>1234</td>
<td>29</td>
<td>3</td>
<td>32</td>
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<td>27848</td>
<td>28944</td>
<td>339</td>
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<td>397</td>
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<td>Neuro-degenerative or neuro-developmental disorder</td>
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<td>1462</td>
<td>1730</td>
<td>75</td>
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<td>Bacterial meningitis</td>
<td>251</td>
<td>745</td>
<td>996</td>
<td>15</td>
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<td>Jaundice at exchange transfusion level</td>
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<td>2634</td>
<td>2788</td>
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<td>40</td>
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<td>Family History of Hearing Loss (wider family)</td>
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<td>NICU &gt; 48 hours</td>
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<td>Aminoglycoside administration &gt; 48 hours</td>
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<td>1709</td>
<td>213</td>
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Table 6: Data for PPV and NNT for risk factors
Auditory Brainstem Response
BSA Recommended Protocols
http://www.thebsa.org.uk/resources/

Recommended Procedures and Publications

The documents and information on this page, except those awaiting review, are the responsibility of the Professional Practice Committee (PPC; formerly Education Committee).

Comments on these documents and this page are welcomed and should be sent to registrar@thebsa.org.uk, marked for the attention of the Chair of the PPC.

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The documents under the category of ‘Awaiting Review’ have not yet been formally approved by BSA (e.g. according to its procedure for processing documents). However, they may have been approved by another group; see comments next to each document.

Accreditation Criteria

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<td>BSA Short Courses - accredited providers</td>
<td>2015</td>
<td>Current</td>
<td>Documents, PPC Group Documents, Accreditation criteria</td>
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<td>Minimum training standards for aural care</td>
<td>2013</td>
<td>Current</td>
<td>Documents, Procedures, Accreditation criteria</td>
<td>Minor amendments made March 2015</td>
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<td>2008</td>
<td>Current</td>
<td>Documents, Procedures, Accreditation criteria</td>
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<td>Current</td>
<td>Documents, Procedures, Accreditation criteria</td>
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Recommended Procedure

Auditory Brainstem Response (ABR) testing for Post-newborn and Adult

Date: September 2019
Due for review: September 2024

Practice Guidance

Guidelines for the Early Audiological Assessment and Management of Babies Referred from the Newborn Hearing Screening Programme

Date: December 2021
Due for review: December 2026
Electroencephalography (EEG)

- EEG represents an electrical signal from a large number of neurons.

- EEG is formed from different brain rhythms occurring either spontaneously or evoked by external stimuli, that overlap and interact with each other.

- This EEG activity can be looked at in the time domain or the frequency domain.
Electrodes Montage

- Prefrontal
- Frontal
- Temporal
- Posterior
- Occipital
- Central/Vertex

Locations:
- Fpz
- F8
- T7
- Cz
- T8
- P8
- Oz
Electrodes

- Reference
- Active
- Common

- Plaiting
- Crossing cables
- Avoid extension leads
Electrodes

- Silver chloride / Gold cap
- Disposable / reusable
- Contact with skin <5kΩ recommended
- Balanced – difference <2kΩ
Commonly used Clinical AEP

- Cochlear microphonic (CM)
- Auditory Brainstem Response (ABR)
- Cortical Evoked Auditory Potential (CAEP)
Effects of maturation on the ABR waveform
ABR Morphology
ABR: Typical Responses

- Latency: <15msec
- Amplitude: >0.04µV
- Attention / Arousal Level Independent
- Frequency Specific
- No Habituation
Stimulus

• Types
  – Tone pip / burst
  – Narrow band chirp (NB-chirp)

• Limitations
  – ≤ 4kHz
  – Time taken
Relationship with the PTA

- **dBnHL**
  - "Stimulus level relative to adult psycho acoustic threshold. In these guidelines the NHSP reference equivalent threshold levels are used"

- **dBeHL**
  - "Estimated PTA from electrophysiological thresholds"
Relationship with the PTA

- Correction factors affected by
  - Age
  - Frequency
  - Transducer, circumaural, inserts, BC
  - Stimulus type

- More accurate with severity of loss
- Rounded to the nearest 5dB
Signal to Noise

Good

Bad
Averaging
Averaging

[Graphs showing data points and curves with labels A2 L400050pHL, A3 L400040pHL, B2 R400050pHL, B3 R400040pHL, B50 R400000pHL, with x-axis in ms ranging from 0.0 to 22.0.]
Waiting...Waiting...
Electrical Interference

• Person
  – Electroencephalogram (EEG)
  – Electromyogram (EMG)
  – Electrocardiogram (ECG)

• Ambient
Good electrophysiological practice

- High Signal
  - Electrode location
  - Good transducer placement

- Low background noise: Muscle
  - Relaxed
  - Electrode location

- Low background noise: Electrical
  - Low electrode impedance
  - Location, location, location
Good electrophysiological practice

- Environment
  - Location in room
  - Material of pram

- Parameters
  - Notch filter
  - High pass filter – to 50Hz
  - Artefact rejection – lengthen test duration
  - Bayesian weighting
ABR: Parameter Impact

- Stimulus
  - Rate
  - Intensity
  - Frequency

- Recording
  - Filter
  - Gain
ABR Morphology
Post Auricular Muscle
ABR – Intensity Effect

ABR – Frequency Effect
Transducer

Position

Pressure

Held on by clinician

• Caution:
  – maximum levels
  – 1kHz BC
  – shunt
Stimulus Artefact