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Assessing the Newborn Baby

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Intended Learning Outcomes

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

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Screening

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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"

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Permanent Childhood Hearing Impairment (PCHI)

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Techniques

- Otoacoustic Emissions
  - Acoustic Response
  - Only as far as the cochlea
  - Baby settled and room quiet
- Auditory Brainstem Response
  - Electrophsyiological
  - Baby asleep and room quiet
- At Screen:
  - Neither is frequency specific
  - Both fully automated

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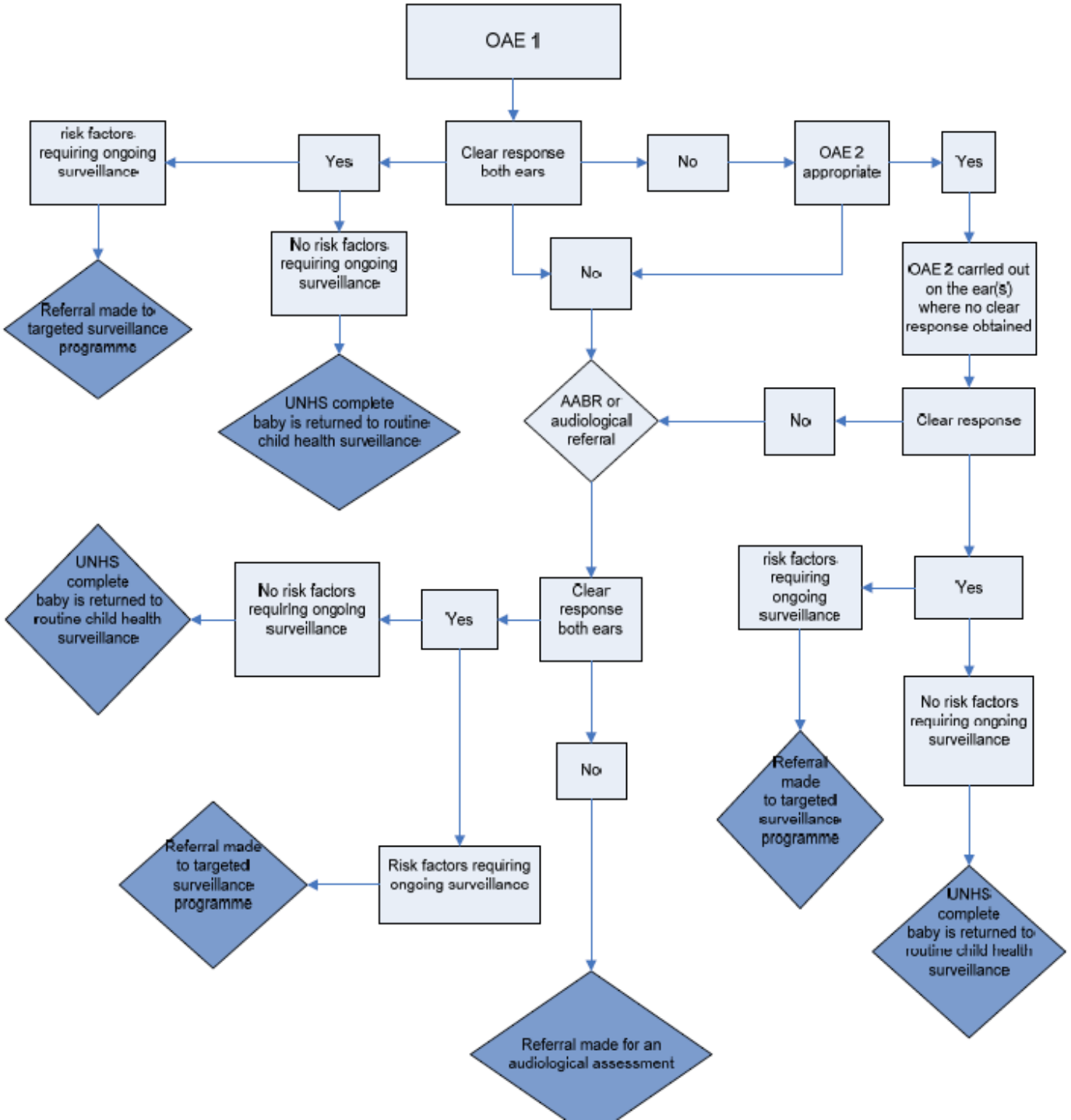

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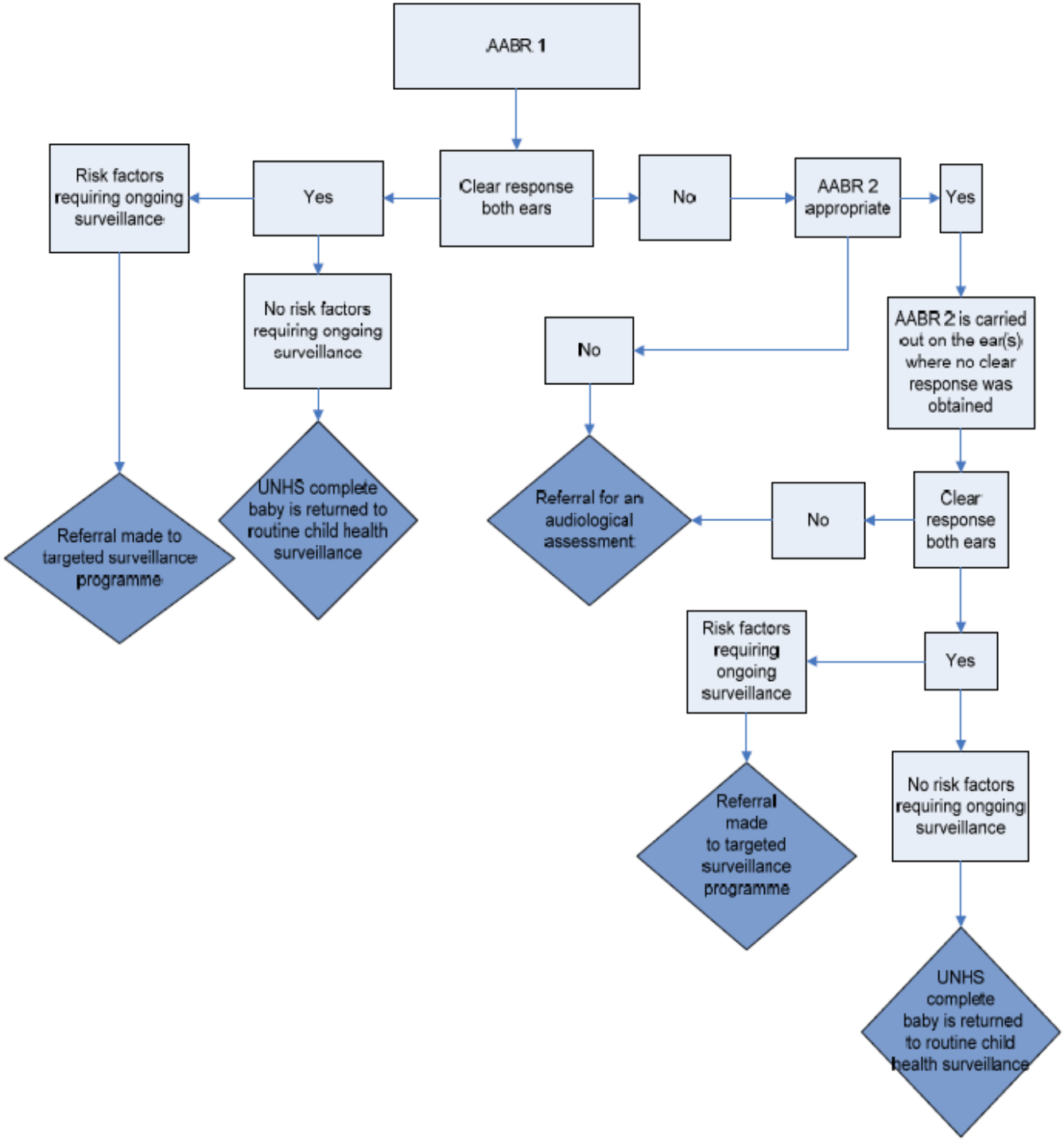

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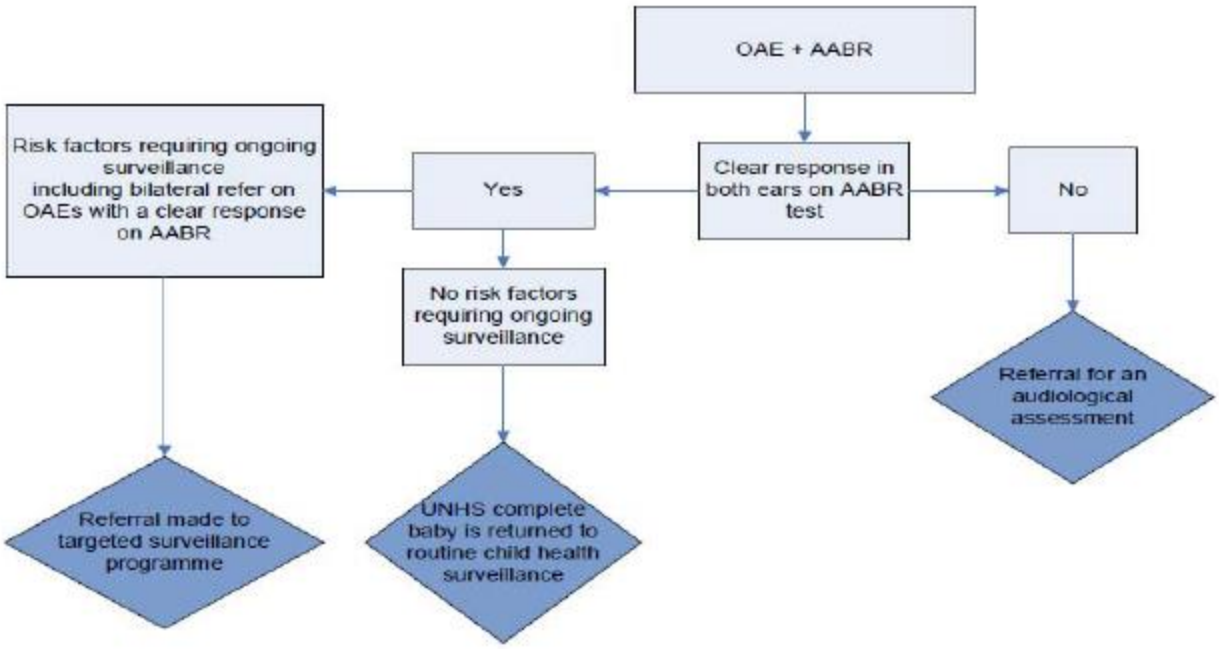
Patient Flowchart NICU Babies –OAE Model



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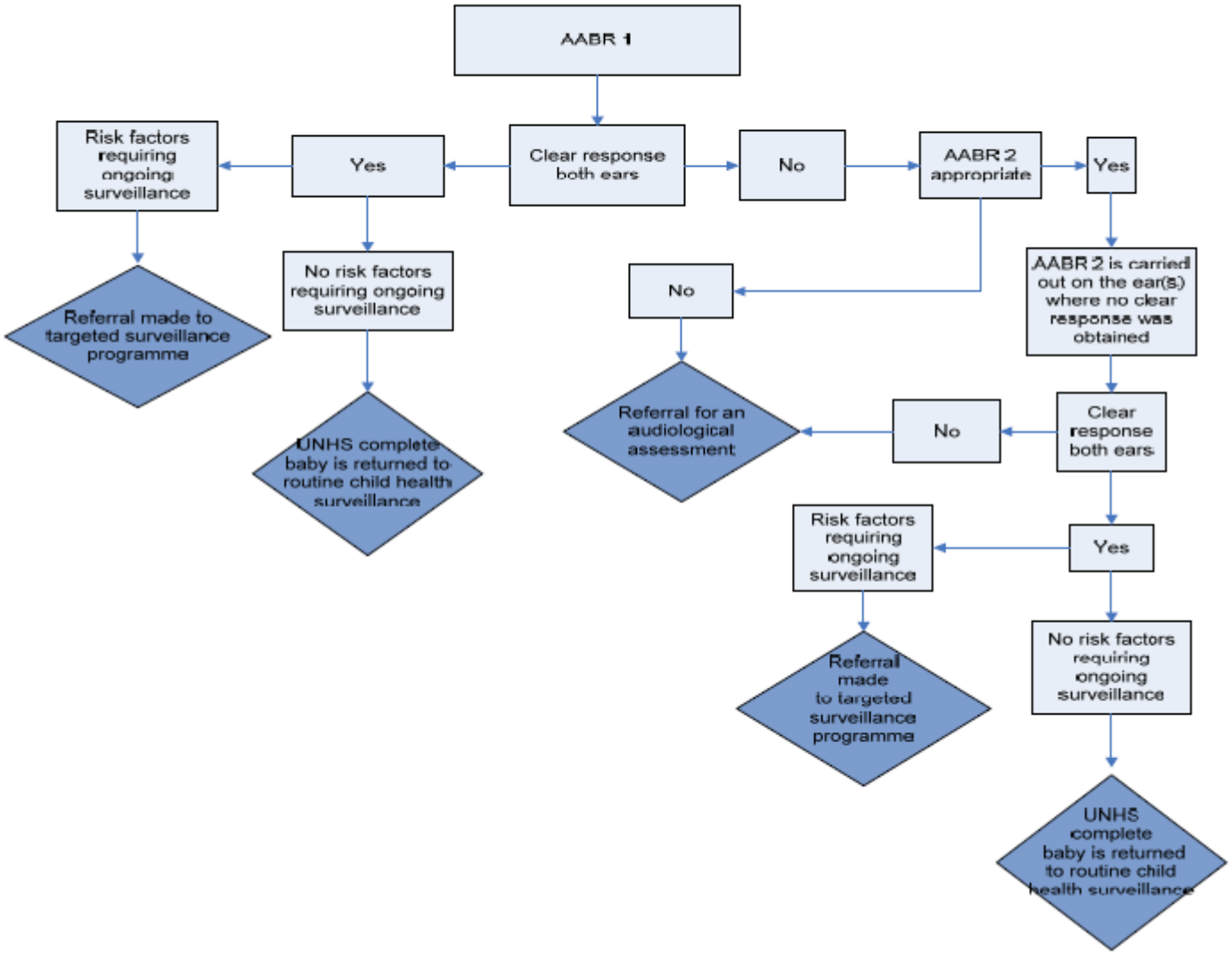
Patient Flowchart NICU Babies – AABR Model



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Well Babies

OAE1

If NCR ↓

OAE2

If NCR ↓

AABR

NICU Babies

OAE

&

AABR

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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**

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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

Int J Audiol. 2012 Jul;51(7):519-28 **The longitudinal follow up of a universal neonatal hearing screen: the implications for confirming deafness in childhood** Watkin P[1], Baldwin M.

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Late onset

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

(Watkin & Baldwin 2012)

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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

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Newborn Hearing Screening Programme (NHSP): recommendations for changes in targeted follow up procedures

Author(s)	**Sally Wood, Adrian Davis, Graham Sutton**
date	**21/11/11**
audience	**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**

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. We plan to produce a response to the consultation and recommendations for future practice in February 2012.

Terminology 1
1.0 Aims 2
2.0 Introduction 2
3.0 Targeted follow up: current guidance and practice 3
4.0 Evidence 4
4.1. Eligibility for targeted follow up 4
4.2 Offer of targeted follow up 5
4.3 Uptake of targeted follow up 6
4.4 Hearing outcomes in the targeted follow up group 6
4.5 PPV for PCHI for all screening outcomes 7
4.6 Risk factors 8
4.7 Resources required for targeted follow up 10
5.0 Summary of evidence 10

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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.

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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 6: Data for PPV and NNT for risk factors

	PCHI=NO			PCHI=YES						
	Screen refer	Not screen refer	Sum:	screen refer	Not screen Refer	Sum:	PPV/1000 if screen refer	PPV/1000 if not refer	NNT if screen refer	NNT if not screen refer
Syndrome associated with hearing loss-other than Downs	323	1243	1566	95	9	104	227.27	7.19	4	139
NICU with NCR/NCR at OAE and CR/CR at AABR	0	3494	3494	0	20	20	na	5.69	na	176
Cranio-facial anomalies	1035	4011	5046	231	19	250	182.46	4.71	5	212
Down syndrome	462	1107	1569	43	4	47	85.15	3.60	12	278
Congenital infection	114	1120	1234	29	3	32	202.80	2.67	5	374
Family history of hearing loss (parents/siblings only	1096	27848	28944	339	58	397	236.24	2.08	4	481
Well baby with NCR/NCR at OAE and CR/CR at AABR	11	33559	33570	2	60	62	153.85	1.78	7	560
IPPV > 5 days or ECMO	821	5228	6049	212	9	221	205.23	1.72	5	582
Neuro-degenerative or neuro-developmental disorder	268	1462	1730	75	2	77	218.66	1.37	5	732
Bacterial meningitis	251	745	996	15	1	16	56.39	1.34	18	746
Jaundice at exchange transfusion level	154	2634	2788	37	3	40	193.72	1.14	5	879
Family history of hearing loss (wider family)	2321	66754	69075	505	75	580	178.70	1.12	6	891
NICU > 48 hours	7555	111784	119339	1062	71	1133	123.24	0.63	8	1575
Aminoglycoside administration > 48 hours	844	15839	16683	158	9	167	157.68	0.57	6	1761
No Risk	35280	2046512	2081792	1709	213	1922	46.20	0.10	22	9609

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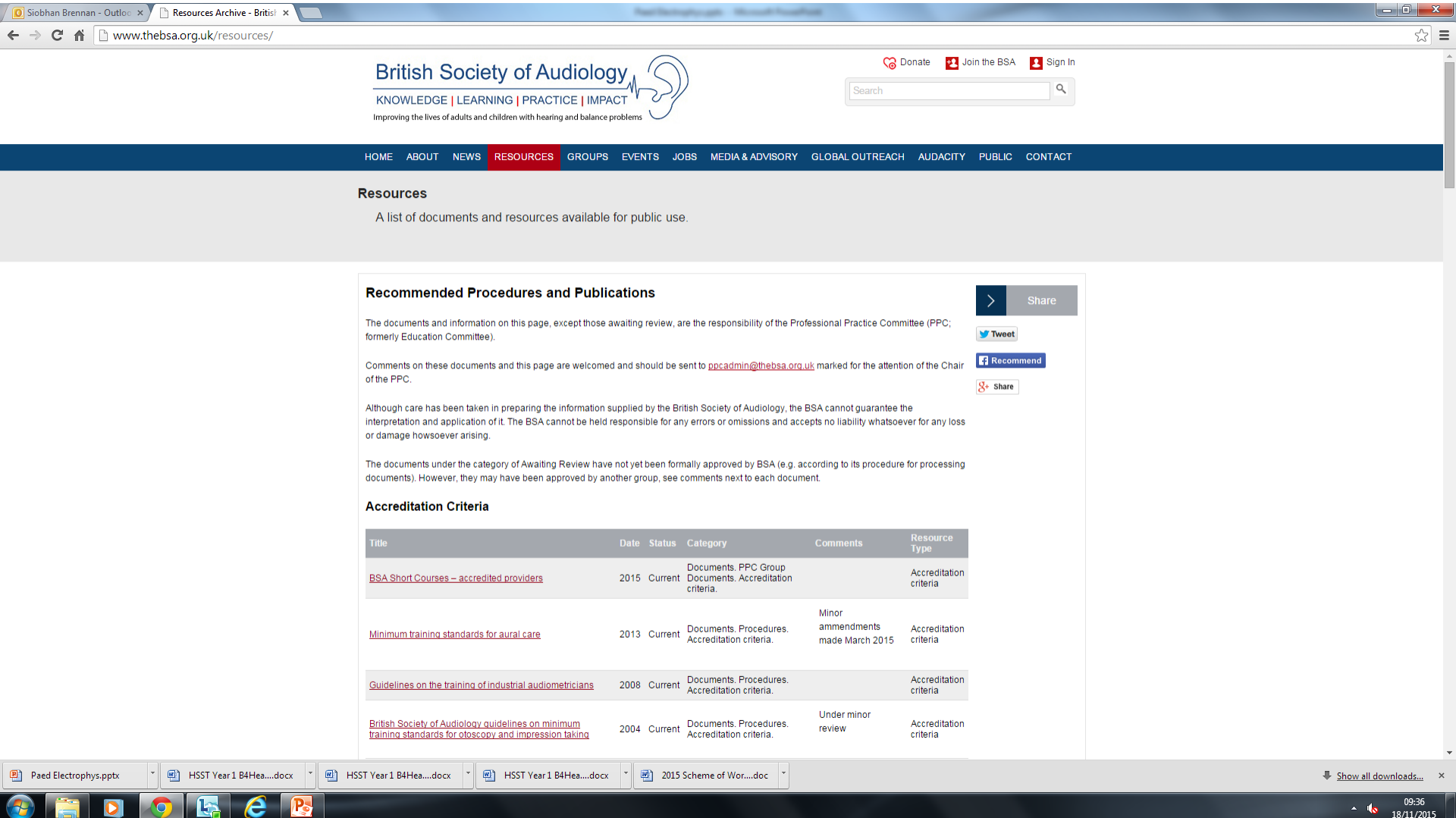
Auditory Brainstem Response

BSA Recommended Protocols
http://www.thebsa.org.uk/resources/



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Recommended Procedure

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

Date: September 2019

Due for review: September 2024

OD104-84 (17/12/2019)

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

OD104-98 (01/12/2021)

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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.

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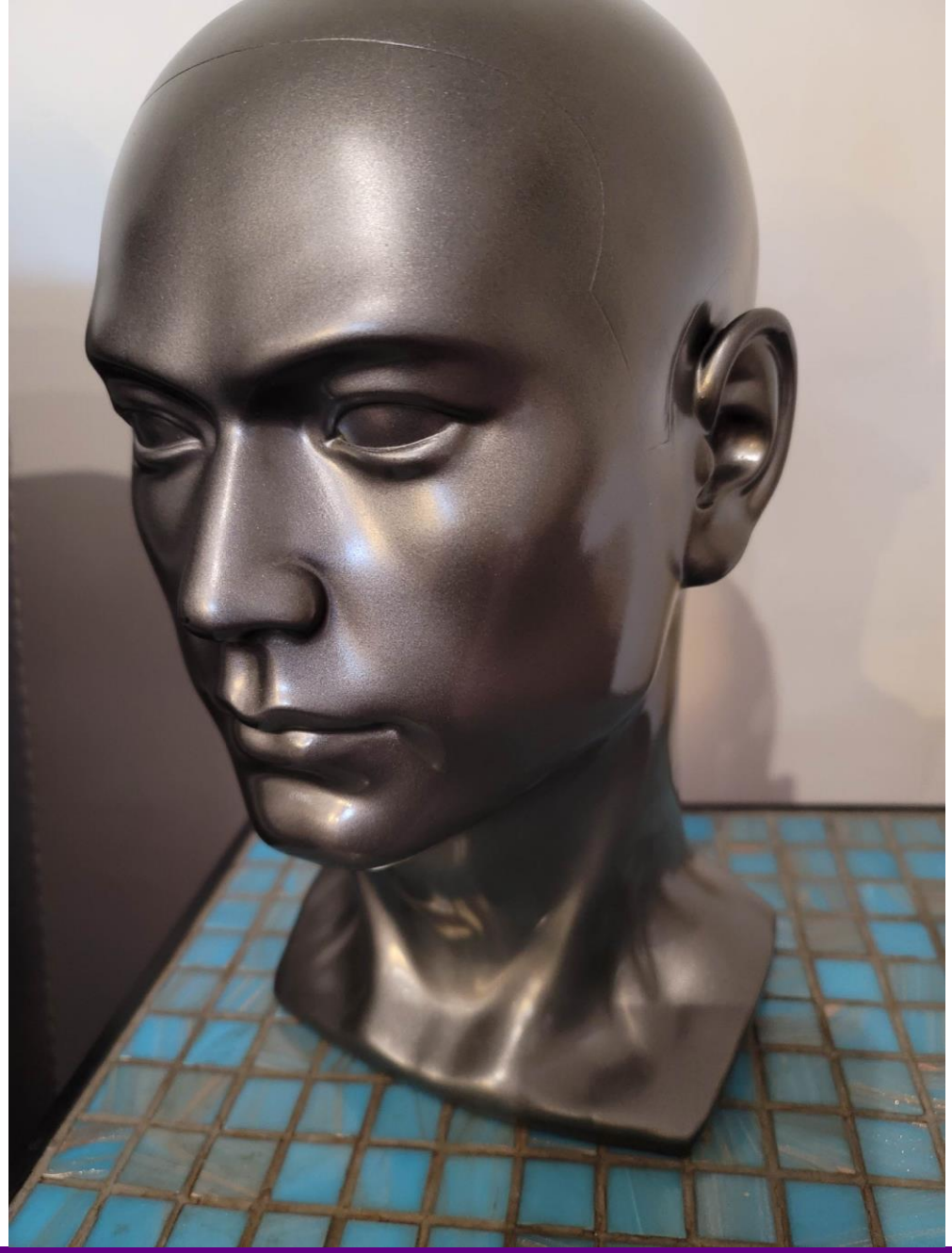

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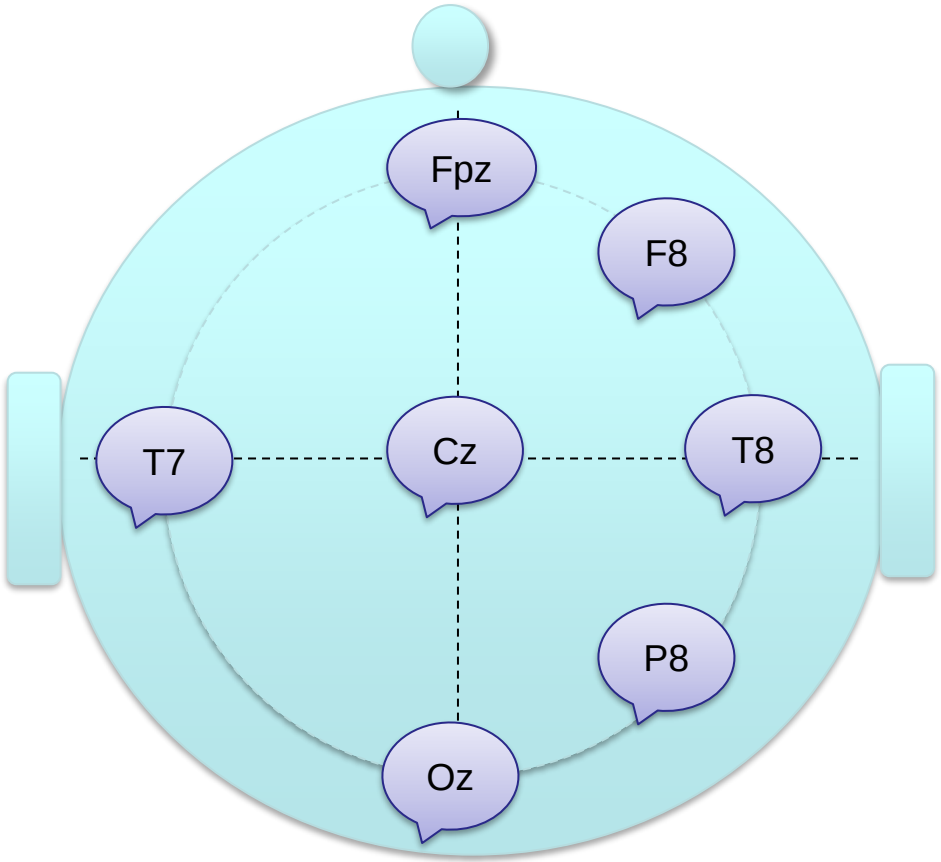
Electrodes Montage



Prefrontal
Frontal
Temporal
Posterior
Occipital
Central/Vertex

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Electrodes

- Reference
- Active
- Common

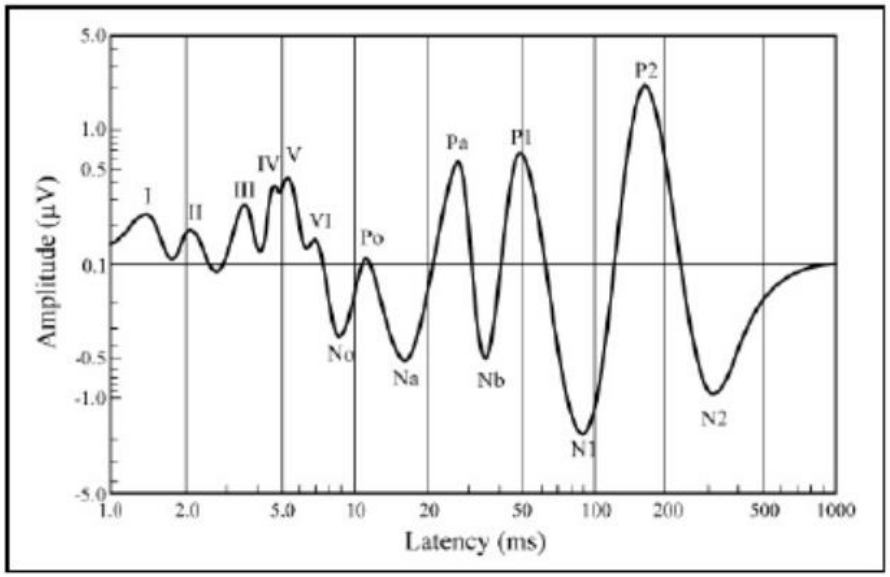
- Plaiting
- Crossing cables
- Avoid extension leads

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)



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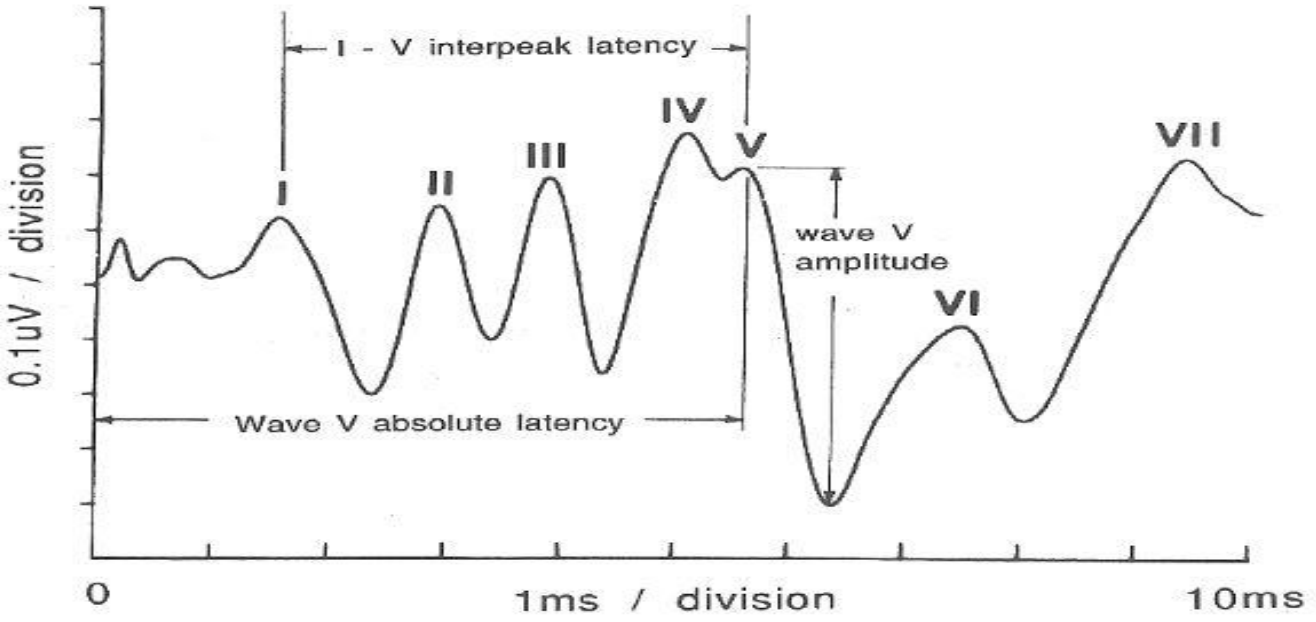
ABR Morphology



Picton, T.W., 2010. *Human auditory evoked potentials*. Plural Publishing.

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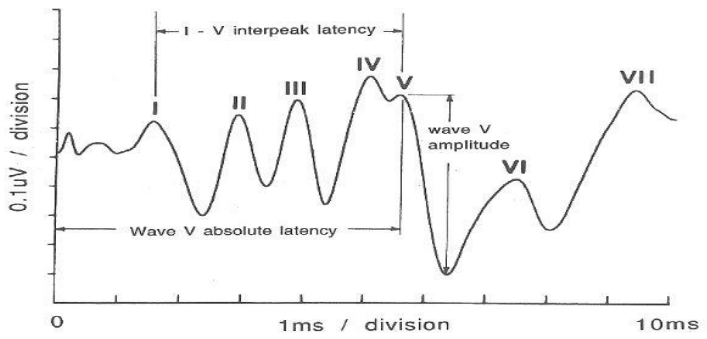
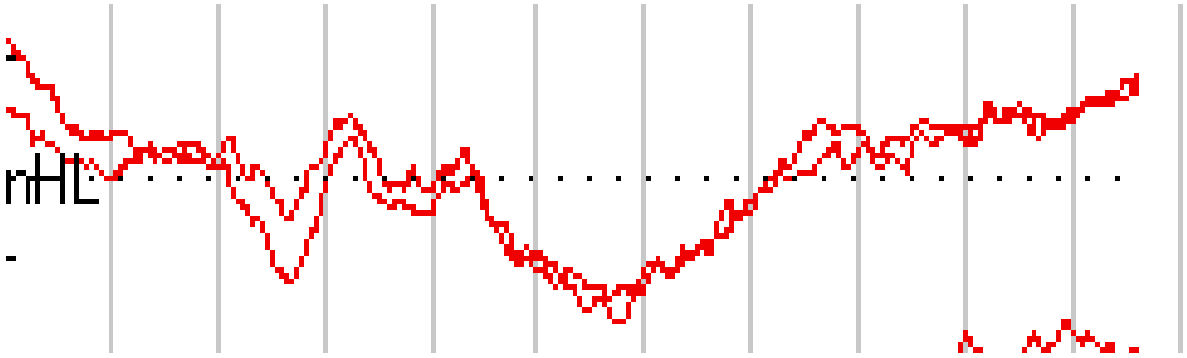
Effects of maturation on the ABR waveform





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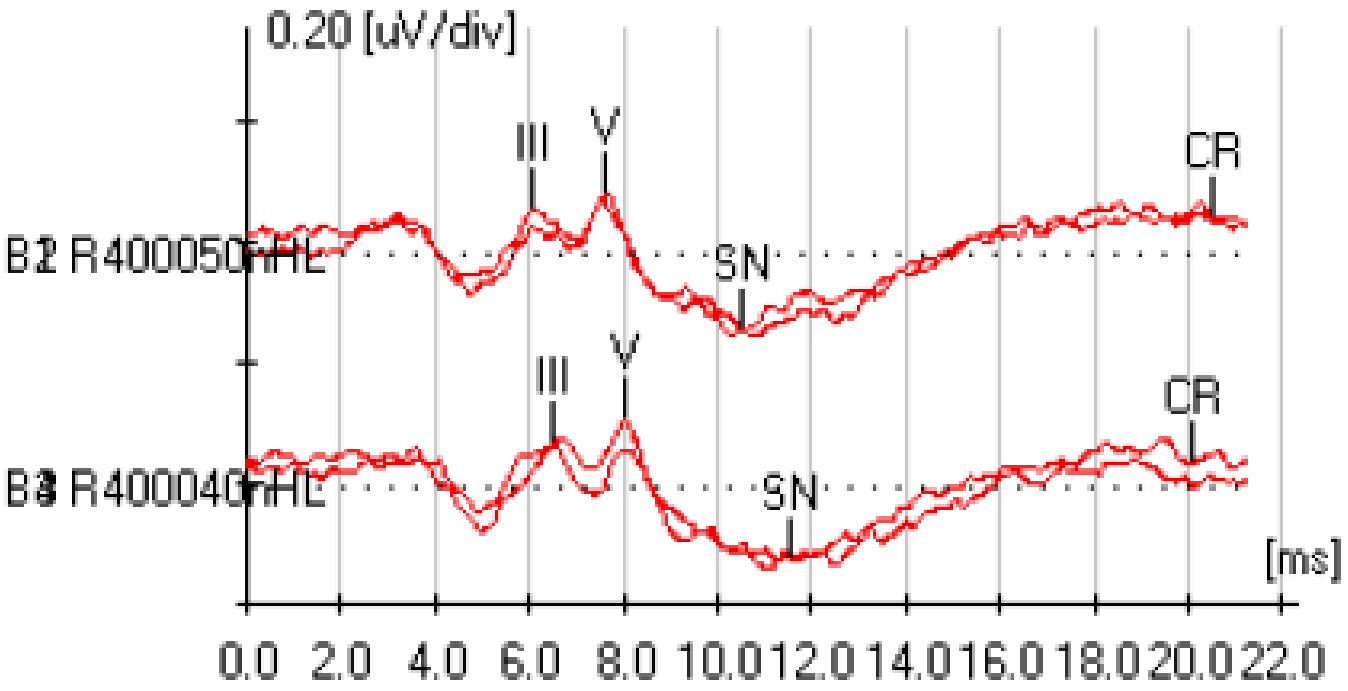
ABR Morphology



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ABR: Typical Responses

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

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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

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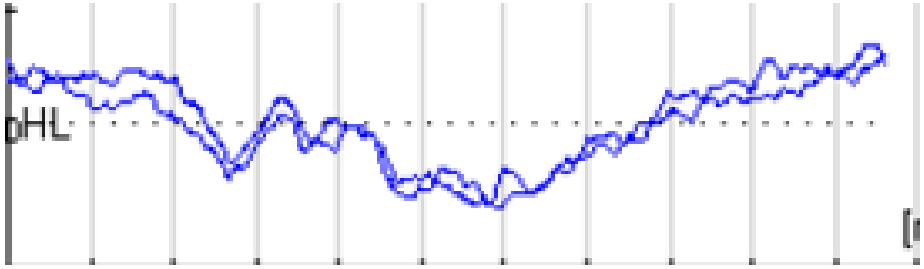
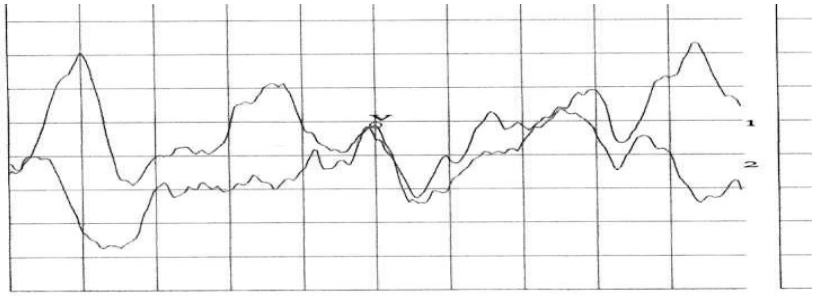
Signal to Noise

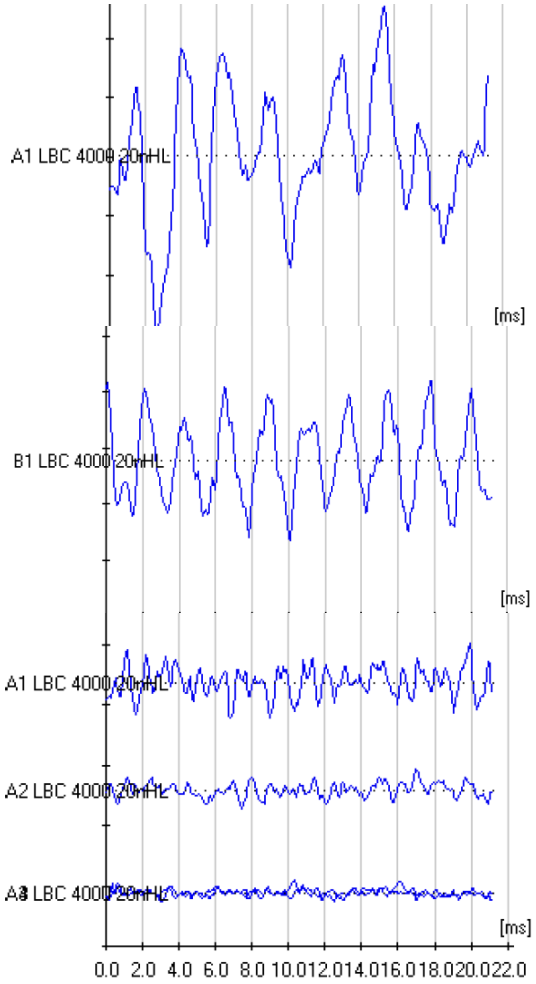




Good

Bad

Averaging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B1 LBC 4000 20nHL
[ms]
A1 LBC 4000 20nHL
A2 LBC 4000 20nHL
A3 LBC 4000 20nHL
[ms]
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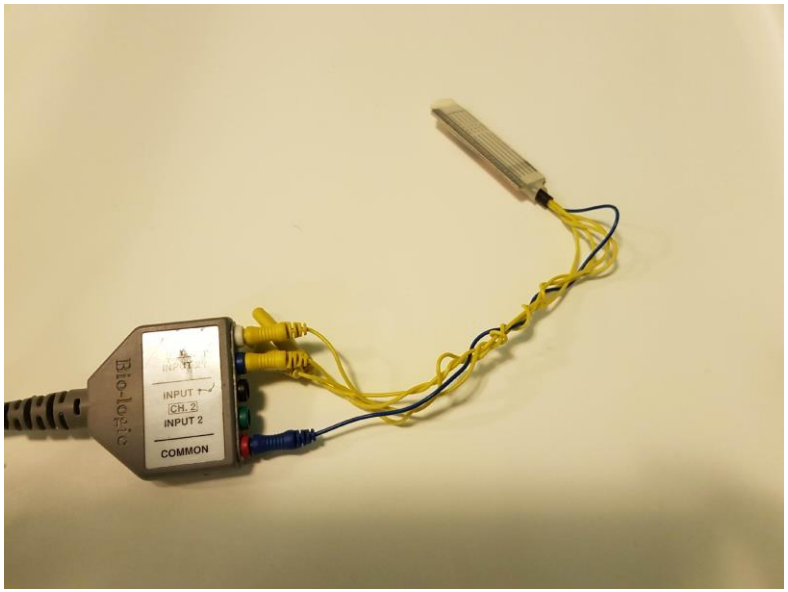
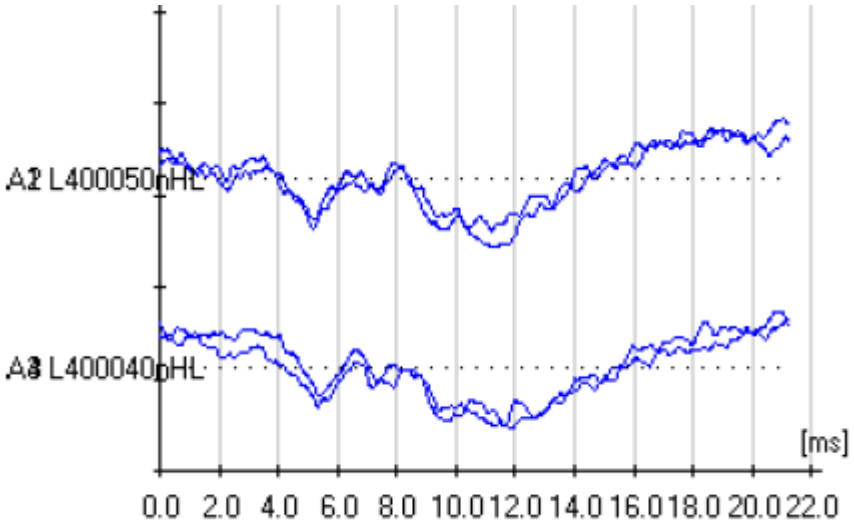

Bio-logic
INPUT 1
CH. 2
INPUT 2
COMMON

Averaging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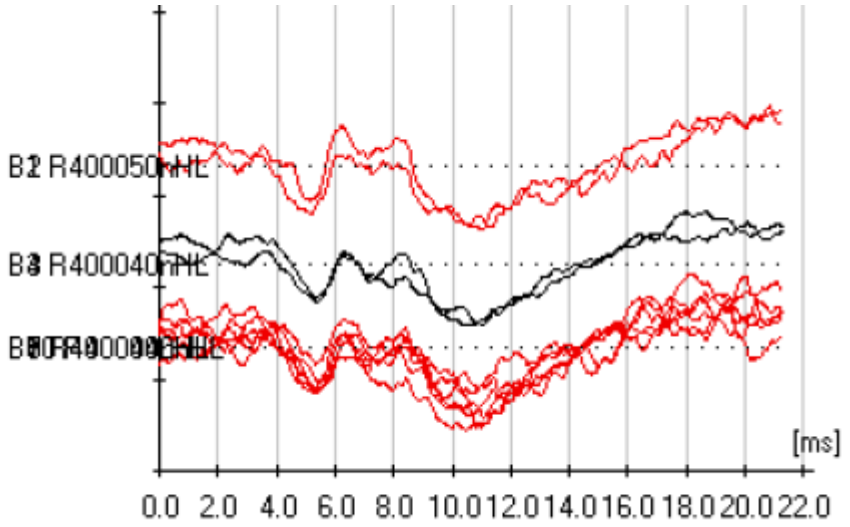
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Waiting…Waiting…

Electrical Interference

- Person
  - Electroencephalogram (EEG)
  - Electromyogram (EMG)
  - Electrocardiogram (ECG)
- Ambient

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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

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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

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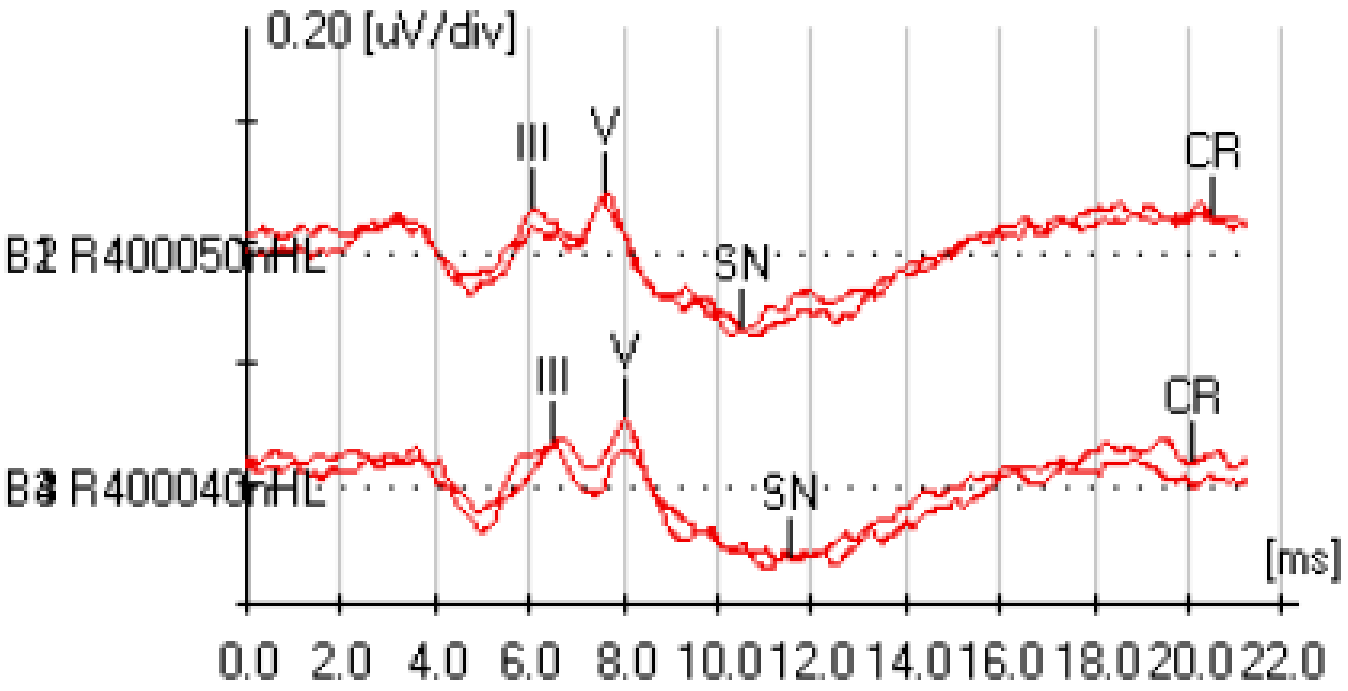
ABR Morphology



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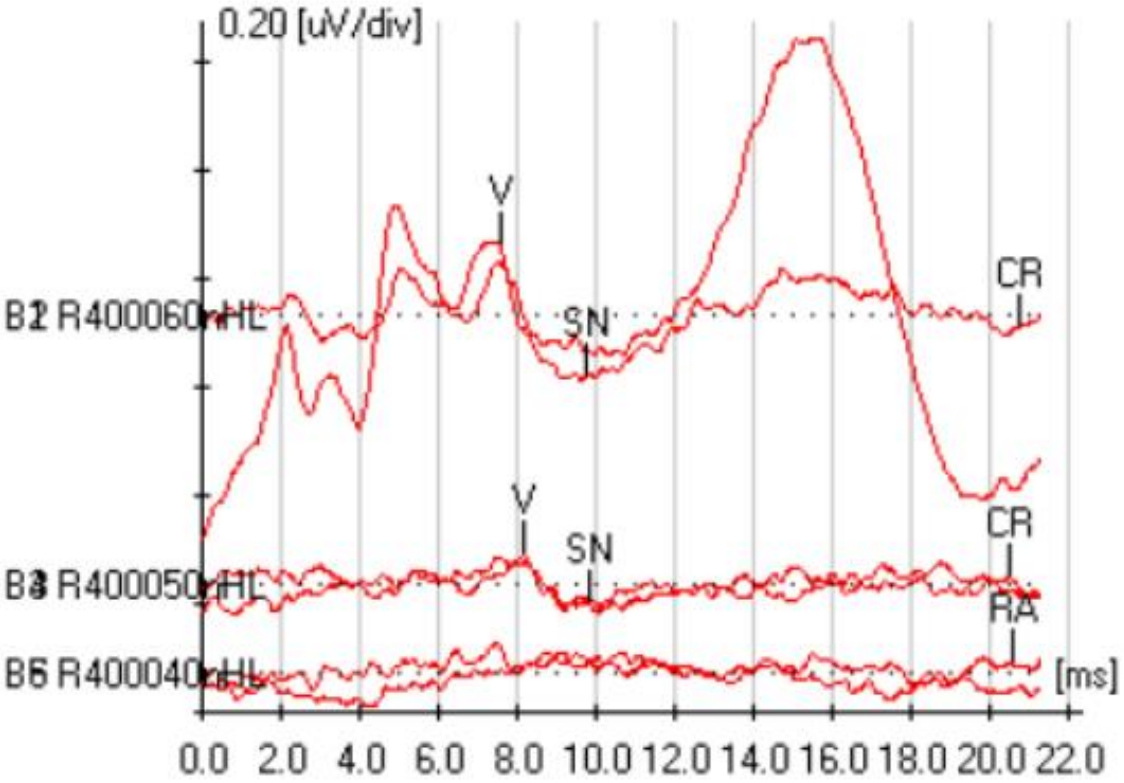
Post Auricular Muscle



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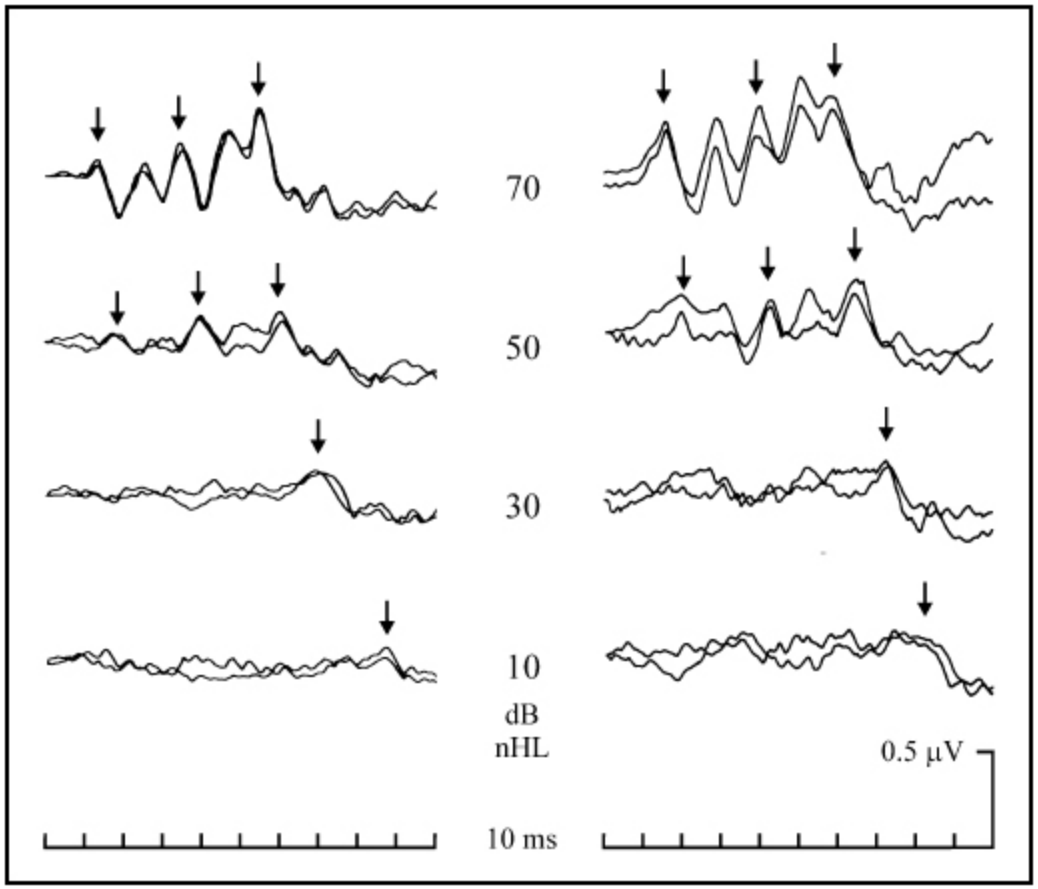
ABR – Intensity Effect



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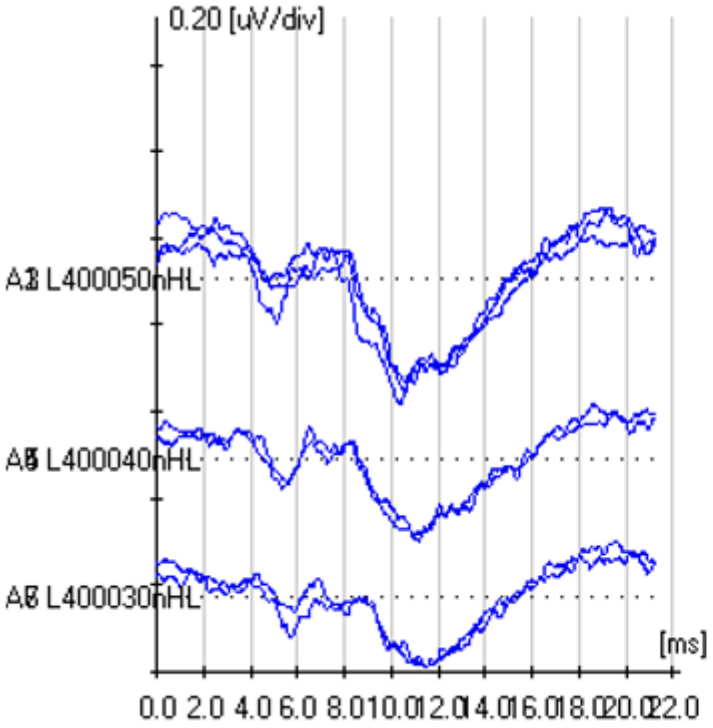
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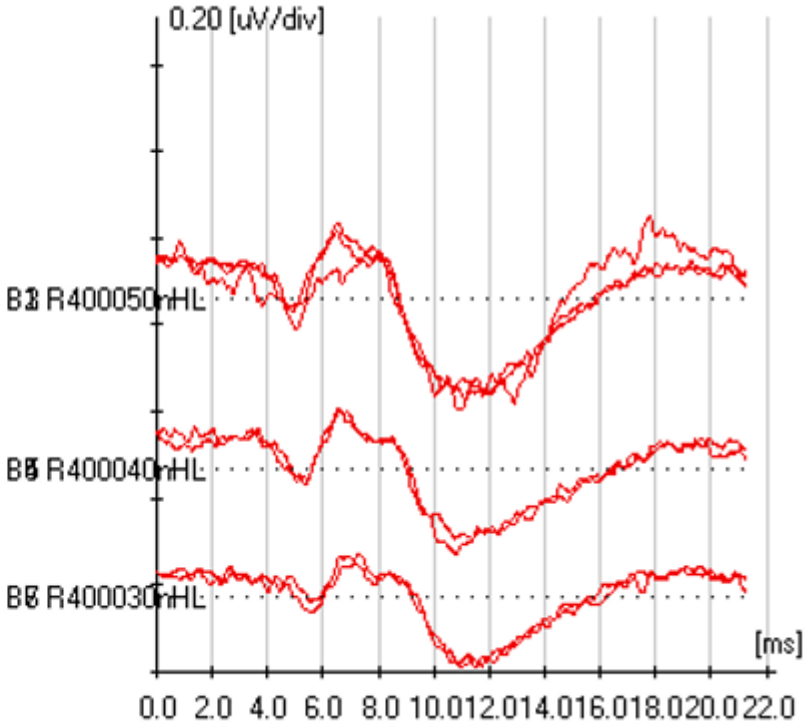
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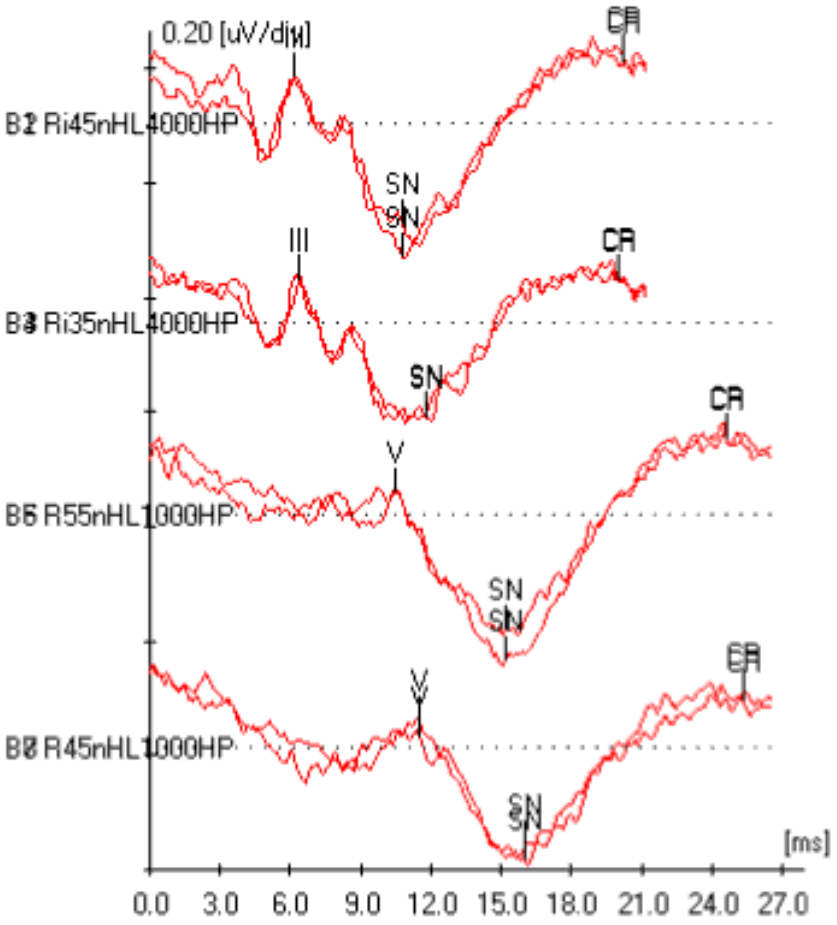
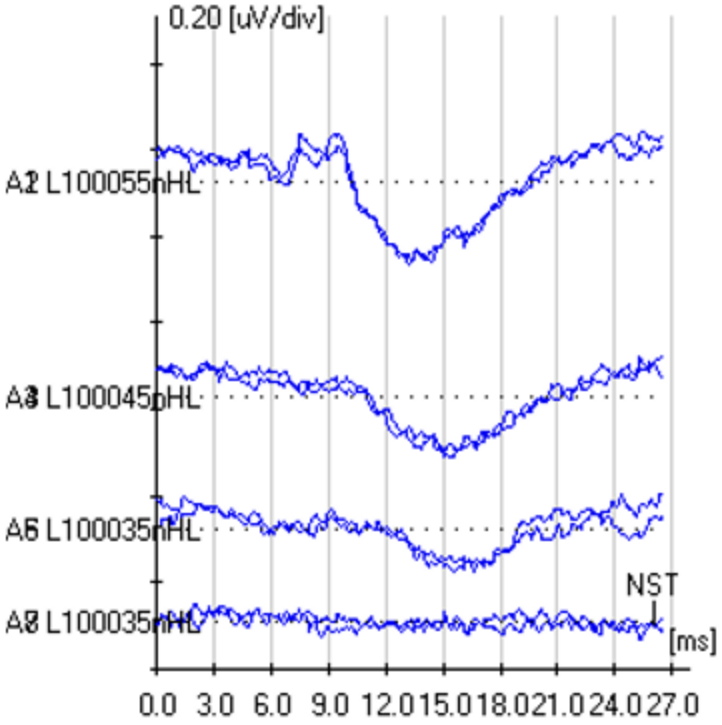
ABR – Frequency Effect

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A4 L100045nHL
A6 L100035nHL
A8 L100035nHL
NST
[ms]
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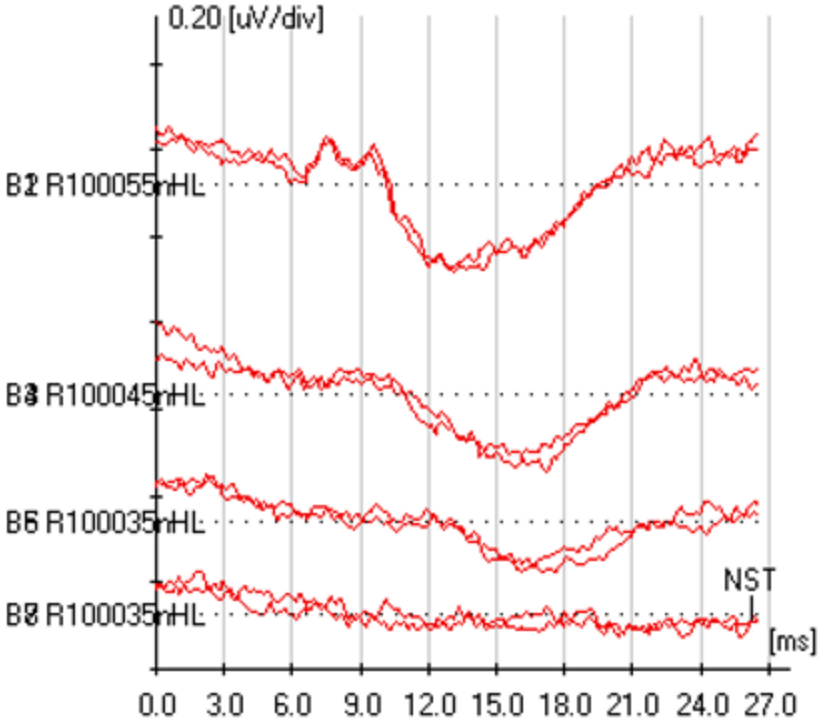
0.20 [uV/div]
B2 R100055nHL
B4 R100045nHL
B6 R100035nHL
B8 R100035nHL
NST
[ms]
0.0 3.0 6.0 9.0 12.0 15.0 18.0 21.0 24.0 27.0

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Transducer

Position

Pressure

Held on by clinician

- Caution:
  - maximum levels
  - 1kHz BC
  - shunt

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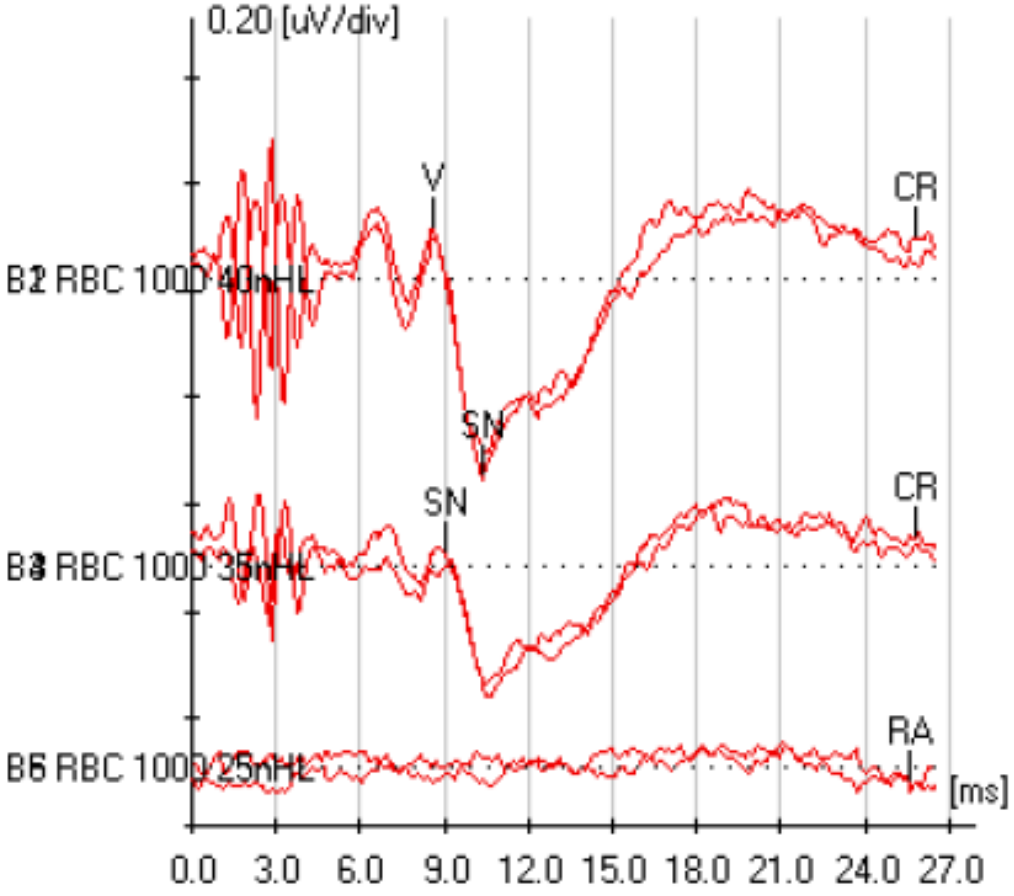
Stimulus Artefact