Association of Neurophysiology Scientists of Australia Inc.
(also known as ANSA, formerly ANTA)
ABN: 80 872 615 302
IARN: A0821425J
www.ansa.org.au

Brainstem Auditory Evoked Potential (BAEP) Recording Guideline

1. PURPOSE

   These guidelines have been prepared to offer guidance towards best practice for recording a BAEP in the routine clinical setting within Australia.

2. INTRODUCTION

   The following guidelines should be considered as minimum standards to record a routine BAEP in clinical practice. They have been prepared by a sub committee governed by ANTA Inc. and have been presented to stakeholders within the field of Clinical Neurophysiology in Australia (see Appendix 1). A review of international guidelines was made to ensure that this ANTA Inc guideline is consistent with worldwide standards (see reference section).

3. LIMITS OF THE GUIDELINE

   This guideline relates to the routine BAEP in clinical practice for adults, children and infants. This guideline does not relate to recording in the operating theatre or non routine setting.

4. ELECTRODES

   (i) Recording Electrode Placement

   Electrodes should be placed in accordance with the International Federation of Clinical Neurophysiology (IFCN) [(1)] which is the internationally recognised standard (10/20ESIF) [(2, 3)].

   The recording electrodes for the BAEP should be placed on the scalp at the vertex (Cz position of the 10-20 International System of EEG electrode placement) and over the left and right earlobes (auricular A1 and A2 positions of the 10-20 System) [(1)] or the left and right mastoid processes (M1 and M2) [(4)].

   The ground electrode should be placed on the scalp in a midline frontal location (position Fz of the 10-20 System) [(4)].

   (ii) Electrode Choice

   Electrodes used to record a BAEP are the same used for EEG recording [(1,5)]. The electrodes used should also be of the same material preferably silver / silver chloride (Ag/AgCl) or gold plated silver due to the inherent time constant of each material [(6)].

   (iii) Electrode Impedance

   Electrode impedance should be measured prior to each recording and at any time during the BAEP where an electrode has be altered or adjusted. Impedances of all electrodes should measure below 5kohms [(1, 7)] and of a similar value within no more than 3kohm range of each other [(5)].

5. MACHINE PARAMETERS

(i) Common mode rejection ratio

For common mode rejection to work effectively the active and reference electrodes should be of near equal impedance [5] and all input electrode impedances maintained below 5Kohms [1, 7].

The amplifier's common mode rejection ratio should be 80dB or greater [7, 8].

(ii) Input Impedance of Pre-amplifiers

The amplifier's input impedance should be at least 100MΩ [7, 9].

(iii) Analogue to digital signal conversion

The sample rate shall be a minimum of 20kHz [1] with a minimum resolution of 8bits[7].

(iv) Automatic artefact rejection

Automatic artefact rejection should be employed to eliminate high amplitude transients [5, 7].

(v) Filters

Filters should be set to the following levels [1, 5] -

High Pass/Low Frequency Filter ≥100Hz (-3dB)

Low Pass/High Frequency Filter ≤ 3kHz (-3dB)

The use of the 50Hz 'notch filter' does not interfere with the BAEP recording [1] if the low frequency filter is set > 50Hz.

(vi) Sweep Duration

Generally 10ms post stimulus for adults and up to 20ms post stimulus for children [1].

(vii) Averaging

At least 1000 individual trials to be averaged – more may be required (up to 2 000[1]) to ensure reproducibility in low amplitude responses and to ensure that a stable waveform is recorded with minimal noise [1,4,5].

At least two total runs should be obtained and superimposed to verify reproducibility of waveform morphology, latency and amplitude [1, 4, 5].

6. RECORDING

Ensure the patient is relaxed, in a position that ensures patient's comfort and minimises muscle activation. Monitor the quality of the live/raw data while averaging the signal to ensure integrity [1].

(i) Patient and Test Information

The following details should be included, as minimum, with any BAEP recording:

- Patient name
- Patient identification number
- Date of Birth
- Recording date
- Referring doctor
- Recording health professional initials
- Relevant clinical details
- Clinical question to be answered
- Current medications
- Sensory hearing level threshold (sHL)
- Time and amplitude scale
- Number of averaged trials
- Montage
- Polarity convention.

(ii) Patient Attention

Level of alertness does not affect the BAEP [1]. The patient may be awake, drowsy or asleep during the recording of the BAEP. Sedation may be required for uncooperative patients [4, 5].

(iii) Stimulus

The stimulation for the BAEP is delivered via calibrated, electrically shielded headphones or ear pieces [4, 5, 7] monaurally [4, 5]. Contralateral white noise masking is used to avoid stimulus crossover through air and bone conduction to the unstimulated side [1].

(iv) Stimulus Type

Monophasic square wave electrical pulses are delivered [1].

(v) Stimulus Polarity

Rarefaction (initial outward movement away from the eardrum or negative pressure) or condensation (initial inward movement towards from the eardrum or positive pressure) stimulus may be used [1] in accordance with normative data collection [4]. Alternating click stimulus (alternating between rarefaction and condensation clicks) can be used to reduce stimulus artefact [1, 4].

Rarefaction is the most commonly chosen stimulus [1].

(vi) Stimulus Rate

Stimulation rate for neurological assessment should be 11Hz [1].

Stimulus rates which are factors of 50 should be avoided to prevent 50Hz synchronisation [1].

(vii) Stimulus Duration

The duration of the stimulus should be 100µs [1, 4].

(viii) Stimulus Intensity

The stimulus intensity should be 70dB above the hearing threshold of the normal population (nHL) or above the sensory hearing level (sHL) of the individual patient according to normative data [1]. If the waveforms are not clearly defined the stimulus intensity should be increased or decreased by 10dB, or more in an attempt to improve waveform definition [5, 7].

Masking should be 30-40dB [1] below stimulus intensity.

(ix) Testing the Sensory Hearing Level

A hearing threshold test should be performed prior to acquiring the BAEP[5]. The Patient is presented with a click stimulus to one ear at a level that is well above the usual hearing threshold (e.g. 40-50db). The stimulus intensity is reduced by 5-10dB[5] increments until the subject can just perceive the stimulus for 50% of the time [1].

(x) Recording Montage

Negative electrical potentials at the ear lobes or mastoids should be displayed as upward deflections [1].

a) Examples of BAEP Recording Montages [1, 5. 8]:

Channel 1: ipsilateral earlobe/mastoid - Cz
Channel 2: contralateral earlobe/mastoid -Cz

Channel display order may vary

e.g. Channel 1: Right earlobe/mastoid – Cz
Channel 2: Left earlobe/mastoid – Cz

b) Markers: The BAEP primary complex is represented by 8 waves, typically labelled with roman numerals, with the first 5 waves I – V having the most clinical significance[1]

Peak latency [1]	I, II, III, IV, V
Inter-peak latency [1, 4]	I-III, III-V, I-V
Amplitude [1, 4]	I, V and I-V amplitude ratio

7. QUALITY CONTROL

(i) Calibration

Calibration of recording systems should be carried out on a regular basis.

A known calibration signal of similar amplitude to the expected biological signal of interest should be injected at the electrode board and displayed to provide a check of polarity, amplitude, latency and filter characteristics of the recording apparatus[7].

The headphones or other stimulus delivery system should be calibrated every 6 months [4].

(ii) Normal Values

Each lab should establish its own normative data using standard stimuli and recording parameters [5].

Recording parameters such as stimulus type should be the same for all patients tested and for all subjects from which normative data is obtained [5].

Normative values from other institutions or sources may only be utilised if equivalent stimulation and recording parameters are employed and only after testing the validity of the adopted normal values on at least 20 locally gathered subjects under normal recording conditions [8].

Additional normative data may need to be acquired for elderly (>60) or paediatric (<5) populations [4, 8].

8. REFERENCES

1. Pratt, H., Aminoff, M., Nuwer, M., Starr, A. (1999). Short-latency auditory evoked potentials. *Recommendations for the Practice of Clinical Neurophysiology: Guidelines of the International Federation of Clinical Physiology (EEG Suppl. 52).*

2. Klem, G. H., Luders, H. O., Jasper, H. H., Elger, C. (1999). The ten-twenty electrode system of the International Federation. (G. Deuschl, A. Eisen, Eds.) *Recommendations for the Practice of Clinical Neurophysiology: Guidelines of the International Federation of Clinical Physiology (EEG Suppl. 52),* 3-6.

3. Jasper, H. (1958). The ten-twenty electrode system of the International Federation. *Electroencephalogr Clin Neurophysiol, 10*, 371-375.

4. American Clinical Neurophysiology Society Guideline 9C: Guidelines on Short-latency auditory Evoked Potentials 2008. http://www.acns.org/ .

5. Chiappa, K. (1997). *Evoked Potentials in Clinical Medicine* (3rd ed.). (K. H. Chiappa, Ed.) Philadelphia, New York: Lippincott-Raven.

6. Nuwer, M., Comi, G., Emerson, R., Fuglsang-Frederiksen, A., Guerit, J., Hinrichs, H., Rappelsberger, P. (1999). IFCN standards for digital recording of clinical EEG. *Recommendations for the practice of Clinical Neurophsyiology: Guidelines of the International Federation of Clinical Physiology, EEG Suppl. 52.*

7. American Clinical Neurophysiology Society Guideline 9A: Guidelines on Evoked Potentials 2006. http://www.acns.org/ .

8. Spehlmann, R. (1985). *Evoked Potential Primer. Visual, Auditory, and Somatosensory Evoked Potentials in Clinical Diagnosis.* Boston etc: Butterworth Publishers.

9. Binnie C., Cooper F, Mauguiere J., Osselton P., Tedman B., (Editors) (2004)*Clinical Neurophysiology, Volume 1 (Revised and Enlarged Edition) EMG, Nerve Conduction Studies and Evoked Potentials.* Chapter 3.2 Methods and Instrumentation. Cooper R, Mauguiere F. Pg 367, Elsevier, The Netherlands.

Additional Readings

Halliday, A. (1982) *Evoked Potentials in Clinical Testing.* USA: Churchill Livingstone.

Evans, A., Boggs, J., 2010, 'Clinical Utility of Evoked Potentials', emedicine, http://emedicine.medscape.com/article/1137451-overview .

Aminoff, M. (20012). Aminoff's *Electrodiagnosis in Clinical Neurology* (6th ed.) Elsevier.

Liveson, J. and Ma, D. (1992). *Laboratory reference for clinical neurophysiology.* USA: Oxford University Press.

Appendix 1 – Stakeholders

Stakeholders

- ANTA Inc. Members
- Document Development Committee
- Document Development Committee Advisory Group
- Other interested parties

Original Document

Angela Borbelj(ACT), Karen Storchenegger (NSW), Paul Weston (SA), Fred Tremayne (Qld), Kate Martin (ACT), Neurologist: Dr Steve Vucic.
ANTA Inc Executive: Stephanie Brooks, Anna Exley, Justin Stent 2010.
Endorsed by ANTA Inc Members (2010)

First Revision – 2012

Document Development Committee

Mary Lynch, Joanne Wex, Holly Campbell, Anna Exley, Santhi Chigurupati, Malcolm Corkhill, Kate Martin, Emma Fetherston, Amy Lofts, Fred Tremayne, Angela Borbelj.

Advisory Committee

The document development committee identified a group of key stakeholders to view the draft documents for feedback. The advisory group was made up of technologists, scientists and neurologists working in the neurophysiology industry around Australia. The comments from this group were considered, compared against the reference material and included where appropriate.

Members Feedback

On completion of the final draft the document was put out to all members of ANTA Inc. for feedback. The comments from members were considered, compared against the reference material and included where appropriate.

Guideline Acceptance

This Guideline was accepted by members in July 2014.

Amendments

2016 May	Disclaimer and Copyright statements added.
2023 July	Rebranded to ANSA Inc.

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