

END-1500: BASIC EVOKED POTENTIALS

Cuyahoga Community College

Viewing: END-1500 : Basic Evoked Potentials

Board of Trustees:

May 2025

Academic Term:

Fall 2025

Subject Code

END - Electroneurodiagnostic

Course Number:

1500

Title:

Basic Evoked Potentials

Catalog Description:

Basic discussion of evoked potential recording techniques. Emphasis on equipment, principles of operation, associated waves related to normal and abnormal waveforms, placement and calibration, and obtaining clearly resolved and replicated obligatory waveforms of brainstem auditory, visual, and somatosensory evoked potentials in adults and pediatric subjects.

Credit Hour(s):

3

Lecture Hour(s):

2

Lab Hour(s):

3

Requisites

Prerequisite and Corequisite

END-1450 Intermediate EEG or concurrent enrollment, or departmental approval.

Outcomes

Course Outcome(s):

Obtain a standard evoked potential record.

Essential Learning Outcome Mapping:

Quantitative Reasoning: Analyze problems, including real-world scenarios, through the application of mathematical and numerical concepts and skills, including the interpretation of data, tables, charts, or graphs.

Objective(s):

1. Obtain clearly resolved waveforms.
2. Obtain two replications demonstrating consistency of latency and amplitude measurements.
3. Demonstrate use of additional electrode derivation and other techniques as needed to enhance or clarify the abnormality.
4. Demonstrate the appropriate recording and stimulus parameters.
5. Demonstrate display of obligatory peaks displayed according to recommended standards.

Course Outcome(s):

Perform assessment of patient's mental state, comprehension level, and accommodate for disabilities and/or special needs of the patient.

Objective(s):

1. Obtain patient history relative to presenting condition.
2. Evaluate and compensate for patient mental status/comprehension level.

Course Outcome(s):

Prepare a detailed data worksheet that includes instrumentation and recording data and a patient data sheet that includes significant medical history; clinical findings of mental, behavioral, and consciousness state; medications; and results of other pertinent testing procedures.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Written Communication: Demonstrate effective written communication for an intended audience that follows genre/disciplinary conventions that reflect clarity, organization, and editing skills.

Objective(s):

1. Use communication skills to achieve patient relaxation/cooperation.
2. Demonstrate explanation of all test procedures appropriate for a patient's understanding.
3. Demonstrate explanation of the electrode application method for a patient's understanding.
4. Demonstrate professional interaction at a level appropriate for a patient's age and mental capacity.
5. Obtain a patient history with the inclusion of symptoms and related medical facts as appropriate for the patient encounter.
6. Demonstrate strategies for maintaining a patient's respect and confidentiality.

Course Outcome(s):

Demonstrate effective oral and written communication skills when interacting with patients and other members of healthcare teams.

Objective(s):

1. Demonstrate the relaying of accurate information to other health care professionals.
2. Demonstrate compliance with HIPAA regulations with emphasis on maintenance of patient privacy.

Course Outcome(s):

Verify the integrity of the evoked potential instrumentation.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):

1. Accurately assess the integrity and proper instrumentation set-up.
2. Demonstrate the input proper montage and electrode derivations for assigned procedure.
3. Demonstrate the practice of proper electrical safety and equipment/patient grounding.

Course Outcome(s):

Utilize medical terminology, electricity, electronic concepts, neuroanatomy and neurophysiology to determine evoked potential abnormalities and maturation of evoked potentials components.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Quantitative Reasoning: Analyze problems, including real-world scenarios, through the application of mathematical and numerical concepts and skills, including the interpretation of data, tables, charts, or graphs.

Objective(s):

1. Demonstrate accurate identification of normal and abnormal responses.
2. Demonstrate use of normal lab values for the determination of normal and abnormal test results as appropriate.
3. Demonstrate identification of locations of abnormalities based on evoked potential responses and knowledge of neural pathways.

Course Outcome(s):

Demonstrate the determination of normative evoked potential data.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Quantitative Reasoning: Analyze problems, including real-world scenarios, through the application of mathematical and numerical concepts and skills, including the interpretation of data, tables, charts, or graphs.

Objective(s):

1. Utilize generated data to conduct simple statistical analysis of results.
2. Determine mean values for latency measures.
3. Determine standard deviations based on mean data gathered.

Course Outcome(s):

Demonstrate the ability to distinguish abnormal evoked potential waveforms.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):

1. Demonstrate a comparison of evoked potential responses based on laboratory normal values.
2. Demonstrate identification of locations of abnormality based on evoked potential responses and knowledge of neural pathways.

Course Outcome(s):

Explain recommended criteria for assessing evoked potentials in pediatric and neonates.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):

1. Describe pediatric patient basic functional neuroanatomy and neurophysiology.
2. Describe and explain sensory system and generator of evoked potential components.
3. Describe evoked potential correlates of clinical conditions such as neurological, orthopedic, neurosurgical, and audiology disorders of the pediatric population.

Course Outcome(s):

Identify and eliminate or reduce artifacts that contaminate waveforms.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):

1. Identify the source of the artifact.
2. Calculate frequency in hertz (Hz) of rhythmic artifacts and demonstrate an understanding of the effects of aliasing.
3. Demonstrate proper grounding of the patient and equipment.

4. Demonstrate the checking of quality of raw signal regularly or when needed.
5. Explain the meaning and significance of artifact rejection.
6. Demonstrate understanding of the relationship of signal-to-noise ratio.
7. Demonstrate recognition of an artifact as physiological or non-physiological.

Course Outcome(s):

Obtain a technically adequate somatosensory evoked potential (SSEP) on an adult subject and a pediatric subject.

Objective(s):

1. Obtain a relevant neurologic, orthopedic, and/or neurosurgical history.
2. Select appropriate timebase, sensitivity and bandpass settings.
3. Apply the appropriate stimulating electrodes, with active cathode over the nerve and anode placed distally.
4. Properly ground the patient to reduce stimulus artifact.
5. Select current of sufficient intensity and duration to elicit a motor twitch from the appropriate areas of stimulation.
6. Use a montage that records responses from multiple levels of pathway such as peripheral nerve, spinal cord, and cortical responses.
7. Resolve the obligate components of Erb's Point, N13, P14, N18, and N120 of the median nerve SSEPs.
8. Resolve the obligate components of popliteal fossa, lumbar potential (LP), N34, and P37 of the posterior tibial nerve SSEP.
9. Demonstrate the calculation of the peripheral nerve conduction velocity.

Course Outcome(s):

Demonstrate acquisition of an auditory evoked potential on an adult subject and on a pediatric subject.

Objective(s):

1. Obtain a relevant audiology, neurological, or neurosurgical patient history.
2. Demonstrate an assessment of a patient's ear canals for obstruction or foreign objects.
3. Demonstrate the establishment of accurate hearing thresholds.
4. Correlate elevations in threshold with any existing hearing loss; conditions of ear structure, noting results of prior hearing evaluations.
5. Use a montage derivation of vertex-to-ipsilateral and vertex-to-contralateral ears.
6. Choose the appropriate click polarity, rate, and intensity.
7. Express click intensity measures in equivalent units of dBSL, dBHL, or dB SPL.
8. Make adequate resolutions of obligate components wave I, III, and V.
9. Use techniques to enhance wave form resolutions.
10. Measure and calculate the absolute latencies, amplitude and interpeak intervals.
11. Demonstrate an understanding of opposite ear masking including its use and effects.
12. Perform latency series for auditory assessment in infants and other persons whenever indicated.

Course Outcome(s):

Obtain a technically adequate visual evoked potential (VEP) on an adult subject and a pediatric subject.

Objective(s):

1. Obtain a relevant ophthalmologic and neurologic history.
2. Use a montage that records responses from both hemispheres.
3. Demonstrate assessment of a patient's visual acuity with a Snellen Eye Chart.
4. Select an adequate check size and positioning the patient at distance from the pattern stimulator appropriate for the desired visual angle.
5. Monitor the patient's attention during the test.
6. Perform the study with the same parameters and conditions used for normative studies including ambient light, pattern luminance and contrast.
7. Adequately resolve peaks N75, P200, N175.
8. Measure and calculate the absolute latency, amplitude, ratios and interocular latency difference of P100.

9. Use flash stimuli in selected patients when use of pattern reversal stimulus is not possible.
10. Explain the use and indications for alternative visual stimulation techniques including hemifield testing and flash stimuli.

Course Outcome(s):

Follow a method of electrode application that includes the international 10-20 system and Queen Square placement and choose the appropriate method of electrode application.

Objective(s):

1. Measure the head using the international 10-20 system and /or Queen Square.
2. Prepare patient's skin for electrode placement.
3. Identify standard types of electrodes.
4. Demonstrate application of electrodes with paste or collodion and electrolyte.
5. Verify that electrode impedances are balanced and below 5000 ohms.

Course Outcome(s):

Apply the principles and concepts of evoked potential instrumentation to the recording using signal averaging and noise reduction, analog to digital conversion function of differential amplifiers, and effects of stimulus and recording parameters on evoked potential waveforms.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):

1. Explain the function of differential amplifiers including the input impedance, common mode rejection, polarity conversion and gain.
2. Explain signal averaging and noise reduction as it relates to digital equipment (including amplitude resolution, sampling rate, analysis time, and the Nyquist frequency).
3. Describe the effects of stimulus and recording parameters of evoked potential waveforms.
4. Discuss electrode impedance and its importance.

Course Outcome(s):

Demonstrate provision of a safe recording environment.

Objective(s):

1. Demonstrate strategies for accurate verification of patient identity.
2. Demonstrate proper cleaning and disinfection of electrodes after each procedure.
3. Demonstrate use of standard precautions and other proper disinfection precautions for infection control.
4. Demonstrate appropriate and professional attention to a patient's needs.
5. Demonstrate recognition and response to life-threatening situations.
6. Obtain and maintain certification for cardiopulmonary resuscitation.
7. Demonstrate compliance with lab protocols for emergency and disaster situations.
8. Demonstrate proper maintenance of instrumentation and equipment in good working order.
9. Demonstrate appropriate precautions to ensure electrical safety.

Course Outcome(s):

Demonstrate professional rapport with patient and/or the patient's family.

Objective(s):

1. Demonstrate professional introduction of yourself to the patient.
2. Demonstrate the ability to ask pertinent questions related to a patient's medical history.
3. Demonstrate the ability of explaining the test set-up to patient using terms appropriate for the patient encounter.

4. Demonstrate the ability of explaining all stimulation situations which apply to the test being performed.
5. Demonstrate reassurance of the patient of their safety.

Methods of Evaluation:

1. Quizzes
2. Exams
3. Homework assignments
4. Comprehensive final exam
5. Laboratory worksheets
6. Laboratory competencies
7. Laboratory comprehensive final exam

Course Content Outline:

1. Basic principles of evoked potentials
 - a. Introduction
 - b. Equipment
 - c. Convention
 - d. Measurements
2. Recording techniques
 - a. Electrodes
 - b. Amplifiers
 - i. input impedance
 - ii. common mode rejection ratio
 - iii. gain and sensitivity
 - iv. frequency response and analog filtering
 - c. Averaging
 - d. Montages
 - i. electrode derivation
 - ii. electrode placement
 - iii. near field and far field recording
 - iv. choice of reference
 - v. brain mapping
 - e. Artifacts
 - i. extraneous interference
 - ii. stimulus artifacts
 - iii. physiological artifacts
 - f. Subject variables
 - i. age
 - ii. gender
 - iii. body temperature
 - g. Stimulus variables
 - i. transient and steady responses
 - ii. visual stimulation
 1. methods
 2. measurements
 - iii. auditory stimulation
 1. methods
 2. measurements
 - iv. somatosensory stimulation
 1. methods
 2. measurements
 - v. motor stimulation
 - h. General considerations
 - i. electrical safety
 - ii. laboratory norms and test effectiveness
3. Visual Evoked Potential (VEP)

- a. Flash response in healthy individual
 - i. mean latency of the components of the flash response
 - ii. variability of the flash response
- b. Pattern flash Evoked Potentials
- c. Pattern-change Evoked Potential
 - i. pattern-onset, offset, and reversal evoked potentials
 - ii. waveform of the normal checkerboard by VEP
 - iii. distribution of the normal full-field checkerboard pattern response
 - iv. comparison of pattern-reversal response from the two eyes
 - v. effect of mean stimulus on pattern-reversal evoked potential
- d. Difference in the normal VEP with sex, age specific criteria, and body size
- e. VEPs in half field stimulation
 - i. hemisphere contribution to the pattern-evoked potential waveform
 - ii. how the ipsilateral half-field response is produced
 - iii. components of the half field response
 - iv. variability of half-field response
 - v. limits of normal variability in the full-field and half-field response
 - vi. the principle of summation
 - vii. upper and lower response
- f. Recognizing abnormalities of the VEP
- g. Model of protocol for clinical VEP testing
- h. Problems in VEP
 - i. deliberate voluntary alterations of the VEP
 - ii. interpreting "difficult" VEP records
- i. VEP in the investigation of diseases of the eye
- j. VEP in the investigation of diseases of optic nerve
- k. VEP in the investigation of chiasmal and retrochiasmal lesions, field defects and systemic diseases
 - l. ERG in the investigation of macular degeneration and "night blindness"
- 4. Brainstem auditory evoked potentials (BAEP)
 - a. Recording the auditory evoked potentials
 - i. acoustic stimulus
 - 1. intensity
 - 2. stimulus polarity (condensation and rarefaction)
 - 3. rate of stimulation
 - 4. masking
 - 5. avoiding stimulus artifacts
 - ii. montage
 - iii. electrodes
 - iv. filter settings
 - iv. data analysis
 - b. Patients
 - i. adults
 - ii. auditory stimulation in infants
 - iii. establishing sensory threshold
 - c. Auditory evoked potential general descriptions
 - i. short-latency, cochlea receptive, exogenous potentials
 - ii. short latency, brainstem, exogenous potentials
 - iii. characteristics of the BAEP components
 - iv. central auditory evoked potentials
 - 1. steady state frequency following response
 - 2. middle-latencies
 - 3. 40hz steady state response
 - 4. long-latency, cortical, endogenous, exogenous potentials
 - e. Clinical application of auditory evoked potentials
 - i. assessment of auditory sensitivity
 - ii. assessment of 8th cranial nerve, brainstem, and central disorders
 - 1. brainstem lesions
 - 2. developmental disorders

3. infectious diseases
4. degenerative diseases
5. myelin disorders
6. tumors
7. vascular lesions
8. toxic-metabolic
9. coma

5. SSEP
 - a. "Standard" waveforms
 - b. SSEP methodology
 - i. stimulation
 1. sites
 2. intensity
 3. frequency
 - c. Recording
 - i. recording
 1. electrodes
 2. sites
 - ii. amplifications
 - iii. averaging
 - d. Analysis
 - i. measurement
 - ii. alternative reference derivation
 - iii. digital filters
 - iv. topographic mapping
 - v. electrical source localizations
 - e. Control data and normal limits
 - i. height
 - ii. age
 - iii. temperature
 - f. Sources of error
 - i. noise
 - ii. identifications of components
 - iii. the patient
 - g. SSEP generators
 - i. afferent pathways and sensory modalities
 - ii. peripheral nerve
 - iii. nerve root and spinal cord
 - iv. brainstem
 - v. thalamus
 - vi. cortex
 1. median SSEP
 2. ipsilateral components
 3. long latency components
 4. tibial SSEP
 - h. Special techniques
 - i. monosegmental stimulation
 - ii. trigeminal nerve stimulation
 - iii. pudendal stimulation
 - iv. tactile stimulation
 - v. tendon tap and passive movement
 - vi. pain and temperature stimulation
 - i. SSEP clinical observations and applications
 - i. organic or functional
 - ii. extrinsic nerve and root lesions
 - iii. extrinsic spinal cord lesions
 - iv. spinal cord trauma
 - v. intrinsic neuropathy and myelopathy
 - vi. degenerative disease of the central nervous system (CNS)

- vii. focal cerebral lesions
- viii. cerebrovascular disease
- ix. cerebral trauma and anoxia
- x. psychiatric conditions and dementia
- 6. Evoked potentials in pediatrics
 - a. Methodology and developmental norms
 - i. BAEP
 - 1. recording parameters
 - 2. maturation of the BAEP
 - ii. VEP
 - 1. recording parameters
 - 2. maturation of the VEP
 - 3. pattern reversal VEPs
 - iii. SSEPs
 - 1. recording parameters
 - 2. median nerve SSEPs
 - 3. median nerve SSEPs in neonates
 - 4. posterior tibial nerves SSEPs
 - 5. lower limb in neonates
 - 6. maturation of SSEP
 - b. Pediatric applications
 - i. auditory
 - 1. neonatal screening auditory
 - 2. evoked potential auditory
 - 3. common applications of evoked potential audiometry in pediatrics
 - ii. ophthalmology
 - 1. assessing visual acuity
 - 2. disorders of visual system
 - 3. cortical blindness
 - iii. neonatology
 - 1. sensory functions
 - 2. neonatal asphyxia
 - iv. neurology
 - 1. ataxia of childhood
 - 2. demyelinating diseases
 - 3. developmental delay
 - 4. hydrocephalus
 - 5. neurodegenerative diseases
 - 6. tumors of CNS
 - 7. spinal cord lesions

Resources

Husain, A. M. (2018) *Illustrated manual of clinical evoked potentials*, Demos Medical Publishing.

Chiappa, K.H. (Ed.). (1997) *Evoked potential in clinical medicine* (3rd ed.), Raven Press.

Yamada, T. & Meng, E. (2022) *Practical guide for clinical neurophysiological testing: -EP, LTM/ccEEG, IOM, PSG, and NCS/EMG* (2nd ed.), Lippincott Williams & Wilkins.

Misulis, K. E. (1994) *Spehlmann's evoked potentials primer: Visual, auditory, and somatosensory evoked potentials in clinical diagnosis*, (2nd ed.), Elsevier Biomedical Press.

American Electroneurodiagnostic Society. (1998). *Evoked potentials*. Volume Set. ASET,

Cooper, R., Binnie, C. D. & Billings, R. (Eds.). (2005). *Techniques in clinical neurophysiology: A practical manual*. Elsevier BV.

Markand, O. N. (2020). *Clinical evoked potentials: An illustrated manual*. Springer,

Resources Other

1. American Clinical Neurophysiological Society. (2025). <https://www.acns.org/>
2. American Clinical Neurophysiological Society. (2006). *Guidelines for evoked potentials*.
 - a. 9A: Guidelines on Evoked Potentials (https://www.acns.org/UserFiles/file/Guideline_9A_Guidelines_on_Evoked_Potentials_10.pdf)
 - b. 9B: Guidelines on Visual Evoked Potentials (https://www.acns.org/UserFiles/file/Guideline_9B_Guidelines_on_Visual_Evoked.11.pdf)
 - c. 9C: Guidelines on Short-Latency Auditory Evoked Potentials (https://www.acns.org/UserFiles/file/Guideline_9C_Guidelines_on_Short_Latency_Auditory.12.pdf)
 - d. 9D: Guidelines on Short-Latency Somatosensory Evoked Potentials (https://www.acns.org/UserFiles/file/Guideline_9D_Guidelines_on_Short_Latency.13.pdf)
 - e. 10: Guidelines for Writing Evoked Potential Reports (https://www.acns.org/UserFiles/file/Guideline_10_Guidelines_for_Writing_Clinical.14.pdf)
3. American Association of Electrodiagnostic Technologists. (2025). <https://www.aaet.info/>.
4. The Neurodiagnostic Society. (2022). <https://www.aset.org/>.

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