END-1500: BASIC EVOKED POTENTIALS

Cuyahoga Community College

Viewing: END-1500 : Basic Evoked Potentials

Board of Trustees:
May 2022

Academic Term:
Fall 2022

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 obligated 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):
2

Requisites

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

Outcomes

Course Outcome(s):
Obtain a standard Evoked Potential (EP) 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 obligate 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 EP 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 EP responses based on laboratory normal values.
2. Demonstrate identification of locations of abnormality based on EP 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 EP components.
3. Describe EP correlates of clinical conditions such as neurological, orthopedic, neurosurgical, and audiologic 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 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 Erbs Point, N13,P14, N18 and N120 of the median nerve SSEPs.
8. Resolve the obligate components of popliteal fossa, lumbar (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 audiologic, 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-ispilateral 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 dBSPL.
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 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, N 175.
8. Measure and calculate the absolute latency, amplitude, ratios and interocular latency difference of P 100.
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 impedance's 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 EP 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. Demonstration 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
        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. measurement
        iii. auditory stimulation
            1. methods
            2. measurements
        iv. somatosensory stimulation
            1. methods
            2. measurement
        v. motor stimulation
    h. General considerations
        i. electrical safety
        ii. laboratory norms and text effectiveness
3. Visual Evoked Potential (VEP)
    a. The 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 ep's
        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 ep
    d. Difference in the normal VEP with sex, age specific criteria, and body size
    e. VEP's 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 visual evoked potential
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. Auditory Evoked Potentials (AEP)
a. Recording the auditory evoked potentials
i. the acoustic stimulus
1. intensity
2. stimulus polarity (condensation and rarefaction)
3. rate of stimulation
4. masking
5. avoiding stimulus artifacts
b. The recording
i. montage
ii. electrodes
iii. filter settings
iv. data analysis
c. The patients
i. adults
ii. auditory stimulation in infants
iii. establishing
d. 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 viith 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. Somatosensory evoked potentials (SEP)
a. The "standard" waveforms
b. SEP 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. SEP generators
i. afferent pathways and sensory modalities
ii. peripheral nerve
iii. nerve root and spinal cord
iv. brainstem
v. thalamus
vi. cortex
1. median SEP
2. ipsilateral components
3. long latency components
4. tibial SEP

h. Special techniques
i. monosegmental stimulation
ii. trigeminal nerve stimulation
iii. pudental stimulation
iv. tactile stimulation
v. tendon tap and passive movement
vi. pain and temperature stimulation

i. Somatosensory evoked potentials 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 cns
vii. focal cerebral lesions
viii. cerebralvascular disease
ix. cerebral trauma and anoxia
x. psychiatric conditions and dementia

6. Evoked potentials in pediatrics
a. Methodology and developmental norms
i. brainstem auditory evoked potentials (BAEP)
1. recording parameters
2. maturation of the BAEP
ii. visual evoked potentials
1. recording parameters
2. maturation of the VEP
3. pattern reversal VEP's
iii. somatosensory evoked potentials (SEP's)

1. recording parameters
2. median nerve SEP's
3. median nerve SEP's in neonates
4. posterior tibial nerves SEP's
5. lower limb in neonates
6. maturation of SEP

b. Pediatric applications
   i. auditory
      1. neonatal screening auditory
      2. evoked potential auditory
      3. common applications of ep 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. demylinating diseases
      3. developmental delay
      4. hydrocephalus
      5. neurodegenerative diseases
      6. tumors of CNS
      7. spinal cord lesions

Resources

Husain, Atif M. (2018) *Illustrated Maunal of Clinical Evoked Potentials*, New York:Springer Publishing Coimpany Demos Medicxal Publishing.

Chaippa, Keith H. (1997) *Evoked Potential in Clinical Medicine (3rd ed.)*, New York: Raven Press.

Yamada, Thoru & Meng, Elizabeth. (2011) *Practical Guide for Clinical Neurophysiological Testing-EP, LTM, PSG, NCS*, Philadelphia, Pa : Lippincott Williams & Wilkins, a Wolters Kluwer business.

American Clinical Neurophysiology Society. "Guidelines in Evoked Potentials, Guidelines in EEG, Evoked Potential and Polysomnography"

Spehlmann, R. (1993) *Evoked Potentials*, New York: Elsevier Biomedical Press.

American Electroneurodiagnostic Society. *Evoked Potentials.* Volume Set. ASET, 1998.

Cooper, Raymond, Binnie, Colin, Billings, Richard. *Techniques in Clinical Neurophysiology A Practical Manual*. AmsterdamThe Netherlands; Elsevier BV, 2005.

Resources Other

American Clinical Neurophysiological Society (ACNS) 2006

Guidelines for Clinical Evoked Potentials

9A: Guidelines on Evoked Potentials

9B: Guidelines on Visual Evoked Potentials

9C: Guidelines on Short-Latency Auditory Evoked Potentials

9D: Guidelines on Short-Latency Somatosensory Evoked Potentials

10: Guidelines for Writing Evoked Potential Reports

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