

END-1350: INTRODUCTION TO ELECTROENCEPHALOGRAPHY (EEG)

Cuyahoga Community College

Viewing: END-1350 : Introduction to Electroencephalography (EEG)

Board of Trustees:

June 2022

Academic Term:

Fall 2022

Subject Code

END - Electroneurodiagnostic

Course Number:

1350

Title:

Introduction to Electroencephalography (EEG)

Catalog Description:

Provides basic knowledge of electroencephalography, and EEG concepts utilized for diagnosis of various cerebral disorders. Includes history, development, basic neurophysiology concepts of EEG, and normal and abnormal brain wave patterns in adults and children, with emphasis on instrumentation and recording techniques.

Credit Hour(s):

3

Lecture Hour(s):

2

Lab Hour(s):

2

Requisites

Prerequisite and Corequisite

BIO-2331 Anatomy and Physiology I or concurrent enrollment, and concurrent enrollment in END-1300 Introduction to Electroneurodiagnostic Technology, and departmental approval: admission to program.

Outcomes

Course Outcome(s):

Discuss landmarks in the history of EEG.

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. Discuss the history and historical individuals in the field of EEG.
2. Describe analog recording techniques.
3. Describe digital recording techniques.
4. Explain analog-to-digital conversion, including Nyquist Principle, and sampling rate.

Course Outcome(s):

Describe the neurophysiological basis of EEG

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 principles of neuron function, including resting membrane potential, and action potential generation.
 2. Discuss concepts of neurotransmitters.
 3. Discuss concepts of interaction between excitatory postsynaptic potentials (EPSP) and inhibitory postsynaptic potentials (IPSP).
 4. Describe the interaction of various sub-cortical structures in the generation of EEG activity.
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Course Outcome(s):

Identify normal awake rhythms in the EEG and relate these patterns and age related criteria specific to certain age groups.

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 EEG frequency ranges (delta, theta, alpha, & beta).
 2. Identify distribution of normal EEG activity.
 3. Identify and elicit reactive EEG patterns in wake, drowsy, and sleeping patients.
 4. Identify EEG transitions from wake, to drowsy, to sleep.
 5. Identify EEG developmental patterns in various age groups.
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Course Outcome(s):

Explain various activation procedures used in routine EEG including advantages and disadvantages of each.

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. Discuss principles and purpose of activation procedures.
 2. Identify the EEG pattern changes associated with activation procedures.
 3. Explain activation procedures to patients, including behavioral and physiologic symptoms which can occur during various activation procedures.
 4. Conduct activation procedures on patients during routine EEG recordings.
 5. Observe patient's behavioral and physiological functions during activation procedures.
 6. Describe and, if necessary, carry-out safety precautions during adverse reactions to activation procedures.
 7. Describe the contra-indications of each activation procedure, and document on record contra-indications and reason for not conducting activation procedures.
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Course Outcome(s):

Discuss abnormal EEG patterns through a classification of abnormalities, which will be related to all age groups.

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. Discuss and identify slowing in background EEG activity.
 2. Discuss and identify various classifications of epileptiform discharges.
 3. Discuss, and identify asymmetries in EEG recordings.
 4. Discuss importance of patient state (clinical & physiological) in evaluating all EEG abnormalities.
 5. Discuss importance of patient age in evaluating all EEG abnormalities.
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Course Outcome(s):

Identify benign variants commonly seen in the EEG and differentiate them from abnormal patterns.

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. Analyze and identify patterns for morphology to identify normal variants.
2. Analyze and identify patterns for distribution to identify normal variants.
3. Analyze and identify physiological variables pertaining to normal variants.

Course Outcome(s):

Identify EEG and clinical seizures and describe these using specific seizure classifications.

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. Differentiate and identify focal and generalized seizures on the EEG record.
2. Differentiate and identify focal and generalized seizures from a clinical standpoint.
3. Analyze and determine onset/cessation of seizure activity from the EEG record.
4. Explain procedures to determine loss of awareness and consciousness during various types of seizures.
5. Discuss nomenclature for seizure classification.

Course Outcome(s):

Discuss all aspects of electrodes: type, metals, conductivity; electrolytes and impedance measures.

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. Discuss various recording electrode types including surface electrodes, cork-screw electrodes, depth (needle) electrodes, and grid electrodes.
2. Discuss the utility of each type of recording electrode.
3. Discuss various metal types for surface electrodes.
4. Discuss the importance of obtaining proper electrode impedances.
5. Obtain proper electrode impedances for quality EEG recording.
6. Discuss various types of electrolytes utilized in surface electrodes, and advantages/disadvantages of each.

Course Outcome(s):

Perform head measurement for placement of electrodes according to the International 10-20 electrode placement. Adjust electrode placement for anatomical defects or anomalies.

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 and list 10-20 electrode placement designations.
2. Obtain competence in 10-20 system measuring and marking.
3. Identify, and discuss situations in which recording electrode locations require location placement adjustment based on various anatomical defects and/or anomalies.
4. Identify and discuss situations in which additional scalp electrodes should be added to recording montages.

Course Outcome(s):

Demonstrate different techniques of applying electrodes using collodion, paste, and electrode caps.

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. Discuss advantages and disadvantages of each electrode application technique.
 2. Demonstrate competency in paste and gauze electrode application.
 3. Demonstrate competency in collodion application using paste.
 4. Demonstrate competency in collodion application utilizing conductive gel with syringe and blunt-tipped needle.
 5. Discuss electrode cap application.
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Course Outcome(s):

Discuss the importance of inter-electrode impedance measures and resistance measures.

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 importance of low and balanced inter-electrode impedance in recording of quality EEG recording.
 2. Demonstrate proper techniques for obtaining low and balanced inter-electrode impedances.
 3. Demonstrate trouble-shooting skills in determining proper inter-electrode impedances.
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Course Outcome(s):

Recognize, identify, and monitor physiological artifacts which may become a part of any routine EEG recording.

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. Discuss the various physiological artifacts which exist in EEG recording.
 2. Identify morphology, distribution, and source of various physiological artifacts.
 3. Discuss and implement various additional recording electrodes to monitor physiological artifacts.
 4. Discuss and implement strategies to reduce and or eliminate (if possible) physiological artifacts that can impede proper EEG identification.
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Course Outcome(s):

Recognize, identify and monitor a variety of non-physiological artifacts which may contaminate the EEG record.

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. Discuss various non-physiological artifacts.
 2. Identify morphology, distribution, and source of various non-physiological artifacts.
 3. Discuss and implement various additional recording electrodes to monitor non-physiological artifacts.
 4. Discuss and implement various strategies to reduce or eliminate (if possible) non-physiological artifacts that can impede proper EEG identification.
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Course Outcome(s):

Differentiate artifacts from cerebral 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. Discuss morphological differences between artifact activity and EEG (cortical) activity.
2. Implement strategies to monitor artifacts.
3. Implement strategies to reduce or eliminate artifact activity.

Course Outcome(s):

Discuss the characteristics of the EEG input board and recording system.

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. Discuss the concepts of differential amplification.
2. Describe and demonstrate polarity rules.
3. Demonstrate the use of the input board for recording EEG activity.
4. Discuss the addition of other channels to the EEG input board.
5. Demonstrate the ability to add channels to the recording.

Course Outcome(s):

Demonstrate how waveform displays are affected by variations in 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. Discuss sensitivity setting changes and effect on EEG record.
2. Demonstrate the proper use of sensitivity settings to record high quality EEG.
3. Discuss low frequency filters (LFF)/(time constants-TC) and effect that changes to LFF & TC has on EEG.
4. Demonstrate the proper use of LFF/TC settings to record high quality EEG.
5. Discuss high frequency filters (HFF) and effects that change HFF on EEG.
6. Demonstrate the proper use of HFF settings to record high quality EEG.
7. Discuss paper speed (epoch size) and effect that changes have on EEG.
8. Demonstrate the use of paper speed (epoch size) changes to record/interpret high quality EEG.

Course Outcome(s):

Define the descriptors of EEG activity; wave form, repetition, frequency, amplitude, distribution, phase, timing, persistence, and reactivity.

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. Discuss classifications of EEG activity by frequency.
2. Discuss classifications of EEG activity by morphology and duration.
3. Identify distribution of various EEG waveforms in wake and sleep EEG records.
4. Discuss reactivity of various EEG activities, including various activation procedures.
5. Demonstrate the use of reactive procedures and activation procedures in eliciting changes in EEG activity.
6. Identify changes noted in EEG during reactive procedures and activation procedures.

Course Outcome(s):

Describe EEG report: description of record, EEG diagnosis, clinical interpretation.

Objective(s):

1. Discuss information pertinent to the EEG report.
 2. Discuss patient history taking.
 3. Demonstrate history taking.
 4. Discuss record review.
 5. Demonstrate ability to describe the EEG record.
 6. Demonstrate ability to correlate EEG record to patient diagnosis.
 7. Discuss clinical interpretation of EEG results.
 8. Demonstrate ability to discuss and write a technical impression of the EEG record.
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Methods of Evaluation:

1. Quizzes
2. Exams
3. Homework Assignments
4. Comprehensive final
5. Laboratory worksheets
6. Laboratory quizzes
7. Laboratory competencies
8. Laboratory comprehensive final

Course Content Outline:

1. Origins of the electroencephalogram
 - a. Historical introduction
 - b. The generator of the EEG
 - c. Rhythmical EEG activity
 - d. Recording of electrical potentials with scalp electrodes
2. Overview of the neurophysiological basis of EEG
 - a. Neurophysiological basis—regulation of cortical rhythm
 - b. Neurophysiological basis—generator of cortical rhythm
3. Recording electrodes
 - a. Electrical properties of recording electrodes
 - i. electrode potential
 - ii. polarization
 - iii. reversible electrodes
 - b. Electrode shapes and application methods
 - c. Types of electrodes
 - d. Measuring of electrode resistance
 - e. Electrode placement
 - i. 10-20 International System
 - f. Connecting electrodes to amplifiers
 - i. bipolar derivation
 - ii. common reference derivation
 - iii. average reference derivation
 - iv. source derivation
4. EEG recording system instrumentation
 - a. Characteristics of the input board
 - b. Characteristics of recording system
 - i. sensitivity
 - ii. linearity
 - iii. frequency response
 - iv. phase response
 - v. noise
 - vi. frequency response controls

1. low-frequency and its time constant
2. high frequency filter
3. notch filter
- vii. paper speed
5. Operational techniques
 - a. Design of montages
 - b. Recording procedures
 - c. Evocative techniques
 - i. hyperventilation
 - ii. photic stimulation
 - iii. sleep
 - iv. intravenous administration of drugs
6. Artifacts
 - a. Physiological
 - b. Nonphysiological
 - c. Troubleshooting of artifacts
7. The normal EEG
 - a. The definition of normal EEG
 - b. The normal EEG from premature age to age of 19 years
 - c. The normal EEG of wakeful resting adults of 20 to 50 years of age
 - d. The normal EEG of adults over 20 years
 - e. The normal EEG of adults over 60 years of age
8. The abnormal EEG
 - a. The definition of abnormal EEG
 - b. Correlation between abnormal EEG patterns, general cerebral pathology and specific neurological diseases
9. Deviation from normal patterns
 - a. Abnormal frequency of alpha rhythm
 - b. Abnormal reactivity of alpha rhythm
 - c. Activity of alpha frequency in coma and seizures
 - d. Immature patterns
10. Classification of seizures
 - a. Definitions
 - b. Classification of seizures--general
 - c. Classification of seizures--specific
11. The EEG report
 - a. Description of the record
 - b. EEG diagnosis
 - c. Clinical Interpretation

Resources

Blume, W.T., Holloway, G.M., Kiabara, M., & Young, B.G. (2011) *Blume's Atlas of Pediatric & Adult Electroencephalography*, Philadelphia PA: Lippincott Williams & Wilkins, a Wolters Kluwer business.

Ebersole, J. S., Husain, A. M., Nordli, D. R. (2014) *Current Practices of Clinical Electroencephalography (4th ed.)*, Philadelphia PA: Wolters Kluwer Health.

Kamen, G., & Gabriel D. A. . (2010) *Essentials of Electroencephalography*,

Libenson, M.H. (2010) *Practical Approach to Electroencephalography*, Philadelphia P. Saunders Elsevier.

Rowan, J.A., and Tolunsky, E. (2003) *Primer of EEG with Mini-Atlas*, Philadelphia PA: Elsevier .

Schomer, D. L. & Lopes da Salva, F. H. (2017) *Niedermeyer's Electroencephalography (7th ed.)*, Philadelphia PA: Lippincott Williams & Wilkins a Wolters Kluwer bussiness.

Tyner, F. S., Knott, J. R., Mayer, W. B. *Fundamentals of EEG Technology, Clinical Correlates*. Raven Press, 1989.

Resources Other

Guidelines and Consensus Statements American Clinical Neurophysiological Society (ACNS) guidelines for EEG recording (Guidelines 1-7)

<https://www.acns.org/practice/guidelines>

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