INTERNATIONAL QEEG CERTIFICATION BOARD

STUDY GUIDE FOR CERTIFICATION

THIS DOCUMENT OUTLINES THE AREAS OF COMPETENCY REQUIRED FOR CERTIFICATION IN QUANTITATIVE ELECTROPHYSIOLOGY. THESE AREAS ARE DESCRIBED IN THE SEQUENCE BELOW.

I. HISTORY (AND DEVELOPMENT OF QUANTITATIVE ELECTROPHYSIOLOGY) (1 hour)

For this section, candidates will demonstrate basic knowledge of the history of quantitative electrophysiology, including raw electroencephalography (EEG), and quantitative electroencephalography (QEEG).

II. NEUROSCIENCE - KNOWLEDGE OF NEUROANATOMY (8 hours)

For this section, candidates must have formal education and knowledge of functional neuroanatomy. The qualifications of those with other qualifications will be assessed on an individual basis. The following areas will be covered in the formal examination, and recommended readings are:

- **A.** Cortical and sub-cortical structures macro and microanatomy
- **B.** Cerebellum
- **C.** Thalamus
- **D.** Basal ganglia
- **E.** Sensory pathways
- **F.** Limbic structures and pathways
- **G.** Autonomic nervous system
- **H.** Major networks
- **I.** Clinical correlations

III. TECHNICAL - INSTRUMENTATION, ELECTRONICS, AND TECHNIQUE (4 hours)

The competent clinical neurophysiologist must acquire knowledge of electronics and instrumentation related to EEG. Such knowledge is essential for the correct supervision and interpretation of clinical studies. This knowledge may come in part from courses in physics and electronics. Furthermore, individuals should have direct, hands-on experience conducting complete EEG studies under critical supervision.

Each certified Practitioner should utilize the most effective methodologies supported by literature for recording EEG. These Practitioners should be sensitive to the clinical populations they serve and knowledgeable about other diagnostic tools and instrumentation.

A. Topography of cortical and subcortical electric fields

1. Effects of the skull or intracranial prosthesis
2. Volume conduction
3. Dipole characteristics

B. Electrodes

1. Characteristics of electrode materials (metals, dry electrodes, saline, gel)
    a. Pros and cons
2. polarization and measurement of resistance and impedance
3. Invasive and non-invasive techniques

C. Instrumentation

1. Amplifiers
    a. Common-mode rejection
    b. Amplifier noise level, signal-to-noise ratio
    c. Sensitivity/gain
    d. Dynamic range
2. Filters
    a. Effects on AC and DC
    b. Roll-off characteristics
    c. Phase shifts
    d. Digital filters (FIR and IIR)
    e. High-pass and low-pass filters
    f. Sampling frequencies
3. Polarity conventions, terminology,
4. Sources and identification of electrical/mechanical artifacts

D. Montages

1. Rationale and procedure for International 10-20 system
2. Bipolar, common reference, average reference, linked ears, Laplacian
3. Montage logic: rationale behind different types and configurations
    a. Applications to localization

E. Electrical Safety

1. "Grounds"
    a. Earth ground
    b. Chassis ground
    c. Patient "ground" and the three-lead differential amplifier
    d. Ground loops
    e. Multiple grounds
    f. Limiting current in the ground circuit

IV. EEG - BASIC TECHNICAL PRINCIPLES OF THE EEG, INCLUDING NORMAL AND ABNORMAL PATTERNS (8 hours).

The fundamentals of functional neuroanatomy, including network theories, neurochemistry, neuropharmacology, and neuropathology, are essential. A significant understanding of basic neurophysiology is necessary for those attempting to record and interpret electrical signals generated by the brain. For this section, it is recommended that applicants complete a formalized program of study, for example, that is offered by EEG CARE (http://www.eegcare.com/technologists.htm) or equivalent. Recommended readings may be found on this website. These readings and the course itself will train recognition, differentiation, and categorization of technical aspects, normal background, artifacts, benign patterns, and EEG abnormalities through the reading of typical clinical EEGs.

The following areas will be covered in the IQCB formal examination:

A. Basic knowledge of the neurophysiology of EEG

1. Physiological properties of normal functioning neurons
    a. Resting membrane potential
    b. Action potential
    c. Synaptic potentials (EPSPs, IPSPs)
    d. Ionic mechanisms of membrane depolarization and hyperpolarization
    e. Ionic transmembrane concentration differences and ionic conductance
    f. Mechanisms of transmitter release

2. Neuronal interactions
    a. Ramifications of synchronization and de-synchronization
    b. Recruiting and augmenting responses
    c. Recurrent inhibition
    d. Presynaptic inhibition
    e. Neurotransmitters (definition and roles)

3. General medical disorders
    a. Metabolic imbalance
    b. Endocrine disorders
    c. Toxic conditions
    e. Neurological (dementia, TBI, Parkinsons, MS)
    f. Immune dysregulation

B. EEG patterns

1. Normal patterns at various ages
2. Alpha rhythm (low Alpha, high Alpha)
    a. Normal parameters, frequency range, distribution, and amplitude at the various ages
    b. Abnormal patterns
        i. Slow alpha variant ("split alpha," subharmonic)
        ii. Fast alpha variant (harmonic)
        iii. Frontal alpha greater than posterior alpha
        iv. Temporal alpha activity
3. Mu Rhythm
    a. Normal parameters at the various ages
    b. Abnormal patterns

4. Beta (Low Beta, high Beta)
    a. Normal parameters at the various ages
    b. Abnormal patterns

5. Theta (including normal variants)
    a. Normal parameters at the various ages
    b. Abnormal patterns

6. Posterior rhythms
    a. Slow fused transients (posterior slowing of youth)
    b. Lambda waves

7. EEG variants of older people
    a. Normal parameters
        i. Slowing of the Alpha frequency
        ii. Low voltage pattern
    b. Abnormal patterns
        i. Increased Theta activity

8. Activation procedures– **THESE PROCEDURES SHOULD ONLY BE PERFORMED UNDER MEDICAL SUPERVISION!**
    a. Hyperventilation responses
    b. Photic driving responses
    c. Sleep and sleep deprivation

9. Drowsy patterns at the various ages
    a. Frontal theta
    b. Posterior theta
    c. POSTS Positive occipital sharp transients of sleep

10. Benign patterns or patterns of uncertain significance
11. 14 and 6 Hz positive spikes
12. Small sharp spikes (benign epileptiform transients of sleep)
13. Rhythmic temporal theta bursts of drowsiness (psychomotor variant)
14. 6 Hz spike and wave (phantom spike and wave)
15. Wicket spikes
16. Midline theta (Midline theta of Ciganek; Fronto-central midline theta rhythm of Ciganek; Theta discharges in the midline)
17. Frontal arousal rhythm of children

C. Abnormal adults and children

1. Nonspecific foreground patterns
2. Slow wave activity
    a. Theta (focal, diffuse)
    b. Focal parietal theta rhythms
    c. Delta Intermittent rhythmic slowing (frontal or occipital intermittent rhythmic delta activity, FIRDA and OIRDA), generalized bilaterally synchronous slow wave bursts, polymorphic delta activity (PDA; focal or generalized)
3. Asymmetry and suppression

D. Distinctive foreground patterns

1. Generalized
    a. 3 Hz spike and wave
    b. Slow spike and wave (generalized sharp and slow wave complexes)
    c. Atypical spike and wave
    d. Multiple spike and wave
    e. Generalized paroxysmal fast activity
2. Focal
    a. Occipital spikes
    b. Central-parietal (Rolandic) spikes
    c. Central-temporal (Sylvian) spikes
    d. Midline spikes
    e. Other focal spikes
    f. Secondary bilateral synchrony

3. Multifocal
    a. Arrhythmia
    b. Multifocal spikes
4. Unilateral
5. Ictal patterns
6. Myoclonus

7. Periodic patterns
    a. Periodic complexes (subacute sclerosing panencephalitis)
    b. Periodic generalized sharp waves (Creutzfeldt-Jakob)
    c. Triphasic waves
    d. Burst suppression
    e. Generalized pseudo-periodic patterns
    f. Pseudo-periodic lateralized epileptiform discharges (PLEDs)
    g. Bilateral independent pseudo-periodic epileptiform discharges

E. Physiologic basis of abnormal EEG

1. Epileptiform activity
    a. Neuronal activity during interictal EEG spikes
    b. Neuronal activity during ictal EEG activity
    c. Mechanisms of abnormal synchronization
2. Slow activity

F. When to refer to a Neurologist

A provider qualified in qEEG analysis and clinical interpretations, after reviewing and qualifying the EEG as acceptable for qEEG analyses, should seek a qualitative EEG review for any segments of the EEG record if there are questionable or concerning features. This review should be sought from an EEG mentor and/or a neurologist (who is sufficiently trained and experienced in EEG interpretation) to render a medical opinion about any clinical relevance of the suspected portions of the EEG.

V. QEEG - GENERAL KNOWLEDGE OF QEEG (9 hours)

The clinical practice of quantitative electroencephalography requires that the practitioner has a clear understanding of the potential contributions and limitations of qEEG. It is not sufficient to learn to identify EEG abnormalities; the goal of the studies is to convey the clinical relevance of EEG findings. This requires an understanding of 1) the functional correlates of abnormal EEG changes, 2) the role of the EEG in understanding and treating specific clinical presentations, and 3) the relationship of the EEG to other laboratory examinations. The fundamentals of functional neuroanatomy, including network theories, neurochemistry, neuropharmacology, standard EEG patterns, and neuropathology, are essential. A significant understanding of basic neurophysiology, as defined above, is key. The utility of defined databases is critical. Interpretation of these data in the light of the eliminated artifact (manual or automated), levels of conciseness, and visual inspection for foreground patterns as defined above become essential.

A. Visual examination of EEG traces to identify the time and location of artifact and pathology

B. Ability to select an appropriate sample of EEG

C. Understand what is meant by test-retest and split-half reliability

D. Have a thorough understanding of and be able to generate and interpret linked ears power spectrum and equivalent surface maps, including:

1. Demonstrate knowledge and limitations of the multiple montages, including Linked Ears, Average Reference, Bipolar, and Laplacian
2. Demonstrate knowledge of Brodmann Areas, hubs, and networks, including knowledge of networks, connectivity, and definition of terms
3. Demonstrate knowledge of the generation of Key-Institute maps. This should include knowledge and understanding of Current Source Density maps

E. Knowledge of and ability to generate and interpret:

1. Use of QEEG norms and methods used to derive QEEG norms

F. Be able to generate a report based on a QEEG Assessment relating to clinical history, symptoms, and other clinical assessments

1. Pediatric case
2. Adult case

VI. PSYCHOPHARMACOLOGY (2 hours)

Potential effects of prescribed and non-prescribed drugs on clinical presentation, potential effects of prescribed and non-prescribed drugs on EEG measure, potential effects of different drugs on learning tasks.

A. Basic cell physiology

1. Cell anatomy and basic physiology
2. Propagation of Action potentials, EPSPs, ISPS, modulatory mechanisms
3. Neurotransmitters – source and basic types
    a. Basic functional networks and role of neurotransmitters
4. Psychotropic manipulations in clinical syndromes

B. Washout periods

1. Effects on EEG and effects on behavior – acute and long-term
    a. Adverse reaction issues

C. Guidelines for the Recording and Evaluation of Pharmaco-EEG Data

1. Effects of different classes of medications on EEG measures
2. Medical history (state of health, prior illnesses, presence of any metabolic syndrome, hyperglycemia, or thyroid disorder),
3. Use of tobacco, coffee, tea, energy drinks, and alcohol (before and during the days of examination).

VII. RESEARCH (2 Hours)

The candidate should have knowledge about basic research design and practice. The purpose is to facilitate research in the field of electrophysiology and to help evaluate published data for purposes of adaptation to clinical practice.

A. Basic vs. Clinical Research

B. Exploratory research vs. hypothesis testing

C. Experimental Design

1. Between vs. Within Subjects vs. Mixed Designs, etc.
2. Control groups
    a. Inclusion/exclusion criteria confounding variables

D. Statistical Analyses

1. Descriptive
    a. Central tendency, dispersion, outliers
2. Inferential
    a. Probability theory and replication
    b. Type I and Type II error
    c. Variables/Cases ratio
3. Parametric/non-parametric
    a. Normal distribution and data transformation
4. Univariate/Multivariate
5. Power analysis

E. Classification and Pattern Recognition

a. Discriminant analysis
b. Cluster analysis
c. Factor analysis
d. Principal component analysis

F. Validation

1. Jackknife/split-half
2. Independent cross-validation
3. Cross-correlation with other relevant metrics

F. Meta-Analysis

1. Statistical Overview, Combining results from different studies
2. Importance of positive and negative results

G. Reporting results and Publication Standards

1. Solicited vs. peer-reviewed publication
2. Open Access – PLOS

H. Statistical analysis

1. Know basic statistical understanding of mean, mode, standard deviations, t-tests, correlations, and ANOVA.

VIII. ETHICS - PROFESSIONAL CONDUCT (2 hours)

A. Responsibilities and liability in the provision of services.

1. responsibilities and liability in the provision of services
2. demonstrated competence in all aspects of the service provided
3. limiting the scope of practice to areas of professional training and qualifications
4. advertising/marketing of services and public statements
5. continuing education and training
6. patients' rights, privacy, confidentiality, and privileged communication
7. informed consent to assessment and treatment
8. accepting clients, abandonment, and appropriate referral
9. supervision/professional relationship and dual relationships
10. conflicts of interest and exploitation of patients
11. consultation, referral, and relationships with other professionals
12. medical and medication monitoring

IX. CLINICAL PRACTICE/FORENSIC (4 hours)

A. Knowledge regarding limits of interpreting QEEG regarding choice of reference databases and recognizing statistical probability versus clinical probability
B. Recognizing the difference in deposition as "fact/treating" witness vs "expert" witness
C. Understand Daubert vs Frye standards and their application to QEEG interpretation and use
D. Emphasis of correlating QEEG with other clinical diagnostic evidence
E. Appropriateness of a QEEG referral
F. Patient conditions related to QEEG evaluation
G. History and prior clinical and laboratory reports review