Electroencephalography Standards

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AMEEGA STANDARDS

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I PREFACE

The membership of the American Medical Electroencephalographic Association (AMEEGA) and various institutions have asked for AMEEGA's position on standards to be used in electroencephalography. This is a complex subject, because recordings may be made under several different conditions, for example, in an office versus operating room.

Guidelines have been published by other EEG organizations. These have proven useful to the entire EEG community. However, there are certain areas in which AMEEGA, representing the clinical practitioners of EEG, does recognize significant legitimate differences of opinion.

These standards, then, have been developed in response to the requests from our membership.

The Council will continue to update these standards in other areas of neurophysiology as needs are brought to our attention and as technology advances.

These standards should be considered as basic, that is minimum, for the adequate recordings of EEGs. Great caution must be used in applying rigid criteria to the clinical neurophysiological study of patients. Implementation of these criteria must be left to the discretion of the clinical electroencephalographer.

The Council of AMEEGA actively solicits your opinion regarding these standards.

II PERSONNEL

A. Medical Director (Qualifications and Duties)

1) The medical director of the laboratory must be certified by the American Board of Electroencephalography and Neurophysiology or equivalent
2) He/she shall maintain regular participation or attendance in continuing medical education activities
3) He/she shall have the authority for the following:
    a) determining that all personnel meet requirements of their job description
    b) assuring that electroencephalographers have had adequate training and current expertise
    c) supervising all policies and procedures of the laboratory, including all issues of safety

B. Clinical Electroencephalographers

1) must be an M.D. or D.O.
2) must be board eligible or board certified in
    a) neurology
    b) neurosurgery
    c) psychiatry
    d) pediatric neurology
    e) pediatrics
    f) internal medicine
3) must complete one year of supervised EEG training
4) must meet the requirements for examination by the American Board of Electroencephalography and Neurophysiology or equivalent

C. Technologist I

1) is a trainee
2) is a high school graduate
3) works under direct supervision for one year
4) is expected to apply for certification as a Certified Medical EEG Technologist (CMET)
5) has CPR training

D. Technologist II *

1) must be a high school graduate
2) has a minimum of one year full time EEG work as a technologist under qualified Technologist III or electroencephalographer as a Technologist I
3) has attained Certified Medical EEG Technologist (CMET) or equivalent
4) works in EEG laboratory under minimal supervision
5) follows a course of graduated increase in duties leading to certification
6) duties may include:
    a) routine EEG recordings with or without special electrodes
    b) EEG recordings at distant sites such as ICUs, neonatal nurseries, isolation rooms, operating rooms
7) instructs the patient regarding procedures
8) obtains a pertinent history
9) maintains equipment
10) attends regular continuing EEG and neurophysiology education programs
11) continues to keep current CPR training

E. Technologist III

1) must be able to perform all duties of Technologist II
2) must have a minimum 2 years of college
3) must have a minimum of 3 years of experience as a Technologist II
4) must be a Certified and Registered Neurophysiology Technologist (CRNT) or equivalent
5) supervises and is active in establishment of training program for technologists
6) keeps records and report controls
7) prepares budgets
8) attends regular continuing EEG or neurophysiology education events
9) supervises and, as necessary, contributes to patient management and performance of all EEG recordings, especially records for ECS, neonatal recordings, intraoperative recordings, infectious case recordings, 24 hour ambulatory recordings and EP recordings

* Individuals who have completed a Committee on Allied Health Education and Accreditation (CAHEA) approved program would enter at this level.

III FACILITIES AND EQUIPMENT

A. Facilities

1) the EEG laboratory shall be in an area relatively free of ambient noise and electrical interference
2) sufficient personnel should be available for typing of interpretations as well as identification, maintenance and storage of records
3) all equipment must be UL approved and have regularly scheduled testing for electrical safety

B. Instrumentation

1) General Standards - The electroencephalographer is responsible for selecting instrumentation which will provide safe tests and accurate EEG recordings. Instruments must meet all local applicable standards for patient safety

The following standards are essential for recording instruments:

a) the calibration signal(s) must be selected so that they provide a meaningful indication of the integrity and sensitivity of all active channels
b) a calibration signal of known size should be introduced in a manner to subject it to the same degree of amplification and filtering which will be used at the start of the recording
c) the calibration will be repeated at the end of the record with all combinations of settings used in the recording
d) for routine EEG recordings, it is acceptable to calibrate an EEG instrument for 1mm output per 5-10 microvolts of input. The most common setting is 7mm of output for 50 microvolts of input. Depending on the amplitude of the activity being recorded, it may be necessary to alter the amplification during the recording
e) there must be a means of verifying that the individual electrode impedance is not excessive. Between 200 and 10,000 ohms is considered an acceptable impedance. The

impedance should be approximately the same in all electrodes

f) biocalibration should follow the EEG machine calibration with the patient connected to the recording system. This calibration uses the same two electrodes from the patient, recording the same activity in each channel

IV OPERATIONS

A. Patient Records

EEG tracings may be filed in complete form, in a cut-out file system, on microfilm or on various forms of electronic storage

B. EEG File Cut-Out

It is not possible to define the EEG file cut-out in rigorous terms. Selecting samples of an EEG for the cut-out must be left to the judgement of the electroencephalographer, provided the file cut-out contains the following general elements

1) calibration of the EEG instrument at the beginning and end of the recording
2) representative samples of background rhythms recorded during periods of alertness, drowsiness, sleep and non-sleep activation, assuming a recording was made of such periods
3) representative samples of normal activity present, which are not necessarily different from the representative samples of background rhythms
4) representative samples of abnormal patterns present (sufficient to confirm the variety and intensity) which are not necessarily different from the representative samples of background rhythms

The decision that an EEG record is "normal" is a matter of professional judgement which must be left to the electroencephalographer

C. Maintenance of patient records

EEG records should be maintained for as long as state law requires

D. Manual, Policy and Procedure, Etc.

To augment internal quality control in the EEG laboratory, -Standard Operating Procedure Manuals- should be maintained. These manuals should be available to the personnel performing EEGs and should include

1) a description of the EEG methodology utilized by the laboratory, properly designated and dated to reflect the most recent supervisory reviews
2) EEG control and calibration procedures
3) EEG safety procedures
4) current library of materials on neurophysiology
5) a teaching file of records is recommended

E. Billing Practices

The patient or responsible agent should receive a clear and concise statement, including itemization of technical and professional fees if required

F. Infectious Disease Precautions

The management of patients with infectious diseases, including the special precautions with illnesses such as Creuzfeldt-Jakob disease, acquired immuno deficiency syndrome and AIDS related complex, infectious hepatitis, etc., should conform with current guidelines relative to each specific disease as outlined by hospital infection control committees, state health departments and the CDC

These guidelines are suggestions for laboratory technologists and electroencephalographers. A professional attitude and humanitarian concern should permeate the laboratory. Expert knowledge about infectious diseases and their potential contagiousness should be available. It is recommended that further information be obtained from specific sources and each individual patient with a potential infectious disease be handled with the preceding recommendations kept in mind

G. EEG Recording Methodology

1) Electrodes

a) routine EEG scalp electrodes should be of such size and conductive material as to be placed conveniently on the scalp. The design of the electrode should minimize characteristics which might result in artifacts from patient movement or electro-chemical changes in the scalp-electrode interface. If electrodes are assembled in an array as part of an appliance (such as electrode cap) there should be provision for adequate flexibility of placement to account for variation in head size and shape
b) the use of needle electrodes is discouraged because of their inherently greater impedance, ease of displacement, the greater risk of infection, and the discomfort to the patient
c) a variety of electrolytes and/or adhesives are currently in use to provide improved electrical contact between the scalp and electrode and to stabilize the electrode in position. Whatever combination may be used the desired effect is to obtain a low artifact contact inter-electrode impedance between 200 and 10,000 ohms, and with approximately the same impedance for all electrodes
d) specialized electrodes such as nasopharyngeal, sphenoidal, naso-ethmoidal, cortical or depth, are too varied for a generalized description. Such electrodes should permit a valid recording with minimal risk and discomfort to the patient

2) Electrode Placement

Acceptable systems of electrode placement commonly used today are International 10-20 System and the Universal APEEGA System (Anatomical Placement of EEG Electrodes). The arrangement of electrodes on the head will depend upon the type of EEG test being performed and may depend upon the nature of the patient's known or suspected pathology. It is not uncommon to change placement or to add additional electrodes as indications occur during the recording process.

Montage refers to the relationship between each channel and the EEG electrodes.

The selection of the montage(s) should optimize the likelihood for detecting and identifying as many EEG abnormalities as may be present in a given case. A montage for which there are few, if any, effective controls should not be used, except as part of research. More type-specific montages should be used to define abnormalities. The montage selection should not be made strictly on an "automatic" basis. Any arrangement of electrodes should be acceptable provided:

1. there are adequate control standards to support a reliable interpretation of the recordings from these electrode placements
2. the arrangement of electrodes is selected optimally to display abnormal patterns which correlate with significant clinical disorders

An EEG instrument used for routine testing should have a minimum of eight channels. The number preferred by any given laboratory will depend upon the application and methodology

3) Instrument & Operating Standards

a) Sensitivity
   1. amplification should be sufficient in all cases to allow visible deflections (1 mm at least) of ongoing activity. In most records amplification of 5-10 uv/mm will achieve this for the resting patient
   2. amplification may need to be reduced for at least a portion of the record to prevent mechanical cut-off or amplifier overload
   3. in low voltage recordings, there may be a need to increase the sensitivity to develop a clearer picture of specific portions of the electrical activity. Increase in sensitivity may have to be accompanied by a simultaneous change in filtering, for example, reduction of high voltage sweat artifact or possibly reduction of muscle artifact for a brief period

b) Filters
   1. the occurrence of specifically different voltages in different frequency bands necessitates judicious restriction of the frequency band recorded at particular points in time:
      a. low frequency filtering: The filtering of the slower frequencies should not cause a reduction of 1 Hertz activity by more than 30% of the true amplitude. This generally requires a time constant of 0.16 seconds or longer. It is permissible and often necessary to use a shorter time constant to allow increased amplification for better elaboration of some fast frequencies for some portion of a specific tracing
      b. high frequency filtering: The effect of high frequency filters used in the routine recording should not reduce 50 Hertz activity by more than 30% of its true amplitude during significant portions of the record.
   2. the impact of the addition of 60 cycle filters on these requencies for particular EEG machines

2. the impact of the addition of 60 cycle filters on these requencies for particular EEG machines should be known. Their use should be avoided as much as possible if they significantly reduce the 50 Hertz activity more than 30%

c) Paper Speed
   1. for routine clinical records a paper speed of 30mm/sec is the standard. Slower speeds have valuefor some sleep and monitoring applications. Faster paper speed to investigate synchrony and to delineate fast activity (spike activity and/or 60 Hertz activity) should be an available option when needed

d) Monitoring
   1. the amplification, high filter and low filter settings should be written, preferably on each montage. At a minimum they must be written when the record begins and ends, and when a change in a setting is initiated or terminated
   2. level of consciousness at the start of the record should be recorded and apparent changes noted as appropriate during the examination
   3. ECG monitoring during EEG recording is a valuable adjunct in order to separate cerebral and cardiac activity. As part of the routine application of electrodes an ECG lead is therefore recommended
   4. other monitoring devices may be used in addition at the discretion of the electroencephalographer

e) EEG Activation
   1. there are several effective means of activating latent EEG abnormalities. Certain types of EEG abnormality are more likely to be observed at one state of consciousness than another. Natural sleep is preferred for EEG recording; however, sleep deprivation and/or sedative medication may be required. It is important to choose a sedative which has as little effect on the EEG as possible and which will not cause too rapid a transition through drowsiness. Sleep, while valuable, should not be recorded routinely to the exclusion of a portion of the record with drowsiness and clearly documented arousal
   2. other frequently used forms of EEG activation include photic stimulation and over-breathing (hyperventilation). Hyperventilation is usually carried out for a 3-5 minute period. This should be done only with clear observation of the patient and a recorded assessment of the patient's effort. A period of baseline (same montage) needs to precede and follow the effort
   3. permission from the referring physician should be obtained when there is any question about a condition that might be a contraindication for hyperventilation

f) EEG Recording Time
   1. the length of time required to obtain a quality EEG test cannot be rigidly defined. The time

required will depend on many factors and must be left to the discretion of the EEG Technologist II-III under the general guidance of the electroencephalographer. The EEG should be no less than twenty minutes of technically satisfactory recording and in many circumstances longer recordings are necessary in order to establish a reasonable presumption of EEG normality or abnormality. The skills of the EEG laboratory staff are very important components of a successful EEG test

H. EEG Referral

An EEG laboratory shall examine patients only at the request of a licensed physician or other person or agency authorized by law to use the findings of laboratory examinations. It is recommended that laboratories obtain orders for sedation from a physician when needed.

1) referral information

The EEG laboratory should record the following information about each patient

a) full name and birth date
b) name and address of person authorizing the referral
c) name of physician authorizing sedation, if indicated
d) name and address of person(s) to whom the report(s) be sent
e) reason for the referral and diagnosis
f) adequate case history to optimize the EEG recording conditions and/or provide a meaningful report. The history should include a description of all medications, including EEG sedation, which the patient was known to have in his/her system at the time of the EEG recording. If current blood drug levels are available, these should be noted as well
g) time and date when the EEG recording was taken, and time of last adequate meal
h) the name of the EEG technologist who made the recording and obtained the EEG laboratory history
i) in known medicolegal cases it is recommended that the patient or responsible guardian sign and date the recording for additional identity verification

I. EEG Report

The EEG report shall be sent promptly to the referring physician or other authorized person or agency requesting the test. The patient has a right to request a copy of an EEG report for his/her records. However, it is recommended that the report be released by the patient's physician whenever possible.

The report should include the following elements:

1) the date the report was completed and date of test
2) the name and signature of the electroencephalographer
3) a technical description of the EEG findings, including level of consciousness, clinical state of the patient, and any activating procedure utilized. The technical description should be written in terms which convey a clear impression to other specialists in the field of EEG

4) a summary description of the EEG findings. They should be written in such a manner as to be clearly understood by supervising physicians
5) clinical correlation of the significant EEG findings should be included in the report

V SPECIAL RECORDING PROCEDURES

A. EEG In Intensive Care Units and In Operating Rooms

1) The variety of patient monitoring equipment and patient support equipment used in an intensive care or surgical suite poses special problems for the EEG laboratory. The EEG staff must be particularly aware that many sources of EEG artifact are present in this environment. They must know how to minimize the artifact without jeopardizing the health of the patient. The EEG staff should never alter the operation of any other equipment in the area without the approval of the staff.

Recording EKG, respiration, muscle activity and/or eye movements are often required in this environment

These patients are susceptible to electrical hazards. It is advisable to use the most reliable equipment with maximum available channels for production of the best record. EEG equipment should be designed and maintained to meet safety standards. The design of the instrument should not be altered

Extension cords will not be used

Grounds leads should not be attached to patients already grounded. The use of multiple ground leads to the patient must be avoided as it is potentially dangerous

With scheduled intra-operative EEGs the recording should begin with standard montages prior to induction of anesthesia. A single montage should be used throughout most of the procedure. The electroencephalographer should be present or otherwise visually monitoring the record during the critical recording time.

B. Recording Standards to be used in case of Electro Cerebral Inactivity (Electro Cerebral Silence)

The standards for this type of recording are delineated in the Journal of Clinical Neurophysiology, 1986, Volume 3, Supplement 1, pp 12-17, AMEEGA endorses these standards

C. Extended EEG Monitoring

1) Introduction

a) extended EEG Monitoring is long term concurrent recording of EEG activity and patient behavior. This technique may vary considerably in time required and may range from several hours to 24 hours or more
b) it is expected that the electroencephalographer has obtained special training and experience in extended monitoring. The electroencephalographer will procure the necessary specialized equipment to achieve the optimal recording quality

c) procedural data shall be incorporated into the Policy and Procedure Manual and updated as advances and innovations occur

2) Indications

Indications include but are not limited to the following diagnostic, treatment and quantification considerations:

a) a satisfactory routine wake and sleep EEG has been performed first and does not adequately meet the needs for clinical diagnosis and treatment
b) electroencephalographic or clinical seizures, non-convulsive seizure activity, pseudoseizure and interictal events may be documented and quantified
c) differential diagnosis of paroxysmal medical disorders (epilepsy, syncope, cerebral ischemia, cardiac arrhythmia, cataplexy, parasomnias, sleep apnea syndrome, pseudoseizures, etc)
d) exploration of a change in the quality, nature or frequency of seizures
e) more precise localization of EEG abnormalities, particularly in evaluation for surgical interventions
f) correlation of stimuli, precipitating factors, or cyclical events with seizures
g) relationship of task related behavior and/or therapeutic agents with seizures
h) behavioral/psychological measurements during ictal and interictal epochs

D. Telephone Transmission of EEG

1) the need for telephone transmission/reception of EEG services is well recognized but should be used only when an on-site recording facility, which meets requirements of this document (Standards) is unavailable
2) clinically pertinent information may be obtained from the telephone EEG in patients suspected of cerebral death. However, since electrical artifact cannot be reliable and completely eliminated, telephone EEGs must not be used in the diagnosis of electro cerebral silence
    a) a minimum of eight (8) EEG channels recording must be utilized. Additional physiological monitoring channels are recommended. EEG methodology should follow recommendations set forth in Standards for regular EEG recordings
    b) in addition to calibration and biologic-calibration ("bio-cal, patient calibration") a minimum of six (6) different montages with referential and bipolar array should be utilized during the recording
    c) the transmitting technician must provide the receiving center with the following , to be incorporated in the front page at the beginning of the record:
        1. patient admittance data: patient name, age, identifying number, date and time of the recording, name of transmitting facility and identifying number and physician ordering tests
        2. technician information sheet
            a. transmitting technician name

b. patient medication, clinical complaints, symptoms, state of consciousness, cooperation, and prior EEG reports

3. recording data
    a. electrode type and placement system
    b. method of electrode application
    c. impedance reading
    d. calibrations
    e. activation procedures

d) the write out ("hard copy") of the EEG recordings shall be at the receiving site. Telephonic transmission usually does not require a simultaneous write out at the transmitting site. An optional monitor scope may be utilized at the transmitting site, but is not obligatory. There are circumstances wherein a simultaneous write out at the transmitting site is desirable and/or necessary. These circumstances should be determined by the electroencephalographer.

e) communication between the transmitting site and receiving site is necessary
    1. voice communication between the transmitting technician and receiving technologist must be available during the recording
    2. signal codes must be utilized to identify procedures, artifacts, sensitivity and montage settings

f) the person receiving the transmitted EEG should be a Certified Registered EEG Technologist or equivalent, and should be directed and supervised by a physician who is ABEN board eligible or board qualified in electroencephalography or equivalent

g) persons transmitting EEGs should be skilled members of the Allied Health Personnel group who have been adequately trained to perform this function

h) persons transmitting EEGs must have initial intensive and full documented training and must attend continuing educational programs best provided at the receiving center. Such programs will be provided by the Certified Registered Technologist or equivalent at the receiving center.
The quality control of this training is the responsibility of the board eligible or board qualified electro-encephalographer

i) manufacturers of telephone EEG equipment must provide detailed specifications regarding their equipment, electrical safety, signal to noise ratio, frequency response, F.D.A. compliance and F.C.C. approval.