CAET TECHNICAL STANDARDS, 2016

Standard One: Routine Adult
Minimum Technical Standards Clinical Electroencephalography

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INTRODUCTION:

The following recommendations represent the minimum standards for routine clinical recording of the adult EEG and are consistent with the Core Entry-to-Practice Competencies for the Profession of Electroencephalography Technology.

Recording at minimum Standards should not give pride to the EEG department working at this level and cannot ensure a satisfactory test. Minimum standards provide barely adequate fulfillment of responsibilities to the patient and the referring physician. To the minimum standards have been added recommendations to improve standardization of procedures and also facilities interchange of recordings and assessment among laboratories in North America. More detail is provided in recommendations from the international federation of Clinical Neurophysiology (Minimal Technical Requirement for Performing Clinical Electroencephalography, ACNS 2008 ) (Deuschl and Eisen, 1999.)

A) EQUIPMENT

1.0 RECORDING INSTRUMENT:

1.1 The EEG equipment should adhere to the following parameters: (Task Force of The Canadian Society of Clinical Neurophysiologists, 2002):
   - Screen resolution: at least 4-pixels per vertical millimeter and at least 1024 x 1280 pixels
   - Sampling rate: 200 samples per second per channel, 12 bits or greater
   - Common mode rejection: 100 dB or greater at each amplifier output
   - Inter-channel cross talk: less than 1%, i.e. 40 dB down or less
   - Horizontal scaling: one second of time occupy 25-35 mm and contain at least 120 data points per channel; scaling at 0.5, 2 and 4 times should be feasible
   - Vertical display: minimum spacing of 10 mm between channels
   - Filter: wide band-pass of 0.1 to 100Hz

1.2 EEG recording must be digital systems. Playback systems should show montage, filter settings, vertical voltage scale, horizontal time scale, technologist’s comments, event markings, and page number or time. The playback unit should allow for post-hoc selection of montages, filters and sensitivity (American Clinical Neurophysiology Society Guideline eight, 2006).

1.3 Amplification and channel acquisition must be available for a minimum of 24 and preferably 32 channels for extra derivation recording.
1.4 Electrical safety of equipment must be ensured by:
   • Canadian Standards Association (CSA) and Health Canada
   • Yearly preventive maintenance checks by certified biomedical personnel to ascertain proper grounding and safe levels of chassis leakage current (not exceeding 100 microamperes); and
   • Supporting documentation of electrical safety of the recording apparatus.

1.5 Faulty equipment must be removed from service until it meets safety requirements.

1.6 An extension cord must not be used between any AC outlet and the 3-pronged plug of the EEG instrument cable. The use of an extension cord increases the leakage current by an unknown and potentially hazardous factor.

1.7 Alternating current (AC) wiring must meet the Underwriters’ Laboratories Standards for hospital grade service. All AC receptacles must provide adequate instrument grounding. The integrity of the ground pin of the recording instrument’s power cable should be checked by biomedical personnel as recommended by the manufacturer.

1.8 All ancillary equipment must have initial approval of the Canadian Standards Association (CSA) and undergo periodic preventative maintenance checks, as recommended by the manufacturer and biomedical engineering staff.

2.0 ELECTRODES:

2.1 Surface, disk electrodes are recommended for routine, clinical use. Electrodes recognized for good recording properties should be employed. (i.e. gold, silver-silver chloride). When indicated, single use or MRI compatible electrodes may be utilized. At minimum all electrodes and placements recommended by the International Federation of Clinical Neurophysiology (IFCN; Jasper HH, 1983) should be used.

2.2 Subdermal electrodes are not recommended for routine recording. If exceptional clinical circumstances necessitate their use (i.e. burns to the head, intraoperative procedures), sterilized, single-use needle electrodes should be used and disposed of after the recording (Task Force of The Canadian Society of Clinical Neurophysiologists, 2002). The technologists who employ needle electrodes need training on the use, disposal, and advantages/disadvantages of their use.(American Clinical Neurophysiology Society Guideline one, 2006).Parallel anteroposterior alignment of the needles is important; misalignment may cause artifactual amplitude asymmetries or distortions. (ACNS Guideline One, 2008)

2.3 It is highly recommended that electrode caps with pre-determined electrode positions not be used. At the very least they should only be used in exceptional circumstances when patient difficulty is such that use of an electrode cap is the only way to obtain an EEG in a patient who is suspected of having ongoing seizures.
2.4 All scalp electrodes applied to a given patient must be of the same type and size to minimize potential difference occurring between electrodes.

2.5 Electrodes may be inserted into adhesive disposable sponge disks to help prevent skin break-down for prolonged recordings.

B) TEST PREPARATION:

1.0 DOCUMENTATION/PATIENT PREPARATION:

1.1 All EEG requisitions must contain the following: date and time of the recording, patient’s name, home address, phone number, date of birth, personal health number, name of referring physician, clinical indication for the test, medications, any special requests for additional procedures (i.e. sleep deprivation or additional electrode placement). Additional information such as contamination risk (i.e. MRSA or VRE) should be included so that appropriate laboratory protocols can be adhered to. For in-patients referrals, the unit or room number should be included.

1.2 The technologist should review the patient referral prior to testing to become familiar with the history and to determine the need for additional information. The digital file should include the following:
   - Patient’s name and date of birth
   - EEG identification number and test date
   - Medications
   - Hand dominance
   - Time of last nourishment
   - Relevant clinical history and observations
   - Relevant past medical history
   - Family medical history
   - Date and time of last seizure, if applicable
   - Contraindications to activation procedures
   - State of the patient (awake, lethargic, comatose, etc.)
   - Skull anomalies (scars, asymmetries, etc.) and corresponding electrode placements if required
   - Additional, relevant information (including limitations as they pertain to testing)
   - Name of the recording technologist

1.4 The technologist should fully explain the procedure. A printed information sheet may be provided to the patient prior the procedure. Temporary side effects and a small risk of seizure induction must also be indicated prior to procedure (Smith, 2005).
2.0 ELECTRODE PLACEMENT/APPLICATION/REMOVAL:

2.1 The International 10-20 System of Electrode Placement is to be used to determine the location of electrode positions. The sites should be accurately identified using a tape measure and a non-toxic marker. (i.e. china marker, hydro marker etc)

2.2 In addition to the standard cerebral electrodes, the technologist should also apply electrooculography (EOG) and electrocardiography (ECG). Extra leads can be added for artefact monitoring or for further localization, when clinically indicated.

2.2 To permit digital reformatting an additional electrode not already in the 10-20 system be placed between Cz and Pz as a system reference electrode. It’s location clearly annotated on the recording is required.

2.4 The application of a ground electrode is required. The technologist must ensure that there will be only one ground electrode on the patient during the recording procedure.

2.5 To reduce skin impedance, the use of Health Canada approved abrasive EEG gels applied with a cotton-tipped applicator prior to applying EEG conductive paste is highly recommended to obtain optimal impedances. Care must be taken to not abrade the skin causing skin lesions.

2.6 The use of blunt tip needles to lower impedance is strongly discouraged, however, if clinically warranted, it must be immediately properly disposed of in a sharps container. (Task Force of The Canadian Society of Clinical Neurophysiologists, 2002)

2.7 Stable electrode application for routine recordings can be achieved through use of a variety of conductive electrode creams or pastes and may be wrapped in gauze.

2.8 The use of ether-based products such as Collodion is not recommended for electrode application in the routine setting. Where its use is unavoidable, proper ventilation is required and must meet established standards for safety as per the Material Safety Data Sheet (MSDS). (Material Safety Data Sheet [MSDS] #C5071, effective date 0701/09, Mallinckrodt Chemicals)

2.9 Residue from gel/paste and marker should be removed from the patient’s scalp and hair following the EEG by using warm water, soap, dry shampoo, etc.

3.0 IMPEDANCES:

3.1. Impedances should be checked at the beginning and end of the recording. They should be balanced and between 100 ohms and 5000 ohms in routine EEG. Values must be saved with the recording and available for review.

3.2 Electrode impedance should be rechecked during the recording when any pattern that might be artefactual appears. (ACNS Guideline One, 2008)
3.3. Balanced impedance slightly higher than the usual 5000 ohms is acceptable during prolonged or long term monitoring recordings with an upper limit of 10 000 ohms in order to avoid skin breakdown, however it is important to maintain a close to 5000 ohms as possible.

C) RECORDING PROCEDURE

It is recommended to adjust the recording settings (montages, filters, sensitivity, and time base) during as well as in review mode to improve signal detection and enhance signal appreciation. To promote communication in interpretation it is expected that departments establish a list of approved montages based on the following parameters.

1.0 MONTAGES:

1.1 The use of longitudinal bipolar, transverse bipolar and referential montages is recommended.

1.2 It is encouraged to use additional or special montages to enhance localization and signal appreciation.

1.3 It is recommended to use a minimum of 24 and preferably 32 channels to improve localization and thereby facilitate accurate interpretation.

1.4 Bipolar connections should run in straight, unbroken, anterior-to-posterior or transverse directions with equal inter-electrode distances.

1.5 Anterior-to-posterior and left-above-right orders of derivations are recommended.

1.6 Each montage is to be fully annotated with the electrodes and each channel derivation specified.

1.7 In a referential montage another recording reference should be chosen if contamination occurs. All changes and troubleshooting should be clearly documented on the EEG.

1.8 Montages (Longitudinal Bipolar, transverse bipolar, and reference montages) should be recorded for a minimum of 3 minutes. When circumstances warrant, the time may be shortened at the technologist’s discretion, and another appropriate montage be selected.
2.0 ANNOTATIONS:

2.1 Careful observations of the patient and frequent annotations are extremely supportive from an interpretive value.

2.2 At the beginning of each montage the following should be either digitally available or annotated: sensitivity, filter settings, eyelid position, head position, and patient’s state. (CAET Minimum Technical Standards 2008)

2.3 Proper assessment of EEG recordings requires periods where eyes are open and closed whether spontaneous, on command or passively and must be clearly annotated.

2.4 Technical, clinical, behavioral and artefactual changes should be indicated on the recording at the time of their occurrence.

2.5 The following should be documented on the recording at the time of their occurrence:
   - Signals or commands to the patient
   - Any change in patient state
   - Presence or absence of clinical response to stimuli/response testing
   - Onset and conclusion of activation procedures as well as appropriate documentation during the procedure
   - Patient movement
   - Movement around patient
   - Other physiological or environmental artefacts

2.6 If abbreviations are used for annotations they should be standardized within each laboratory. If the record is being reviewed outside of the recording lab, a list of annotations should be included.

3.0 SENSITIVITY SETTINGS:

3.1 A standard sensitivity setting of 5-10uV/mm is recommended. Sensitivity adjustments should be made to allow recorded signals to be free from amplifier blocking and signal distortion. Appropriate adjustments also should be made in order to record low voltage signals.

4.0 FILTER SETTINGS:

4.1 The low frequency filter should be no higher than 1Hz and the high-frequency filter should be no lower than 70 Hz during recording of routine EEG studies. It is important to understand filters and cautiously use them to emphasize or clarify certain patterns or waveforms in the recording along with clear annotations of their use.
To display HFF 70 Hz, a computer monitor would need a horizontal resolution of at least 1400 pixels in the data display area. Interpreters should be aware that some loss of high frequency resolution will otherwise occur, along with the possibility of lower frequency distortion due to spatial aliasing. A LFF setting higher than 1 Hz should not be used routinely to attenuate slow wave artifacts in the record. Vital information may be lost when pathologic activity in the delta range is present. (ACNS Guideline One, 2008)

4.2 The 60 Hz (notch) filter should not be used in routine clinical settings. Its use should be restricted to hostile recording environments (i.e. intensive care units) where 60 Hz interference cannot be readily eliminated by proper troubleshooting techniques. The use of the notch filter may mask a serious safety hazard.

5.0 TIME BASE:

5.1 A time base of 30 mm/sec should be used for the majority of the recording. Slower or faster time base should be selectively used when indicated to enhance patterns or waveforms such as periodicity or secondary bilateral synchrony.

6.0 LENGTH OF RECORDING:

6.1 Minimally, the baseline EEG should consist of at least 20-minutes of artefact-free recording in addition to the time needed to perform activation procedures.

6.2 Spontaneous sleep should be encouraged and captured when circumstances permit.

6.3 If the patient becomes drowsy or falls asleep after the 20 minutes of baseline recording, an additional 10 minutes of recording should be added.

6.4 When the recording is dominated by sleep, a period of alert wakefulness should be acquired and every effort made to wake or stimulate the patient to obtain moments of wakeful EEG recording.

7.0 RESPONSE TESTING:

7.1 In stuporous or comatose patients, and those with an invariable EEG pattern, various stimuli (visual, auditory, somatosensory, painful) should be applied during the recording.

7.2 Response testing should be carried out systematically in the event of either clinical seizures or electrographic seizures. Simple motor responses, verbal probe recall and serial subtraction are examples appropriate tasks.
8.0 EXTRA-CEREBRAL MONITORING:

8.1 One channel of electrocardiogram (ECG) is recorded during every EEG.

8.2 At least one channel of electrooculogram (EOG) should be recorded during every EEG to distinguish between frontal abnormality and eye movement artefact. Sites for the placement of EOG electrodes must be identified on the recording and labels should be standardized in each EEG lab. Two channels dedicated to EOG is suggested so that both vertical and horizontal eye movements can be displayed in separate channels (i.e. RSC-A2, LIC-A1).

8.3 Additional physiological monitors should be used when appropriate. These may include electromyogram (EMG), oxygen-saturation monitor, or respiratory monitoring (oral/nasal thermistors or strain gage).

9.0 VIDEO MONITORING

9.1 Simultaneous, video monitoring of the patient is recommended in order to capture clinical events. It should be performed according to laboratory protocol. Patient consent may be required, as per institutional guidelines and provincial PHIA (privacy health information act) regulation.

10.0 ELECTRICAL CEREBRAL SILENCE RECORDINGS

10.1 Must be performed by a Registered Technologist and follow the specific guidelines set forth by CAET Standards for Electrocerebral Silence (ECS) Recordings.
D) ACTIVATION

If activation procedures are discontinued prematurely or omitted, reasons should be documented on the recording and in the technical report.

1.0 HYPERVENTILATION:

1.1 Hyperventilation (HV) should be performed for 3 minutes unless clinically contraindicated.

Contraindications include:
- Recent status epilepticus
- Severe cardiac or pulmonary disease
- Exertion-induced asthma
- Sickle cell disease
- Moya-Moya disease
- Cerebrovascular disorders
- Inability to comprehend or execute the task due to mental incapacity (i.e. intellectual disability, dementia) or unwillingness to perform.
- Selectively during pregnancy – (unless specifically approved by referring physician)
- Clinical judgment should be used for patients over the age of 65. If the following have occurred within one year, or otherwise clinically indicated:
  - Brain surgery
  - Acute vascular incidents
  - Intra-cerebral hemorrhage
- Discuss with laboratory medical director or neurologist if uncertain.

1.2 If no significant EEG changes, outside of normal buildup, are noted during routine three minutes of HV and there is a strong suspicion of absence epilepsy, the protocol should be prolonged and/or repeated according to laboratory standards. (Craciun L, et al Seizure2015,).

1.3 Elapsed time of hyperventilation should be documented in 30-second intervals.

1.4 Qualitative assessment of patient effort during hyperventilation should be documented on the recording. (American Clinical Neurophysiology Society Guideline one, 2006).

1.5 The EEG should be recorded for at least 1 minute before and 2 minutes after hyperventilation on the same montage.
2.0 PHOTIC STIMULATION:

2.1 Intermittent photic stimulation (IPS) should be performed in accordance with “Guidelines for Visual-Sensitive EEG Testing” (Can J Neurol Sci. 2008 May;35(2):133-9) as endorsed by the Canadian Society of Clinical Neurophysiologists (CSCN) and adopted by CAET, Inc.

2.2 Clinical Considerations:

2.2.1. IPS should be done in all routine studies unless contraindicated.
   - Status epilepticus
   - Pregnancy unless directed by referring physician
   - Recent eye surgery

2.3 Recommended IPS Procedure:

   • The patient may be seated or supine and preferably alert.

   • The lamp distance from the nasion should be 30 cm.

   • The ambient light should be dim. Lighting should be standardized within the lab for consistency.

   • IPS must not take place within the completion of two minutes of hyperventilation to avoid late effects of over-breathing.

   • The following frequencies should be used in sequence: 1, 2, 3, 4, 6, 8, 10, 12, 14, 16, 18, 20, 60, 50, 40, 30, 25, and 20 again, in that order. If the laboratory is not equipped to deliver the specified frequencies, then the protocol used should include the proposed frequencies as close as possible.

   • Flashes should occur in trains of 10 seconds (per frequency) with an interval of at least 7 seconds between frequencies.

   • The first 5 seconds of each flash train should occur with the patient’s eye open and directed at the lamp’s center. The patient’s eyes should be closed for the remaining 5 seconds. (Seshia et al., 2008, Flink et al., 2002).

   • Photic stimulation should be stopped immediately if any generalized epileptiform activity occurs. Additional attempts at that specific frequency may be required to confirm photosensitivity. (Seshia et al, 2008, Flink et al., 2002).

   • If IPS is discontinued prematurely or omitted, reasons should be documented on the recording and in the technical report.

3.0 SLEEP:
3.1 Sleep should be recorded whenever possible. Drowsiness and sleep is extremely beneficial for increasing yield of EEG abnormalities, and essential for patients with suspected or confirmed epilepsy.

3.2 Montages should include midline derivations to clearly define sleep stages.

3.3 A minimum of 10 minutes of spontaneous sleep recording should be acquired before the patient is awakened. It is recommended that a minimum of 20 minutes of recording be obtained without activation procedures, and 30 minutes with, therefore if the patient fell asleep at 26 minutes, the recording would continue to record 10 minutes of sleep followed by arousal and awake state.

3.4 If patient is stuporous or comatose, noxious stimuli such as verbal, touch, pressure must be utilized to obtain all state changes. Stimuli and patient response must be annotated at the time of occurrence.

4.0 SLEEP DEPRIVATION:

4.1 At the time of appointment scheduling, the patient should be advised of the risks of driving in a sleep-deprived state. Alternate travel arrangements are required. Patients who refuse to comply will not be tested.

4.2 At a minimum, sleep should be half the time of normal sleep pattern unless otherwise indicated by referring physician or laboratory protocol.

4.3 At least 30 minutes of artefact-free recording should be obtained. Additional time is required for a period of wakefulness before and after sleep; plus hyperventilation and photic stimulation, unless contraindicated.

5.0 SEDATION:

5.1 Sedation is not recommended for routine EEG recording. When clinically warranted, only qualified healthcare professionals, in keeping with hospital and professional standards of practice, should undertake sedation administration and patient monitoring.
E) INFECTION CONTROL:

1.0 INFECTION CONTROL:

1.1 Disk electrodes as applied for routine EEG procedure are classified as semi critical (due to skin abrasion) requiring high level disinfection. (Scott NK. 2013)

1.2 As a minimum, universal precautions must be observed. Appropriate cleaning, disinfection or sterilization of electrodes and accessories is mandatory between patients and must follow their specific MSDS specifications, in accordance with Health Canada, OSET, respective institutional and laboratory standards for infection control.

1.3 In the event of suspected or confirmed communicable disease, additional precautions must be undertaken according to the facility/institution’s infection control standards. Such illnesses include but are not restricted to: Creutzfeld-Jacob Disease (CJD); Gerstmann-Straussler-Scheinker Syndrome (GSS); Acquired Immunodeficiency Syndrome (AIDS); Human Immunodeficiency Virus (HIV); Methicillin-resistant Staphylococcus Aureus (MRSA); and Vancomycin-resistant Enterococcus (VRE).

1.4 In the presence of head lice, a non-urgent EEG should not be performed. The procedure should be rescheduled after the patient has received successful treatment. When testing is unavoidable, appropriate disinfection/cleaning of the electrodes, equipment and recording environment is required. Disposable electrodes are preferred in such cases.

F) SAFETY:

1.0 WORKPLACE HEALTH AND SAFETY:

1.1 The technologist should ensure electrical safety of equipment and patients, especially in patients with indwelling catheters or pacemakers. Routine maintenance, electrical safety checks and appropriate grounding (instrument and patient) are essential.

1.2 The technologist should know and comply with Workplace Hazardous Materials Information System (WHMIS) standards in the handling, storage and disposal of hazardous workplace materials.

1.3 The technologist should apply Occupational Health and Safety principles to work environment practices to ensure a hazard-free recording environment.

1.4 The technologist should follow appropriate reporting procedures of incidents, injuries, and potential safety concerns.

1.5 The technologist should know and comply with institutional policies for response to emergency incidents/codes.
2.0 PATIENT-CENTERED CARE:

2.1 First do no harm, and maintain patient privacy as per HIPPA Standards.

2.2 It is recommended that technologists be certified in cardiopulmonary resuscitation and recertified every two years (Canadian Heart and Stroke Foundation 2015).

2.3 The technologist should demonstrate care when working around intravenous lines as well as monitoring and life support devices and provide a safe environment by:
   • Using equipment locking mechanisms
   • Removing or securing physical obstacles
   • Removing known contact irritants and allergens
   • Transferring patients safely
   • Ensuring continuous patient supervision

G) EEG REPORTING AND INFORMATION STORAGE:

1.0 ANALYSING AND REPORTING:

1.1 The EEG technologist should use standard medical terminology when documenting relevant information on the recording and when preparing a written technical impression for the interpreting physician. This preliminary report should reflect the following:
   • Medication effects on the EEG
   • Waveform localization
   • Clinical conditions
   • Physiological and non-physiological artefacts
1.2 If the technologist recognizes significant EEG findings (critical test results) that require urgent or immediate attention they should alert the appropriate staff/physician. These findings may include:

- Status epilepticus
- Electrographic or clinical seizures
- Electrocerebral silence
- Significant epileptiform activity
- Unexpected, significant, focal findings
- ECG changes

2.0 INFORMATION STORAGE:

2.1 Retention, storage, and disposal of the legal typed reports and actual recordings must be maintained as per local facility, health region, or provincial policies and mandatory regulations while ensuring patient confidentiality. (Task Force of the Canadian Society of Clinical Neurophysiologists, 2002)

2.2 All records should meet the guidelines for medical records as stated in the Public Hospital’s Act for each province. (Task Force of the Canadian Society of Clinical Neurophysiologists, 2002).
APPENDIX B

INTERNATIONAL 10 - 20 SYSTEM

10-20 System References.


References:

Material Safety Data Sheet [MSDS] #C5071, effective date 07/01/09, Mallinckrodt Chemicals)
Craciun L, et al Seizure 2015
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https://www.resuscitation.heartandstroke.ca/courses


OSET: Recommendations for Minimum Standards for the Education and Training of Electrophysiological Practitioners; 2006


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