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The Canadian Association of Electroneurophysiology Technologists, Inc
L'Association Canadienne des Technologues en Electroneurophysiologie, Inc

**STANDARD ONE:
MINIMUM TECHNICAL STANDARDS
CLINICAL ELECTROENCEPHALOGRAPHY:
ROUTINE ADULT**

INTRODUCTION

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

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A) EQUIPMENT:

1.0 RECORDING INSTRUMENT

1.1 The EEG equipment should adhere to the following parameters:

- Screen resolution of at least 4-pixels per vertical millimeter and at least 1024 x 1280 pixels requiring no less than a 17 inch monitor
- Sampling rate of at least 200 samples per second per channel, 12 bits or greater depending on the highest frequency to be sampled
- 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 occupying 25-30 mm and containing at least 120 data points per channel; 0.5, 2 and 4 times should be feasible.
- Vertical display of a minimum spacing of 10 mm between channels
- Filter of wide band-pass, 0.1 to 100 Hz

1.2 EEG recording must utilize digital systems. Playback systems should show:

- Montage
- Filter settings
- Vertical voltage scale
- Horizontal time scale
- Technologist's comments
- Event markings
- Page number or time.

The playback unit should allow for post-hoc selection of montages, filters and sensitivity.

1.3 Amplification and channel acquisition must be available for a minimum of 24 and preferably 32 channels to permit 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)
- 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 annually by biomedical personnel or 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 made of metals 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.
- 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 testing has been completed. The technologists who employ needle electrodes require training in their use, disposal, and advantages/disadvantages.
- 2.3 It is highly recommended that electrode caps with pre-determined electrode positions not be used. If no other options exist, for example in exceptional circumstances when patient cooperation is such that use of an electrode cap is the only way to obtain an EEG, then such a system may be used. When using an electrode cap the technologist must clearly document this on the recording.
- 2.4 All scalp electrodes applied to a given patient must be of the same metal, type and size to eliminate potential differences in recording properties between electrodes.

B) TEST PREPARATION:

1.0 DOCUMENTATION/PATIENT PREPARATION

1.1 All EEG requisitions must contain the following information:

- Date and time of the recording
- Patient's name
- Home address and 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 inpatients 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 data:

- Patient's full 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 changes, if required
- Additional, relevant information (including limitations as they pertain to testing)
- Name of the recording technologist

1.3 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 explained prior to initiating the procedure.

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 scalp electrodes, the technologist should also apply electrooculography (EOG) and electrocardiography (ECG) monitoring leads. Extra leads can be added for artefact monitoring or for further localization, when clinically indicated.
- 2.3 To permit digital reformatting, an additional electrode not already in the 10-20 system, or used in any of the programmed reformatted montages, must be placed as a system reference electrode. The actual location of the system reference must be clearly annotated on the recording.
- 2.4 The application of a ground electrode is required. The technologist must ensure that there will be only one true ground electrode on the patient during the recording procedure.
- 2.5 To reduce skin impedance, the use of Health Canada approved abrasive gels is recommended to obtain optimal impedances. Care must be taken to not over-abrade the skin, causing skin breakdown.
- 2.6 The use of blunt tip needles to lower impedance is strongly discouraged. However, if clinically warranted, the tip must be properly disposed of in a sharps container after use.
- 2.7 The use of an ether-based product such as Collodion is not recommended for electrode application in the routine setting. When used, proper ventilation is required and must meet established standards for safety as per the Material Safety Data Sheet (MSDS).
- 2.8 Residue from gel/paste and marker should be removed from the patient's scalp and hair following the EEG

3.0 IMPEDANCE

- 3.1 Impedances should be checked at the beginning and end of the EEG recording. They should be balanced and measure 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.
- 3.3. In patients being recorded for prolonged periods (eg. those in the Epilepsy Monitoring Units, cEEG, and those with skin integrity issues) an upper limit of 10000 ohms is acceptable. When impedances higher than 5000 ohms are unavoidable, balanced impedances are essential.

C) RECORDING PROCEDURE:

Adjust the recording settings (montages, filters, sensitivity, and time base) during as well as afterwards (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 Bipolar and referential derivations are recommended
- 1.2 Additional or special montages are encouraged to enhance localization and signal appreciation.
- 1.3 A minimum of 24 and preferably 32 channels is recommended to improve localization and 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 an alternate reference should be chosen if contamination occurs. All parameter changes and attempts to troubleshoot should be clearly documented on the EEG.
- 1.8 Appropriate montage selection and duration of individual montages is at the discretion of the recording technologist to best display the waveforms seen.

2.0 ANNOTATION

- 2.1 Careful observation of the patient and frequent annotations are required for accurate interpretation. Digital video does not replace the need for appropriate annotation by the technologist.
- 2.2 At the beginning of each montage the following should be either digitally available or annotated:
 - Sensitivity
 - Filter settings
 - Eyelid position
 - Head position
 - Patient's state.
- 2.3 Proper assessment of EEG recording requires periods with eyes open and closed whether spontaneous, on command or passively . These periods must be clearly annotated.
- 2.4 Technical, clinical, behavioral and artefactual changes are indicated on the recording at the time of their occurrence.
- 2.5 The following should be documented on the recording at the time of 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
 - Any additional information which could assist the Electroencephalographer during interpretation of the study
- 2.6 The use of abbreviations is discouraged. 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 must be included with the recording.

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 viewed clearly.

4.0 FILTER SETTINGS

- 4.1 Routine EEG filter settings should be from 1.0 to 70 hertz or higher. Adjust the filters as needed to enhance visualization of the waveforms, especially when reviewing a study.
- 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 routine recordings. 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 Routine EEG should consist of at least 20-minutes of recording in addition to the time needed to perform activation procedures. Any EEG performed for less than this specified time should have an explanation for early termination of the test .
- 6.2 Spontaneous sleep should be encouraged and captured when possible.
- 6.3 If the patient becomes drowsy or falls asleep after the 20 minutes of baseline recording, the recording should be continued to obtain an adequate sample of sleep.
- 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) 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 of appropriate tasks.

8.0 EXTRA-CEREBRAL MONITORING

- 8.1 One channel of electrocardiogram (ECG) should be 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.
- 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 gauge, as examples).

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) regulations.

10.0 ELECTRICAL CEREBRAL SILENCE RECORDINGS

10.1 Such recordings must be performed by a Registered EEG 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, the reasons for such must 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, but are not limited to:

- 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 requested by referring physician and approved by the Electroencephalographer
- Clinical judgment should be used for patients over the age of 65.
- Recent brain surgery, CVA or intracranial 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.

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.

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 laboratory policy.

2.2 Clinical Considerations:

2.2.1. IPS should be done in all routine studies unless contraindicated.

Contraindications include, but are not limited to:

- Status epilepticus
- Pregnancy, unless requested by the referring physician and approved by the Electroencephalographer.
- Recent eye surgery
- Recent administration of a pupillodilatory agent

2.3 The recommended technical process for IPS should include the following:

- The patient may be seated or supine and preferably alert.
- The lamp distance from the nasion must be 30 cm.
- The ambient light should be dim. Lighting should be standardized within the lab for consistency.

- IPS must not take place immediately following two minutes of hyperventilation in order to avoid late effects of over-breathing.
- Flashes should occur in trains of 10 seconds (per frequency) with an interval of at least 7 seconds between frequencies.
- Frequency protocols are specific to individual laboratories
- 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.
- Photic stimulation should be stopped immediately if any generalized epileptiform activity occurs. Additional attempts at that specific frequency, along with frequencies just before and just after the frequency in question (a process called "bracketing") may be required to confirm photosensitivity.
- If IPS is discontinued prematurely or omitted, reasons for such 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 are beneficial for increasing the 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.
- 3.4 If the patient is stuporous or comatose, noxious stimuli such as verbal, touch and 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 must 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 Patients referred for a sleep deprivation test should be awake for portions of, or all of the night, prior to testing as per laboratory protocol. Partial or full sleep deprived protocols are specific to individual laboratories.
- 4.3 At least 30 minutes of 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 or electrode caps for EEG recording are classified as semi critical (due to skin abrasion) requiring high level disinfection as per hospital/institutional protocol.
- 1.2 Universal precautions must be observed. Appropriate cleaning, disinfection or sterilization of electrodes and accessories is mandatory between patients and must follow specific MSDS specifications, in accordance with Health Canada, OSET, and specific 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.
- 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 as per institutional policies and procedures.
- 1.5 The technologist should know and comply with institutional policies for response to emergency incidents/codes.

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
 - Documentation of normal and abnormal patterns (i.e. posterior dominant rhythm, sleep potentials, epileptiform activity, dysrhythmias, etc.)
 - 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.

2.2 All records should meet the guidelines for medical records as stated in the Public Hospital's Act for each province.

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