



AANEM POSITION STATEMENT: OVERVIEW OF ELECTRODIAGNOSTIC MEDICINE

Electrodiagnostic (EDX) medicine is the medical subspecialty that applies neurophysiologic techniques to diagnose, evaluate, and treat patients with impairments of the nervous, neuromuscular, and/or muscular systems. The term EMG often has been used to mean the entire spectrum of EDX tools used to evaluate nerve and muscle diseases. Strictly speaking, however, EMG refers only to the needle or surface electrode examination of the bioelectric activity of muscles.

When a patient presents with a neuromuscular problem, the evaluation includes a focused review of the symptoms, a physical examination, and an electrophysiologic evaluation of selected functions of the central nervous system, nerve roots, peripheral nerves, neuromuscular junctions, and muscles. When an accurate diagnosis is made, the referring physician is able to develop the best treatment plan possible.

Collection of the electrophysiologic data is achieved by a variety of procedures, including motor and sensory nerve conduction latency and velocity studies, invasive needle or surface electrode electromyography (EMG), repetitive stimulation studies, reflex latency measurements, and measurements utilizing electronic averaging of evoked potentials, twitch tension measurements, exercise tests, and evaluation of autonomic nervous system functions. Many of these tests also are carried out for the purpose of monitoring nerve and muscle function during surgical procedures or for therapeutic treatments.²⁵

THE ELECTRODIAGNOSTIC MEDICINE EVALUATION

There are broad, general principles that hold for any aspect of the practice of medicine by physicians. The critical determinants in defining the practice of medicine are: (a) to make a medical diagnosis and (b) to treat the patient. The physician, however, must take a number of steps along the

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Key Words: EMG • qualifications • equipment • reports • laboratory organization

way to achieve these two ends. These steps, which depend upon the physician's knowledge, skill, and experience, specifically include: (1) *definition* of the clinical problem, (2) *selection* of data to be collected, (3) *collection* of data, (4) *interpretation* of the data collected and its integration into a final medical diagnosis, and (5) *implementation* or recommendation of a course of action. The EDX evaluation, as described below, is clearly the practice of medicine as defined by these general principles.

EDX medicine is an extension of the neurologic portion of the physical examination and requires detailed knowledge of the patient and neuromuscular diseases and musculoskeletal disorders. The range of specific tests available to the EDX physician is extensive, and only a few selected tests are used to collect data on any given patient. Unlike many laboratory tests, the EDX evaluation is not performed in the same fashion every time but must be specifically designed for each individual patient. Even patients with similar presenting complaints may require different approaches. Throughout the course of the study, the EDX physician must, therefore, continuously monitor and interpret the data of each specific test, in the context of both the data previously collected and the patient's clinical problem. It is often necessary to modify or add to the procedure during the examination, depending on the findings. The evaluation requires progressive problem solving by the physician throughout the course of the study, in addition to the analysis and conclusions reached at the completion of the study. Only in this way can the appropriate data be collected and the proper conclusions be drawn.

Developed by the American Association of Electrodiagnostic Medicine (AAEM) Professional Practice Committee (1991-1998): Chairs: Neil A. Busis, MD; Lois M. Nora, MD, JD; Members: John A. Aalbers, MD; Albert A. Ackil, MD; Paul E. Barkhaus, MD; Alan R. Berger, MD; Samuel M. Bierner, MD; H. Steven Block, MD; Arlene M. Braker, MD; James L. Cosgrove, MD; Timothy R. Dillingham, MD, MS; Peter D. Donofrio, MD; Morris A. Fisher, MD;

Based on his or her training, knowledge, and experience, the EDX physician interprets the electrophysiologic data and integrates it with other clinical data to make a diagnosis preliminary to development of the best treatment plan. Improper performance or interpretation of the EDX tests may be dangerous to the patient and misleading to the referring physician. For example, the exact site and type of surgical operation performed on a patient may be determined in part by disease findings discovered during the course of an EDX evaluation. Therefore, the physician's knowledge of diseases and their manifestations is necessary to interpret such results properly.

Needle electrode insertion requires a detailed knowledge of anatomy and carries a small but finite risk of injury to anatomic structures (e.g., nerves, arteries) that can reliably be identified by a physician. Appropriate precautions also must be taken to avoid transmitting possibly lethal diseases, such as hepatitis, Jakob-Creutzfeldt disease, or acquired immune deficiency syndrome. Furthermore, some patients have additional risk factors that require testing by a physician knowledgeable in the recognition and management of those problems. Such patients include those who require examination near major blood vessels or the abdomen or lung; are on anticoagulants; or have pacemakers, implanted cardioverters or defibrillators, bleeding disorders, indwelling central venous or arterial lines; or have undergone recent cardiac surgery for valve replacement.

The EDX physician should be a physician who has had special training in the diagnosis and treatment of neurologic and neuromuscular diseases and in the application of particular neurophysiologic techniques to the study of these disorders. The knowledge and expertise gained from such specialized medical training maximizes the physician's ability to consider appropriate differential medical diagnoses, dependent upon the initial definition of the particular patient's clinical problem using preliminary data collected from the patient's history and physical examination, in planning the course of the EDX examination. This knowledge and expertise also enables the physician to assist colleagues in particularly complex diagnostic situations.

QUALIFICATIONS

Electrodiagnostic Medicine Physician

As outlined above, an EDX physician is a physician who has special training in the diagnosis and treatment of neurological and neuromuscular diseases and is also an expert in the application of particular neurophysiologic techniques used to study these disorders. AANEM recommends that EDX physicians have at least 6 months full-time or equivalent supervised training during a neurology or physical medicine and rehabilitation residency accredited by the Accreditation Council for Graduate Medical Education (ACGME)¹,

American Osteopathic Association (AOA) or the Royal College of Physicians and Surgeons of Canada (RCPSC),²¹ and complete 200 studies of both adults and children and of differing complexity levels (straightforward, moderate, and high complexity). To sit for the American Board of Electrodiagnostic Medicine (ABEM), physicians must also have at least 1 year of experience following training (see www.abemexam.org). For a detailed explanation of training requirements and physician's qualifications, please refer to AANEM's position statements, *Educational Guidelines for Electrodiagnostic Training Programs*,²⁷ and *Who Is Qualified to Practice Electrodiagnostic Medicine?*²⁶

Electrodiagnostic Medicine Laboratory Directors

To help ensure standardization of procedures and normal values, diagnostic needle EMG and nerve conduction studies (NCSS) should typically be performed, in a single EDX laboratory. Although a number of EDX physicians as well as paramedical personnel may work at such a laboratory, it should be under the direction of an actively practicing EDX physician.

For an EDX laboratory director, the minimal qualifications are the educational and training experience outlined above for an EDX physician. Ideally, the director should have training and experience beyond the minimal qualifications in the evaluation of the full spectrum of neuromuscular diseases. Certification by the American Board of Electrodiagnostic Medicine (ABEM) also is strongly recommended.

LABORATORY ORGANIZATION

The laboratory director should have direct control over the selection of all laboratory personnel, including other medical staff and technologists, and control over the selection of equipment, normal values, and procedures offered as clinical services. AANEM has developed a laboratory accreditation program. The Electrodiagnostic Laboratory Accreditation Program is a voluntary, peer review process that identifies and acknowledges EDX laboratories for achieving and maintaining the highest level of quality, performance, and integrity based on professional standards. Accreditation provides laboratories specializing in EDX medicine with a structured mechanism to assess, evaluate, and improve the quality of care provided to their patients. More information can be found at www.aanem.org/accreditation.

Medical Personnel

EDX laboratory medical personnel might include the laboratory director, other EDX physicians, physician trainees (residents and fellows), and allied health support such as technologists.

Technologists

Many clinical neurophysiology laboratories utilize technologists to improve operational efficiency. A technologist must always work under the supervision and direction of a fully trained EDX physician as outlined in the *Who is Qualified to Practice Electrodiagnostic Medicine?* position statement.²⁶ The EDX physician should be responsible for the planning and interpretation of EDX studies, but a technologist may perform a variety of functions and tests (excluding needle EMG) in the laboratory depending on the technologist's level of training and experience. To ensure an appropriate level of training, it is recommended that technologists obtain certification, such as CNCT (Certified Nerve Conduction Technologist) granted by ABEM or R.NCS.T. granted by American Association of Electrodiagnostic Technologists (AAET). For more detailed information on technologists' roles and training, refer to *Responsibilities for an Electrodiagnostic Technologist*³⁰ and *Job Descriptions for Electrodiagnostic Technologists*.³¹

A technologist should be able to establish good rapport with patients and staff and be able to deal with severely ill patients. He or she should be able to instruct the patient in the tests to be conducted, prepare the patient, apply surface electrodes, make accurate measurements, keep the equipment in good condition, and file and retrieve reports.

With appropriate training, the technologist may perform a variety of NCSs, reflex studies, repetitive stimulation tests, and evoked potential tests. The test results must be recorded adequately for review by the EDX physician. The EDX physician must be immediately available and present in the office suite to review any problems that develop during the NCSs. The physician need not be physically present in the room when the NCSs are performed. The EDX physician should be alerted immediately during the testing if any results appear to be unusual or unexpected, so there is opportunity to reassess the differential diagnosis and develop alternative testing strategies.

The patient should remain in the examination room until the supervising EDX physician has reviewed the NCS results and determined whether more studies are needed. It is recommended, that the patient's NCSs and needle EMG examination be performed on the same day by the same EDX physician, to ensure continuity of care and consistency in reporting.

Senior technologists may have responsibility for laboratory work assignments, in-service training, and instruction of junior personnel. Their knowledge and skills should be demonstrated through oral, written, and practical examinations. Such examinations are provided by the American Board of Electrodiagnostic Medicine, and AAET.

Performing the Electrodiagnostic Medicine Evaluation

The EDX physician must be involved in the pretest evaluation of the patient and in planning the studies. The physician should perform only those tests that are medically indicated. While it is permissible for a technologist or a physician trainee to assist an EDX physician by performing NCSs, the physician has the ultimate responsibility for these tests.

All needle EMG examinations should be performed by a qualified EDX physician as described in *Who is Qualified to Practice Electrodiagnostic Medicine?*²⁶ In the case of residents or fellows, needle EMG studies should be performed under the direction of a qualified EDX physician. Under no circumstances should a technologist, regardless of qualifications or experience, perform needle EMG examinations. This position is endorsed by the American Medical Association,⁵ the American Academy of Neurology,² the American Neurological Association, the American Academy of Physical Medicine and Rehabilitation,³ and the Department of Veterans Affairs (Veterans Administration),²⁴ as well as many state medical examining boards. There has also been court decisions upholding this principle.⁷

Somatosensory evoked potential (SEP) testing requires direct supervision by, but not the constant physical presence of, an EDX physician trained in its use. The EDX physician supervising the SEP study should be immediately available to see the patient, review the SEP results, or review the set-up of the electrodes. When SEP testing is performed during surgery, the EDX physician must be immediately available during those critical portions of the surgical procedure that require immediate interpretation of results. The patient should remain in the examination room until the supervising EDX physician has reviewed the SEP results. This will help to minimize the number of cases in which further SEPs need to be performed based on the results of the initial SEP examination.

At the conclusion of the study, the report should be prepared by the EDX physician or by a resident or fellow under the direction of the EDX physician

PATIENT COMFORT AND PREPARATION

Electrodiagnostic testing can cause the patient pain and anxiety.^{6,11,14,15,17,21} Interpretation of NCS results can be complicated by patient movement artifact. Interpretation of needle EMG can be compromised if the patient is unwilling to properly recruit motor units in the muscle being examined. In extreme cases, the EDX evaluation should be terminated prematurely.

Patients with high levels of pretest pain and anxiety¹⁵ and with ineffective coping strategies⁶ report the most pain during a needle EMG. The EDX physician should be able to recognize those patients most at risk to have extreme pain or anxiety during the test since physicians' and patients' ratings of patient pain and anxiety are concordant.^{11,15} In order to assist patients with anxiety issues, EDX physicians may use analgesics, anxiolytics, or oral benzodiazepines.¹⁷ Chaperones in the testing room may also be indicated in certain circumstances.

Most EDX evaluations can be performed without sedation. If studies are performed under moderate or deep sedation, the AANEM recommends the EDX evaluation be performed in a hospital/surgery center or outpatient setting where appropriate equipment and support personnel are immediately available to handle emergency situations arising from sedation. Use of drugs to assist patients with anxiety issues are not considered moderate or deep sedation (e.g., anxiolytics, or oral benzodiazepines). The AANEM recommends EDX physicians using sedation follow the guidelines that have been established at their hospital or outpatient clinic or those established by the American Society of Anesthesiologists (Practice Guidelines for Sedation and Analgesia by Non-Anesthesiologists). For pediatric patients, physicians should follow the American Academy of Pediatrics *Guidelines For Monitoring and Management of Pediatric Patients During and After Sedation for Diagnostic and Therapeutic Procedures*⁴ which contains detailed recommendations on this topic. In addition to the above, United States EDX laboratories must comply with the provisions of the Americans With Disabilities Act.

QUALITY ASSURANCE PROGRAMS

The goal of a quality assurance program is to improve patient care and satisfaction using ongoing monitoring and evaluation strategies. It is the responsibility of physicians to establish processes by which they can achieve this goal.

A quality assurance program should include effective mechanisms for reviewing and evaluating patient care. Patient satisfaction questionnaires are an excellent method to assess this vital aspect of an EDX practice. The program should also provide for effective responses to increase patient satisfaction, based on the results of patients' questionnaires.

Specific examples of some of the aspects of EDX medicine that could be monitored and evaluated, as well as guidelines for some of the aspects of quality assurance can be found on the AANEM website at <http://www.aanem.org/Practice.aspx>. AANEM has also developed Performance in Practice modules to assist physicians to work on quality improvement initiatives.

REPORTS AND RECORDS

Reports

Following the examination, a written report should promptly be prepared. The report should include the following main components:

1. Description of Patient Data and the Clinical Problem Section
 - A. Patient demographic information
 - B. The reasons for referral, brief relevant symptom history, and physical examination findings.
2. Nerve Conduction Studies Section
 - A. List of the nerves studied
 - B. Numerical values for the results of each NCS
 - C. Reference laboratory values or statement of abnormal findings
 - D. Limb temperature
3. Needle Electromyography Section
 - A. Description of the insertional, spontaneous, and voluntary activity for each muscle tested as normal or abnormal.
 - B. Listing of the specific abnormalities
 - C. Information on type of needle electrode used (monopolar or concentric)
4. Summary of Abnormalities Section
5. Diagnostic Interpretation Section
 - A. Statement of the normality or abnormality of the study
 - B. Probable electrophysiological diagnosis
 - C. Description of any limitations on the interpretation of results
 - D. Description of any interval changes and the nature of the change in the NCS and needle EMG compared to previous study (if applicable)
 - E. Optionally, a differential diagnosis and recommendation for future testing may be included.

The statement of the problem should include at least a brief description of symptoms and clinical signs, as well as the clinical diagnosis and problem that was elucidated by the study.

The report of the findings should contain a description of the NCSs and evoked potential tests conducted, including the limb temperature, sites of stimulation and recording, amplitudes of responses, configuration, latencies, and distances or velocities. The AANEM recommends that this data be provided in a tabular format. For late responses, limb length or body height should be measured. For repetitive

stimulation tests, measurements should be those described in standard texts.^{10,16,18} The method of measuring, for example, peak-to-peak or baseline-to-negative peak, should be mentioned. Technical problems, such as local swelling or deformity, should be recorded. In reporting needle EMG studies, the type of needle electrode should be specified, and the data should be quantified according to currently accepted standards.⁸ Insertional activity, spontaneous activity, and parameters of motor unit action potentials (MUAPs), such as, amplitudes, durations, form, and recruitment pattern, should be recorded and quantified when indicated. For single fiber EMG (SFEMG), accepted methods of description should be used.^{20,22} This should enable another EDX physician to interpret the tests or make a comparison with prior and subsequent tests. Hard copy of actual waveforms generated during the electrodiagnostic testing need not be included in the report.

The statement regarding the normality or abnormality of the findings should be directed to the referring physician and be as succinct as possible. It should include a statement regarding the degree and significance of the abnormalities. Providers should include reference laboratory values for NCS data in their reports to permit independent review of NCS data by an outside reviewer or provide literature references or other sources for the normal values. If the report does not contain reference laboratory values, abnormal results should be clearly identified. This is particularly important in NCSs of children.

The diagnostic conclusion should attempt to explain how the findings of the EDX studies fit, or do not fit, the clinical picture. In many instances, the EDX evaluation can be diagnostic of a definite anatomic or physiologic abnormality but not of a definite clinical disease. In such cases, a differential diagnosis should be offered. When the referring diagnosis is at odds with the EDX evaluation findings, possible reasons for the discrepancy should be mentioned, including clinical findings elicited by the EDX physician. More detailed information is available in the AANEM practice topic, *Reporting the Results of Needle EMG and Nerve Conduction Studies: An Educational Report*,²⁸ at <http://aanem.org/Practice/Position-Statements.aspx>. Also available on the AANEM website is a sample report and a report checklist.

Records

Records should be kept and filed in an easily retrievable manner, whether this is a paper or electronic medical record. These records should be kept secure in a manner compliant with the Health Insurance Portability and Accountability Act (HIPAA).

Referring physicians have the right, and may delegate the right, to examine any records of EDX consultations pertaining to

their own patients. In addition, patients' written requests that reports be sent to appropriate outside physicians and other parties, including attorneys and insurance companies, should be promptly honored if the request is in accordance with state law.

EQUIPMENT

In general, the equipment used for EDX testing (typically called EMG systems) must fulfill two requirements. It must be: (1) accurate in making required measurements and (2) safe.¹² The electric activity recorded in a standard EDX evaluation varies widely in several important characteristics, and the EMG system must be capable of accurately reproducing this activity in all circumstances.

The EDX evaluation typically consists of measurements of motor and sensory nerve conduction and recording of spontaneous and voluntary activity from muscles. Specialized techniques in common use include signal averaging of evoked responses generated from central structures to peripheral stimulation and SFEMG. Each technique requires different stimulating and recording characteristics.

The EMG system must be capable of recording and accurately reproducing electric signals that range from submicrovolt levels to greater than 10 mV. Gain settings should be available to make recordings over this 10,000-fold range. The frequency spectrum of bioelectric signals may vary over a range from 2 Hz to 20 kHz, and specific applications may emphasize particular frequency bands. The instrument should have either adjustable low- and high-frequency cutoffs or filter settings that are appropriate for the types of electric activities studied. An important component of any EMG system is a volume-controlled loudspeaker for auditory monitoring of bioelectric activity.

Since the measurement of the time of occurrence of specific electric events is crucial for accurate bioelectric signal recording, the machine should be equipped with an accurate time-base generator and controls for a range of sweep durations from less than 10 ms to 1 second. A number of different options are available for display of the electric signals which allow for accurate measurements of time. Among these are the following: a moveable time index, electronic storage for displays from digital memory, and permanent recording on heat-sensitive paper.

An electric nerve stimulator should be an integral component of the EMG system. The stimulator should have the capability of delivering either single or repetitive stimuli. Each EDX physician must select the instrument that provides the most appropriate pattern of repetitive stimulation for a given laboratory. Stimulators are available that deliver either

constant current or constant voltage stimuli; there is no consensus among EDX physicians as to the preferred type. The stimulator, however, should be capable of delivering a stimulus of variable intensity and duration and should have separate controls for each.

On May 9, 1997, the Food and Drug Administration (FDA) issued a Final Rule which established a performance standard for the use of electrode lead wires and patient cables.⁹ This performance standard applies directly to the electrode lead wires and patient connection cables rather than to the medical equipment to which they are attached. As part of this rule, the FDA adopted applicable portions of the international performance standard of the International Electrotechnical Commission¹³ which prohibits electrode lead wires and patient cables from having the capacity to make conductive contact with hazardous voltages.

All new equipment sold today incorporates the new standard. For existing equipment which does not use safety connectors, physicians should obtain, from the manufacturer, protected connector input cables and plug-in units (i.e., a new preamplifier) to replace the noncon-forming older ones. With regard to older equipment, the FDA allows approved adapters to be used with existing equipment. Several companies in the field of EDX medicine have adapters available.

Compliance with this standard requires that traditional 2 mm male pin connectors on all electrodes used on a patient be changed to the female 1.5 mm safety connector. The corresponding traditional rectangular female power connectors, which are plugged into “head boxes” and are used on virtually all electronic equipment that has a removable power cord, will have to be changed to male connectors.

Electrode lead wires and patient cables not meeting the performance standard on or following the effective dates are “adulterated.” Using a device that fails to comply with the performance standard is prohibited and the FDA will use its enforcement powers to deter noncompliance. A person who violates the act may be subject to injunction. The person responsible for the violation may also be subject to civil penalties and criminal prosecution.

Any electric equipment used in the examination of human subjects should fulfill minimum electric specifications. Underwriters Laboratories has set standards for the amount of allowable leakage current for medical and dental equipment.²³

Any equipment used in an EDX laboratory should conform to these standards and be regularly checked to maintain electric safety. The EDX physician is responsible for ensuring that electrodiagnostic equipment is not used in an electrically hazardous manner. Ungrounded devices should not be used in a patient area, and liquid spillage near any instrument should be promptly removed to avoid high-leakage current flow.

DISCLAIMER

This report is provided as an educational service of the AANEM. It is based on an assessment of the current scientific and clinical information. It is not intended to include all possible methods of care of a particular clinical problem, or all legitimate criteria for choosing to use a specific procedure. Neither is it intended to exclude any reasonable alternative methodologies. The AANEM recognizes that specific patient care decisions are the prerogative of the patient and his/her physician and are based on all of the circumstances involved.

Approved by the Board: May 1999.

Reviewed by members of the 2012 Professional Practice Committee (PPC) Andrea J. Boon, MD and Lisa D. Hobson-Webb, MD

Revised and reapproved by the Board: June 2013

REFERENCES

1. Accreditation Council for Graduate Medical Education: Directory of Graduate Medical Education Programs. Chicago, Accreditation Council for Graduate Medical Education, 1993 – 1994.
2. American Academy of Neurology. Minutes of Executive Board Meeting 11.9 (1) December 2, 1981.
3. American Academy of Physical Medicine and Rehabilitation. Statement re: Clinical Diagnosis Electromyography, November 1983.
4. American Academy of Pediatrics, Committee on Drug: Guidelines for Monitoring and Management of Pediatric Patients During and After Sedation for Diagnostic and Therapeutic Procedures. *Pediatrics* 1992;89, No.6:1110-1115.
5. American Medical Association. House of Delegates Policy H-275.990. American Medical Association Policy Compendium, 1995 Edition.
6. Buckelew SP, Conway RC, Shetty MS, Lawrence JA, Grafing MR, Anderson SK, Hewett Je, Keefe FJ: Spontaneous coping strategies to manage acute pain and anxiety during electrodiagnostic studie. *Arch Phys Med Rehabil* 1992; 73:594-598.
7. *Selective Insurance Co. v. Rothman* 414 N.J. Super. 331 (App. Div 2010); affirmed by Supreme Court of New Jersey – January 18, 2012; *Caniglia v. New Jersey State Board of Medical Examiners* No. A-3435-74 (Superior Court of New Jersey, Appellate Division, June 17, 1976)
8. Daube JR: The description of motor unit potentials in electromyography. *Neurology* 1978; 28: 623-625
9. Department of Health and Human Services. FDA Final Rule: Medical Devices: Establishment of a performance standard for electrode lead wires and patient cables. *Federal Register*, No. 90, May 9, 1997, pp. 25477-25498.
10. Desmedt JE: Identification and titration of myasthenic defect by nerve stimulation. *Electroencephalogr Clin Neurophysiol* 1962; 22(suppl): 63-64.
11. Gans BH, Kraft GH: Pain perception in clinical electromyography. *Arch Phys Med Rehabil* 1977; 58:13-16.
12. Guld C, Rosenfalek A, Willison R: Technical factors in recording electrical activity of muscle and nerve in man. *Electroencephalogr Clin Neurophysiol* 1970; 28:399-413.
13. International Electrotechnical Commission (IEC) 601-1 (Safety of medical electrical equipment, Part 1: General requirements) subclause 56.3(c) (1995).
14. Kaplan RM, Metzger G, Jablecki C: Brief cognitive and relaxation training increases tolerance for a painful clinical electromyographic examination. *Psychosom Med* 1983; 45:155-162.
15. Khoshbin S, Hallett M, Lunbeck R: Predictors of patients experience of pain in EMG. *Muscle Nerve* 1977; 10:629-632.
16. Kimura J: *Electrodiagnosis in Diseases of Muscle and Nerve*. Philadelphia, F.A. Davis Company, 1983, pp 617-619.
17. LaJoie WJ: Analgesia in electromyography. *Arch Phys Med Rehabil* 1963; 44:42-44.
18. Lambert EH: *Recent Advances in Clinical Electromyography: Third Annual Continuing Education Course*. Rochester, Minnesota, American Association of Electromyography and Electrodiagnosis, 1980, p 60.
19. Royal College of Physicians and Surgeons of Canada: *Accredited Residency Programs*. Ottawa, Ontario, Royal College of Physicians and Surgeons of Canada, 1993.
20. Sanders DB, Howard JE: *AAEM Minimonograph #25: Single-Fiber Electromyography in Myasthenia Gravis*. Rochester, Minnesota, American Association of Electromyography and Electrodiagnosis, 1987.
21. Sherman HB, Walker FO, Donofrio, PD: Sensitivity for detecting fibrillation potentials: a comparison between concentric and monopolar needle electrodes. *Muscle Nerve* 1990;12:1023-1026.
22. Stolberg EV, Trontelj JV: *Single Fibre Electromyography*. Old Woking, Surrey, Mirvalle Press, 1979.
23. Underwriters Laboratories Inc: *Standard For Medical and Dental Equipment, UL 544*, ed 2. Northbrook, Illinois, Underwriters Laboratories Inc, 1976.
24. Veterans' Administration. Professional Services Letter: Professional Qualifications for Performing Electromyographic Examinations IL- 11-80-1, January 4, 1980.
25. Nuwer MR, Emerson RG, et al.: Intraoperative spinal monitoring with somatosensory and transcranial electrical motor evoked potentials. *Neurology* 2012;78:585-589.
26. Association of Neuromuscular & Electrodiagnostic Medicine (AANEM) Position Statement. Who is qualified to practice electrodiagnostic medicine. Approved by the AANEM – 2012. Retrieved August 17, 2012, from <http://aanem.org/Practice/Position-Statements.aspx>