AUSTRALASIAN FACULTY OF REHABILITATION MEDICINE

The Royal Australasian College of Physicians

Musculoskeletal Medicine
Training Module

Workbook 3

Nerve Conduction Studies (NCS) and Electromyography (EMG)
Acknowledgement

The AFRM would like to acknowledge the contribution made by Dr Susan Inglis, FAFRM, in the development of this workbook.

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## ATTACHMENTS

1. Workbook Evaluation Form
Introduction

The purpose of the workbook is to help guide you through a self-directed learning program on musculoskeletal (MSK) rehabilitation, in this case Nerve Conduction Studies (NCS) and Electromyography (EMG).

The learning objectives are designed to make clear what is expected from you. A deep approach to learning will hopefully enable you to transfer your knowledge and skills into the clinical situation and provide expert care for patients with musculoskeletal problems. How well you understand this “topic” will ultimately affect them.

You can choose to work in small groups or on your own. The clinical scenarios will help guide your research as each one covers different topics of the curriculum in MSK. The skills you need to acquire are detailed in the learning objectives.
Learning Objectives

Knowledge

- Define NCS and indications for its use.
- Define EMG and indications for its use.
- Describe normal values for motor and sensory responses.
- Describe the findings for NCS and EMG when there is pathology at these anatomical sites:
  - Anterior horn cell
  - Nerve root
  - Plexus
  - Peripheral nerve
  - Neuromuscular junction
  - Muscle

Skills

- Demonstrate ability to discuss NCS and EMG findings and clinical implications with patients and their families.
- Demonstrate ability to design and run training sessions on NCS and EMG for medical Students, Interns, RMO’s, Registrars, Consultants and General Practitioners using different teaching methods.
- Demonstrate ability to give a verbal or written report of normal/abnormal EMG and NCS (i.e. suitable for medical legal reports).
- Demonstrate ability to perform EMG and NCS including: identifying the nerve, placement of stimulating and recording electrodes for common studies.
Learning Opportunities

- Attend Electrophysiology laboratory
  For you to arrange individually or in small groups. (public or private).

- Consultants and Supervisors
  Ask your Consultant to explain abnormalities. Use protected teaching time for tutorials on this topic.

- Faculty State Branch training sessions

- Arrange invited speakers with clinical examples
  - Interactive teaching session conducted by peers
  - Practice sessions on communication skills with families and peers.
  - Arrange session on medicolegal writing technique
  - Arrange a session on being an “expert witness”

- Peer training sessions
  (For you to arrange i.e. discuss as a small group/ on line)
  Write clinical scenario’s based on actual patients for each other to solve.

- Independent workshops/ courses

- Patients under your care
  - Accompany your own patient for their electrophysiology
  - Practice discussing investigative results with patients and families.

- Neurology Outpatient Clinics

- Discuss with Neurology registrars and Consultants.

- Attend Court with a Rehabilitation Consultant
  You will need to arrange this yourself. Some Fellows working in the private sector attend court frequently; you will need to seek out this opportunity.

- Library resources / texts/ journals
Checklist for Electrophysiology

Electromyography

Identified
- Insertional activity
  - fibrillation potential

Spontaneous activity
- fibrillation potential
  - positive sharp waves
  - myokymic discharges
  - fasciculation potentials
  - complex repetitive discharges

Motor unit
- polyphasic
  - amplitude
  - duration

Recruitment

Nerve Conduction Studies

Distal motor latency

Amplitude
- sensory
  - motor

Conduction Velocity

Temporal dispersion

Wave latencies

Made correct diagnosis based on investigation findings

Able to explain findings to patient
  (In appropriate language)
Evaluation

Always start with **self-evaluation** because ultimately you will be the one evaluating your own independent practice in future years.

**Self**

- Can you interpret NCS and EMG correctly and consistently?
- Do you consistently miss the same point?
- How can you change this?
- Does your patient understand your explanation?

**Peer**

- Practice describing NCS and EMG findings with peers
- Device a checklist for consistency with descriptions

**Consultant**

When you feel ready ask your Consultant to evaluate your skills. Show them your checklist and ask them to use it. Ask for what you did well and what you need to improve on.

*You should attempt this process every few weeks to receive feedback on your performance. (Formative feedback)*

**Supervisor**

This may be the same person as above. Include your MSK learning objectives and be sure your supervisor is aware of your efforts. Repeat evaluations as many times as necessary until you consistently reach the standard required. There is no limit to how many times you try.

*You should attempt this process at least twice per term to receive feedback on your performance. (Formative feedback)*

**Formal Examinations**

This process formally tests your knowledge, skills and attitudes. The checklists will be provided for examiners to use in the assessment process. *(Summative assessment)*
Clinical Scenarios

These scenarios are suggested as they cover the main clinical areas of electrophysiological investigations. They are designed to be starting points for discussion with peers, supervisors, and team members and to encourage further reading around each topic. They have no set or right answers and are based on “real” patients.

To get the most out of these exercises it would be helpful to:

- Practise taking a history
- Practise examination technique
- Spend time viewing and interpreting the investigations
- Consider the underlying pathology and how it gives rise to symptoms
- Practise talking to patients about all of the above
- Examine the current evidence for treatment options
- Learn how to perform NCS and EMG (Strongly recommended as very helpful for private practice).

Working in small groups at Faculty State Branch training sessions or on your own consider the following clinical scenarios:

1. A 65-year-old woman underwent a recent total hip replacement. Since surgery she has noticed a lack of knee control. She is currently unable to walk, even with a rollator as her knee gives way.
   a) What investigation/s would you order and why?
   b) What results would you expect on the tests and why?
   c) Describe how you would discuss the findings and the implications on prognosis with the patient.
   d) What is your management plan?

2. A 24-year-old man was involved in a motorbike accident. He has sustained a fractured femur, multiple abrasions and complains of weakness of his right arm with altered sensation. He is unable to raise his right arm above his head. You are asked to advise on his potential for rehabilitation.
   a) What is the likely cause of the weakness in his right arm and why?
   b) What investigations will you order and why?
   c) What changes would you expect NCS and EMG?
   d) Write a medicolegal report on his likely prognosis using investigative results and current evidence from the literature.
3. A seventeen year old man attends your practice complaining of gradual onset of weakness in his legs over the last eight months. He has difficulty using stairs and says his thighs are sore. He complains of tiredness and is not coping with school. You notice he has a mild rash over his face and hands.

   a) What investigations will you order and why?
   b) What changes would you expect to find on EMG and NCS?
   c) How will you approach discussion of these findings with this patient?
   d) What is your rehabilitation plan?

4. A 45-year-old woman with a two year history of numbness in both hands and pain that wakes her at night. Shaking her hands relieves her symptoms. She has some reduction in dexterity in her right hand and pain in both wrists.

   a) What investigations will you order and why?
   b) What is your rehabilitation plan? (short, medium and long term)
      (Use current evidence from the literature to support your approach)

5. A 70-year-old man had a recent fractured femur. He was immobilised with a cast for eight weeks and had this removed the previous day. He complains that he cannot walk. When you examine him you find he has a foot drop.

   a) What is the likely cause of his footdrop? (Explain the pathophysiology)
   b) What investigations will you request and why?
   c) What changes will you expect to find on NCS and EMG and why?
   d) Describe how you will explain the findings to the patient and the likely effects of rehabilitation. (Use current evidence to support your response).

6. A 60-year-old woman complains of tiredness. She is normally very active and plays tennis. She has been unable to play for the last six months. She has had recent pneumonia and finds she is coughing after drinks and her food gets “stuck” when eating. She also complains of weakness in her legs (left more then right).

   a) What investigations will assist you in the diagnosis and what changes will they demonstrate?
   b) What treatment options will you recommend? (Use current literature to support).
   c) How will you approach discussions on prognosis with this patient?
7. A 23-year-old man presents complaining that he cannot move his right hand. He had been “binge drinking” the night before and fell asleep on the chair. He works as a carpenter and is very concerned, as he cannot use his right hand.

   a) What do you expect to find on his NCS?
   b) What is his diagnosis and how will you discuss this with him?
   c) What are the implications for his work?
Suggested Learning Resources

Recommended Readings


Journals: Clinical Neurophysiology
           Muscle Nerve
           Neurophysiologic clinics
           Archives of Physical medicine and Rehabilitation

Websites:

1. www.aaem.net/default.html
2. www.aapmr.org/cme.htm
   (Case of the month - highly recommended)
Journal Abstracts

1: Clin Neurophysiol 2000 Sep;111(9):1527-30

Syringomyelia presenting as ulnar neuropathy at the elbow.

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OBJECTIVES: Syringomyelia may present with confusing, unilateral patterns of segmental muscle involvement and dissociated sensory loss. The objective of this study was to report a patient with Chiari malformation type 1 (CM1) and syringomyelia who had an unusual presentation suggesting ulnar neuropathy at the elbow. RESULTS: A 24-year-old woman presented with clinical evidence of ulnar neuropathy at the elbow except that there was disproportionate abductor digiti minimi (ADM) atrophy and weakness, equivocal ipsilateral abductor pollicis brevis weakness and hyporeflexia in both arms. Nerve conduction studies revealed marked amplitude reduction of the left ulnar ADM-compound muscle action potential (ADM-CMAP) with a normal first dorsal interosseous-CMAP amplitude, no focal slowing or conduction block, and a normal ulnar sensory response amplitude. Electromyography (EMG) showed multi-segmental, left C7-T1 fibrillations and chronic reinnervation changes. Magnetic resonance imaging (MRI) of the cervical spine demonstrated CM1 and syringomyelia. CONCLUSIONS: Syringomyelia may clinically mimic ulnar neuropathy at the elbow.


Electrodiagnostic studies in amyotrophic lateral sclerosis and other motor neuron disorders.

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The clinical electrodiagnostic medicine (EDX) consultant asked to assess patients with suspected amyotrophic lateral sclerosis (ALS) has a number of responsibilities. Among the most important is to provide a clinical assessment in conjunction with the EDX study. The seriousness of the diagnoses and their enormous personal and economic impact require a high-quality EDX study based on a thorough knowledge of and experience with motor neuron diseases (MNDs) and related disorders. Clinical evaluation will help determine which of the EDX tools available to the EDX consultant should be applied in individual patients. Although electromyography (EMG) and nerve conduction study are the most valuable, each of the following may be helpful in the assessment of selected patients based on their clinical findings: repetitive nerve stimulation, motor unit number estimate, single-fiber EMG,
somatosensory evoked potential, autonomic function test, and polysomnography. The pertinent literature on these is reviewed in this monograph. The selection and application of these EDX tools depend on a thorough knowledge of the MNDs and related disorders.


Epidemiology, physical examination, and neurodiagnostics.

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The overall frequency of troublesome neck pain is estimated to be approximately 34%, and it was observed that the frequency of complaints lasting 1 month or longer was higher in women than in men. The prevalence increased with age with regard to both pain duration and chronic pain. A total of approximately 14% of a randomly selected population meets the criteria for chronic neck pain, with complaints lasting for more than 6 months. It could be that the structural transformation of the intervertebral disc, the uncovertebral processes, and the zygapophyseal joints is a process accompanied by disturbed function, ultimately inducing pain. For diagnosis of radicular and myelopathic syndromes, the physical and neurologic examination is enhanced by neurophysiologic assessment. Electromyography, performed with needle electrodes, is the oldest method to diagnose nerve root compression syndromes and is claimed to have no false positive results. Electromyography for radiculopathy is justified if clinical symptoms, such as muscular weakness, don't correlate with clinical findings (diminished or absent reflex), or for documentation of muscle activity if difficult decompressive surgery is expected. For diagnosis of cervical myelopathy by routine examination, the sensory evoked potentials by stimulation of tibial nerve as well as motor evoked potentials from upper and lower extremities are recommended because clinically "silent" myelopathy can be verified by abnormalities in evoked potentials. During history taking, the symptoms possibly attributed to radiculopathy or myelopathy should be differentiated from primary systemic neurologic disorders such as shoulder angiotrophy ("plexus neuritis"), multiple sclerosis, amyotrophic lateralsclerosis, and peripheral neuropathy. The assessment of range of motion, the functional status of shoulder and neck muscles, and palpatory examination of soft tissue is widely used to determine non-operative therapeutic procedures. However, scientifically, the validity of the different testing procedures has not been evaluated satisfactorily.


Electrodiagnosis of polyneuropathy.

Johnsen B, Fuglsang-Frederiksen A.

Department of Clinical Neurophysiology, University Hospital, Norrebrogade HH, DK 8000, Aarhus, Denmark.
Electrodiagnostic studies comprising electromyography (EMG) and nerve conduction studies (NCS) are well-established objective methods for the diagnosis, quantification and classification of polyneuropathies (PNP). This paper reviews examination techniques, their pathophysiological interpretation, examination strategies and diagnostic criteria for the diagnosis and classification of a PNP. The routine electrodiagnostic evaluation includes sensory NCSs performed with surface or needle electrodes, motor NCSs. F-wave studies and EMG by qualitative or quantitative techniques. Sensory NCSs and F-wave studies have a high sensitivity in PNPs and the different techniques complement each other. The distinction between a PNP with predominantly axonal loss and a PNP with predominantly demyelination is one of the major aims of the electrophysiological examination. There are, however, large variation in suggested criteria for predominantly demyelination. The degree of slowing in conduction taken to indicate demyelination varies between a decrease of 50 to 30% from mean of controls, distal latency prolongation criteria vary from 35% to 70% of mean of controls, F-wave latency prolongation criteria vary from 120% to 150% of upper limit of controls, and criteria for partial motor conduction block vary from 11 to 50% reduction of CMAP amplitude and/or area between proximal and distal stimulation. Needle EMG studies may be valuable in order to detect and quantify denervation activity, to assess chronicity by an evaluation of the extent of reinnervation, and to evaluate the topographical distribution of changes. It is concluded that electrodiagnostic studies are valuable in patients with suspected PNP and the results may have consequences for prognosis and therapy of individual patients. Large variation in examination techniques, strategies, interpretations and diagnostic criteria have been found among electromyographers and it is suggested that the value of electrodiagnostic studies may be further improved by international standardisation.

5: Arch Phys Med Rehabil 1998 Dec;79(12):1510-1

Electrodiagnostic studies: are they useful in clinical practice?

Kothari MJ, Blakeslee MA, Reichwein R., Simmons Z, Logigian EL.

Section of Neurology, Pennsylvania State University, College of Medicine, Hershey, USA.

OBJECTIVE: Electrodiagnostic testing (electromyography [EMG] and nerve conduction studies [NCS]) may result in some patient discomfort. The justification for such testing should be based on the expectation that the results will affect patient management. This study was conducted to determine how frequently the results of EMG/NCS change the clinical management of the patient. METHODS: one investigator (MB) spoke to each referring physician after EMG/NCS to determine if any management decisions were altered by the test. RESULTS: One hundred forty consecutive EMGINCS records were obtained. Follow-up was available on 100 patients. Of 78 patients with abnormal findings on EMG/NCS, 29 (37%) had a diagnosis different from the referring diagnosis. For 43 of the 78 (55%), the physician reported that additional diagnostic testing was undertaken or treatment
plans were altered. CONCLUSION: EMG/NCS are useful, informative, and diagnostic in the management of various neurologic disorders.


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Evaluation of Musculoskeletal Rehabilitation Training Workbook

Nerve Conduction Studies & Electromyography

Please take a few moments to complete this evaluation form. Your thoughtful comments will be reviewed by the Vocational Training Committee and will assist the Committee in the planning and development of future training resources.

1. Was the workbook helpful in your learning of this topic? (i.e. Did it clarify what knowledge attitude and skills you needed to reach competency in this area?)


2) Did you find the clinical scenarios and references helpful?


3) Do you feel your skills have improved as a result of using the workbook? Have you used your improved skills in the clinical setting?


4. If you have not used your new skills, what has prevented you from doing so?
5. What further questions about this topic remain in your mind?


6. Please give any additional comments about other aspects of the workbook, including requests for future workbook topics (or improvement on the existing book).


7. What other support do you feel the Faculty could provide to assist or facilitate your learning in Musculoskeletal Medicine?


Name ______________________ date ___________ signature_________________

Thank you for your assistance.

The Vocational Training Committee

Please return completed evaluation forms to: AFRM, 145 Macquarie Street, Sydney