

UNIVERSITY OF JORDAN  
 FACULTY OF MEDICINE  
 DEPARTMENT OF PHYSIOLOGY & BIOCHEMISTRY  
 INTRODUCTION TO NEUROPHYSIOLOGY  
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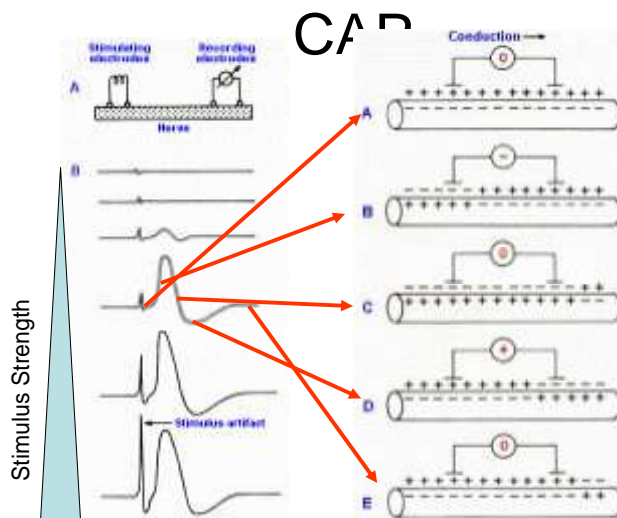
**Textbook of Medical Physiology**  
 by: Guyton & Hall, 12<sup>th</sup> edition 2011

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**Compound AP:**

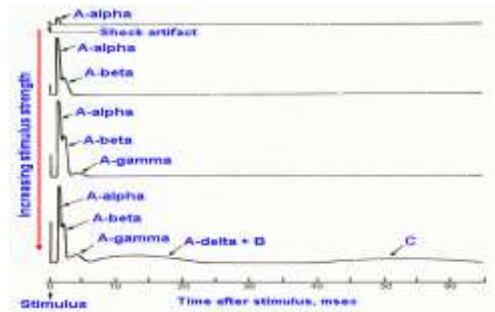
When the strength of the stimulus is very low, we see no response from the nerve. This stimulus strength is **subthreshold**. If the strength is raised, a tiny response appears in the record and, as the strength is increased even more, the response grows to a maximum value; further increases in stimulus strength do not further augment the response. The stimulus strength that just gives a response is termed a **threshold stimulus**; any stimulus of greater strength is **suprathreshold**. The strength that just gives the **maximal response** is a **maximal stimulus**; any strength greater is **supramaximal**. The response of the nerve is called the **compound action potential**. The compound action potential is graded in nature, in striking contrast to the all-or-none response of single axons and this is because the compound AP represents the summation of many AP's that all of them are all or none. Also it has multiple peaks and is recorded from nerve trunk (Median nerve, ulnar nerve ...etc). The nerve trunk contains many myelinated large nerve fibers and even more unmyelinated small nerve fibers.

**Compound Action Potential,**



<http://www.unmc.edu/Physiology/Mann/mann12.html>

The Conduction velocity varies from 100/120 to 0.25/ 0.5 m / sec respectively. The appearance of multiple peaks in the potential is due to the presence of families of nerve fibers with varying speeds of conduction.



### **Electrodiagnostic tests (EDX):**

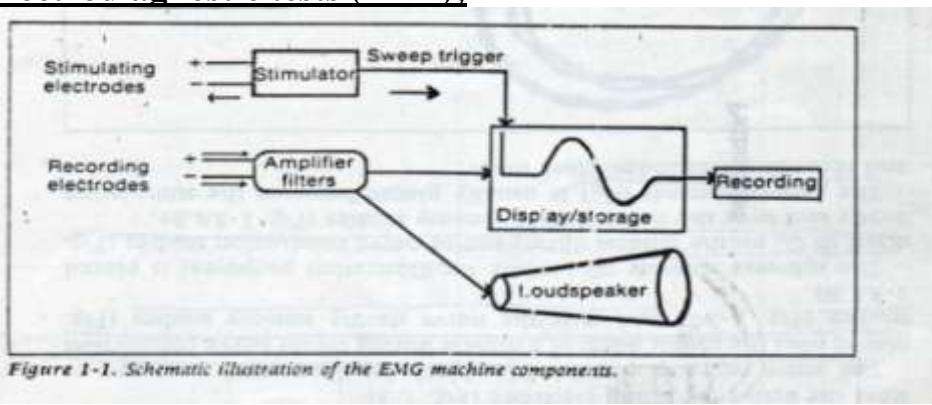


Figure 1-1. Schematic illustration of the EMG machine components.

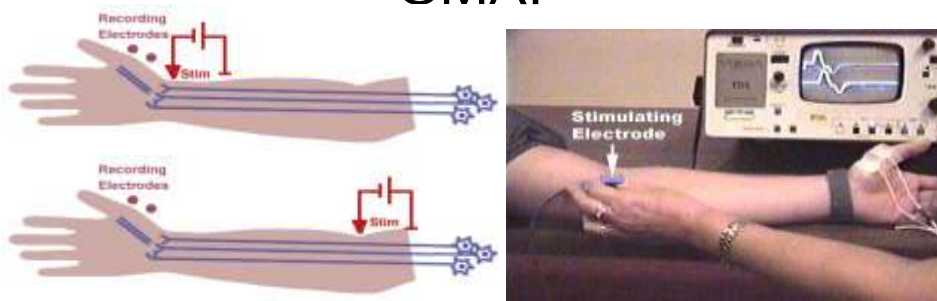
During *nerve conduction studies*, an electric pulse applied transcutaneously sets up a wave of depolarization, which can be recorded at different points along the course of the nerve allowing estimation of conduction velocity in different segments of the nerve. Each nerve contains axons of different thickness and myelination, so much so conduction of action potentials is not at uniform speed; the larger the axon, the thicker the myelin sheath and faster the conduction. Since it is difficult to ensure that the particular axons stimulated at one spot on the nerve are the same ones stimulated at a different site, it is necessary to stimulate all the axons at each site to obtain accurate estimates of motor conduction velocity; this is achieved by using a stimulus intensity, 10 % more than that produces maximum amplitude of the nerve or muscle action potential (supra-maximal stimulus)

### **How EDX tests are done:**

**Motor NCV:** The electrical response to nerve stimulation is recorded over a target muscle using surface electrodes; the active electrode is placed over the motor point of the muscle belly and reference electrode over the tendon. A supramaximal stimulus is

applied transcutaneously over the nerve, with the cathode of the stimulator facing the muscle; the resulting contraction of the muscle is accompanied by electric activity, recorded as the CMAP (compound muscle action potential). By stimulation of the same nerve distally and proximally, the time interval between the onsets of the CMAPs (onset latency difference) can be measured; the distance between the sites of proximal and distal stimulation divided by the latency difference gives the motor conduction velocity.

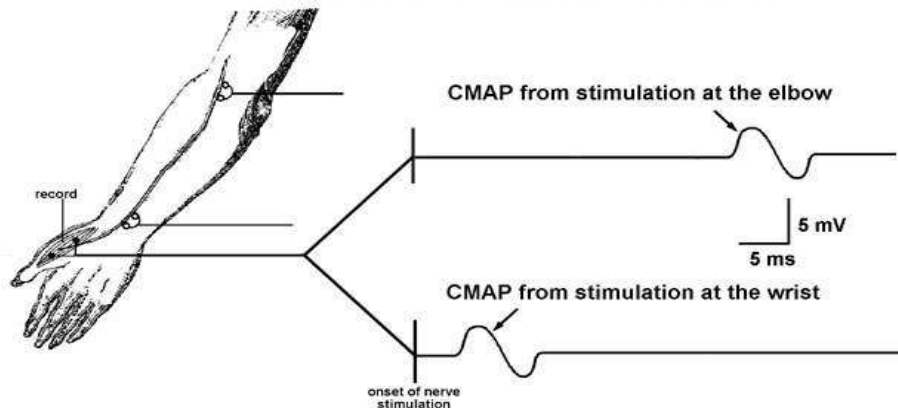
## Compound Motor Action Potential: CMAP



Motor nerve is stimulated and muscle response is calculated. Latency includes synaptic transmission etc. By subtracting the two latencies, the conduction velocity can be calculated.

<http://www.mmi.mcgill.ca/Dev/chalk/lect72p2.htm>

Median nerve stimulation at the elbow and wrist.  
Recording is from the thenar muscle group.



### Sensory Conduction:

Sensory axons may be stimulated at the level of the digital branches and the resulting action potential (SNAP) can be tracked as it passes towards the spinal cord (orthodromic); a limiting factor is the small size of the potential, which makes it difficult to pick it up as the nerve goes deeper and deeper from the surface. Several responses may have to be averaged to separate the response from random electrical noise. One could also stimulate proximally and record the responses over the digits distally (antidromic); in this instance, the digital nerves are closer to the skin and the recording electrodes and hence the SNAPs are larger.

# SNAP: Sensory Nerve Action Potential

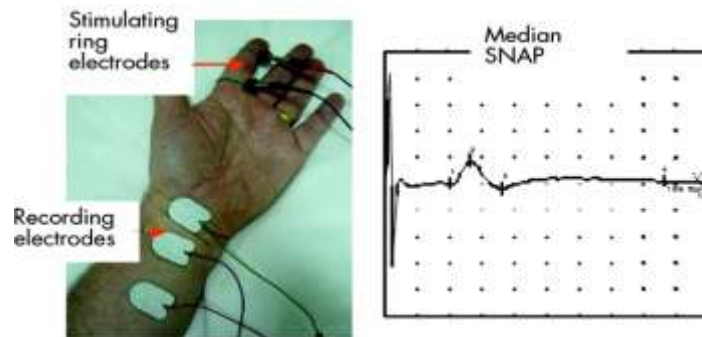


Figure 2 Median orthodromic sensory study. The index finger digital nerves are stimulated via ring electrodes and the response recorded over the median nerve at the wrist.

Mallik, A et al. J Neurol Neurosurg Psychiatry 2005;76:ii23-31 ii



## **Abnormal patterns and their significance:**

General observations:

1. Focal demyelination (FD): There is focal slowing of conduction across the area of demyelination. If the segment is long it is easy to detect; however, if the segment is short, one needs special techniques such as “inching” study.
2. Axon loss: The portion below the area of axon loss shows no conduction if Wallerian degeneration has already set in (takes a week or more after injury); the muscles show denervation changes. If partial axon loss, there is decreased amplitude of CMAP and also denervation changes.

Demyelination is indicated if conduction velocities have fallen below 50% of normal. Even significant loss of axons commonly reduces conduction velocities by only about 30%, based on a loss of the fastest conducting fibers.

