**Needle EMG**

**Settings**
Sweep speed is the horizontal measurement and gain is the vertical measurement. In general gain is 50 μV/div for spontaneous recordings and 200 μV/div for voluntary MUAP (motor unit action potential) recordings with 200 msec (or 100 msec) sweep speed. There are 10 divisions each horizontally and vertically. The needle only assesses 7-15 muscle fibers of a given MUAP or even overlapping MUAP at a time. Most skeletal muscles have 100-300 motor units, extraocular 20 motor units. (extraocular motor units may be as small as 3 muscle fibers and gastrocnemius may have as many as 2000-3000 muscle fibers per motor unit)

**Grading Spontaneous Activity**
- Persistent trains of p-waves or fibrillations lasting 2-3 seconds in at least two areas +1
- Moderate number of p-waves or fibrillations in 3 or more areas +2
- Many potentials in all areas +3
- Full interference pattern of potentials +4 (rare)

Very regular firing rate of 0.5-10 Hz, remember MUAP are irregular and >5 Hz

**Grading Voluntary Motor Unit Action Potentials (MUAP)**

**Amplitude**
Technically amplitude equates to muscle fiber density, so will increase if a reinnervated motor unit acquires more muscle fibers or muscle fibers hypertrophy, small changes in amplitude not really sensitive for differentiating neurogenic from a myopathic process, but if significant increase in MUAP amplitude then likely represents a neurogenic loss of muscle fibers

Measured when recording needle is closest to muscle fibers as indicated by steepest rise time and highest possible amplitude. Measure the amplitude from negative peak (positive deflection) to bottom of positive peak (negative deflection). Using sweep speed of 200 ms/screen (20 ms/div x 10 divisions) and gain of 200 μV/division (200 μV x 10 = 2000 μV). MUAP have larger amplitudes in distal muscles and smaller amplitudes in proximal muscles. MUAP amplitude of the Biceps Brachii should be <1000 μV (1 mV), but distal muscles could have somewhat taller MUAP amplitudes up to 2 mV. Most MUAP should be >100 μV, but keep in mind the normal Biceps Brachii can have 25% of fibers at 100 μV and 13% at 50 μV (Buchthal F, et al. Action potential parameters in normal human muscle and their dependence on physical variables. Acta Physiol Scand 1954;32:200)

**Rule of Thumb for grading increased amplitude:**
- >1000 and <2000 μV, MUAP fill screen when set at 200u V/div = +1 (but be cautious distal muscles may have normal units close to 2000 μV)
- ≥2000 and <5000 μV, MUAP off screen at 200 uV but not at 500 uV/div = +2
- >5000 and <10,000 μV, MUAP off screen at 500 μV but not at 1 mV = +3
- >10,000 μV (10 mV) off screen or completely filling screen at 1 mV= +4
- +4 will be rare and usually requires a chronic anterior horn cell disease like polio, even in ALS MUAP are routinely below 10 mV (Salajegheh M et al. Neurology. 2006 Sep 26;67(6):1078-9)

**Rule of Thumb for grading decreased amplitude:**
- Majority of units <200 μV in distal muscles = decreased amplitude
- Majority of units <100 μV in proximal muscles = decreased amplitude
- Again -4 decrease in amplitude will be very rare.

**Duration**
Best reflects number of muscle fibers in the motor unit and the dispersion of their depolarizations over time. It increases with age and with decreased temperature. Challenging to measure as must be able to determine beginning and end of MUAP, but detectable with pitch as dull thud, increased duration and sharp crisp decreased. Normal range is 5-15 msec. >then one division at 20 msec/div is increased and <half of a division at 10 msec/div is decreased

**Polyphasia**
Number of phases reflect muscle fiber diameter as diameter affects conduction of muscle fiber AP, and phases reflect how well nerve conductions AP to muscle fibers. Phases may increase if muscle fibers AP are out of sync such as in reinnervation. So not specific for myopathic or neurogenic process.

Phases are the number of baseline crossings +1 or the number of negative and positive peaks that extend from the baseline. Phases should be < 4. However, 5-10% may be >4 and 25% of deltoid MUAP are >4 phases.

Turns (serrations) are changes in directions that don’t cross the baseline and should be 5 or less. A combination of phases and turns is termed a complex MUAP. By changing needle position can change turns into phases and vice-versa.

**Recruitment**
Refers to the frequency of MUAP firing relative to force. Abnormal recruitment is a neuromuscular pathological process. If a patient is unable or unwilling to move a limb or contract the muscle this is not an alteration of recruitment but decreased activation. Decreased activation occurs in CNS disorders, conversion disorder, or pain inhibition.

Hz = 1 cycle/sec. Screen 10 div x 20 msec/div = 200 msec

1 cycle/sec = 1/200 msec x 1000 msec/sec = 1000/200 = 5 Hz frequency of MUAP firing if only one unit is seen per 200 msec screen

If clearly see 2 units per screen then unit firing at 10 Hz if 3 units then 15 Hz, if 4 units then 20 Hz. At 10 Hz with normal recruitment a second unit is recruited. If recruitment is decreased that unit will fire faster than 10 Hz appear on the screen more then twice.