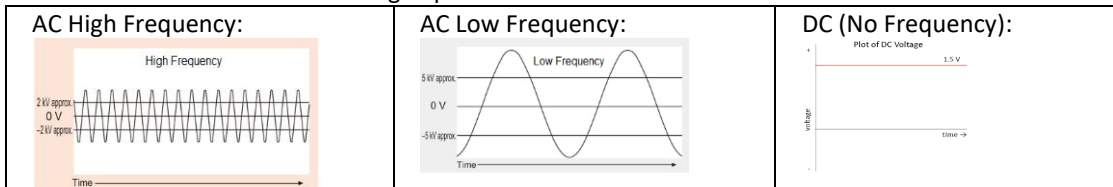


Electrotherapy:

- An electrical current: "Flow of charged particles or electrons"



- **Motor Points** are most effective areas for electrical current

- Most common **uses**:

- Muscle Strengthening & Reeducation
- Pain Control
- Wounds
- Resolving Edema
- Transdermal drug delivery

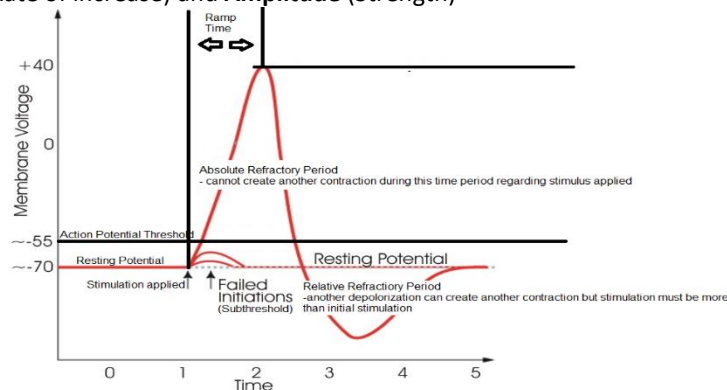
- **Nerve Depolarization** (the way Electric Stimulation (ES) works)

- The normal nerve cell is negatively charged on inside (Resting Membrane Potential)
- The ES application (above threshold) leads to Depolarization
- The nerve cell returns to negative state (Repolarization)

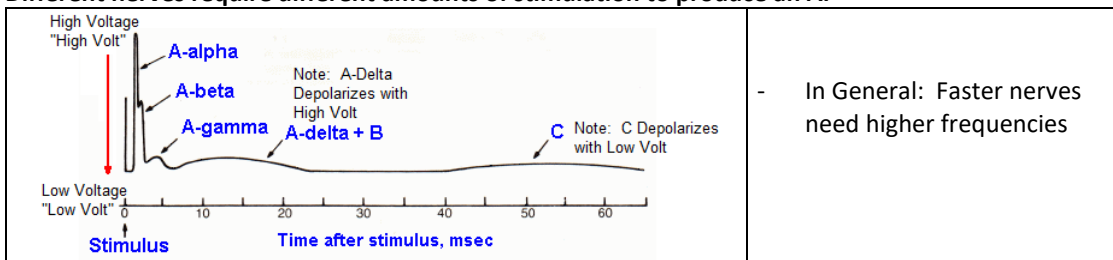
- **Action Potential** – (AP) is the threshold that leads to Depolarization

- **Absolute Refractory Period** and **Relative Refractory Period**

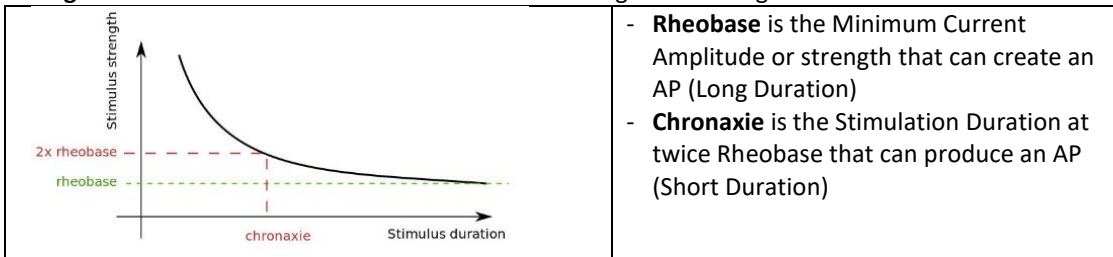
- **Ramp Time** (Rate of increase) and **Amplitude** (Strength)



- **Different nerves require different amounts of stimulation to produce an AP**



- **Strength-Duration Curve:** Nerves can fire at lower strengths with longer duration stimulation



- In general:

- Lower Amplitudes and Shorter Pulse Durations Depolarize Sensory Nerves
- Higher Amplitudes and Longer Durations Depolarize Motor Nerves

Electrotherapy:

Effects

| | |
|---|---|
| <ul style="list-style-type: none">• Relaxation of muscle spasm• <u>Muscle strengthening</u>• <u>Improve range of motion</u>• <u>Facilitate wound healing</u>• <u>Decrease Edema</u> | <ul style="list-style-type: none">• <u>Eliminate Disuse Atrophy</u>• <u>Muscle re-education</u>• <u>Increase local circulation</u>• <u>Facilitate Bone Repair</u>• <u>Decrease Pain</u> |
|---|---|

Indications:

| | |
|---|---|
| <ul style="list-style-type: none">• Muscle Spasms• Muscle weakness• Pain• Decreased ROM• Idiopathic scoliosis• Fracture• Joint Effusion | <ul style="list-style-type: none">• Facial neuropathy• Muscle atrophy• Open wound/ulcer• Bell's Palsy• Use with labor and delivery• Stress Incontinence• Shoulder subluxation |
|---|---|

Contraindications:

| | |
|--|--|
| <ul style="list-style-type: none">• Cardiac Pacemaker• Patient with a bladder stimulator• Use over a carotid sinus• Seizure disorders• Phlebitis | <ul style="list-style-type: none">• Malignancy• Use over a pregnant uterus• Cardiac arrhythmia• Osteomyelitis |
|--|--|

Parameter Types:

Monopolar Technique:

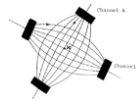
- Active electrode over target area (Smaller)
- Dispersive electrode another remote site (Larger)
- Used with wounds, iontophoresis, Edema

Bipolar Technique:

- Two active electrodes placed over target area (Equal in size)
- Used for muscle weakness, Neuromuscular facilitation, spasms and ROM

Quadripolar Technique:

- Two electrodes from two separate stimulating circuits positioned so the currents intersect
- Interferential current

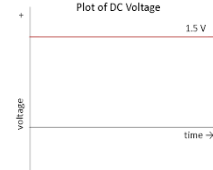
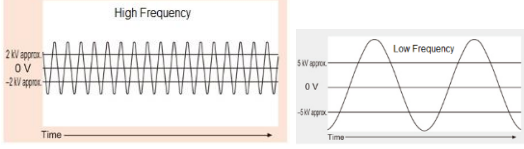
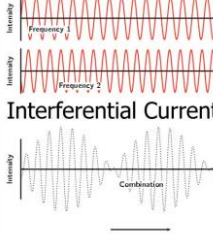


Electrode Size:

| | |
|--|--|
| Small Electrodes <ul style="list-style-type: none">• Increased current density• Increased impedance (Resistance to flow)• Decreased current flow• HIGHER RISK OF TISSUE DAMAGE | Large Electrodes <ul style="list-style-type: none">• Decreased current density• Decreased impedance• Increased current flow |
|--|--|

Electrotherapy:

Treatment Parameters

| | |
|--|---|
| <p><u>Direct Current: (DC)</u></p> <ul style="list-style-type: none"> Galvanic Current Constant flow of electrons without interruption Iontophoresis uses direct current |  |
| <p><u>Alternating Current: (AC)</u></p> <ul style="list-style-type: none"> Polarity changes from positive to negative Can be symmetrical or asymmetrical Used in muscle retraining, spasticity, stimulation of denervated muscle |  |
| <p><u>Interferential Current: (IFC)</u></p> <ul style="list-style-type: none"> Combines two high frequency AC wave forms Used for deep muscle stimulation <ul style="list-style-type: none"> (2-50pps – 100-200msec) Used for pain control <ul style="list-style-type: none"> (50-120pps – 50-150msec) |  |
| <p><u>Russian Current</u></p> <ul style="list-style-type: none"> Medium frequency AC wave forms <ul style="list-style-type: none"> (50pps – 50-200msec) Used for strengthening over healthy muscle tissue leading to increased contraction Type of NMES and/or FES | <p><u>Indications</u></p> <ul style="list-style-type: none"> Strengthen healthy tissue (athletes) <p><u>Contraindications</u></p> <ul style="list-style-type: none"> Over abdominal and pelvis in pregnancy Over hemorrhage Malignancy Over anterior cervical area Over electronic implants |
| <p><u>Neuromuscular Electrical Stim (NMES)</u></p> <ul style="list-style-type: none"> NMES and Functional Electric Stim (FES) are the same with computer assist <ul style="list-style-type: none"> FES to promote function (i.e. Dorsiflexion assist, swallowing) Used for maintaining strength (unproven) | <p><u>Parameters:</u></p> <ul style="list-style-type: none"> 20-40pps – on 6-10sec OFF 50-60sec <ul style="list-style-type: none"> Avoid fatigue (1:10) Treatment Time: 15 – 20 min |
| <p><u>Transcutaneous Electrical Nerve Stim (TENS)</u></p> <ul style="list-style-type: none"> Used for pain (Acute & Chronic) Uses Gate Control Theory <ul style="list-style-type: none"> (Melzak & Wall) Uses endogenous Opiate Theory <p><u>Indications</u></p> <ul style="list-style-type: none"> Pain: Post-op, labor, fractures, chronic, trigeminal, phantom For antiemetic effects Improved blood flow | <p><u>Contraindications</u></p> <ul style="list-style-type: none"> Pacemakers (Relative) Epilepsy 1st trimester of pregnancy Over uterus in pregnancy Over anterior trans-cervical area <p><u>Parameters:</u></p> <ul style="list-style-type: none"> Monophasic pulsatile current or biphasic pulsatile current Wave forms can be spiked, rectangular or sinewave Place over nerve roots or trigger points Because AC, no net polarity |
| <p><u>Iontophoresis</u></p> <ul style="list-style-type: none"> Administer meds transcutaneously Uses DC Stim Use same polarity as drug to drive into skin (Opposites attract / Same repulse) | <p><u>Acidic Reaction:</u> Sclerotic – Hardening skin <u>Alkaline Reaction:</u> Sclerotic – Softens skin <u>Buffering:</u> decrease acidic/alkaline reactions <u>Electrolysis:</u> Decomposition of drug with stim <u>Electron Exchange:</u> DC changes electron balance <u>Redox Reaction:</u> Water breakdown with stim into H⁺ at anode & OH⁻ at cathode</p> |

Electrotherapy:

| NMES PARAMETERS | | | | | | | |
|------------------------|---------------------------------------|---------------------------------------|--|--|---------------|--------------------|-----------------------------------|
| Goal | Pulse Freq | Pulse Duration | Amplitude (Strength) | Duty Cycle On/Rest time | Ramp Time | Treatment Time | Times per day |
| Muscle Strength | 35-80 pps Note: 1pps = 1 Hz | 150-200 microseconds Small Muscles | To > 10% of MVIC in injured >50% in uninjured | 6-10 sec on 50-20 sec off (5:1 ratio) | 2 sec or more | 10-20 min | Every 2-3 hours |
| Muscle Reeducation | 35-50 pps | 200-350 microseconds Large Muscles | Sufficient to activity | To activity-on when exerting effort-off with rest | | Activity Dependent | NA – as tolerated (avoid fatigue) |
| Muscle Spasm Reduction | | | To contraction | To contraction then off/relax to create pumping action | 1 sec or more | 10-30 min | Every 2-3 hours |
| Edema | | | | | | 30 min | 2X/day |

ES For Pain Control:

| Parameter Settings: | Pulse Frequency | Pulse Duration | Amplitude | Modulation (Freq or Duration) | Treatment Time | Mechanism of Action |
|-----------------------------|----------------------------------|----------------|-------------------------------|-------------------------------|--------------------|----------------------------|
| Conventional TENS | 100 - 150pps (1pps = 1hz) | 50-80 ms | To the production of tingling | Use if available | Can wear 24 hr/day | Gaiting at the spinal cord |
| Low Rate (Acupuncture-like) | 2 – 10 pps | 200 – 300 ms | To Visible contraction | None | 20 – 30 min | Endorphin Release |
| Burst | 10 bursts (usually preset) | 100 – 300 ms | To Visible contraction | None | 20 - 30 min | Endorphin Release |

ES for Tissue Healing:

| Parameter settings/goals | Waveform | Polarity | Pulse Frequency | Pulse Duration | Amplitude | Treatment Time |
|--|---------------------------------|----------|-----------------|-----------------------------|--------------------------------|----------------|
| Tissue Healing Phase: Inflammatory Infected | High Volt Pulsed Current (HVPC) | Negative | 60-125 pps | Usually preset for 40-100ms | Produce a comfortable tingling | 45-60min |
| Tissue Healing Phase: Proliferation Clean | | Positive | | | | |

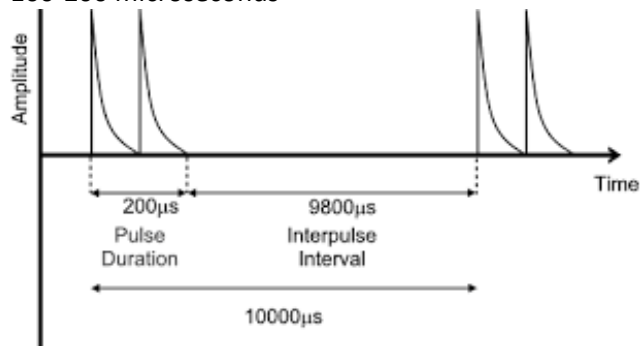
ES for Iontophoresis:

| Goal | Waveform | Pulse Frequency | Pulse Duration | Amplitude | Polarity | Treatment Time |
|--|----------|-----------------|----------------|--|------------------|--------------------------------|
| Iontophoresis to deliver drug | DC | NA | NA | To patient tolerance no greater than 4mA | Same as drug ion | To produce a total of 40mA-min |
| Positively Charged Drugs: (Driven by Anode) | | | | Negatively Charged Drugs: (Driven by Cathode) | | |
| Lidocaine Hydrocortisone Histamine Lithium Magnesium Zinc | | | | Acetate Dexamethasone Salicylate Iodine Chlorine Tap water (Can be either + or -) | | |

Electrotherapy:

High-Voltage Pulsed Current (HVPC)

- High-Volt is a twin-peak, monophasic (Direct) pulsed current
- No concern with ionic build-up because it is very brief duration
- Phase duration is set in most machines at 5 – 20 microseconds and a pulse duration between 100-200 microseconds



- There is one large dispersive pad with 1, two, or 4 active electrodes (can be Positive or Negative depending on treatment goals).

Effects

- Wound Healing due to Increase blood flow
- Increase in strength (muscle contraction)
- Decreased pain
- pressure in tissues to exchange fluids between capillaries and tissues.

Indications:

- Wound management
- Pain management
- Soft tissue edema
- Levator ani syndrome
- Muscle spasm
- Muscle weakness
- Bell's Palsy

Contraindications:

- Cardiac Pacemakers (Relative contraindication)
- Over heavy scarring
- Malignancy
- Over lower abdomen during pregnancy
- Over anterior transcervical area
- Over osteomyelitis

Parameters:

- One electrode over the wound with other over health tissue >5 cm away
- Polarity in reversal mode
 - Leads to 50% treatment in positive/50% of treatment in negative (no ion build-up)
- Frequency 30-200 pps, Amplitude 1-500V, 10-60 minutes of treatment

Electromyography (EMG)

- Used to evaluate motor units
 - Anterior horn cell, axion, neuromuscular junction and muscle fibers
- Can be surface (Surface EMG) or intramuscular needles
- Muscles at rest should display electrical silence

Abnormal potentials

Spontaneous

- Fibrillation Potential: Indicative of Lower Motor Neuron dysfunction
- Positive Sharp Wave: Denervated muscle at rest, primary muscle disease (MD)
- Fasciculations: Injury/irritation/degeneration of:
 1. Anterior horn cell
 2. nerve root compression
 3. muscle spasm
- Repetitive discharges: Lesions of anterior horn cell or peripheral nerves

Voluntary

- Polyphasic potentials: Myopathies, muscle or peripheral nerve involvement

Biofeedback

- Used to provide visual and/or Auditory Feedback to performance
- Increase motor, kinesthetic, or physiological response

MEASURES:

| | | |
|-----------------|---------------------------|--------------------------|
| Muscle Activity | Heart Rate/Blood Pressure | Skin Temperature |
| Balance | Posture | Abnormal/Normal Movement |

Types:

| | | |
|------------------------|----------------------|------------------------------|
| EMG – Biofeedback (BF) | Position BF | Electroencephalographic BF |
| Respiratory BF | Sphincter control BF | BP/Temperature/Blood Flow BF |

Therapeutic Effects:

| | | |
|-------------------|------------------------|-------------------|
| Muscle Relaxation | Neuromuscular Control | Increase Strength |
| Decrease Spasm | Decrease accessory use | Decrease Pain |

Indications:

| | | |
|------------|------------------|------------------------------|
| Spasm | Weakness | Pain |
| Hemiplegia | SCI | CP |
| Relaxation | Impaired control | Incontinence (bowel/bladder) |

Contraindications:

| | |
|---------------------------------|--------------------------|
| When Contraction is Detrimental | Skin Irritation or wound |
|---------------------------------|--------------------------|

Parameters/Directions:

| | |
|----|--|
| 1. | Apply electrodes parallel to muscle fibers (if there is a ground it can be anywhere) |
| 2. | Request a maximal muscle contraction |
| 3. | Adjust sensitivity to point where patient can perform 6-10 reps (60% of 1RM) |
| 4. | Treatment 10-15 min |

ELECTROTHERAPY TERMS:

| | |
|---|---|
| Accommodation | Threshold for excitability increases (get "use to" stimulation) |
| Alternating Current (AC or biphasic) | Ionic movement shifts between positive and negative (no ion build-up) |
| Ampere | Measures RATE OF CURRENT |
| Amplitude | Magnitude of current (Voltage or Intensity) |
| Anode | Positive (+) Electrode - Attracts Negative (-) ions or Anions |
| Biphasic | AC current Types: <ul style="list-style-type: none">- Symmetrical: Positive identical to negative phase- Asymmetrical:- Balanced: + Charge is = to - Charge- Unbalanced: |
| Burst | A "Burst" of charges delivered at one time |
| Capacitance | Insulator that "HOLDS CHARGES" like a short-term battery |
| Cathode | Negative (-) Electrode - Attracts + ions or Cations |
| Chronaxie | Measure of time to develop muscle contraction at any intensity |
| Conductance | Ease of electric movement |
| Current | Flow of electrons (Amplitude) |
| Direct Current (DC or galvanic) | Ionic movement in one direction (ion build-up) |
| Duration of Stim/Rest | On Time/to/Off Time Ratio - Ratio changes change fatigue |
| Duty Cycle | On Time as related to whole treatment - 66% is on 2/3 of treatment |
| Impedance | Resistance to current flow |
| Frequency | Rate of pulses per second (also called rate) |
| High-Volt | >150V with short pulse duration – INTERMITTENT and DEEP PENETRATION - Used for PAIN |
| Low-Volt | <15V Used for muscle stim |
| Ohm's Law | Voltage = Current x Resistance ($V = IR$) |
| Ramp | Rate of increase in current strength or amplitude |
| Resistance | Resist current flow |
| Rheobase | Minimal current to create current flow over resistance |
| Volt | Electrical Power |