BASIC PHYSICS OF ELECTRICITY & WORKING MECHANISMS IN THERAPY

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3. BASIC PHYSICS OF ELECTRICITY

Understanding the fundamental principles of electricity is crucial for safe and effective use in therapeutic settings.

3.1 Electrical Terms and Definitions

Term	Symbol	Definition	Unit
Voltage	V	The **potential difference** or "electrical pressure" that pushes charges.	Volts (V)
Current	I	The **flow of electric charge** through a conductor.	Amperes (A)
Resistance	R	The **opposition** to the flow of current in a material.	Ohms (Ω)
Power	P	The **rate at which energy is consumed or produced**.	Watts (W)

Power Formula:
$P=V\times I\boxed{P = V \times I}P=V×I$

3.2 Ohm's Law

Definition: Describes the relationship between voltage, current, and resistance in an electrical circuit.

Formula:
$V=I\times R\boxed{V = I \times R}V=I×R$

Rearranged Forms:

$I=VRI = \dfrac{V}{R}I=RV$

$R=VIR = \dfrac{V}{I}R=IV$

Practical Application:

Helps determine safe and effective settings for electrotherapy devices.

3.3 Conductors and Insulators

Type	Definition	Examples
Conductors	Materials that allow easy flow of electric current.	Metals, saline solution, body tissues.

Type	Definition	Examples
Insulators	Materials that resist electric current.	Rubber, plastic, dry skin, fat.

In therapy:

Conductive gels are used to reduce **skin resistance**.

Electrodes should be applied to well-hydrated skin for better conduction.

3.4 Frequency and Waveforms

Frequency

Definition: Number of cycles or pulses per second.

Measured in: Hertz (Hz).

Example: 50 Hz means 50 cycles per second.

Waveforms in Electrotherapy

Waveform	Description	Usage
Sinusoidal	Smooth, repetitive waveform.	Used in diagnostic testing.
Square	Abrupt rise and fall in current.	NMES, TENS.
Rectangular	Similar to square but with more gradual transitions.	TENS, stimulation therapies.
Faradic	Short-duration, high-frequency pulses (asymmetrical, biphasic).	Muscle stimulation (interrupted).
Galvanic	Long-duration, low-frequency direct current (monophasic).	Iontophoresis, wound healing.

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4. WORKING (MECHANISM OF ACTION)

Understanding how electricity interacts with human tissues and how devices function ensures **safe and effective electrotherapy**.

4.1 How Electricity Affects Tissues

Sensory and Motor Nerve Stimulation:

Electrical impulses can activate **A-beta (touch)** and **A-alpha (motor)** fibers.

Blocks pain transmission from **A-delta and C fibers** (pain fibers).

Increases Blood Flow:

Muscle contractions stimulate **circulation**, aiding oxygen and nutrient delivery.

Enhances Metabolic Activity:

Stimulates **cell metabolism** and enzyme activity for healing.

Alters Cell Membrane Permeability:

Aids in **ion exchange**, improving cellular function and healing.

4.2 Current Path in the Body

Path of Least Resistance:
Electricity travels through areas with **high water and electrolyte content**.

Good Conductors in the Body:

Muscle, **blood**, **nerves** – all have high water content.

Poor Conductors:

Skin (especially dry or calloused), **fat**, **bone**.

Clinical Tip:

Apply **conductive gel** and clean skin before electrode placement to reduce resistance.

4.3 Device Working Principles

Modern electrotherapy devices allow precise control over stimulation parameters:

Parameter	Definition
Intensity (Amplitude)	Strength of the current (usually in mA or V).
Frequency	Number of pulses/cycles per second (Hz).
Duration (Pulse Width)	Time each pulse lasts (microseconds or milliseconds).
Type of Current	AC, DC, Pulsed, Faradic, Galvanic – depending on therapy.

Devices often have **pre-programmed modes** for specific therapeutic goals (e.g., pain relief, muscle stimulation).

4.4 Safety Mechanisms
Ensuring **safe application** is essential to prevent harm:
Built-in Safety Features:

Overload Protectors: Prevent overheating or excessive current.

Grounded Equipment: Minimizes the risk of electric shock.

Timers and Auto Shut-off: Prevent overuse or user error.

Best Practices:

Electrode Placement:

Avoid bony prominences and sensitive areas.

Ensure full contact with skin.

Regular Inspection:

Check cables, electrodes, and machines before each use.

Patient Monitoring:

Always observe the patient’s response.

Stop immediately if discomfort, burning, or irritation occurs.