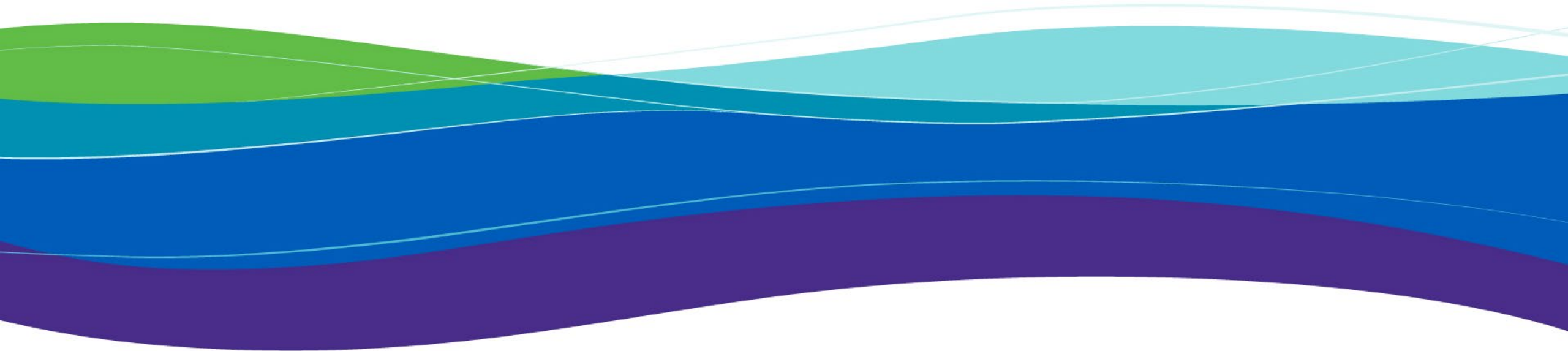


Upper Limb Functional Electrical Stimulation

Alison Hoyle & Elizabeth Cheshire

Pennine Lancashire Community Stroke Team



Learning Objectives

Illustrate how FES can be applied as an effective adjunct to upper limb therapy in stroke

Identify appropriate patient selection

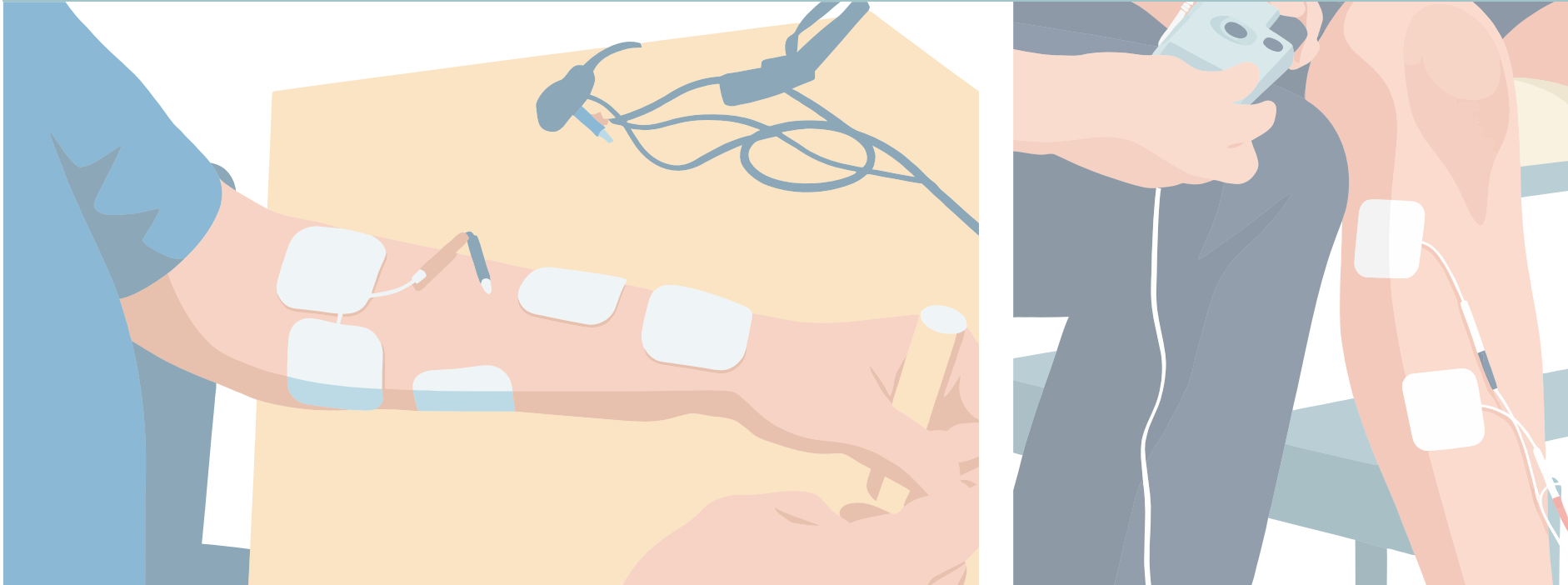
Develop understanding of current supporting guidelines for FES

Outline the key principles underpinning the application of FES, including setup, delivery, and optimisation of treatment.

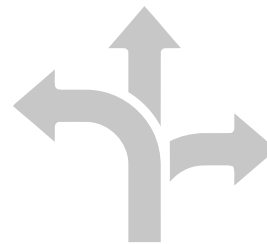
To support FES being considered as routine adjunct across network.

What is FES?

Production and control of movement in paralysed muscles by application of electrical impulses



National Guidance



Strength Training

'Consider a trial of electrical stimulation therapy as part of a comprehensive rehabilitation programme for people who have evidence of muscle contraction after stroke but cannot move their arm against resistance.' (NICE, 2023)

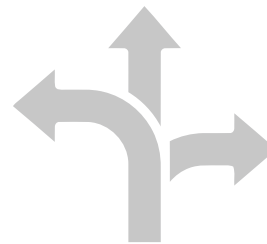
'Continue electrical stimulation therapy if the persons strength and their ability to practice functional tasks is found to be improving.' (NICE, 2023)

'People with wrist and finger weakness which limits function after stroke should be considered for functional electrical stimulation applied to the wrist and finger extensors, as an adjunct to conventional therapy.' (National Clinical Guidance for Stroke 2023)

Shoulder pain

'Consider neuromuscular electrostimulation in the management of shoulder pain.' (NICE, 2023)

National Guidance



Subluxation

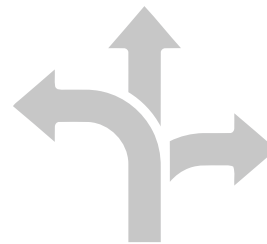
'People with inferior shoulder subluxation within 6 months of hemiplegic stroke should be considered for neuromuscular electrical stimulation, unless contraindicated.' (National Clinical Guidance for Stroke, 2023)

Spasticity

'People with spasticity in the upper or lower limbs after stroke should not be treated with electrical stimulation to reduce spasticity.' (National Clinical Guidance for Stroke, 2023)

'Consider a trial of NMES, functional electrical stimulation (FES) or transcutaneous electrical nerve stimulation for people after stroke with focal spasticity.' (NICE, 2023)

National Guidance



Task specific / intensity

'People with weakness after stroke should be taught task-specific, repetitive, intensive exercises or activities to increase their strength. Exercise and repetitive task practice should be the principal rehabilitation approaches.' (National Clinical Guidance for Stroke, 2023)

FES supports increased repetition and increased intensity of therapy which promotes neuroplasticity.

How does FES work?

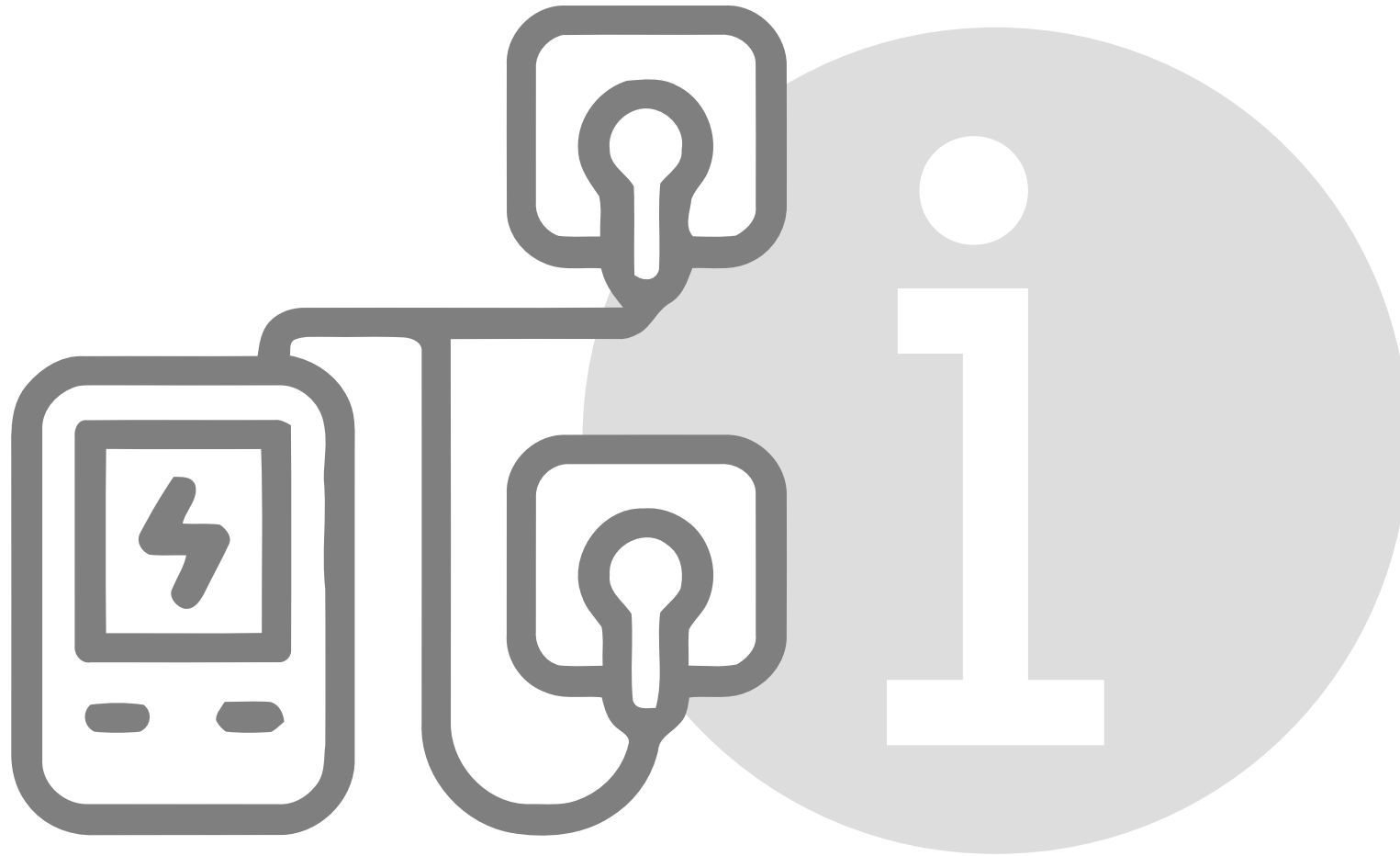
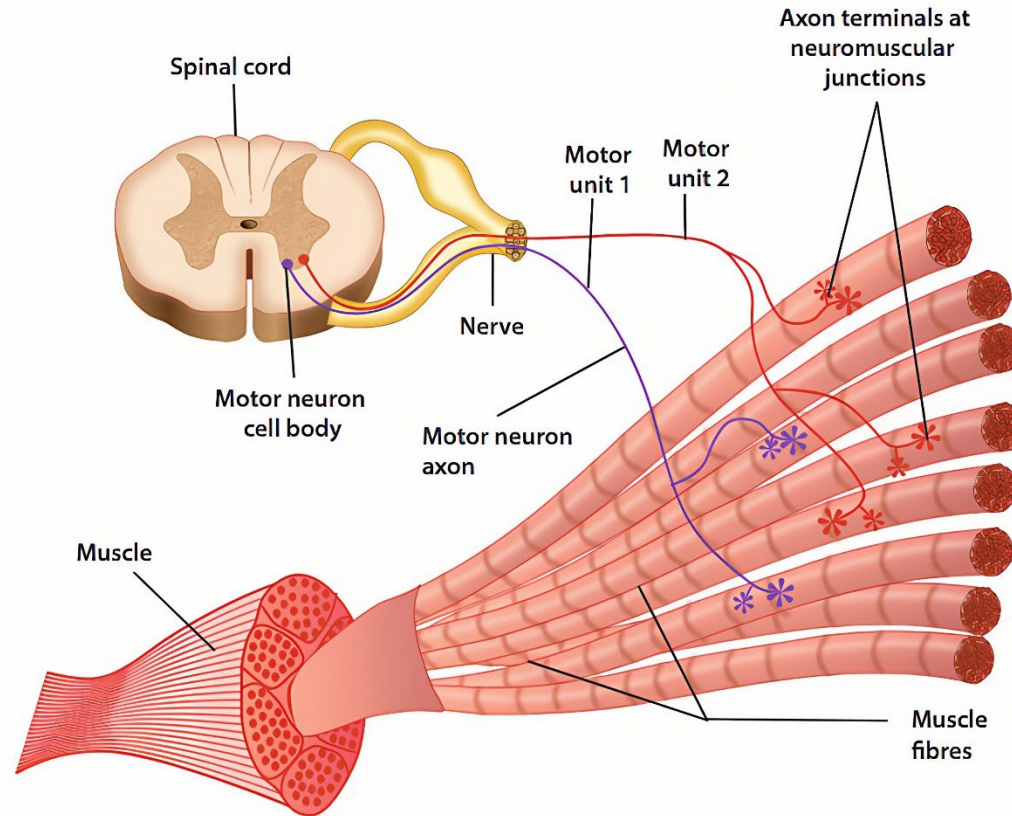


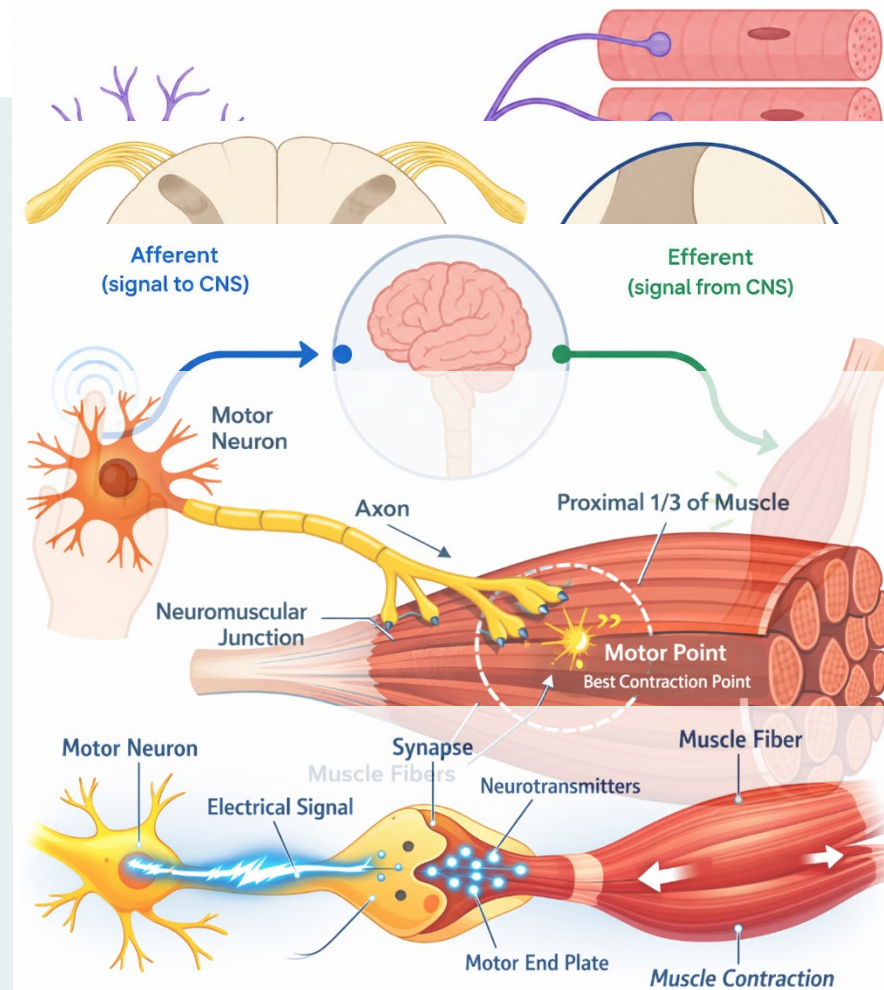
Diagram of a Motor Unit



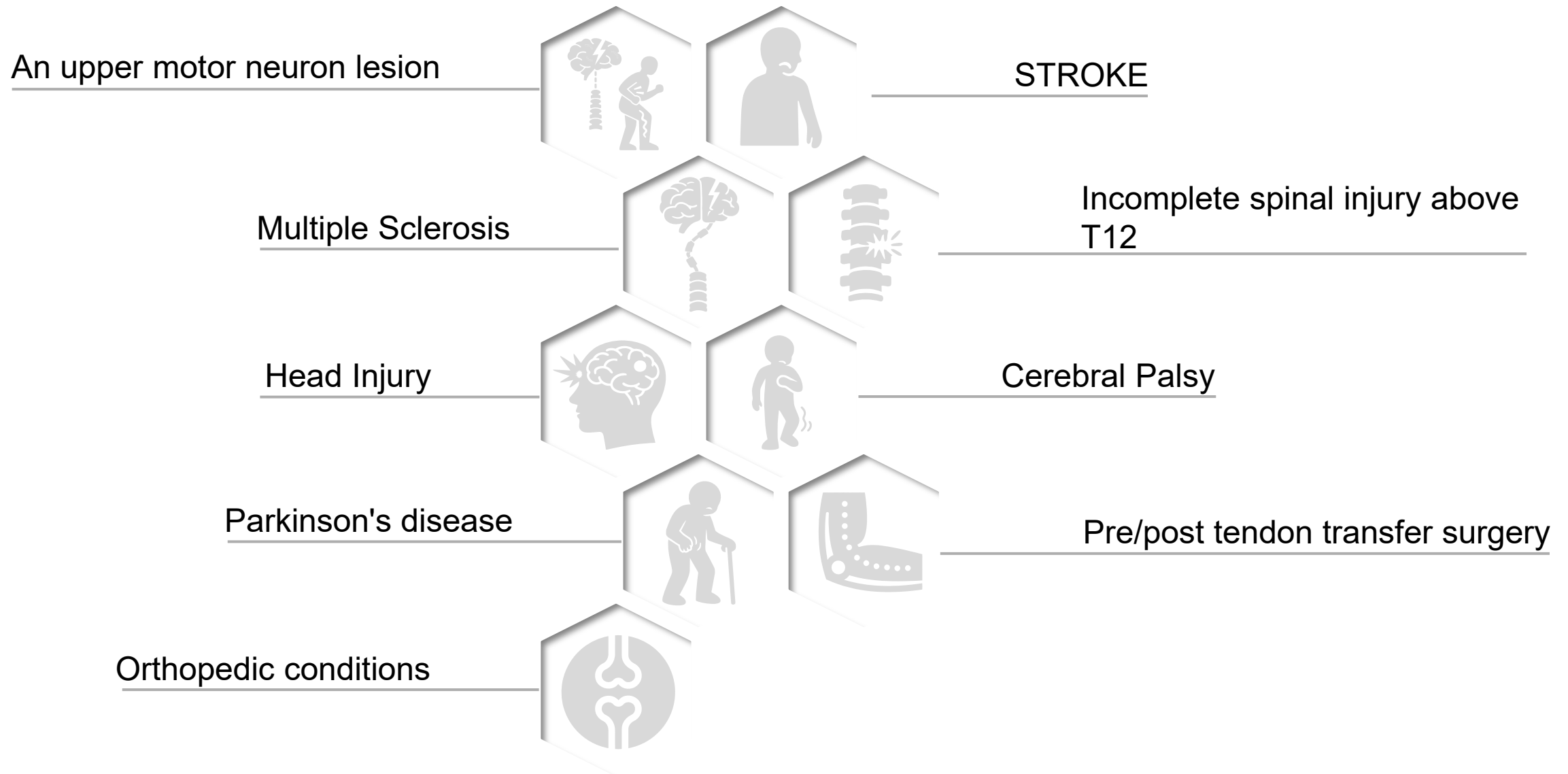
Axon of motor neurons extend from the spinal cord to the muscle. There each axon divides into a number of axon terminals that form neuromuscular junctions with muscle fibers scattered throughout the muscle.

How does FES work?

- Motor Unit consists of a motor neuron and all skeletal muscle fibres it innervates.
- Spinal cord contains the cell body of motor neuron in the anterior horn of the spinal cord.
- Afferent and efferent signals are transmitted.
- The Motor Neuron extends to muscle fibres where they synapse at the neuromuscular junction, this is where you find the motor point which gives the best contraction of muscle (usually proximal 1/3 of the muscle belly).
- Muscle contraction occurs when electrical current travels into tissues and causes depolarisation of an intact motor neuron that carries the signal to the target muscle through synaptic transmission to the motor end plates causing the muscle to contract.



Who can use FES



Contraindications

Contraindications

- Cardiac pacemakers
- Implantable defibrillator or other active implanted devices
- Cancerous tumour – increased blood flow can increase tumour growth
- Orthopaedic metal work within stimulation area
- Open wounds / inflamed areas
- Pregnancy (effects not known – limited research)
- Poorly controlled epilepsy

Precautions

- Poor skin condition
- Epilepsy
- Autonomic dysreflexia – discontinue if occurs
- Diabetes
- Spasticity



Benefits of using FES

- Increasing muscle activation / strength
- Motor learning
- Increasing fatigue resistance

Other considerations include:

- Pain
- Spasticity
- Increases sensory awareness & neglect
- Facilitates intensity of therapy and repetition



Practical considerations

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graph TD; A[Practical considerations] --> B[Motivation and compliance with treatment program essential]; A --> C[Ability to apply daily independently or support from family/ carers]; A --> D[Cognition / Communication – ability to understand and attend to treatment];
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Motivation and compliance with treatment program essential

Ability to apply daily independently or support from family/ carers

Cognition / Communication – ability to understand and attend to treatment

Treatment Parameters

Frequency

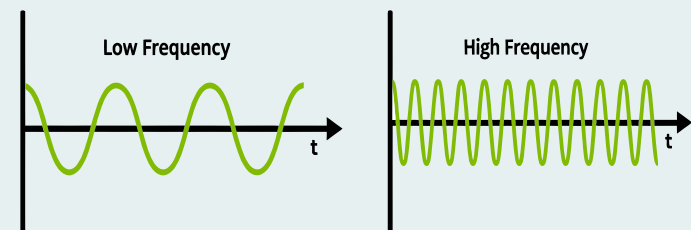
- Number of stimulation pulses delivered per second Measured in Hertz (Hz)
- Low frequency – 1-10Hz
- Medium – 20-60Hz
- High – 60+ Hz

Current /Intensity

- Strength of stimulation being delivered, measured in milliamps (Ma).
- High enough to evoke muscle contraction whilst
- remaining comfortable
- With ongoing treatment as muscle gets stronger may
- achieve same contraction with lower intensity

Pulse width

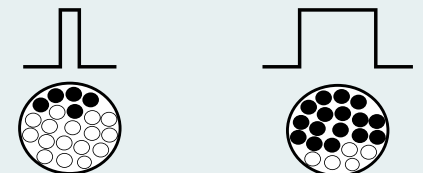
- Length of time pulses of stimulation is set to, measured in microseconds (μ s)
- Pre-set of micro stim machine
- Longer pulse width – recruit more motoneurons resulting in stronger muscle contraction.
- Shorter pulse width – more comfortable for patient.



Nerve bundles. Filled circles indicate “excited” nerve fibres

Pulse width

ODF 5° pace range
0-360 μ s (0-100%)



ODSTOCK MICROSTIM 2

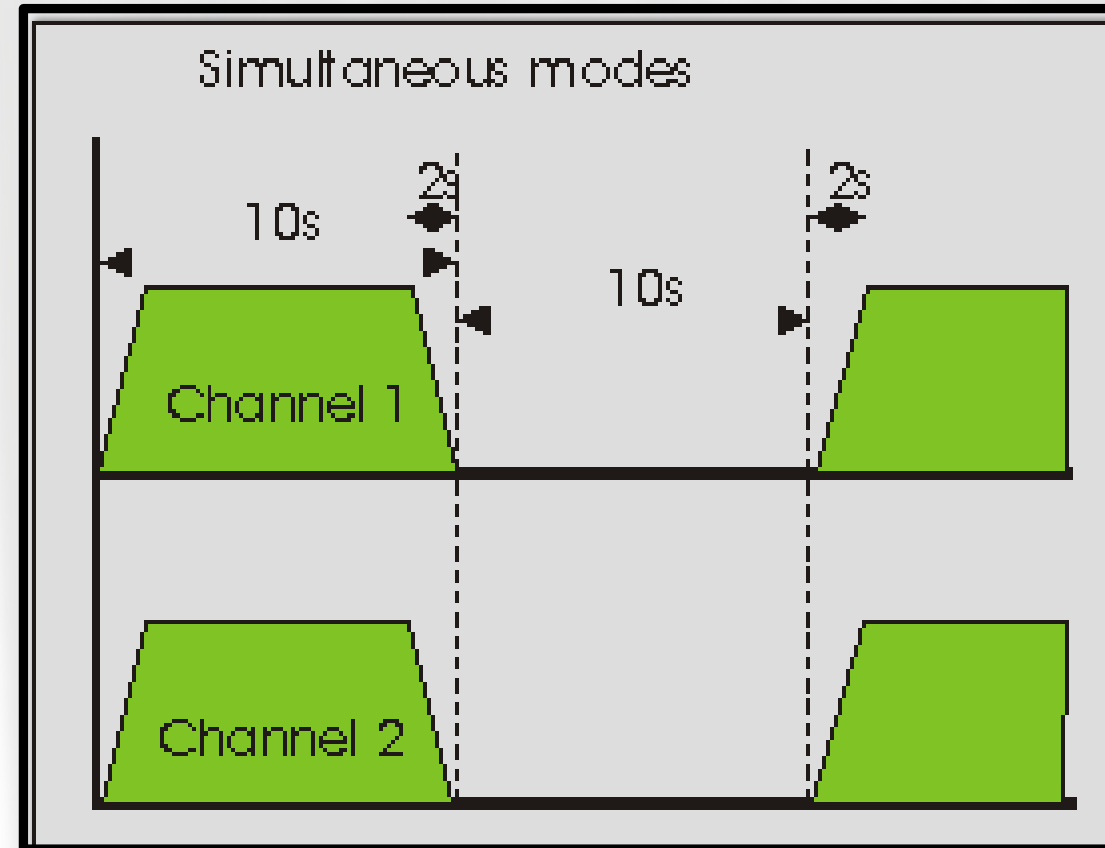


Finger & Wrist extension



Microstim 2

Modes -Simultaneous

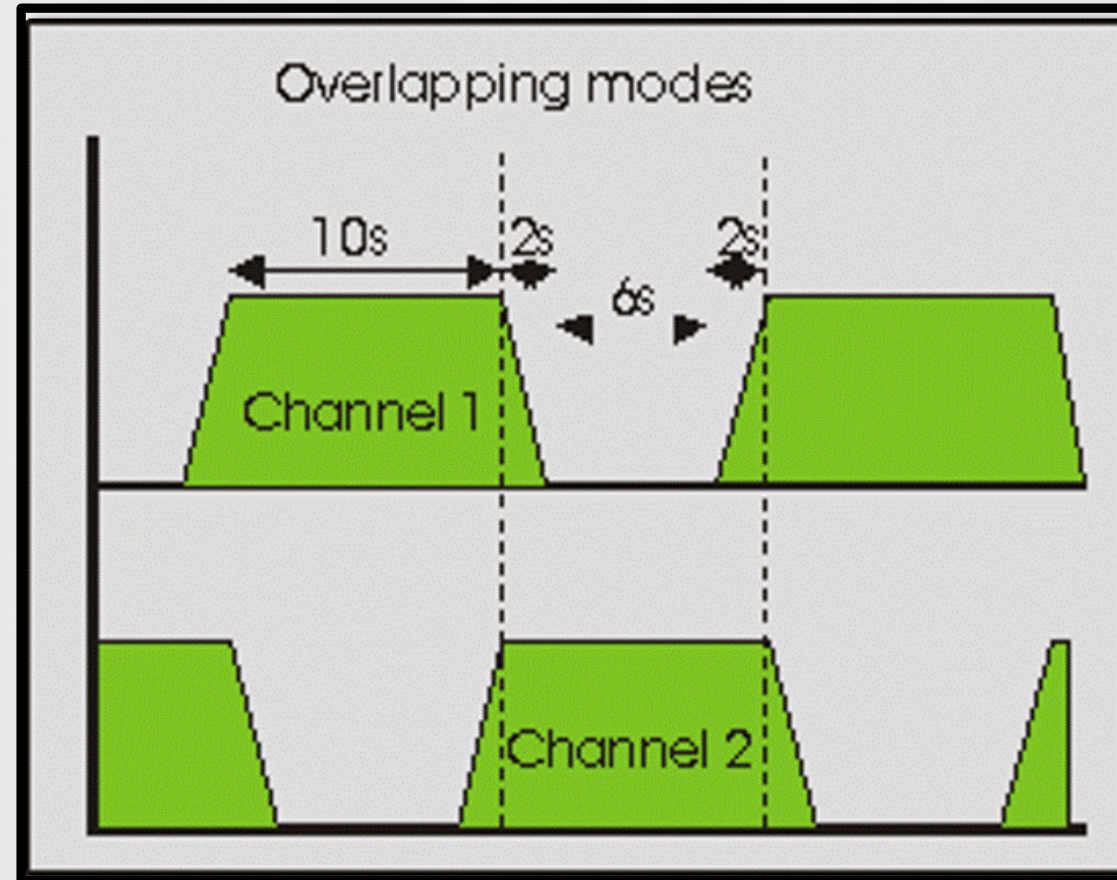


Shoulder Subluxation

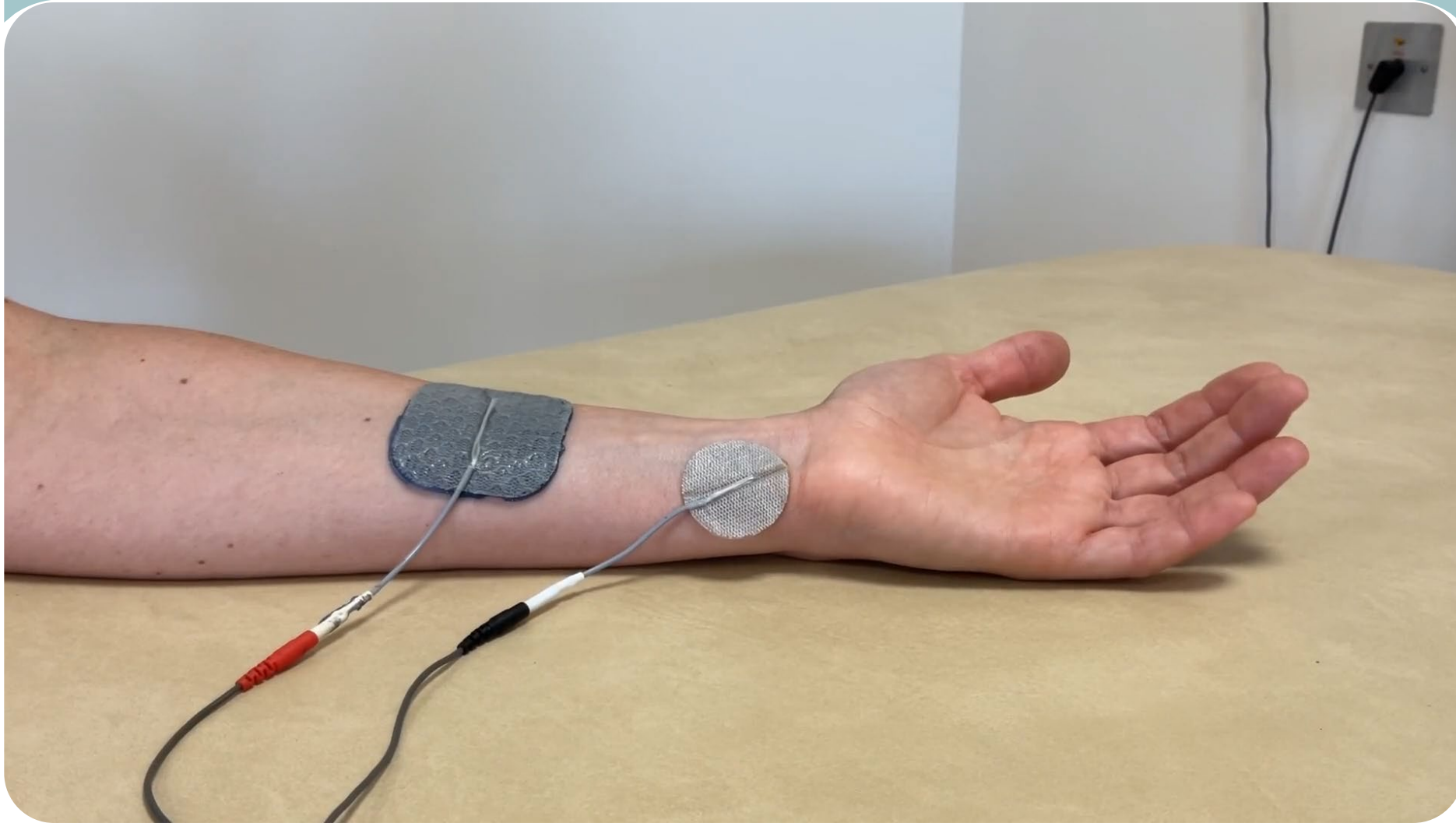


Microstim 2

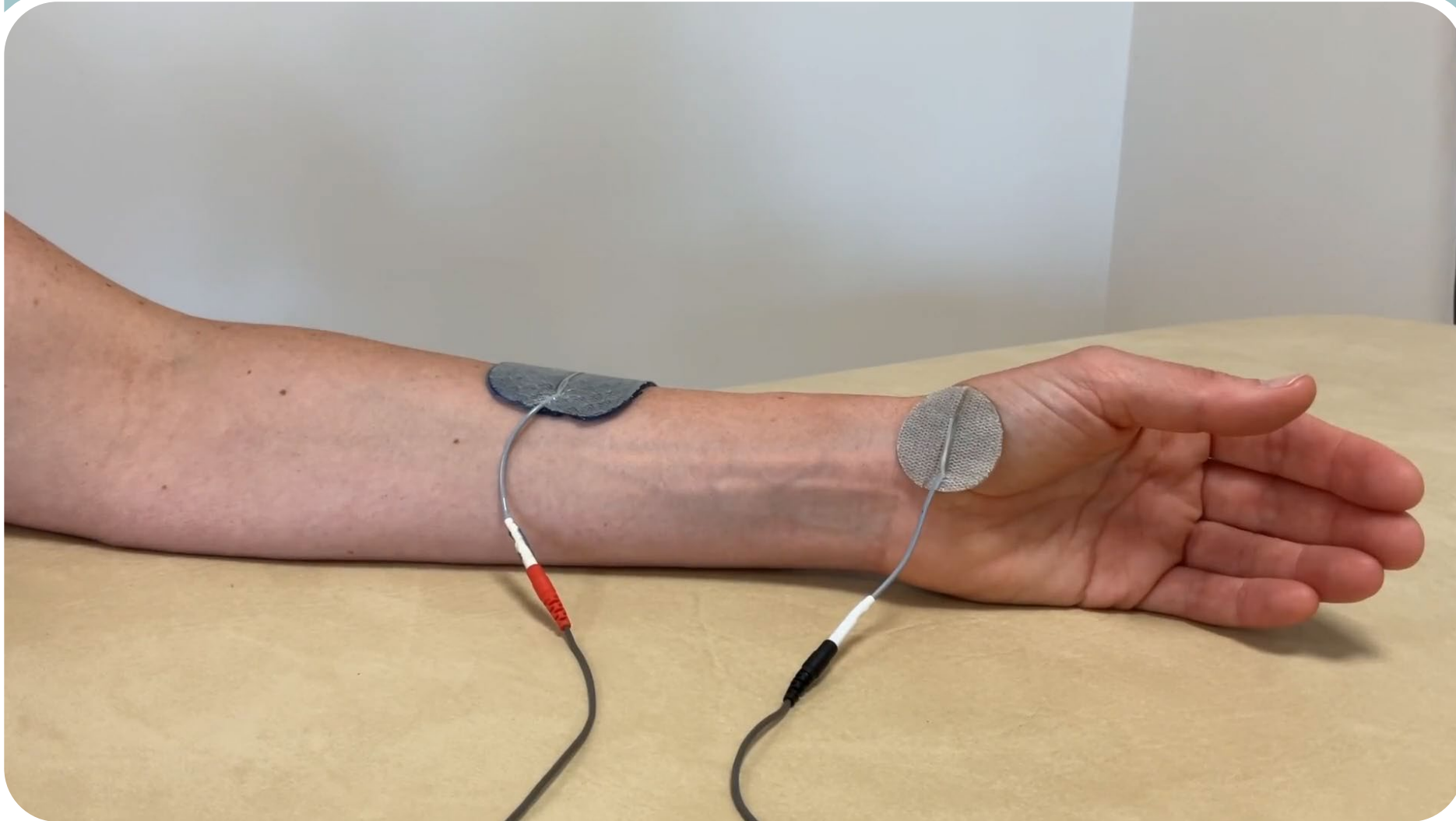
Modes -Overlapping



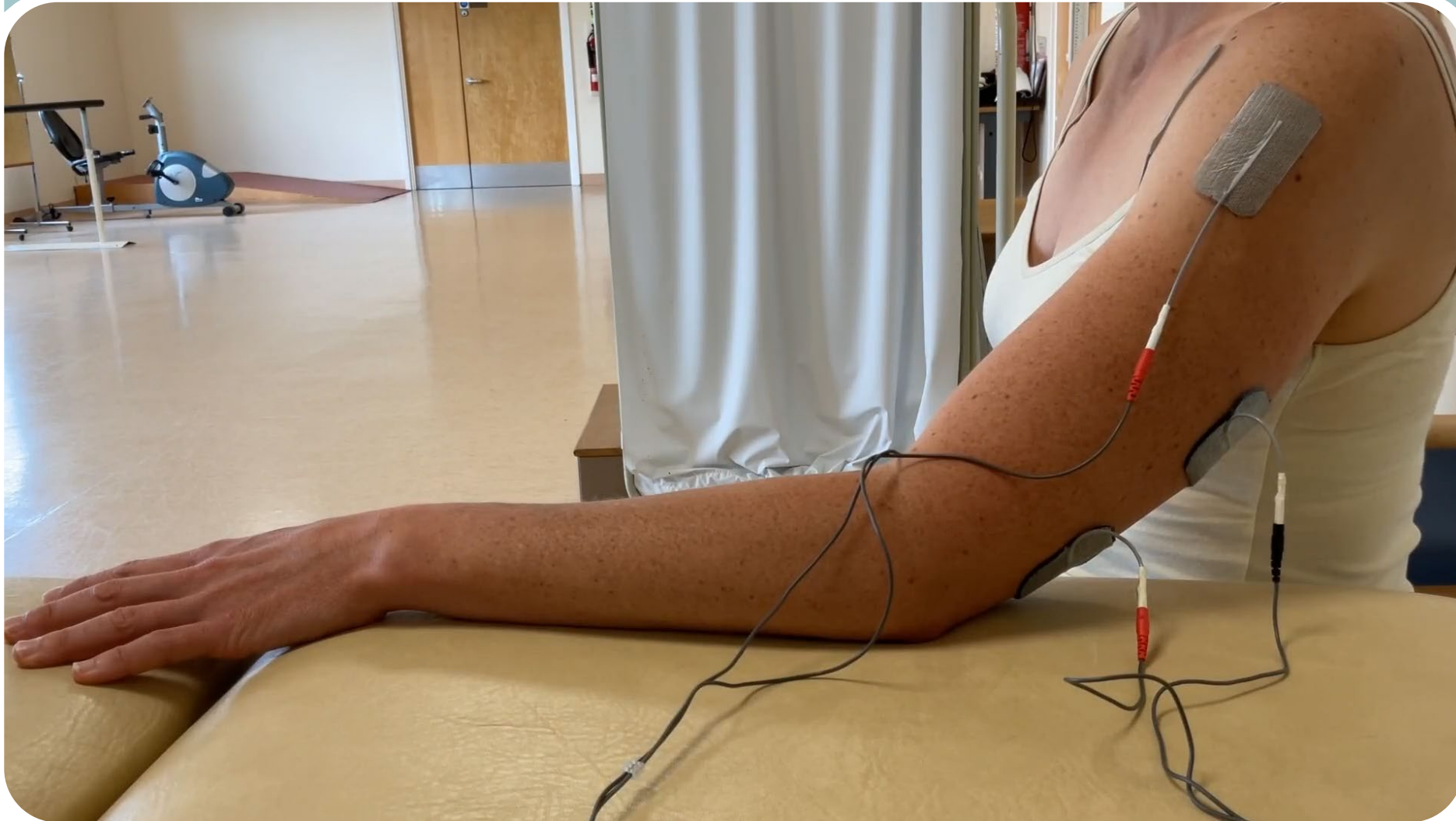
Lumbrical Activation



Thumb Abduction



Shoulder flexion with elbow extension (Transportation)



Helpful tips...

	Adding water to electrodes both before and after application can increase lifespan
	Trim hair to improve conductivity.
	Video or drawing around electrodes to enable easy replication of set up
	No moisturiser on skin
	Written instructions or video
	Managing patient set up expectations in relation to variability and encouraging patients to persist with set up.

Any questions?



References

- National Clinical Guideline for Stroke for the UK and Ireland. London: Intercollegiate Stroke Working Party; 2023 May 4. Available at: www.strokeguideline.org
- Stroke rehabilitation in adults (NG 236- Published 2023 – National Institute for Health and Care Excellence)

Useful Resources

- <https://pubmed.ncbi.nlm.nih.gov/28093928/>
- [Slide 1](#)