

HASOMED

RehaMove[®]

FES Cycling with RehaMove

Frequently Asked Questions



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Medical questions

What is functional electrical stimulation (FES)?

- FES is a therapy method where nerves are stimulated with electrical current in order to cause a muscular contraction.
- The aim is to produce a functional movement.

What's the difference between FES and other forms of electrotherapy?

TENS	Usual devices for electrotherapy	Advantages FES with RehaMove
<ul style="list-style-type: none"> · Stimulation of blood circulation, muscle relaxation, and pain reduction · No or low physiological contraction/movement · No building up muscle strength · No complex stimulation 	<ul style="list-style-type: none"> · Only few channels · No complex functional movement 	<ul style="list-style-type: none"> · Stimulation of functional movements · Motorlearning and call up of neuromuscular patterns · Cycling due to connection with the MOTOmed · External trigger (cause stimulation via manual switch) · Different training options: sequence, adaptive/constant mode

Classification of FES in electrotherapy

	Current	Frequency	Pulse	Main application	Indication
FES with RehaMove	Alternating current (AC)	10-50 Hz	20-500 μ s	Maintenance of muscle function or limitation of atrophy	Movement disorders after SCI and central lesions
Galvanisation	Constant current and direction			Iontophoresis: improvement of motor excitability etc.	Arthrosis, Spondylosis, Tendinosis, Ligamentosis, Neuralgia, etc.
Russian stimulation	Alternating current (AC)	2,5 Hz	Rectangular pulses in "bursts" (pulse sequences)		
TENS	Stimulation current with weak AC	2-220 Hz	Monophasic or biphasic pulses 50-200 μ s	Especially used for pain treatment (Analgesia)	Chronic, causally untreatable pain
Diadynamic currents	Currents with direct current (DC) and pulse current proportions	50-60 Hz	Sinusoidal half-waves, pulse width 8-10 ms	Analgesic, anti-inflammatory, reducing nerve pain, etc.	Rheumatic diseases, pain, Sudeck's Atrophy in case of disuse atrophy
Faradic current	Low-frequency stimulation currents (rectangular pulse)	40-80 Hz	Width: 0,5-5 ms, monophasic or biphasic	Motor stimulation	Normally innervated, weak muscles, mild paresis
Exponential current	Rectangular pulse with pulses of increasing intensity	<1000 Hz	100 ms-800 ms	Maintenance of muscle function or limitation of atrophy	Completely denervated muscles

Sources: Bossert (2006) Guideline Elektrotherapie; Robertson et al. (2006) Electrotherapy explained-Principles and practice

What's the advantage of FES Cycling compared with motion therapy without current?

FES Cycling	Motion training without FES
<ul style="list-style-type: none"> · Physiological muscle activation with high training intensity · Strong effects on the cardiovascular system by using the major muscles of the body · high neuronal input by stimulating a high number of afferences · Severe venous reflux · Cosmetic aspects: muscle buildup · Physiological effect: patients can "use" their arms and legs again 	<ul style="list-style-type: none"> · Passive movement of paralysed muscles, thus only low or no physiological activation

For which clinical pictures the training can be used?

- generally applicable in lesions with an intact lower motoneuron
- Spinal cord injury
- Stroke
- Traumatic brain injury (TBI)
- Multiple sclerosis
- Guillain-Barré syndrome
- Parkinson's disease
- Chronic polyarthritis (Rheumatoid arthritis)
- Cerebral palsy
- ALS (Amyotrophic Lateral Sclerosis)
- Orthopaedic diseases
- Muscle weakness and paralysis due to Impairments of the peripheral nerve

[Note: Patient's individual physical constitution or contraindications may forbid an FES application. Please consult your doctor before!]

Which muscle groups can be stimulated?

- generally every paralysed muscle with an intact lower motoneuron
- the surface of the muscle must be large enough for electrode placement

What are the contraindications for FES therapy?

FES and the RehaMove should not be used by a few people:

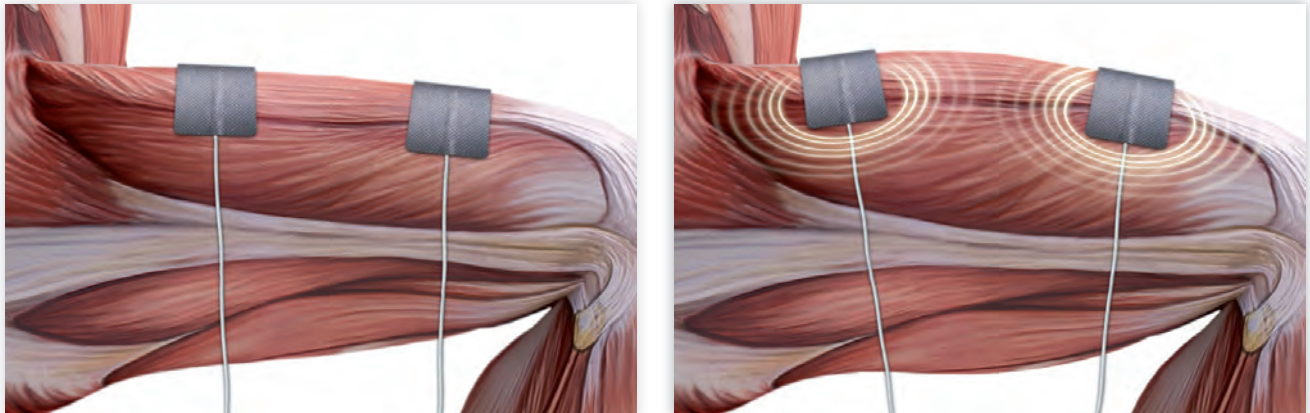
- who use cardiac pacemakers
- with unhealed fractures in lower extremities if the legs shall be trained; in upper extremities, the area of the shoulder girdle and upper ribs if the arms shall be trained
- with damages of the rotator cuff or the potential luxation of the shoulder joint, if the arms shall be trained
- with epilepsy
- with known allergies to electrode gel
- with metal implants underneath or near the muscle groups which are to be stimulated
- pregnant women should desist from using stimulation because the possible adverse effects are unknown and have not yet been rigorously investigated

Which training duration is recommended?

- depending on the patient, the clinical picture, and the training aim
- patient should be able to get used to the therapy
- training start: 5-10 minutes as the muscles are untrained and fatigue quickly
- up to 1 hour training per day is possible when training regularly
- higher therapeutic effect when training 3-4 times per week for 30 minutes

How does the stimulation work?

- Electrical pulses activate the peripheral motor nerves leading to the corresponding muscles.
- Pulses pass between two electrodes and thus activate the nerves between the electrodes.
- Each nerve has a particular threshold (all-or-nothing principle) triggering an action potential.
- Activation can take place when stimulation intensity is high enough (increase pulse width or current) in order to exceed this threshold.



Important terms

- Innervation:**
- supply the human organism with nerves for stimulus conduction
 - intact connection between nerve and muscle
- Denervation:**
- no intact nervous connection between organ/ muscle and brain
- Disuse atrophy:**
- muscular atrophy
- Afference:**
- all information are transferred via neuronal afferences from the periphery (arms, legs) to the central nervous system (CNS)
- Afferent stimulus setting:**
- conscious and arbitrary muscle activation in order to produce a directed movement
- Reafference:**
- information from the central nervous system to the periphery
- Muscle tone:**
- tension of the muscle
 - can be influenced by the number of activated motor units or by excitation frequency
 - higher muscle tone in case of spasms
 - muscle tone depends on malpositions and contractures
- Spasticity:**
- increased muscle tension with increased muscular proprioceptive reflex
- Adduction:**
- movement towards the center of the body or towards body axis (e.g. foot lifting)
- Abduction:**
- lateral movement of a body part

Level of paralysis und related functions

■ CERVICAL Division:

- breathing (C1 - C4)
- head & neck movement (C2)
- heart rate (C4 - C6)
- shoulder movement (C6 - C7)
- hand & finger movement (C7 - T1)

■ THORACIC Division:

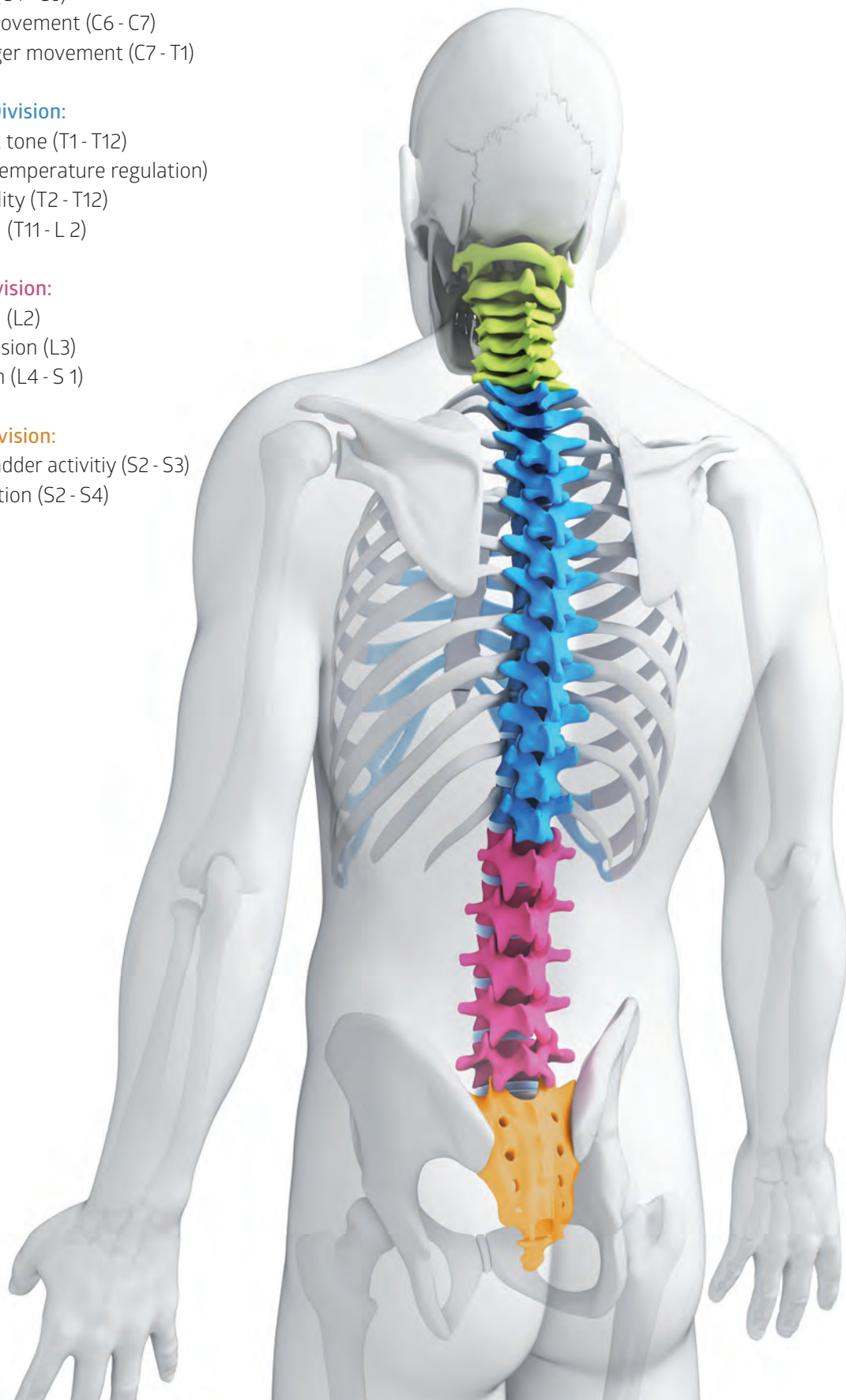
- Sympatetic tone (T1 - T12)
(including temperature regulation)
- trunk stability (T2 - T12)
- ejaculation (T11 - L2)

■ LUMBAR Division:

- hip motion (L2)
- Knee extension (L3)
- foot motion (L4 - S1)

■ SACRAL Division:

- bowel & bladder activitiy (S2 - S3)
- penile erection (S2 - S4)



Technical questions

How many muscles/ channels can be stimulated simultaneously?

- up to 8 stimulation channels/ 8 muscles

Which electrode size is used for which application?

- in general: the bigger the electrode the better (more comfortable for the user due to a lower current density)
- electrode size depends on the area of the muscle to be stimulated: for small muscles it's recommended to use small electrodes and the other way round
- electrode forms: oval or rectangular

Where adhesive electrodes have to be placed?

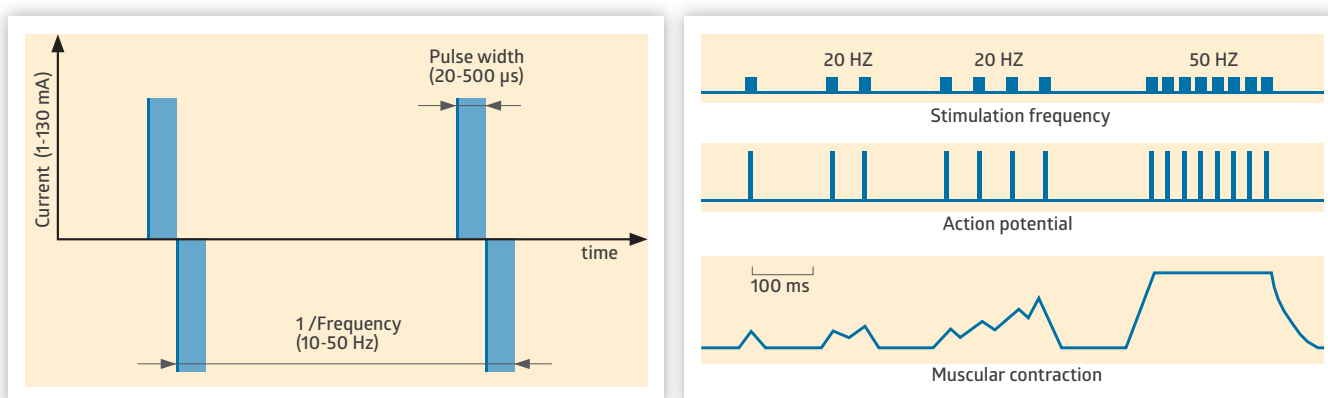
- centrally on the muscle belly
- for a higher therapeutic effect, electrodes have to be placed with a handbreadth between them
- shave if necessary to improve electrode adhesion and skin contact

Is it possible to use different electrodes?

- due to guarantee and warranty claims we recommend the use of HASOMED electrodes
- adhesive electrodes of the company HASOMED can be used for up to 15 applications
- application note: adhesive electrodes should not be used on skin where e.g. body lotion has been applied

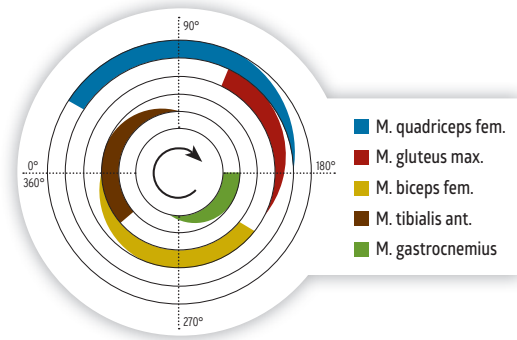
Which pulse forms are used with the RehaStim2?

- stimulation with biphasic rectangular pulses
- the negative pulse ensures an active dislodging to prevent electrolytic effects or skin irritations



In which way the movement is synchronised with the stimulator?

- stimulator and MOTOMed communicate via data cable
- data exchange of all relevant parameters (angle or position of the crank arm, rpm and rotational direction, symmetry, gear, time, distance)
- stimulation sequences of controlled channels are triggered by angle-based MOTOMed data; thus, the stimulator “knows” when to stimulate which muscle



Which parameters are available and what do they effect?

- Frequency:**
- number of pulses per second, indicated in Hertz (Hz)
 - stimulation frequency determines the type of muscle fiber, which is activated, and which muscular strength is achieved
 - optimum frequency for a muscle depends on the individual distribution of muscle fibers
 - if the frequency is set too low, the muscle reacts only with twitching without strength
 - between 10-50 Hz

- Current:**
- charge flowing per time, measured in Milliampere (mA)
 - between 0-130 mA
 - alternating current is used (balanced charge)

- Pulse width:**
- duration of pulses, measured in Microseconds (μ s)
 - between 20-500 μ s

Which parameters are typically used for complete and incomplete paralysis?

- generally depending on the clinical picture of the patient
- start with low values and carefully increase gradually
- aim: a smooth and powerful contraction
- in case of spasticity, better use less Hz first to avoid an excessive increase of the muscle tone (up to 30 Hz)
- it's advisable to massage muscles before training to desensitize them, longer warm up phase
- in case of maintained sensitivity: the tolerance limit of the patient is the limit of stimulation (after familiarization phase, intensity can generally be increased gradually)

Complete SCI	Stroke, TBI and spinal cord lesion with (residual) sensibility
<ul style="list-style-type: none"> · Current: 40-90 mA · Pulse width: 250-500 μs · Current test starting with 0 mA/ 250 μs · MOTOMed: servo cycling with gear 0-1 	<ul style="list-style-type: none"> · Current: 30-40 mA · Pulse width: 100-300 μs · Current test starting with 0 mA/ 100 μs · MOTOMed: servo cycling with gear 0-6

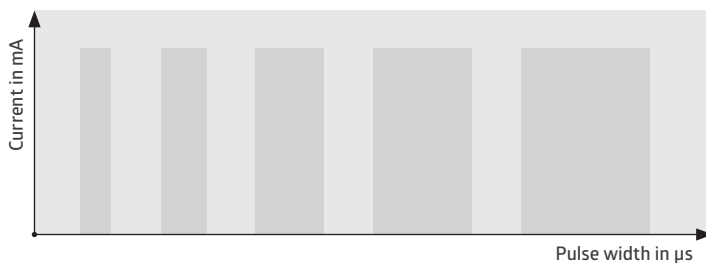
How endurance and strength can be trained?

- for strength training higher frequencies are necessary (starting with 30 Hz)
- for endurance training only lower frequencies are used (up to 30 Hz)
- Type of muscle fiber:

Type I fibers – slow twitch	Type II fibers – fast twitch
<ul style="list-style-type: none"> · contract and relax slowly · resistant to fatigue · for endurance-type activities · well supplied with blood: red · stimulation with frequencies < 30 HZ 	<ul style="list-style-type: none"> · quick and powerful contraction · white muscle fibers · for "sprint" and muscular strength · 2 subtypes: a) fast-fatigue-resistant b) fast-fatigable · stimulation with frequencies > 30 Hz

What is the ramp for?

- pulse width is built slowly and gradually
- especially suitable for sensitive and anxious patients
- example: ramp 5; pulse is built in 5 steps with increasing intensity



Is it possible to adapt the current with increasing training duration?

- depends on the patients adapting threshold and sensitivity
- during training, current can be adjusted for each channel; frequency and pulse width can be adjusted for all channels

With which motion trainer the RehaStim2 can be used?

- only use the RehaStim2 with the MOTOMed viva 2 (without light version) as arm and leg trainer

When the adaptive training is used?

- in general: therapist decides on the patient group to be treated
- adaptive training: adapts automatically to the patient's performance
- stimulation is adapted to the residual muscle function of the patient
- mostly used in incomplete and central paralysis: stroke, TBI
- adjustment of maximum and minimum pulse width:
 - when a certain speed is reached, stimulation will stop slowly
 - stimulation starts again below this speed

When the constant training is used?

- in general: therapist decides on the patient group to be treated
- constant training: stimulation intensity remains constant even if the patient pedals faster and more powerful
- mostly used in complete paraplegia

Sequence training with RehaStim

How does the sequence training work?

- RehaStim can be used without the MOTOMed as stand-alone device
- cyclical movements of arms and legs can be trained (e.g. grasping, flexion)

When the sequence training is used?

- for activation or movement of single muscles
- in order to increase training intensity, e.g. alternating activation of quadriceps muscle and biceps muscle
- Sequence training is used where the RehaMove cannot be applied, e.g. when reinitiating complex motion sequences like grasping
- RehaStim includes templates for the most common applications e.g. FES walking, crawling, sit-to-stand or shoulder stabilization

How can I get the sequence training?

- can be activated via additional licenses for present stimulators

What is the difference between percent and second mode in sequence training?

- percent sequence training includes all templates for gait training/FES walking in percentage according to the natural gait phases in a complete gait cycle
- second sequence training includes templates in seconds (start + duration of each single muscle in seconds)

What effect has the button “Period” in the percentage-sequence training?

- duration of the complete sequence is adjusted
- periods are adjustable in seconds

What effect has the button “Interval” in the second-sequence training?

- there is always a break between single sequences
- break times can be selected in steps of one second

Which trigger types are available?

- Sequence training offers a manual or automatic triggering
- an additional external trigger software with external single or double trigger is available

RehaMove Solutions for Movement Therapy with FES

