

Supplementary file 3

Standardised exercise protocol

20-minute in-suit session used in the active and sham WB-EMS arms

EMS-PL HF STUDY — Whole-body electromyostimulation in patients with chronic heart failure undergoing in-hospital cardiac rehabilitation (DRKS00040045).

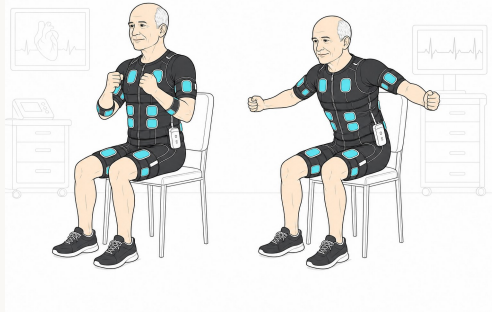
Session overview

Each session consists of two blocks of exercises separated by a two-minute rest, giving a total of 20 minutes of in-suit exercise. The block comprises nine progressive exercises performed in a fixed order; each exercise is performed for 45 s with a 15-s recovery interval before the next exercise. The protocol is identical in both the active and the sham WB-EMS arms; only the stimulation parameters differ (active: 85 Hz strength pattern titrated to 50–60% of the individually tolerated intensity; sham: 100 Hz “massage” pattern at a minimally perceivable intensity).

Each numbered exercise below specifies the starting position, the movement to be performed, and the work–rest timing, accompanied by a schematic illustration of the technique with WB-EMS electrode placement. Whole-body electromyostimulation is delivered concurrently with the exercise via the Wiemspro Revolution Pro suit, addressing ten major muscle groups (quadriceps, hamstrings, gluteals, lumbar paraspinals, latissimus dorsi, trapezius, abdominal muscles, pectorals, biceps brachii and triceps brachii).

Exercises

Exercise 1. Trunk inclination with heel-press and bilateral arm extension



Starting position

Seated on a chair with backrest. Arms and forearms held at 90° flexion and adduction (forearms joined in front of the body at chest level); lower limbs apart at hip width with heels gently pressed into the floor.

Movement

Slight forward inclination of the trunk with simultaneous pressing of the heels into the floor. Abduction of the forearms, followed by extension of the upper limbs in the sagittal plane, then return to the starting position.

Timing

45 s work / 15 s rest

Exercise 2. Seated march with contralateral arm-leg coordination



Starting position

Seated on a chair with backrest.

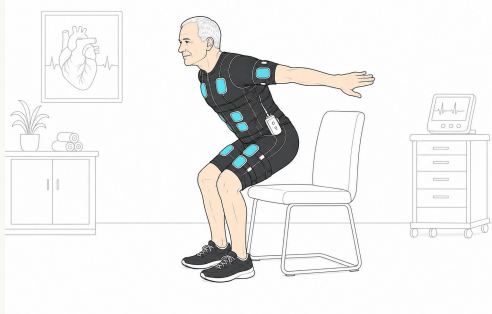
Movement

Seated marching with alternating, contralateral movement of the upper and lower limbs. Dynamic movement.

Timing

45 s work / 15 s rest

Exercise 3. Partial sit-to-stand with posterior upper-limb extension



Starting position

Seated on a chair with backrest. Upper limbs extended forward at 90°, palms facing each other.

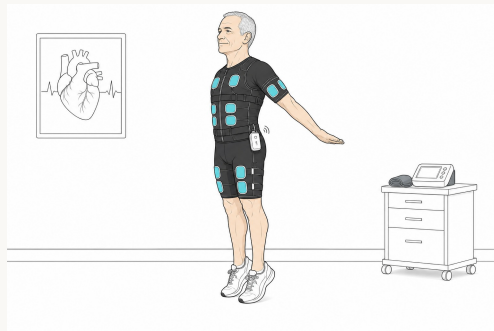
Movement

Partial rise from the chair with simultaneous posterior extension of the upper limbs; lower limbs remain in slight flexion at the knees and the trunk inclines forward.

Timing

45 s work / 15 s rest

Exercise 4. Calf raise with bilateral arm extension and gluteal contraction



Starting position

Standing. Upper limbs flexed at the elbows, hands clenched into fists at shoulder level.

Movement

Rise onto the balls of the feet with simultaneous extension of the upper limbs, opening of the hands and gluteal contraction. In the final phase the hands are behind the buttocks with the upper limbs fully extended.

Timing

45 s work / 15 s rest

Exercise 5. Alternating lunges with arm flexion



Starting position

Standing.

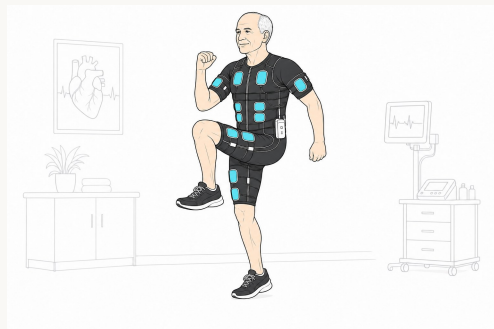
Movement

Alternating forward lunges with simultaneous arm elevation through flexion of the upper limbs.

Timing

45 s work / 15 s rest

Exercise 6. Dynamic march with high knees



Starting position

Standing.

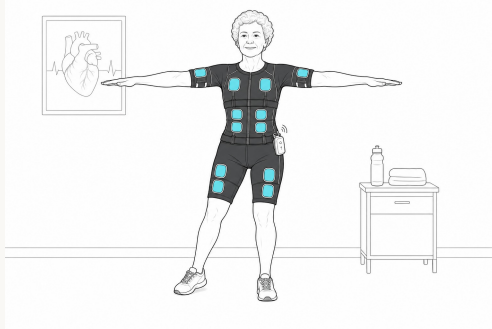
Movement

Dynamic marching in place with vigorous upper-limb movement and high knee lift.

Timing

45 s work / 15 s rest

Exercise 7. Lateral side-step with bilateral arm abduction (90°)


Starting position

Standing. Upper limbs flexed and adducted at the elbows, hands placed one over the other with the dorsal surface facing the ceiling.

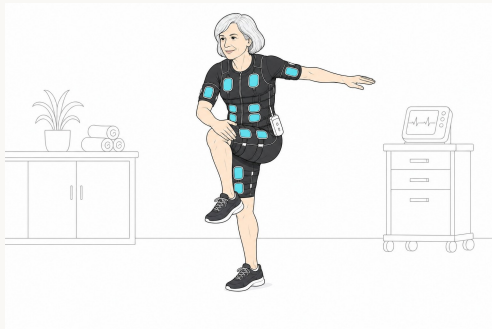
Movement

Lateral side-step alternately to the left and to the right, with simultaneous full abduction of the upper limbs to 90° and rotation of the hands so that the dorsal surface faces the floor. Return to the starting position.

Timing

45 s work / 15 s rest

Exercise 8. Contralateral knee-to-hand crunch (standing)


Starting position

Standing.

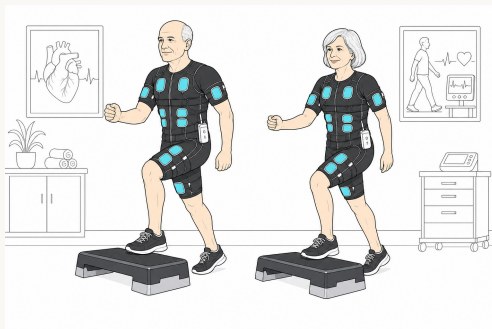
Movement

Alternating contralateral knee-to-hand contact with simultaneous abdominal contraction: right hand to left knee, left hand to right knee.

Timing

45 s work / 15 s rest

Exercise 9. Step-up / step-down on a low platform


Starting position

Standing in front of a low step platform.

Movement

Alternating step-up onto and step-down from the platform.

Timing

45 s work / 15 s rest

Citation

Sendrowski D, Polańska-Szczap A, Hus B, Vlaieva A, Sendrowska MK, Markowski S, Carlé-Calo A, Kozłowski D. EMS-PL HF STUDY — Supplementary file 3: Standardised exercise protocol. Pomeranian University in Słupsk; Janusz Korczak Voivodeship Specialist Hospital in Słupsk, 2026. DRKS00040045.