## Supplemental materials

<table>
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<th>Item</th>
<th>Control group</th>
<th>Intervention group</th>
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<td>1. Brief name: ‘provide the name or phrase that describes the intervention.’</td>
<td>Combined Robot assistance and routine VR training</td>
<td>Combined Robot assistance and NeuCir-VR training</td>
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| 2. Why?: ‘describe any rationale, theory, or goal of the elements essential to the intervention’ | Rationale for combined robot assistance and routine VR training: Multiple studies have shown that robot-assisted lower extremity motor function training can improve patients’ flexibility and coordination after stroke and improve their balance and walking ability.

1. Early start of robot-assisted gait training after stroke can accelerate bi-hemispheric reorganization of motor-related brain regions, especially the superior temporal gyrus, cingulate gyrus, and posterior central gyrus.

2. In addition, VR can provide a variety of scenes and sensory stimulation through an enriched environment and dual tasks. A previous study found that enriched environmental training can activate brain-derived neurotrophic factor (BDNF) protein expression, improve neurological function, and enhance resilience to cerebral ischemia. Some studies have shown that enriched environment treatment may promote ischemic stroke recovery by providing neuroprotection, enhancing angiogenesis, and promoting functional recovery after ischemic injury. Essential elements:

   - Robot-assisted training
   - Highly repetitive tasks
   - Motor relearning
   - VR training | Rationale for combined assistance and NeuCir-VR training: Multiple studies have shown that robot-assisted lower extremity motor function training can improve patients’ flexibility and coordination after stroke and improve their balance and walking ability.

1. Early start of robot-assisted gait training after stroke can accelerate bi-hemispheric reorganization of motor-related brain regions, especially the superior temporal gyrus, cingulate gyrus, and posterior central gyrus.

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   - Robot-assisted training
   - Highly repetitive tasks
   - Motor relearning
   - NeuCir-VR training
   - Enriched environment
   - Multisensory stimulus feedback |
| 3. What materials?: ‘describe any physical or informational materials used in the intervention, including those provided to participants or used in intervention delivery or in training of intervention providers. Provide information on where the materials can be accessed’ | The robot-assisted rehabilitation system called iReGo (Shanghai Jinshi Robot Technology, China) is used (http://www.ga-robot.com/product/irego#).

   - It is a lower limb training robot with pelvic support programmed to move individuals’ lower limbs along a predetermined trajectory on a ground walking track.

   - The applications of VR will run through the Steam software application on the laptop computer connected to an HTC VIVE headset (three base stations had been set up in the room) (Pro Eye Series).

   - Study-specific manuals describing Combined Robot assistance and VR training were produced and are used by physiotherapists delivering therapy.

   - Study-specific documentation is used by physiotherapists to record session attendance and session duration. The robot-assisted rehabilitation system records data on the robot difficulty level used, the type of VR scenario, the type of training tasks, the duration of each task, and the score of each task.

   - Physiotherapists are delivering combined robot assistance and VR training program receive specific training. | The robot-assisted rehabilitation system called iReGo (Shanghai Jinshi Robot Technology, China) is used (http://www.ga-robot.com/product/irego#).

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   - Physiotherapists are delivering combined robot assistance and NeuCir-VR training program receive specific training. |
| 4. What (procedures)?: ‘describe each of the procedures, activities and/or processes used in the intervention, including any enabling support activities’ | In the control group, a 20-minute robot-assisted training and a 10-minute VR training program are delivered separately.

   - Robot-assisted training is divided into 3 kinds of tasks (Figure 4a-4c). And the difficulty of each task can be divided into 3 modes: easy, general, and difficult. | In the intervention group, a combination of robot assistance and NeuCir-VR training program is conducted for 30 minutes simultaneously.

   - The training is divided into 4 kinds of tasks (Figure 4h-4j). And the difficulty of each task can be divided into 3 modes: easy, general, and difficult. Be sure to...
Be sure to wear an iReGo safety belt before training.

Task 1: Standing training lasts for 5 minutes. In the easy mode, patients stand with their eyes open. In general mode, patients stand with their eyes closed. In the difficult mode, patients stand on one leg and each leg for 2.5 minutes.

Task 2: Sitting training lasts for 5 minutes. In the easy mode, iReGo will provide all the assistance to help patients complete sit-to-stand continuously. In general mode, patients need to actively participate in the training, and iReGo will provide partial assistance to help patients complete sit-to-stand continuously. In the difficult mode, patients need to complete sit-to-stand by themselves continuously, and iReGo will not provide assistance except for safety protection.

Task 3: Walking training lasts for 10 minutes. Patients are trained to walk in the treatment area after wearing iReGo belts. In the easy mode, the patients can only control the speed and direction of walking through a remote sensor, and iReGo will provide all the assistance to ensure the safety. In general mode, patients can control the walking speed and direction by themselves. The iReGo will provide partial assistance. In the difficult mode, patients can only control the walking speed and direction by themselves, and iReGo will not provide assistance except for safety protection. If it is not safe for the patients to operate the remote sensor by themselves, the physiotherapist will operate it.

All task instructions will be told to patients by the iReGo voice assistant. After 20 minutes of robot-assisted training, 10 minutes of VR training immediately followed.

VR training is based on Game training, which lasts for 10 minutes. There are four games: Matching Pattern, Whac-A-Mole, Obstacle Avoidance 1 (horizontal direction), and Obstacle Avoidance 2 (vertical direction) (Figure 4d-4g). And the difficulty of each task can be divided into 3 modes: easy, general, and difficult.

Be sure to wear the iReGo safety belt and VR headset before training.

In the Matching Pattern game, patients need to find a pattern that matches the standard pattern and twist their waist and lower extremities to match the two patterns perfectly. As the difficulty mode increases, the pattern becomes more complex, and more patterns need to be judged. In the Whac-A-Mole game, the patients need to quickly shoot a gopher out of a hole (there are nine holes, and the gophers come out randomly) by twisting his waist and lower extremities. As the difficulty mode increases, the gophers come out faster and faster. In Obstacle Avoidance 1 (horizontal direction) game and Obstacle Avoidance 2 (vertical direction) game, patients need to quickly move their waist and lower extremities to avoid horizontal or vertical obstacles. As the difficulty mode increases, obstacles appear faster and faster.

All task instructions will be told to patients by the VR voice assistant through the headset.

The therapist can customize the difficulty and intensity (duration) of each task according to the limb function of the patients. The treatment session lasts 30 minutes.
### References

