

Therapy for chronic incomplete cervical spinal cord injury

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Research question: For adults living with a high-level Spinal Cord Injury at least 5+ years post-injury, how does the provision of a high level of physiotherapy and/or occupational therapy hours for the purpose of restoring upper limb function, compared to reduced therapy hours and a delegated model of care, impact functional upper limb outcomes?

Date: 13/6/24

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2. Summary

There is some evidence that therapy continues to be effective in improving upper limb function and strength for people in the chronic stage of cervical spinal cord injury. Conventional physiotherapy or occupational therapy focussing on hand and arm function is possibly effective in this cohort and participants may be benefited by conventional training combined with robot-assisted upper limb training and/or electrical stimulation. It may be more likely that benefit could be achieved for people with incomplete rather than complete injury.

However, the level of evidence reviewed is generally low to very low certainty. Insufficient evidence was found to determine optimal frequency or timing to achieve the possible benefits for upper limb function and strength. Insufficient evidence was found to determine whether gains were likely to be achieved after 5 years.

No studies were found investigating the efficacy of a delegated model of care for the people with chronic cervical spinal cord injury.

3. Improving function for chronic spinal cord injury

The chronic phase of spinal cord injury is usually defined as starting from 12 months post-injury and represents a period during which the neurological function of the person stabilises. Some sources indicate that functional gains can still be made up to 2 years post-injury and possibly longer in the case of incomplete injury (Spinal Cord Injury Guidelines, 2022; Willig et al, 2022; Kalsi-Ryan et al, 2021). Therapy and management during this phase will often focus on adaptive skill-building and preventing secondary complications (contracture, pressure sores, inactivity, weight gain, decline in strength and fitness) (Spinal Cord Injury Guidelines, 2022; Kalsi-Ryan et al, 2021).

Some evidence shows that functional outcomes may be improved during the chronic stage of spinal cord injury. Chiou et al (2022) found moderate quality evidence that arm-crank exercise could improve cardiorespiratory fitness in people with chronic spinal cord injury. However, the study does not differentiate effect for higher and lower levels of injury. A review from Figoni et al (2021) that looks specifically at those with higher level injuries found inconclusive evidence aerobic exercise could improve fitness for people with tetraplegia.

4. Therapy targeting upper limb function

Reviews analysing evidence into the effectiveness of therapies for improvement of upper limb function for people with people with chronic spinal cord injury have generally showed positive results from very low certainty evidence. One review found exercise interventions were able to improve upper extremity motor control and functional ability in people with chronic cervical spinal cord injury (Kloosterman et al, 2009). The authors noted good methodological quality in the included studies. However, later reviews tend to find positive results from very low certainty evidence. Lu et al (2014) found evidence that improvements in upper limb function and

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strength was possible for people in the chronic stage of spinal cord injury. While they note that the internal validity of the studies was fair to good, the external validity was generally poor.

The *Australian and New Zealand Clinical Practice Guidelines for the physiotherapy management of people with Spinal Cord Injury* evaluate the evidence and clinical consensus surrounding physiotherapy management strategies for people with spinal cord injury (Glinsky et al, 2022). As of 2022, none of the management strategies that the authors identified were supported by good quality evidence, though many achieved high levels of clinical endorsement (refer to [Table 1](#)).

A more recent meta-analysis of variables associated with improved function hand-arm training programs for people with cervical spinal cord injury notes:

analysis of 8 training programmes showed that training programmes using only skill training or combined with strength and endurance training exhibited a moderate effect on [arm-hand skilled performance]. Training programmes that integrate the task-oriented training components: functional movements, clear functional goals, real-life object manipulation, multiple movement planes, total skill practice, context-specific environment, exercise variety, and bimanual practice demonstrated a moderate effect on [arm-hand skilled performance] (Bertels et al, 2023, p.9).

The authors also compared effect sizes for participants with complete and incomplete injuries, and for sub-acute and chronic stages. While the authors suggest that the results were no different for each group, they also note that the meta-analysis was not reported due to an insufficient number of studies.

Bertels et al (2022) also note that a minimum of 8 weeks seems to be required to achieve moderate effect size. However, they also note that dosage parameters are not reported consistently and were unable to identify optimal frequency or intensity of therapy to achieve clinically meaningful results.

Bertels et al (2022) note very low certainty evidence around robotic assisted therapy for upper limb function. They provide a strong consensus recommendation in favour of the therapy. More recent evidence provides inconsistent support for this recommendation. Ho et al (2023) reviewed seven studies looking into the effectiveness of robotic-assisted upper limb rehabilitation to improve upper limb function after cervical spinal cord injuries. Four of the studies showed statistically significant improvements in upper limb function and strength. The studies showing significant results in favour of the intervention (4 out of 7) were all small sample case-series or observational studies. The only randomised control trial included in the review did not produce a statistically significant effect.

Other recent studies have produced suggestive evidence. A 2023 observational study of 6 patients with chronic C5-7 level injury investigated the effects of the functional hand protocol. The participants were between 30 and 90 years old. Two participants were <2 years post-injury. The other four participants had sustained spinal cord injury between 13 and 35 years prior (Ciardi et al, 2023). The functional hand protocol is described as:

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a structured shortening of fingers and thumb’s flexor muscles, so to make the patient able to perform light, functional and useful everyday grips; functional hand needs to be supported by the activity of radial extensor of carpus, or by an orthosis to stabilize the wrist (thus permits movement through biceps activation) (Ciardi et al, 2023, p.2).

The authors found that the functional hand protocol may improve hand function, even many years after injury.

Table 1 Evidence and consensus recommendations for physiotherapy interventions
(Source: Glinsky et al, 2022)

Intervention	Outcome	Evidence	Consensus	Level
upper limb and hand function training for people with tetraplegia	Upper limb function	Very low	92%	Strong +
robotic upper limb training for people with tetraplegia	Upper limb function	Nil	89%	Strong +
upper limb virtual reality training	Upper limb function	Very low	96%	Weak +
combined functional electrical stimulation and upper limb and hand function training	Upper limb function	Very low	100%	Weak +
Strength training for partially paralysed muscles	Voluntary strength	Very low	-	Weak +
Electrical stimulation	Voluntary strength	Very low	95%	Weak +

combined with strength training				
Electrical stimulation	Voluntary strength	Very low	-	Weak -
Shoulder exercises	Pain	Very low	81%	Strong +

5. References

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