Guidelines for the Management of Patients With Spinal Cord Injury: The Type and Timing of Rehabilitation

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Introduction

The objective of this study is to develop guidelines that outline the appropriate type and timing of rehabilitation in patients with acute spinal cord injury (SCI)
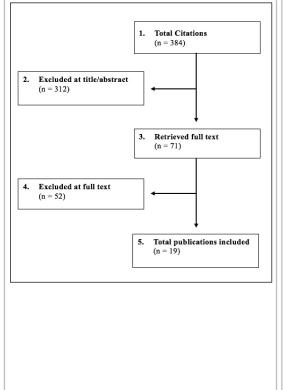
Inclusion and Exclusion Criteria

	Inclusion	Exclusion
Patients	• Adults with acute or subacute traumatic spinal cord injury at any level • Undergoing rehabilitation therapy • ASIA Grade A-D (or comparable)	• Pediatric patients • Pregnancy • Cord compression due to tumor, hematoma, degenerative disease • ASIA E (or comparable) • Non-traumatic etiology > 40% • Follow-up < 70%
Intervention (KQ 1&2)	• KQ1: Earlier implementation of rehabilitation therapy • KQ2: Different rehabilitation strategies	• KQ2: neural prosthetics, cell therapy, spinal cord stimulators, speech/language therapy only, pharmacological therapy, respiration/breathing therapy only
Comparison	• KQ1: Delayed initiation of rehabilitation therapy • KQ2: Different rehabilitation strategies	
Predictive Factors (KQ3)	• Patient characteristics (e.g., age, sex, race, BMI, marital status, education level, vocational status) • Injury characteristics (e.g., presence of comorbidities; level, cause, and/or severity of injury; neurologic and functional status at admission; surgical stabilization)	
Outcomes	**Efficacy/effectiveness** • Neurologic outcomes (e.g., American Spinal Injury Association, ASIA Impairment Scale) - Functional outcomes - patient or physician reported outcomes (e.g., FIM, functional performance) - Muscle strength **Safety** • Complications • Mortality • Rehospitalization **Cost data** • Incremental Cost-Effectiveness Ratio (or a similar cost-effectiveness metric comparing treatment costs and effectiveness)	• Muscle/nerve activity (electromyography) • Muscle/skeletal composition • Physiological outcomes (VO2 max, peak work, etc.) • KQ4: costs only, utilities only, differences in outcomes only
Study design	• KQ1: comparative studies comparing early with delayed initiation of rehabilitation therapy, controlling for injury severity • KQ2: comparative studies comparing different rehabilitation therapies, controlling for injury severity • KQ3: cohort studies assessing important predictors of outcomes following rehabilitation, while controlling for injury severity • KQ4: full economic studies	• In vitro biomechanical studies • Animal studies • Cadaveric studies • Case series
Publication	• Studies published or translated into English in peer-reviewed journals	• Abstracts, editorials, letters • Duplicate publications of the same study which do not report on different outcomes • Single reports from multicenter trials • White papers • Narrative reviews • Proceedings/abstracts from meetings • Articles identified as preliminary reports when results are published in later versions

Methods

A systematic review of the literature was conducted to address the following questions: (1) Does the time interval between injury and commencing rehabilitation affect outcome? (2) What is the comparative effectiveness of different rehabilitation strategies? (3) Are there patient or injury characteristics that impact the efficacy of rehabilitation? (4) What is the cost-effectiveness of various rehabilitation strategies?

From Evidence to Recommendations: Important Considerations

A multidisciplinary guideline development group used this information, in combination with their clinical expertise, to develop recommendations for the type and timing of rehabilitation. The benefits and harms, financial impact, acceptability, feasibility and patient preferences were carefully considered.

1. **Total Citations** (n = 384)
2. **Excluded at title/abstract** (n = 312)
3. **Retrieved full text** (n = 71)
4. **Excluded at full text** (n = 52)
5. **Total publications included** (n = 19)

Results

There were no significant differences in FIM-Locomotor, Lower Extremity Motor Score (LEMS), distance walked in 6 minutes or timed walk between BWSTT and conventional rehabiliation groups.

BWSTT versus Conventional Rehabiliation

Author	Outcome	ASIA B BWSTT	ASIA B Conventional	ASIA C/D BWSTT	ASIA C/D Conventional
Dobkin 2007	**FIM-L**				
	6 weeks (mean ± SD)	1.07 ± 0.27	1.06 ± 0.24	3.0 ± 2.1	3.9 ± 2.1
	3 months (mean ± SD)	1.31 ± 1.11	1.94 ± 1.73	4.7 ± 2.1	5.5 ± 1.4
	6 months (mean ± SE)	2.0 ± 0.6	2.5 ± 0.5	5.3 ± 0.3	5.6 ± 0.27
	12 months (mean ± SE)	2.7 ± 0.7	2.1 ± 0.6	5.8 ± 0.3	5.6 ± 0.32
	LEMS				
	6 weeks (mean ± SD)	4.1 ± 5.5	4.6 ± 6.5	29.1 ± 14.2	29.5 ± 11.5
	3 months (mean ± SD)	6.1 ± 8.6	7.3 ± 10.3	34.7 ± 13.3	35.7 ± 11.3
	Distance walked in 6 min (m)				
	3 months (mean ± SD)	10.7 ± 32	16.4 ± 36.3	247.7 ± 187.6	251.3 ± 203.7
	Timed walk (m/s for 15.2 m)				
	6 weeks (mean ± SD)	0.11 ± NR	0.16 ± 0.08	0.69 ± 0.40	0.51 ± 0.42
	3 months (mean ± SD)	0.41 ± NR	0.27 ± 0.13	0.85 ± 0.55	0.84 ± 0.54
	6 months (mean ± SE)	0.22 ± 0.07	0.24 ± 0.09	0.98 ± 0.10	1.09 ± 0.10
	12 months (mean ± SE)	0.25 ± 0.08	0.72 ± 0.08	1.21 ± 0.11	1.09 ± 0.10

Patients receiving BWSTT achieved superior improvements in maximum hip extension during stance, maximum plantar flexion during pre-swing and spatial-temporal gait parameters.

BWSTT versus Conventional Rehabiliation

Author	Outcome	ASIA C/D BWSTT	Conventional
Lucareli 2011	**Angular Kinematic Parameters**		
	DF stance (°)	0.0 (-0.4, 0.4)	0.7 (0.2, 1.1)
	PF pre-swing (°)	0.0 (-1.8, 1.9)	-9.7 (-11.6, -7.8)
	Knee ext. stance (°)	-1.4 (-4.9, 2.1)	-1.1 (-4.6, 2.4)
	Knee flex. swing (°)	-0.4 (-4.4, 3.5)	1.5 (-2.4, 5.5)
	Hip flex. walking (°)	0.7 (-2.7, 4.1)	1.1 (-2.3, 4.5)
	Hip ext. stance (°)	-0.2 (-1.4, 1.08)	-7.8 (-9.1, -6.6)
	Spatial-Temporal Parameters		
	Gait velocity (ms⁻¹)	0.4 (0.09, 0.71)	0.02 (-0.51, 0.55)
	Time of gait cycle (s)	0.85 (0.24, 1.46)	-0.1 (-0.74, 0.54)
	Stance/duration of support (% of cycle)	-4.04 (-5.45, -2.63)	-0.1 (-2.05, 1.85)
	Swing/balance duration (% of cycle)	3.91 (2.47, 5.35)	-0.7 (-2.61, 1.21)
	Step length (cm)	10.25 (8.34, 12.16)	0.5 (-1.68, 2.68)
	Distance (m)	10.75 (3.19, 18.31)	1.8 (-4.14, 7.74)
	Cadence (steps per min⁻¹)	15.0 (7.94, 22.06)	4.19 (-2.94, 11.32)

Patients in the Functional Electrical Therapy group had significantly greater improvements on the FIM Motor, FIM Self-Care and SCIM Self-Care subscores than the control group.

FET versus Control Rehabilitation

Author	Outcome	Baseline FES	Baseline Control	Discharge FES	Discharge Control
Popovic 2011	FIM Motor Subscore	7.2	6.8	22.2	10.9
	FIM Self-Care Subscore	8.1	7.8	28.2	17.8
	SCIM Self-Care Subscore	1.9	3.3	12.1	6.4
	TRI HFT				
	10 objects	37.1	27.2	53.8	38.5
	9 rectangular blocks	49.7	29.3	49.7	38.4
	cylinder (able to hold)	1.0	1.90	1.7	1.33
	cylinder (torque, nm)	0.26	0.26	1.13	2.59
	credit card (able to hold)	1.0	1.33	1.7	1.41
	credit card (force, nm)	4.42	2.67	12.5	8.76
	wooden bar (able to hold)	0.8	0.63	1.5	0.96
	wooden bar (thumb direction, length values, cm)	1.67	2.88	10.94	10.5
	wooden bar (little finger direction, length values, cm)	5.56	3.17	12.78	11.85

Predictive Value of Patient Factors

Certain patient and injury factors are associated with neurological outcomes, activities of daily living, ambulation, quality of life, rehospitalization and pressure ulcers.

Predictive Value of Injury Factors

Evidence-Based Recommendations and Guidelines

Our recommendations were: (1) We suggest rehabilitation be offered to patients with acute spinal cord injury when they are medically stable and can tolerate required rehabilitation intensity; (2) We suggest BWSTT as an option for ambulation training in addition to conventional overground walking, dependent on resource availability, context, and local expertise; (3) We suggest that individuals with acute and subacute cervical SCI be offered functional electrical stimulation as an option to improve hand and upper extremity function; and (4) Based on the absence of any clear benefit, we suggest not offering additional training in unsupported sitting beyond what is currently incorporated in standard rehabilitation.