Reviewer ID: Carlos L. Cano Herrera, Matthew Querée, Janice Eng

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Research Summary – Upper Extremity Motor Score (UEMS) – Upper Limb

Author Year Country Research Design Setting	Demographics and Injury Characteristics of Sample	Validity	Reliability	Responsiveness Interpretability
Sato et al. 2023 Psychometric study to evaluate the criterion validity of the trunk assessment scale for spinal cord injury (TASS) and the construct validity of the TASS and trunk control test in individuals with SCI (TCT-SCI) Rehabilitation hospital, Japan	N=30 Mean (SD) age 63.8 (10.7) years 5M, 25F Traumatic tetraplegia (n=15), traumatic paraplegia (n=5), non-traumatic tetraplegia (n=2), traumatic paraplegia (n=8) AIS A (n=6), AIS B (n=0), AIS C (n=8), AIS D (n=16) Mean (SD) time from onset to assessment 1142.0 (1720.7) days	Construct validity (Spearman coefficients) between TASS/TCT-SCI and UEMS: • TASS: r = 0.46 (0.12-0.70) • TCT-SCI: r = 0.82 (0.73-0.93)		
Lili et al. 2023 Observational cross-sectional study to determine	N = 25 participants with SCI Mean (range) age: 58.4 (44.6-72.2) years 18 males, 7 females Etiology: Traumatic (n	Correlation analysis (Spearman coefficients) between SCIM-III total and UEMS: r = 0.21		

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which aspects of independence in activities of daily living are correlated with upper extremity functioning in individuals with SCI Outpatient clinic at Sahlgrenska University Hospital in Gothenburg, Sweden	= 20), non-traumatic (n = 5) Level of injury: Cervical (n = 17), thoracic (n = 8) ASIA: A-B (n = 14), C-D (n = 11) Mean (SD) time since injury: 17.5 (15.4) years			
Lena et al. 2021 Prospective, observational study 3 Italian rehabilitation hospitals	N=140 non-traumatic SCI, 92M, 48F Mean age: 60 ±16 years (range 15–86) Level: Cervical: 30 Thoracic: 78 Lumbar: 32	The correlation between the SCIM self-care subscore and the UEMS was fair, although significant ($r = 0.407$; $p < 0.001$). The correlations improved by considering persons with tetraplegia and	Inter-rater correlation: r = 0.931 (0.855-0.980), p = 0.001; Krippendorff's Alpha (95% CI) = 0.668 (0.562-0.772), p = 0.001 Internal consistency: Cronbach Alpha = 0.995 (0.993-0.996)	

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	AIS A: 32 AIS B: 11 AIS C: 33 AIS D: 64	paraplegia separately, dividing the assessment at admission from one at follow-up and dividing incomplete and complete lesions.		
Harkema et al. 2016 Prospective multicenter observational; Neuromuscular Recovery Scale (NRS) 13-item version 6 outpatient rehabilitation centers in the Christopher and Dana Reeve Foundation NRN	N=152 (123M, 29F) Mean (SD) age: 36 (15) Median (range) time since SCI: 0.9 (0.1-45.2) years Level of Injury: 110 cervical, 42 thoracic AIS-A/B/C/D: 43/21/39/49 Physician-referred outpatients without progressive lesions above T11, capable of stepping using body weight support, with ability to wean off	Pearson's r (95%CI) between UEMS and: • Modified Functional Reach: 0.23 (0.09, 0.36) • Berg Balance: 0.3 (0.19, 0.41) • 6MWT: 0.24 (0.15, 0.34) • 10MWT: 0.24 (0.15, 0.34) Pearson's r (95%CI) between UEMS and: • NRS Overall Phase: 0.41 (0.31-0.50) • NRS Summary Score: 0.49 (0.39-0.59)		**Responsiveness:** UEMS Standardized Response Means after Locomotor Training: • All individuals: 0.38 • AIS-A/B: 0.21 • AIS-C: 0.64 • AIS-D: 0.35 Median (range) number of sessions of NRN-standardized locomotor training: 70 (23-520) **Interpretability:** Mean (SD) UEMS: All individuals: • Enrollment: 35 (14) • Discharge: 37 (13)

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	anti-spasticity medication Median (range) number of sessions of NRN-standardized locomotor training: 70 (23-520)	• NRS Body Weight Supported Treadmill Subscale: 0.24 (0.13, 0.36) • NRS Trunk & Leg Subscale: 0.39 (0.28, 0.50) • NRS Arm & Shoulder Subscale: 0.63 (0.54, 0.71) • NRS Arm & Shoulder + Trunk & Leg Subscales: 0.54 (0.44, 0.63)		AIS-A/B: • Enrollment: 33 (16) • Discharge: 34 (15) AIS-C: • Enrollment: 31 (12) • Discharge: 35 (10) AIS-D: • Enrollment: 40 (10) • Discharge: 42 (9) * Enrollment = pre-intervention; discharge = post-intervention; median (range) number of sessions of NRN-standardized locomotor training: 70 (23-520)
Kalsi-Ryan et al. 2016 Multicenter, observational,	N =53 (48M, 5F) Mean (SD) age 49.6 (15.6)			**Responsiveness:** Mean Difference, Std Error, Std Response Mean and Effect Sizes (Mean diff; SE; SRM;

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longitudinal, cohort study 5 centers (7 sites) in Ontario, Canada	All acute SCI, 0-10 days post-injury AIS-A/B/C/D: 11/5/16/21 Level of injury: 51 cervical, 2 thoracic			ES) at different post-injury intervals: ISNCSCI (ASIA) UEMS: • 1 month -> 3 month: 5.06; 0.72; 1.00; 0.38 • 1 month -> 6 month: 7.21; 0.99; 1.10; 0.54 • 1 month -> 12 month: 10.03; 1.24; 1.31; 0.76 Breakdown by motor completeness and other time intervals available in article
Sisto et al. 2016 Cross-sectional; Neuromuscular Recovery Scale (NRS) 11-item version 7 NRN outpatient	N=350 (267M, 83F) AIS-C/D: 101/249 Mean (SD) age: 42 (16) Median (range) time since SCI: 0.9 (0.1-53.1) Incomplete SCI			**Interpretability:** Mean (SD) initial UEMS scores: • All patients: 39 (11) • Cervical SCI: 35 (10) • High Thoracic SCI: 50 (1)

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rehabilitation clinics	Presence of nonprogressive lesion above T11 No current inpatient rehabilitation No anti-spasticity medication use in the past 3 months Capable of stepping using body weight support Referred to PT by physician			• Low Thoracic SCI: 50 (0) Median (range) initial UEMS scores: • All patients: 41 (4-50) • Cervical SCI: 36 (4-50) • High Thoracic SCI: 50 (48-50) • Low Thoracic SCI: 50 (50-50)
Tester et al. 2016 Prospective; testing the Neuromuscular Recovery Scale 14-item version 6 outpatient sites in the Christopher and Dana Reeve Foundation	N = 72 (57M, 15F) completing 20 sessions of standardized locomotor training Mean (SD) age: 36 (15) Median (range) time since SCI: 0.7 (0.1-14.7) years N=45 longer than 6 months 44 cervical, 28 thoracic			**Interpretability:** Smallest Real Difference (SRD): 1.3

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NeuroRecovery Network	AIS-A/B/C/D: 17/10/20/25			
Misirlioglu et al. 2016 Cross-sectional, clinical measurement to investigate the validity of the Duruöz Hand Index (DHI) in the assessment of hand function in patients with tetraplegia	N = 40; Mean Age = 35.6 (10.1) years; Mean Duration of Injury = 116.7 (93.7) months; Turkish sample	**Convergent Validity:** Excellent correlations between DHI and UEMS: r =-0.80, p = 0.001		
Velstra et al. 2016 Prospective longitudinal multicenter study 5 European SCI centers; Recruitment	N = 61, 45 male Mean age 47, SD = 19 Acute (16-40 days after injury) tetraplegia at recruitment 58/61 traumatic SCI AIS at 1 month: A=16, B=10, C=7, D=28	Backward multiple binary logistic regression reveals that combinations of select predictors have similar predictive accuracy as that of 10 predictors: Combination of FDP & Delto predicting		

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between 2009 ~ 2012		GRASSP-QtG at 6 months: • Sensitivity = 86.4% (74.7-93.3%), Specificity = 86.5% (75.5-93.0%) All 10* unilateral muscle predictors predicting GRASSP-QtG at 6 months: • Sensitivity = 86.4% (74.7-93.3%), Specificity = 86.5% (75.5-93.0%) Combination of ElbowFlex, WristExt, EDC & FPL predicting SCIM-Self-care at 6 months: • Sensitivity = 81.8% (61.5-92.7%), Specificity =		

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		89.2% (75.7-97.2%) All 10* bilateral muscle predictors predicting SCIM-Self-care at 6 months: • Sensitivity = 86.4% (66.7-95.3%), Specificity = 89.2% (75.3-95.7%) Combination of WristExt, FDP, Delto & FPL predicting SCIM-Mobility at 6 months: • Sensitivity = 96% (80.5-99.3%), Specificity = 91.2% (77.0-96.7%) All 10* bilateral strength predictors predicting SCIM-Mobility at 6 months:		

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		• Sensitivity = 92% (75.0-97.8%), Specificity = 91.2% (77.0-96.7%) UEMS = Upper extremity motor score GRASSP-MMT = GRASSP Manual muscle testing *Predictors included: - ElbowFlex = Elbow flexors (UEMS) - WristExt = Wrist extensors (UEMS) - Triceps = Elbow extensors (UEMS) - FDP = Long finger flexors (UEMS) - AbdDigV = Small finger abductors (UEMS) - Delto = M. anterior deltoid (GRASSP-MMT)		

Author Year Country Research Design Setting	Demographics and Injury Characteristics of Sample	Validity	Reliability	Responsiveness Interpretability
		- EDC = M. extensor digitorum communis (GRASSP-MMT) - OPP = M. opponens pollicis (GRASSP-MMT) - FPL = M. flexor pollicis longus (GRASSP-MMT) - DI1 = M. first dorsal interosseus (GRASSP-MMT) URP-CTREE analysis revealed that GRASSP-QlG subtest** can accurately predicted upper-limb function: • "The combination of proximal and distal upper limb muscles as well as the early ability to initiate simplified grasp movements (ie, CylGrasp,		

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		LatPinch, and TTPinch), predicted upper limb function very well" (p300) **Predictors included: • CylGrasp = Cylindrical grasp • LatPinch = Lateral key pinch • TTPinch = Tip-to-tip pinch		
Marino et al. 2015 Repeated measures Studying the CUE-Test (CUE-T) Outpatient rehab center	N=50, (36M) Mean age 48.1, SD=18.2, range 17~81 Neurological levels of injury: C2~T6 AIS-A/B = 20/50 AIS-C/D = 30/50	Spearman's correlation between AISA UEMS and Capabilities of Upper Extremity Test (CUE-T): 0.827		

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Velstra et al. 2015
 	
Prospective longitudinal multicenter study
 	
5 European SCI centers; Recruitment between Jan 2009 ~ Jun 2011
	N = 74 (51M)
	Mean age 49, SD=18
	
	SCI patients <= 10 days post-injury at enrollment
	
	AIS at 1 month: A=18, B=12, C=10, D=34
	69/74 traumatic SCI
		Spearman Correlations ($p<0.0001$):
		• At 1 month postinjury:
		  ○ GRASSP-MMT subscale & ASIA UEMS = 0.95
		  ○ GRASSP-SWM subscale & ASIA LT = 0.58
		• At 3 month postinjury:
		  ○ GRASSP-MMT subscale & ASIA UEMS = 0.94
		  ○ GRASSP-SWM subscale & ASIA LT = 0.64
		• At 6 month postinjury:
		  ○ GRASSP-MMT subscale & ASIA UEMS = 0.94
		  ○ GRASSP-SWM subscale & ASIA LT = 0.65
				Responsiveness:
				SRMs with respect to 1~3, 1~6, 1~12, 3~12, 3~6, 6~12 months post-injury:
				• In all patients: ASIA UEMS: 0.69~1.29
				• In AIS-A/B patients: ASIA UEMS: 0.79~1.21
				• In AIS-C/D patients: ASIA UEMS: 0.63~1.33
				
				Breakdown by motor completeness and other time intervals available in article

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		• At 12 month postinjury:
		  ○ GRASSP-MMT subscale & ASIA UEMS = 0.88
		  ○ GRASSP-SWM subscale & ASIA LT = 0.66
		(GRASSP-MMT = Manual Muscle Testing subscale – based on Daniels and Worthington, 1995)		

Oleson & Marino 2014 Longitudinal, with convenience sample Studying the revised CUE-Questionnaire (CUE-Q; 5pt instead of 7pt scale)	N = 46 (42M) Median age 44±21 yrs AIS-A = 14, B = 5, C = 8, D = 19 Right motor level: C1-C4 = 11, C5 = 25, C6 = 7, C7-C8 = 3 Left motor level: C1-C4 = 9, C5 = 27, C6 = 5, C7-C8 = 5	Spearman correlations between ASIA UEMS and: • Revised CUE-Q total at: Admission: r=0.89 Discharge: r=0.70 • FIM Self-care subscale at: Admission: r=0.76 Discharge: r=0.73		**Responsiveness:** Effect size of admission-discharge ASIA UEMS change: 0.87

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"Data were obtained at admission and discharge from acute inpatient rehabilitation"	28 Caucasian, 18 African-American Etiology: fall = 18, MVA = 17, sports = 8	Spearman correlations between change in ASIA UEMS and: • Change in CUE-Q total: r=0.07 • Change in FIM Self-care subscale: r=0.41		
Scivoletto et al. 2013 Analysis of prospectively collected data Studying the ISNCSCI N=600 SCI unit of a rehab hospital in central Italy	N = 600 (440M) Mean age 50.35±18.8 Mean time from lesion 51.6±36.8 days Mean time in rehab 123.6±86.3 days 334 traumatic, 266 nontraumatic Lesion level: cervical 192, thoracic 289, 110 lumbar 233 AIS-A, 67 B, 158 C, 142 D			**Interpretability:** UEMS: Admission mean =40.15, SD=14.9, Discharge mean = 42.9, SD=12.2 MCID=2.72, ES-based estimate for small change=2.98, substantial change = 7.45 **Mean (SD) UEMS scores:** Cervical A (Admission)=19.3(14.7)

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				Cervical A (Discharge)=23.6(14.4) Cervical B (Admission)= 19.05(11.6) Cervical B (Discharge)=28(9.3) Cervical C (Admission)=23.8(11.6) Cervical C (Discharge)=37(12.6) Cervical D (Admission)=35.4(10.9) Cervical D (Discharge)=41.2(7.9) MID by Injury Level and Severity: Cervical A = 2.91 Cervical B = 2.1 Cervical C = 2.42 Cervical D = 1.9 Effect size-based estimate for small/large changes in UEMS scores: Cervical A = 2.94/7.35

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				Cervical B/C = 2.32/5.8 Cervical D = 2.18/5.45
Marino et al. 2012 Cross-sectional study of the CUE-Test (CUE-T) N=30	N = 30 (23M, 7F) Mean age 44.8 Chronic SCI participants SCI participants with level of injury at: C4-6: 9 complete, 6 incomplete C7-T1: 7 complete, 4 incomplete T2-6: 4 complete, 0 incomplete	Spearman correlation of ASIA UEMS with Capabilities of Upper Extremity Test (CUE-T): 0.91		
Kalsi-Ryan et al. 2012 Cross-sectional multi-center trial focused on establishing the	Study site: (total N=72) Toronto Rehabilitation Institute, Canada (N=15) Vancouver Coastal Health, Canada (N=10)	Construct validity: Precision of GRASSP was established by comparing the sensation and strength subtest items to the sensory		

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reliability and validity of GRASSP Test-retest reliability study: N=45 (North American centers) Inter-rater reliability study & Construct validity study: N=72 Seven centers collected data: Rehabilitation Institute of Chicago, Chicago, Illinois; Toronto Rehabilitation Institute, Toronto, Ontario; Vancouver Coastal Health,	Rehabilitation Institute of Chicago, USA (N=10) Thomas Jefferson University, USA (N=10) Balgrist University Hospital, Switzerland (N=9) Krakenhaus Hohe Worte, Germany (N=8) Traumacenter Murnau, Germany (N=10) Sample description: Mean age (years): 39.7 (10.7) Time post-injury (years): 7.6 (6.1) AIS complete: n=28 (39%) AIS incomplete: n=44 (61%) C6-C7 AIS motor level: 52.5% C4-C6 AIS sensory level: 66.0%	and motor upper limb items in the ISNCSCI. On average, 54% of the sample showed discordance in sensory innervation when assessed with the GRASSP due to the additional test locations of sensory testing included (added palmar locations and increased response levels of the SWM). Table 1. On average, 53% of the sample showed a different degree of motor innervation when assessed with the GRASSP due to the added muscles in the GRASSP, and the designation of the		

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Vancouver, British Columbia; Thomas Jefferson University, Philadelphia, Pennsylvania; Balgrist University Hospital, Switzerland; Krakenhaus Hohe Worte, Germany; Traumacenter Murnau, Germany.	Chronic tetraplegia AIS grades: A: 38.8% B: 25.2% C: 16.6% D: 19.4% Each site engaged two examiners who were either occupational or physical therapists who had expertise with SCI. In total 14 examiners were involved in the study, 12 of whom were occupational therapists and two of whom were physical therapists. Two workshops (one in Europe and one in North America) were conducted to train the examiners on the study protocol and	most caudal level in the ISNCSCI. Table 2. Concurrent validity: Spearman correlation coefficients were used to establish the association between GRASSP subtests and the CUE, SCIM-total and SCIM-SS (self-care subscale). All associations were positive and significant (P<.0001). Table 3. *Right and left data were combined for the analyses SCIM-SS showed stronger association than SCIM-total with GRASSP subtests. CUE showed the strongest associations with GRASSP,		

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<table>
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Interpretability</th></tr>
<tr><td></td><td>appropriate use of all study measures.
Inclusion and exclusion criteria: Individuals with chronic (more than 6 months after injury) traumatic tetraplegia who were neurologically and medically stable, between the ages of 16 and 65 and able to provide informed consent were included in the study. Individuals with moderate brain injury who were neurologically unstable or individuals with any other pathology causing upper limb impairment were excluded.</td><td>indicating strong association between self-perceived function and tested impairment.</td><td></td><td></td></tr>
<tr><td></td><td colspan="4">Table 2.<table><tr><th></th><th>Agreement</th><th>Discordance</th></tr></table></td></tr>
</table>

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<tr><td></td><td colspan="4">
<table>
<tr><th>ISNCSCI motor level:</th><th>n</th><th>n (%)</th><th>1*
n (%)</th><th>2*
n (%)</th></tr>
<tr><td>Total sample (R)</td><td>72</td><td>36 (50)</td><td>19 (26)</td><td>17 (24)</td></tr>
<tr><td>Total sample (L)</td><td>72</td><td>34 (47)</td><td>20 (28)</td><td>17 (24)</td></tr>
<tr><td>C2-C4 (R)</td><td>10</td><td>1 (1)</td><td>6 (8)</td><td>3 (4)</td></tr>
<tr><td>C2-C4 (L)</td><td>14</td><td>6 (8)</td><td>6 (8)</td><td>1 (1)</td></tr>
<tr><td>C5 (R)</td><td>10</td><td>3 (4)</td><td>2 (3)</td><td>5 (7)</td></tr>
<tr><td>C5 (L)</td><td>9</td><td>3 (4)</td><td>1 (1)</td><td>5 (7)</td></tr>
<tr><td>C6 (R)</td><td>23</td><td>13 (18)</td><td>3 (4)</td><td>7 (10)</td></tr>
<tr><td>C6 (L)</td><td>21</td><td>11 (15)</td><td>5 (7)</td><td>4 (6)</td></tr>
<tr><td>C7 (R)</td><td>17</td><td>9 (12)</td><td>6 (8)</td><td>2 (3)</td></tr>
<tr><td>C7 (L)</td><td>16</td><td>6 (8)</td><td>7 (10)</td><td>3 (4)</td></tr>
<tr><td>C8 (R)</td><td>4</td><td>2 (3)</td><td>2 (3)</td><td>0 (0)</td></tr>
<tr><td>C8 (L)</td><td>5</td><td>1 (1)</td><td>1 (1)</td><td>3 (4)</td></tr>
<tr><td>T1 and below (R)</td><td>8</td><td>8 (11)</td><td>0 (0)</td><td>0 (0)</td></tr>
<tr><td>T1 and below (L)</td><td>7</td><td>7 (10)</td><td>0 (0)</td><td>0 (0)</td></tr>
</table>
</td></tr>
<tr><td>Burns et al. 2011

Cross-sectional validation of WISCI II

Canada</td><td>Patients who are able to ambulate >= 10m
N = 76 (79%M)

Mean age: 43.3±13.8

Mean post-injury time: 6.32±5.99 years</td><td>Spearman correlations between UEMS (tetraplegic only, N=41) and:
Self-selected WISCI level: 0.496 (p<0.0001)</td><td></td><td></td></tr>
</table>

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	45% paraplegia, 55% tetraplegia AIS-A/B/C/D: 3%/1%/8%/88%	• Self-selected WISCI Speed: 0.491 ($p<0.05$) • Max WISCI level: 0.502 ($p<0.0001$) • Max WISCI speed: 0.469 ($p<0.0001$) More details of paraplegic/tetraplegic values available in article.		
Rudhe et al. 2009 Cross-sectional analysis. Part of larger international multicenter GRASSP study. N=29	N = 29 with traumatic or ischemic SCI Time since injury = 1-15 months (mean = 4.5 ± 3 months) Age= 19-81 years (mean = 50 ± 18 years) 16 males, 13 females ASIA-A/B/CD: 12/4/13	SCIM III scores correlated well with UEMS, MMT and hand capacity tests total scores ($P<0.001$): Please see Table 1 below. Estimation of SCIM-III Self care score using ASIA UEMS: $R^2_{adjusted} = 0.69$		
	Table 1 **Spearman's correlations between SCIM-III and other measures**			

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<tr><td></td><td colspan="4"><table>
<tr><th>SCIM III</th><th>UEMS</th><th>MMT</th><th>Hand Capacity Tests</th></tr>
<tr><td>Feeding</td><td>0.73</td><td>0.75</td><td>0.67</td></tr>
<tr><td>Bathing upper body</td><td>0.80</td><td>0.77</td><td>0.77</td></tr>
<tr><td>Bathing lower body</td><td>0.72</td><td>0.76</td><td>0.71</td></tr>
<tr><td>Dressing upper body</td><td>0.73</td><td>0.76</td><td>0.76</td></tr>
<tr><td>Dressing lower body</td><td>0.64</td><td>0.70</td><td>0.60</td></tr>
<tr><td>Grooming</td><td>0.88</td><td>0.89</td><td>0.80</td></tr>
<tr><td>Self-care Total</td><td>0.82</td><td>0.84</td><td>0.80</td></tr>
<tr><td>Respiration & Bladder Total</td><td>0.63</td><td>0.68</td><td>0.65</td></tr>
<tr><td>Mobility Total</td><td>0.65</td><td>0.71</td><td>0.72</td></tr>
<tr><td>Total Score</td><td>0.78</td><td>0.78</td><td>0.76</td></tr>
<tr><td colspan="4">UEMS = upper extremity muscle score
MMT = manual muscle testing</td></tr>
</table></td></tr>
<tr><td rowspan="2">Marino et al. 2008

Inter-rater and intra-rater reliability study.

Inpatients and outpatients from the Kessler Institute for Rehabilitation.</td><td>N = 16 patients with SCI (2 inpatient, 14 outpatient)
10 men, 6 women, age range from 18-65 years

N = 16 examiners (8 physicians, 8 physical therapists)
> 2 years of experience in field of SCI</td><td></td><td>Test-retest, Inter-rater, Intra-rater
Inter-rater:
Please see Table 2 below.

Intra-rater:
Excellent AIS UEMS ICC = 0.98</td><td>Interpretability:
Minimal Detectable Change:
Smallest Real Difference:
UEMS = 2.0</td></tr>
<tr><td colspan="4">Table 2<table>
<tr><th></th><th>All Patients</th><th>Complete</th><th>Incomplete</th></tr>
</table></td></tr>
</table>

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<table>
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<tr><td></td><td colspan="3"><table>
<tr><td>AIS light touch</td><td>0.96[a]</td><td>0.99[a]</td><td>0.86[a]</td></tr>
<tr><td>AIS pin-prick</td><td>0.89[a]</td><td>0.99[a]</td><td>0.69[b]</td></tr>
<tr><td>AIS total motor</td><td>0.98[a]</td><td>1.00[a]</td><td>0.95[a]</td></tr>
<tr><td>UEMS (tetra)</td><td>0.96[a]</td><td>n/a</td><td>n/a</td></tr>
<tr><td>LEMS</td><td>n/a</td><td>n/a</td><td>0.98[a]</td></tr>
<tr><td colspan="4">a- Excellent reliability (ICC ≥0.75)
b- Adequate reliability (ICC 0.4<0.74)</td></tr>
</table></td><td></td><td></td></tr>
<tr><td>Dahlgren et al. 2007

Cross-sectional study to examine whether the Klein-Bell ADL Scale discriminates cervical SCI patients in daily activities and to explore its applicability in this group of patients, to examine the association</td><td>N=55 (43M, 12F)
Mean age=39
Mean time since injury=5.5 years

Inclusion criteria: traumatic SCI or acute vascular injury in the cervical level of the spinal cord</td><td>Correlation between raw sum score in the K-B Scale and the UEMS for shoulder muscles to intrinsic muscles r=0.63 (P<.01)</td><td></td><td></td></tr>
</table>

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between basic ADL and upper extremity function, and to investigate if grip ability can be discerned in the scale. SCI Unit, Sweden.				
Graves et al. 2006 Retrospective medical record analysis USA	N = 6,116 AIS motor scores 80% male 48% paraplegia	Separate UE/LE motor scores more accurately represented motor function than a single combined score: P<.0001 (82% in 1D model and 87% of variance in 2-D model)		
Marino & Graves 2004 Secondary analysis of prospectively collected data	N = 4338 (3443M, 895F) People with traumatic SCI discharged between Jan. 1994 and Mar. 2003	• R^2 =0.59 for total ASIA motor score in predicting total FIM motor. • R^2 = 0.71 for separate UE/LE ASIA scores in		**Interpretability** Normative data (N=4338): • Median ASIA Motor at discharge: 50 (IQR= 31~70)

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Model Spinal Cord Injury Systems centers. USA	Median age: 33 (IQR= 22~46) Median time from injury to rehab admission: 15 (IQR= 9~28) days Median time in rehab: 46 (IQR= 29~73) days AIS-A/B/C/D: 2049/511/655/1123 Neurologic category: Complete tetraplegia: 854 Incomplete tetraplegia: 1464 Complete paraplegia: 1195 Incomplete paraplegia: 825	predicting total FIM motor. • R^2=0.44 for predicting FIM UE score with total ASIA motor score • R^2=0.72 for predicting FIM LE score with separate UE/LE ASIA scores • R^2=0.60 for predicting FIM LE score with total ASIA motor score • R^2=0.65 for predicting FIM UE score with separate UE/LE ASIA scores		• Median Upper Extremity Motor Score at discharge: 44 (IQR= 23~50) • Median Lower Extremity Motor Score at discharge: 0 (IQR= 0~30) **Flooring and ceiling effect:** • Upper Extremity Motor Score: 42% of subjects at ceiling (50) • Lower Extremity Motor Score: 53% of subjects at floor (0)
Fujiwara et al. 1999 Cross-sectional Subjects recruited from National	N = 14 (12M, 2F) C6 complete tetraplegic patients Mean age: 30.7 (13~62) Mean time since SCI: 462 (169~1080) days	• Spearman's rho between ASIA Motor Score with FIM Motor Score: 0.73 ($p<0.01$) • Spearman's rho between ASIA Motor Score with		

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Murayama Hospital (1995-1997)		FIM Transfer Score: 0.64 ($p<0.01$)		
Marino & Goin 1999 Cross-sectional design collected at 6 months post SCI to develop a short-form version of the Quadriplegia Index of Function (QIF) Regional Spinal Cord Injury Center	N=95 (85M, 10F) Mean (SD) age: 31.2 (13.2); range from 16-68 years Tetraplegia, non-ambulatory at 6 months.	Correlation between UEMS and short-form QIF: $\rho = 0.824$		
Yavuz et al. 1998 Cross-sectional Ankara Rehabilitation Center	N=29 (20M, 9F) Mean age 37yrs (range 14-66yrs) C3-T1 tetraplegic (18 ASIA complete, 11 ASIA incomplete).	Spearman correlation of QIF, FIM, and ASIA upper extremity motor scores (UEMS) in self-care categories: See table 1.		

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<tr><td></td><td>Consecutive patients of the Ankara Rehab Centre between May 1994 and January 1996. Mean time since injury to admission 20 wks (range 272 wks).</td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="4">Table 1.
<table><tr><th>Category</th><th>UEMS vs QIF</th><th>UEMS vs FIM</th><th>QIF vs FIM</th></tr><tr><td>Grooming</td><td>r = 0.85, p < 0.001</td><td>r = 0.83, p < 0.001</td><td>r = 0.91, p < 0.001</td></tr><tr><td>Bathing</td><td>r = 0.75, p < 0.001</td><td>r = 0.76, p < 0.001</td><td>r = 0.96, p < 0.001</td></tr><tr><td>Feeding</td><td>r = 0.84, p < 0.001</td><td>r = 0.76, p < 0.001</td><td>r = 0.91, p < 0.001</td></tr></table>Quadriplegia Index of Function (QIF)</td></tr>
<tr><td>Curt et al. 1998

Correlation study on a prospective cohort

SCI center, university hospital.

Switzerland</td><td>N = 70

Acute=36
M/F = 31/5

Median age = 40.5y (17-77)

Chronic=34
M/F = 26/8

Median age = 32y (18-73)</td><td>UE (upper extremity) ASIA MS (motor score) correlated with nonstandardized assessment of hand function= 0.79 (acute), 0.83 (chronic)

LE (lower extremity) ASIA MS and nonstandardized ambulatory</td><td></td><td>Interpretability:
ASIA scores – mean (SD) – of acute and chronic patient groups with cervical SCI:
Please see Table 5 below</td></tr>
</table>

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<tr><td rowspan="2"></td><td>Level of Injury SCI : C2-T1</td><td>capacity=0.79 (acute), 0.78 (chronic)</td><td></td><td></td></tr>
<tr><td colspan="4">Table 5
<table>
<tr><th>ASIA scores</th><th>Acute SCI – Initial Examination</th><th>Acute SCI - Increment after 6 months</th><th>Chronic SCI</th></tr>
<tr><td>Motor (total)</td><td>39 (30.4)</td><td>18.4 (19.1)</td><td>44.8 (27.3)</td></tr>
<tr><td>Upper limb</td><td>23.6 (15)</td><td>8.1 (7.7)</td><td>28.4 (13.2)</td></tr>
<tr><td>Lower limb</td><td>15.4 (19.9)</td><td>10.3 (14.4)</td><td>14.4 (17.2)</td></tr>
<tr><td>Light touch</td><td>65.2 (33.4)</td><td>8 (16.8)</td><td>60.4 (34.9)</td></tr>
<tr><td>Pin prick</td><td>53.3 (36.2)</td><td>12.1 (21.4)</td><td>49.3 (34.9)</td></tr>
</table></td></tr>
<tr><td>Marino et al. 1998

Cross-sectional Survey

Regional spinal cord injury center.</td><td>N = 154 tetraplegic patients

Avg. age = 37 years, injured for avg. of 8 years.

99% of subjects had neurological examinations within 2 years of completing study.

AIS-A/B/C/D: 93/12/24/25</td><td>Correlation of ASIA UEMS with:
Capabilities of the Upper Extremity (CUE) Instrument:
Motor incomplete patients (N=49): Pearson’s r = 0.683, Spearman’s ρ = 0.650
Motor complete patients (N=105): Pearson’s r = 0.798,</td><td></td><td></td></tr>
</table>

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		Spearman's ρ = 0.815 o All patients (N=154): Pearson's r = 0.782, Spearman's ρ = 0.798 • Functional Independence Measure (FIM): o Motor incomplete patients (N=49): Pearson's r = 0.593, Spearman's ρ = 0.580 o Motor complete patients (N=105): Pearson's r = 0.772, Spearman's ρ = 0.825 o All patients (N=154):		

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<tr><td></td><td></td><td>Pearson’s r = 0.741,
Spearman’s ρ = 0.803</td><td></td><td></td></tr>
<tr><td rowspan="2">Marino et al. 1993

Assessing self-care status in quadriplegia: comparison of the quadriplegia index of function (QIF) and the functional independence measure (FIM)</td><td>N=22 SCI

Level: C4-C7
Time post-injury: 3-12 months</td><td>UEMS and Self-care category (bathing, grooming and feeding) scores for the QIF and FIM were not significantly correlated to each other (except for UEMS and QIF feeding, and UEMS and FIM feeding):
See table 3 below</td><td></td><td></td></tr>
<tr><td colspan="4">Table 3
Spearman correlation of QIF, FIM, and ASIA upper extremity motor scores (UEMS) in self-care categories
<table>
<tr><th>Category</th><th>UEMS vs QIF</th><th>UEMS vs FIM</th><th>QIF vs FIM</th></tr>
<tr><td>Grooming</td><td>r=0.90</td><td>r=0.91</td><td>r=0.94</td></tr>
<tr><td>Bathing</td><td>r=0.84</td><td>r=0.75</td><td>r=0.92</td></tr>
<tr><td>Feeding</td><td>r=0.90
P<0.001</td><td>r=0.53
P<0.001</td><td>r=0.75</td></tr>
</table></td></tr>
</table>