Reviewer ID: DW & JH, John Zhu, Jeremy Mak, Matthew Querée, Joanne Chi			
Type of Outcome Measure: Ashworth (original, modified and V-MAS)			**Total articles:** 18
Author ID Year	**Study Design**	**Setting**	**Population (sample size, age) and Group**
Akpinar et al. 2017	Psychometrics Study	Inpatient rehabilitation clinics at two state hospitals	N=58 Mean Age: 44 ± 14 years M/F= 37/21 Mean time since injury: 49 ± 60 months Age range: 18-88 years AIS A= 13 AIS B= 8 AIS C= 16 AIS D= 21
Baunsgaard et al. 2016	Intra and inter-rater reliability study	Clinic for Spinal Cord Injuries, Rigshospitalet, Hornbaek, Denmark	N= 31 Mean Age: 48.3 ± 20.2 years Age range: 15-88 years 17 traumatic, 14 non traumatic M/F= 20/11 AIS A,B,C (C1-C4) = 3 AIS A, B,C (C5-C8) = 6 AIS A,B,C (T1-S5) = 9 All AIS D = 13
Aydin et al. 2005	Cohort	Réhabilitation Centre	N= 21 traumatic SCI M/F=6/15 C/T=5/16 AIS A/B/C/D=10/3/7/1 Traumatic SCI
Benz et al. 2005	Cross-sectional study	Rehab lab and Outpatient medical clinic	N=17 Age 22-63 C5-T10 AIS A-D Time since injury=24-372m
Boviatsis et al. 2005	Cohort	Neurosurgical unit	N=22; MS=15 SCI=7 M/F=12/10 SCI Age 27-49 y SCI M/F=5/2 MS, SCI C4-T11, Duration of symptoms: 1-5 years for total N, Avg disease duration SCI: 2.71y
Craven & Morris 2010	Observational study	Tertiary Academic Rehab Centre in Toronto, Canada	N=20 (M=17, F=3) Mean Age = 38.9±13.6y Mean time after SCI = 8.89±8.0y Chronic SCI C4-T10 >12 months after injury Para AIS A = 3 Para AIS B-D = 5

			Tetra AIS A = 3 Tetra AIS B-D = 9
Gianino et al. 1998	Prospective, cohort	Dept of Neurosurgery	N=25 Mean age: 39.4 (11.2) 60% of subjects were female 80% Caucasian 15 (60%) multiple sclerosis, 7 (28%) SCI, other neurological diseases 3 (12%) 16 (66.7%) paraparetic 6 (25%) quadriparetic 1 hemiparetic 1 monoparetic 1 undocumented
Haas et al. 1996	Inter rater reliability	National Spinal Injuries Centre (Inpatient)	N=30 M/F=24/6 Mean age = 40.3y (17-72) SCI C2-L1 Frankel A-D Mean time since injury = 17.2m (1-294m)
Lechner et al. 2006	Cross-sectional study and Longitudinal study	Paraplegic Centre - outpatient	Cross-sectional study: N=47 Age 44.1y (21.5-75) Longitudinal study: N=8 Age (31-59) SCI C6-T10 AIS A or B Time since injury=14.3y (1.7-51y) C6-T10 AIS A or B Time since injury=9y (1.5-21y)
Lee et al. 1989	Cohort	Depts of Neurology, PT and OT.	N=12 No ages specified SCI, MS (multiple sclerosis)
Mishra et al. 2014	Cross sectional Tested plantar flexor muscle		N= 38(6F, 32 M) Age: 31.94 ±12.63 Time since SCI (months): 7.89 ±5.58 (Range: 2 to 24) AIS A: 10 AIS B: 9 AIS C: 10 AIS D: 9
Penn et al. 1989	Cohort	Depts of Neurosurgery, Physiology, PM&R; PE	N=20 Age 23-62 M/F=11/9 MS/SCI=10/10 C5-T9

			SCI, MS
Priebe et al. 1996	Case Series/Cross-sectional study	VAMC-SCI service in/out-patient	N=85 Mean age=46y±13 (21-82) AIS A/B/C/D=37/20/16/12 SCI C3-T10 AIS A-D Duration of injury: 1m to 25y
Sherwood et al. 2000	Cohort	Dept of Physical Medicine and Rehabilitation, Veteran Affairs Medical Center	N=97 Mean age = 45y (21-82) M/F=95/2 C/T=62/35 SCI Time since injury=0.5-39y
Skold 2000	Part I: Observational, prospective cross-sectional study; Part II: experimental, prospective longitudinal study.	Regional SCI centre - outpatient	N=45 M/F=39/6 Mean age=26y (17-47) Cervical and Thoracic AIS A-D Time since injury=11y (3-26)
Skold et al. 1998	Cross-sectional study	Outpatient	N=15 All male Mean Age=33 (21-48y) SCI C4-C8 AIS A/B = 10/5 Time since injury=9y(1-21y)
Smith et al. 2002	Cross-sectional study	Out/In-patient, tertiary care	N=22 Mean Age=33.4 ±12.5 (16-63y) 14 quads, 8 paras 4 incomplete (18 complete) Time since injury = 29.8m±43.2 (4-172m)
Tederko et al. 2007	Observational study	Inpatient	N = 30 M/F=23/7 Mean age = 33.9±14.7 (17-65y) Cervical SCI Tetraplegia = 16 Tetraparesis = 14 Mean time since injury = 14.1m(4 - 66m)

1. RELIABILITY

Author ID	**Internal Consistency**	**Test-retest, Inter-rater, Intra-rater**
Akpinar et al. 2017		**Inter-rater (MAS)** K = 0.531-0.774 **Test-retest (MAS)** K=0.580-0.716

Baunsgaard et al. 2016		**Intra-rater** Kappa weighted: 0.81 (Hip right flexors)) Simple Kappa: 0.38 (Hip) **Inter-rater** Kappa weighted: 0.54 (Hip right flexors) Simple Kappa: 0.17 (Hip right flexors)
Lee et al. 1989	No data available	With 4 raters: Kendall 0.92 Avg. Spearman rank correlation of 0.89 with 95% CI (7.5-1.0) 7.2-9.4 intra-rater variability (coefficient of repeatability) with a coefficient of variation 5.4-7.7%
Haas et al 1996	No data available	Mean Kappa values: Original=0.41 Adductor=0.61 to Plantarflexor=0.21 Modified=0.34 Adductor=0.62 to Plantarflexor=0.20
Smith et al 2002	No data available	Mean Kappa values MAS=0.14-0.35 Mean ICC for V-MAS = 0.59-0.88 Spearman's correlation coefficient=0.73
Tederko et al 2007	No data available	Mean ICC for MAS = 0.56 (adequate reliability, averaged from scores from age, sex, neurological status, site of injury, functional status, pharmacotherapy for spasticity, rating by specialist, rating by resident)
Craven & Morris 2010	No data available	For Rater A, the intra-rater reliability for lower extremity MAS was substantial to high (0.6<k<1.0) for three of six muscle groups. Muscle groups with poor reliability were the knee extensor, ankle plantarflexor and dorsiflexor muscle groups. For rater B, reliability varied between sessions: - in session 1, reliability was poor-to-fair (k<0.4), except for ankle plantarflexors and contrarily were substantial-to-high (0.6<k<1.0) for session 5 for all except knee quadriceps and hamstrings Inter-session reliability was fair-to-good (0.4<ICC<0.75) for all muscle groups. The ICC for the knee flexors, knee extensors and adductors were lower (0.4<ICC<0.4) than the ankle plantarflexors (ICC=0.75). These results indicate that lower extremity MAS score reliability is much lower than the clinically desired value (ICC>0.75) for all but one muscle group (Right knee hamstrings). Inter-rater reliability was poor-to-moderate (k<0.6) for all muscle groups except the hip adductors. The agreement between the two raters was inconsistent across muscle groups and sessions and much lower than the desired Kappa (k>0.81)

Commented [VN1]: In the paper there are values for other body parts (e.g. knee and ankle). What was the reasoning for not including these?

Mishra et al. 2014		Interrater: Gastrocnemius: Kappa: 0.70 (good; p< 0.001) Kendall tau-b: 0.77 (strong, p< 0.001) Soleus: Kappa: 0.75 (good; p< 0.001) Kendall tau-b: 0.88 (strong, p< 0.001)

2. VALIDITY

Author ID	**Validity**
Sherwood et al 1998	There was a significant difference between average sEMG scores for those with average Ashworth 0 vs 2&3, and 1 vs 2&3 (P<0.001) but not between 0 and 1. However, when assessing individual muscles, the sEMG is more discriminatory.
Skold et al 1998	64 (80%) of EMG measures correlated significantly with MAS (P<.05). However, when subjects scoring 0 were removed from the analysis, only 25% of correlations were significant suggestive of an end-of-range effect.
Smith et al 2002	Spearman r between MAS and PT= -0.69 (no 95% CI) V-MAS and PT=0.83 (95% CI=0.73-0.89)
Priebe et al 1996	Polychoric correlations Ashworth& Clonus=0.267 Patellar tap=0.553 Achilles tap=0.235 Adductor tap=0.340 Plantar=0.205
Skold 2000	Spearman r Correlations between self-rated and modified Ashworth before and after passive movement session. Muscle before after Rt Quad 0.49 0.56 Rt Ham 0.49 0.48 Lt Quad 0.44 0.62 Lt Ham 0.50 0.61
Benz et al 2005	Spearman r Correlations between Ashworth (hip, knee, ankle) vs Spinal Cord Assessment Tool for Spastic Reflexes (SCATS) (clonus, flexion, extension) vs Penn Spasm Frequency Scale (PSFS) Hip knee ankle PSFS 0.43 0.43 0.51 Hip 0.90 0.67 Knee 0.77 Clonus 0.56 0.65 0.60 Flexion 0.55 0.47 0.40 Ext 0.98 0.88 0.61
Baunsgaard et al. 2016	Spearman's r Correlations between Modified Ashworth (hip, knee, ankle) vs Spasm Frequency Scale Hip Knee Ankle Right Flexors 0.9 0.21 Left Flexors 0.13 0.03 Right Extensors 0.21 0.01 Left Extensors 0.08 -0.13

	Right Dorsiflexors -0.04 Left Dorsiflexors 0.03 Right Plantarflexors 0.18 Left Plantarflexors 0.18
Akpinar et al. 2017	Significant correlations between MAS and MTS X grades for all muscles r:0.791 (Hip adductor muscles) r:0.920 (hip extensor muscles) r:0.539 (knee extensor muscles) r:0.562 (knee flexor muscles) r:0.864 (ankle plantar flexor muscles)

3. RESPONSIVENESS

Author ID	**Responsiveness**
Penn et al. 1989	IT Baclofen, Ashworth was reduced from 4.0±1.0 to 1.2 ±0.4 (P<.0001), concomitant decrease in spasm frequency 3.3 ±1.2 to 0.4± 0.8 (P<.0005). After mean follow-up of 19.2months, Ashworth was 1.0± 0.1 and SFS (Spasm Frequency Scale) was 0.3± 0.6.
Gianino et al. 1998	IT Baclofen, mean Ashworth decreased from 3.78 to 1.48 in one year (P=.00000014), concomitant decreases in spasm scores from 2.6 to 0.5 over 1 year. (P=.000017).
Aydin et al. 2005	Baclofen (n=10) Pre-post Spasm Frequency Score (SFS) and Lower Limb Ashworth Score (LLAS) were -28±30 and -28±22, respectively. TENS (transcutaneous electrical nerve stimulation) (n=11) pre-post SFS and LLAS was -16±16 and -17±17, respectively. All other spasticity related measures progressed in the same direction also.
Boviatsis et al. 2005	From pre-tx to final post-tx, Ashworth decreased from 4.57 to 2.57 (P=.0134). Concomitant reduction in spasm scores from 3.71 to 1.27 (P=.00006).

4. FLOOR/CEILING EFFECT – no data available

5. INTERPRETABILITY

Author ID	**Interpretability**
Sherwood et al. 2000	Subject characteristics by Ashworth score:

	Ashworth score				
	Subcategory:	0	1	2	3
Gender	M	24	33	22	16
	F	1	/	1	/
ASIA	A	12	14	9	6
	B	10	10	5	3
	C	/	6	7	4
	D	3	3	2	3
Level	Cervical	12	21	17	12
	Thoracic	13	12	6	4
Motor	Mean	41.5	35.9	28.5	34.9
	SD	20.0	21.8	20.1	21.1
Age	Mean	42.3	46.1	49.4	43.7
	SD	13.2	13.3	17.1	13.7
Time post-injury	Mean	7.6	8.4	6.4	8.6
	SD	9.4	7.7	6.5	7.7

Gianino et al. 1998	At entry into the study, the mean spasm score was 2.6 (SD=1.2, range 0-4) Average intrathecal baclofen doses: 236.6 mcg/day at 3 months, 289.65mcg/day at 6 months and 298.44 mcg/day at 12 months After receiving intrathecal baclofen, mean spasm scores decreased to: 1.0 (SD=0.9, range 0-3) at 3 months 0.6 (SD=0.9, range 0-3) at 6 months 0.5 (SD=0.8, range 0-3) at 12 months
Haas et al.	Number of assignments and agreements for each score for the Ashworth and Modified Ashworth scale:

1996	*Original scale*	**0**	**1**	**/**	**2**	**3**	**4**	**Total**
	Assignments	152	115	/	129	68	8	472
	Agreements	62	27	/	29	17	1	136
	Modified scale	**0**	**1**	**1+**	**2**	**3**	**4**	
	Assignments	149	55	77	117	66	8	472
	Agreements	61	6	6	26	17	1	117