APPENDIX THREE:

Canadian Stroke Best Practices Screening and Assessment Tools for Acute Stroke Severity

Assessment Tool	Number and description of Items	Time to Administer	Reliability/validity	Interpretation of Scores	Training Required
Neurological Status/Stroke Severity					
Canadian Neurological Scale (CNS)(1)	Items assess mentation (level of consciousness, orientation and speech) and motor function (face, arm and leg). Motor function evaluations are separated into sections A1 (and A2. A1 is administered if the patient is able to understand and follow instructions (5 items). A2 is administered in the presence of comprehension deficits (3 items)(1, 2)	5-10 minutes(1, 2)	**Interobserver reliability***: k ranged from 0.535(facial weakness) to 1.000 and there was no significant difference in agreement between physician and nurse raters(1); agreement between assessments by 2 nurses, r=0.924 – at the item level κ ranged from 0.535 (level of consciousness) to 1.00 (motor response- face)(2) **Internal consistency:** $\alpha \geq 0.89$ (neurologist, neurology student and nurse raters)(1); $\alpha = 0.792$(2) **Concurrent validity:** CNS scale scores correlated with the Mathew scale, Orgogozo scale, Scandinavian Stroke Scale, and the National Institutes of Health Stroke Scale – correlations ranged from –0.85 to 0.92(3); and with MCA Neurological Score scores (r=0.977), NIHSS scores r=-0.948 and Guy's Prognostic Scores (0.397)(4) **Construct validity (known groups):** CNS scores were significantly different (p<0.001) for patients grouped as "alive at home", "alive in care" and "dead" at 3 months(4) **Predictive validity**: Significant associations have been reported between the results of acute assessment using the CNS and length of hospital stay(5), mortality(2, 5, 6), functional outcome or independence at 3 months post stroke(4, 7) and at 6 months post stroke(2, 8).	Motor items are rated in terms of severity. Ratings are weighted and summed to provide a total score out of 11.5.(2) Higher scores represent decreasing levels of stroke severity or improved neurological status.	Yes

National Institutes of Health Stroke Scale (NIHSS)(9)	15 items: impairment in LOC, ability to respond to questions/ obey simple commands, papillary response, gaze deviation, hemianopsia, facial palsy, resistance to gravity (weaker limb), plantar reflexes, limb ataxia, sensory loss, visual neglect, dysarthria and aphasia. Each item is graded on an ordinal scale from 0-3 or 0-4 where 0=no impairment.	Approximately 6-7 minutes(9)	**Test-retest:** ranging from 0.66 (emergency department nurse clinician) to 0.77 (neurologist)(9); ICC = 0.93 (3 month test interval-assessment of videotaped patient) (10) **Interobserver reliability****: For total overall scores, mean kappa values have ranged from 0.61 – 0.96(9, 11, 12) while reported ICC values range from 0.95-0.96(10, 13, 14). Single item reliability has varied substantially; the limb ataxia item has most often demonstrated poor interobserver reliability(11, 13, 15, 16). **Internal consistency**: Person separation reliability = 0.32 for total sample, 0.73 (left hemisphere stroke), 0.62 (right hemisphere stroke)(16); α = 0.85 and ω = 0.96(14) **Concurrent validity:** NIHSS scores associated with Mathew scale, Orgogozo scale, Scandinavian Stroke Scale, CNS (r ranging from –0.85 to 0.92)(3) (De Haan et al. 1993); also with MCA Neurological Score scores (r=-0.95), CNS scores (r=-0.948) and Guy's Prognostic Scores (r=-0.38)(4) **Construct validity**: NIHSS scores associated with stroke volume on CT(9, 17) as well as with assessments of function(3) and HRQOL(18) **Construct validity (known groups):** NIHSS scores were significantly different ($p<0.001$) for patients grouped as "alive at home", "alive in care" and "dead" at 3 months(4); baseline NIHSS scores correlated strongly with TOAST classification(19) **Predictive validity**: NIHSS scores have been demonstrated to be predictive of function/impairment status(9, 19-21) and of discharge destination or place or residence(9, 22)	Total scale score = 0-42. Higher scores reflect greater severity. Stroke severity may be stratified as follows: >25 = very severe, 15 – 24 = severe, 5 – 14 = mild to moderately severe and 1 – 5 = mild	Yes(11, 23, 24)
Pediatric National Institutes of Health Stroke Scale (PedNIHSS)(25)	This is a variation of the adult form NIHSS designed for use in individuals aged 2 – 18. All items from the original version have been retained;	Not reported.	**Interobserver reliability:***** For *prospective administration*, reported ICC = 0.99 (95% CI 0.97, 0.99) between study neurologists. Item level agreement ranged from $K_w = 0.40$ (sensory) to 1.00 (LOC-commands)(25); When used for *retrospective derivation* of PedNIHSS scores, ICC=0.95 and item level agreement ranged from $K_w = 0.47$ (visual) to 0.93 (motor left and right arm items). (26)	All scoring strategies were retained from the adult version(25)	Yes. The scale authors provide a guide for administration in children aged 2-18.

	however, age appropriate adaptations have been applied to language items, pictures and commands.		**Internal consistency reliability**: α=0.99(25)		
Glasgow Coma Scale (GCS)(27, 28)	15 items in 3 categories: motor response (6 items), verbal response (5 items), and eye opening (4 items). Points are awarded for the best response in each category. Categories are summed to provide a total score.	Approximately 1 minute.	**Interobserver reliability**: Scale authors reported low rates of disagreement, but noted variations in motor responses based on stimulus used(28). Reported agreements ranged 0.48 (verbal) to 0.72 (eye opening)(29) and from 0.39 – 0.79.(30) Percentage agreements have been reported as 90% overall, and as ranging from 83.8% (eye opening, right) to 98.7% (best motor response – left).(31) In addition, similar rates of between observer agreement have been reported in groups of experienced nurses (98.6% - 100%), newly graduated nurses (94.3%-96.2%) and student nurses (77.3% - 100%).(32) **Construct validity**: In review of GCS, evidence supports association between extent of brain damage and depth of coma as assessed on GCS. GCS scores significantly associated with length of coma ($p<0.0001$). (33) **Predictive validity**: GCS score is a significant predictor of death following stroke (34, 35) or traumatic brain injury (modified by age and mechanism of injury) (36), though eye-opening may be less strongly associated than either the motor or verbal score components(37). GCS scores are also predictive of survival (AUC=0.89), though eye-opening may not add to predictive accuracy(38). GCS scores have been demonstrated to be predictive of Glasgow Outcome scores at 6 months to 1 year post injury (33, 39-42), Disability Rating Scale scores at discharge(43) and at 6 months(44), FIM scores at discharge(43, 45) and employment status at one-year(46).	GCS scores range from 3 – 15, where 3 represents total unresponsiveness and 15 represents alert and fully responsive. Scores may be divided into categories by severity: 13-15 = mild; 9-12=moderate and ≤8 represents severe injury.(47)	Yes.
Assessment of Function					
Modified Rankin Scale	A global outcomes rating scale in which	15 minutes (via	**Interobserver reliability:** In a systematic review, there was substantial variability demonstrated with reported weighted	mRS scores range from 0-5 such that '0'	No. However,

(mRS)(56)	individuals are assigned a subjective grade or rank ranging from 0-5 based on level of independence with reference to pre-stroke activities rather than observation of task-based performance. Modifications to the original scale have included expansion of the scale to include a "0" rank(57) and several changes to item wording (e.g. replacing disability with handicap).(58)	structured interview)(59, 60)	kappa agreements ranging from 0.25 to 0.95. The authors note, however, that reliability was often low, particularly in studies with larger sample sizes(61); Overall reported agreement was ICC=0.675, between the experienced and inexperienced raters K_w=0.686, agreement between experienced and inexperienced raters using a decision making tool K_w=0.568, and agreement between inexperienced raters without a tool and inexperienced raters with a decision tool was K_w=0.736(62) **Test-retest reliability**: K_w=0.95(63); k_w=0.94 for rater 1 and k_w=0.99 for rater 2 with a mean re-test interval of 7 days(59); κ=0.72 (based on re-assessment of videotapes, 3 month interval)(64) **Concurrent validity :** MRS scores correlated with the Barthel Index (3, 65-67), Functional Independence Measure(67), the Frenchay Activities Index(68) and the physical function scale of the SF-36.(66) **Convergent/discriminant validity:** In a comparison between mRS scores and scores obtained via the Sickness Impact Profile, there were stronger associations reported between SIP subscale assessments of functional ability (IADL), mobility and living arrangements and mRS scores than there were between mRS scores and SIP subscales of cognitive alertness or social interaction.(3) **Predictive validity** : pre-stroke mRS scores were an important predictor of post-stroke outcome assessed on both the Barthel Index and mRS.(66)	is indicative of no symptoms, while a rank of 5 is indicative of the most severe disability (described as bedridden, incontinent, requiring constant nursing care).(57)	training and/or the use of structured interview tools has been associated with improved reliability.(59, 69, 70)
Functional Independ-ence Measure (FIM) (71)	18 items to evaluate 6 areas of function (self-care, sphincter control, mobility, locomotion,	Approx. 30 minutes to administer and score; however, it is	**Interobserver reliability**: In a review and meta-analysis (n=11 studies), interobserver reliability ranged from 0.89 to 1.0. When converted to a common metric and pooled, median agreement was reported to be 0.95(73)	Items are scored on a 7-pt. Likert scale according to the amount of assistance required in the	Yes.

	communication and social cognition). These may be placed into 2 domains; 1) motor (13 items: motor-FIM) and cognitive (5 items: cognitive-FIM).	recommended that ratings be derived by multidisciplinary team consensus following a period of observation.(72)	**Test-retest reliability**: In a review and meta-analysis (n=11 studies), median test-retest reliability was reported to be 0.95(73) **Internal consistency reliability:** Reported values for α range from 0.88(74) to 0.95(75, 76); reported item-to-total correlations range from 0.53 to 0.87(76). **Construct validity**: The 2-factor structure (motor + cognitive) of the FIM has been confirmed on factor analysis(77, 78), although a possible 3-factor model has also been reported (self-care, cognition, elimination)(79) **Concurrent validity**: Strong associations have been demonstrated between motor-FIM scores and scores from the Barthel Index(67, 74), the mRS(67), the Disability Rating Scale (DRS)(80), the Action Research Arm Test (81), The Fugl-Meyer Assessment(81), the Wolf Motor Function Test (time and functional assessment scores)(81) as well as between the cognitive-FIM and the DRS(80) **Construct validity (known groups):** FIM scores discriminated between groups right vs left-sided involvement in individuals with stroke at admission ($p<0.005$) and discharge ($p< 0.05$)(75); at admission and discharge, FIM scores were significantly different for individuals with and without neglect ($p<0.001$ and $p<0.02$, respectively) and with or without aphasia ($p<0.01$; $p<0.09$)(82). **Predictive validity:** admission (rehab) FIM has been reported to be associated with discharge FIM scores (total FIM, motor-FIM, cognitive-FIM)(83), length of inpatient rehabilitation stay(83, 84), functional gain(82), discharge assessments of balance and mobility(84), discharge walking speed(85) as well as discharge destination(75, 86). FIM scores have been reported to predict burden of care in terms of minutes of help/day required(87); motor-FIM scores have been associated with amount of direct assistance required, cognitive-FIM scores with direct supervision required(88); FIM scores at one month post stroke have been reported to be associated with depression at 3 months post stroke(89).	performance of each one (1=total assistance, 7 = total independence). Item scores are summed to provide a total out of 126. Motor and cognitive subscale scores may be calculated separately an may yield more useful information specific to each domain(77)	

Alpha-FIM(90)	A shortened version of the Functional Independence Measure. 6 items: 4 motor (eating, grooming, bowel management and toilet transfers) and 2 cognition items (expression and memory). If the individual with stroke is able to ambulate ≥150 feet then walking and bed-to-chair transfers may be substituted for eating and grooming items in the evaluation(91)	Approx. 5 minutes(92)	**Interobserver reliability:** ICC=0.92(92) **Internal consistency reliability:** α=0.87, item-to-total correlations ranged from 0.27 (toilet transfer) to 0.75 (memory)(90); α=0.90(92) **Construct validity:** A single factor/component has been identified on factor analyses, accounting for the majority of the variance in functional status(90, 92) **Concurrent validity:** Alpha-FIM scores were significantly associated with total-FIM scores (r=0.75), and there was no significant difference reported between projected and actual FIM scores(90); correlated with Barthel Index scores (r=0.68)(92) **Predictive validity:** Alpha-FIM scores obtained in acute care were predictive of FIM scores on admission to and discharge from rehabilitation(90, 91), length of stay(90, 91), FIM gain(91) and discharge to the community(90).	Items on the Alpha-FIM are scored as per the original FIM scale. Scale scores range from 6 – 42. Alpha-FIM scores may be transformed to projected FIM scores using a [proprietary] algorithm ranging from 18-100.(90)	Yes.

***A number of studies have examined the reliability of retrospective calculation of CNS scores based on documentation provided in medical records. In general, these studies have demonstrated consistently high (excellent) levels of interobserver(93-95) and internal consistency(93) reliability. **As for the CNS, investigators have studies the use of the NIHSS for performing retrospective, chart-based evaluations.(94, 96, 97) In general, the reported reliability of these assessments is lower than that associated with the CNS and should be based upon neurologist reports where possible (94, 98). ***The PedNIHSS appears to maintain a high level of reliability when used for retrospective derivation of an NIHSS score. In addition, there was no significant difference demonstrated between scores derived prospectively vs. retrospectively (p=0.49)(26)*

Useful Links:

1. Additional information regarding the CNS, NIHSS, mRS, and FIM is available at www.ebrsr.com and at www.strokengine.ca
2. There is a site for international users of the NIHSS scale – it may be found here: http://www.nihstrokescale.org/ It provides links to the scale in English, as well as lots of good training information – but it also provides links to the scale in quite a number of other languages as well.
3. Here is a link to the NIHSS booklet in PDF form: http://www.mdcalc.com/clinical_images/NIH_Stroke_Scale_Booklet.pdf
4. And to an online calculator: http://www.mdcalc.com/nih-stroke-scale-score-nihss/

5. Here is a link to the Hunt and Hess Scale itself: http://www.neurosurgic.com/index.php?option=com_content&view=article&id=439&Itemid=607 or http://radiopaedia.org/articles/hunt-and-hess-grading-system (this page also supplies links to the Fisher scale and to the WFNS scale)
6. Here is a link to the Fisher Scale: http://www.neurosurgic.com/index.php?option=com_content&view=article&id=438&Itemid=606
7. Here is a more descriptive presentation of the WFNS: http://www.strokecenter.org/wp-content/uploads/2011/08/WWF_scale.pdf
8. The Rankin scale has its own website: http://www.rankinscale.org/
9. The FIM is also reviewed at: http://www.rehabmeasures.org/lists/rehabmeasures/dispform.aspx?id=889
10. The official site for the Alpha-FIM: http://www.udsmr.org/WebModules/Alpha/Alp_About.aspx