ONLINE-ONLY SUPPLEMENT

[Supplemental Methods]
Appendix A: Shooting Procedure

This standardized procedure aims at minimizing differences in shooting among individuals. The researchers record a patient using two digital video cameras from two points of view. The cameras are fixed on tripods. The zoom function of the camera is used when shooting the distal parts of the upper extremities. Details of the camera views are listed below.

Fugl-Meyer Assessment for Upper Extremity (Motor)			Camera 1	Camera 2
A. SHOULDER/ ELBOW/FOR EARM	1.	Flexors Reflex	Frontal plane (front view)	Sagittal plane (affected side)*
	2.	Eextensors Reflex	Frontal plane (front view)	Sagittal plane (affected side)
	3.	Shoulder Retraction	Frontal plane (front view)	Sagittal plane (affected side)
	4.	Shoulder Elevation		
	5.	Shoulder Abduction		
	6.	Shoulder Ext. rotatin		
	7.	Elbow Flexion		
	8.	Forearm Supination		
	9.	Shoulder Adduction/Int. rotation	Frontal plane (front view)	Sagittal plane (affected side)
	10.	Elobw Extension		
	11.	Forearm Pronation		
	12.	Hand to Lumbar spine	Frontal plane (back view)	Sagittal plane (affected side)
	13.	Shulder Flexion 0-90	Frontal plane (front view)	Sagittal plane (affected side)
	14.	Pronation-Supination	Frontal plane (front view)	Sagittal plane (affected side)
	15.	Shoulder Abduction 0-90	Frontal plane (front view)	Sagittal plane (affected side)
	16.	Shoulder Flexion 90-180	Frontal plane (front view)	Sagittal plane (affected side)
	17.	Pronation-Supination	Frontal plane (front view)	Sagittal plane (affected side)
	18.	Normal Reflex	Frontal plane (front view)	Sagittal plane (affected side)*
B. WRIST	19.	Stability at 15 dorsiflextion	Frontal plane (front view)	Sagittal plane (affected side)
	20.	Repeated dorsifflexion/volar flexion	Frontal plane (front view)	Sagittal plane (affected side)
	21.	Stability at 15 dorsiflextion	Frontal plane (front view)	Sagittal plane (affected side)
	22.	Repeated dorsifflexion/volar flexion	Frontal plane (front view)	Sagittal plane (affected side)
	23.	Cicumduction	Frontal plane (front view)	Sagittal plane (affected side)
C. HAND	24.	Hand Mass Flexion	Frontal plane (front view)	Sagittal plane (affected side)
	25.	Hand Mass Extension	Frontal plane (front view)	Sagittal plane (affected side)
	26.	Grasp A, Flexion in PIP and DIP/Extension in MCP	Frontal plane (front view)	Zoom-in the affected hand
	27.	Grasp B, Thumb Adduction	Frontal plane (front view)	Zoom-in the affected hand
	28.	Grasp C, Opposition	Frontal plane (front view)	Zoom-in the affected hand
	29.	Grasp D, Cylinder Grip	Frontal plane (front view)	Zoom-in the affected hand
	30.	Grasp E, Spherical Grip	Frontal plane (front view)	Zoom-in the affected hand
D. COORDINAT ION/SPEED†	31.	Tremor	Frontal plane (front view)	Sagittal plane (affected side)
	32.	Dysmetria		
	33.	Time		

*Zoom-in on the affected hand for finger flexors.
†The examiner needs to shoot not only the affected, but also the unaffected side.

		Action Research Arm Test	Camera 1	Camera 2
A. GRASP	1.	10 cm Block	Frontal plane (front view)	Sagittal plane (unaffected side, obliquely)
	2.	2.5 cm Block	Frontal plane (front view)	Sagittal plane (unaffected side, obliquely)
	3.	5.0 cm Block	Frontal plane (front view)	Sagittal plane (unaffected side, obliquely)
	4.	7.5 cm Block	Frontal plane (front view)	Sagittal plane (unaffected side, obliquely)
	5.	7.5 cm Diameter Ball	Frontal plane (front view)	Sagittal plane (unaffected side, obliquely)
	6.	10 x 2.5 x 1.0 Stone	Zoom-in the object (starting point)	Sagittal plane (unaffected side, obliquely)
B. GRIP	7.	Pour Water from Glass to Glass	Frontal plane (front view)	Sagittal plane (unaffected side, obliquely)
	8.	2.25 cm Tube	Frontal plane (front view)	Sagittal plane (unaffected side, obliquely)
	9.	1.00 cm Tube	Frontal plane (front view)	Sagittal plane (unaffected side, obliquely)
	10.	Washer over Bolt	Zoom-in the object (starting point)	Sagittal plane (unaffected side, obliquely)
C. PINCH	11.	6 mm Ball Bearing - Thumb and Ring Finger	Sagittal plane (unaffected side, obliquely)	Zoom-in the object (starting point)
	12.	1.5 cm Marble - Thumb and Index Finger	Sagittal plane (unaffected side, obliquely)	Zoom-in the object (starting point)
	13.	6 mm Ball Bearing - Thunb and Middle Finger	Sagittal plane (unaffected side, obliquely)	Zoom-in the object (starting point)
	14.	6 mm Ball Bearing - Thumb and Index Finger	Sagittal plane (unaffected side, obliquely)	Zoom-in the object (starting point)
	15.	1.5 cm Marble - Thumb and Ring Finger	Sagittal plane (unaffected side, obliquely)	Zoom-in the object (starting point)
	16.	1.5 cm Marble - Thumb and Middle Finger	Sagittal plane (unaffected side, obliquely)	Zoom-in the object (starting point)
D. GROSS	17.	Place Hand behind Head	Frontal plane (front view)	Sagittal plane (affected side)
	18.	Place Hand on Top of Head	Frontal plane (front view)	Sagittal plane (affected side)
	19.	Hand to Mouth	Frontal plane (front view)	Sagittal plane (affected side)

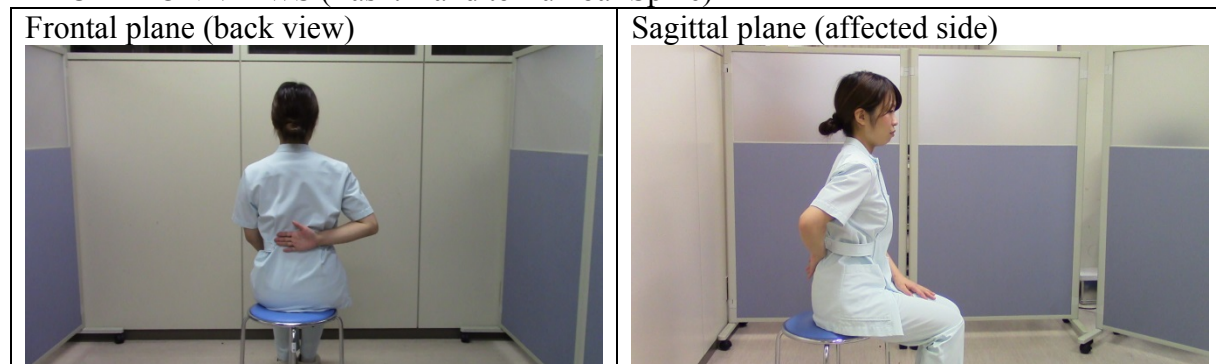Additional examples of camera views are shown below.

FUGL-MEYER ASSESSMENT
A. SHOULDER/ELBOW/FOREARM
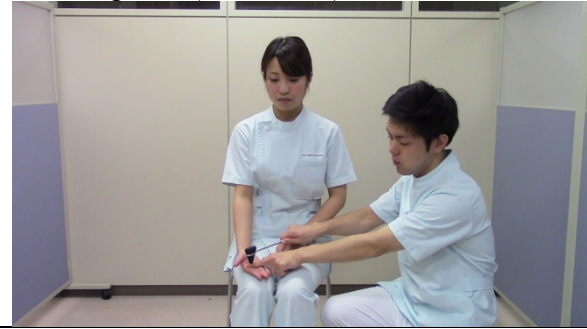BASIC VIEWS (Task: Flexor Synergy)

Frontal plane (front view)	Sagittal plane (affected side)
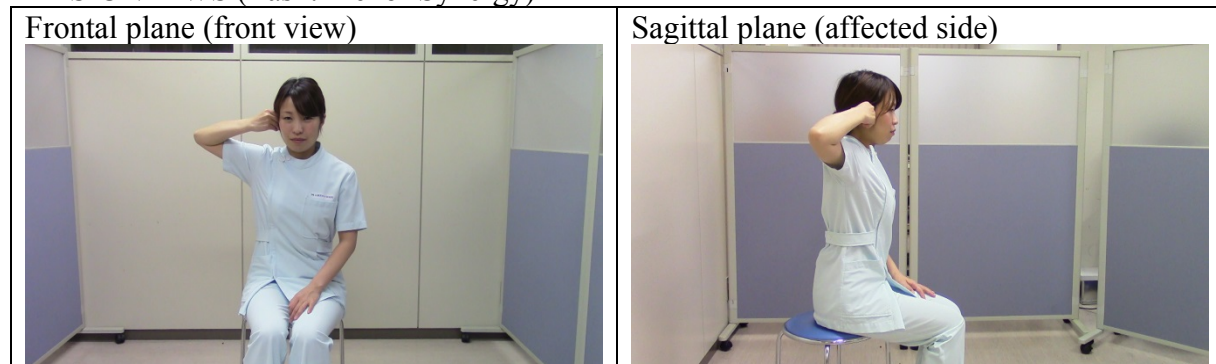
EXCEPTION VIEWS (Task: Hand to Lumbar Spine)

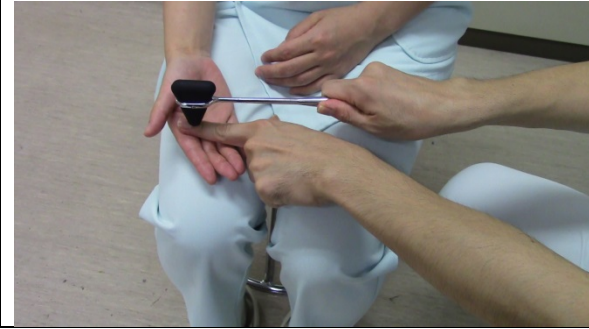| Frontal plane (back view)	Sagittal plane (affected side)

EXCEPTION VIEWS (Task: Flexors Reflex/Normal Reflex [Finger Flexors])

Frontal plane (front view)	Zoom-in on the hand

B. WRIST
BASIC VIEWS (Task: Stability at 15 Dorsiflexion)

Frontal plane (front view)	Sagittal plane (affected side)

C. HAND
BASIC VIEWS (Task: Hand Mass Flexion)

Frontal plane (front view)	Sagittal plane (affected side)

EXCEPTION VIEWS (Task: Grasp C, Opposition)

Frontal plane (front view)	Zoom-in on the affected hand

EXCEPTION VIEWS (Task: Grasp E, Spherical Grip)
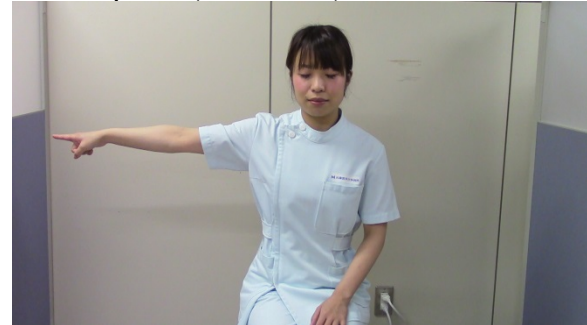
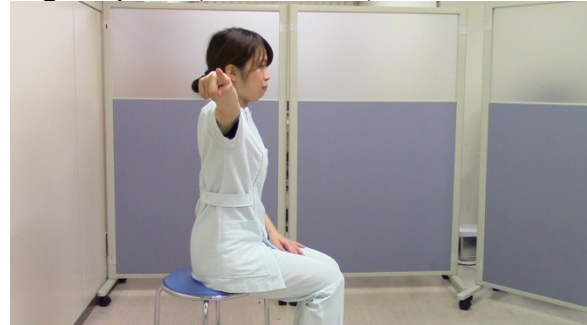| Frontal plane (front view)	Zoom-in on the affected hand

C. COORDINATION/SPEED
BASIC VIEWS (Task: Finger-to-Nose Test)

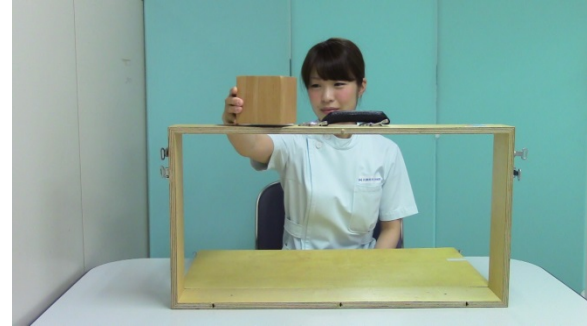| Frontal plane (front view)	Sagittal plane (affected side)

ACTION RESEARCH ARM TEST
A. GRASP
BASIC VIEWS (Task 1: 10 cm Block)
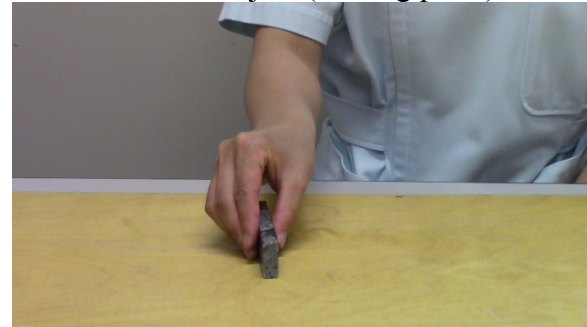
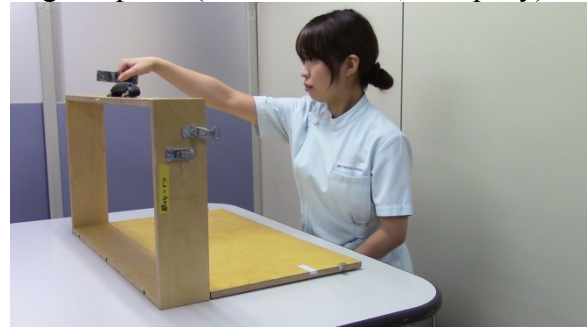| Frontal plane (front view)	Sagittal plane (unaffected side, obliquely)

EXCEPTION VIEWS (Task 6: 10 × 2.5 × 1.0 Stone)

Zoom-in on the object (starting point)	Sagittal plane (unaffected side, obliquely)

B. GRIP
BASIC VIEWS (Task 9: 1.00 cm Tube)

Frontal plane (front view)	Sagittal plane (unaffected side, obliquely)
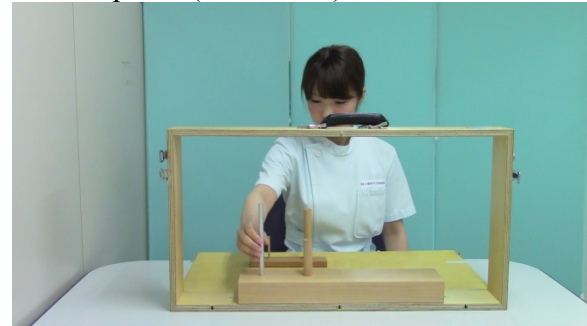
EXCEPTION VIEWS (Task 10: Washer over Bolt)

Zoom-in on the object (starting point)	Sagittal plane (unaffected side, obliquely)

C. PINCH
BASIC VIEWS (Task 11: 6 mm Ball Bearing - Thumb and Ring Finger)
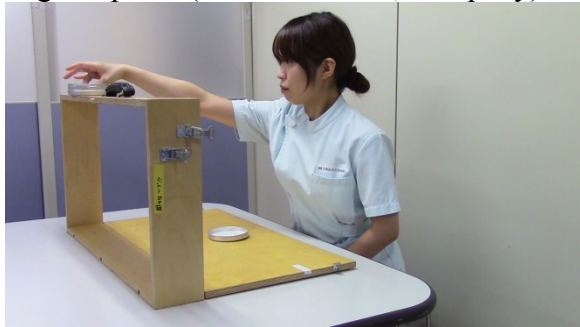
Sagittal plane (unaffected side, obliquely)	Zoom-in on the object (starting point)

D. GROSS MOVEMENT
BASIC VIEWS (Task 17: Place Hand behind Head)

Frontal plane (front view)	Sagittal plane (affected side)

[Supplemental Tables]
Table I: Inter-rater Reliability of the Individual Item Scores (Details of Weighted Kappa)

Fugl-Meyer Assessment for Upper Extremity (Motor)			Weighted Kappa	Z-Value	95% CI	P-Value
A. SHOULDER/ELBOW/FOREARM	1.	Flexors Reflex	NA	NA	NA	NA
	2.	Eextensors Reflex	1.000	1.438	1.000-1.000	0.151
	3.	Shoulder Retraction	0.905	4.217	0.777-1.032	< 0.001
	4.	Shoulder Elevation	0.946	4.446	0.841-1.050	< 0.001
	5.	Shoulder Abduction	0.787	4.804	0.616-0.957	< 0.001
	6.	Shoulder Ext. rotatin	0.697	3.897	0.500-0.893	< 0.001
	7.	Elbow Flexion	0.865	3.273	0.684-1.046	< 0.005
	8.	Forearm Supination	0.858	5.154	0.706-1.010	< 0.001
	9.	Shoulder Adduction/Int. rotation	1.000	3.998	1.000-1.000	< 0.001
	10.	Elobw Extension	1.000	4.602	1.000-1.000	< 0.001
	11.	Forearm Pronation	0.948	4.228	0.847-1.048	< 0.001
	12.	Hand to Lumbar spine	1.000	5.227	1.000-1.000	< 0.001
	13.	Shulder Flexion 0-90	0.878	4.394	0.748-1.009	< 0.001
	14.	Pronation-Supination	0.927	5.991	0.829-1.025	< 0.001
	15.	Shoulder Abduction 0-90	1.000	6.274	1.000-1.000	< 0.001
	16.	Shoulder Flexion 90-180	0.921	5.870	0.816-1.027	< 0.001
	17.	Pronation-Supination	0.889	5.873	0.770-1.008	< 0.001
	18.	Normal Reflex	0.828	2.957	0.583-1.072	< 0.005
B. WRIST	19.	Stability at 15 dorsiflextion	0.960	4.636	0.882-1.037	< 0.001
	20.	Repeated dorsifflexion/volar flexion	0.960	6.242	0.884-1.037	< 0.001
	21.	Stability at 15 dorsiflextion	0.962	4.893	0.889-1.035	< 0.001
	22.	Repeated dorsifflexion/volar flexion	0.962	6.343	0.889-1.035	< 0.001
	23.	Cicumduction	0.959	6.176	0.880-1.038	< 0.001
C. HAND	24.	Hand Mass Flexion	0.898	4.149	0.761-1.035	< 0.001
	25.	Hand Mass Extension	1.000	6.430	1.000-1.000	< 0.001
	26.	Grasp A, Flexion in PIP and DIP/Extension in MCP	1.000	5.101	1.000-1.000	< 0.001
	27.	Grasp B, Thumb Adduction	0.924	5.308	0.823-1.026	< 0.001
	28.	Grasp C, Opposition	1.000	6.208	1.000-1.000	< 0.001
	29.	Grasp D, Cylinder Grip	1.000	6.029	1.000-1.000	< 0.001
	30.	Grasp E, Spherical Grip	1.000	5.429	1.000-1.000	< 0.001
D. COORDINATION/SPEED	31.	Tremor	0.917	5.041	0.806-1.028	< 0.001
	32.	Dysmetria	0.964	5.262	0.893-1.034	< 0.001
	33.	Time	1.000	4.957	1.000-1.000	< 0.001

NA: not applicable. NA was only identified for item 1 (Flexors Reflex) because the contingency table for kappa statistics only occupied one cell.

Action Research Arm Test			Weighted Kappa	Z-Value	95% CI	P-Value
A. GRASP	1.	10 cm Block	1.000	6.457	1.000-1.000	< 0.001
	2.	2.5 cm Block	1.000	5.375	1.000-1.000	< 0.001
	3.	5.0 cm Block	1.000	5.872	1.000-1.000	< 0.001
	4.	7.5 cm Block	0.952	6.155	0.888-1.016	< 0.001
	5.	7.5 cm Diameter Ball	0.977	5.825	0.932-1.022	< 0.001
	6.	10 x 2.5 x 1.0 Stone	1.000	6.313	1.000-1.000	< 0.001
B. GRIP	7.	Pour Water from Glass to Glass	0.930	6.141	0.856-1.005	< 0.001
	8.	2.25 cm Tube	0.973	5.185	0.922-1.025	< 0.001
	9.	1.00 cm Tube	0.974	5.585	0.923-1.024	< 0.001
	10.	Washer over Bolt	1.000	6.155	1.000-1.000	< 0.001
C. PINCH	11.	6 mm Ball Bearing - Thumb and Ring Finger	0.977	6.005	0.932-1.022	< 0.001
	12.	1.5 cm Marble - Thumb and Index Finger	0.975	5.637	0.927-1.023	< 0.001
	13.	6 mm Ball Bearing - Thunb and Middle Finger	0.977	6.039	0.934-1.021	< 0.001
	14.	6 mm Ball Bearing - Thumb and Index Finger	0.977	6.108	0.933-1.021	< 0.001
	15.	1.5 cm Marble - Thumb and Ring Finger	0.955	5.845	1.895-1.015	< 0.001
	16.	1.5 cm Marble - Thumb and Middle Finger	0.977	5.893	0.932-1.021	< 0.001
D. GROSS	17.	Place Hand behind Head	0.937	6.055	0.853-1.021	< 0.001
	18.	Place Hand on Top of Head	0.909	5.806	0.811-1.007	< 0.001
	19.	Hand to Mouth	0.965	5.085	0.898-1.032	< 0.001

Table II: Summary of Studies Examining Inter-rater Reliability of the Fugl-Meyer Assessment for the Upper Extremities (Motor)

Year	Journal	First Author	Reference Number *	Subjects	Sample Size	Type of Observation	Simultaneity	Statistical Analysis	Results
1983	Phys Ther	Duncan PW	[12]	CVA Not from trauma, brain tumor, surgery, or any other etiology	8	Direct vs. Direct	–	1) ANOVA, post-hoc tests 2) Pearson correlation coefficients	1) Total, NS; Synergy sub, NS; Wrsit sub, NS; Hand sub, NS; Coordination sub, $P = 0.04$; Reflexes sub, $P = 0.05$ 2) > 0.96 ($P < 0.01$)
1993	Phys Ther	Sanford J	[13]	CVA	12	Direct vs. Direct	–	1) ICC (type 2,1), 95%CI 2) Standard error of measurement	1) 0.97, 0.94-0.99 2) 3.6
2005	Clin Rehabil	Platz T	[14]	Stroke, multiple sclerosis or traumatic brain injury	44	Video vs. Video	YES	1) ICC 2) Spearman's rho 3) Wilcoxon signed-rank test 4) Bland-Altman method (limits of agreement; LOA)	1) > 0.97 2) > 0.97 3) $P > 0.2$ 4) LOA = −2 to +2
2009	Phys Ther	Lin JH	[15]	Stroke (acute)	30	Direct vs. Direct	–	1) ICC, 95%CI 2) Minimal detectable change (MDC) 3) MDC%	1) 0.96, 0.92-0.98 2) 12.9 3) 20
2011	Stroke	Sullivan KJ	[16]	Stroke (acute, subacute)	15	Direct vs. Video	YES	1) ICC (2, 1), 95%CI 2) Bland-Altman method (modified)	1) 0.99, 0.97-1.0 2) Bias, ≈ −1; 95%CI Paired-T, ≈0.5 to ≈−2; 95%CI SD, ≈4 to ≈ −6
2011	Res Bras Fisioter	Michaelsen SM	[17]	Stroke (chronic)	10	Direct vs. Direct	–	1) ICC, 95%CI	1) 0.98 (Total), 0.94-0.99 (Total); NS in Reflex Activity, ICC = −0.74, 0.02-0.57
2013	Neurorehabil Neural Repair	See J	[18]	Stroke	27	Direct vs. Direct	–	1) ICC 2) Spearman's rho 3) MDC(90)	1) 0.99 2) 0.97 3) 3.2
2016	Disabil Rehabil	Lundquist CB	[19]	Stroke (acute, subacute)	50	Direct vs. Direct	–	1) ICC, 95%CI	1) 0.95, 0.93-0.98

*Reference number in the manuscript. CVA: cerebrovascular accident; ICC: intraclass correlation coefficient; NS: not significant.

Table III: Summary of Studies Examining Inter-rater Reliability of the Action Research Arm Test for the Upper Extremities

Year	Journal	First Author	Reference Number *	Subjects	Sample Size	Type of Observation	Simultaneity	Statistical Analysis	Results
1981	Int J Rehab Research	Lyle RC	[20]	Sustained cortical damage from stroke, road traffic or industrial accident, assault, or surgery for aneurysm or haematoma	10	Direct vs. Direct	YES	1) Pearson correlations	1) 0.99
1998	Age Ageing	Hsieh CL	[21]	Subarachnoid haemorrhage, cerebral haemorrhage, cerebral infarction or other	50	Direct vs. Direct	–	1) ICC, 95%CI	1) 0.98, 0.97-0.99
2001	Arch Phys Med Rehabil	Van der Lee JH	[22]	Stroke (chronic)	20	Video vs. Video	YES	1) ICC 2) Spearman's rho 3) Mean difference, 95%CI 4) Limits of agreement (LOA) 5) Range of Weighted kappa (Median)	1) 0.989 2) 0.995 3) 0.75, 0.02-1.48 4) −2.35 to 3.85 5) 0.83-1 (0.93)
2002	Clin Rehabil	Hsueh IP	[23]	Subarachnoid haemorrhage, cerebral haemorrhage, cerebral infarction or other	61	Direct vs. Direct vs. Direct	–	1) ICC, 95%CI	1) 0.99, 0.98-0.99
2005	Clin Rehabil	Platz T	[14]	Stroke, multiple sclerosis or traumatic brain injury	44	Video vs. Video	YES	1) ICC 2) Spearman's rho 3) Wilcoxon signed-rank test	1) 0.998 2) 0.996 3) $P > 0.3$
2008	Neurorehabil Neural Repair	Yozbatrian N	[24]	Stroke (> 3 months, chronic)	9	Direct vs. Dorect	YES	1) ICC 2) Spearman rank correlation coefficient	1) 0.9986 2) 0.96
2009	Phys Ther	Lin JH	[15]	Stroke (acute)	30	Direct vs. Direct	–	1) ICC, 95%CI 2) Minimal detectable change (MDC) 3) MDC%	1) 0.95, 0.90-0.98 2) 13.1 3) 23
2010	J Rehabil Med	Nijland R	[25]	Stroke	18	Direct vs. Direct	–	1) ICC 2) Bland-Altman method	1) 0.92 2) LOA = ≈−8 to ≈20
2014	J Rehabil Med	Nordin A	[26]	Stroke (> 6 weeks)	35	Direct vs. Direct	YES	1) Percentage agreement 2) Systematic disagreement 3) Individual variability	1) 69-100 (range) 2) No significant disagreements 3) Statistically significant but negligibly small

*Reference number in manuscript. ICC: intraclass correlation coefficient.

Table IV: Comparison with Previous Studies Examining Inter-rater Reliability

	Fugl-Meyer Assessment Upper Extremity (Motor)	Action Research Arm Test
Summary table	Table II	Table III
Studies of inter-rater reliabiltiy	8 studies	9 sutdies
"Direct vs. Direct" design	6 studies	7 studies
"Video vs. Video" design	1 study	2 studies
"Direct vs. Video" design	1 study	–

Only one study was found for the "Direct vs. Video" design in the Fugl-Meyer Assessment. However, assessing the inter-rater reliability of remote evaluations was not an objective of this study.

Table V: Summary of Reliability Criteria in Systematic Reviews of Stroke-specific Function Assessment for the Upper Extremities

Year	Journal	First Author	Reference Number *	Target Population	Target Function	Target Analysis	Reliability Criteria
2008	J Rehabil Med	Ashford S	[32]	Stroke Brain injury	"Real-Life" active and passive function (upper-limb)	Reliability coefficients	≥ 0.85 for "good" reliability 0.75-0.80 for "moderate" reliability
2012	Arch Phys Med Rehabil	Connell LA	[31]	Neurologi conditions	Ability (upper-limb)	ICC Kappa statistics	≥ 0.75 for "adequate" reliability
2013	Arch Phys Med Rehabil	Tse T	[30]	Stroke	Participation	ICC Kappa statistics	≥ 0.80 for "good" reliability ≥ 0.60-0.80 for "moderate" reliability ≥ 0.40-0.60 for "weak" reliability
2015	Circ Cardiovasc Qual Outcomes	Bushnell C	[29]	Chronic Stroke	Motor Function	ICC	> 0.70 for "adequate" reliability

*Reference number in manuscript. ICC: intraclass correlation coefficient.

Table VI: Differences between Direct and Video Observation Assessment

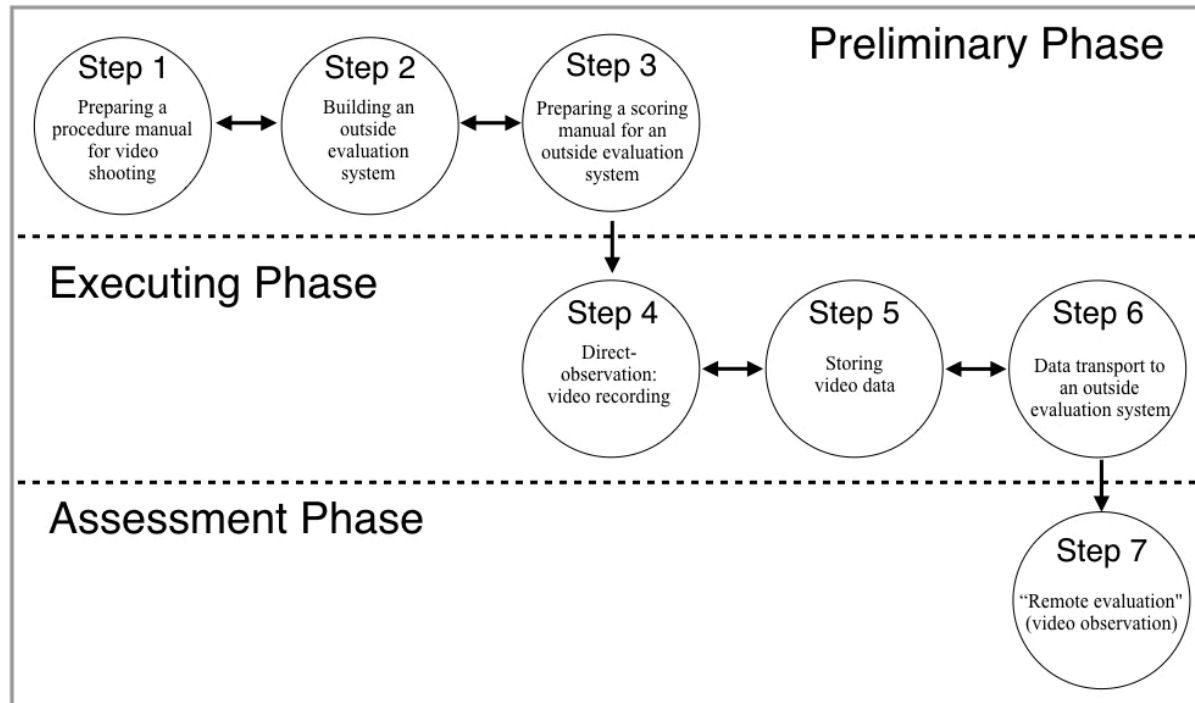|	Direct Assessment	Video Assessment
Information Dimension	Three dimensions	Two dimensions
Feasibility of Confirmation	Low (Assessor have to judge at the precise moment)	High (Assessor can repeat the video many times)
Simultaneity	Low (Performance would change if repeaated the task)	High (Assessor can repeat the video many times)
Burden of Tester	As usual	Larger than usual (Tester have to care to ensure that the cameras fully shoot a patient)
Necessary Time	As usual (≈30 minutes for FMA U/E motor and ARAT)	More time than usual (Setting video-cameras and tripods for a tester and video assessmen for an assessor)
Burden of Costs	As usual	Higher than usual (A need for cameras, tripods, and computers)
Feasibility of Blinding	Low (Researchers have to employ assessors from outside)	Higher than direct assessment (With the centralized outside evaluating system)

Figure I: Evaluation Process
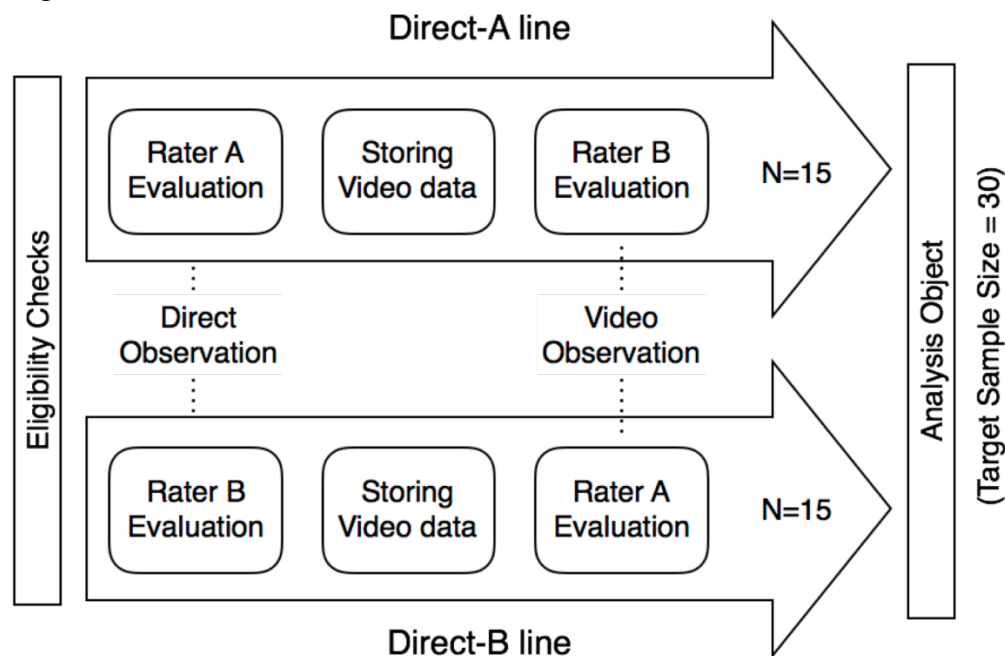
Figure II: The Seven-Step Model for Remote Evaluation

[Supplemental References]
None.