NAH CONGRES
Niet-aangeboren hersenletsel
in Vlaanderen vandaag

Welkom

Motorische revalidatie na beroerte: onderzoek, prognose en interventie

Maar wat volgt?

Prof. Geert Verheyden

KU Leuven, Departement Revalidatiewetenschappen

KU LEUVEN

LEUVEN BRAIN INSTITUTE

Hersenletsel Liga
Samen voor mensen met NAH

INCLUSIE IN-ZICHT

Wat is motorische revalidatie?

Motor rehabilitation after stroke: European Stroke Organisation (ESO) consensus-based definition and guiding framework

Gert Kwakkel[1,2,3*], Cathy Stinear[4*], Bea Essers[5],
Maria Munoz-Novoa[6], Meret Branscheidt[7], Rosa Cabanas-Valdés[8] (iD),
Sandra Lakičević[9], Sofia Lampropoulou[10],
Andreas R Luft[7], Philippe Marque[11], Sarah A Moore[12,13],
John M Solomon[14,15], Eva Swinnen[16], Andrea Turolla[17,18] (iD),
Margit Alt Murphy[6,19#] and Geert Verheyden[5#] (iD)

ESO definition of Motor Rehabilitation after Stroke

"Motor rehabilitation is a process that **engages** people with stroke in order to benefit their **motor function, activity capacity and performance** in daily life. It is **necessary** for all people with residual motor disability whose goal is to enhance their **functioning, independence and participation**.

Motor rehabilitation strives to reduce motor impairments and improve functioning in activities through **learning- and use-dependent mechanisms.** The trajectory of motor and functional **recovery varies between patients and stages of recovery**. At early stages, behavioral restitution of motor function depends on the underlying **mechanisms of spontaneous neurological recovery**. At later stages, further functional improvements can be achieved by **compensations**.

Motor rehabilitation is guided by **regular assessment** of motor function and activity **using consensus-based measures**, including patient-reported outcomes. Results are discussed with the patient and their carers in order to **set personal goals.**

The core element of motor rehabilitation incorporates **principles of motor control** in which patients learn to optimize and adapt their motor, sensory and cognitive functioning through **appropriately dosed, repetitive, goal-oriented, progressive, task- and context-specific training.**

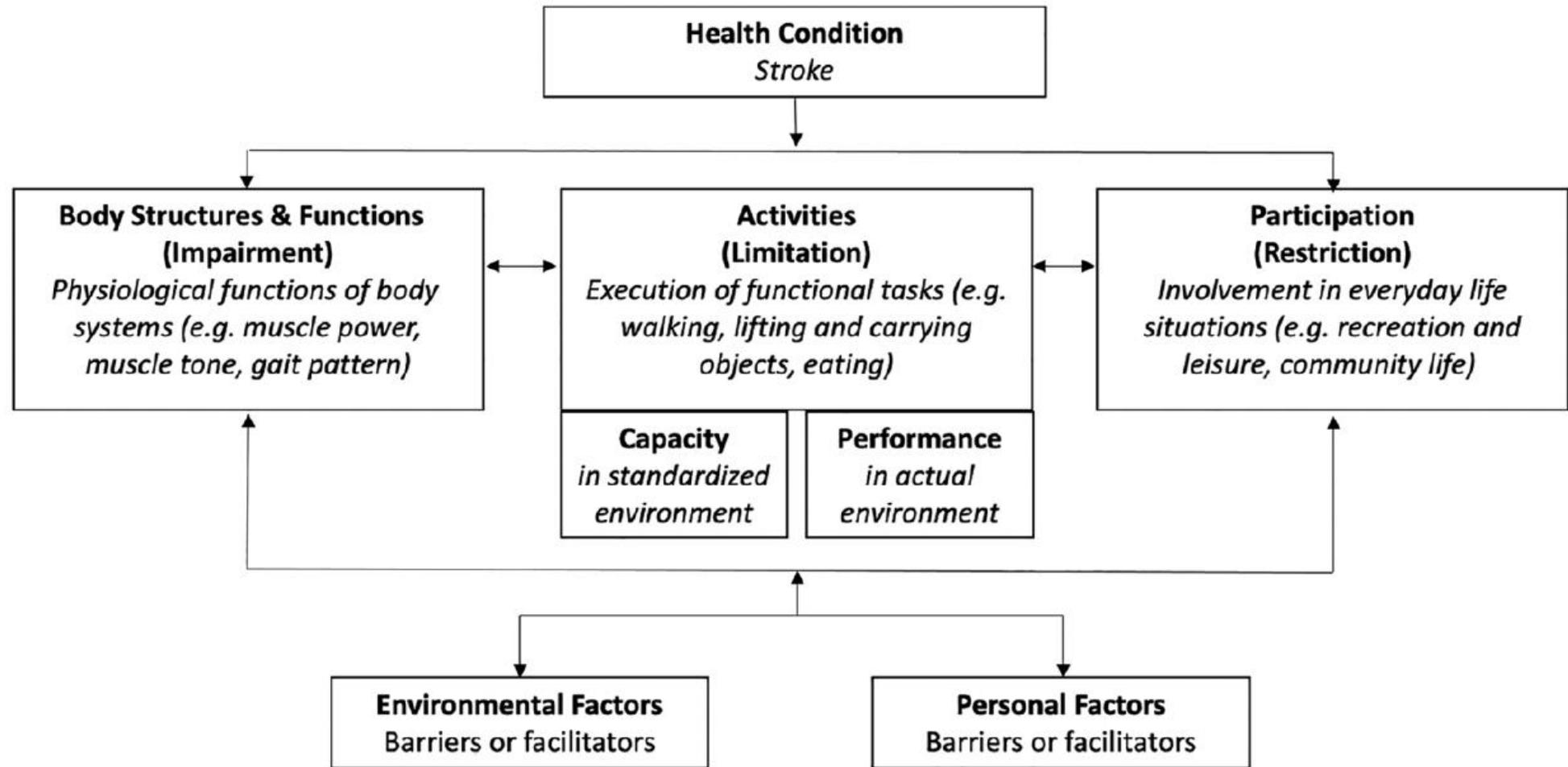Motor rehabilitation **supports** people with stroke to **maximise health, well-being and quality of life**."

Kwakkel et al. 2023

Onderzoek

ICF

Figure 1. The international classification of functioning, disability and health.[8]

Kwakkel et al. 2023

Recent consensus-based recommendations for motor assessments in stroke rehabilitation

Source	Aim	Focus	Time post stroke	Recommended assessments
CAULIN 2021	Clinical practice	UL	Within 1st week, 3-, 6- and 12-months; prior to discharge or transfer; before, during and after a rehabilitation program	**FMA-UE, ARAT** Extended: Kinematics, BBT, CAHAI, WMFT, NHPT, ABILHAND Supplementary: MI, CMSA, STREAM, FAT, MAS, sensor-based use of the upper limb
Core set 2020	Clinical practice	Motor	Day 2±1 and 7, week 2 and 4, month 3, 6 and 12, and every following 6 months	**FMA, ARAT**, **10MWT, TUG, BBS, SIS**
SRRR-2 2019	Research	UL QoM	Within 1st week, 3-, 6- and 12-months, 4 and 8 weeks recommended	2D reaching, finger individuation, grip/pinch strength and 3D functional drinking task
SRRR-1 2017	Research	Recovery	Within 1st week, 3-months, 6- and 12-months recommended	NIHSS, **FMA-UE and FMA-LE, ARAT, ability to walk, 10MWT,** mRS and EQ-5D

CAULIN: Clinical Assessment of Upper Limb in Neurorehabilitation
SRRR: Stroke Recovery and Rehabilitation Roundtable
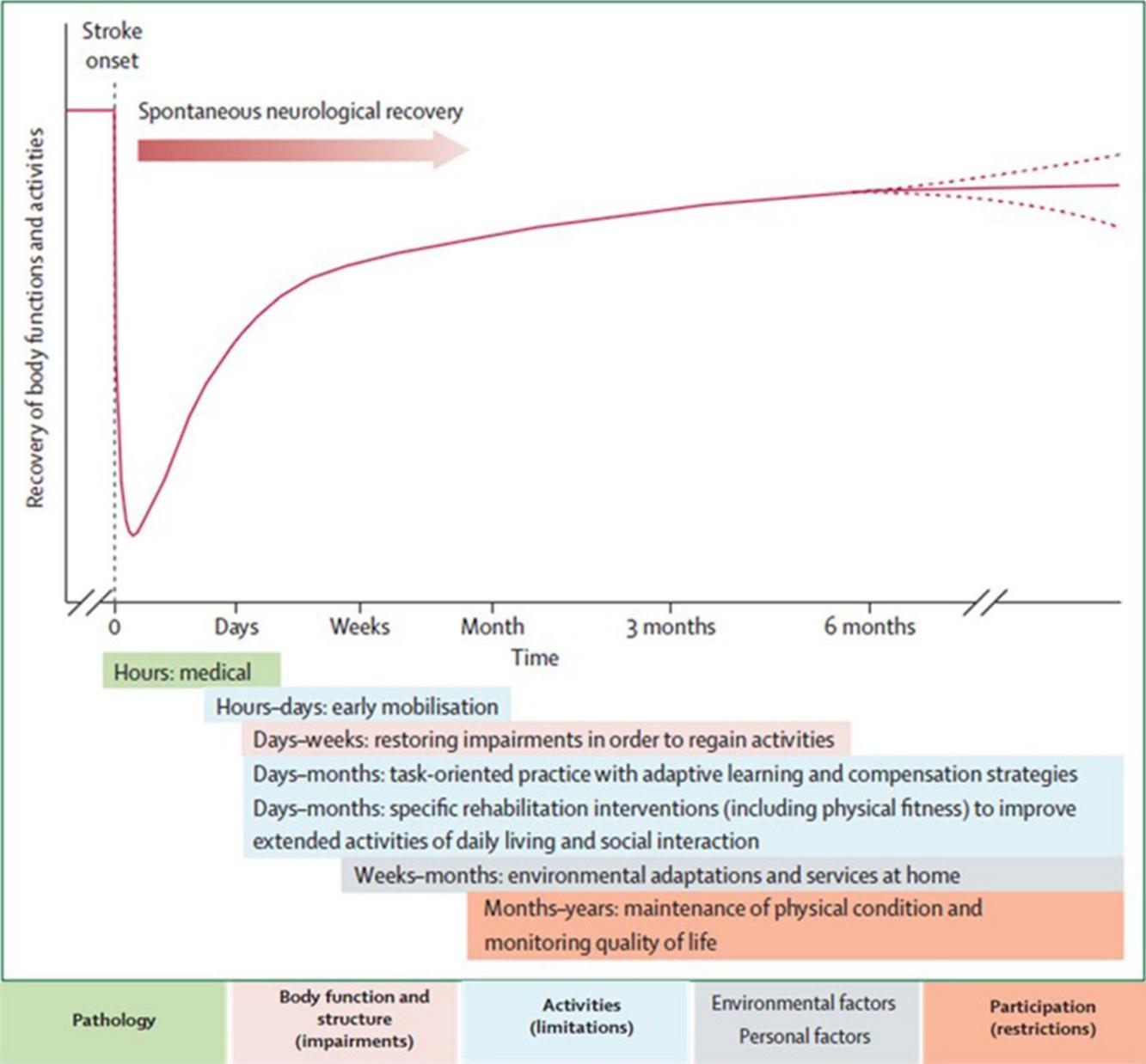
Kwakkel et al. 2023

Langhorne et al. Lancet 2011
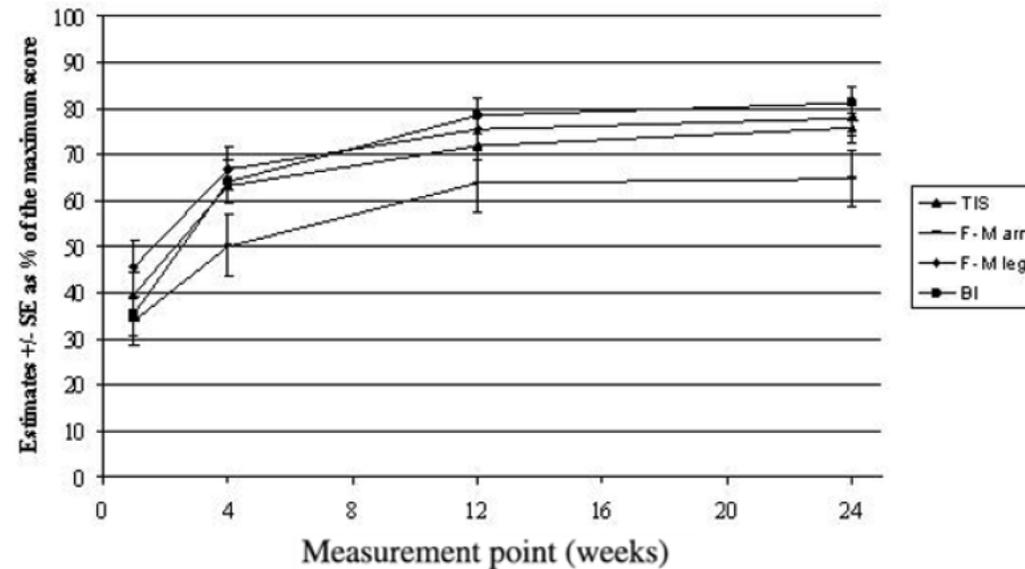
Motor and functional recovery

Figure 2. Recovery pattern of estimates $\pm$ standard errors (expressed in percentage of maximum score) for trunk (TIS), arm (F-M arm), leg (F-M leg), and functional performance (BI) for 32 ischemic stroke patients. Repeated measures analysis revealed no significant difference between recovery patterns ($P = .2565$).

Verheyden et al. NNR 2008

Figure I. Framework that encapsulates definitions of critical timepoints post stroke that link to the currently known biology of recovery.
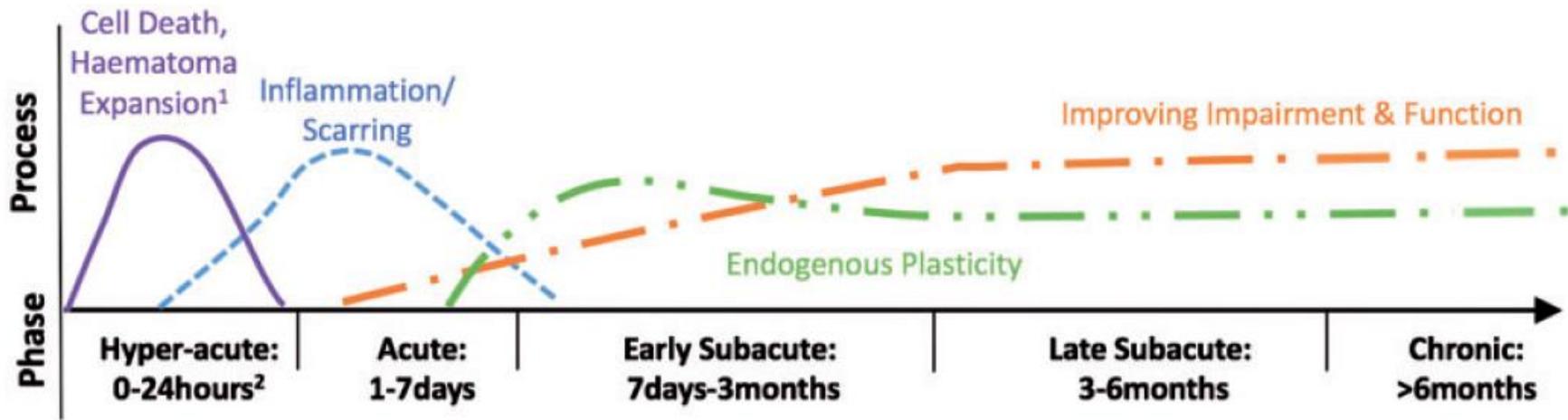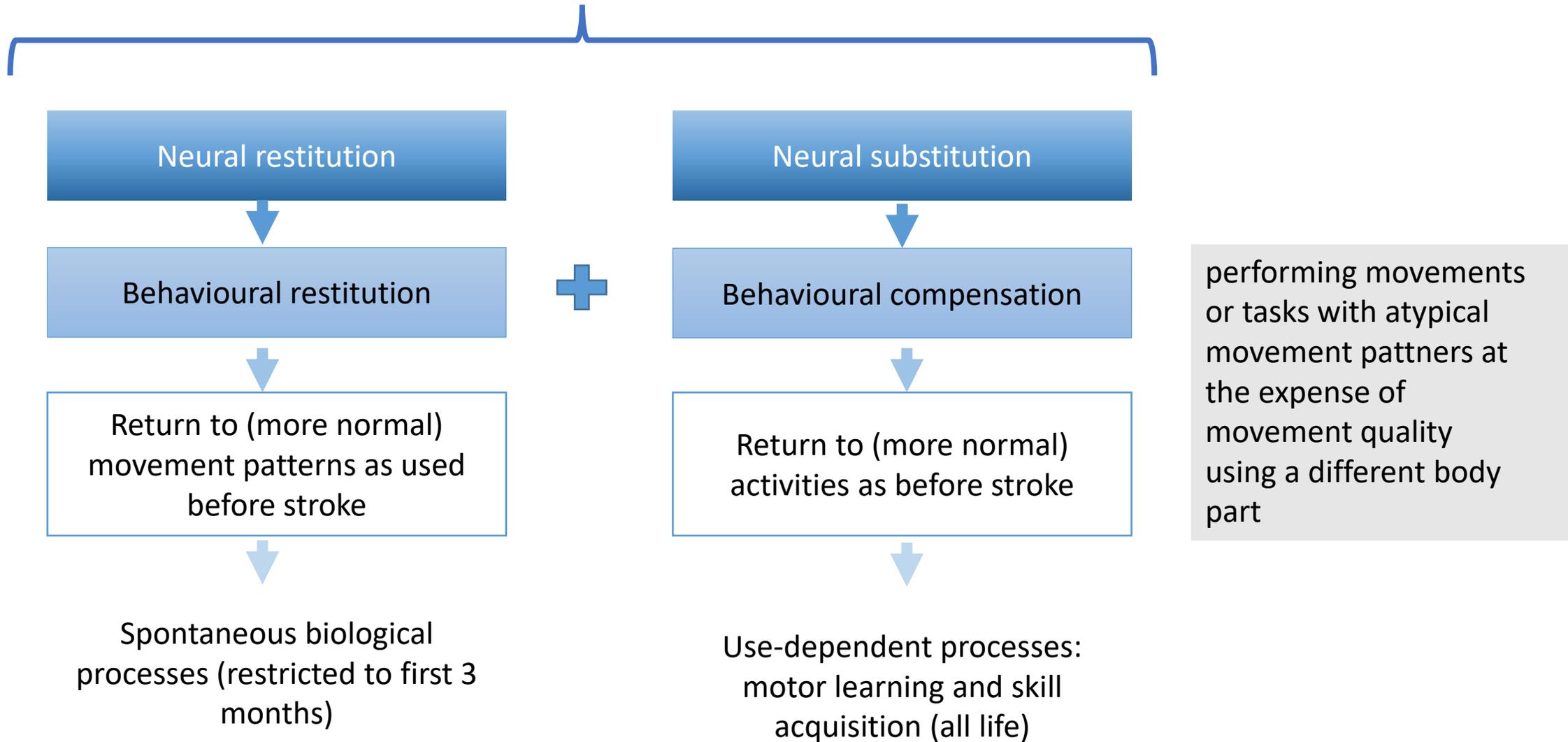

[1] Haemorrhagic stroke specific. [2] Treatments extend to 24 hours to accommodate options for anterior and posterior circulation, as well as basilar occlusion.

Agreed definitions and a shared vision for new standards in stroke recovery research: The Stroke Recovery and Rehabilitation Roundtable taskforce

Julie Bernhardt[1,2], Kathryn S Hayward[1,2,3], Gert Kwakkel[4,5], Nick S Ward[6,7], Steven L Wolf[8,9], Karen Borschmann[1,2], John W Krakauer[10], Lara A Boyd[3,11], S Thomas Carmichael[12], Dale Corbett[13,14] and Steven C Cramer[15]

Motor recovery
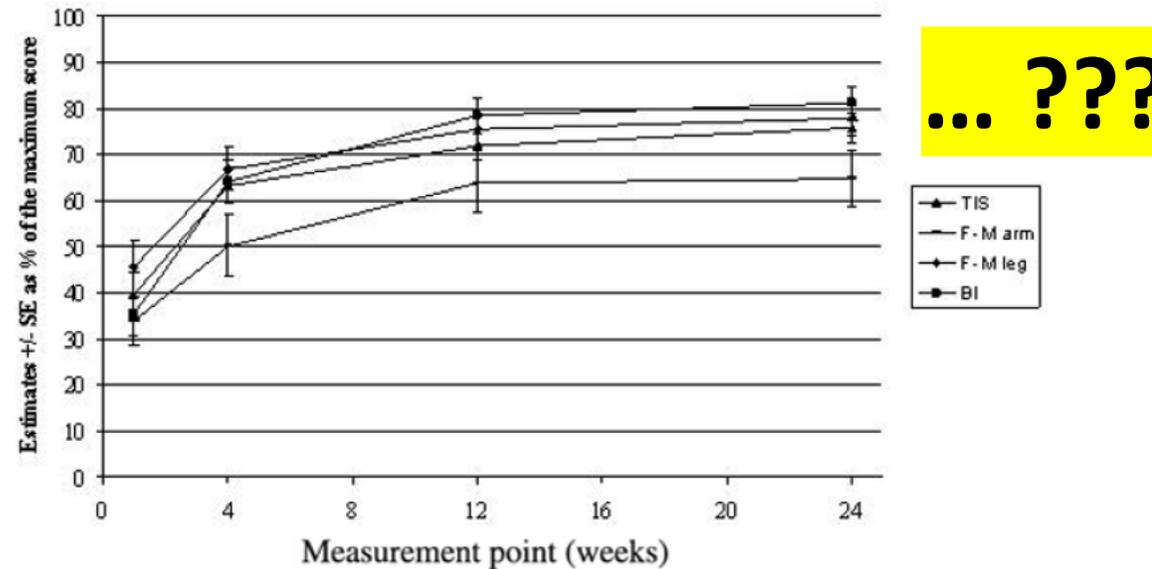
Neural restitution		Neural substitution
↓		↓
Behavioural restitution	**+**	Behavioural compensation
↓		↓
Return to (more normal) movement patterns as used before stroke		Return to (more normal) activities as before stroke
↓		↓
Spontaneous biological processes (restricted to first 3 months)		Use-dependent processes: motor learning and skill acquisition (all life)

performing movements or tasks with atypical movement pattners at the expense of movement quality using a different body part

Motor and functional recovery

... ???

**Figure 2.** Recovery pattern of estimates ± standard errors (expressed in percentage of maximum score) for trunk (TIS), arm (F-M arm), leg (F-M leg), and functional performance (BI) for 32 ischemic stroke patients. Repeated measures analysis revealed no significant difference between recovery patterns ($P = .2565$).

Verheyden et al. NNR 2008

Long-term evolution?
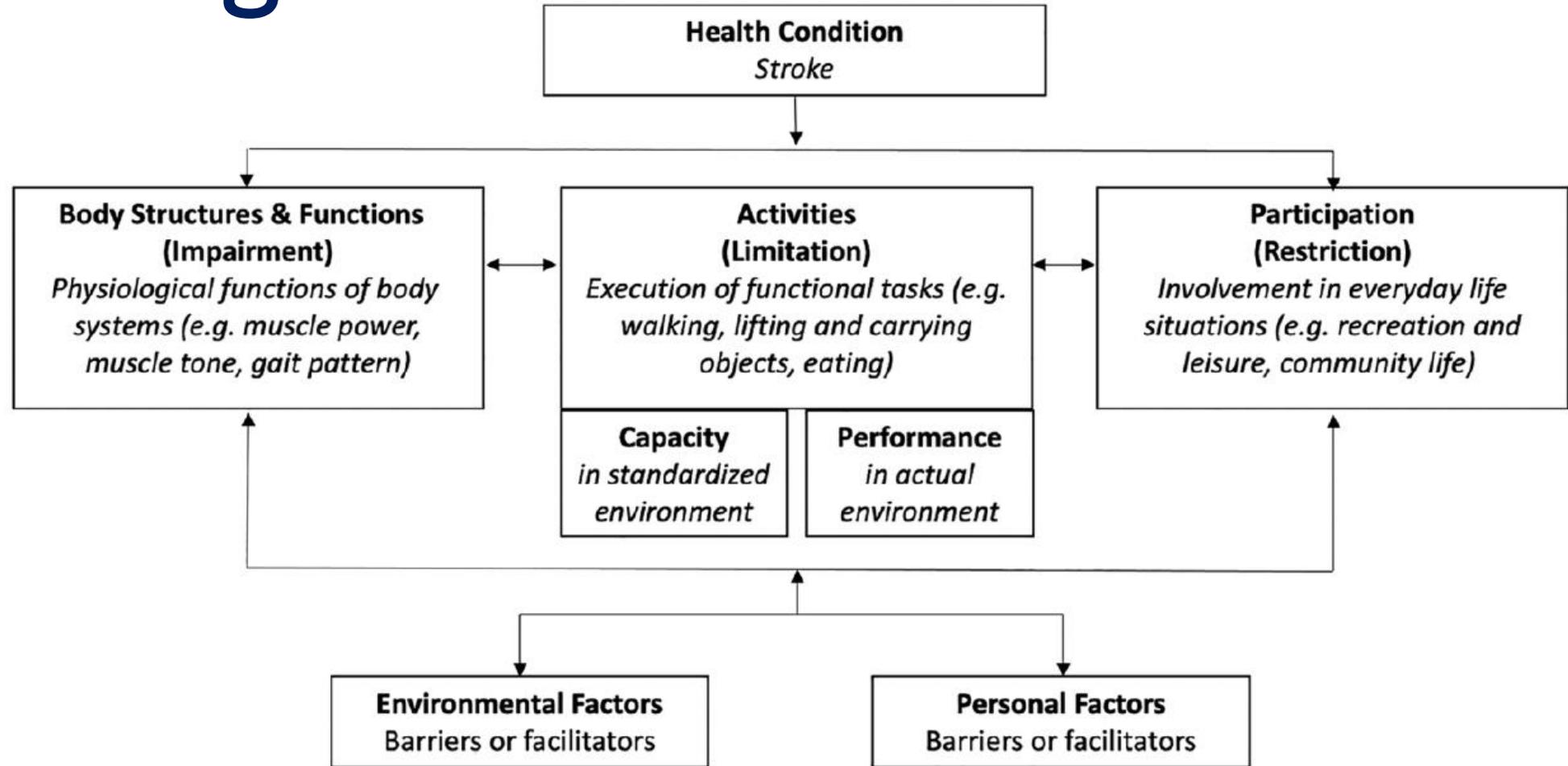

Meyer et al. Stroke 2015
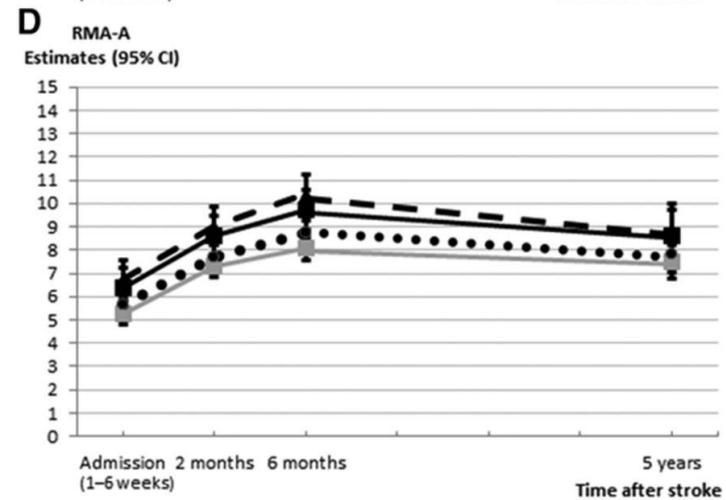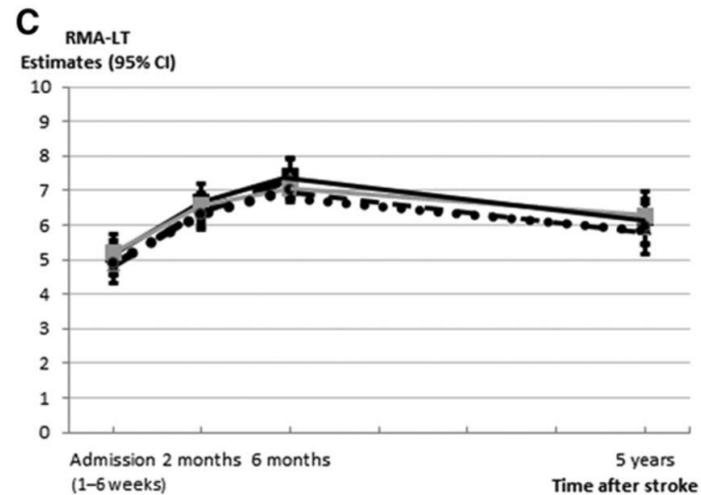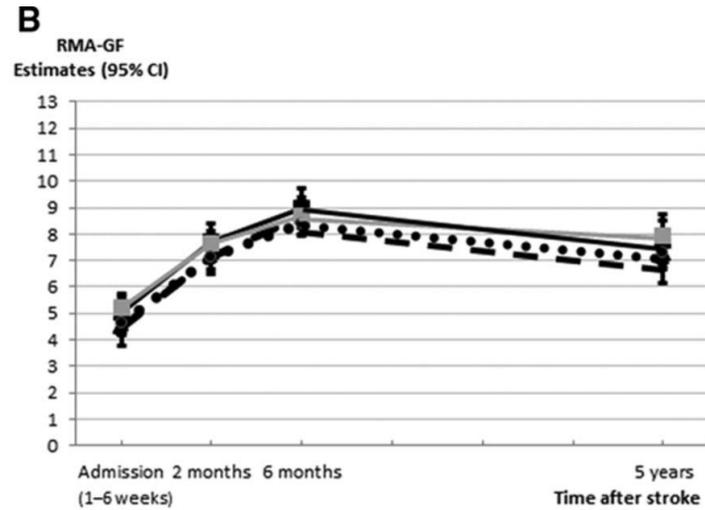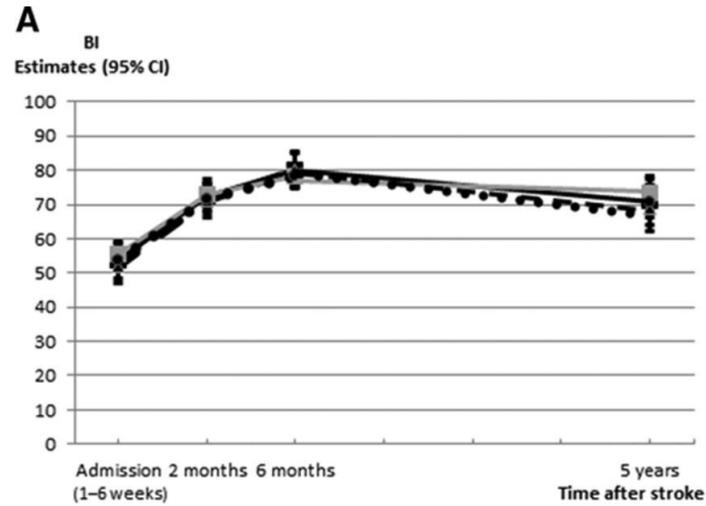
Wat volgt?

Figure I. The international classification of functioning, disability and health.[8]

How Should We Measure Physical Activity After Stroke? An International Consensus

How should we measure
physical activity after stroke?
An international consensus

Natalie A Fini[1,2], Dawn Simpson[2,3,4], Sarah A Moore[5,6],
Niruthikha Mahendran[2,7], Janice J Eng[8,9], Karen Borschmann[2,],
David Moulaee Conradsson[11,12], Sebastien Chastin[13],
Leonid Churilov[2,14] and Coralie English[2,3,4]

WHICH DEVICE IS BEST*?: IT DEPENDS ON WHAT YOU WANT TO MEASURE AND WHY…*

IN RESEARCH

PA Intensity (eg. energy expenditure)

Actigraph, Actical & Activ8

PA Duration (eg. time spent in postures)

ActivPAL

PA Frequency (eg. step count)

Step Activity Monitor

IN CLINICAL PRACTICE

PA Frequency, Intensity and Duration

Fitbit

WHICH QUESTIONNAIRE IS BEST?

Questionnaires with good construct validity and feasibility:

- International Physical Activity Questionnaire

- Physical Activity Scale for the Elderly

- Physician-based Assessment and Counselling for Exercise Score

- Stroke Physical Activity Questionnaire

Fini NA et al., How should we measure physical activity after stroke? An international consensus. *International Journal of Stroke* 2023; 1-11. DOI: 10.1177/17474930231184108.

Prognose
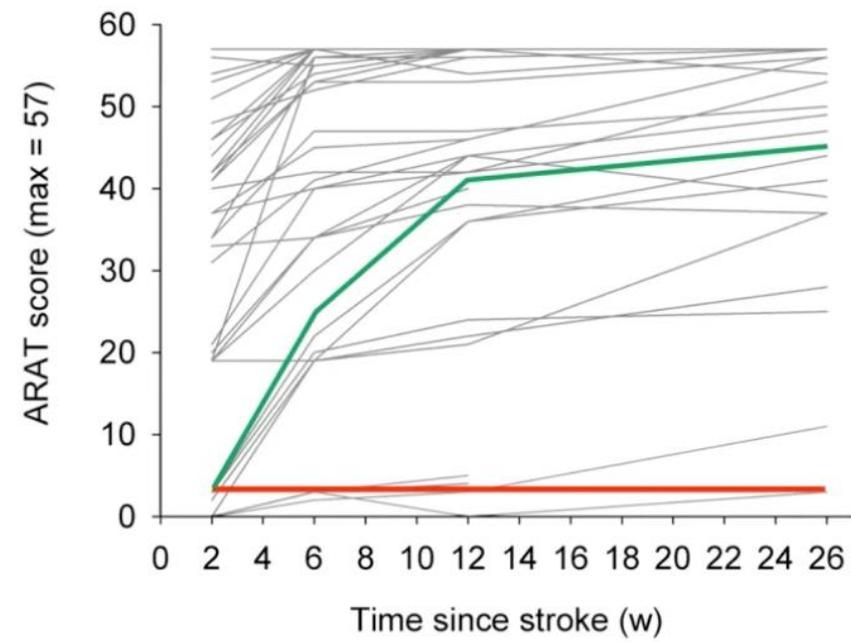
Validated tools that predict outcomes at specific time points for individual patients

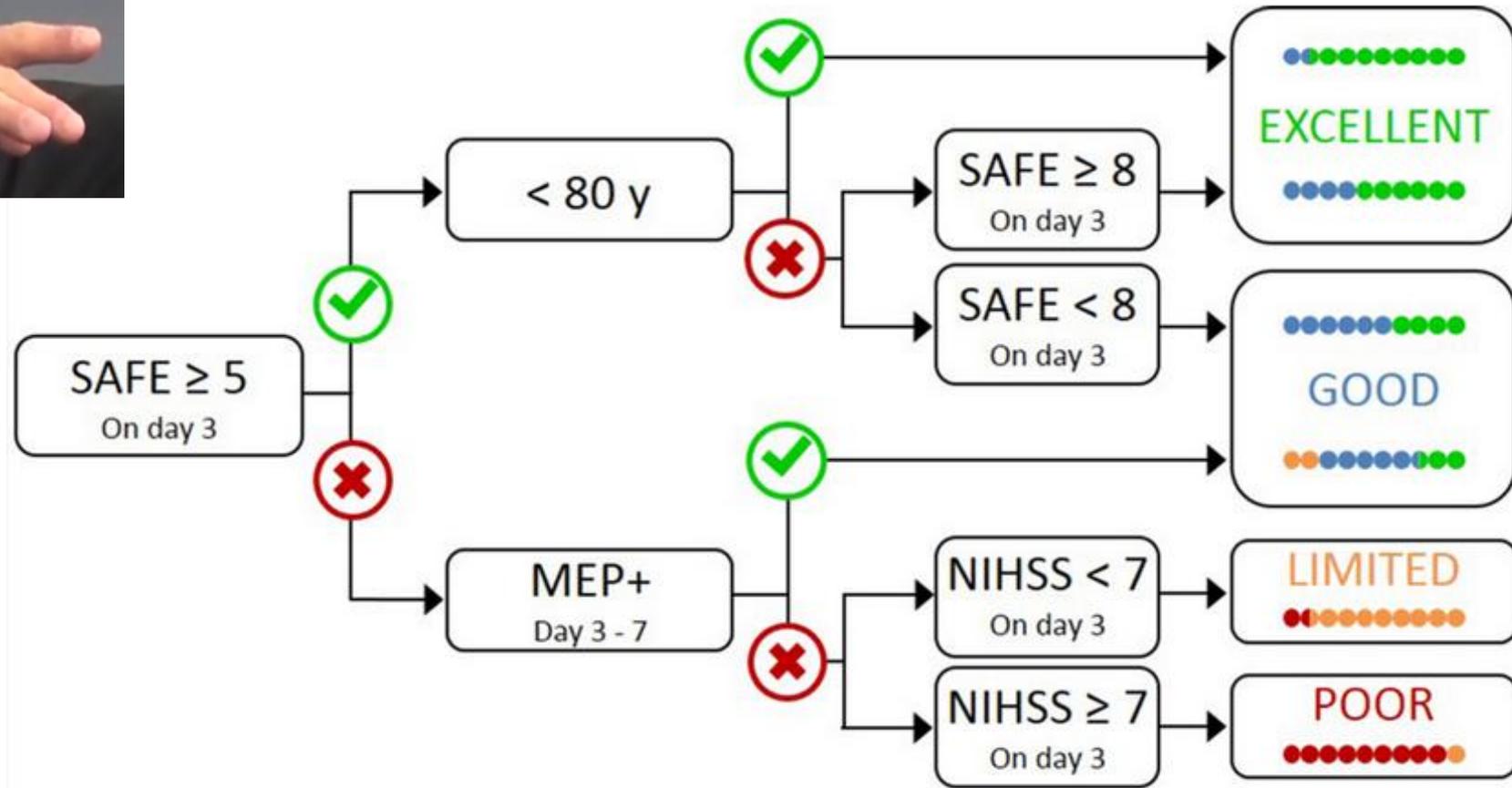| Prediction tool	Outcome	Prediction time	Outcome time	Type of tool	Predictor variables
PUPPI	NIHSS arm < 2 of 4 points	24 hours	3 months	Scoring system	Age, NIHSS
PREP2	Upper limb activity capacity: Excellent, Good, Limited, Poor	3 – 10 days	3 months	Decision tree	SAFE, Age MEP status, NIHSS
EPOS-UL	>10 out of 57 points on ARAT	2 – 10 days	3 months	Multi-variable equation	FMA-UE, finger extension, MI, shoulder abduction
EPOS-LL	FAC >3 of 5 points	3-10 days	3 months	Multi-variable equation	Trunk Control Test, MI leg
TWIST	FAC >3 of 5 points	7 days	1-3 months	Scoring system	Age, knee extension, BBS
Kwah	Independent walking	Within 7 days	6 months	Multi-variable equation	Age, NIHSS

PUPPI: Persistent Upper Extremity Impairment
EPOS: Early Prediction of Functional Outcome after Stroke
TWIST: Tenectaplace in Wake-up Ischemic Stroke Trial

Kwakkel et al. 2023

PREP-2: predicting upper limb outcome

Stinear et al Brain 2007; Boyd et al 2017 J Stroke; Stinear et al. 2017 Ann Clin Transl Neurol & Stroke; Smith et al. 2019
https://presto.auckland.ac.nz/how-prep2-works/
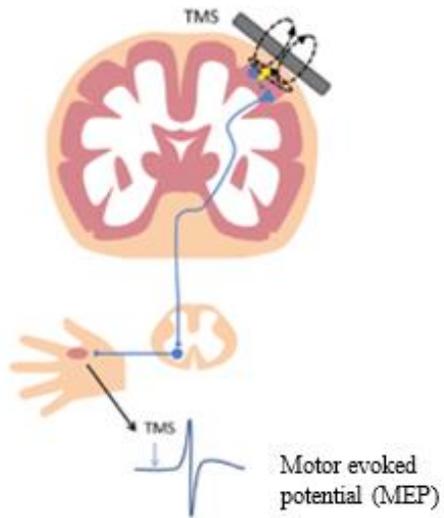
Category	Upper Limb Prediction	Upper Limb Rehabilitation Focus
Excellent	Potential to make a complete, or near-complete, recovery of hand and arm function within 3 months.	Promote normal use of the affected hand and arm with task-specific practice, while minimizing compensation with the other hand and arm.
Good	Potential to be using their affected hand and arm for most activities of daily living within 3 months, though they may continue to experience some weakness, slowness, or clumsiness.	Promote normal function of the affected hand and arm by improving strength, coordination, and fine motor control with repetitive and task-specific practice. Emphasis is placed on minimizing compensation with the other hand and arm, and the trunk.
Limited	Potential to regain movement in their hand and arm within 3 months, but daily activities are likely to require significant modification.	Promote movement and reduce impairment by improving strength and active range of motion. Promote adaptation in daily activities while incorporating the affected upper limb wherever safely possible.
None	Unlikely to regain useful movement in their hand and arm within 3 months.	Prevent secondary complications such as pain, spasticity, and shoulder instability. Reduce disability by learning to complete daily activities with the stronger hand and arm.

TWIST predicting independent walking at 6 months post stroke

(Functional Ambulation Scale)

TWIST Score			
Age	≥ 80 y	0	
	< 80 y	1	
Knee extension strength *Medical Research Council grade*	< 3	0	
	≥ 3	1	
Postural Control *Berg Balance Test*	< 6	0	
	6–15	1	
	≥ 16	2	
	Total	/4	
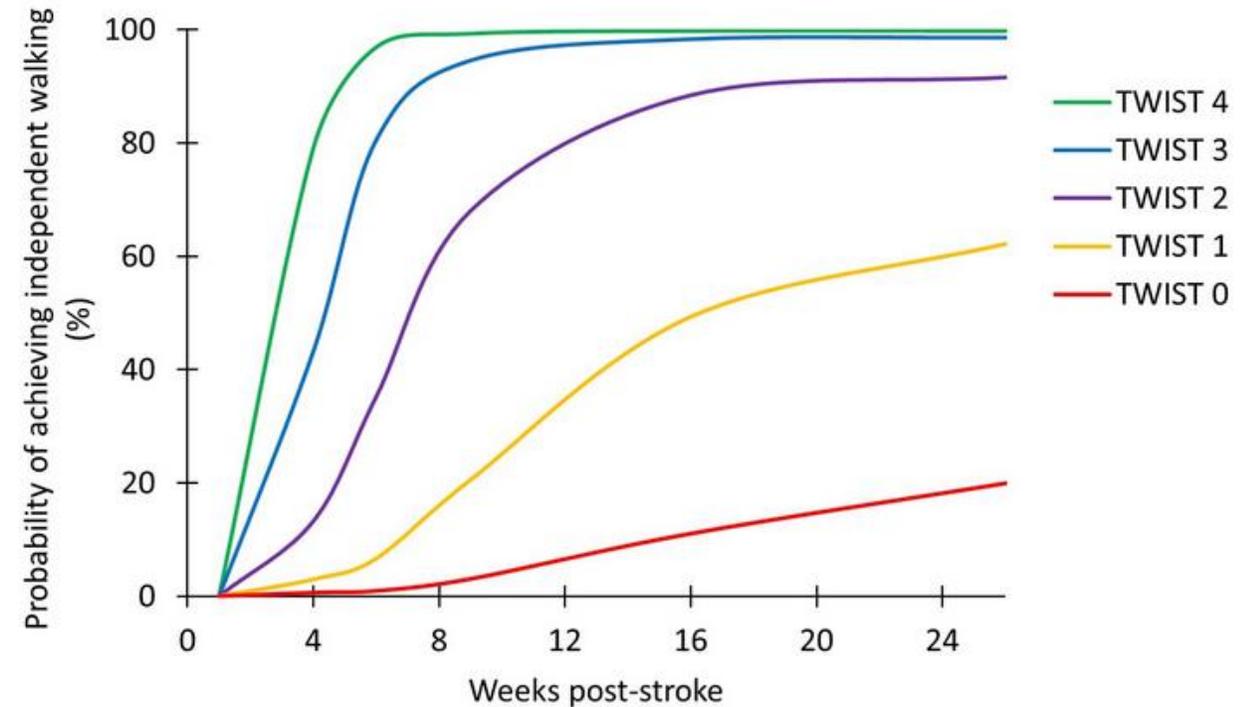
Smith MC, Barber AP, Scrivener BJ, et al. The TWIST tool predicts when patients will recover independent walking after stroke: an observational study. *Neurorehabil Neural Repair* 2022; 36: 461–471.

Interventie

Strongly recommended evidence-based interventions

- Summary of national clinical practice guidelines, included if
  - Guidelines written in English or Dutch
  - Containing a section 'rehabilitation after stroke'
  - Received 'strong' recommendation 'in favour' in at least three guidelines (2 reviewers)

- 5 high-quality guidelines included
  - Australian and New Zealand Guidelines
  - Canadian Guidelines
  - American Guidelines
  - UK National Clinical Guidelines
  - Guidelines from the Netherlands

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Strongly recommended evidence-based interventions

More is better

Principles

Intensity (amount of rehabilitation)

Rehab is structured to provide as much scheduled therapy (OT and PT) as possible.	AU/NZ, CA, NL	**AU/NZ**: therapist should maximize the amount of active task practice during therapy sessions. Use of objective measurement of activity should be considered. **CA**: once deemed to be medically and neurologically stable, more therapy results in better outcomes. **NL** (in all phases): intensifying exercise therapy (more hours) compared to fewer hours leads to faster recovery of the dissociated movement, comfortable walking speed, maximum walking speed, walking distance, muscle tone, sitting and standing balance, the performance of basic activities of daily living, quality of life and degree of depression and feelings of anxiety.

2023 UK National Clinical Guidelines:
- *at least 3 hours of therapy per day*
- *people should be supported to remain active for 6 hours a day, including the hours of therapy*

Kwakkel et al. 2023

Strongly recommended evidence-based interventions

Repetitive, intense, task- and context specific, progressive training

General considerations

Patients should participate in training that is meaningful, engaging, progressively adaptive, intensive, task-specific and goal-oriented in an effort to improve transfer skills and mobility.	CA, UK, US	**CA**: Therapy should include repetitive and intense use of patient-valued tasks that challenge the patient to acquire the necessary skills needed to perform functional tasks and activities. **UK**: People with loss of movement should be taught task-specific, repetitive, intensive exercises or activities that will increase strength. **US**: Intensive, repetitive, mobility-task training if gait limitations.

Kwakkel et al. 2023

Progressive strength and functional balance training should be provided for those with reduced strength or balance

Specific therapies

Weakness

Progressive resistance training to improve strength	AU/NZ	**AU/NZ:** For stroke survivors with reduced strength in their arms or legs, progressive resistance training should be provided to improve strength.

Balance

Balance training	NL, UK, US	**NL** (examined in ER, LR and RC): balance training during different activities improves *sit- and standing balance* and *basic ADL activities*. **UK:** People with significant impairment of their balance and walking ability after stroke should receive progressive balance training. **US:** Individuals with stroke who have poor balance, low balance confidence, and fear of falls or are at risk for falls should be provided with a balance training program.

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Strongly recommended evidence-based interventions

Walking in different forms

Individualized, repetitive, task and context specific, high variability combined with high number of repetitions

Circuit class therapy with focus on overground walking and mobility

Treadmill training with or without BWS

Robot-assisted for those who would otherwise not practice walking, but robotics should not used in place of conventional gait therapy

Ankle foot orthosis (AFO) should be offered when needed

Functional electric stimulation (FES) for drop-foot

Kwakkel et al. 2023

# Strongly recommended evidence-based interventions

Arm training – specific therapies

Original or modified CIMT – active repetitive task-practice is the key element, no evidence for restraint alone, only relevant for those with minor cognitive deficits, and some finger/wrist function

Mental practice as adjunct therapy – for suitable candidates

Robot-assisted therapy only as an adjunct therapy, can increase repetition in those with moderate to severe impairment, shoulder and elbow movements

NMES as adjunct therapy for wrist/finger extensors can be offered for those with minimal active function, during the first months of stroke

Kwakkel et al. 2023

Langhorne et al. Lancet 2011
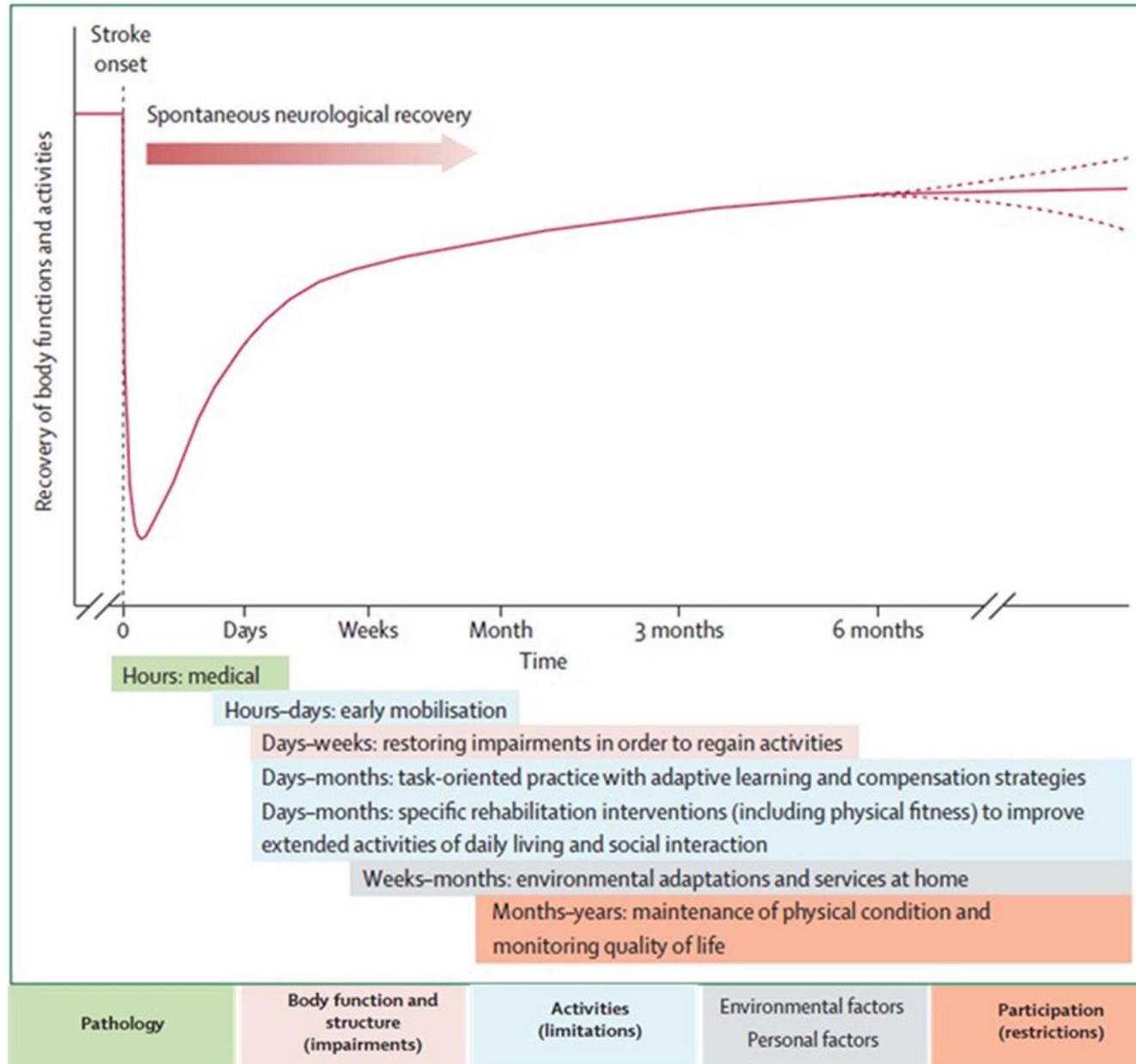
Arm-Hand Boost Therapy During Inpatient Stroke Rehabilitation: A Pilot Randomized Controlled Trial

Sarah Meyer[1]*, Geert Verheyden[2], Kristof Kempeneers[1] and Marc Michielsen[1]

[1] Jessa Hospital, Rehabilitation Centre, Campus Sint-Ursula, Herk-de-Stad, Belgium, [2] Department of Rehabilitation Sciences, KU Leuven-University of Leuven, Leuven, Belgium

Boost

The specific intensive boost program for the upper limb (BOOST) is focused around five topics: scapula-setting, core-stability training in relation to reaching, training of external shoulder rotation and elbow extension (movements with 30–60° flexion/abduction in shoulder), fine manipulation or dexterity training and integration in complex ADL tasks. For each of those topics, a list of example exercises was created that could be used depending on the individual abilities of the patient, including a gradual increase in levels of difficulty. Each of the interventions is tailored to the individual patient, based upon the ongoing assessment using the Model of Bobath Clinical Practice (11), discussion within the group of therapists and individual treatment goals of the patient.
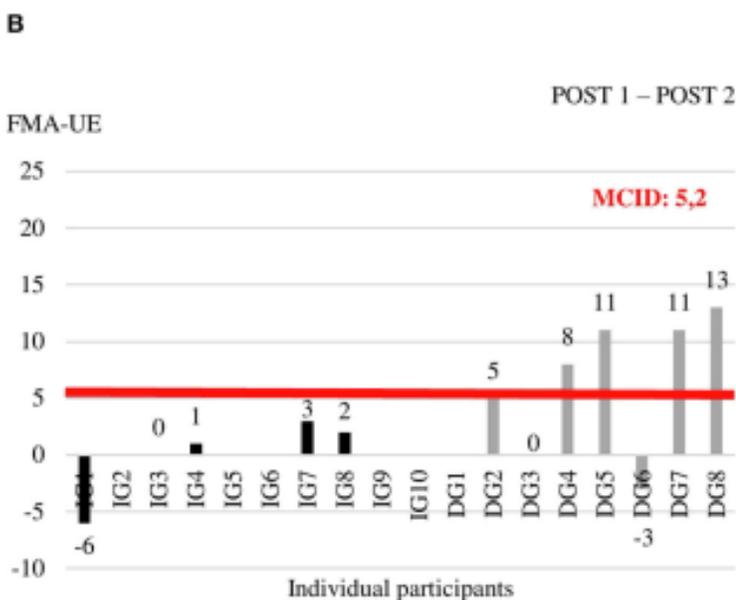
+24 hours in 4 weeks
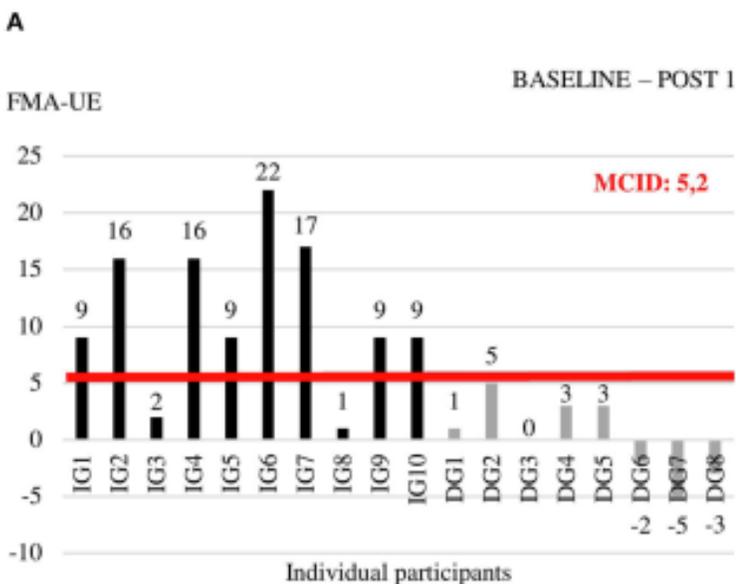

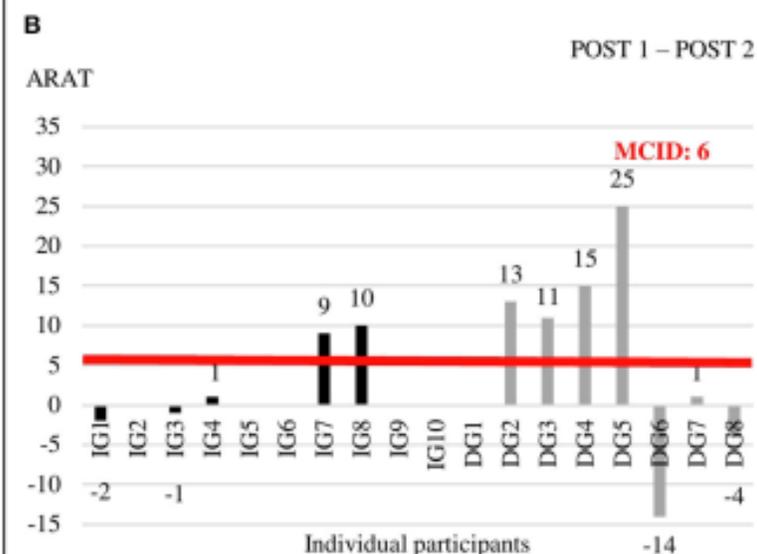FIGURE 2 | Individual change scores in FMA-UE between BASELINE and POST 1 **(A)** and between POST 1 and POST 2 **(B)**.
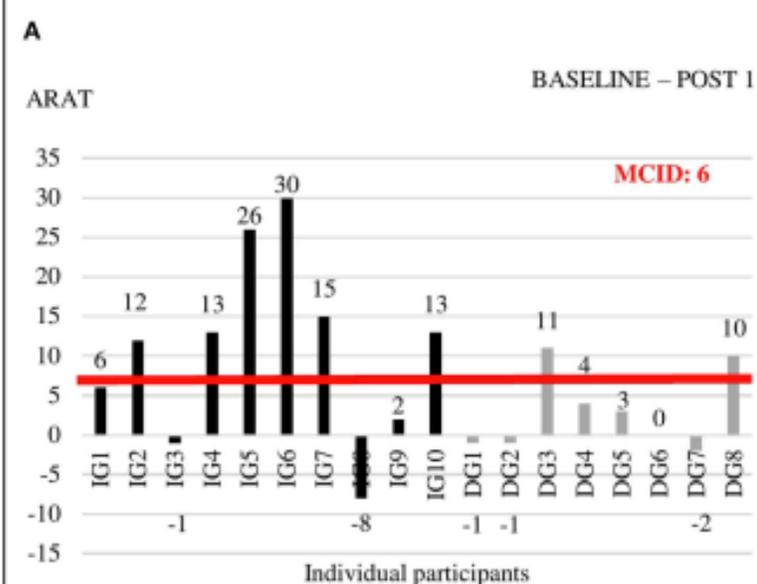

FIGURE 3 | Individual change scores in ARAT between BASELINE and POST 1 **(A)** and between POST 1 and POST 2 **(B)**.

2023-2027

Arm-hand BOOST therapy to enhance recovery after stroke: clinical, health economic and process evaluation.

The overall aim of this project is to investigate for patients after stroke, who are admitted to inpatient stroke rehabilitation, and who have the potential to relearn, whether additional, targeted comprehensive arm-hand therapy (Aha BOOST), when compared to dose-matched therapy for the lower limb, can enhance outcome above the current level of recovery and long-term, and in addition demonstrate a beneficial health economic and quality of life effect, providing impact for patient and society.

AHA-BOOST

Zie ook poster 2 en 3 op de posterbeurs!

f w o Research Foundation Flanders
Opening new horizons

KU Leuven

Tasks

› General management of the study
› Clinical randomized controlled trial

Team

› Prof. Geert Verheyden
› Dr. Sarah Meyer
› PhD Liesel Cornelis

Vrije Universiteit Brussel

Tasks

› Health economic evaluation
› Process evaluation

Team

› Prof. Koen Putman
› Prof. Maaike Fobelets
› Prof. Ann De Smedt
› PhD Lisa Cruycke

Jessa ziekenhuis

Tasks

› Dissemination & utilisation of Aha Boost program

Team

› Mr. Marc Michielsen
› Dr. Maaiken Vander Plaetse
› Dr. Sarah Meyer

Clinical sites

Revalidatieziekenhuis RevArte

Edegem

Collaborator: Prof. Christophe Lafosse

UZ Gent, Revalidatiecentrum K7

Gent

Collaborator: Prof. Katie Bouche

Wat volgt nog?

Langhorne et al. Lancet 2011
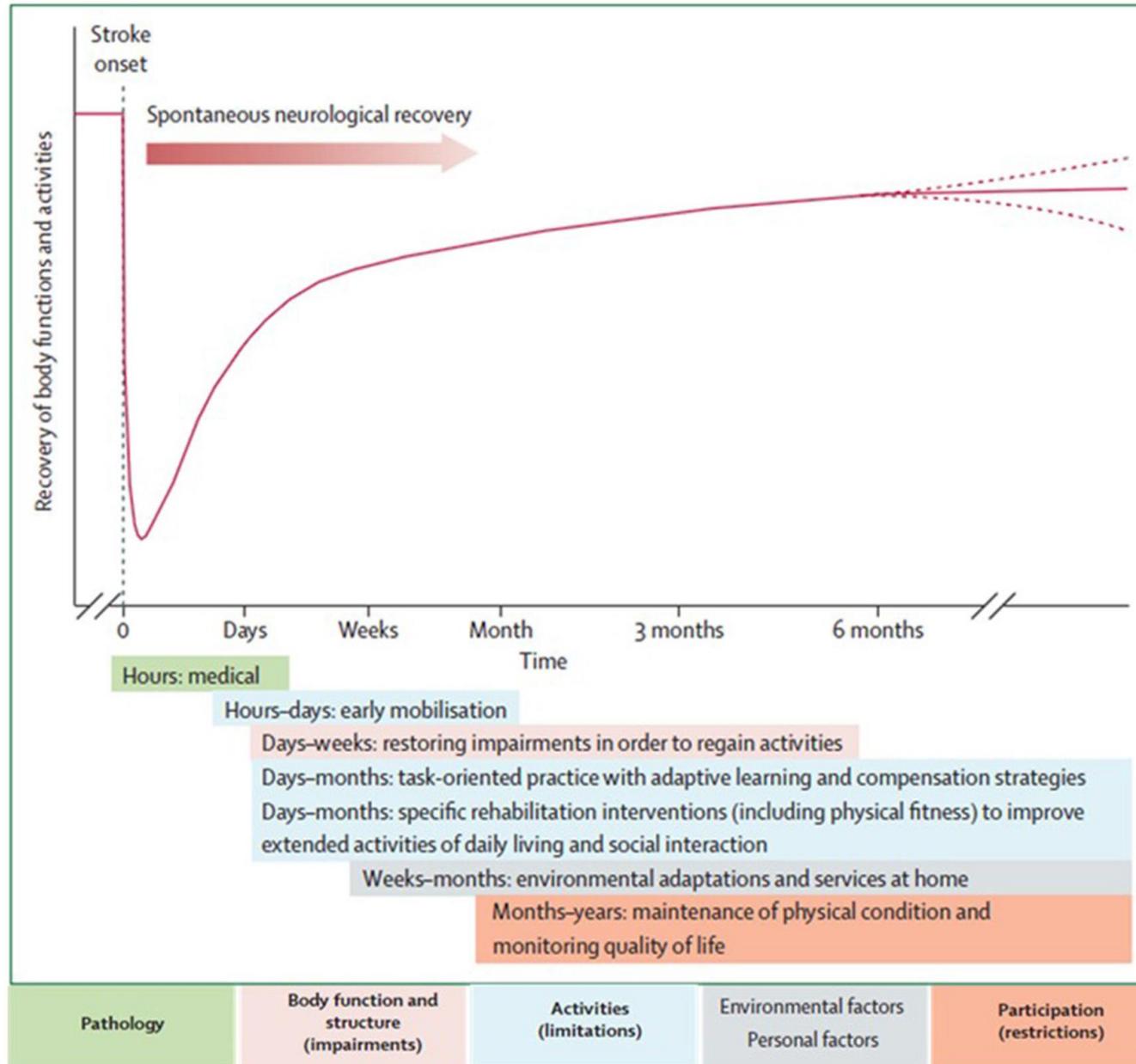
Improved outcome in chronic phase?

RESEARCH PAPER

Intensive upper limb neurorehabilitation in chronic stroke: outcomes from the Queen Square programme

Nick S Ward, [1,2,3] Fran Brander, [2,3] Kate Kelly[2,3]

Prospective single-center cohort study
N=224
3-week UL boost
90 hours

Ward et al. JNNP 2019

Table 3 Changes in upper limb scores

|	Adm - Dis	Adm - 6 weeks	Adm - 6 months
FM-UL	6 (3 to 9)	8 (4 to 11)	9 (4 to 12)
ARAT	6 (2 to 8)	7 (2 to 10)	8 (3 to 11)
CAHAI	9 (5 to 13.5)	10 (5 to 16)	12 (6 to 17)
ArmA-A	−2 (−5 to −1)	−3 (−6 to −1)	−4 (−8 to −1)
ArmA-B	−7 (−14 to −3)	−10 (−17 to −4)	−11 (−19 to −5)

All scores given as median (IQR).
ARAT, Action Research Arm Test; ArmA-A, Arm Activity Measure A; ArmA-B, Arm Activity Measure B; CAHAI, Chedoke Arm and Hand Activity Inventory; FM-UL, Fugl-Meyer (upper limb).

"Black box" of UL stroke therapy

2022-2025
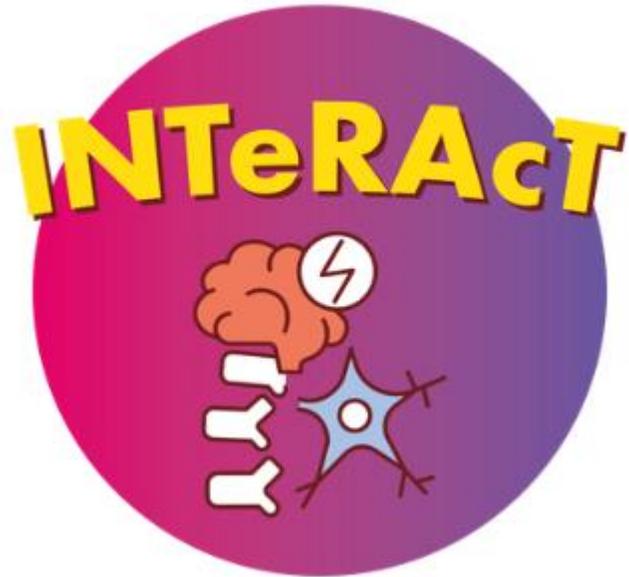
INTeRAcT
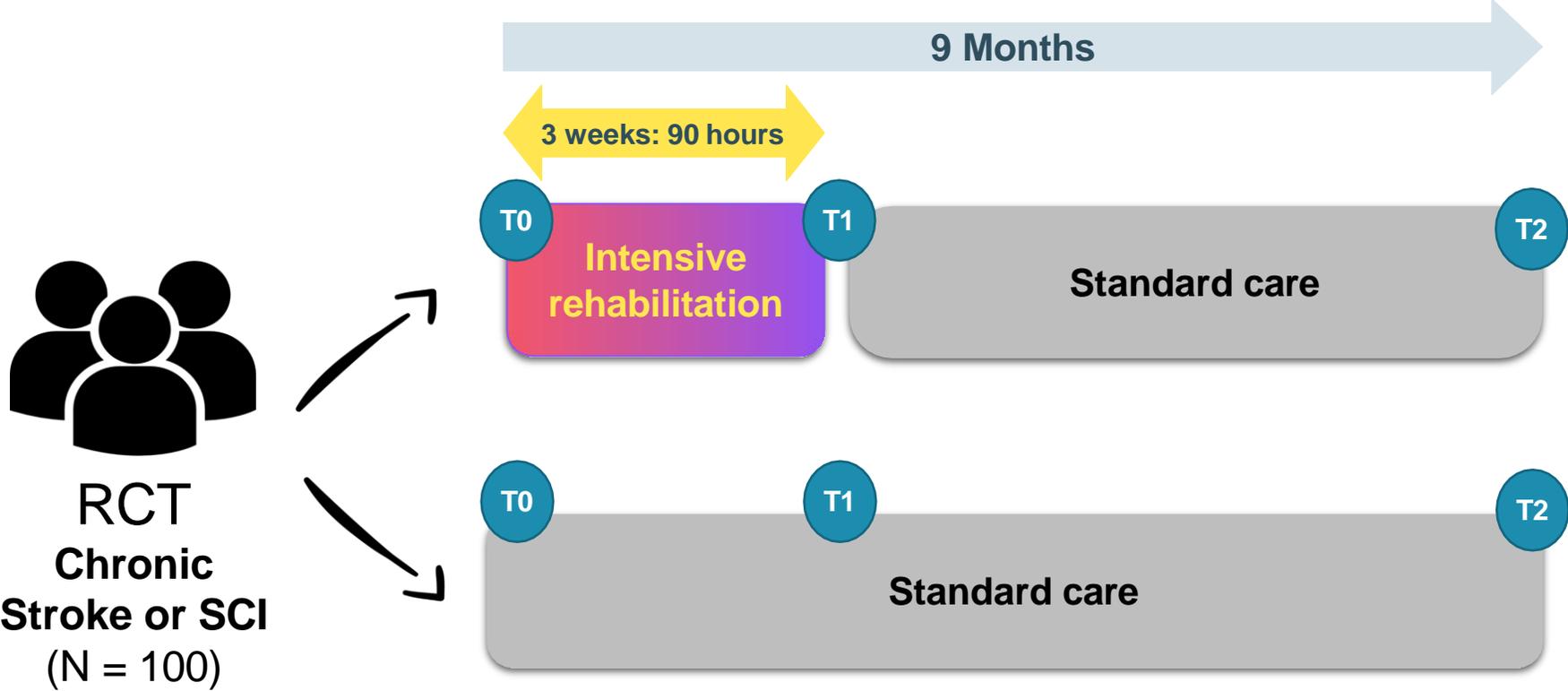
	Monday	Tuesday	Wednesday	Thursday	Friday
9u30-10u	Goal oriented training	Self-management	Goal oriented training	OL therapy + Technology	BL therapy + Technology
10u-10u30		OL therapy + Technology			
10u30-11u	OL therapy		OL therapy	BL therapy	OL therapy + Technology
11u-11u30		Goal oriented training			
11u30-12u	BL therapy + Technology		Self-management GT	BL therapy + Technology	Self-management
12u-12u30		Cardiovascular fitness training GT			Cardiovascular fitness training GT
12u30-13u	Pause	Pause	Pause	Pause	Pause
13u-13u30					
13u30-14u	Cardiovascular fitness training GT	BL therapy	BL therapy + Technology	Cardiovascular fitness training GT	BL therapy
14u-14u30				Goal oriented training	
14u30-15u	BL therapy	BL therapy + Technology	BL therapy		OL therapy
15u-15u30				Self-management	
15u30-16u	OL therapy + Technology	OL therapy	OL therapy + Technology	OL therapy	Goal oriented training
16u-16u30					

Assess — Make valid prognosis to guide individual goal setting, incorporating patient's preferences

Use standardized recommended assessments including patient-reported measures

Review

Adjust plan for rehabilitation setting and resources

Analyze — Consider time after stroke and other domains such as sensation, communication and cognitive impairments

Select — Follow clinical practice guidelines and apply principles of motor control

Deliver

Motor rehabilitation after stroke benefits function, activity and daily life performance

Acknowledges variability between patients and stages of recovery

Is guided by regular assessment, discussed with patient and carers

Optimizes and adapts motor, sensory and cognitive functioning

Supports people to maximize quality of life

Kwakkel et al. ESJ 2023

Welkom

Dank U

Geert.Verheyden@kuleuven.be