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Is robot-gestuurde gangtraining effectief na een beroerte?

Van herstelmechanismen tot toepassing in de revalidatie.

University of Antwerp
MOVANT | Movement Antwerp
FWO Research Foundation Flanders
Opening new horizons

“Key questions”

1. Wat is de evidentie voor de kinesitherapie in de revalidatie na beroerte?
2. Wat is het tijdsbeloop van herstel in de eerste 6 maanden na beroerte?
3. Hoe (her-)leren revalidanten de basale activiteiten van het dagelijkse leven?

1. Wat is de evidentie voor de kinesitherapie in de beroete revalidatie?

Wetenschappelijk evidentie: Welke therapievormen?

OPEN ACCESS Freely available online

PLOS | ONE

What Is the Evidence for Physical Therapy Poststroke? A Systematic Review and Meta-Analysis

Janne Marieke Veerbeek[1], Erwin van Wegen[1], Roland van Peppen[2], Philip Jan van der Wees[3], Erik Hendriks[4], Marc Rietberg[1], Gert Kwakkel[1,5]*

1 Department of Rehabilitation Medicine, MOVE Research Institute Amsterdam, VU University Medical Center, Amsterdam, The Netherlands, **2** Department of Physiotherapy, University of Applied Sciences Utrecht, Utrecht, The Netherlands, **3** Scientific Institute for Quality of Healthcare (IQ healthcare), Radboud University Nijmegen Medical Center, Nijmegen, The Netherlands, **4** Department of Epidemiology, Maastricht University, Maastricht, The Netherlands, **5** Department of Neurorehabilitation, Reade Center for Rehabilitation and Rheumatology, Amsterdam, The Netherlands

*"There is strong evidence for PT interventions favoring **intensive high-repetitive task-oriented training** in all phases poststroke. Effects are mostly restricted to the actually trained functions and activities."* *(Veerbeek 2014)*

Wetenschappelijk evidentie: Hoe intensief?

Is More Better? Using Metadata to Explore Dose–Response Relationships in Stroke Rehabilitation

Keith R. Lohse, PhD; Catherine E. Lang, PT, PhD; Lara A. Boyd, PT, PhD

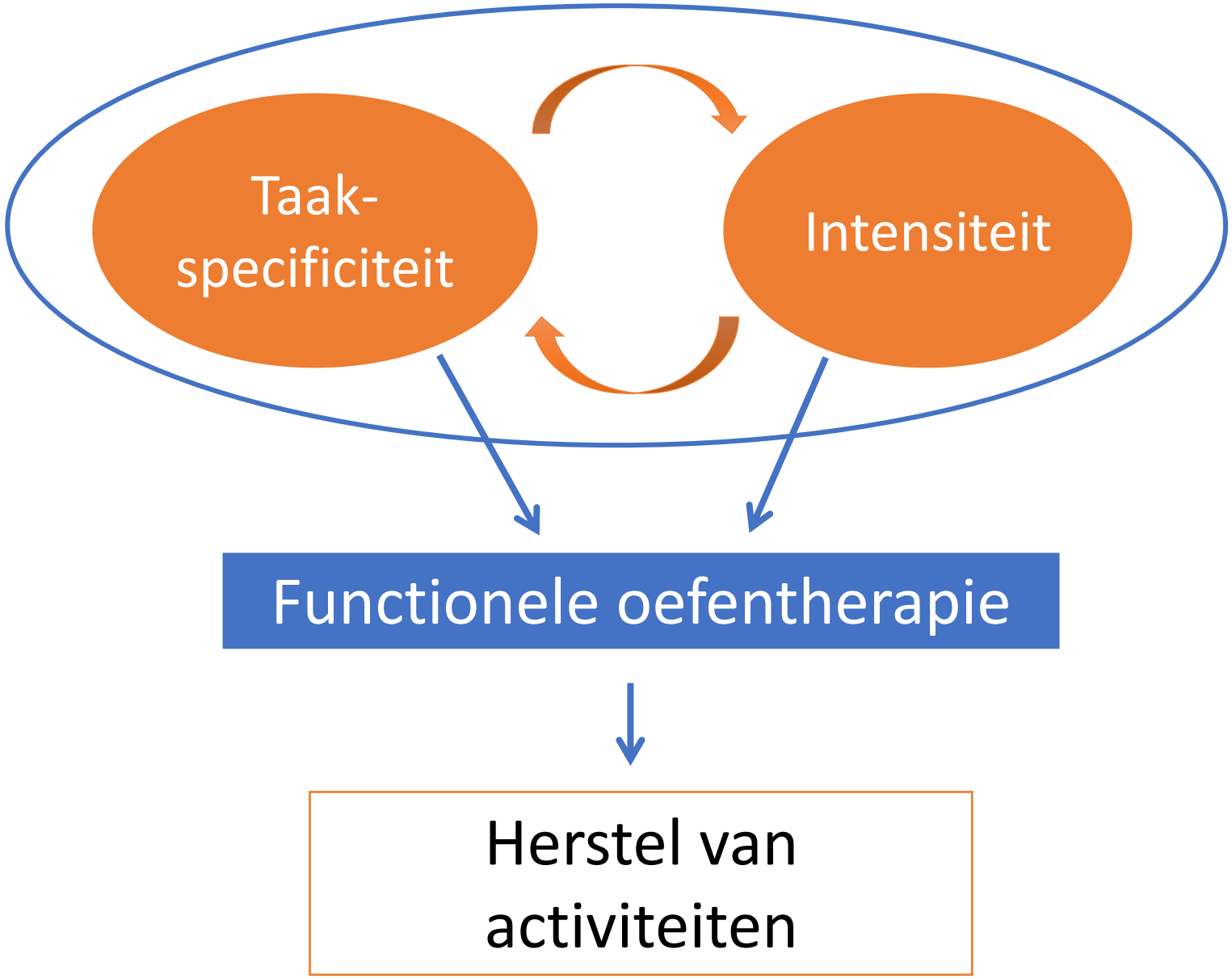
"Large doses of therapy lead to clinically meaningful improvements." *(Lohse 2014)*

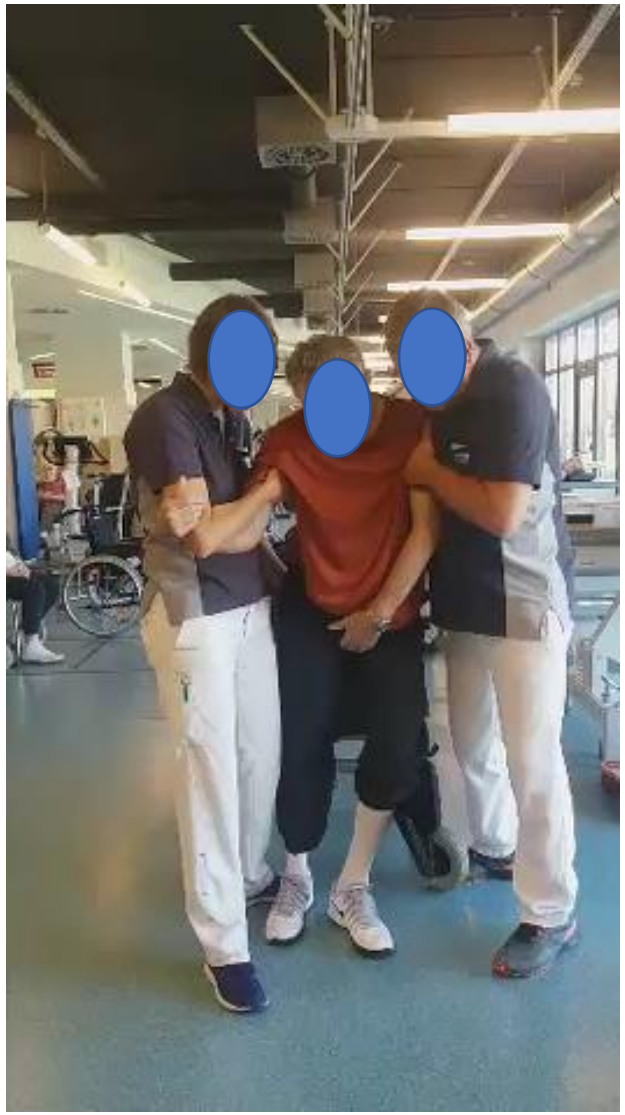
Effects of Augmented Exercise Therapy on Outcome of Gait and Gait-Related Activities in the First 6 Months After Stroke

A Meta-Analysis

Janne M. Veerbeek, MSc; Muriel Koolstra, MSc; Johannes C.F. Ket; Erwin E.H. van Wegen, PhD; Gert Kwakkel, PhD

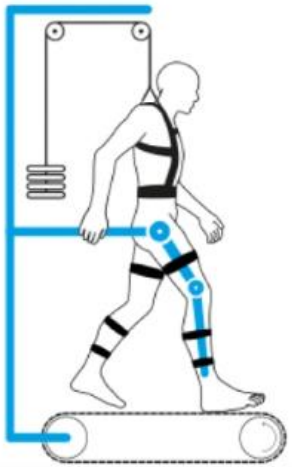
"Increased time spent on exercise of gait and gait-related activities in the first 6 months poststroke results in significant effects on walking ability" *(Veerbeek 2011)*


Taak-
specificiteit
Intensiteit
Functionele oefentherapie
Herstel van
activiteiten

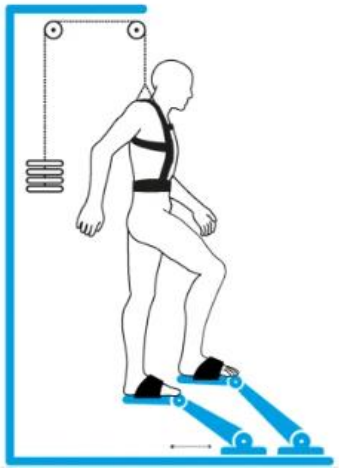


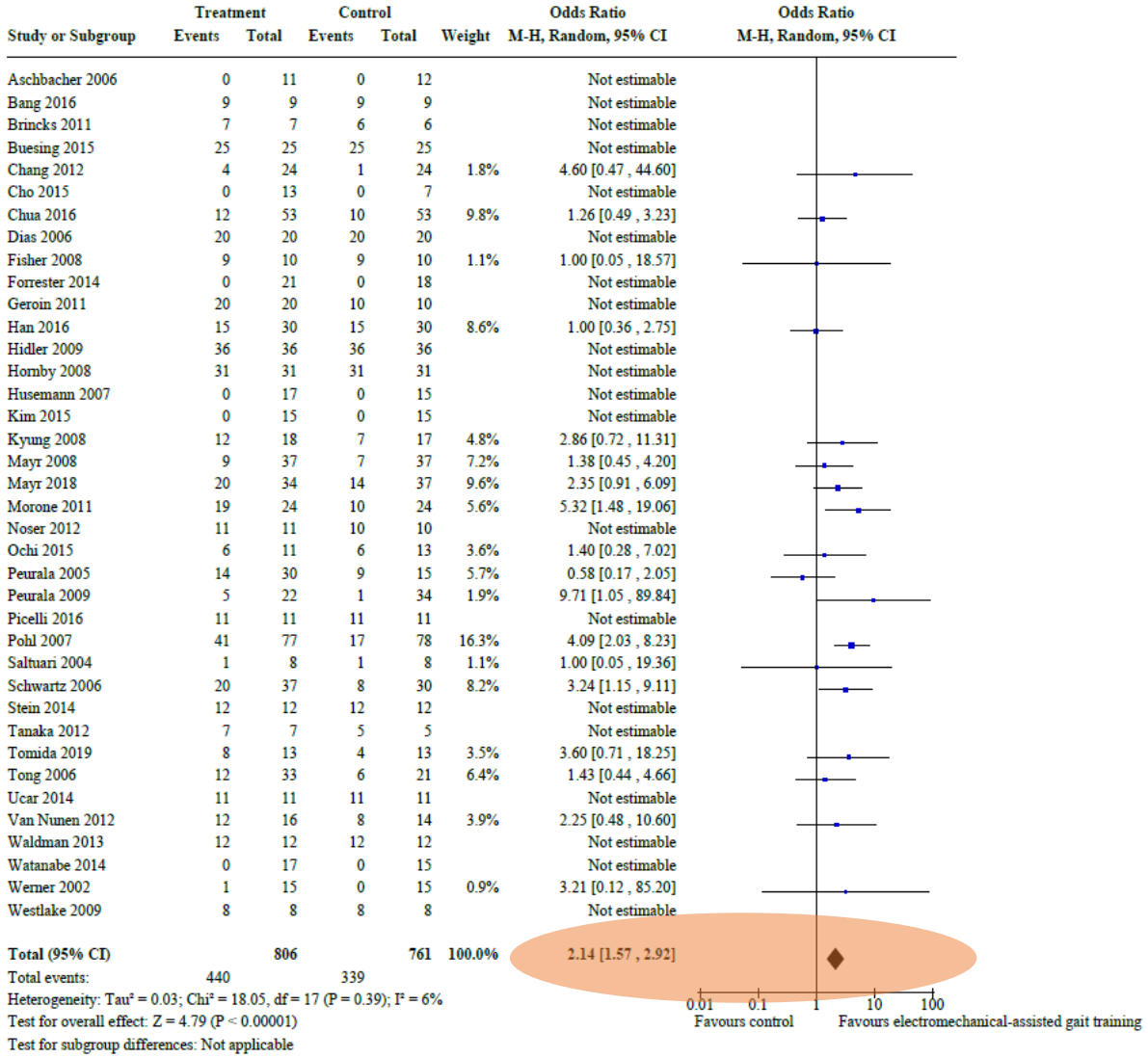
Introductie van revalidatierobots met veel enthousiasme!

Exoskeleton ~ Orthese



End-effector ~ Voetplaten





Study or Subgroup	Treatment Events	Total	Control Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
Aschbacher 2006	0	11	0	12		Not estimable
Bang 2016	9	9	9	9		Not estimable
Brincks 2011	7	7	6	6		Not estimable
Buesing 2015	25	25	25	25		Not estimable
Chang 2012	4	24	1	24	1.8%	4.60 [0.47 , 44.60]
Cho 2015	0	13	0	7		Not estimable
Chua 2016	12	53	10	53	9.8%	1.26 [0.49 , 3.23]
Dias 2006	20	20	20	20		Not estimable
Fisher 2008	9	10	9	10	1.1%	1.00 [0.05 , 18.57]
Forrester 2014	0	21	0	18		Not estimable
Geroin 2011	20	20	10	10		Not estimable
Han 2016	15	30	15	30	8.6%	1.00 [0.36 , 2.75]
Hidler 2009	36	36	36	36		Not estimable
Hornby 2008	31	31	31	31		Not estimable
Husemann 2007	0	17	0	15		Not estimable
Kim 2015	0	15	0	15		Not estimable
Kyung 2008	12	18	7	17	4.8%	2.86 [0.72 , 11.31]
Mayr 2008	9	37	7	37	7.2%	1.38 [0.45 , 4.20]
Mayr 2018	20	34	14	37	9.6%	2.35 [0.91 , 6.09]
Morone 2011	19	24	10	24	5.6%	5.32 [1.48 , 19.06]
Noser 2012	11	11	10	10		Not estimable
Ochi 2015	6	11	6	13	3.6%	1.40 [0.28 , 7.02]
Peurala 2005	14	30	9	15	5.7%	0.58 [0.17 , 2.05]
Peurala 2009	5	22	1	34	1.9%	9.71 [1.05 , 89.84]
Picelli 2016	11	11	11	11		Not estimable
Pohl 2007	41	77	17	78	16.3%	4.09 [2.03 , 8.23]
Saltuari 2004	1	8	1	8	1.1%	1.00 [0.05 , 19.36]
Schwartz 2006	20	37	8	30	8.2%	3.24 [1.15 , 9.11]
Stein 2014	12	12	12	12		Not estimable
Tanaka 2012	7	7	5	5		Not estimable
Tomida 2019	8	13	4	13	3.5%	3.60 [0.71 , 18.25]
Tong 2006	12	33	6	21	6.4%	1.43 [0.44 , 4.66]
Ucar 2014	11	11	11	11		Not estimable
Van Nunen 2012	12	16	8	14	3.9%	2.25 [0.48 , 10.60]
Waldman 2013	12	12	12	12		Not estimable
Watanabe 2014	0	17	0	15		Not estimable
Werner 2002	1	15	0	15	0.9%	3.21 [0.12 , 85.20]
Westlake 2009	8	8	8	8		Not estimable
Total (95% CI)		**806**		**761**	**100.0%**	2.14 [1.57 , 2.92]
Total events:	440		339			

Heterogeneity: Tau² = 0.03; Chi² = 18.05, df = 17 (P = 0.39); I² = 6%
Test for overall effect: Z = 4.79 (P < 0.00001)
Test for subgroup differences: Not applicable

Odds Ratio M-H, Random, 95% CI

0.01 0.1 1 10 100
Favours control | Favours electromechanical-assisted gait training

Cochrane Library
Cochrane Database of Systematic Reviews

Electromechanical-assisted training for walking after stroke (Review)
Update 2020

Mehrholz J, Thomas S, Werner C, Kugler J, Pohl M, Elsner B

- In total, 64 onderzoeken (2002-2019) met 2.440 participanten
- Vergelijking:
  Robot-gestuurde gangtraining + conventionele therapie t.o.v. alleen conventionele therapie
- Primaire uitkomst:
  Kans om het zelfstandig stappen te herstellen (38 studies, 1.567 participanten)

~ 8 Pt'en moeten behandeld worden om één geval van afhankelijkheid te voorkomen

Neutrale/onzekere effecten op vlak van de wandelsnelheid en –uithouding.

Cochrane Library

Cochrane Database of Systematic Reviews

Sub-groep analyses

Electromechanical-assisted training for walking after stroke (Review)

Update 2020

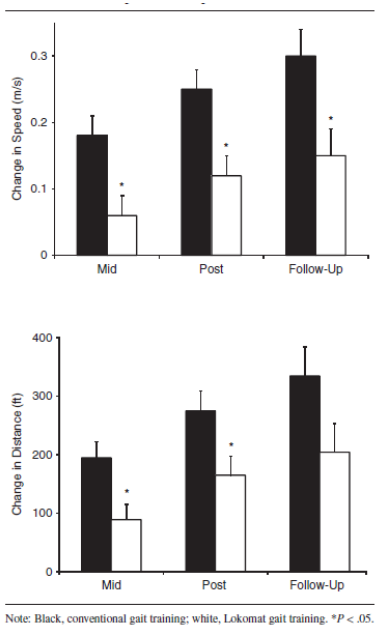
Mehrholz J, Thomas S, Werner C, Kugler J, Pohl M, Elsner B

- *"Those who are **not able to walk** seem to benefit most from this intervention."*
- *"Specifically, people in the **first three months** after stroke benefit most from this intervention."*

Neutrale effecten ten opzichte van een “actieve” controle

Hidler et al. 2009

- N=63 (15-19 weken na beroerte, < 6 maanden)
- Standard therapie (focus op arm/hand)
  - 45 min robot-gestuurde gangtraining (Lokomat)
  - 45 min conventionele gangtraining (statisch/dynamisch balanscontrole, gewicht-transfer… -> loopbandtraining, trappen nemen…)
- 3x/week, voor 8-10 weken (max. 24 sessies)

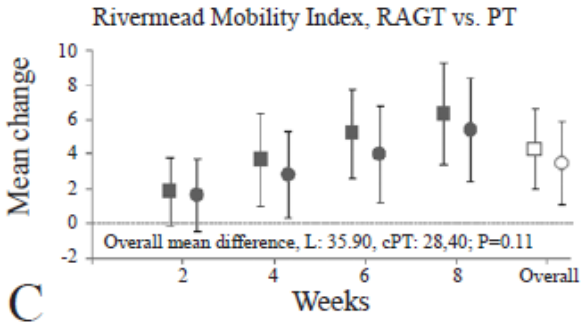


Note: Black, conventional gait training; white, Lokomat gait training. *$P < .05$.

=<

Mayr et al. 2018

- N=74 (1-8 weken na beroerte, < 3 maanden)
- 45min standaard therapie PLUS
  - 45min robot-gestuurde gangtraining (Lokomat)
  - 45 min conventionele gangtraining (statisch/dynamisch balanscontrole, gewicht-transfer, zwaai inzetten…)
- 5x/week, voor 8 weken



Neutrale effecten ten opzichte van een “actieve” controle

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Body-Weight–Supported Treadmill Rehabilitation after Stroke

Pamela W. Duncan, P.T., Ph.D., Katherine J. Sullivan, P.T., Ph.D., Andrea L. Behrman, P.T., Ph.D., Stanley P. Azen, Ph.D., Samuel S. Wu, Ph.D., Stephen E. Nadeau, M.D., Bruce H. Dobkin, M.D., Dorian K. Rose, P.T., Ph.D., Julie K. Tilson, D.P.T., Steven Cen, Ph.D., and Sarah K. Hayden, B.S., for the LEAPS Investigative Team

Duncan *et al*. (LEAPS) 2011

- N=408 (< 2 maanden na beroerte)
- 3x/week, voor 12-16 weken (30-36 sessions)

  Standard zorg PLUS

  1. 90min sessies loopband training met gewichtsdragende harnass 2 maanden post (vroeg)
  2. 90min sessies loopband training met gewichtsdragende harnass 6 maanden post (laat)
  3. 90min intensieve, gestructureerde thuisoefeningen 2 maanden post (vroeg)

*“An early training priority is to achieve an **upright symmetrical posture** with **spatial-temporal symmetry of the stepping** pattern.”*
(Duncan et al. 2007)

*“The duration of a single home-exercise session (76±10 minutes) was significantly **less than** that of an early (83±6 minutes) and a late locomotor-training session (82±5 minutes).”*
(Duncan et al. 2011)

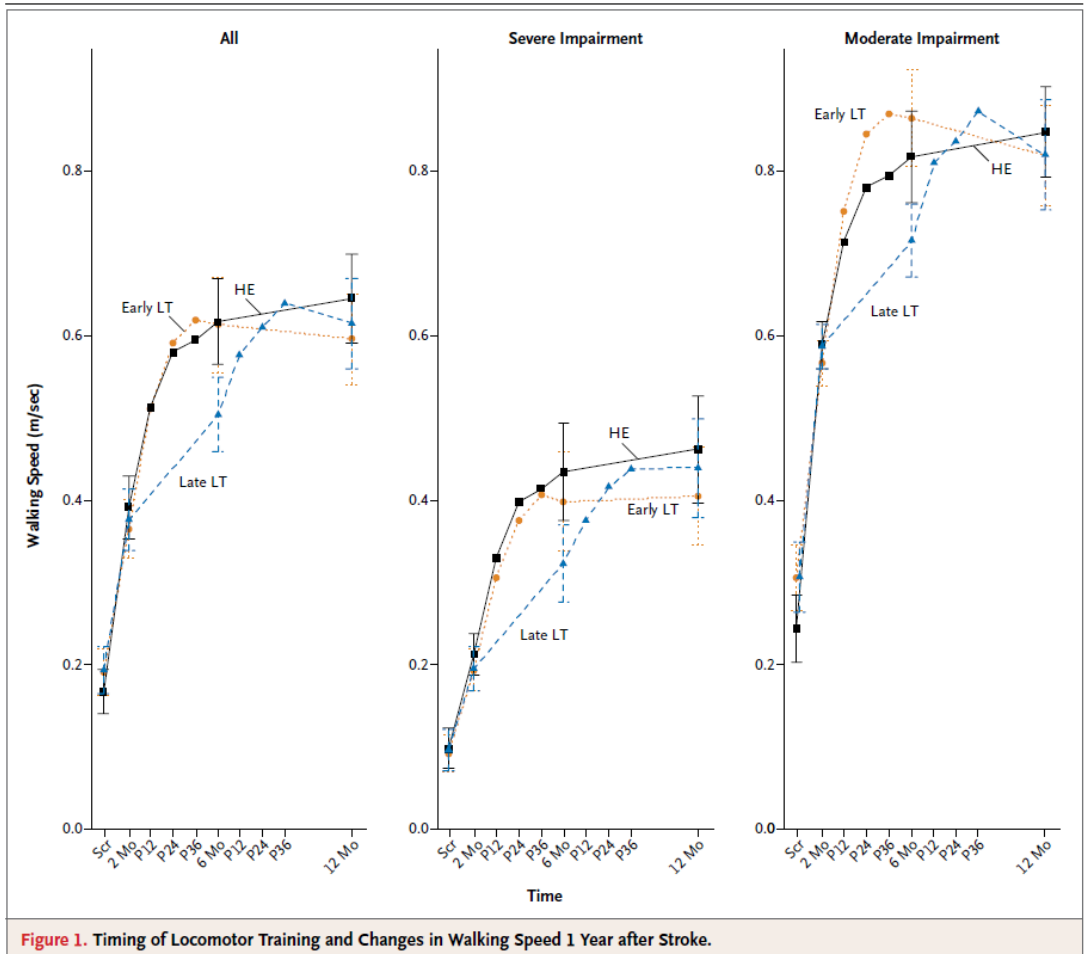


Figure 1. Timing of Locomotor Training and Changes in Walking Speed 1 Year after Stroke.

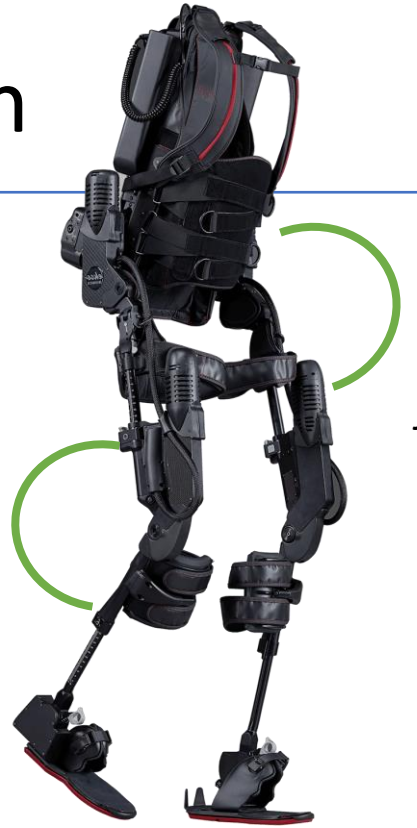
Klinische betekenisvolle resultaten na intensieve taak-gerichte training kunnen eveneens in de chronische fase behaald worden!

Robots sturen louter de “normale beweging” aan

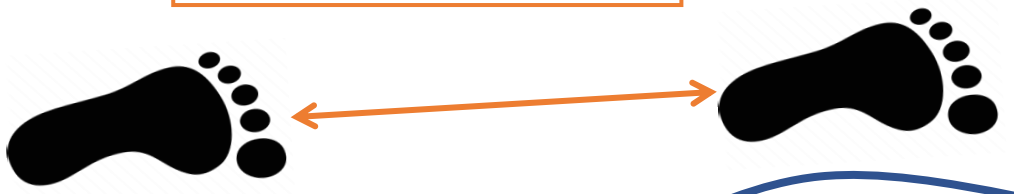
Symmetrische gewrichtsbewegingen

Θ *heup flex/ext*

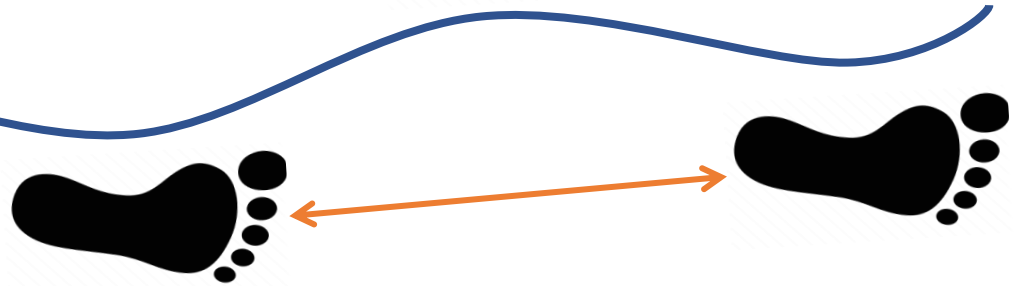
Θ *knie flex/ext*



Symmetrische stappen



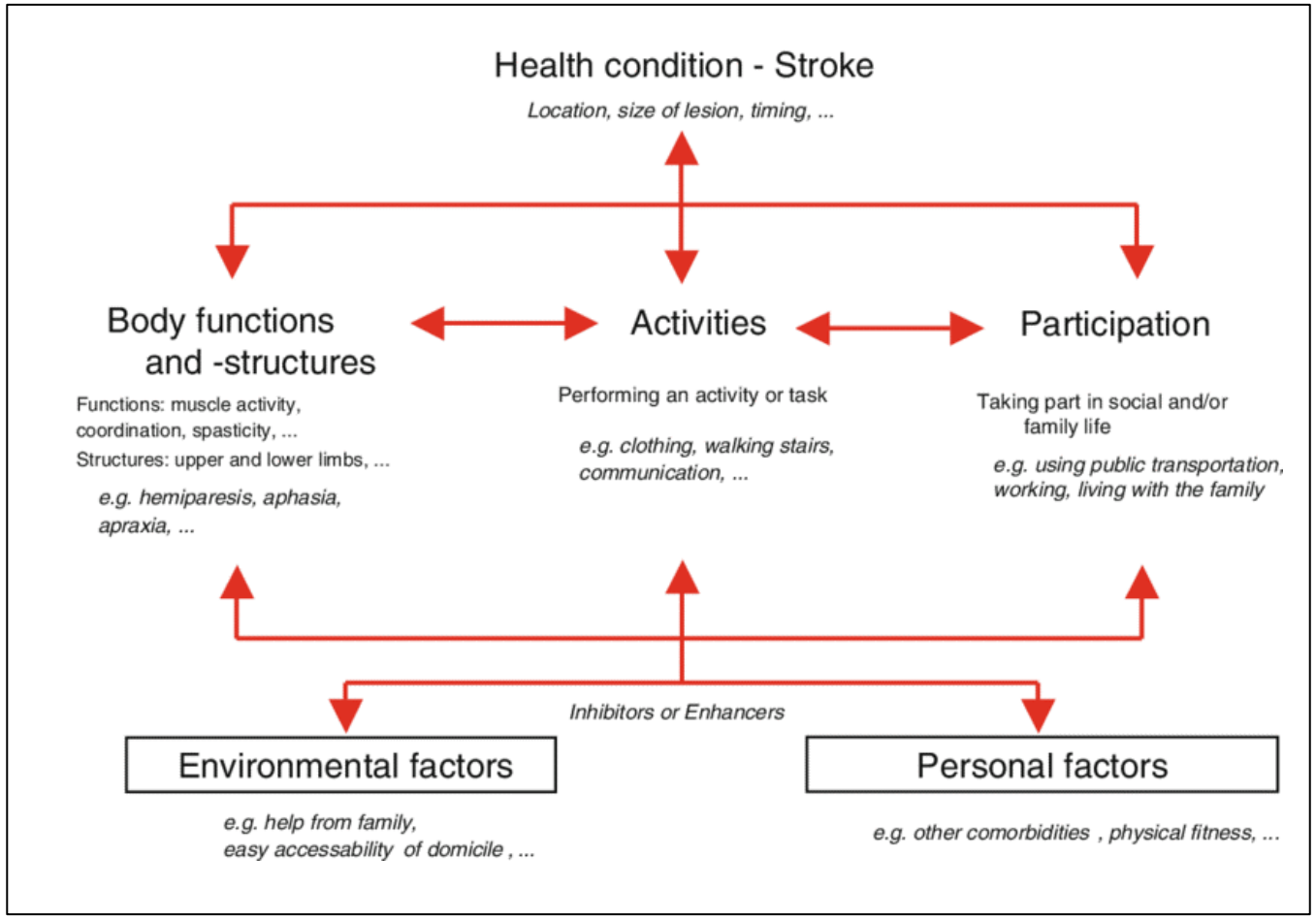
Symmetrische gewichtsverplaatsing



Stap lengte

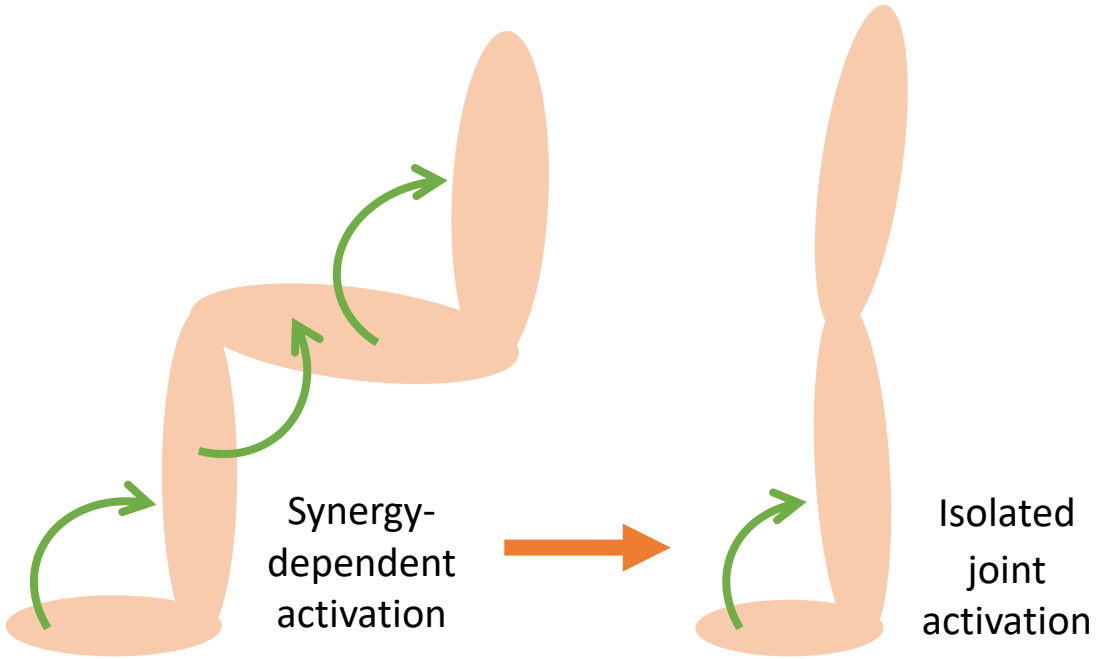
Gewichtverplaatsing

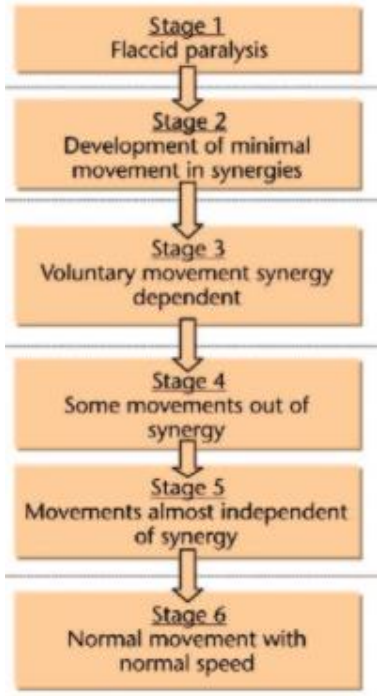
2. Wat is het tijdsbeloop van herstel in de eerste 6 maanden na een beroerte?

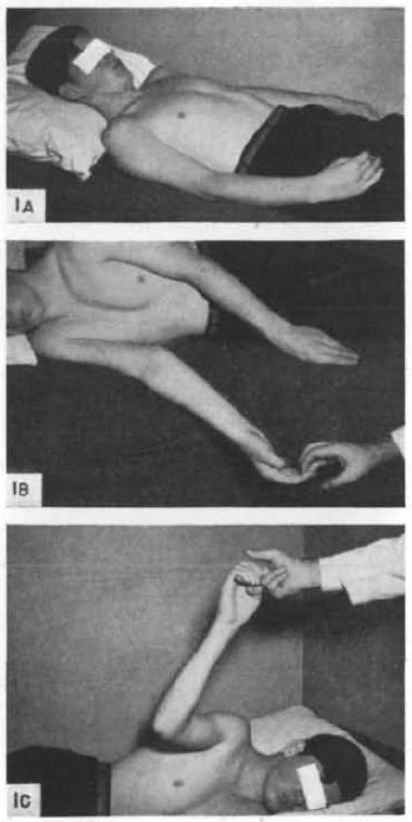

Health condition - Stroke
Location, size of lesion, timing, ...
Body functions and -structures
Functions: muscle activity, coordination, spasticity, ...
Structures: upper and lower limbs, ...
e.g. hemiparesis, aphasia, apraxia, ...
Activities
Performing an activity or task
e.g. clothing, walking stairs, communication, ...
Participation
Taking part in social and/or family life
e.g. using public transportation, working, living with the family
Inhibitors or Enhancers
Environmental factors
e.g. help from family, easy accessability of domicile , ...
Personal factors
e.g. other comorbidities , physical fitness, ...

ICF level: Lichaamfuncties

- Verstoring in de beweginscontrole van het meest aangedane been
  - Synergie-vorming/Coordinatie
  - Kracht

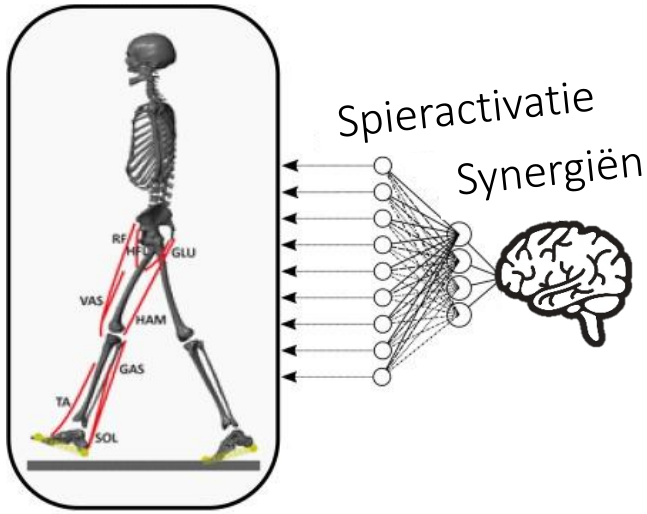






Twitchell 1951

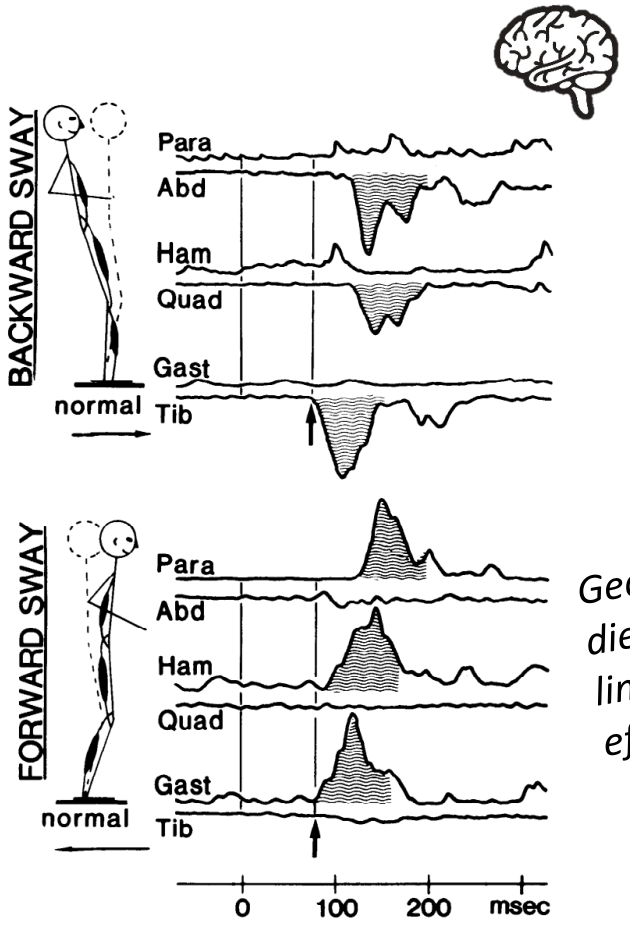
Beweging



Spieractivatie

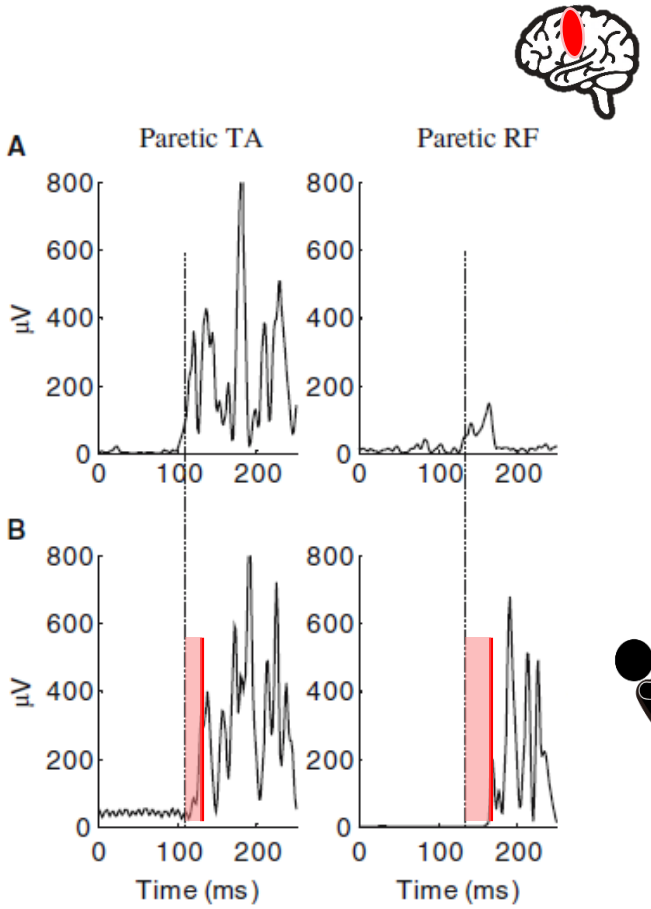
Synergiën

Synergistische spieractiviteit draagt bij tot het vallen



Gecoordineerde spiersynergieën, die distale en proximale activiteit linkt, is fundamenteel voor een efficiënte houdingscontrole.

Horak & Nashner 1986



Marigold & Eng 2006

DISABILITY AND REHABILITATION
https://doi.org/10.1080/09638288.2019.1578421

Taylor & Francis
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REVIEW ARTICLE

Lower limb muscle synergies during walking after stroke: a systematic review

Tamaya Van Criekinge[a,b], Jordi Vermeulen[a], Keanu Wagemans[a], Jonas Schröder[a], Elissa Embrechts[a], Steven Truijen[a,b], Ann Hallemans[a,b] and Wim Saeys[a,b,c]

[a]Department of Rehabilitation Sciences and Physiotherapy, Faculty of Medicine and Health Science, University of Antwerp, Antwerp, Belgium; [b]Multidisciplinary Motor Centre Antwerp (M²OCEAN), University of Antwerp, Antwerp, Belgium; [c]RevArte Rehabilitation Hospital, Edegem, Belgium

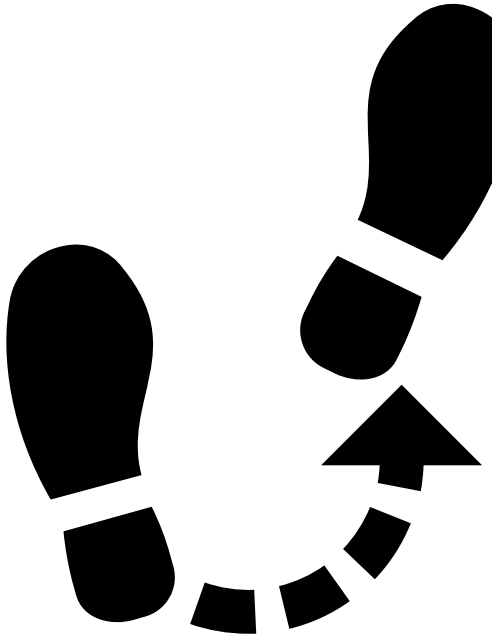


Table 4. Amount and distribution of muscle synergies in healthy adults.

Reference	Muscles															Muscles measured
	TA	SOL	GAS	RF	VM	VL	BF	MH	LH	Gmed	Gmax	PL	AL	TFL	ES	
Allen et al., 2013 [20]	S3	S2	S2	S1		S1		S4	S4	S1						8
Clark et al., 2009 [22]	S3	S2	S2	S1	S1			S4	S4	S1						8
				S3												
Coscia et al., 2015 [23]	S3	S2	S2	S1	S1		S1		S1	S1	S1	X	S3	S1		12
				S3	S3		S3		S3							
Gizzi et al., 2011 [24]	S3	S2	S2	S3		S3	S4				S1				X	8
Kautz et al., 2011 [25]	X	X	X	X	X			X	X	X						8
Routson et al., 2013 [26]	S3	S2	S2	S1	S1			S4	S4	S1						8
				S3				S1	S1							
Shiavi et al., 1987 [29]	S2	S1	S1	S2				S2								5
Srivastava et al., 2016 [27]	S2	S1	S1	S2	S3	S3	S4	S4		S3						9
				S3												

TA: tibialis anterior; SOL: soleus; GAS: gastrocnemius; VM: vastus medialis; VL: vastus lateralis; RF: rectus femoris; MH: medial hamstrings; LH: lateral hamstrings; Gmed: gluteus medius; Gmax: gluteus maximus; BF: biceps femoris; PL: peroneus longus; ST: semitendinosus; AL: adductor longus; TFL: tensor fascia latae; ES: erector spinae; S1-S4: synergy 1–4 as mentioned in the studies; X: muscle measured.
Consensus synergies review:
1. Blue: synergy 1 = GM + RF + VL.
2. Orange: synergy 2 = SOL + GAS.
3. Yellow: synergy 3 = TA (+RF).
4. Green: synergy 4 = Hamstrings.
5. No colors: no distribution of synergies mentioned in the studies.

Table 5. Amount and distribution of paretic muscle in stroke survivors.

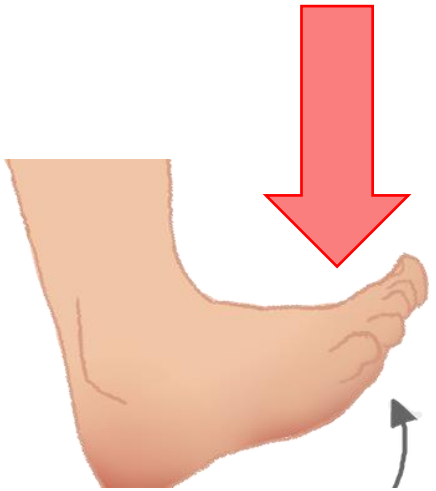
Reference	Muscles															Muscles measured
	TA	SOL	GAS	RF	VM	VL	BF	MH	LH	Gmed	Gmax	PL	AL	TFL	ES	
Allen et al., 2013 [20]	S3	S1	S1	S1		S1		S2	S2	S1						8
				S2		S2				S2						
Barroso et al., 2017 [21]	X	X	X	X		X	X			X	X		X	X	X	11
Clark et al., 2009 [22]	S2	S1	S1	S1	S1			S3	S3	S3						8
				S2	S3											
				S3												
Coscia et al., 2015 [23]	S3	S2	S2	S1	S1		S1		S1	S1	S1	X	S3	S1		12
				S3	S3		S3		S3							
Gizzi et al., 2011 [24]	S4	S2	S2	S3		S2	S2				S1				X	8
		S3				S3	S1									
Hashiguchi et al., 2016 [28]	X	X	X	X	X		X		X							7
Kautz et al., 2011 [25]	X	X	X	X	X			X	X	X						8
Routson et al., 2013 [26]	S4	S2	S2	S1	S1			S1	S1	S1						8
		S3	S3	S2	S2			S3	S3	S2						
Shiavi et al., 1987 [29]	S1	S2	S2	S1				S1								5
Srivastava et al., 2016 [27]	S2	S1	S1	S2	S3	S3	S4	S4		S3						9
				S3												

TA: tibialis anterior; SOL: soleus; GAS: gastrocnemius; VM: vastus medialis; VL: vastus lateralis; RF: rectus femoris; MH: medial hamstrings; LH: lateral hamstrings; Gmed: gluteus medius; Gmax: gluteus maximus; BF: biceps femoris; PL: peroneus longus; ST: semitendinosus; AL: adductor longus; TFL: tensor fascia latae; ES: erector spinae; S1-S4: synergy 1–4 as mentioned in the studies; X: muscle measured.
Consensus merged synergies review:
1. Orange: merged synergy 1 = SOL + GAS + Gmed + Quadriceps.
2. Green: merged synergy 2 = Hamstrings + Gmed + Quadriceps.
3. Blue: synergy 1 = GM + RF + VL.
4. Blue: synergy 3b = SOL + GAS + Hamstrings.
5. No colors: no distribution of synergies mentioned in the studies.

Van Criekinge *et al.* 2019

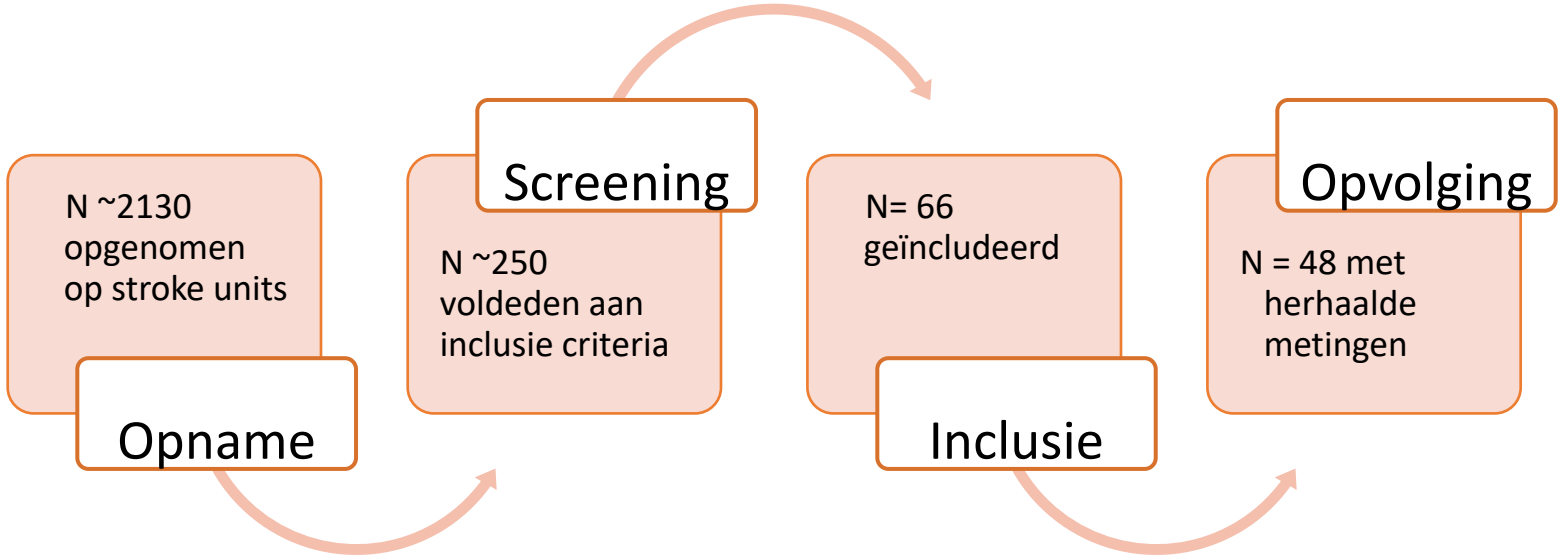
ICF level: Lichaamfuncties

- Verstoring in de beweginssturing van het meest aangedane been
  - Synergie-vorming/Coordinatie
  - Kracht

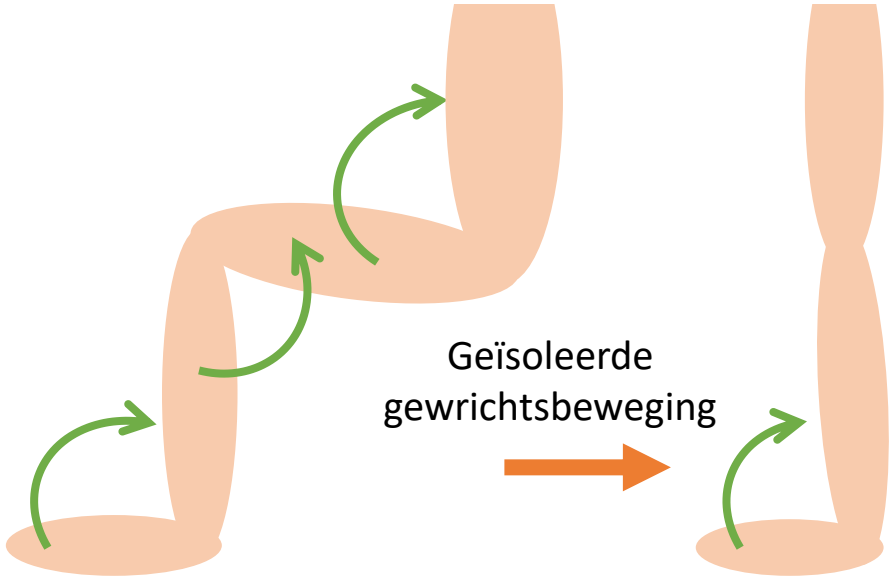


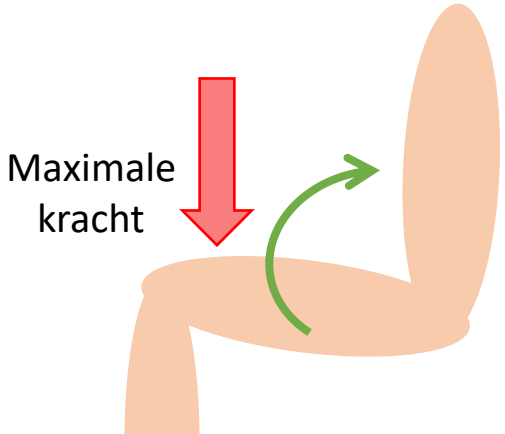
TARGET-1

- ✓ Eerste hemorragische/ischemische beroerte
- ✓ <3 weken na beroerte
- ✓ Mild-tot-ernstig krachtsverlies in het onderste lidmaat
- ✓ Leeftijd: 18 - 90 jaar
- ✓ Pre-morbide onafhankelijkheid in ADL
- ✓ Geen eerdere belangrijke orthopedische of neurologische aandoening
- ✓ Geen ernstig communicatie deficit



TARGET-1



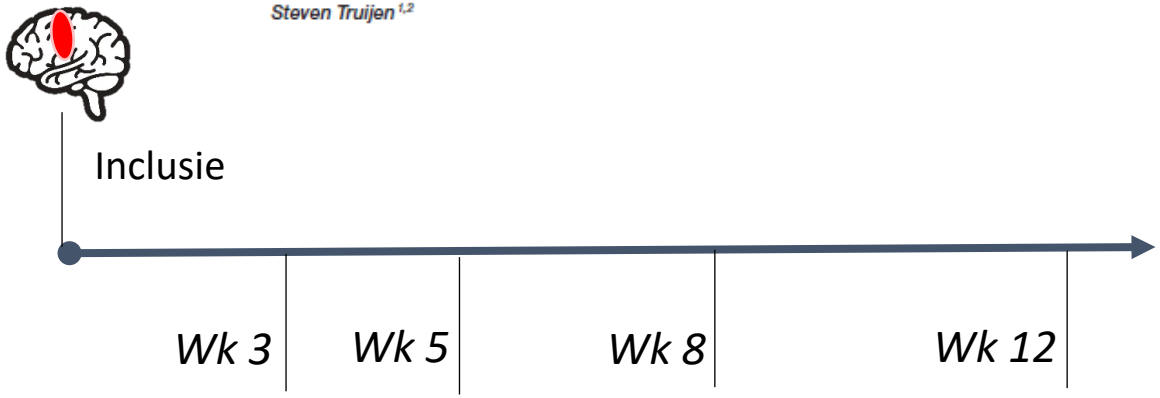


frontiers in Neurology

STUDY PROTOCOL
published: 21 February 2022
doi: 10.3389/fneur.2022.781416

Time Course and Mechanisms Underlying Standing Balance Recovery Early After Stroke: Design of a Prospective Cohort Study With Repeated Measurements

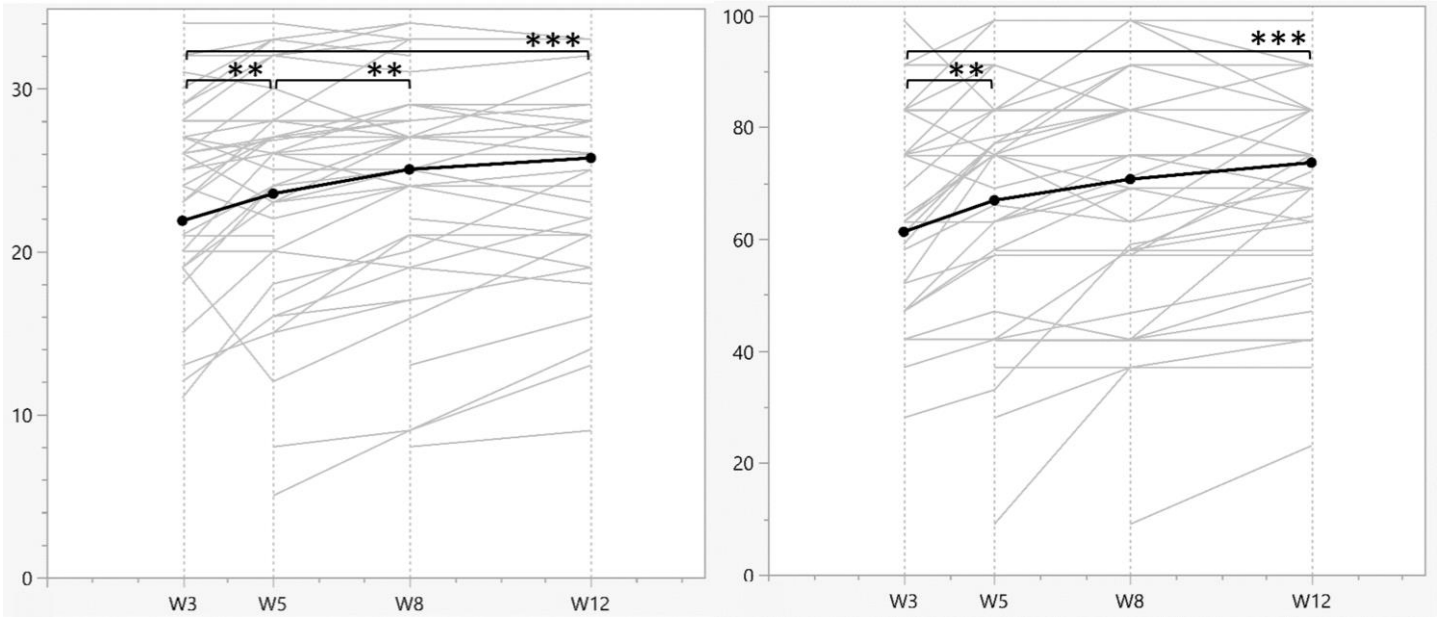
Jonas Schröder[1,2], Wim Saeys[1,2,3], Laetitia Yperzeele[4,5], Gert Kwakkel[6,7,8] and Steven Truijen[1,2]*



Follow-up metingen in de tijd

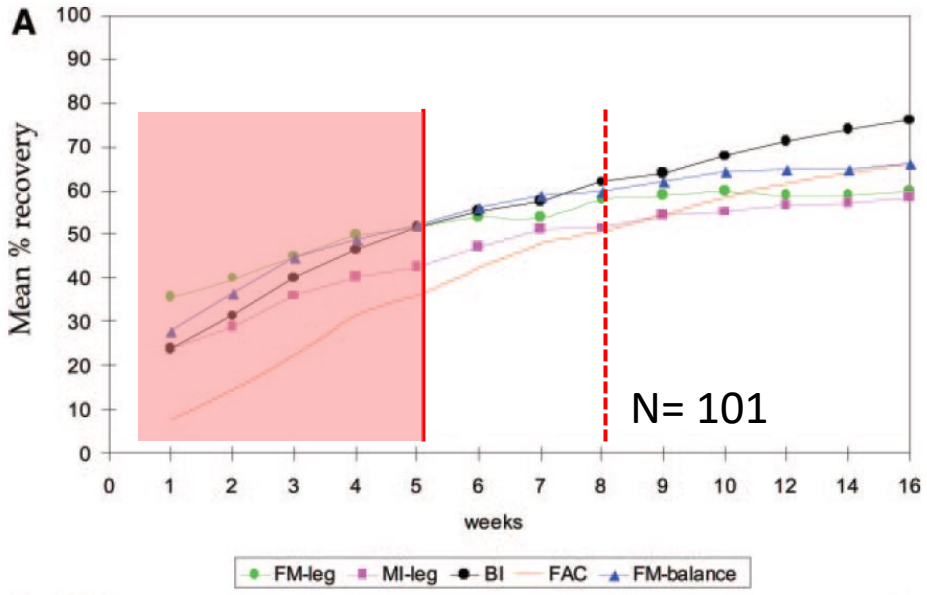
Klinische uitkomsten

- Fugl-Meyer motorische schaal - onderste extremiteit (FM-LE)
  ~ Synergie-afhankelijke controle
- Motricity Index schaal - onderste extremiteit (MI-LE)
  ~ Kracht

	FM-LE (0-34)	**MI-LE** (0-99)
		
Algemeen effect van tijd	**β (SE)= 3.84 (0.49); *P*= <.001***	**β (SE)= 12.37 (1.79); *P*= <.001***
Effect week 3-5	**β (SE)= 1.66 (0.44); *P*= .002****	**β (SE)= 5.63 (1.61); *P*= .004****
Effect week 5-8	**β (SE)= 1.49 (0.43); *P*= .004****	β (SE)= 3.77 (1.57); *P*= .082
Effect week 8-12	β (SE)= 0.70 (0.45); *P*= .410	β (SE)= 0.70 (0.45); *P*= .267

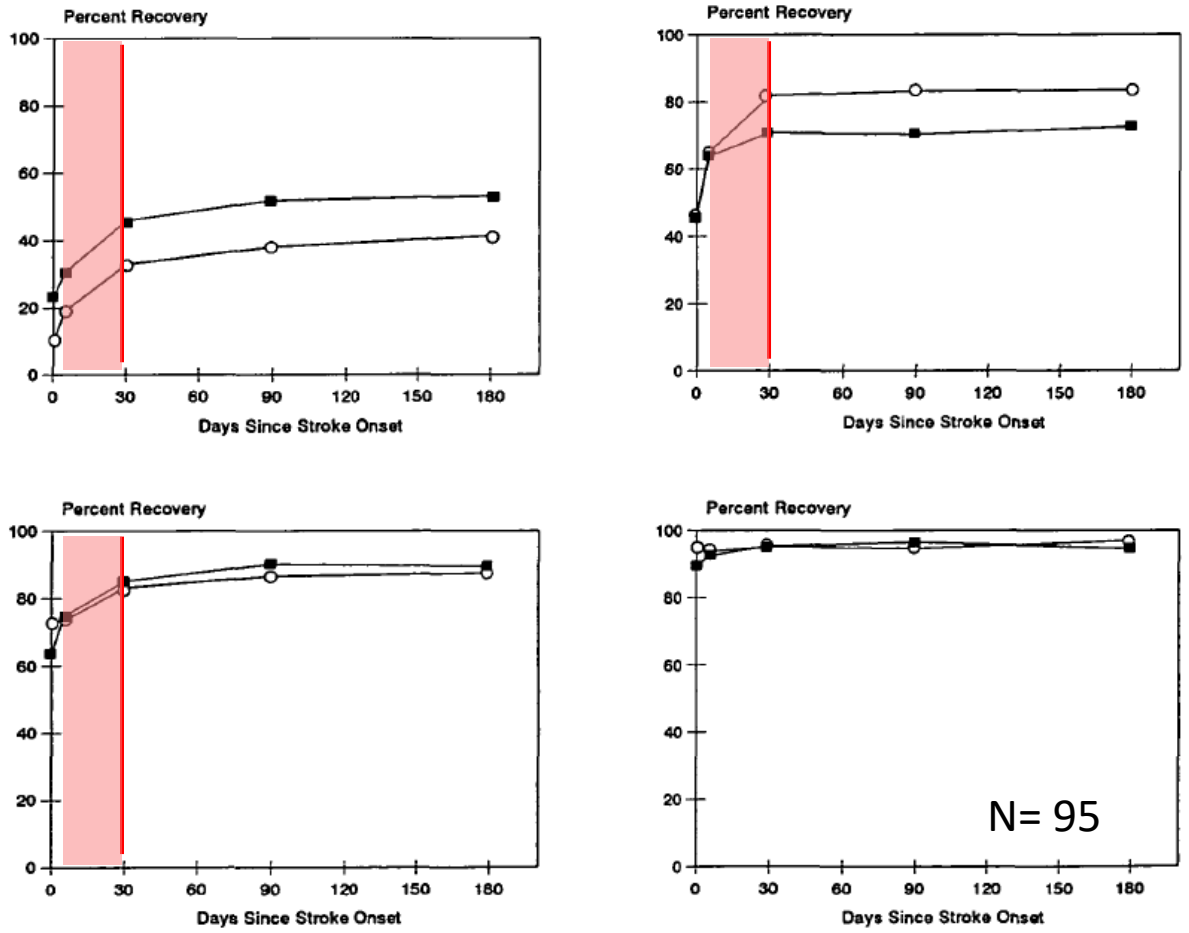
***, *P* <.001; **, *P* <.01; *; *P* <.05 indicating statistical significance
Values are: estimated regression coefficients of change (β), standard error (SE) and probability estimates (*P*)

Kritisch tijdsvenster voor motorisch herstel



FM - Onderste extremiteit
MI – Onderste extremiteit

Kwakkel *et al.* 2006



○ FM - Bovenste extremiteit
■ FM – Onderste extremiteit

Duncan *et al.* 1994

ICF level: Activiteiten

- Herstelbeloop en “mijlpalen” van de functionele mobiliteit na een beroerte

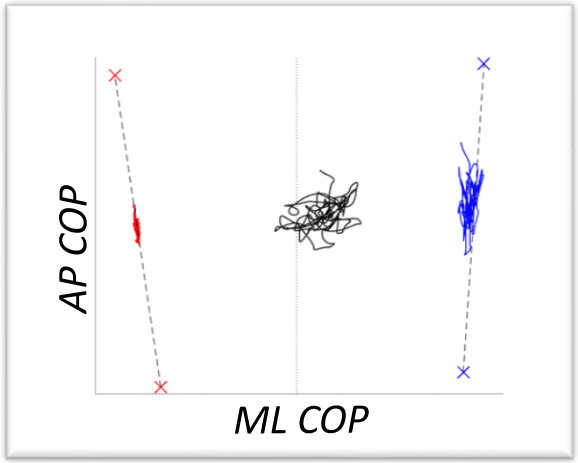
- De zelfstandige stabalans wordt vooral behaald in de eerste 3 maanden na een beroerte (Smith 1999)

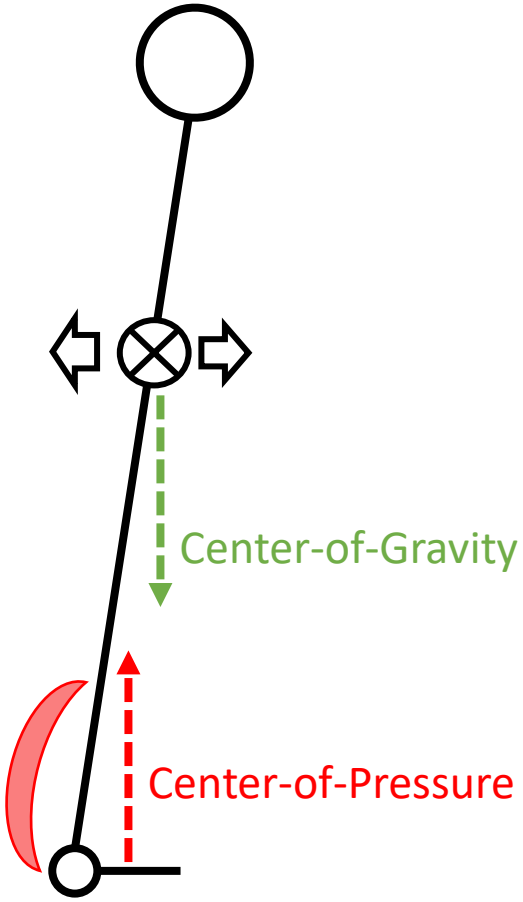
- Vroegtijdig herstel van de stabalans is predicitef voor het zelfstanding kunnen stappen (Bohannon 1995, Kollen 2005, Smith 2022)

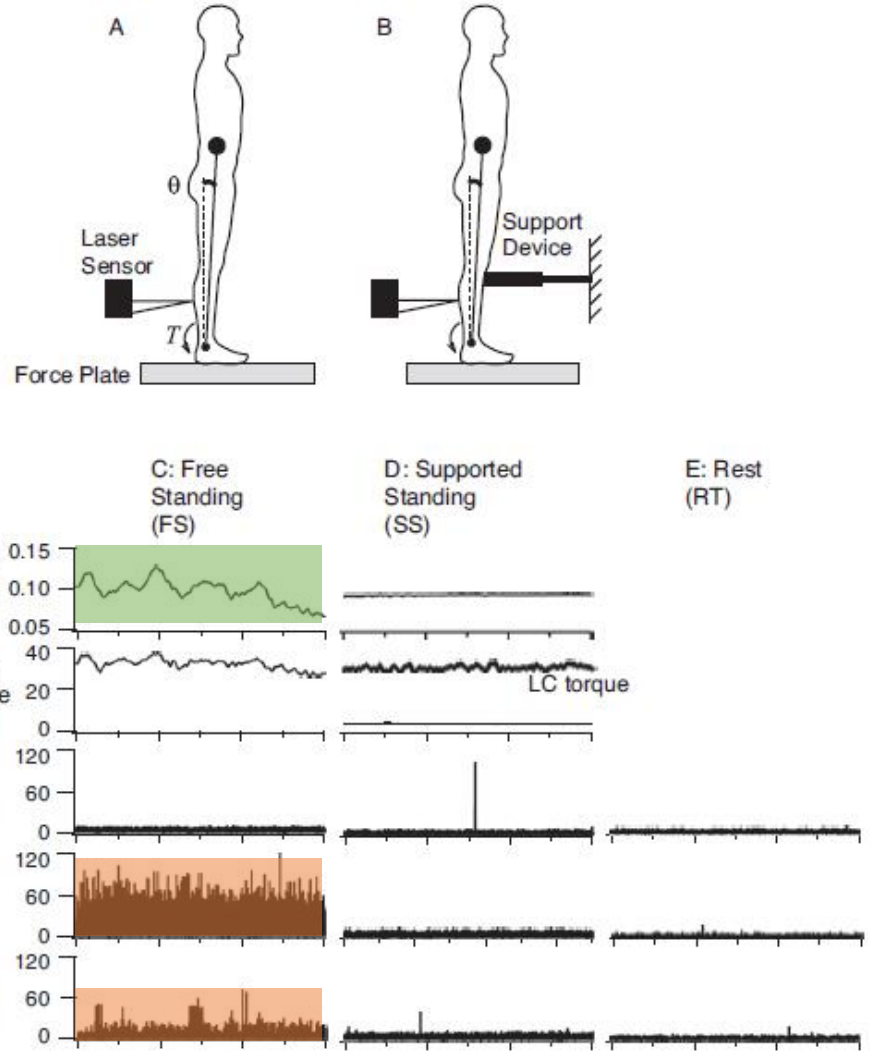
- Blijvende balans deficieten zijn gelinkt aan een beperkte mobiliteit (Van de Port 2008) & vallen (Simpsons 2011)

3. Hoe (her-)leren revalidanten de basale activiteiten van het dagelijkse leven?

Stilstaan is bewegen!

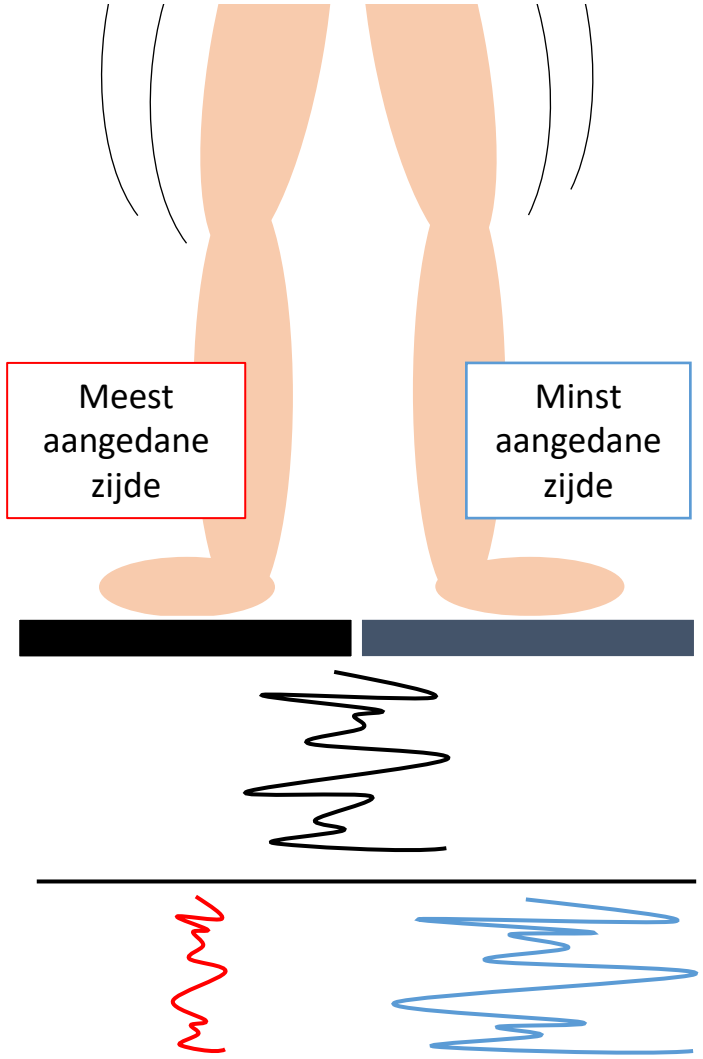






Masani *et al.* 2013

TARGET-1



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STUDY PROTOCOL
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Time Course and Mechanisms Underlying Standing Balance Recovery Early After Stroke: Design of a Prospective Cohort Study With Repeated Measurements

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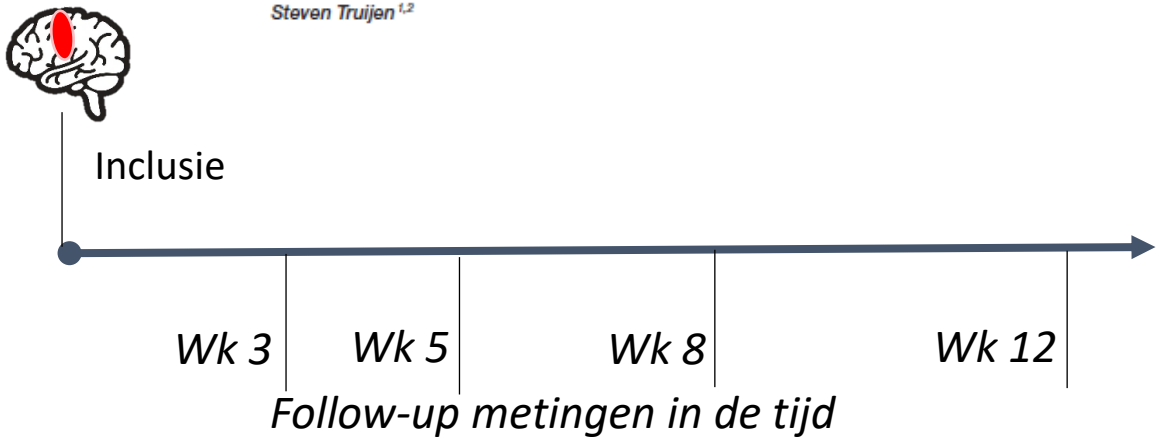
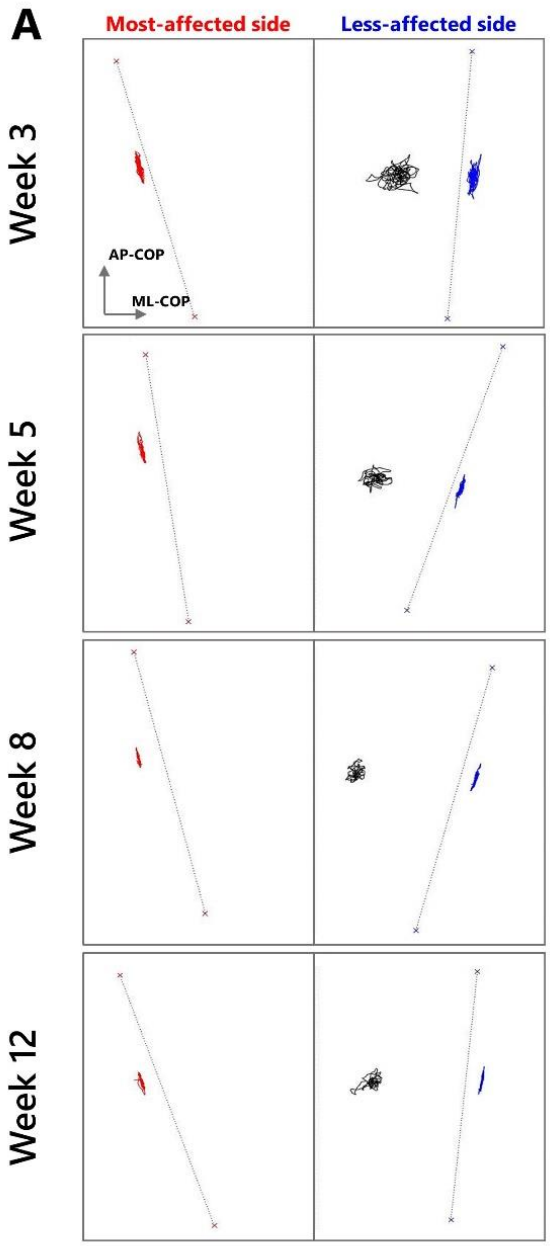
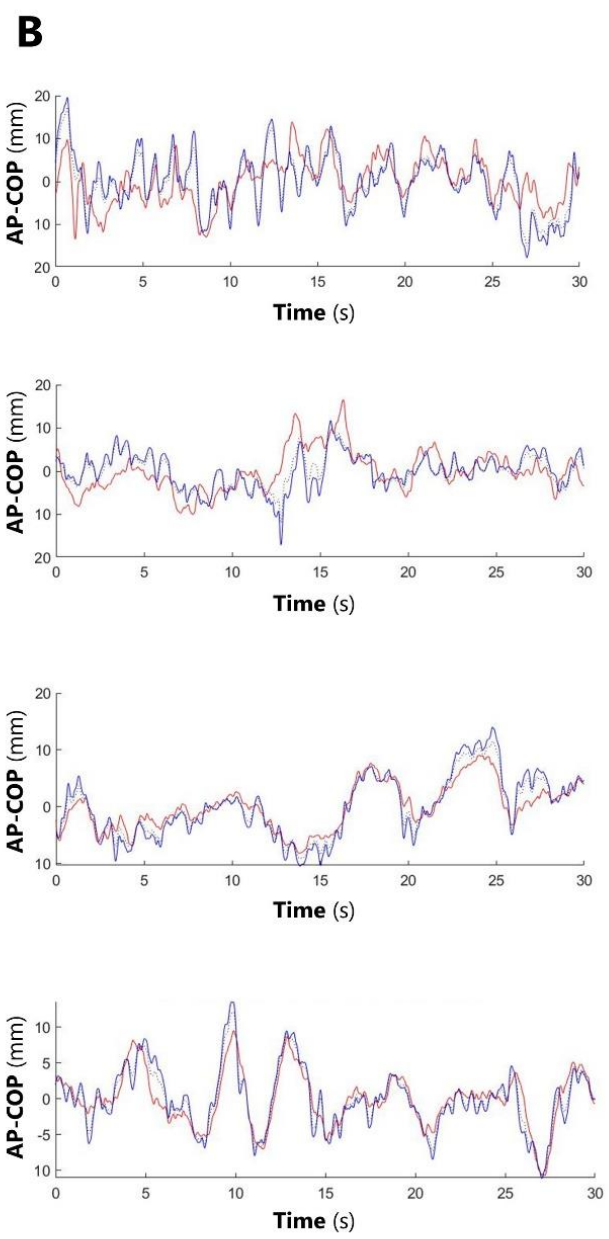


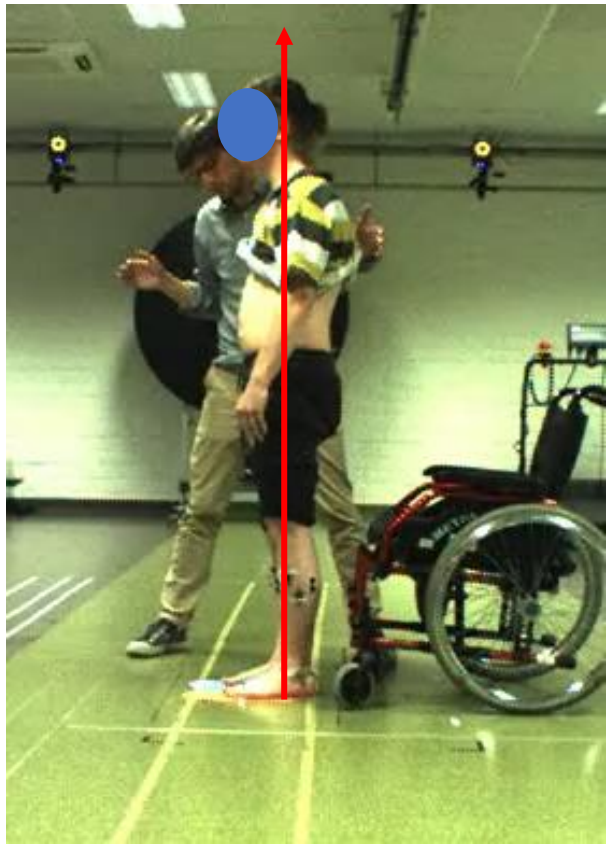
Posturografische uitkomsten

- Totale COP zwaai oppervlakte en snelheid in specifieke richtingen
  ~ Posturale stabiliteit
- Lidmaat-specifieke COP zwaai snelheid in AP richting
  ~ Kinetische regulatieasymmetrie



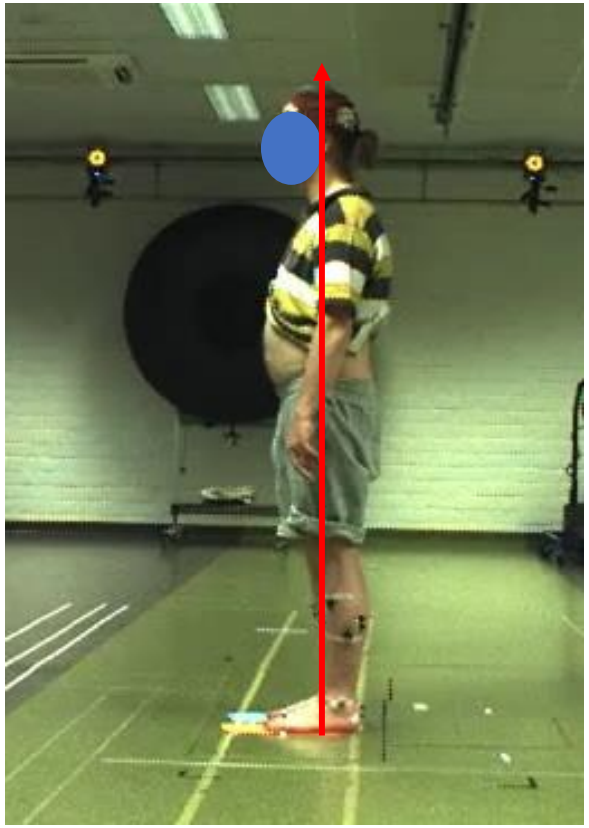


Week 3

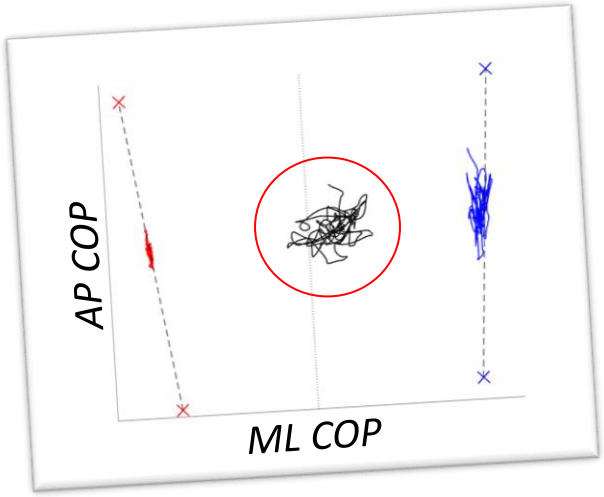


- Ruis wordt onderdrukt waardoor het paretisch been de rol van een “passieve passagier” inneemt.
- De kinetische regulatie wordt steeds thv. het niet-paretische been uitgevoerd.

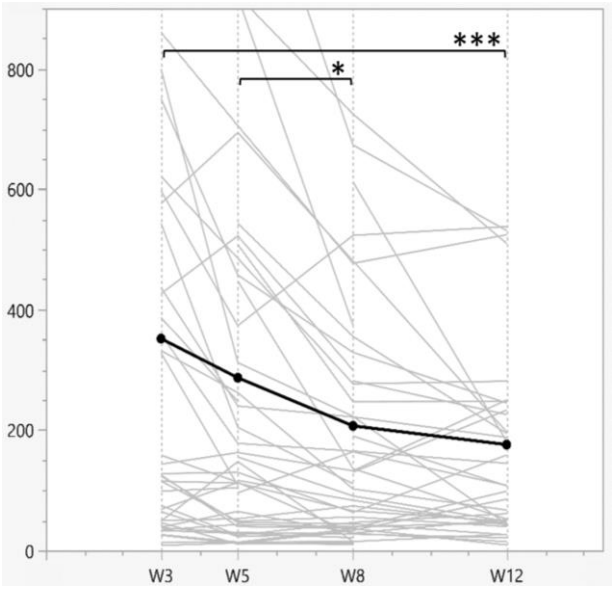
Week 12



TARGET-1



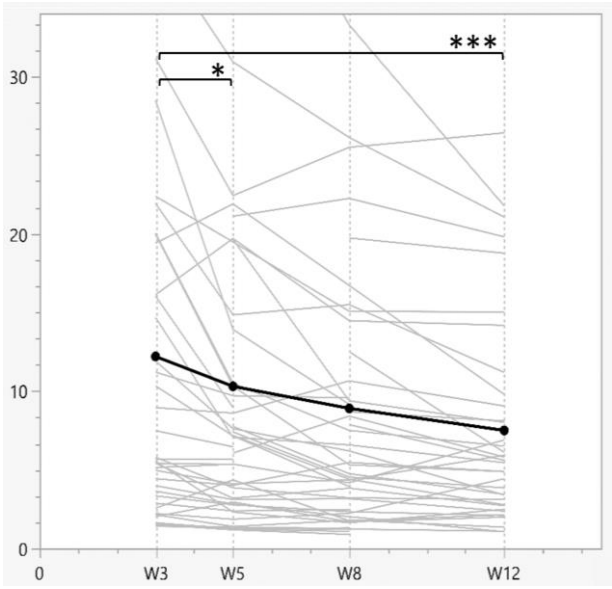
COP area (mm²)



β (SE)= -176.04 (33.76); *P*= <.001***

β (SE)= -65.04 (31.08); *P*= .162
β (SE)= -79.92 (30.14); *P*= .045*
β (SE)= -31.08 (31.36); *P*= .755

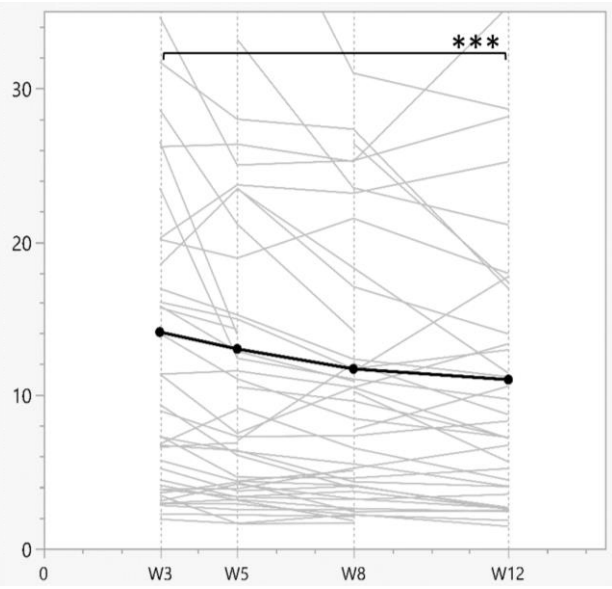
ML COP velocity (mm/s)



β (SE)= -4.70 (0.77); *P*= <.001***

β (SE)= -1.90 (0.71); *P*= .041*
β (SE)= -1.46 (0.69); *P*= .153
β (SE)= -1.34 (0.71); *P*= .246

AP COP velocity (mm/s)

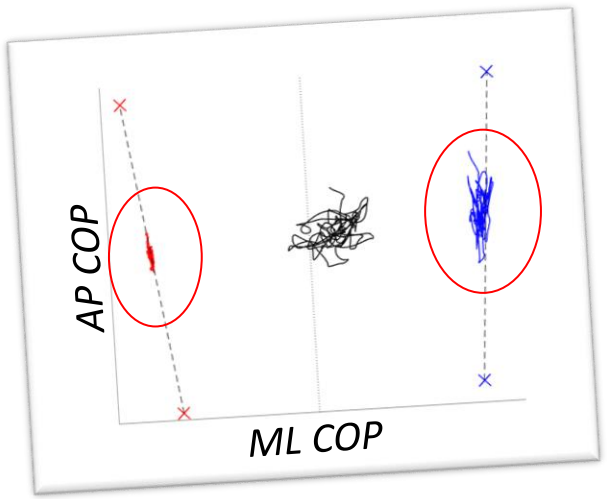


β (SE)= -3.14; *P*= <.001***

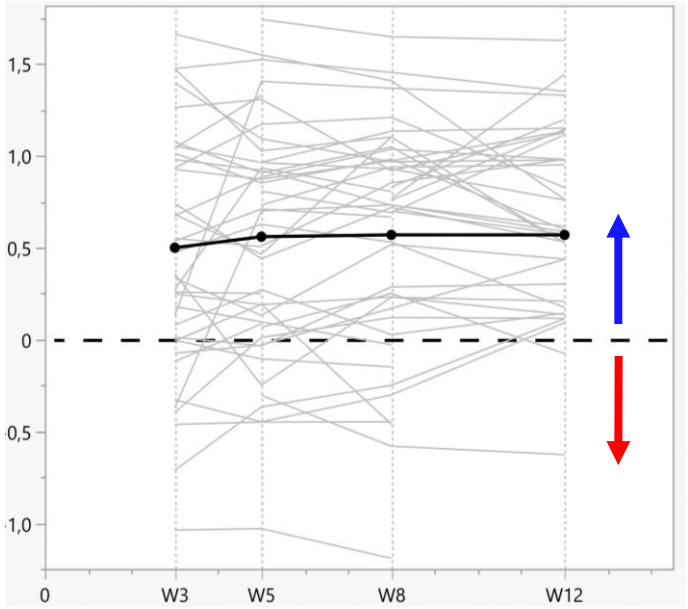
β (SE)= -1.11 (0.69); *P*= .372
β (SE)= -1.31 (0.67); *P*= .211
β (SE)= -0.72 (0.69); *P*= .730

***, *P* <.001; **, *P* <.01; *; *P* <.05 indicating statistical significance
Values are: estimated regression coefficients (β), standard error (SE) and probability estimates (*P*)

TARGET-1

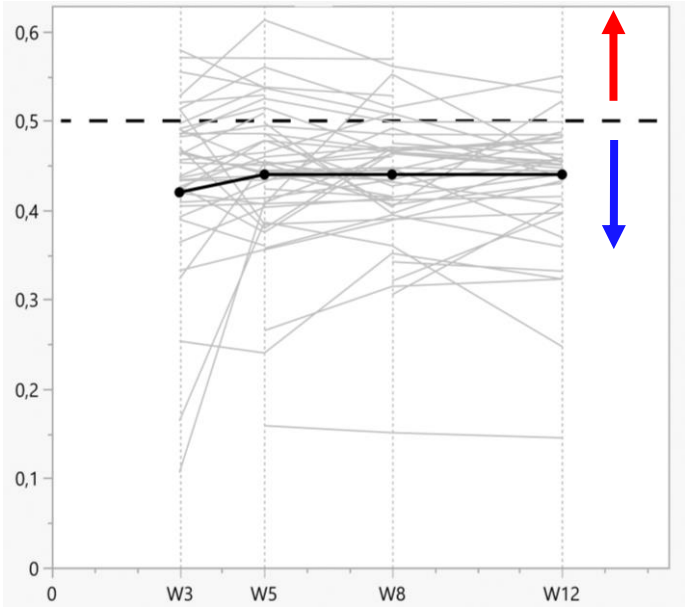


Dynamic control asymmetry (DCA)

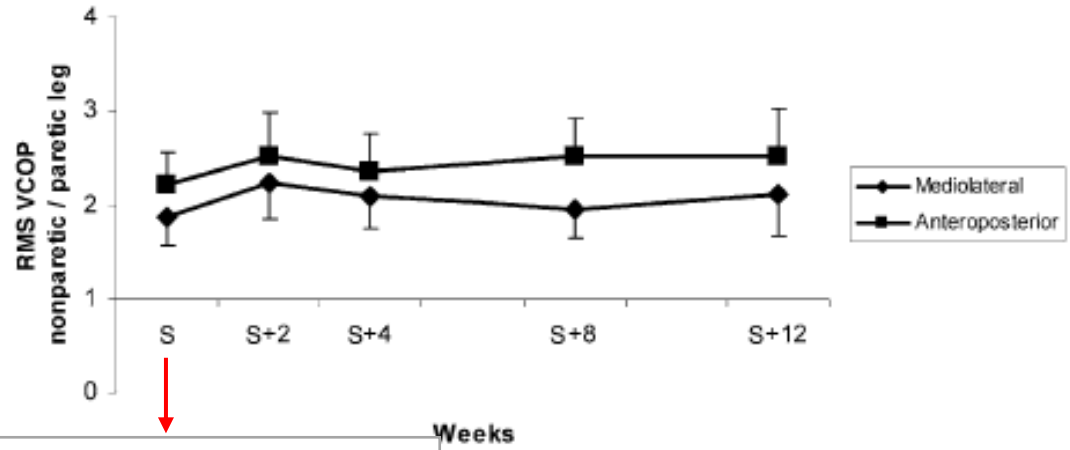


β (SE)= 0.07 (0.06); *P*= .673

Weight-bearing asymmetry (WBA)



β (SE)= 0.02 (0.01); *P*= .123



Weken na beroerte: 10.0 +- 5.4 (3.3–24.1)

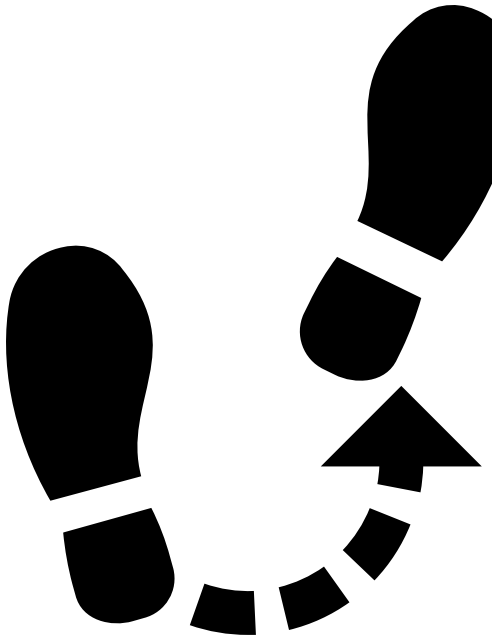
De Haart *et al.* 2004

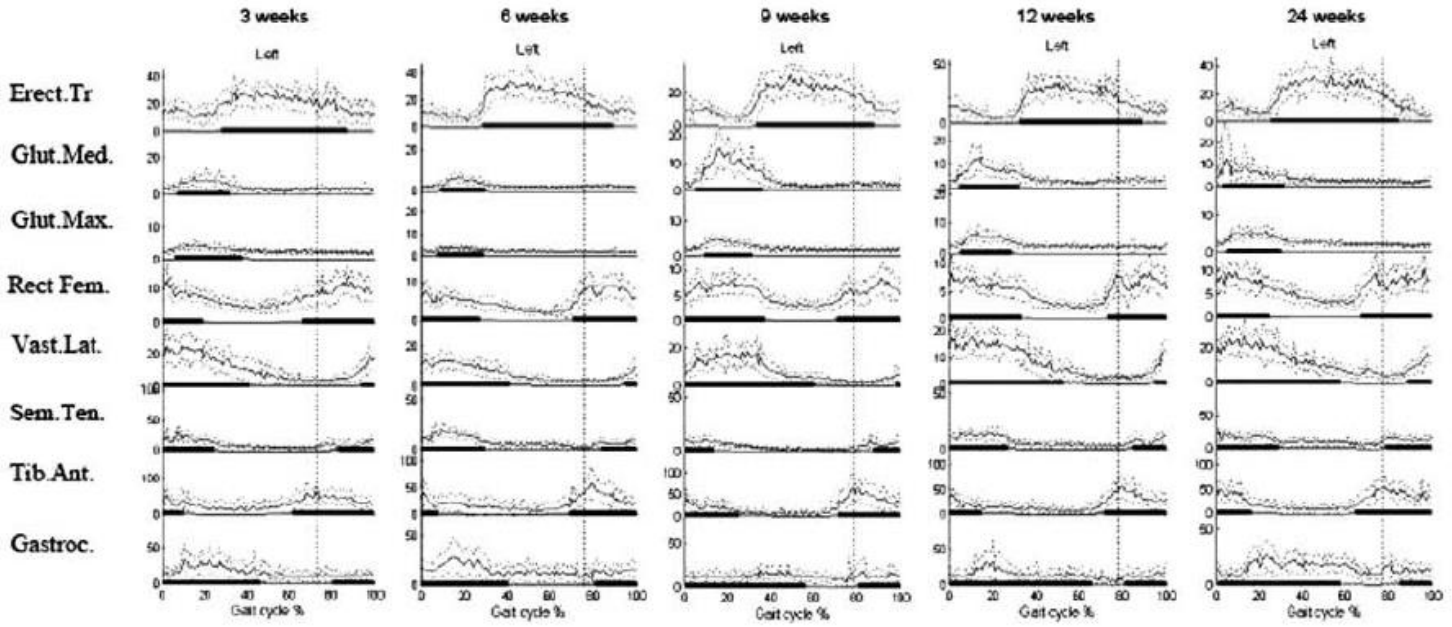
Motorische reacties op balansverstoringen normaliseren nauwelijks

- **Anticipatoir** opspannen van de achterste beenspieren tijdens het snel **opheffen van een arm** blijft vertraagd aan paretische zijde.
  (Garland 2003, 2007, Peters 2014)

- **Reactief** opspannen van de heupabductoren na een zijwaartse “duwtje” verbeterde over tijd, maar bleef vertraagd.
  (Kirker 2000)

- **Beide onderzoeken tonen compensatoire reacties thv. het niet-paretisch been indien de houdingsreacties aan de paretische zijde verstoord blijven.**





Buurke *et al.* 2008

recover

[ri-**kuhv**-er]

Synonyms Examples Word Origin

See more synonyms on Thesaurus.com

verb (used with object)

1. to get back or regain (something lost or taken away):
   to recover a stolen watch.
2. to make up for or make good (loss, damage, etc., to oneself).

Consensus

International Journal of Stroke WSO

International Journal of Stroke

Agreed defi
for new star
research: Th
Rehabilitatic

Julie Bernhardt[1,2], Nick S Ward[6,7], S John W Krakauer Dale Corbett[13,14]

Guidelines

International Journal of Stroke WSO

Standardized measurement of quality of upper limb movement after stroke: Consensus-based core recommendations from the Second Stroke Recovery and Rehabilitation Roundtable

International Journal of Stroke
0(0) 1–9

DOI: 10.1177/1747493019873519
journals.sagepub.com/home/wso
SAGE

G Kwakkel[1], EEH Van Wegen[2], JH Burridge[3], CJ Winstein[4], LEH van Dokkum[5], M Alt Murphy[6], MF Levin[7] and JW Krakauer[8]; on behalf of the ADVISORY group

*1. "**Behavioral restitution** […] is a return towards more normal patterns of motor control with the impaired effector and reflects the process toward 'true recovery'."*

*2. "To accomplish a goal through substitution with a new approach rather than using their normal pre-stroke behavioral repertoire constitutes **compensation**."*

J Rehabil Med 2019; 51: 78–88

REVIEW ARTICLE

FEASIBILITY AND EFFECTIVENESS OF REPETITIVE GAIT TRAINING EARLY AFTER STROKE: A SYSTEMATIC REVIEW AND META-ANALYSIS

Jonas SCHRÖDER, MSc[1,2], Steven TRUIJEN, MSc, PhD[1,2], Tamaya VAN CRIEKINGE, MSc[1,2] and Wim SAEYS, MSc, PhD[1–3]
From the [1]Research group MOVANT (MOVement ANTwerp), Department of Rehabilitation Sciences and Physiotherapy, University of Antwerp, Wilrijk, [2]Multidisciplinary Motor Centre Antwerp (M2OCEAN), University of Antwerp, and [3]Rehabilitation Hospital Revarte, Edegem, Belgium

	Experimental/Control group		Activity[a] (i.e. walking ability)				Body function[a]	
ID	Adverse events	Drop-outs	Walking Independence post-intervention	Walking Independence follow-up	Walking Speed	Walking Endurance	Motor control	Muscle strength
Peurala et al. (48) 2009	0	5/3	×	×	×	×		
Tong et al. (39) 2006 Ng et al. (42) 2008	0	0/4	□	□	□			×
Morone et al. (43) 2011	4/3	12/9	□*	□*		□*		
Morone et al. (44) 2012			×	×	×	×		×
Chua et al. (40) 2016	0	7/13	×		×	×		
Pohl et al. (35) 2007	0	5/6	□	□	□			□
Chang et al. (38) 2012	0	1/3	×				□	×
Han et al. (49) 2016	0	0/4	×				×	
Schwartz et al. (45) 2009	0	4/2	□					
Ochi et al. (46) 2015	0	0/0	□		×		×	×
Franceschini et al. (47) 2009	0	9/3	×	×	×	×		×
Ada et al. (36) 2010	0	4/2	×					
Dean et al. (37) 2010 Nilsson et al. (41) 2001	0	4/3	×		×		×	

*Indicates the low motricity group, i.e. the group with more motor impairments at baseline. The studies Tong et al. 2006 and Ng et al. 2008, Morone et al. 2011 and Morone et al. 2012, and Ada et al. 2010 and Dean et al. 2010 are dependent as they investigated the same dataset. [a]Results for gait-specific outcome are reported as stated in the original article. These might differ from results of the meta-analysis due to differences in statistical methodology: (x), neutral or uncertain effect; (□), beneficial effect or likely to be beneficial.

TARGET-2

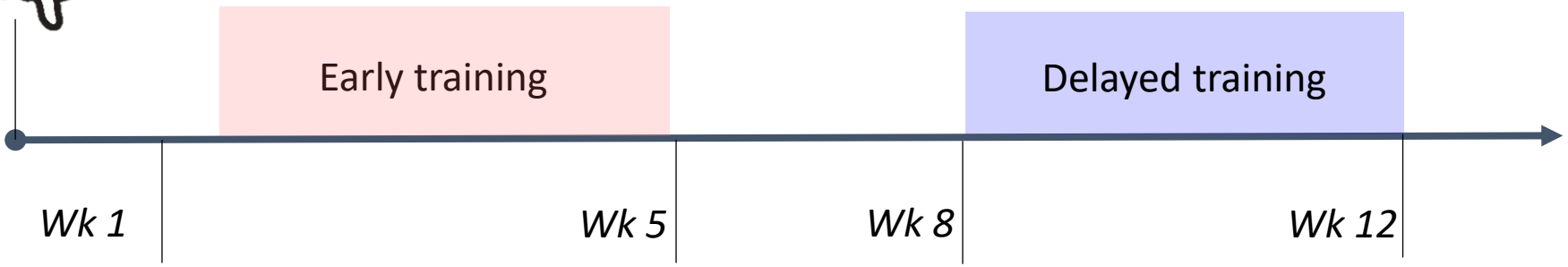
- ✓ Eerste hemorragische/ischemische beroerte
- ✓ **<14 dagen na beroerte**
- ✓ **Afhankelijkheid voor het stappen**
- ✓ **Gematigd-tot-ernstig krachtsverlies in het onderste lidmaat**
- ✓ Leeftijd: 18 - 90 jaar
- ✓ Pre-morbide onafhankelijkheid in ADL
- ✓ Geen eerdere belangrijke orthopedische of neurologische aandoening
- ✓ Geen ernstig communicatie deficit

	Early n=10	Delayed n=9	Non-randomized control n=10
Age, mean (SD)	65.9 (15.5)	62.1 (19.0)	59.7 (13.1)
Gender, F/M	4/6	5/4	2/8
Stroke Type, I/H	9/1	7/2	7/3
Affected Side, L/R	6/4	7/2	5/5

TARGET-2

- **Protocol:** 4 weken, 4x/week, max. 45 min per sessie, bijkomend tov. standard therapie
- **Doel:** Hoge dosis van stapoefeningen met de nadruk op een symmertisch gangpatroon

Early n=10	Delayed n=9
Start: 15 (11-18) dagen na beroerte	Start: 59 (56-65) dagen na beroerte
15.5 (13-16) sessies	16 (16) sessies
22.5 (10.0-33.3) min rechtstaand geoefend	21 (15.9-24.9) min rechtstaand geoefend

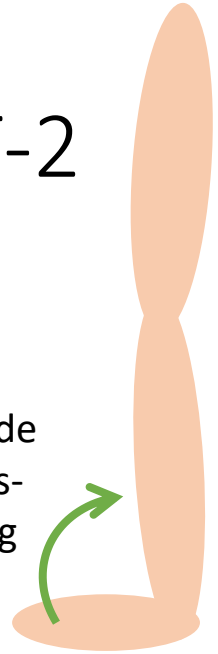


Inclusie & randomizatie

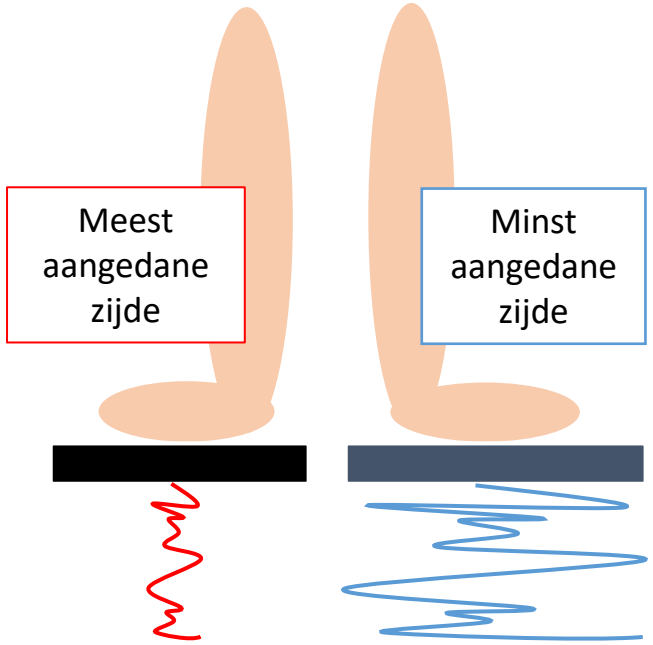
Follow-up metingen in de tijd

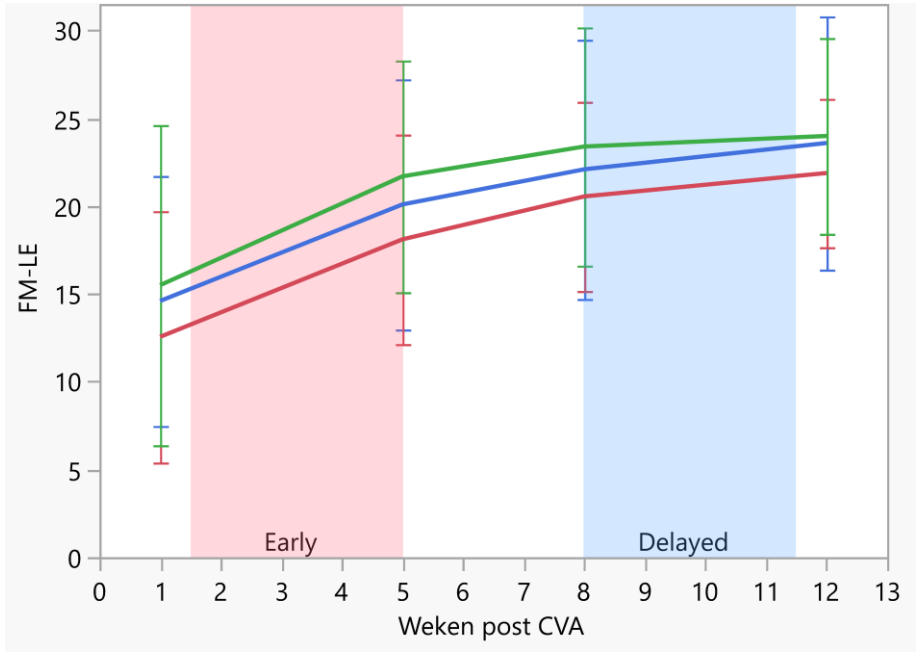
Klinische uitkomsten
Posturografische uitkomsten

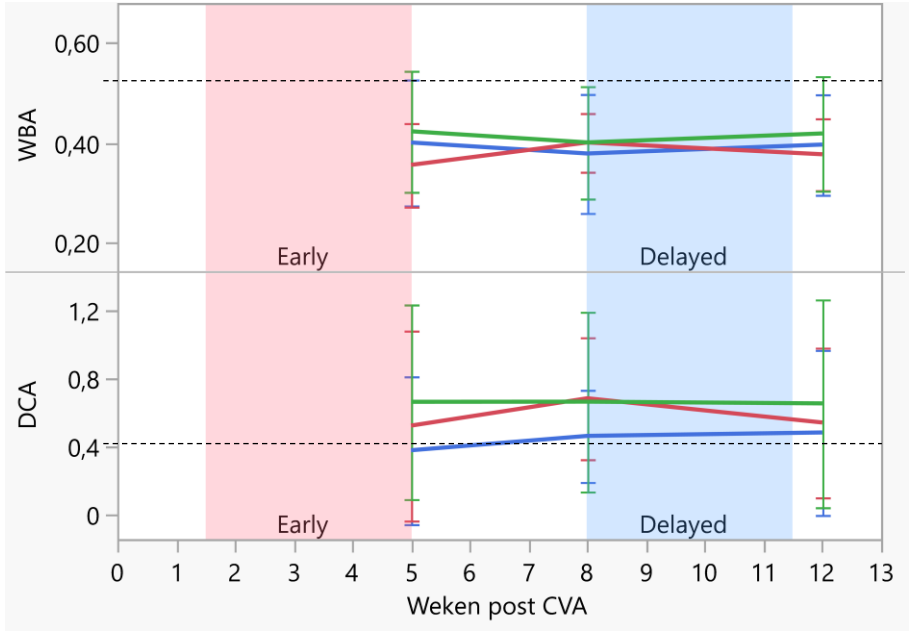
TARGET-2



Geïsoleerde gewrichts-beweging







Early training
Delayed training
Non-randomized control

Term	P-value
Group*Time	n/s
Time	**<,0001**

Term	P-value
Group*Time	n/s
Time	n/s

Is “normale” beweging een goed referentiekader voor de neurologische revalidatie?

Zijn robots de goede behandelmethode?

- Klinische effectstudies laten steeds meer zien dat de **variabiliteit van het oefenen** (m.b.t. taken en omgevingen) een ander belangrijk determinant zijn van effectieve revalidatie. (Hornby *et al.* 2016)

- De subtaken van het stappen waar het meest metabole energie voor nodig is, zijn de **propulsie van het lichaam** (i.e., push-off) en het **oprichten** tegen de zwaartekracht. (Grabowski *et al.* 2005, Gotschall & Kram 2005)

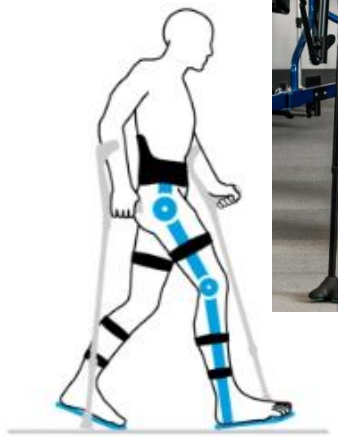
Nieuwe toestellen, same old story?

Louie et al. 2021:

- N=36, gemiddeld 5-6 weken na beroerte (<12wk)
- Conventionele therapie vs. robot-gestuurde training
- 4-5x/week 60 min (robot min 3x/week), max 8 weken

Molteni et al. 2021:

- N=75, gemiddeld 5 weken na beroerte (<12wk)
- Conventionele therapie vs. robot-gestuurde training
- 5x/week 60 min, max 15 sessions



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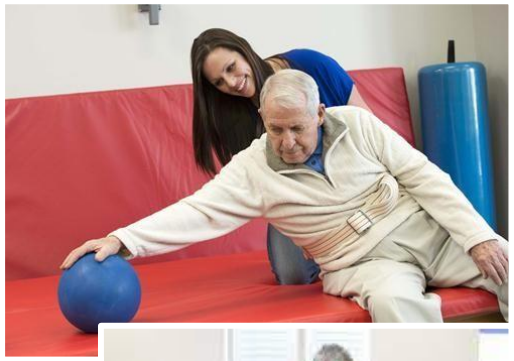

Fixatie en controle blijft in handen van het toestel!

Nieuwe toestellen, same old story?

- Hocoma Andago

- Motek Rysen

Consortium

UNIVERSITY OF ANTWERP
- MOVANT
  - **Jonas Schröder (PI)**
  - **Prof. Dr. Wim Saeys**
  - **Prof. Dr. Steven Truijen**
  - Elissa Embrechts
- M²OCEAN LAB
  - Prof. Dr. Ann Hallemans
  - Patrick de Bock

University of Antwerp
MOVANT | Movement Antwerp

M²OCEAN
Multidisciplinary Motor Centre Antwerp
University of Antwerp

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