Advances in Devices for Stroke Rehabilitation

UT Southwestern Cerebrovascular and Stroke Symposium

Kim Barker, MD

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UT Southwestern Medical Center

Disclosures

- None

Objectives

REVIEW OF PERTINENT REHAB ASSESSMENTS FOR STROKE PATIENTS

DEVICES UTILIZED TO IMPROVE UPPER EXTREMITY MOTOR SCORES AND FUNCTION

DEVICES UTILIZED FOR PHARYNGEAL DYSPHAGIA

FUGL-MEYER ASSESSMENT UPPER EXTREMITY (FMA-UE) Assessment of sensorimotor function

ID:
Date:
Examiner:

Fugl-Meyer AR, Jaasko L, Leyman I, Olsson S, Steglind S: The post-stroke hemiplegic patient. A method for evaluation of physical performance. Scand J Rehabil Med 1975, 7:13-31.

A. UPPER EXTREMITY, sitting position

I. Reflex activity	none	can be elicited
Flexors: biceps and finger flexors (at least one)	0	2
Extensors: triceps	0	2
Subtotal I (max 4)		

II. Volitional movement within synergies, without gravitational help			none	partial	full
Flexor synergy: Hand from contralateral knee to ipsilateral ear. From extensor synergy (shoulder adduction/ internal rotation, elbow extension, forearm pronation) to flexor synergy (shoulder abduction/ external rotation, elbow flexion, forearm supination).	Shoulder	retraction	0	1	2
		elevation	0	1	2
		abduction (90°)	0	1	2
		external rotation	0	1	2
	Elbow	flexion	0	1	2
	Forearm	supination	0	1	2
Extensor synergy: Hand from ipsilateral ear to the contralateral knee	Shoulder	adduction/internal rotation	0	1	2
	Elbow	extension	0	1	2
	Forearm	pronation	0	1	2
Subtotal II (max 18)					

III. Volitional movement mixing synergies, without compensation		none	partial	full
Hand to lumbar spine hand on lap	cannot perform or hand in front of ant-sup iliac spine hand behind ant-sup iliac spine (without compensation) hand to lumbar spine (without compensation)	0	1	2
Shoulder flexion 0°- 90° elbow at 0° pronation-supination 0°	immediate abduction or elbow flexion abduction or elbow flexion during movement flexion 90°, no shoulder abduction or elbow flexion	0	1	2
Pronation-supination elbow at 90° shoulder at 0°	no pronation/supination, starting position impossible limited pronation/supination, maintains starting position full pronation/supination, maintains starting position	0	1	2
Subtotal III (max 6)				

IV. Volitional movement with little or no synergy		none	partial	full
Shoulder abduction 0 - 90° elbow at 0° forearm pronated	immediate supination or elbow flexion supination or elbow flexion during movement abduction 90°, maintains extension and pronation	0	1	2
Shoulder flexion 90° - 180° elbow at 0° pronation-supination 0°	immediate abduction or elbow flexion abduction or elbow flexion during movement flexion 180°, no shoulder abduction or elbow flexion	0	1	2
Pronation/supination elbow at 0° shoulder at 30°- 90° flexion	no pronation/supination, starting position impossible limited pronation/supination, maintains start position full pronation/supination, maintains starting position	0	1	2
Subtotal IV (max 6)				

V. Normal reflex activity assessed only if full score of 6 points is achieved in part IV; compare with the unaffected side		0 (IV), hyper	lively	normal
biceps, triceps, finger flexors	2 of 3 reflexes markedly hyperactive or 0 points in part IV 1 reflex markedly hyperactive or at least 2 reflexes lively maximum of 1 reflex lively, none hyperactive	0	1	2
Subtotal V (max 2)				

Total A (max 36)	

Fugl-Meyer Assessment Upper Extremity

<30 severe impairment

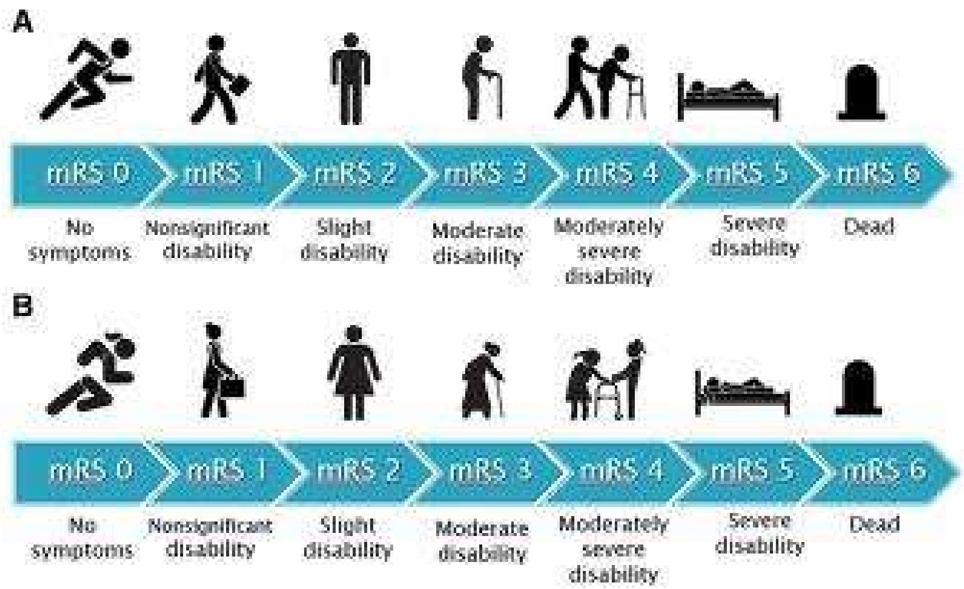
31-45 moderate impairment

>45 mild impairment

Wolf Motor Function Test

Task	Time	Functional Ability	Comment
1. Forearm to table (side)		0 1 2 3 4 5	
2. Forearm to box (side)		0 1 2 3 4 5	
3. Extend elbow (side)		0 1 2 3 4 5	
4. Extend elbow (weight)		0 1 2 3 4 5	
5. Hand to table (front)		0 1 2 3 4 5	
6. Hand to box (front)		0 1 2 3 4 5	
7. Weight to box	______________lbs.		
8. Reach and retrieve		0 1 2 3 4 5	
9. Lift can		0 1 2 3 4 5	
10. Lift pencil		0 1 2 3 4 5	
11. Lift paper clip		0 1 2 3 4 5	
12. Stack checkers		0 1 2 3 4 5	
13. Flip cards		0 1 2 3 4 5	
14. Grip strength	______________kgs.		
15. Turn key in lock		0 1 2 3 4 5	
16. Fold towel		0 1 2 3 4 5	
17. Lift basket		0 1 2 3 4 5	

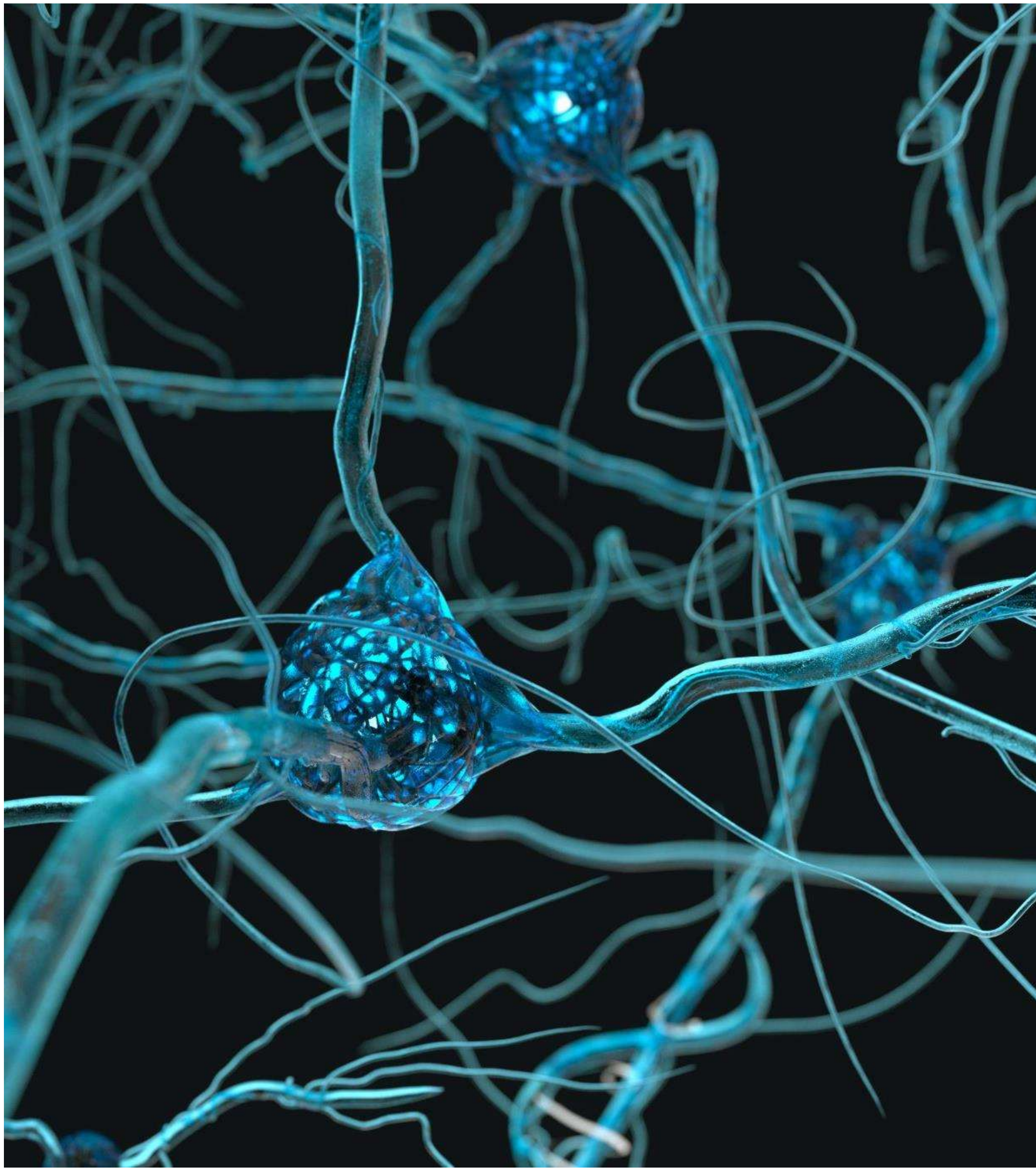
Modified Rankin Scale

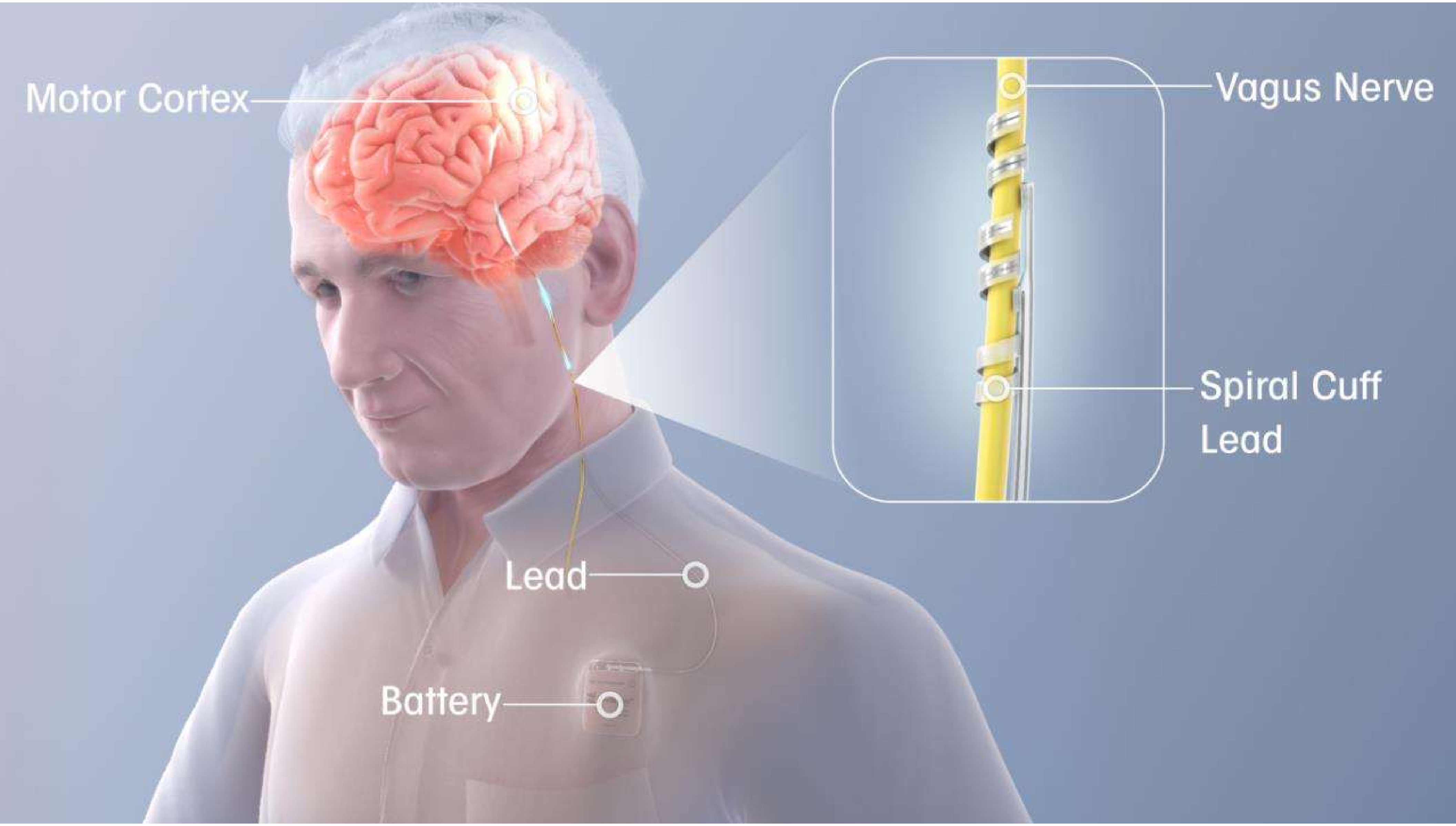


Jeffrey L. Saver. Stroke. Standardized Nomenclature for Modified Rankin Scale Global Disability Outcomes: Consensus Recommendations From Stroke Therapy Academic Industry Roundtable XI, Volume: 52, Issue: 9, Pages: 3054-3062, DOI: (10.1161/STROKEAHA.121.034480)

Vagus nerve stimulation

- Enhance the reorganizational potential and neuroplasticity of the brain by modulating cholinergic and monoaminergic motor cortex neurons
- Done by stimulating the vagus nerve while pairing with sensory or motor training

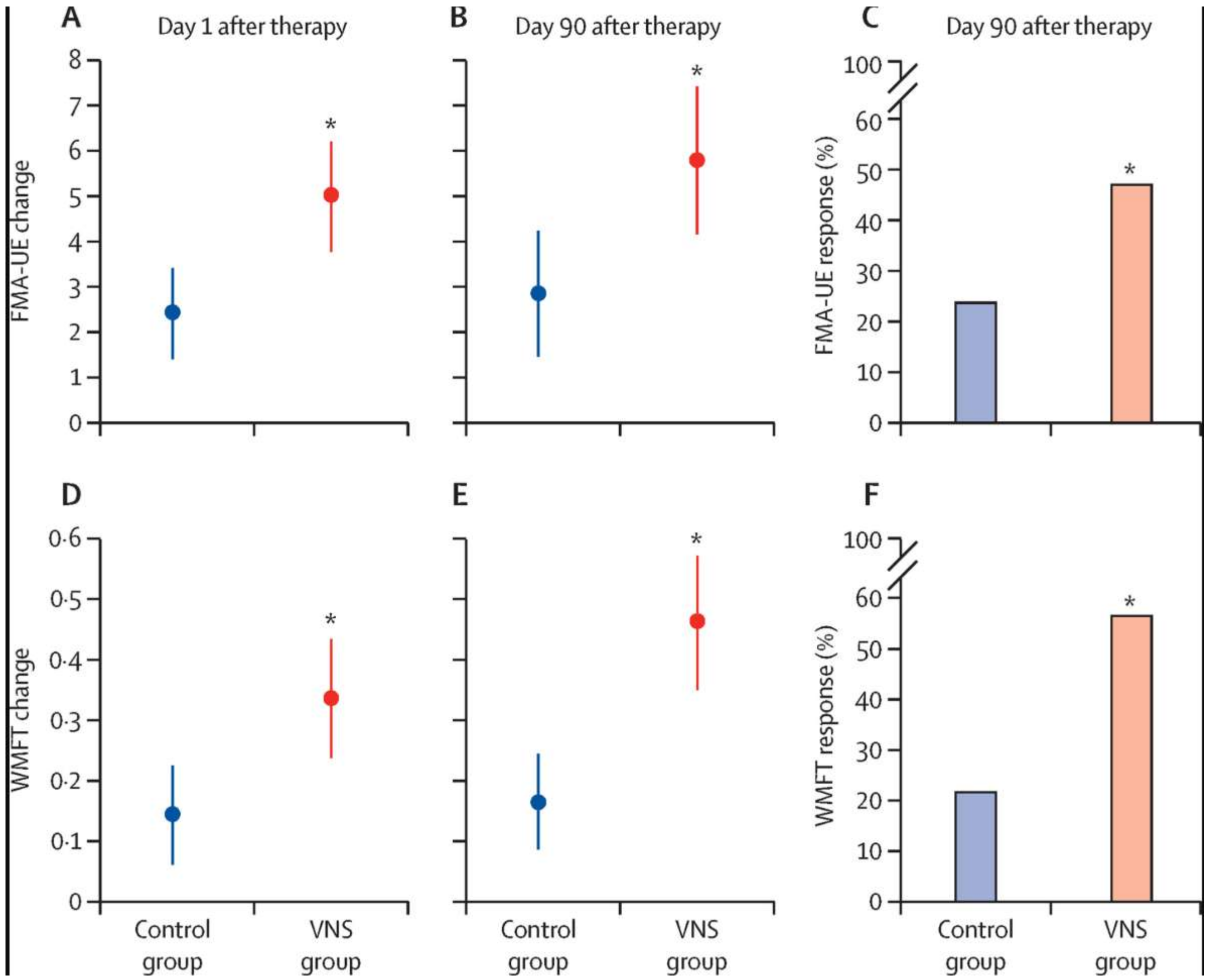



Motor Cortex
Vagus Nerve
Spiral Cuff
Lead
Lead
Battery

Vagus nerve stimulation & Upper Extremity

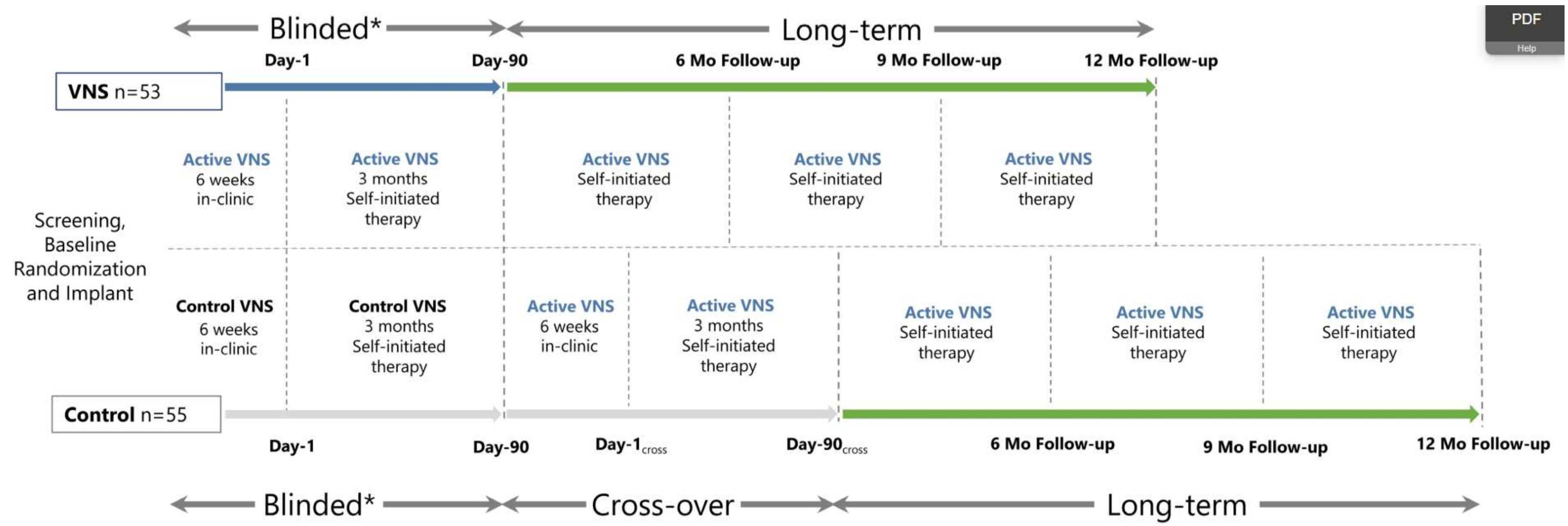
- VNS-REHAB study
  - Triple blind, sham-controlled trial at 19 locations in the US and UK, 108 participants
  - Moderate to severe arm weakness >/= 9 months s/p ischemic stroke
  - Everyone had a device implanted
    - 0.8mA, 100 microseconds, 30 Hz stim pulses lasting 0.5s
    - 0mA pulses
  - 6 weeks of in-clinic therapy (3x/wk, 18 total sessions), then home program
  - Fugl-Meyer was assessed at 90 days
  - Dawson et al.

Response and change to FMA-UE and WMFT

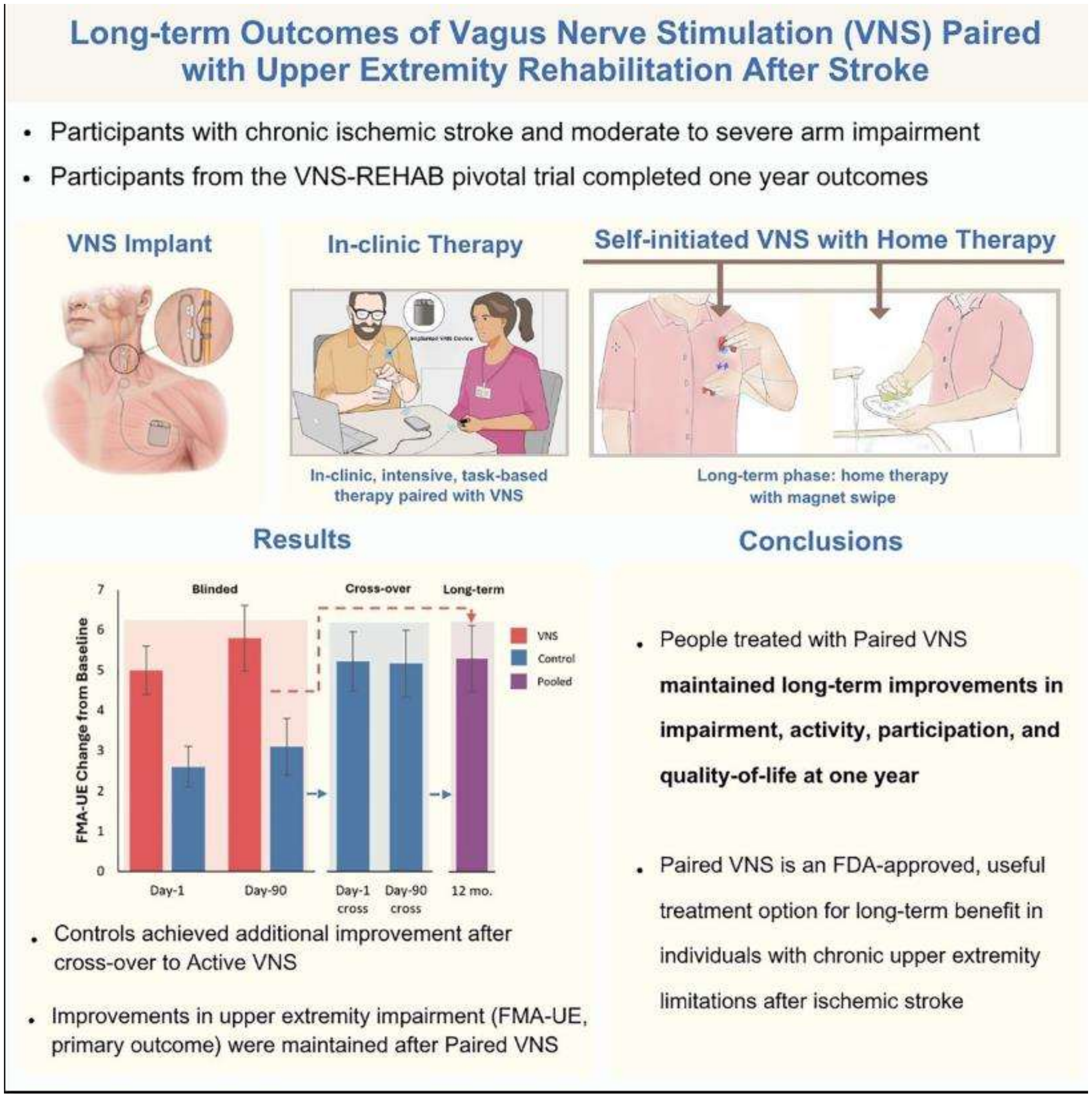


Dawson et al.

Long-term outcomes of VNS with UE Rehabilitation



Kimberley et al.



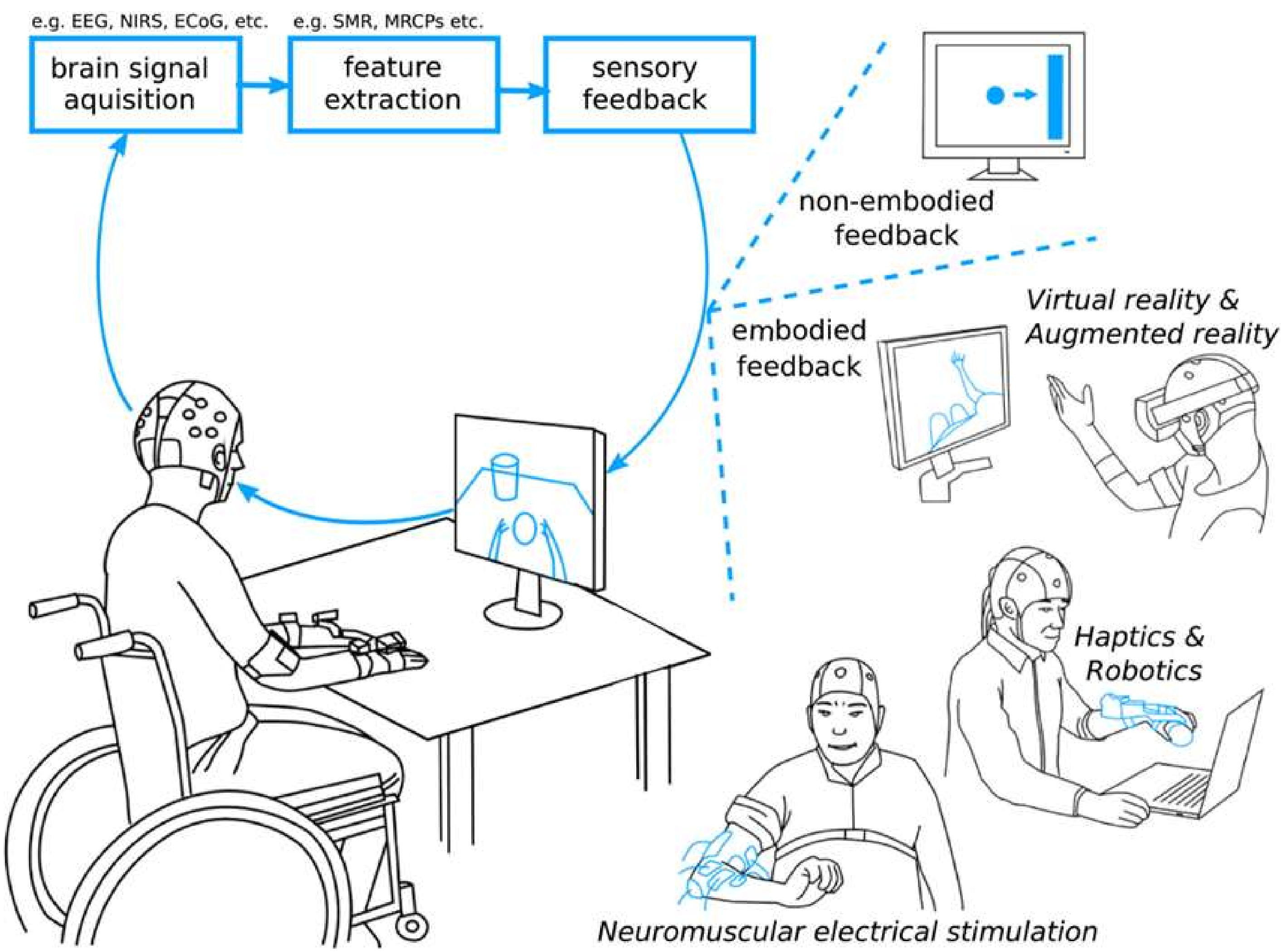
Kimberley et al.

Brain Computer Interface (BCI)

Direct communication between the brain's electrical activity and an external device, such as a robotic limb

For stroke patients, it can provide sensory feedback to modulate purposeful sensorimotor activities

- Potentially repeated use can trigger neurological recovery and improvement in motor function



e.g. EEG, NIRS, ECoG, etc.
e.g. SMR, MRCPs etc.
brain signal aquisition
feature extraction
sensory feedback
non-embodied feedback
embodied feedback
Virtual reality & Augmented reality
Haptics & Robotics
Neuromuscular electrical stimulation

BCI and post-stroke motor recovery

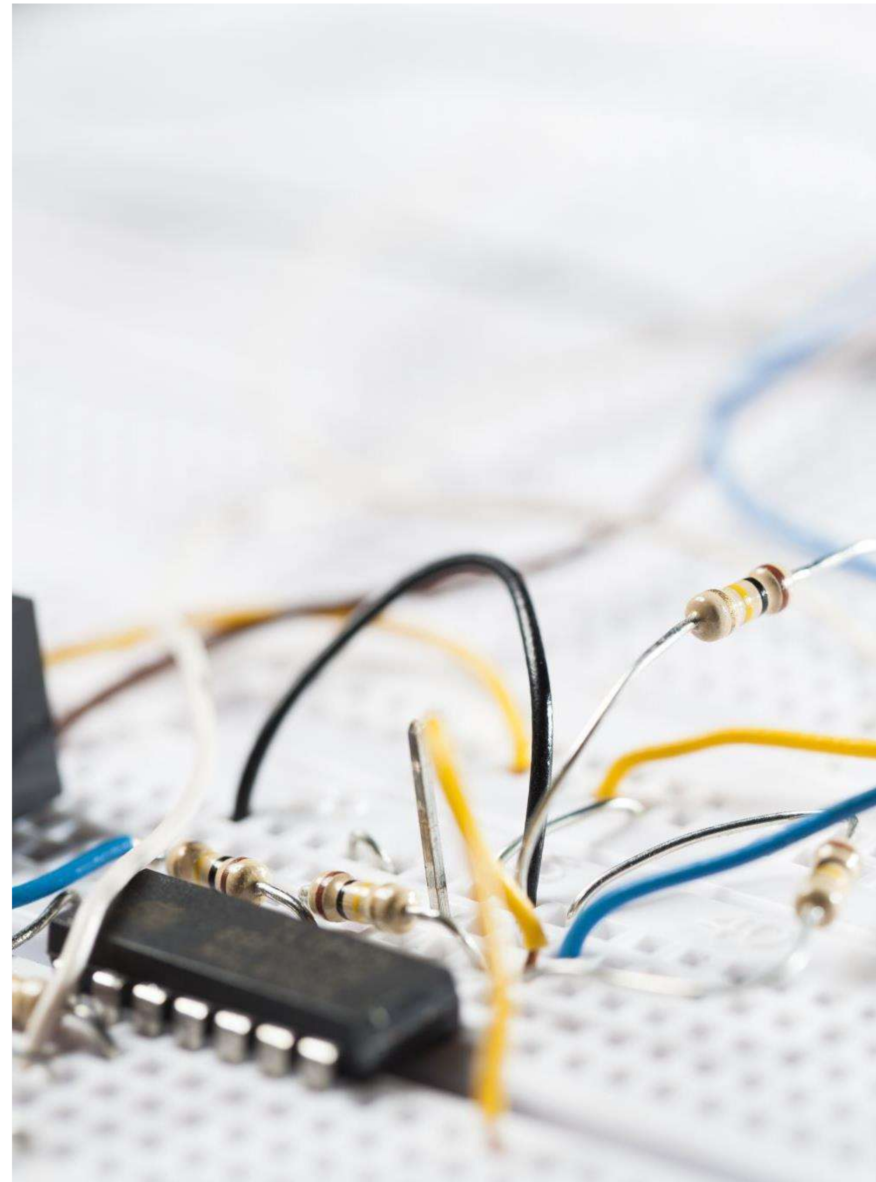
- Meta-analysis (Cervera et al.)
- 6 smaller studies demonstrated improvement in the FMA-UE exceeding the minimally clinically important difference
    - N varied from 14 to 47
- Overall, standardized mean improvement of 0.79 in FMA-UE
- Studies with larger sample sizes are needed though

BCI and post-stroke motor recovery

- Another meta-analysis suggests slight efficacy in improving upper limb functioning
- Possibly slight improvement
  - Subgroup analysis demonstrated better effects if <12h of training rather than >12h of training
  - No difference in ADLs
- Follow-up times in the studies was quite variable, from 2 weeks to 18 weeks
- Zhang et al

Electromagnetic Network Targeting Field (ENTF) Therapy

- Non-invasive electromagnetic field treatment
  - Low frequency 1-100h
  - Low intensity electromagnetic field (<1 Gauss)
- Exposing impaired neuronal networks to oscilliating fields similar to a healthy CNS produces neuroprotective mechanisms AND promotes functional network reorganization
- Encouraging pilot study ...



Frequency tuned electromagnetic field treatment

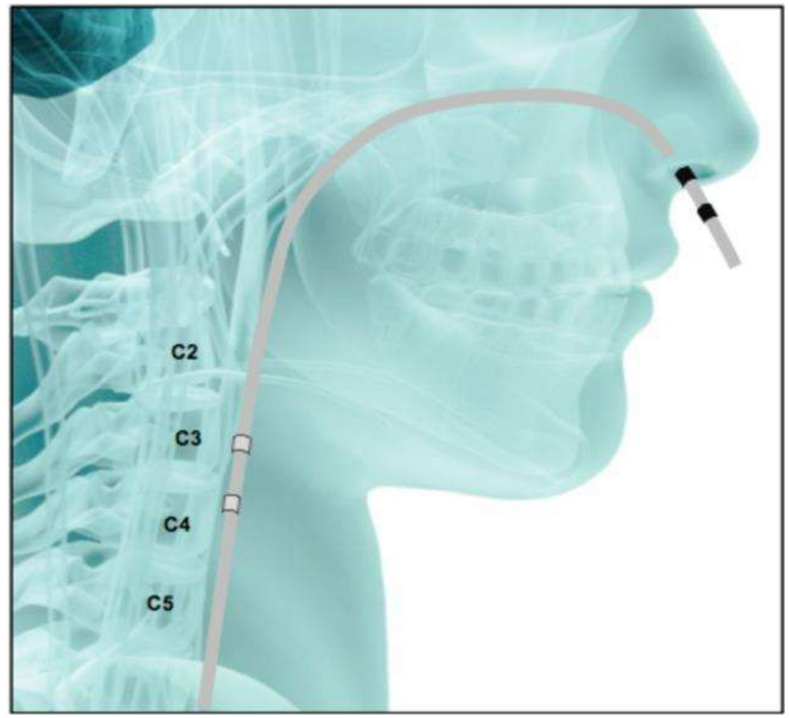
- EMAGINE-Study
- Moderate to moderately-severe global disability stroke patients with upper extremity impairment
- More acute than other studies (4-21 days after the stroke)
- 45 treatment sessions

EMAGINE

- Trial was stopped after 100 participants were enrolled
- Interim analysis did not show that results would meet statistical significance
- Difficulties:
  - Imbalance in randomization treatment group tended to have more R hemisphere strokes, larger strokes, and greater disability at baseline

Pharyngeal E-stimulation

- An internal device inserted similar to an NG tube with built-in stimulation electrodes
- Maximal corticobulbar excitability occurs at 5Hz, 10 minutes, 75% maximum tolerated intensity (Hamdy, Fraser)
    - Demonstrated faster initiation of each swallow and a reduction in the frequency of aspiration for at least 1h after stimulation.



Pharyngeal E-stimulation

- Bath et al.'s RCT 162 patients with recent ischemic or hemorrhagic stroke and dysphagia with Penetration Aspiration Score >/=3 on VFSS
  - Within 42 days of stroke
  - 3 on the scale = entry of material into the larynx without clearing
  - Threshold and tolerance levels were determined for both groups, but sham did not receive stimulation afterwards.
  - Researchers were not blinded

Pharyngeal E-stimulation

- Primary outcome: swallowing safety at 2 wks
- Secondary outcome: dysphagia severity, function, QOL, and serious adverse events at 6 and 12 weeks
- Results:
  - Study demonstrated swallowing safety at 2 weeks
  - No serious adverse events at 6 and 12 weeks
  - But when compared to sham stimulation, no significant superiority regarding aspiration

Pharyngeal E-stimulation

- Another study with participants with wider variety of causes of neurogenic related dysphagia (Bath et al.)
- Safe, but no evidence of statistically significant improvement in swallow

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