Assessment and Treatment of Spasticity

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Learner Objectives

The learner will:

- Participants will be able to identify and differentiate various assessment tools used in assessing spasticity
- Participants will be able to discuss various treatment options for patients with spasticity

Where do we start?

How can we make our assessments meaningful?

Ashworth/Modified Ashworth

- One of the most commonly used assessment for spasticity in the clinic
- Frequently used as the “gold-standard” to validate other spasticity measures against.
- Measure of *RESISTANCE TO PASSIVE MOVEMENT* [1]
- Is NOT a measure of spasticity, but scores may by influenced by spasticity [2]
- Is performed at one speed only (one-second[1]), so does not capture the “velocity-dependent” component of spasticity
- Good screening tool to indicate when further assessment needed

1. Bohannon R,, et al. *Physical Therapy* 1987. 67:1068-1071 2. Pandyan AD, et al. *Clin Rehab* 1999;13(5):373 – 383

Psychometrics – Mixed Reviews

Author	Subjects	Results/Findings
Sloan et al	34 hemiplegic	"MAS has acceptable interrater reliability for testing of upper limb spasticity, but not so for testing of the lower limb spasticity."
Nuyens,et al	30 MS	"AS more reliable for muscles of the ankle than for muscles of the knee, and least reliable for muscles of the hip."
Haas, et al	30 SCI	Interrater reliability varied between AS and MAS, between muscle groups (hip adductors > hip extensors/flexors > ankles plantarflexors), and between limbs. Recommended for both to be used with caution when assessing LE spasticity with SCI patients
Allison et al	30 TBI	Low interrater reliability for ankle plantarflexors, and argued that there was no support for continued use of MAS to assess PFs in pts with TBI.
Gregson, et al	32 acute CVA	Intra/inter-rater reliability found to be "good to very good for the elbow, wrist and knee, but less satisfactory over the ankle."
Blackburn et al	36 CVA	Acceptable intra-rater reliability, but poor inter-rater reliability for MAS. Most agreement was with scores of "0," so conclusion was that reliable measurements could be obtained to determine whether normal or low muscle tone is present or not.

Pandyan AD, et al. *Clin Rehab* 1999;13(5):373 – 383
Malhotra S, et al. *Clin Rehabil*. 1998: 1005-1115

Ashworth/Modified Ashworth

0	No increase in tone
1	Slightly increased tone, with a catch & release or minimal resistance at terminal ROM
1+	Slight increase, catch followed by minimal resistance throughout the remainder of the range (<1/2 of the ROM) (only in MAS)
2	Marked increase through most of the ROM, but affect part is easily moved
3	Considerable increase, passive ROM difficult
4	Affected part is rigid

Passive movements of muscle groups should be performed over a one-second time frame

Bohannon R,, et al. *Physical Therapy* 1987. 67:1068-1071

"The results...are clear and tell us the Ashworth Scale has insufficient validity and reliability to be used as a measure of spasticity. However, we are left with the problem of how to measure spasticity in a valid and reliable way. The quest for this holy grail is ongoing."

- Katharina S Sunnerhagen

Sunnerhagen, K. Stop Using the Ashworth scale for the assessment of spastisity [letter]. *J Neurol Neurosurg Psychiatry* 2010. 81:2

Slow down!

- MAS performed as a 1-second movement – which is not as fast as many of us learned in school
- The score is based on the resistance felt during that one second of passive movement
- Should be done 1-3 times at most

MAS

Case Example

- 36 y/o male with R CVA, resulting in spastic left hemiparesis. Below are the MAS scores for his L UE and LE.

UE Muscle Group	MAS	LE Muscle Group	MAS
Shoulder Flexors	0	Hip Flexors	0
Shoulder Extensors	2	Hip Extensors	3
Shoulder Adductors	3	Hip Adductors	3
Elbow Flexors	2	Hip Int Rotators	0
Elbow Extensors	0	Hip Ext Rotators	2
Wrist Flexors	3	Knee Extensors	0
Wrist Extensors	0	Knee Flexors	2
Finger Flexors	3	Ankle Plantarflexors	3
Thumb Adductors	0	Ankle Inverters	0
		Ankle Everters	0

So how do we assess further??

The Tardieu Scale

The Tardieu Scale

Measures two aspects of spasticity
1) Quantity -- Spasticity Angle
2) Quality - Spasticity Grade

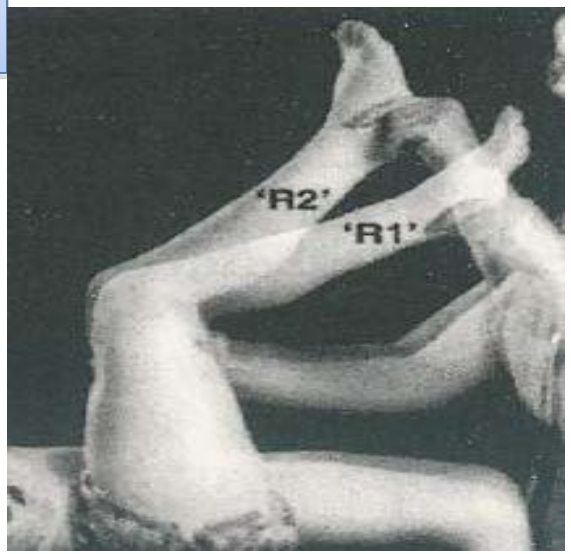
May be more useful in terms of predicting the functional implications of the spasticity, as well as assessing the effects of treatment

Gracies JM, et al. Arch Phys Med Rehabil 2010;91:421-8.

Spasticity Angle

Range of motion measured at two different velocities
- V1 – Slow as possible (R2)
- V3 – Fast as possible (R1)

R2 − R1 = Spasticity Angle



Large spasticity angles indicate a large dynamic component (spasticity), whereas small differences indicate predominantly muscle contracture

Gracies JM, et al. Arch Phys Med Rehabil 2010;91:421-8.

Spasticity Grade

0	No resistance throughout passive movement
1	Slight resistance throughout passive movement
2	Clear catch at precise angle, interrupting passive movement, followed by release
3	Fatigable clonus (<10 s when maintaining pressure) occurring at a precise angle, followed by release
4	Unfatigable clonus (>10s when maintaining pressure) occuring at a precise angle

Notes:

If spasticity angle = 0, grade must be a 0 or 1 by definition

If spasticity angle > 0, grade must be at least a 2, even if no definite “release” felt

Gracies JM, et al. Arch Phys Med Rehabil 2010;91:421-8.

What does the literature say?

- More likely to identify presence of spasticity [but not severity] and the presence of contractures than MAS/AS[1]
- Very good intra-rater reliablity across 2 sessions in elbow flexors and ankle plantarflexors [2]
- Good reliability in assessing elbow flexor and ankle plantarflexor spasticity [3]
- Reliability significantly increases with training[3]
- “In patients with severe brain injury and impaired consciousness the Modified Tardieu Scale provides higher test retest and inter-rater reliability compared with the Modified Ashworth Scale and may therefore be a more valid spasticity scale in adults.” [4]

See additional references

How to perform the Tardieu Scale

- Measure R2 – Achieved with a SLOW and powerful passive movement (V1). This should give us the full range of motion of the muscle group.
  - Should be slow enough to prevent eliciting any stretch reflexes
  - Should be powerful enough to overcome any resting dystonia
  - R2 is documented as the point where no further passive movement is achievable.

Gracies JM, et al. Arch Phys Med Rehabil 2010;91:421-8.

How to perform the Tardieu Scale

- Measure R1 – Achieved with a passive movement that is as fast as possible (V2)
  - R1 is documented as the angle at which the first resistance is felt
- Calculate Spasticity angle – the difference between the two angles of R2 and R1
- Assign Spasticity Grade to the resistance felt during R1 measurement

Case Example, cont

UE Muscle Group	MAS	R2	R1	Spasticity >	Prob Implication
Shoulder Extensors	2	180	40	140	↑ Spasticity
Shoulder Adductors	3	120	120	0	M Tightness
Elbow Flexors	2	150	120	30	M Tightness ↑ Spasticity
Wrist Flexors	3	100	80	20	M Tightness ↑ Spasticity
Finger Flexors	3	150	150	0	M Tightness
Hip Extensors	3	100	100	0	Tightness (M, C?)
Hip Adductors	3	120	110	10	M Tightness
Hip Ext Rotators	2	110	110	0	Capsular
Knee Flexors	2	180	60	120	↑ Spasticity
Ankle Plantarflexors	3	70	70	0	M Tightness

Assessing the spasticity angle

Active Range of Motion

- NOT a measure of strength, but a measure of how much the spastic muscle can be overcome!
- Documented as the number of degrees of active movement.
- Are we seeing co-contraction of the antagonist?

Gracies JM, et al. Arch Phys Med Rehabil 2010;91:421-8.

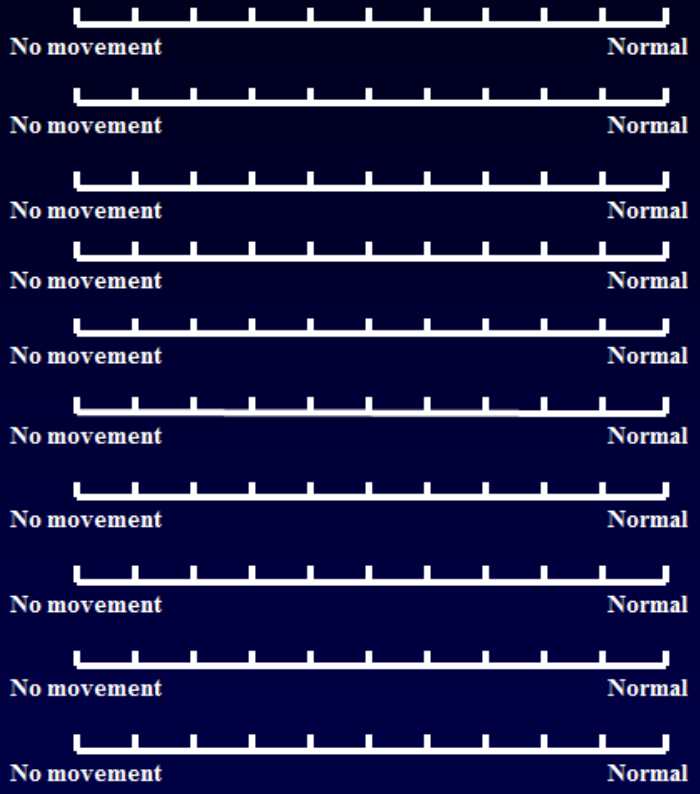
Rapid Alternating Contractions

- Looking at the time it takes to perform a set number of active movements (into their full AROM)
- Co-contraction usually increases with effort and fatigue
- May be more indicative of what we see in functional mobility (ie, gait, feeding).

Gracies JM, et al. Arch Phys Med Rehabil 2010;91:421-8.

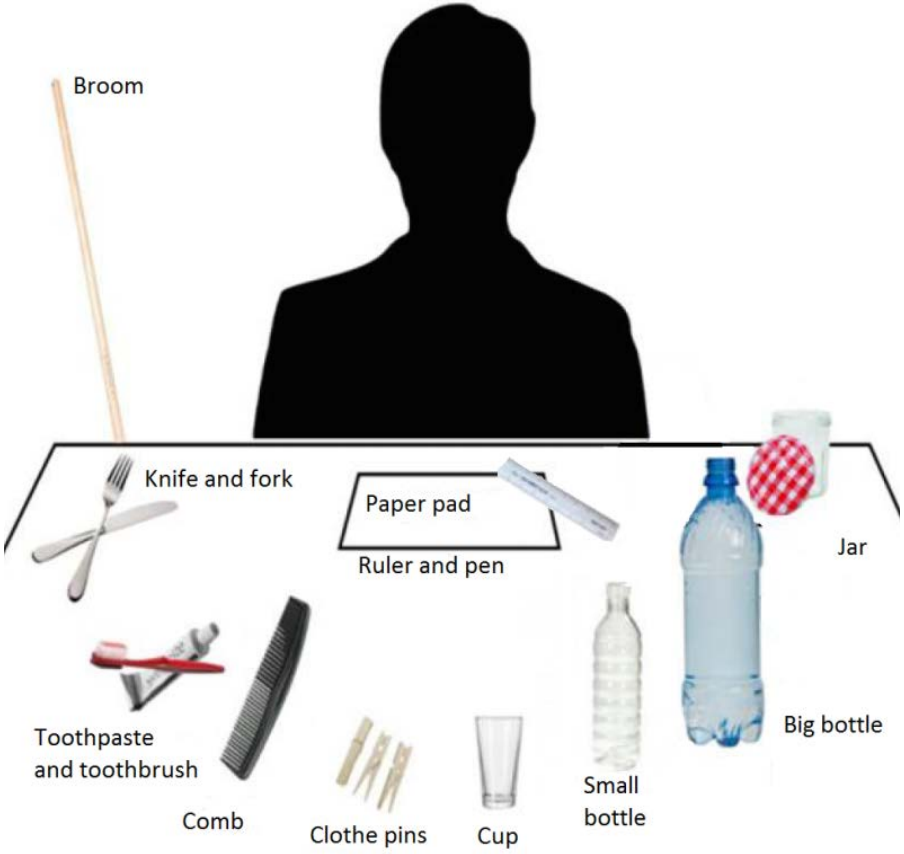
Modified Frenchay Scale

1. Open and close jam jar	*two hands*
2. Draw line on paper using ruler	*two hands*
3. Pick-up and release big bottle	affected hand
4. Pick up and release small bottle	affected hand
5. Pick up Glass and bring to mouth	affected hand
6. Clip 3 clothes pins on paper pad edge	*two hands*
7. Pick up comb and mimic combing	affected hand
8. Put toothpaste onto toothbrush	*two hands*
9. Pick up knife and fork and mimic cutting on paperpad	*two hands*
10. Sweep floor with broom	*two hands*



Gracies et al, 2002, Handbook of Botulinum Toxin Treatment
ACRM-ASNR Joint Educational Conference; Denver 2009

Modified Frenchay Scale



0 = not able to perform any of task/no mvmt

5 = barely accomplished task

10 = normal performance

→ **High intra- and inter-rater reliability** *(Baude et al. ESNR, 2015)*

Gracies,Handbook of botulinum toxin 2002; 2009; 2015

FUNCTION!!!

Functional Assessment

- ASK QUESTIONS!
  - How is this impacting their lives? **Severity ≠ Significance!**
  - What are THEIR goals of treatment?

- OBSERVE!
  - Watch them walk, transfer, maneuver w/c, eat, dress, etc
  - How are they positioned?
  - VIDEO, VIDEO, VIDEO!

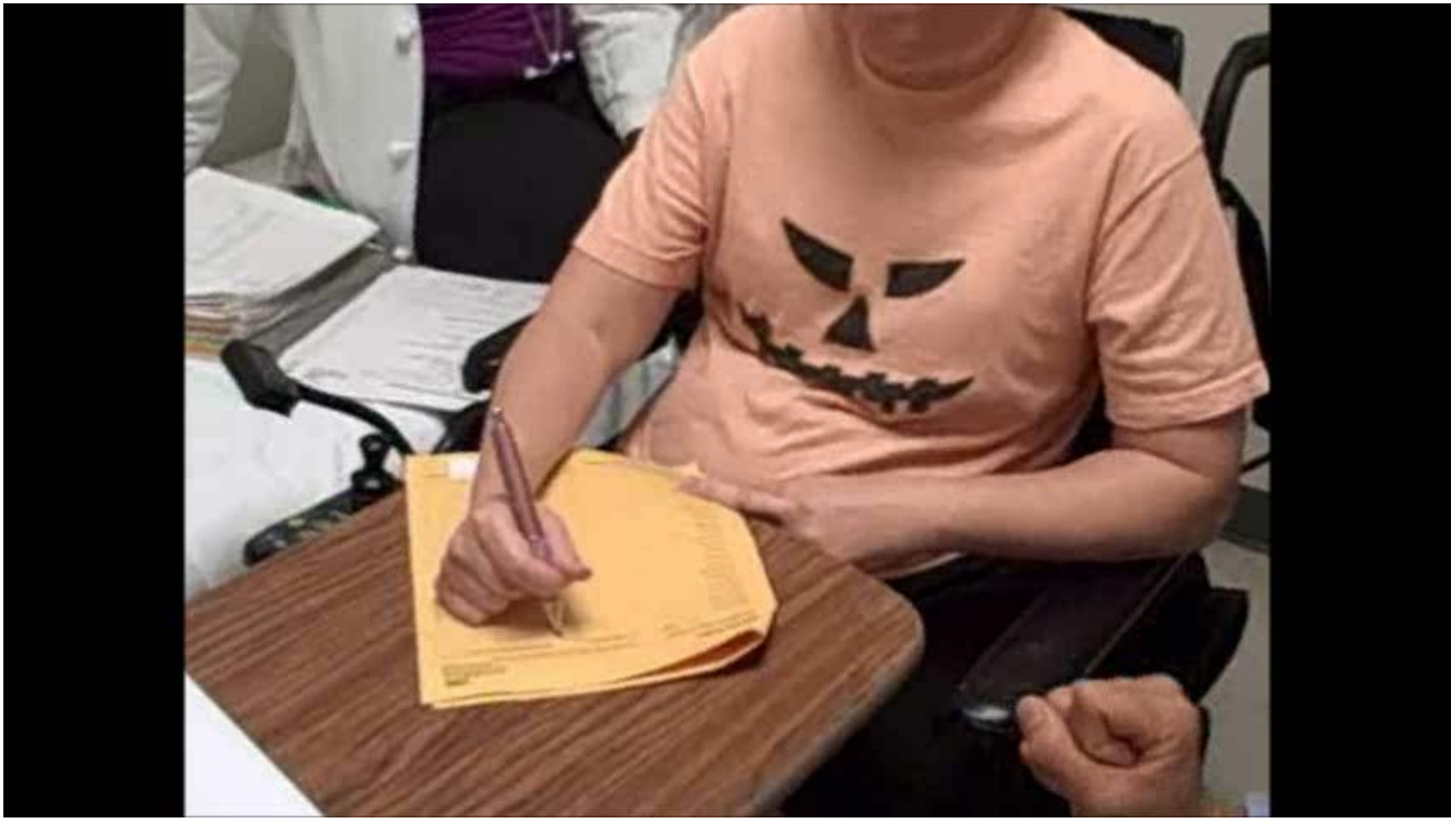
- BE OBJECTIVE
  - Use measures such as 10-meter walk, 6-minute walk test, Gaitrite, Goal Attainment Scale

1. Gracies JM, et al. Arch Phys Med Rehabil 2010;91:421-8
2. Doan, et al. *PMR* 2012 Jan; 4(1):4-10 (abstract)

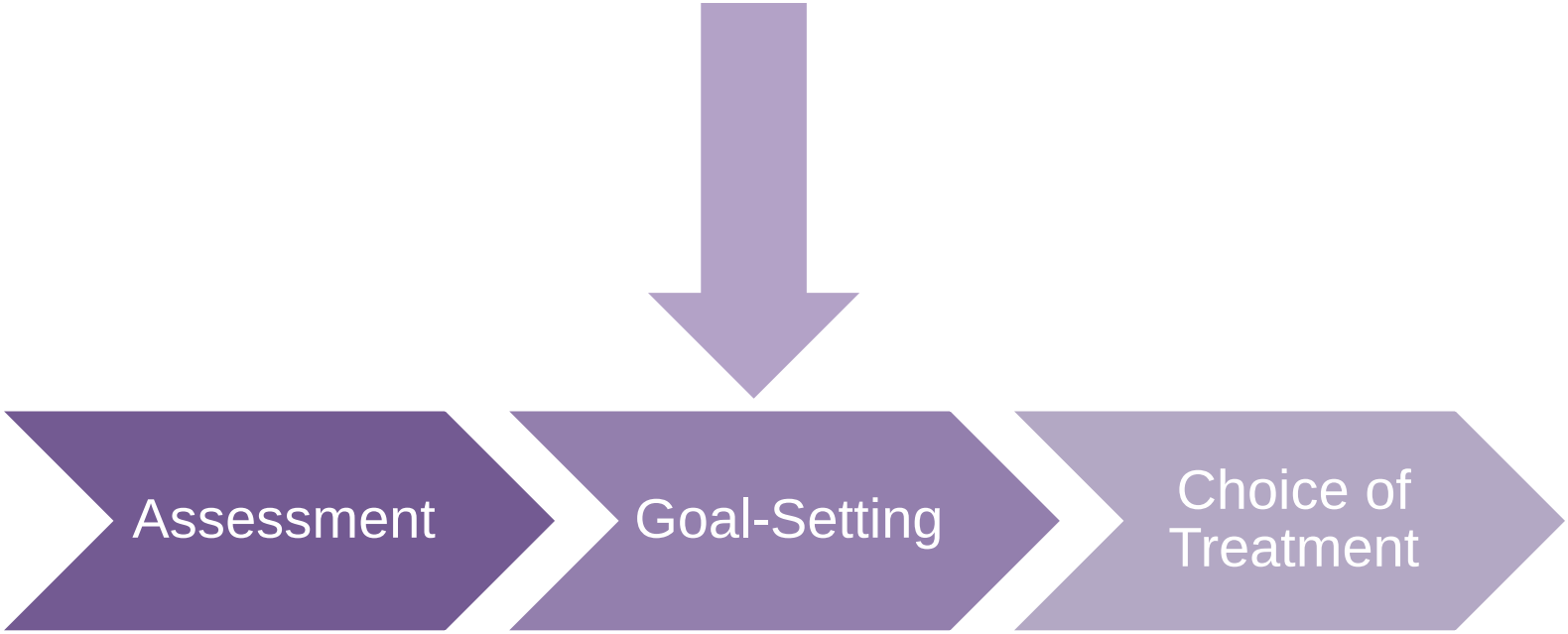
Pre-trial gait

Post-trial gait

Handwriting



Setting goals



Clinician Goals

Patient Goals

Who are we focused on when setting goals?

Goal check

Meaningful

Realistic/Achievable

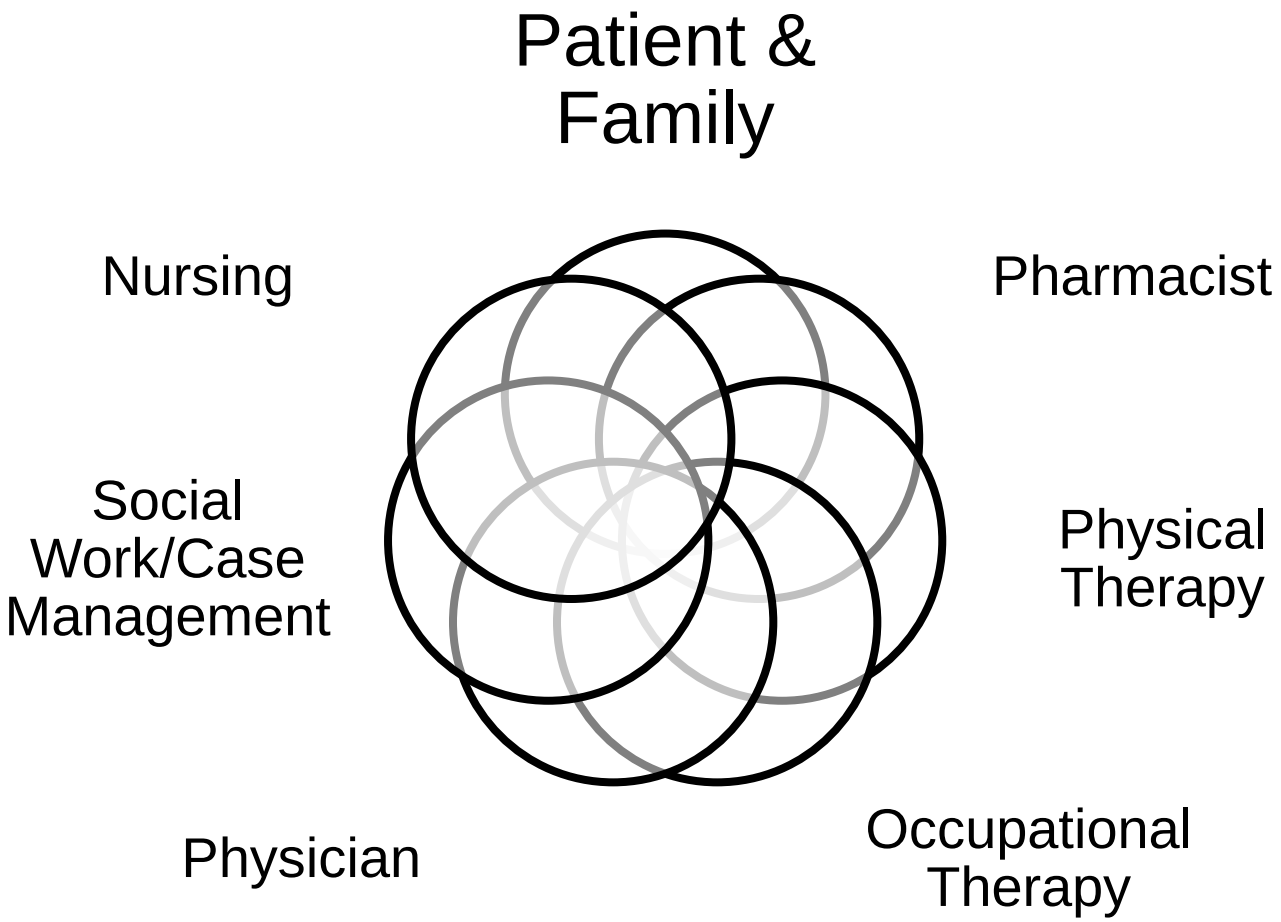
Patient-centered

Functional

Objective

Treatment options

Interdisciplinary Treatment



ITB patient education

The pre and post trial process

Implant process

What we are looking for during the post-trial assessment

Pump precautions

What a pump may or may not help with

Possibility of initial functional decline

- Necessity for further therapy

Potential for weight gain

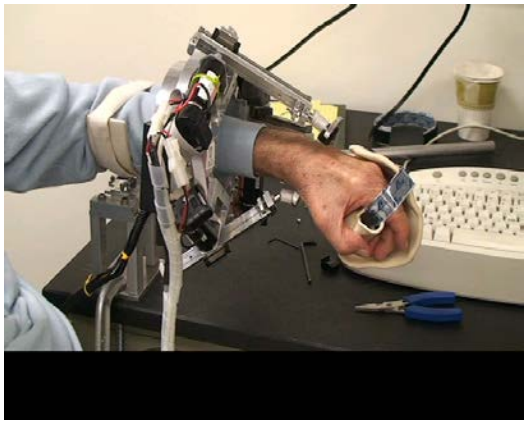
Importance of refills

Signs of withdrawal!!!

- Itcy, witchy, twitchy

Graham, L. *Oxford Journals, 2013 (42)435-441*

Therapy management



Therapy-driven neuroplasticity?

- 23 patients at least 6 months post-CVA
  - Documented spasticity and at least trace activation in selected UE muscle groups
- Outcome measures – MAS, FM, sensory tests, fMRI
- Intervention – 12 week motor learning therapy program, including treatment for spasticity
- Results
  - Greater spasticity correlated with poorer function according to FM scores, and with greater severe sensory deficits
  - Significant gains in motor function measured with FM total score
  - Improvements in spasticity correlated with increased task-related brain activation in the CONTRAlesional M1, LPM, S1 and AS regions

Pundik, et al. *Stroke Research and Treatment* (2014); 306325

BWSTT vs Tilt Table in SCI

When body weight supported treadmill training and tilt table programs were compared in patients with SCI -

- BWSTT had greater decreases in flexor spasms, clonus, and self-reported mobility after 4 weeks of treatment
- Tilt table standing had greater reduction in extensor spasms after 4 weeks of treatment.
- Participants in BWSTT appeared to have higher scores on QoL measures

Adams, M and Hicks A. *The Journal of Spinal Cord Medicine;* 2011 (31) 488-494

Casting

- A conservative and effective modality to reduce muscle tightness, decrease chance of deformity, and achieve optimum alignment of a joint.
- Casts offer a temporary, specific, and noninvasive intervention as an alternative or complement to other interventions.
- Casting may help eliminate, delay, or minimize the need for surgical interventions.
- Best outcomes combined with medical management

Verplancke D, et al. *Clinical Rehabilitation.* 2005. 19(2): 117-125

Park E, *et al*. *Yonsei Medical Journal.* 2010; 51(4): 579-584

Alternatives

Positioning

Positioning

Modalities

- Heat and Cold
  - Temporarily decreases tone and increases pain thresholds
  - May be beneficial in conjunction with strengthening antagonistic muscles or prior to casting
- Vibration
  - Shown to have short term decreases in tone as well as improvement in function
  - Should be used in conjuction with other therapies

Smania, N, et al. *Eur J Phys Rehabil Med* 2010; 46:423-38

Modalities

Estim leading to muscle contraction:

- Pure sensory stimulation thought to inhibit overactivity through influencing the excitability of the alpha motor neurons and triggering sensorimotor reorganization
- Stimulation of the overactive muscles may lead to fatigue, thus decreasing activation

- Minimal results published regarding long-term effects, but has been shown to have good short term effects
- Increases in function are thought to be a result of increased motor control gained during brief inhibitory period following e-stim

Smania, N, et al. *Eur J Phys Rehabil Med* 2010; 46:423-38

Strengthening

Does strengthening a spastic muscle increase the over-activity?

Historical thought

was…YES

Research says…..NO

- Research shows us that spastic muscles are weak muscles
- Strengthening (post-CVA) has been shown to
  - Increase function
  - Decreased perceived limitations & increase perceived QOL
  - Increase gait speed
  - Has not been shown to increase spasticity (as measured by Pendulum test or MAS)

Smania, N, et al. *Eur J Phys Rehabil Med* 2010; 46:423-38

The dreaded PLATEAU

Who is plateauing?

- The patient?
- The therapist?
- The physician?

Can we change the recovery trajectory for the patient?

Is one year all we get?

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Physiotherapy for patients with mobility problems more than 1 year after stroke: a randomised controlled trial

John Green, Anne Forster, Sue Bogle, John Young

Summary

Background Community physiotherapy is often prescribed for stroke patients with long-term mobility problems. We aimed to assess the effectiveness of this treatment in patients who had mobility problems 1 year after stroke.

Methods We screened 359 patients older than 50 years for a single-masked, randomised controlled trial to assess the effects of community physiotherapy. Assessments were made at baseline, 3, 6, and 9 months in 170 eligible patients assigned treatment or no intervention. The primary outcome measure was mobility measured by the Rivermead mobility index. Secondary outcome measures were gait speed, number of falls, daily activity (Barthel index scores), social activity (Frenchay activities index), hospital anxiety and depression scale, and emotional stress of carers (general health questionnaire 28). Analyses were by intention to treat.

Findings Follow-up was available for 146 patients (86%). Changes in scores on the Rivermead mobility index (score range 0–15) differed significantly between treatment and control groups at 3 months (p=0·018), but only by a median of 1 point (95% CI 0–1), with an interpolated value of 0·55 (0·08–1·04). Gait speed was 2·6 m/min (0·30–4·95) higher in the treatment group at 3 months. Neither treatment effect persisted at 6-months' and 9-months' follow-up. Treatment had no effect on patients' daily activity, social activity, anxiety, depression, and number of falls, or on emotional stress of carers.

Interpretation Community physiotherapy treatment for patients with mobility problems 1 year after stroke leads to significant, but clinically small, improvements in mobility and gait speed that are not sustained after treatment ends.

Lancet 2002; **359:** 199–203
See Commentary page 182

Introduction

Patients who have had a stroke often have long-term difficulties with walking and other daily activities such as getting out of a chair and climbing stairs.[1] Falls are a frequent and potentially serious consequence of stroke.[2] Patients who have deteriorating mobility or who have had falls are often referred for physiotherapy treatment by family practitioners and other agencies, such as social services.[3] However, the benefit of community physiotherapy for patients with long-term mobility problems after a stroke is inconclusive. Wade and colleagues[4] reported a small but temporary improvement in walking speed for patients who had mobility problems 1 year or longer after stroke. However, the study[4] was underpowered and was not done within an established community physiotherapy service. In our single-masked, randomised, controlled trial we aimed to assess the effectiveness of routine community physiotherapy for patients with mobility difficulties 1 year after onset of a stroke.

+0,04 m/sec

Methods

Patients

We identified patients from hospital and community therapy stroke registers. Eligible patients were those who were older than 50 years, had had a stroke at least 1 year previously, and who had associated persisting mobility problems. We defined a mobility problem as: use of a mobility aid (other than a walking stick); a fall in the previous 3 months; unable to manage stairs, slopes, or uneven surfaces independently; or a slower gait speed over 10 m than expected for age group.[5] We excluded patients who had another cause than stroke for the mobility problem, dementia (a score of less than 7 on the abbreviated mental test),[6] severe comorbidity, were bedfast, or had undergone physiotherapy treatment within the previous 6 months. We asked patients the date at

Where do we stand?

Journal of Neurology, Neurosurgery, and Psychiatry 1983;**46**:5–8

Recovery after stroke

CLIVE E SKILBECK, DERICK T WADE, R LANGTON HEWER, VICTORINE A WOOD

From the Stroke Recovery Research Unit, Department of Neurology, Frenchay Hospital, Bristol, UK

SUMMARY One hundred and sixty-two patients were referred to a rehabilitation unit after an acute stroke. The patterns of recovery of overall functional ability, arm function, walking and speech in 92 of 101 survivors have been analysed. In all modalities the majority of recovery occurs within 3 months; although improvement is seen thereafter it does not reach statistical significance. Possible reasons for the apparent lack of late recovery are discussed.

Recovery after stroke

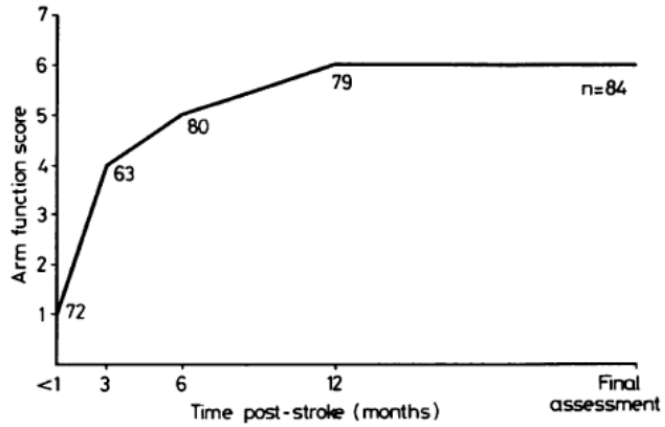

Fig 3 *Median Arm Function scores for survivors.*

Overall function

The 92 survivors were sub-divided into three groups according to their initial disability, as judged by their Barthel score. The graph (fig 1) illustrates the

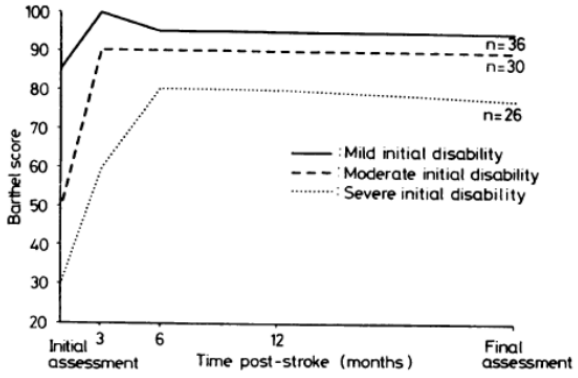

Fig 1 *Median Barthel scores for survivors in 3 groups.*

Self-Guided Contract

- Retrospective study by Pradines, et al in 2015
- 30 subjects (all > 1 yr post lesion) all followed self-guided contract
  - Antagonist-based
  - Diary-based
- Alternating stretching and rapid maximal amplitude alternating movements (eccentric stretches), documented in daily diary, performed for at least 1 year

Pradines M et al. Ann Phys Rehabil Med 2015;58(S1):e87

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PASSIVE STRETCH

ACTIVE TRAINING

HIP

☐ Passive stretch (1)

____ min ____ times/day

Gluteus maximus

☐ Active hip flexion, knee flexed (2)

____ sec ____ times/day

HIP

☐ Passive stretch (3)

____ min ____ times/day

Hamstrings

☐ Active hip flexion, knee extended (4)

____ sec ____ times/day

HIP

☐ Passive stretch (5)
Hip flexor - adductors

____ min ____ times/day

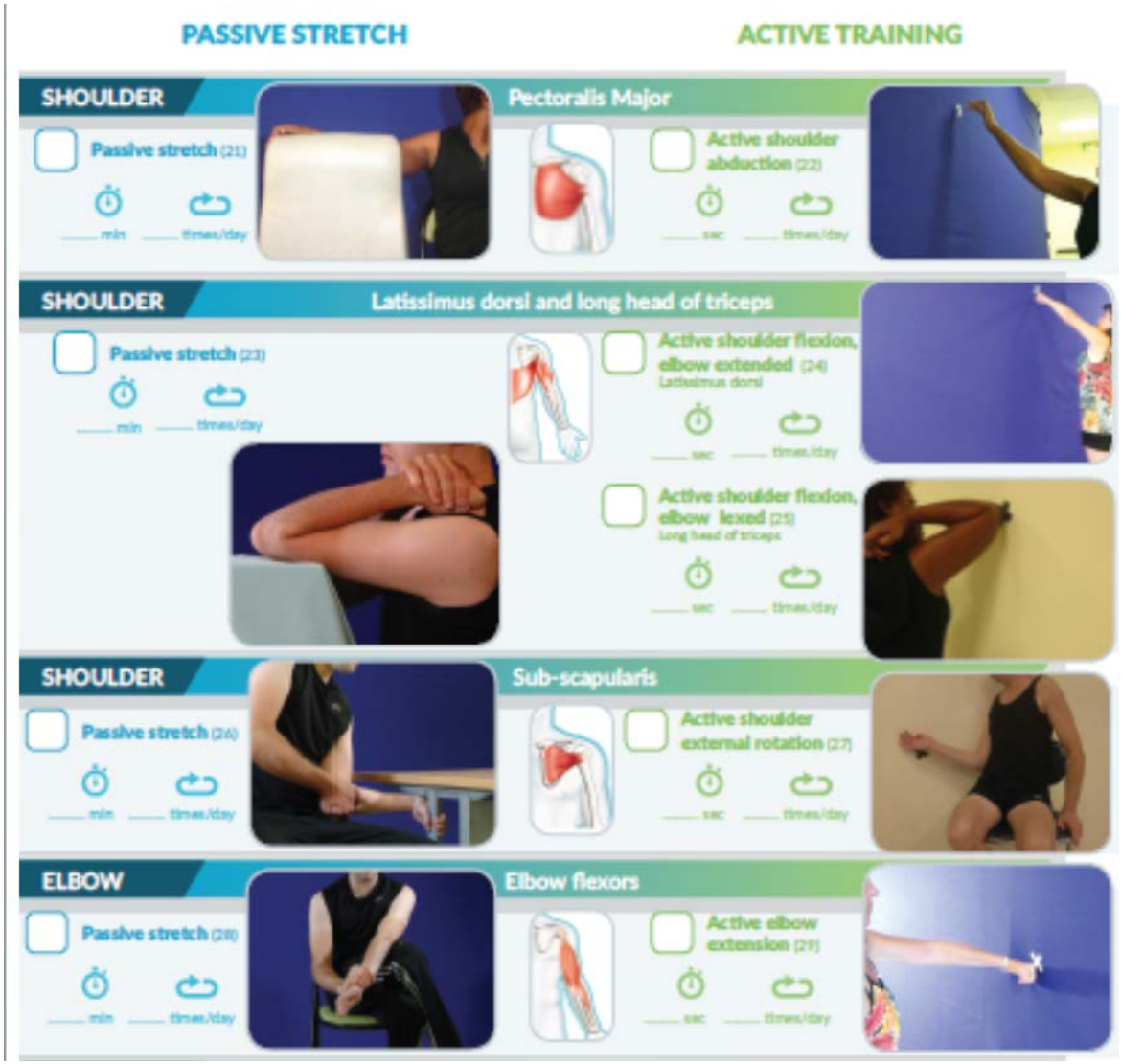
☐ Passive stretch (6)
Hip extensor-adductors

____ min ____ times/day

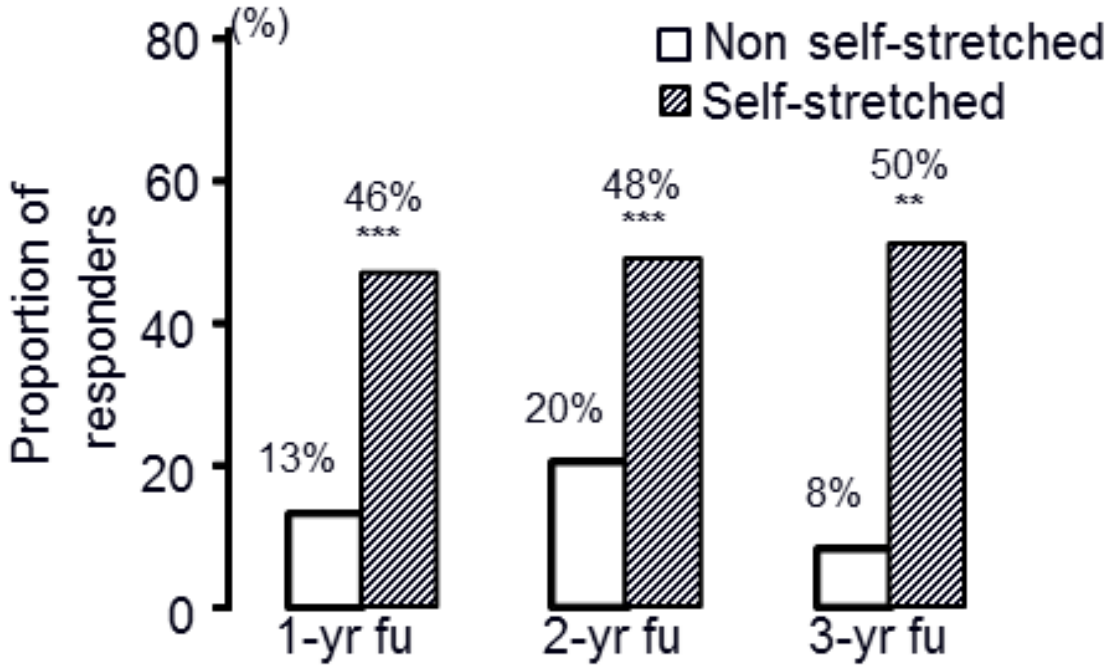
Hip adductors

☐ Active hip abduction (7)

____ sec ____ times/day


PASSIVE STRETCH
ACTIVE TRAINING
SHOULDER
Pectoralis Major
Passive stretch (21)
min
times/day
Active shoulder abduction (22)
sec
times/day
SHOULDER
Latissimus dorsi and long head of triceps
Passive stretch (23)
min
times/day
Active shoulder flexion, elbow extended (24)
Latissimus dorsi
sec
times/day
Active shoulder flexion, elbow flexed (25)
Long head of triceps
sec
times/day
SHOULDER
Sub-scapularis
Passive stretch (26)
min
times/day
Active shoulder external rotation (27)
sec
times/day
ELBOW
Elbow flexors
Passive stretch (28)
min
times/day
Active elbow extension (29)
sec
times/day

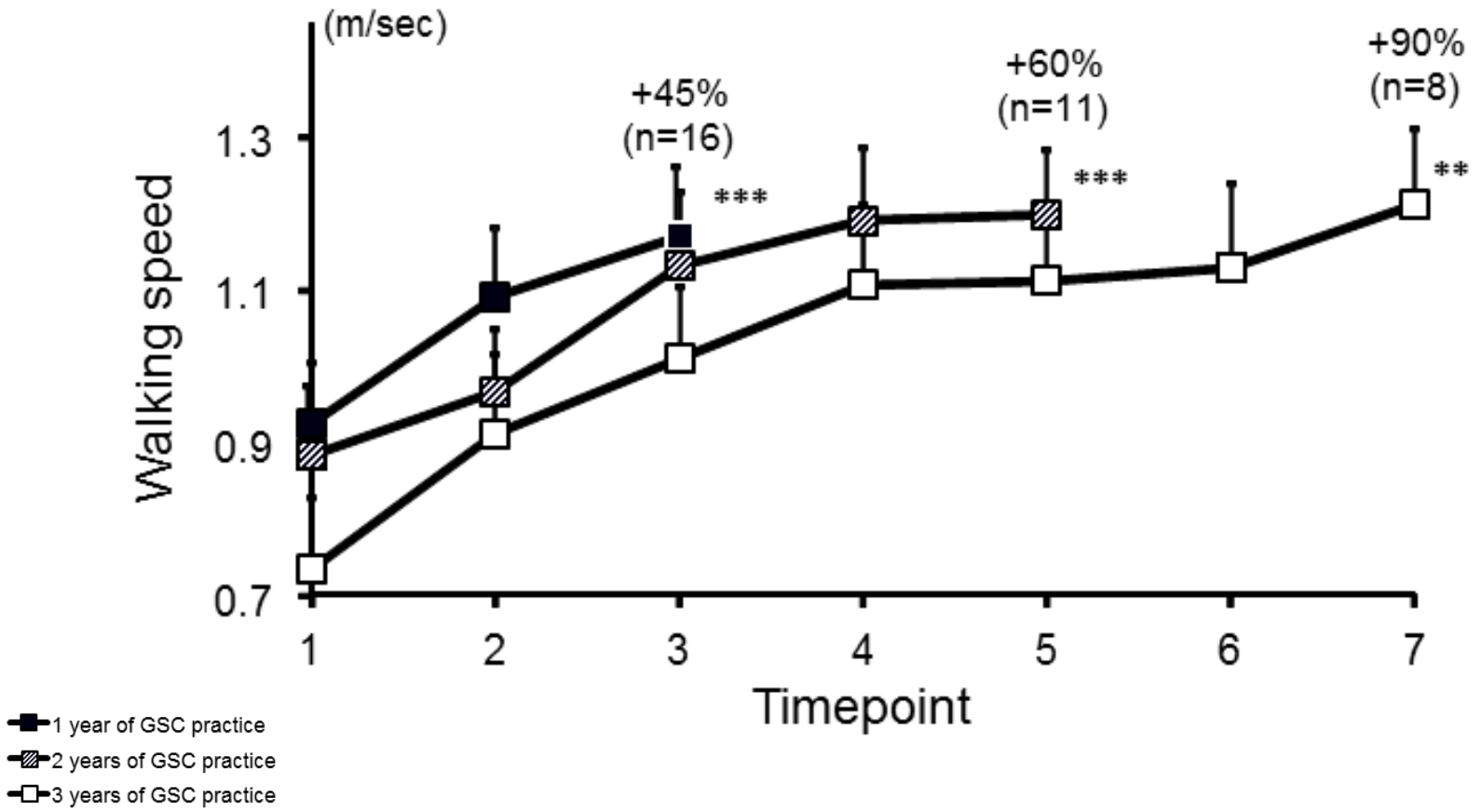
Responder rate



Pradines M et al. Ann Phys Rehabil Med 2015;58(S1):e87; submitted to NNR

ΔX_{V1} for individual muscle \ Duration of self-stretch program	1 YEAR	2 YEARS	3 YEARS
RECTUS FEMORIS	+7°±6	+13°±7	+20°±8
VASTUS	+4°±2	+6°±2	+20°±3
HAMSTRINGS	+6°±4	+9°±6	+13°±7
GASTROCNEMIUS	+1°±1	+3°±2	+4°±2
SOLEUS	+3°±3	+2°±2	+4°±2

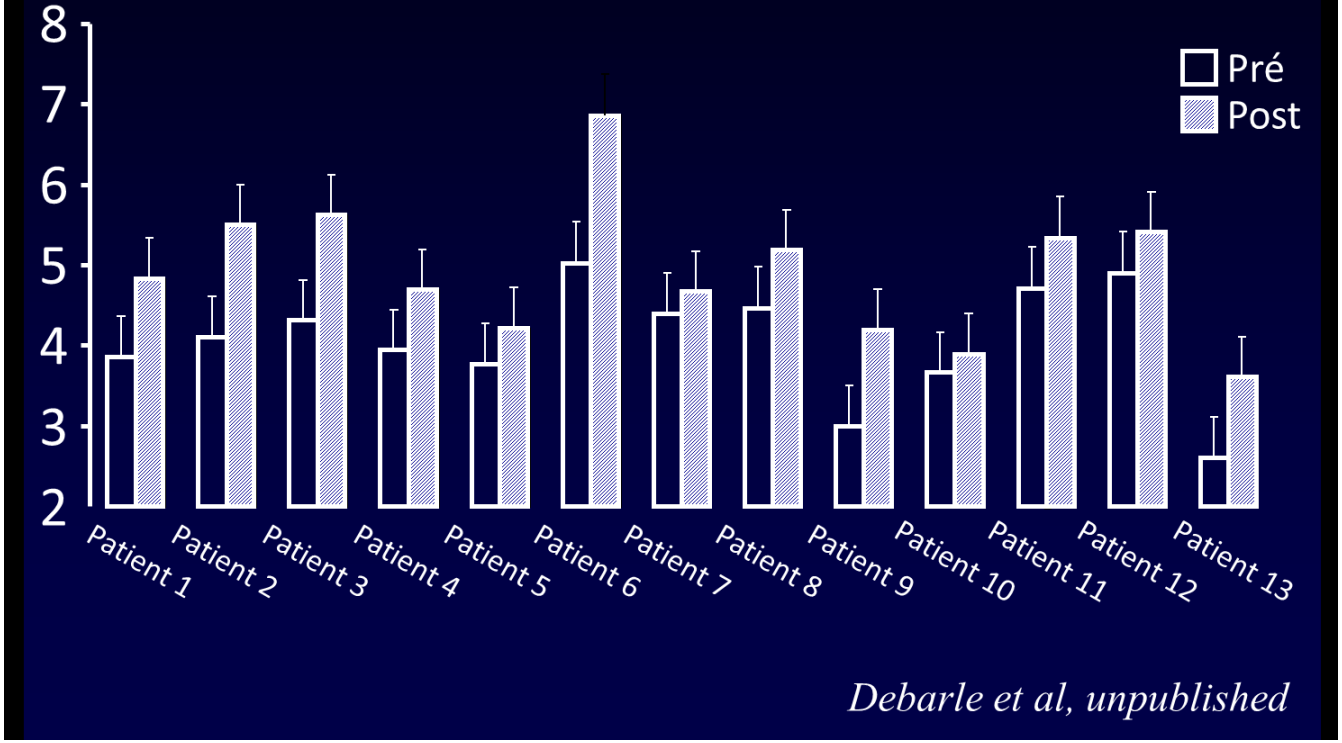
Gait speed



Pradines M et al. Ann Phys Rehabil Med 2015;58(S1):e87

>1 year retrospective study

Modified Frenchay mean score



Optimizing Outcomes

Pre and post Botox

Pre and post Botox

Outcome
Team approach to spasticity management

- 37-yo male who suffered a severe traumatic brain injury from an assault two years earlier
- Completed one month of inpatient rehabilitation
- Was sent home just as he was emerging from a coma

Outcome
Team approach to spasticity management

- Home therapy cannot do much because of posture
- Drugs and injections to treat muscle tightness did not work
- Surgery?

Outcome
Team approach to spasticity management

Before Any Therapy Can be Done:

- INFECTIOUS DISEASES CONSULTATION
  - Antibiotics for groin abscess
- ORTHOPEDICS
  - Hip contracture release
  - Groin abscess I&D
- NEUROSURGERY
  - Intrathecal Baclofen therapy

Outcome
Team approach to spasticity management

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Before

After Surgeries

Outcome
Team approach to spasticity management

- Inpatient rehabilitation
  - PHYSICAL AND OCCUPATIONAL THERAPY
- Botulinum toxin injections to neck
  - SPEECH THERAPY
    - Improved speech and swallowing

Outcome
Team approach to spasticity management

- ORTHOPEDIC SURGEON
  - Knee flexion contracture
- Repeat botulinum toxin injections to wrists and neck
- More therapies

Botox™ 200 units :

- Finger flexors (FDS, FDP)
- Long thumb flexor (FPL)

67/male, 3 years post TBI, Anoxia, Stroke

Botox™ 200-250 units :

- Finger flexors (FDS, FDP)
- MCP flexor (lumbricals)
- FPL

Occupational therapy:

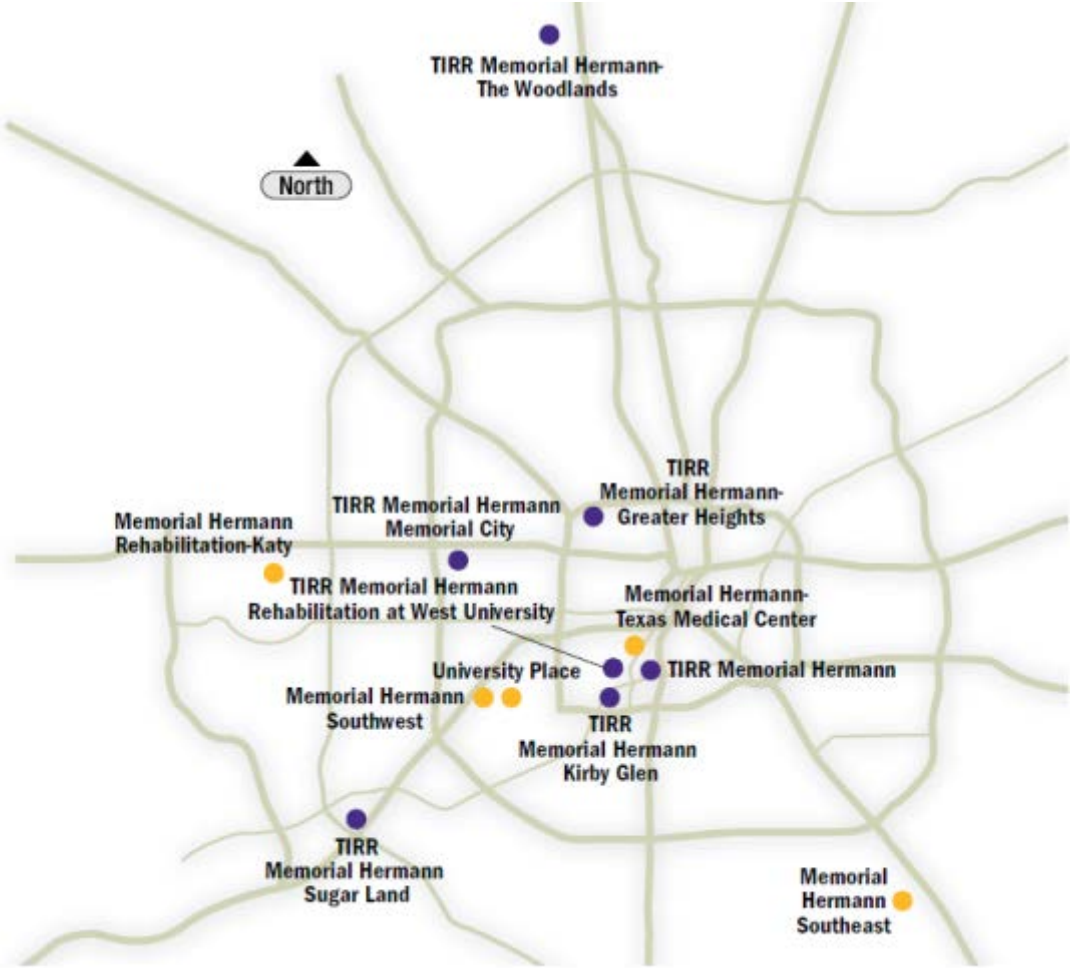
- Stretch/weight-bearing
- Serial casting
- “Forced-use”

Questions???

Additional References

1. Patrick E, Ada L. The Tardieu Scale differentiates contracture from spasticity whereas the Ashworth Scale is confounded by it. Clinical Rehabilitation. 2006;20(2):173–181.
2. Singh P, Joshua A, Ganeshan S, Suresh S. Intra-rater reliability of the modified Tardieu scale to quantify spasticity in elbow flexors and ankle plantarflexors in adult stroke subjects. *Annals of Indian Academy of Neurology* 2011. 14(1): 23-36
3. Gracies JM, Burke K, Clegg NJ, Browne R, Rushing C, Fehlings D et al. Reliability of the Tardieu Scale for assessing spasticity in children with cerebral palsy. Arch Phys Med Rehabil 2010;91:421-8.
4. Mehrholz J, Wagner K, Meissner D, Grundmann K, Zange C, Koch R, Pohl M. Reliability of the Modified Tardieu Scale and the Modified Ashworth Scale in adult patients with severe brain injury: a comparison study. *Clin Rehabil.* 2005. 19(7): 751-759

TIRR Memorial Hermann and the Memorial Hermann Rehabilitation Network



- **TIRR Memorial Hermann Entities**
- **Memorial Hermann Rehabilitation Network Entities**