Stroke Rehab vs ABI Rehab: Similarities, Differences and what could we learn from each other?

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- No commercial relationships related to the material being presented.

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Let's Learn a little about You

Which population do you work with?

A. Almost always ABI (>80% of time)
B. Majority of your time with ABI (>50%)
C. Mix of Stroke and ABI and General Neuro i.e. 25-50% is ABI
D. Minority (25%) of my patients have ABI

Objectives

By the end of this presentation, participants should be able to:

1. Name at least 5 differences in the strength and nature of the evidence for treatment in Stroke Rehab compared to ABI rehabilitation
2. Describe some best emerging practices in Stroke Rehabilitation that could/should be applied in Brain injury care
3. Debate when ABI programs may be better suited to treated stroke patients and vice versa

Joan

- 63 year old arborist
- Was working with others on pruning some trees
- Walked by a chipper and part of a log kicked back
- Struck her on the left side of head

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Joan

- Rendered unconscious
- Taken to hospital
- CT Scan- Left frontotemporal depressed skull fracture
- Underwent rapid craniotomy
- Postoperatively, awake in ICU and extubated day 2
- Aphasic with right hemiparesis and apraxia
- Alert, no behaviours and no visuospatial difficulties
- Where should Joan get rehab?

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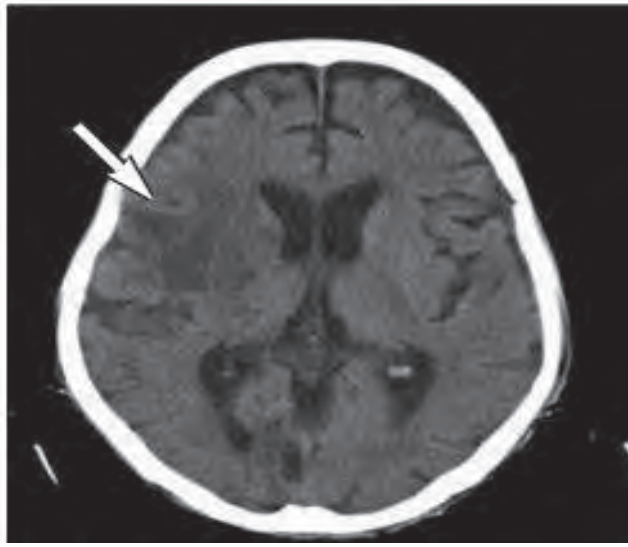
Abdi

- 39 year old man who has a history of rheumatic fever as a child and developed mitral valve stenosis.
- Woke up one morning with headache, disorientation and thought he had a viral illness and slept
- Wife noted he was mildly weak on the left side.
- Taken to ER where noted to be in Intermittent atrial fibrillation
- CT Scan showed a right frontal ischemic infarct
- Too late for thrombolysis



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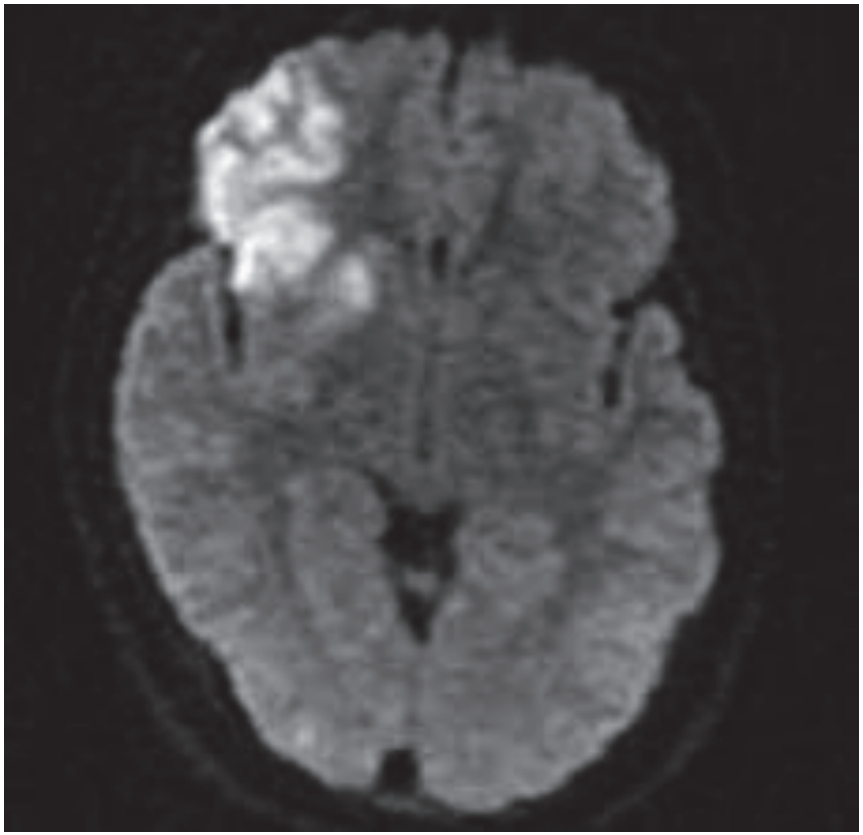
Abdi

- Right Frontal infarct
- Continues to have significant disorientation, confabulation and anosognosia
- Walking with walker
- Wants to go home
- Restless and disinhibited.
- Where should he go for rehab?

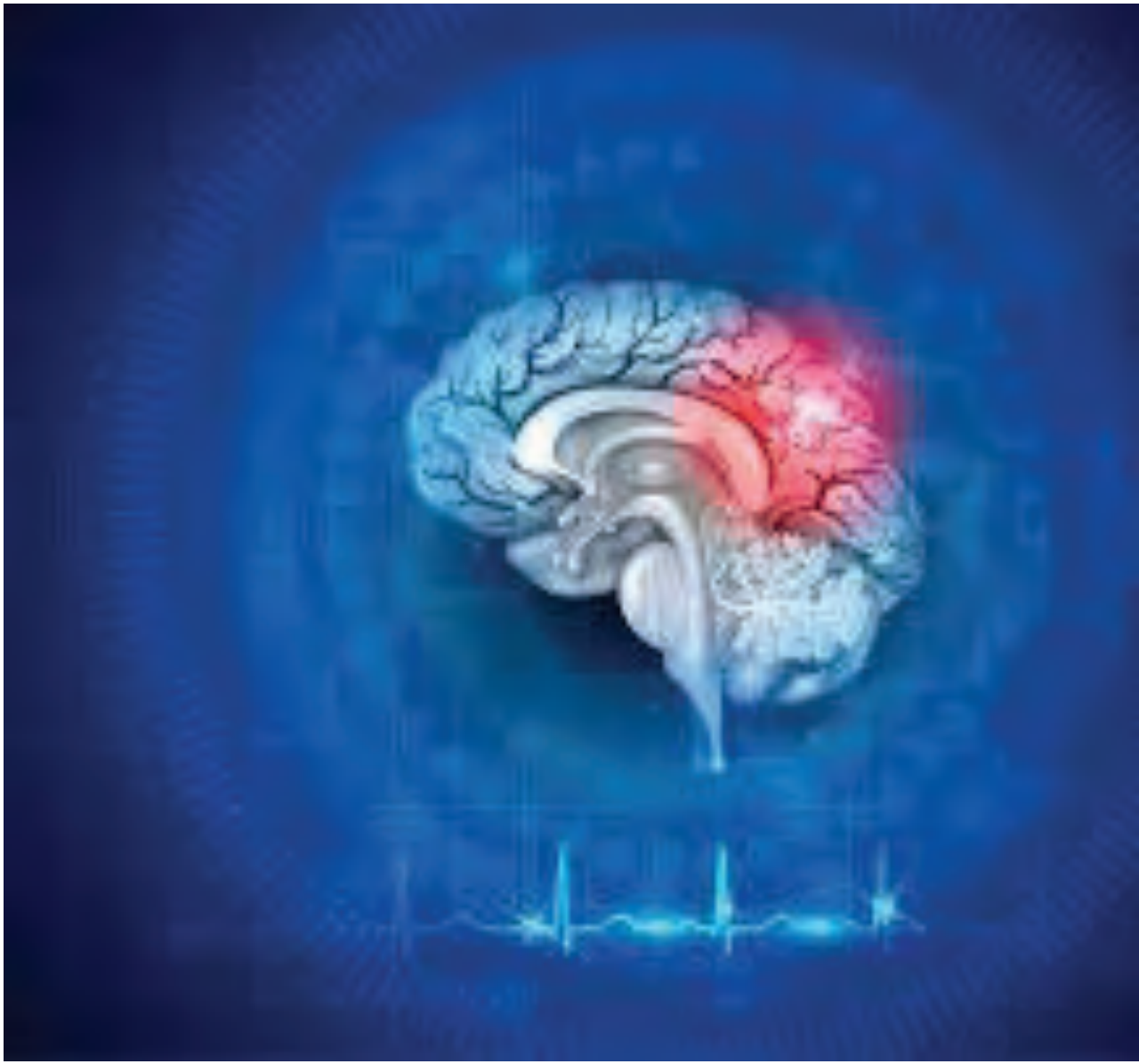


Objective 1

- Name at least 5 differences in the strength and nature of the evidence for Stroke and ABI

“We learn neurology stroke by stroke”

C. Miller Fisher



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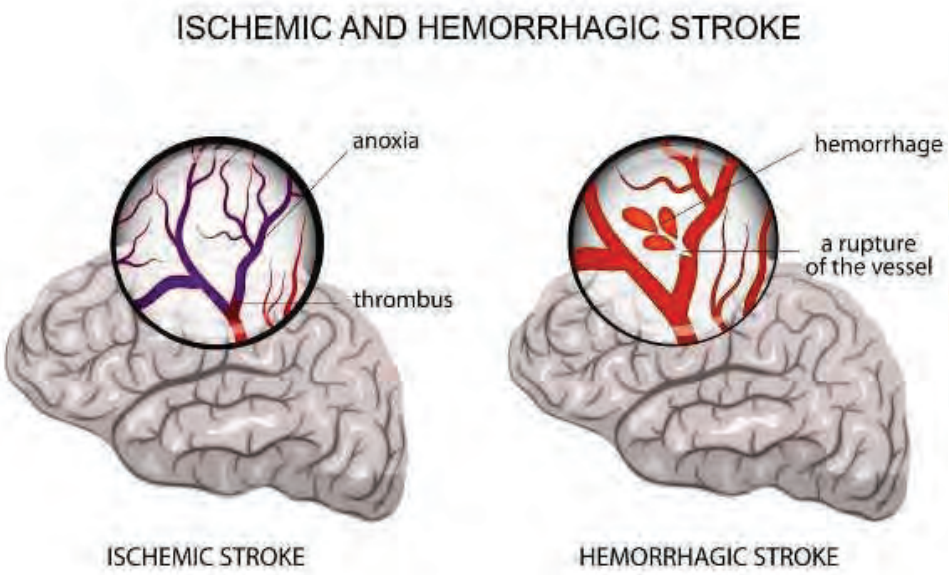
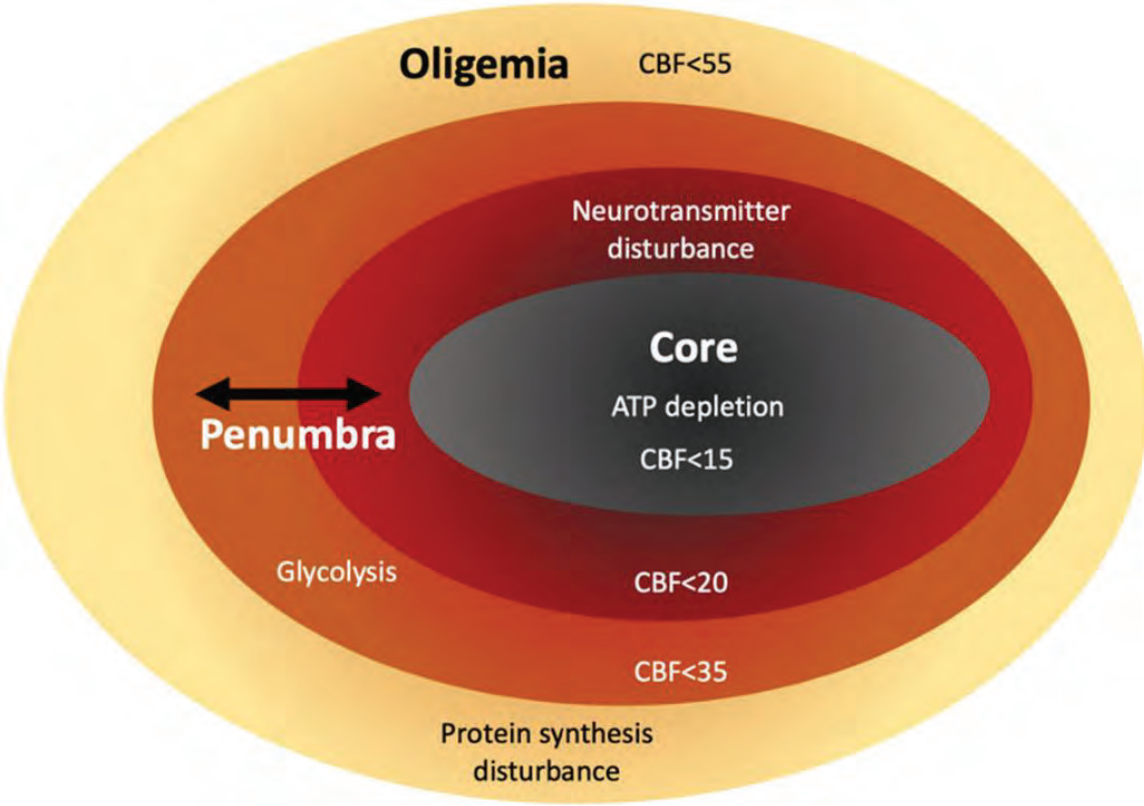
#1 Stroke is by its nature more **focal**





Traumatic Brain Injury is more Diffuse

Focal contusion

- Frontal
- Temporal

Diffuse Axonal Injury

- Upper brainstem,
- Corpus Callosum
- Cerebellar Peduncle
- Gray white matter junction

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#2 Neurological Deficits

Stroke

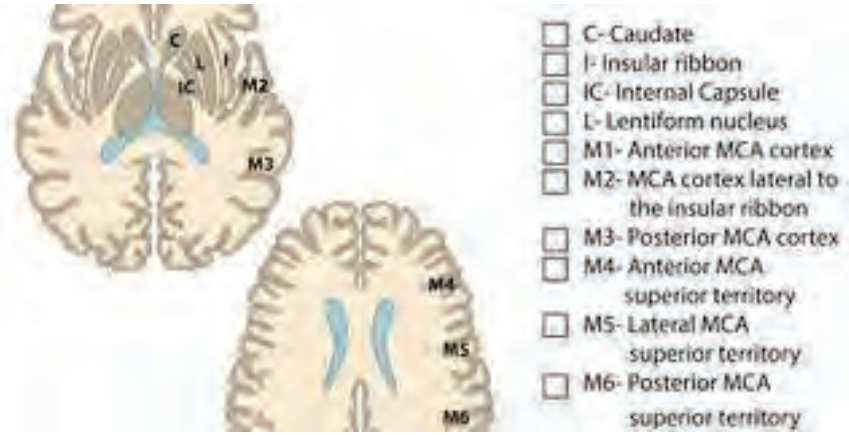
- Hemiparesis
- Aphasia
- Visual spatial
- Sensory/Neglect
- Apraxia

Brain

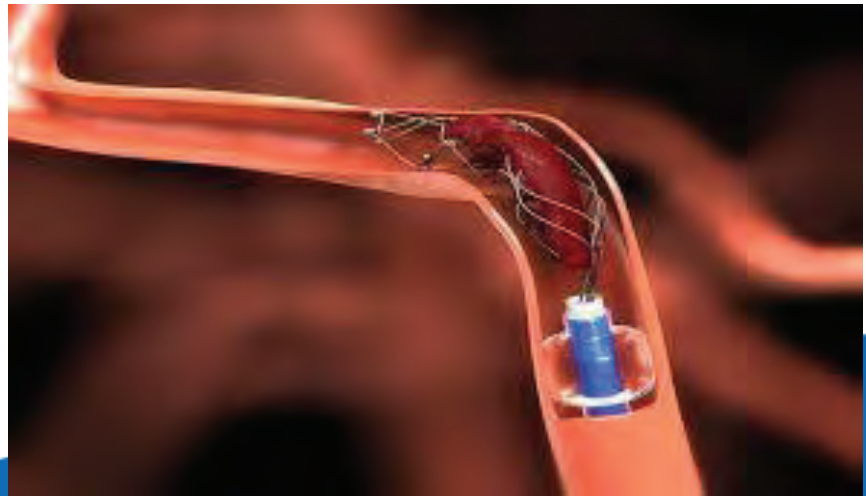
- Executive/Behavioural changes
- Memory
- Word finding
- Hemiparesis
- Balance difficulties

#3 Acute treatment of large vessel Stroke is changing

- Endovascular thrombectomy is effective at removing large vessel occlusions.
- Thrombectomy has a virtually unlimited time window in carefully selected patients.
- It is unclear if thrombolysis plus thrombectomy is superior to thrombectomy alone.
- Ontario EVT for ~ 4-5% of strokes



ASPECTS score



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#3 Acute treatment of Stroke is changing

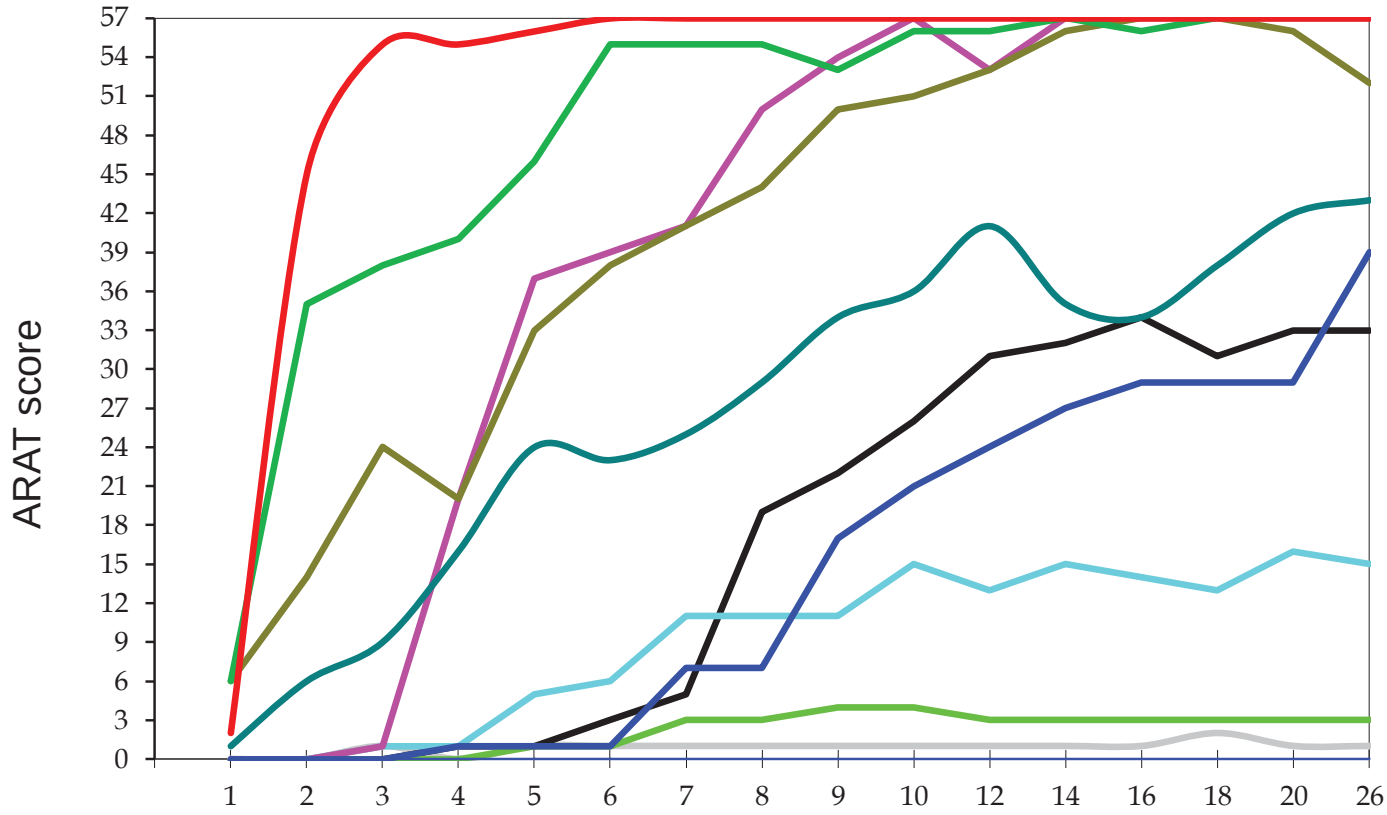
- Thrombolysis can be provided to select patients whose time-of-onset is unknown for example wake-up with a stroke
- Tenecteplase is new thrombolytic may soon be standard of care for stroke thrombolysis.
- Thrombolysis in Ontario ~12-13% of all diagnosed

IMPACT= Nature of patients presenting for rehabilitation is changing

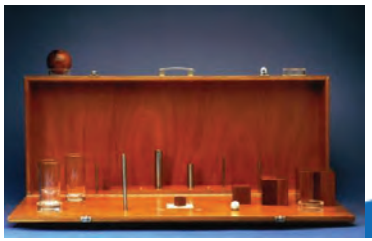
#4. Developments in Prognostication

- Can we predict who will recover and respond to intervention?
- How can we utilize our knowledge of neuroplasticity to individualize intervention to enhance recovery and function?
- Why does the brain recovery slow down?

Random selection of patients with an upper limb paresis post stroke (N=10)



Courtesy of G. Kwakkel (2015)



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Probabilities of achieving some dexterity at 6 months after stroke (N=188)

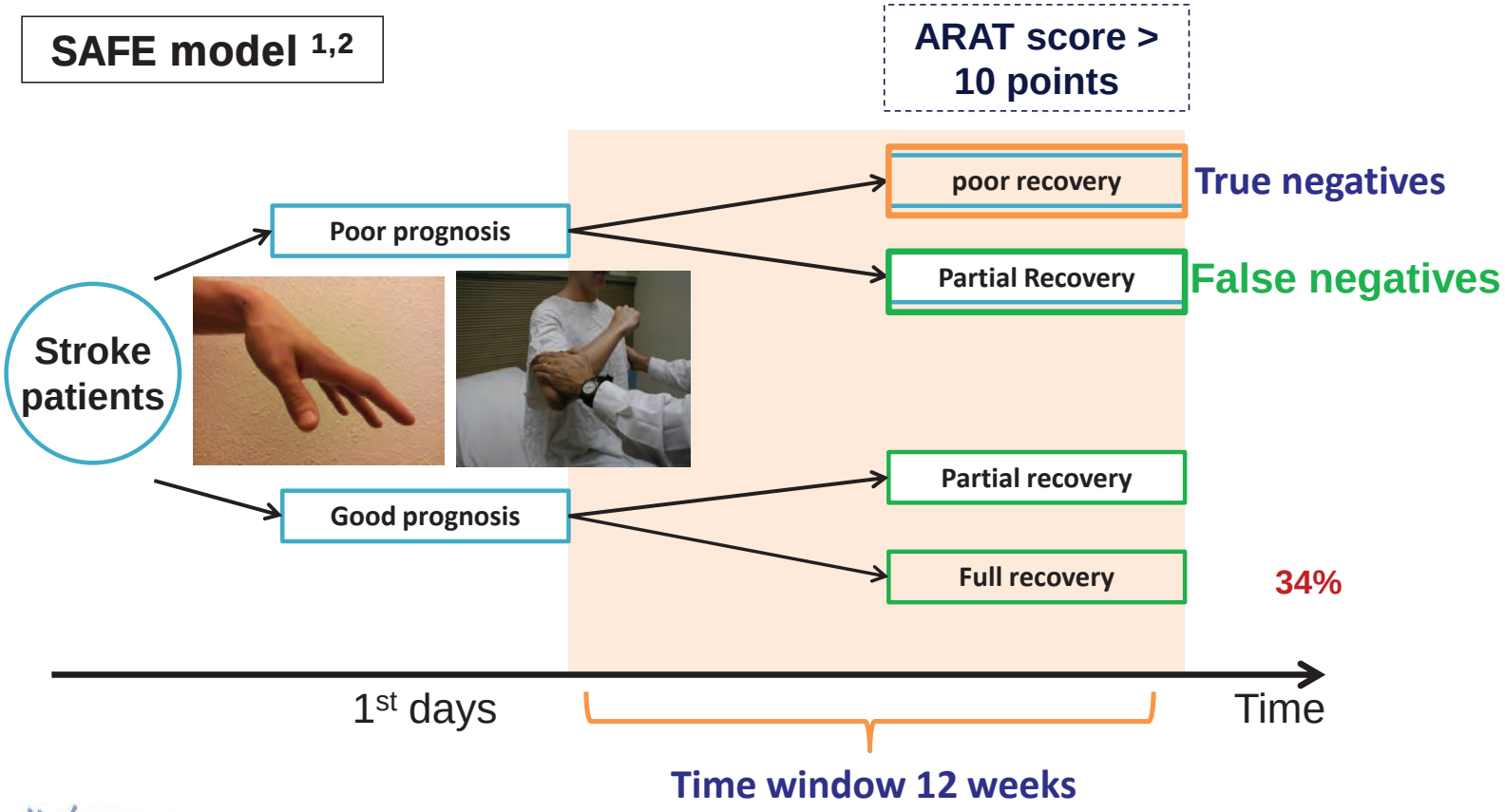
ARAT ≥ 10 at 6 months

Finger Extension	Shoulder Abduction	True Negatives N	False Negatives N	False Positives N	True Positives N	Prob.
Model at day 2:	$P=1/(1+1*(EXP(-1.119+2.807*X_1+2.149*X_2)))$					
FM-FE ≥1	MI-SA ≥9					
+	+	38	12	8	98	0.98
+	-					0.89
-	+					0.71
-	-					0.25

34% full recovery

Nijland RH et al, Stroke 2010;41(4):745-50.

Prognosis for recovery of upper limb capacity following ARAT

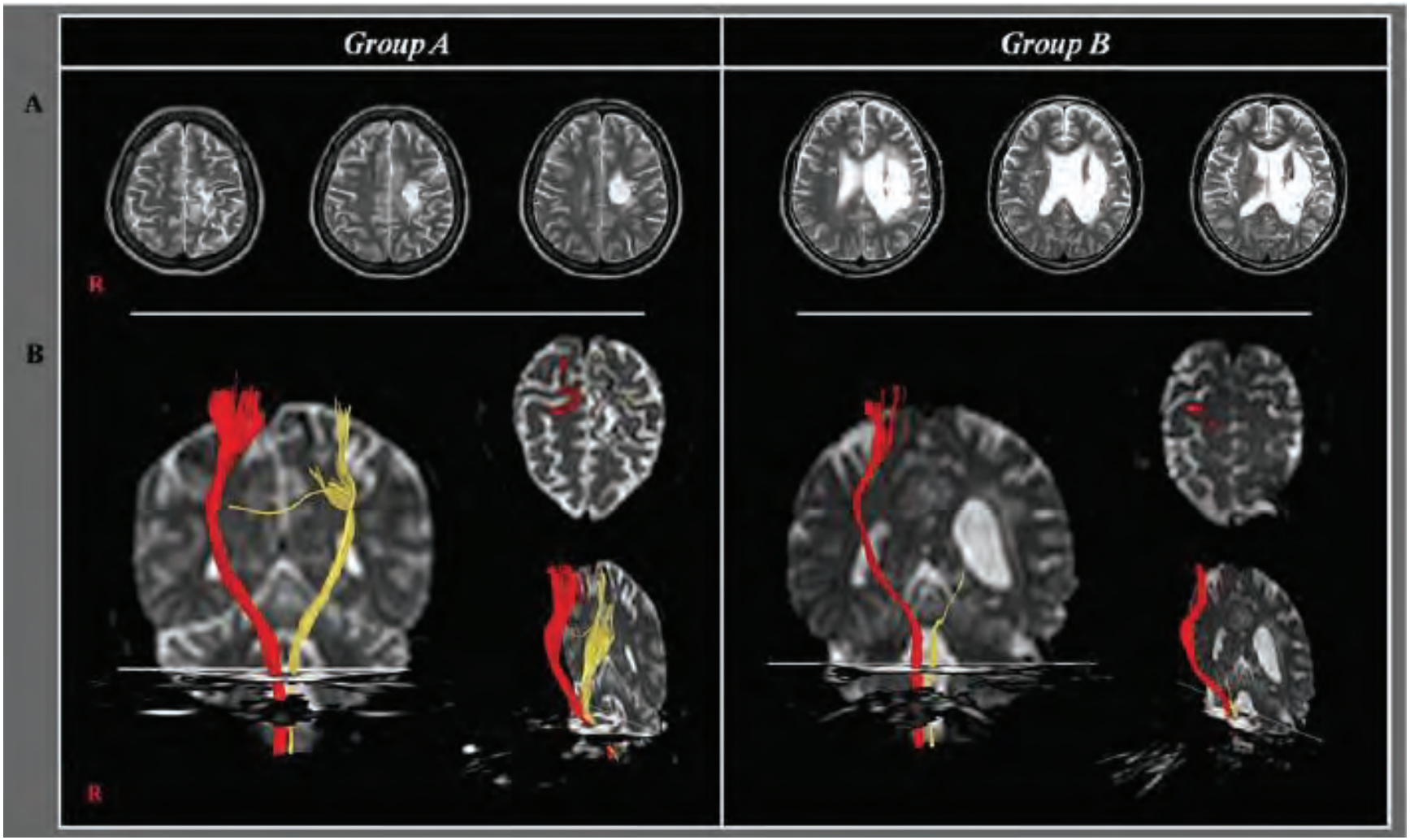


[1] Nijland et al. Stroke 2010:41(4):745-750;
2 Stinear et al. Lancet Neurol 2010;9:1228-1232;
Winters et al. [in preparation]

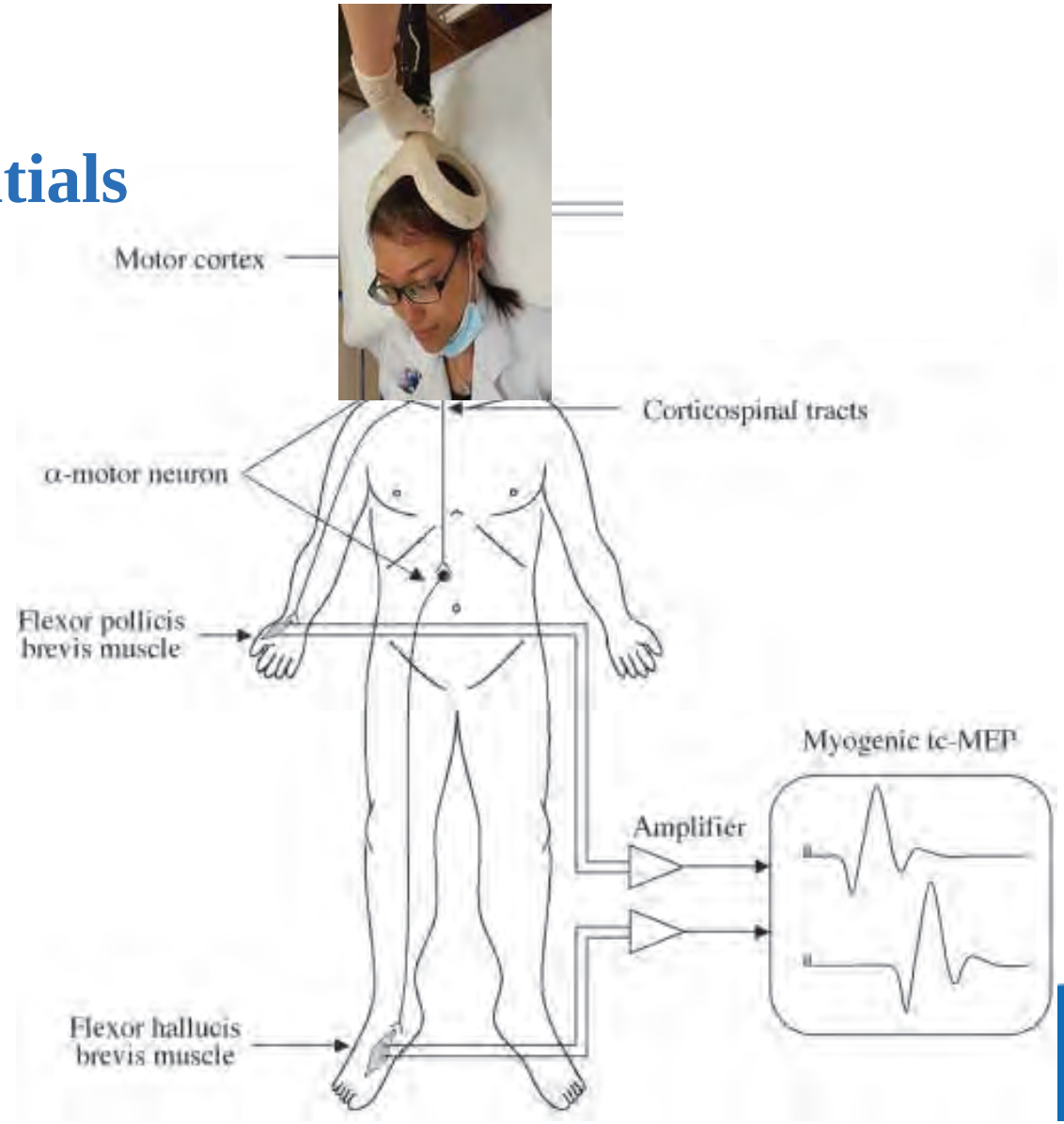
Neuroimaging and Recovery

- Early measurement of Corticospinal tract fiber number via diffusion tensor imaging (DTI) on MR , predicts motor outcome (Fugl–Meyer score) at 12 months
- Extent of CST injury predicts treatment gains
- Machine learning methods- classification of a recovery was more accurate using lesion information from a range of cortical and subcortical motor-related regions compared to just using CST (87% vs 73%)

Diffusion Tension Tractography



Motor Evoked Potentials



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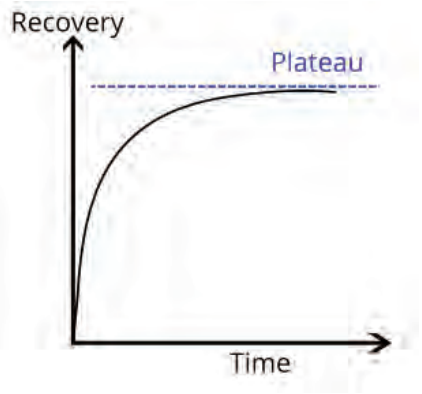
Motor evoked potentials (MEP)

- presence of upper limb motor evoked potential (MEP) to transcranial magnetic stimulation (TMS) in hyperacute and acute stages predicts good motor recovery
- in the leg, presence of a MEP indicates that an individual is more likely to be independently mobile 12 months post-stroke,
- Prediction of recovery is more challenging for pts without an MEP and combining TMS with MRI biomarkers may be useful in this context

Integrity of Corticospinal Tract: Fixed Proportion

- Within 6 mos upper limb impairment resolves by **fixed proportion**
- 70% of each patient's maximum possible improvement occurs regardless of the initial impairment (Fugl-Meyer score), but only for those with relatively intact corticospinal (motor) tract function (Prabhakaran et al 2008)
- Holds true for patients across all ages and countries with different rehab services (Byblow et al. 2015)
- Irreversible structural damage to the corticospinal tract severely limits recovery of the upper limb movement (Stinear et al 2007; 2012)



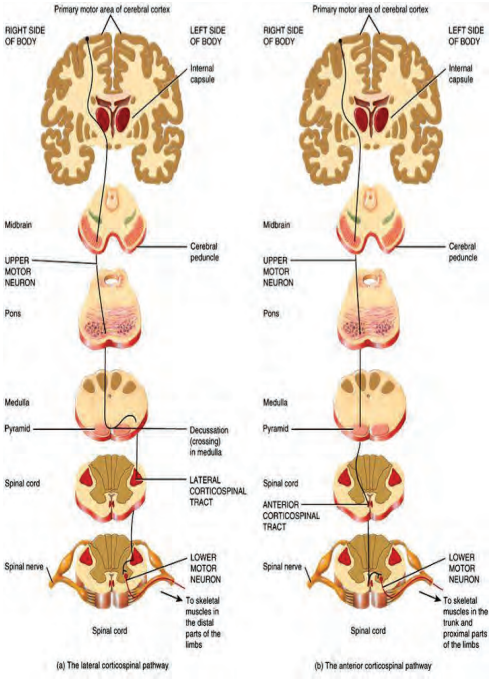
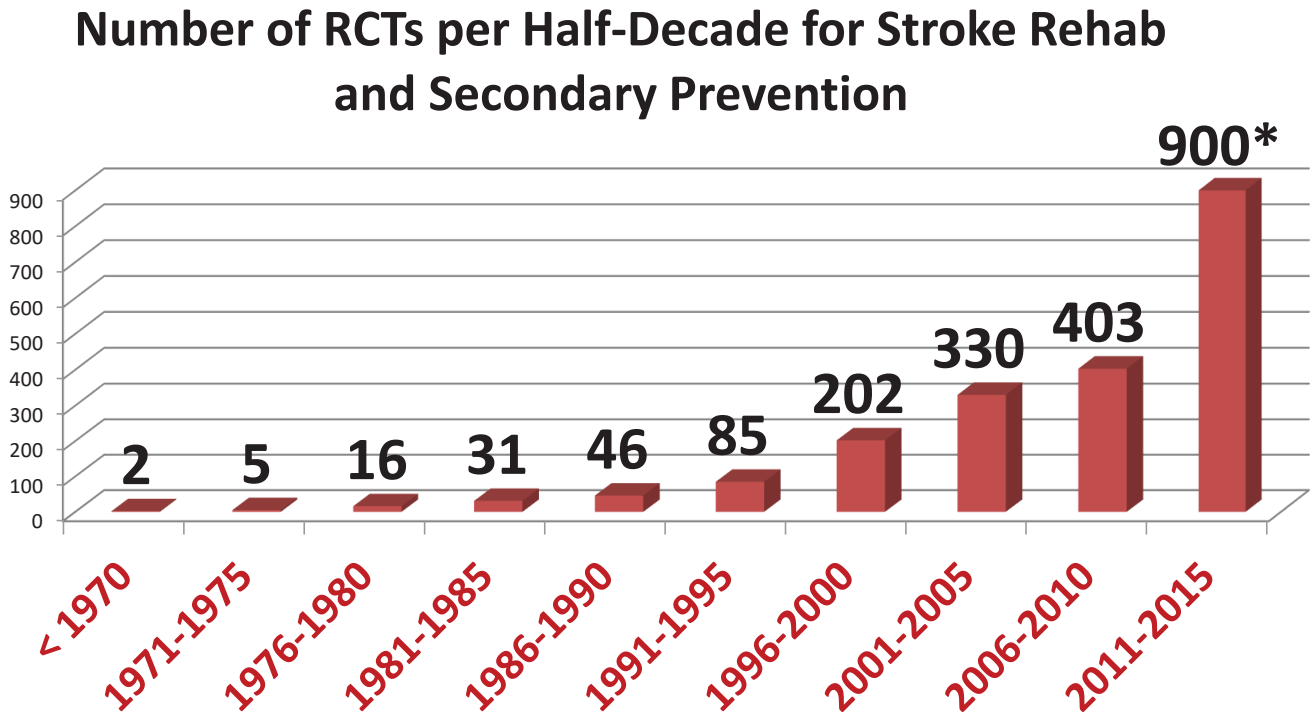


Figure 16.10 Tortora - PAP 12/e

Prabhakaran et al 2008
Byblow et al. 2015
Stinear et al. 2007
Stinear et al. 2012

#5 Scope and Nature of Rehabilitation research in Stroke and ABI?

Research in Stroke Rehabilitation



McIntyre A, Richardson M, Janzen S, Hussein N, Teasell R. The evolution of stroke rehabilitation randomized controlled trials. *International Journal of Stroke* 2014; 9(6):789-792.

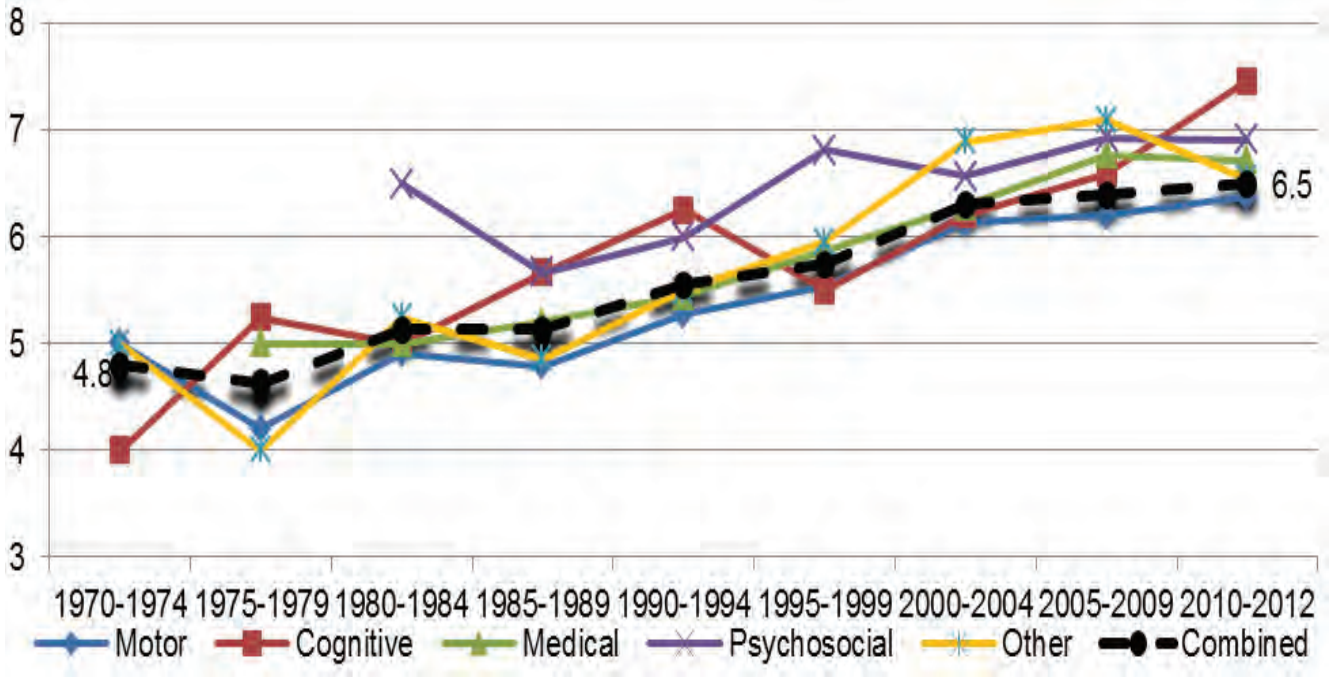
Stroke Rehabilitation Evidence-Based Review –www.ebrsr.com

EBRSR
www.ebrsr.com

Quality of Stroke Rehab Research Over Time

EBRSR
www.ebrsr.com

Mean PEDro scores (y axis) for each five-year time bracket from 1970-1974 to 2010-2012 (x axis) for all RCTs combined and each intervention type (i.e., motor, cognitive, medical, and psychosocial)



Overall, PEDro scores increased linearly from approximately 4.8 ± 1.2 in 1970-1974 to 6.5 ± 1.5 in 2010-2012 (*P* =0.0072).

McIntyre et al. The evolution of stroke rehabilitation randomized controlled trials. *International Journal of Stroke* 2014; 9(6):789-792.

Timing of RCTs in Motor Rehab Post Stroke

- Stinear et al. (2013) examined stroke rehab RCTs (largely using the SREBR) with a motor outcome, published in English which did not treat a secondary motor complication such as spasticity or shoulder subluxation
- Found 532 RCTs of motor rehab post stroke

"Misalignment between timing of RCTs and real-world delivery of stroke rehab may be an important aspect of the evidence-base that limits its translation into clinical practice" (Stinear et al. 2013)

Category	All Patients Enrolled By	Number	%
Early	<30 days	63	11.8%
Late	30-180 days	179	33.8%
Chronic	>180 days	284	53.4%
Not Reported		6	

Stinear et al. *Stroke* 2013; 44:2039-2045

Evidence Based Review of Acquired Brain injury Methodology (www.abiebr.ca)

ERABI Purpose: To conduct a systematic review of the rehabilitation literature of moderate to severe acquired brain injuries (ABI) from traumatic and non-traumatic causes.

Step 1: Systematic Literature Search

+ 6000 references reviewed

Inclusion Criteria:

- Intervention based study
- ≥ 50% of participants have a moderate to severe ABI
- Published in English
- Articles from 1980 – Present
- ≥3 participants

Step 2: Article Analysis

798 Selected for careful data abstraction and quality determination.

Studies are tabled: Study design, study population, intervention and outcomes

RCTs are appraised using the PEDro Scale

Step 3: Conclusion Statements

Statement s about the effectiveness of interventions are made and levels of evidence are assigned for each

Comparing Size and Nature of Literature

Table 1 Number of Randomized Controlled trials

Categories	Stroke Rehab To end of June 2018	ABI Rehab To end of Dec 2017	Ratio
Models of Care	179	9	19.9:1
Motor/Sensory	1410	28	50.4:1
Cognitive	293	81	3.6:1
Medical Complications	165	44	3.8:1
Psychosocial	198	53	3.7:1
Total	2172	216 (209)	10.4:1

Table 2 Number of trial participants

Categories	Stroke Rehab To end of June 2018	ABI Rehab to end of 2017	Ratio
Total	197,626	12642	15.6
Models of Care	31,659	441	71.8:1
Motor/Sensory	65,764	980	67.1:1
Cognitive	30,506	4,406	6.9:1
Medical Complications	50,832	3,291	15.4:1
Psychosocial	26,460	3,524	7.5:1

Comparison of Cognitive rehab studies

Stroke

- Hypertension
- Exercise
- Vascular cognitive impairment
- Attention
- Acetyl cholinesterase
- Brain stimulation

Brain Injury

- Executive dysfunction
- Memory
- Attention
- Cognitive Communication
- Arousal/coma medications

Summary of Differences: Stroke vs ABI

1. Stroke is more focal and directly effects blood flow whereas TBI has a diffuse but predictable pattern
2. Stroke more frequently affects cortical functions such as aphasia, neglect, apraxia than ABI
3. Stroke acute treatment is changing the typical patient
4. Improving evidence for predicting motor recovery after stroke (prognosis)
5. Stroke rehab research is more extensive with massive focus on motor recovery and models of care

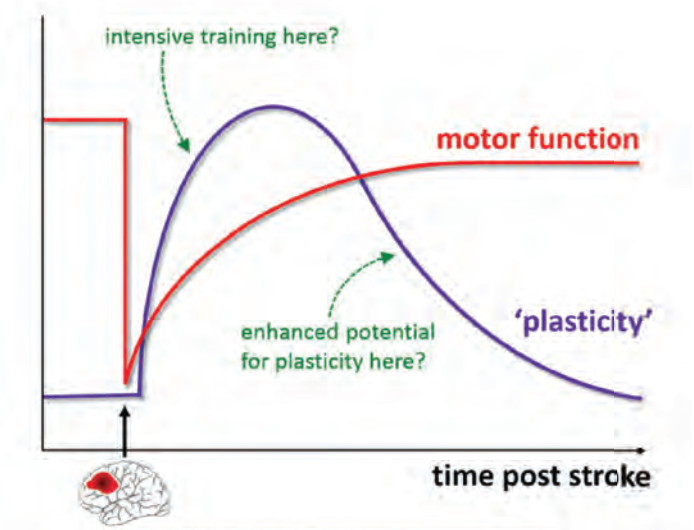
Objective 2

Describe some best practices in Stroke Rehabilitation that could/should be applied in Brain injury care

i.e. What are some emerging rehab strategies coming out of Stroke rehab research?

Timing- Early Rehabilitation

- Animal studies suggest there is a **time window when brain is "primed" for maximal response to rehab therapies,** such that delays are detrimental to recovery (Bernaskie et al. 2004)
- **Brain is "primed" to "recover" early post-stroke**
- **Clinical association between early admission to rehab and better functional outcomes** (Paolucci et al. 2000, Salter et al. 2006 and Bai et al. 2012)
- A **single day delay** in starting neuro-rehabilitation is associated with **significant decreases in FIM** (0.3 FIM pt/day) and **significant increased rates of institutionalization** at discharge (Murie-Fernandez et al. 2012)



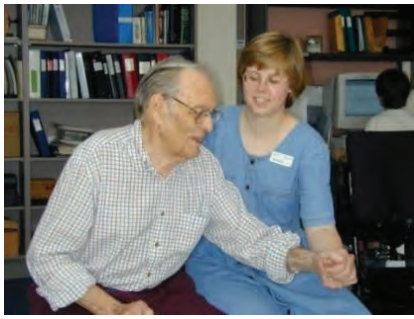
Bernaskie et al. *J Neurosci* 2004; 24(5):1245-54
Paolucci et al. *Arch Phys Med Rehab* 2000; 81(6):695-700
Bai et al. *J Clin Neurosci* 2012; 19(10):1376-9
Salter et al. *J Rehabil Med* 2006; 38(2):113-7
Murie-Fernandez et al. *Neurología* 2012;27:197—201

AVERT Trial: Can Rehab Be Too Early?

- Patients < 24 hrs post stroke randomly assigned to standard care (SC) (N=1050) or SC + Very Early Mobilization (VEM) (N=1054) until discharge or 14 days
- 56 site international RCT over 8 years (Australia, Asia and Europe)
- VEM group started earlier (18.5 vs. 22.4 hrs post stroke), got more out of bed sessions (6.5 vs. 3.0) and received more therapy (31 min/day: total 201 min vs. 10 min/day: total 70 min)
- **More pts in Usual Care (n=525) than VEM (n=480) (p=.001) had favourable outcome** (modified Rankin Scale [0-2] at 3 mos post stroke)
- Later analysis (Bernhardt et al. 2016) found improved odds of favourable outcome with increased daily frequency of out-of-bed sessions
- Overall, **shorter more frequent early mobilization improves chance of regaining independence; higher doses of long-term mobilization worsens outcomes.**

The AVERT Trial Collaboration Group. Lancet 2015; 386:46-55
Bernhardt et al. Neurology 2016; 86:2138-2145

Intensity of Therapy



- Greater intensity of practice results in better outcomes
- Research with animals involves thousands of repetitions
- Lang et al. (2007) found practice of task-specific, functional U/E movements occurred in half of U/E rehab sessions: Average number of reps = 32
- Van Peppen et al. (2004) noted an additional therapy time of 17 hours over 10 weeks is necessary to see significant positive effects; affirmed by Verbeek et al. (2014)
- Klassen-. Subjects randomized into: control (usual care) physical therapy:

1 hour, 5 days/week; Determining Optimal Post-Stroke Exercise (DOSE1): 1 hour, 5 days/week, more than double theintensity of Control (based on aerobic minutes and walking steps); and DOSE2: 2 hours, 5 days/week, for 4 weeks

Both intensified groups improved

Lang et al. *Arch Phys Med Reha*bil 2009: 90:1692-1698
Van Peppen et al. *Clinical Rehab* 2004; 18:833-862.
Verbeek et al. *PLOS ONE* 2014; 9(2):e87987
Klassen Stroke. 2020;51:2639–2648

Lower Extremity

Lower Extremity	RCTs	Mean Subjects (SD)	Total Subjects
(633)	633	45.7 (65.3)	
Treadmill training	65	50.4 (67.5)	3,276
Robotics	47	32.4 (19.3)	1,523
Functional electrical stimulation	46	41.3 (59.0)	1,900
Virtual reality	42	24.5 (8.9)	1,029
Strength and resistance training	35	37.8 (23.4)	1,323
Botulinum toxin	31	77.0 (91.4)	2,387
Task specific training	27	64.6 (78.9)	1,744
Performance feedback	21	43.0 (35.7)	903
Orthotics	21	29.1 (15.6)	611
Force platform biofeedback/balance trainers	20	35.4 (13.1)	708
Custom physiotherapy	20	55.2 (34.9)	1,104
Rhythmic auditory stimulation	18	26.4 (10.8)	475
Neuromuscular electrical stimulation	16	34.6 (13.9)	554
Repetitive transcranial magnetic stimulation	16	28.7 (13.0)	459
Acupuncture	15	92.3 (72.8)	1,385
Transcutaneous electrical stimulation	15	51.1 (31.2)	767

Upper extremity Rehab

Upper Extremity Intervention	RCTs	Mean Subjects (SD)	Total Subjects	Mean PEDro (SD)
Robotics	181	37.8 (60.2)	6842	6.1 (1.4)
Task-Specific Training	113	45.1 (81.1)	5097	6.0 (1.5)
Exercise or Custom/Unique Physiotherapy Protocols	112	65.6 (89.1)	7346	6.3 (1.6)
Constraint-induced movement therapy (includes modified constraint induced movement therapy & forced use therapy)	111	40.3 (39.1)	4476	6.1 (1.65)
Virtual Reality	99	39.9 (35.5)	3953	6.0 (1.4)
Neuromuscular Electrical Stimulation (NMES)	98	38.1 (27.6)	3737	5.9 (1.66)
Repetitive Transcranial Magnetic stimulation (rTMS)	86	36.2 (27.9)	3113	6.6 (1.4)
Transcranial direct current stimulation (tDCS)	86	25.4 (18.4)	2186	6.9 (1.5)
Mirror Therapy	75	37.9 (23.0)	2843	5.9 (1.3)
Botulinum Toxin (Botox)	68	84.2 (84.6)	5727	6.6 (1.5)
Bilateral Arm Training	66	39.3 (27.2)	2591	5.7 (1.8)
EMG biofeedback	66	33.6 (24.6)	2218	5.9 (1.7)
Functional Electrical Stimulation (FES)	62	30.6 (16.1)	1895	5.8 (1.7)
Mental Practice or Motor Imagery	55	29.0 (19.5)	1596	6.0 (1.55)
Orthotics, Splints & Assistive Devices	53	38.3 (28.3)	2029	5.9 (1.7)
Transcutaneous Electrical Stimulation (TENs)	41	35.4 (22.6)	1451	6.5 (1.6)
Acupuncture	41	103.1 (123.4)	4226	6.1 (1.7)
Visual or Auditory Feedback	40	37.9 (44.6)	1515	5.7 (1.6)
Strength Training	35	35.5 (47.6)	1244	5.9 (1.3)
Stretching or Positioning Programs	32	40.9 (37.2)	1308	6.2 (1.5)

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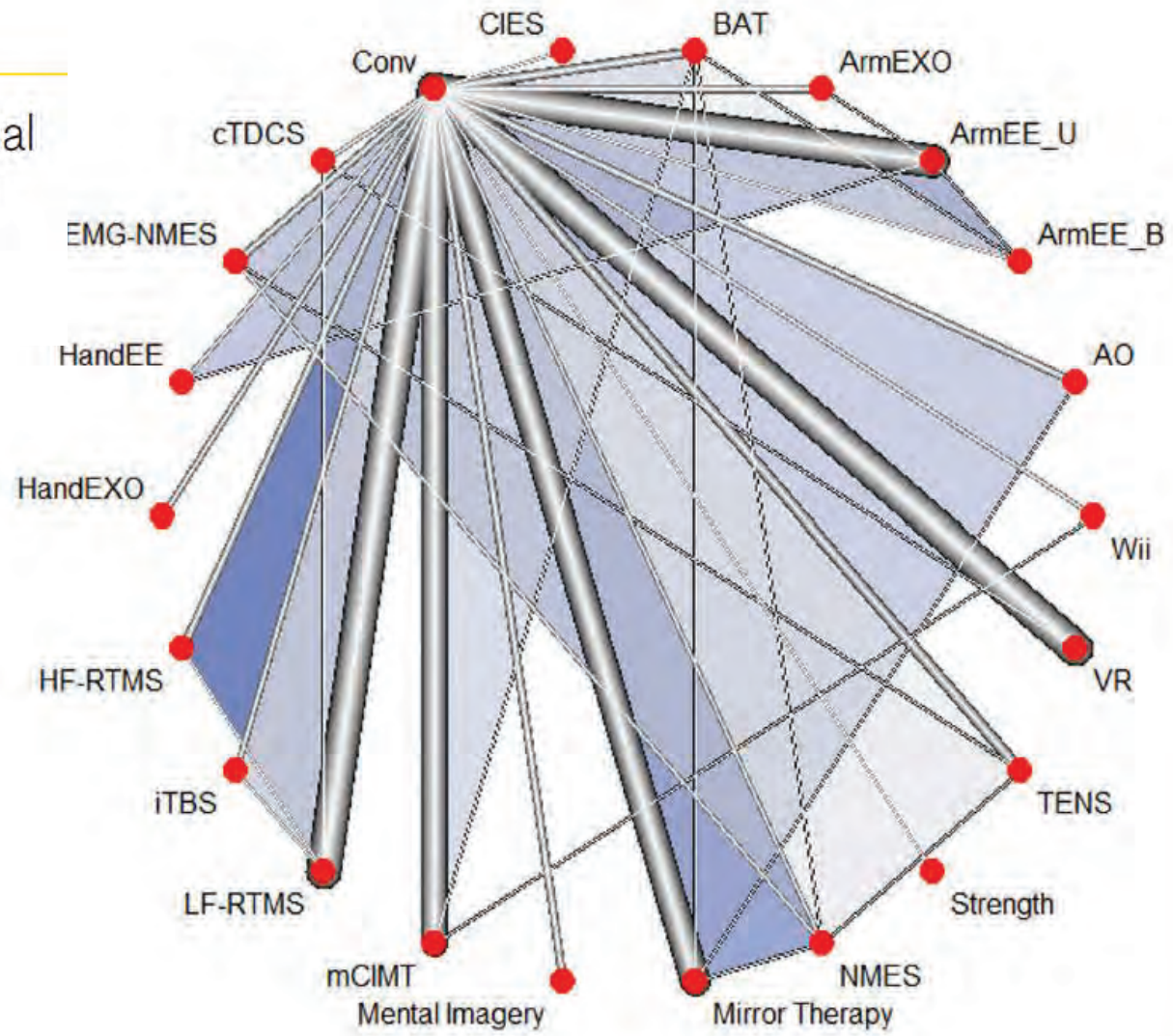
Stroke

CLINICAL AND POPULATION SCIENCES

Network Meta-Analysis of Non-Conventional Therapies for Improving Upper Limb Motor Impairment Poststroke

Marcus Saikaley, BSc; Griffin Pauli, MD (c), MSc; Hao Sun, MSc (c); Julisa Rodriguez Serra, BSc; Jerome Iruthayarajah, MSc; Robert Teasell, MD



Stroke. 2022 Dec;53(12):3717-27.

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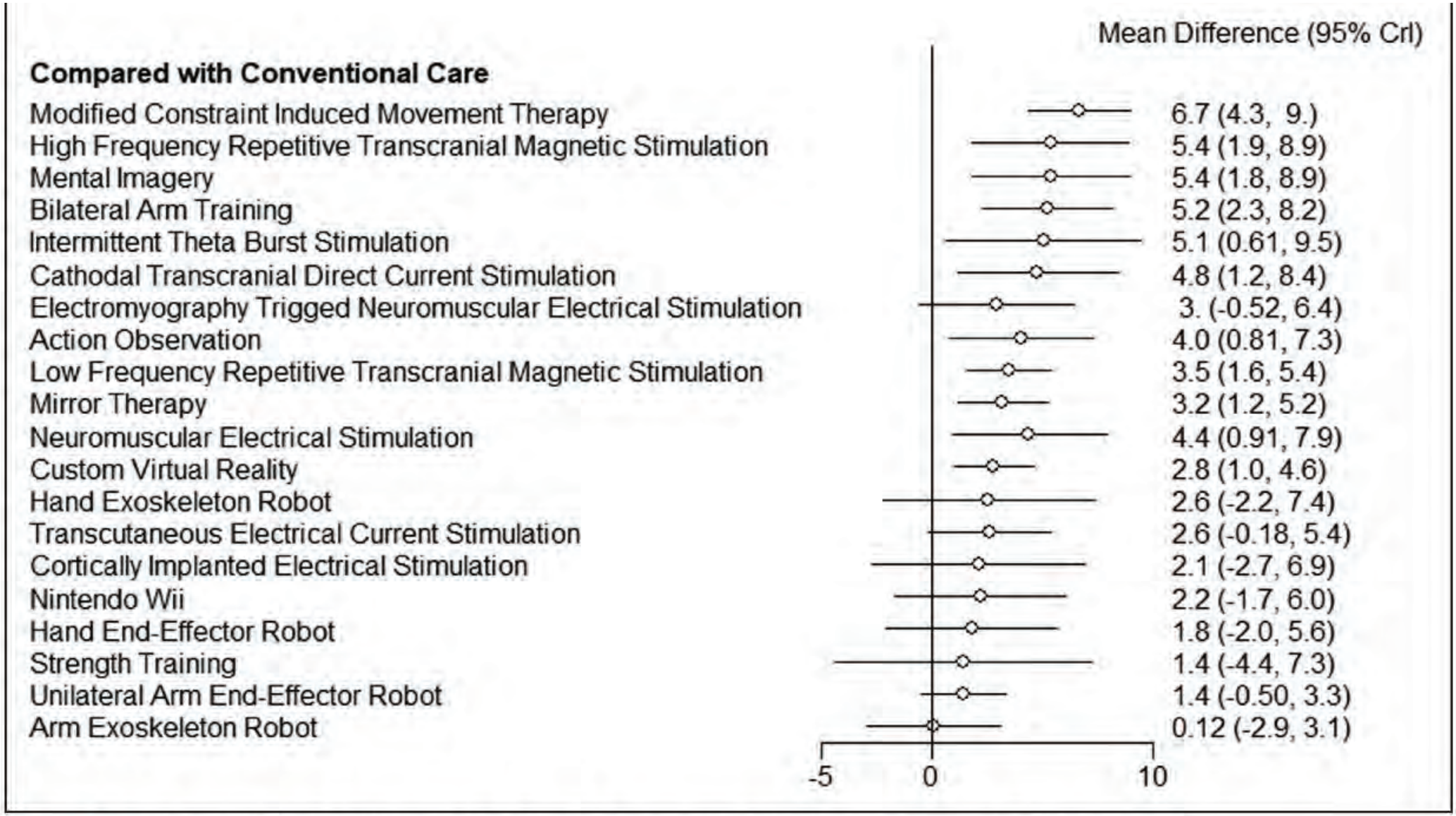
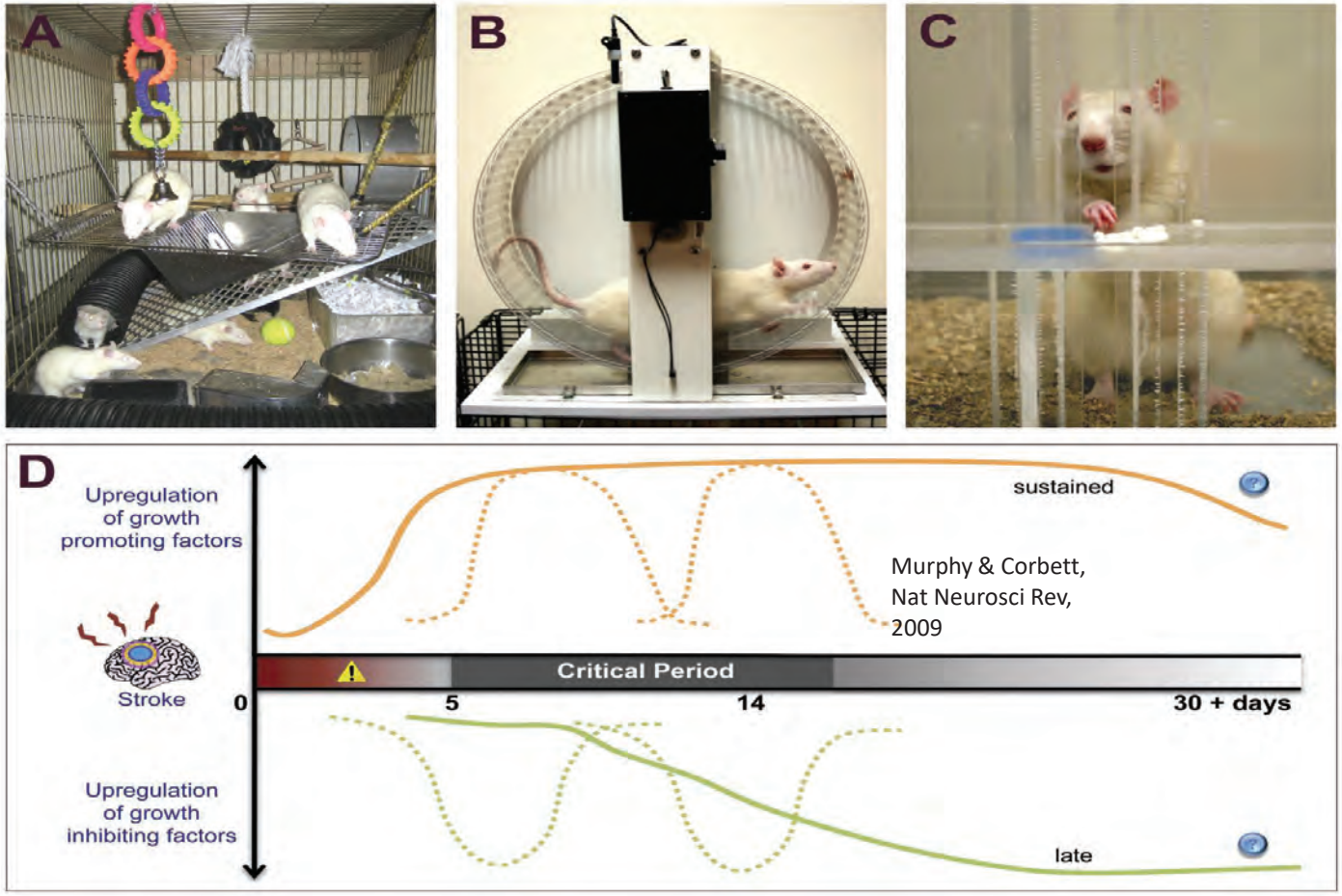


Figure 4. Forest plot of mean difference and 95% CIs for included interventions versus conventional care

CanStroke Recovery Trials Platform

Fondation Brain Canada Foundation

The Critical Period for Stroke Recovery



1. Fluoxetine to Open the Window (FLOW) of stroke recovery as a Demonstration Project
2. Modafinil and Exercise Trial (MODEX)

3. CAMAROS- Canadian Maraviroc to Optimize Stroke Recovery

Shift to Outpatient and Long-Term Rehabilitation

- Rehabilitation is not a place; it is a process
- Cochrane review of 14 RCTs of 1,617 patients (Outpatient Trialists 2003) involved in home based, day hospital and outpatient clinic
- **Therapy reduced odds of a poor outcome** (death, deterioration or dependency) (OR 0.72; 95% CI 0.57-0.92; p=0.009) **and increased personal ADL scores** (SMD 0.14; 95% CI 0.02-0.25; p=0.02)
- NNT in order to spare one person from experiencing a poor outcome was 14
- Reduces rehospitalization and allows earlier discharge home
- **Estimated savings is $2 for every $1 spent on outpatient therapies**
- Greater intensity may not be as critical (ICARE; Winstein et al. 2016

Outpatients Services Trialists. ***Cochrane Database Syst Rev*** **2003**

What can ABI clinicians learn from stroke rehab research?

- transfer to inpatient rehab as early as possible
- Earlier intervention the better (to a point)
- Intensify interventions and more effortful
- Consider using some of the syntheses and meta-analyses to select some therapies to enhance recover of hemiparesis/motor function
- Enhance use of Technology to intensify therapy
- Follow some of the emerging techniques such as non-invasive stimulation and medications

Objective 3

- Debate when ABI programs may be better suited to treated stroke patients and vice versa

Joan

- Rendered unconscious
- Taken to hospital
- CT Scan- Left frontotemporal depressed skull fracture
- Underwent rapid craniotomy
- Postoperatively, awake in ICU and extubated day 2
- Aphasic with right hemiparesis and apraxia
- Alert, no behaviours and no visuospatial difficulties
- Where should Joan get rehab?

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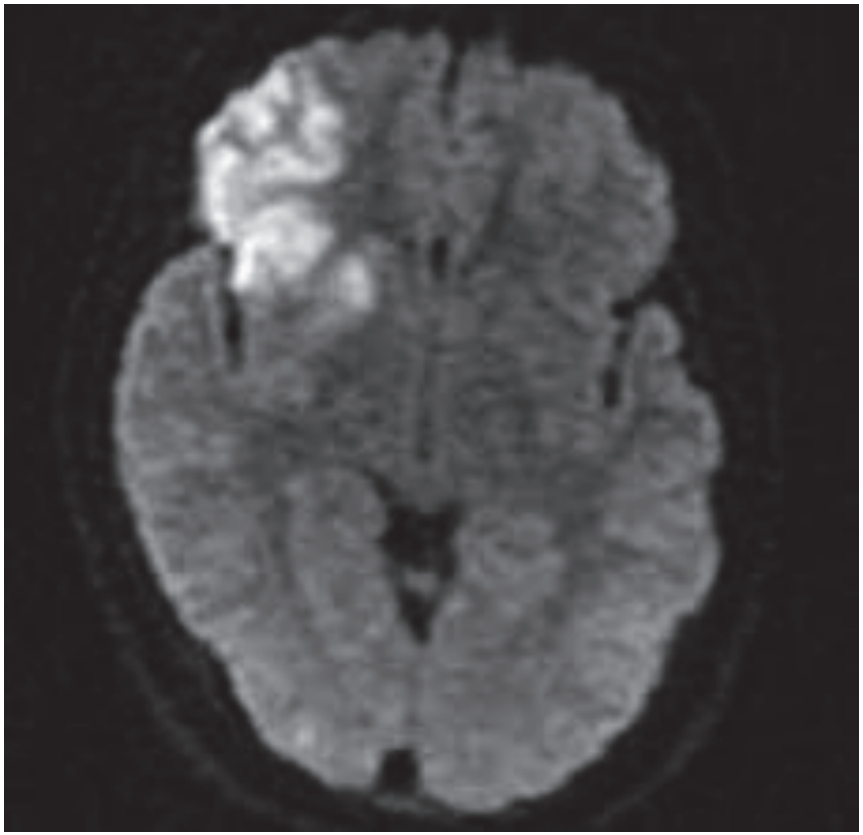
How many would be comfortable treating her on a stroke rehab service?

- Why not

Abdi

- Right Frontal infarct
- Continues to have significant disorientation, confabulation and anosognosia
- Walking with walker
- Wants to go home
- Restless and disinhibited.
- Where should he go for rehab?



How many think Abdi might be better treated on a ABI service?

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Conclusions

1. Stroke and Brain injury differences include:
   - Stroke more focal and TBI more diffuse
   - Number of developments in stroke care including
     - Acute care treatments that are effective
     - Better prognostication
     - Exploding literature
2. There are a number of emerging treatments that probably should be adopted for ABI as well
3. Person-centered rehab vs Diagnosis driven?

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- Robert Teasell
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Questions and Discussion

A few Resources

- www.ebrsr.com
- www.erabi.ca
- www.strokebestpractices.ca
- braininjuryguidelines.org
- INCOG guidelines Journal of Head Trauma Rehab January 2023

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