DISCLOSURES

None
AGENDA

- What is PM&R and who is on the team
- Impact of Stroke
- Patterns of recovery
- Neuroplasticity
- Hyperacute Phase
- Treatments in rehab
Latin ~ habilitas “to make able”

Literal translation “to be able to again”

Our role is to coordinate and facilitate the process to help a person achieve the highest level of function, independence and improve their quality of life.
THE PATIENTS WE WORK WITH

**NeuroRehab:**
- CVA

**Trauma:**
- Concussions
- TBI
- SCI
- Amputee
- Burns
- GSW/Stabwound

**Ortho:**
- Simple joint replacements
- Multi-fracture

**Cancer**
- Lymphedema

**Cardio/Pulm/Deconditioning**
INTERVENTIONS PROVIDED

- Peripheral Joint Injections
- Carpal Tunnel Injection
- Tendon injections
- MSK US
- US guided peripheral joint injections
- EMG
- Botox
- Acupuncture
- Trigger point injections
- Prosthetic/Orthotic Evaluation
- Assistive Device or Adaptive Equipment Evaluation
ACUTE INPATIENT REHAB: THE TEAM

- PM&R
- PT
- OT
- SP
- Neuropsych
- Art Therapy
- Music Therapy
- Nurse educator
- SW/CM
- Consultants
- P&O
- Nutrition
- Pastoral Care

TEAM: TOGETHER, EVERYONE ACHIEVES MORE
CRITERIA FOR ADMISSION TO A COMPREHENSIVE REHABILITATION PROGRAM

- Stable neurologic status
- Significant persisting neurologic deficit
- Identified disability affecting at least 2 of 5 functions, including mobility, self-care activities, communication, swallowing and bowel or bladder control
- Sufficient cognitive function to learn
- Sufficient communicative ability to engage with therapists
- Physical ability to tolerate the active program
- Achievable therapeutic goals
The doctor asked me to spend at least one hour per day on the treadmill.
EXERCISE IS THE BEST MEDICINE

❖ **Physical Therapy**

ROM, strengthening, balance, coordination, gait-retraining, bracing, endurance, selective sensory stimulation, FES

❖ **Occupational Therapy**

ADLs, IADLs (executive function), Driving, Home Adaptation, Splinting, FES

❖ **Speech Therapy**

Swallow, Feeding, Higher level cognitive exercises
FUNCTIONAL E-STIM
Contoured Textured Grips
Built-up, ergonomic handles for comfort and stability
FACTS AND FIGURES

❖ Stroke is the #1 cause of disability worldwide

❖ Cost burden of $65.5 billion per year

❖ 800,000 new strokes per year

❖ 650,000 people survive a new stroke annually

❖ 7 million Americans live with the complications of stroke
ROAD TO RECOVERY
TWITCHELL

- Flaccid Paralysis & Areflexia
- Return of reflexes & Spasticity
- Voluntary movements & Synergy
- Dec in Spasticity
- Volitional movements with reduction of synergy
- Normalization of volitional movements
WHO ARE THE LUCKY ONES

- Limited spasticity
- Rapid progression through stages
- Intact proprioception
- Proximal muscle return
- Preservation of distal motor function
- Limited neglect

*Predictors of upper limb recovery after stroke: a systematic review and meta-analysis*

Fiona Coupar, Alex Pollock, Phil Rowe, Christopher Weir, Peter Langhorne 10/11
Outcome and Time Course of Recovery in Stroke. Part II: Time Course of Recovery. The Copenhagen Stroke Study
Henrik S. Jørgensen, MD, Hirofumi Nakayama, MD, Hans O. Raaschou, MD, Jørgen Vivel-Larsen, MD, Mogens Støier, MD, Tom S. Olsen, MD, PhD
Recovery Patterns in Stroke Patients

Copenhagen Stroke Study  Jorgensen et al 1999

- Arm function – 9 weeks
- Ambulation – 11 weeks
- Aphasia – 6 weeks
- Neglect – 12 weeks

- 80% independent mobility
- 70% independent self care
Stroke onset

Spontaneous neurological recovery

Recovery of body functions and activities

Time:
- 0: Hours - medical
- Days: Hours - days - early mobilisation
- Weeks - days: restoring impairments in order to regain activities
- Days - months: task-oriented practice with adaptive learning and compensation strategies
- Days - months: specific rehabilitation interventions (including physical fitness) to improve extended activities of daily living and social interaction
- Weeks - months: environmental adaptations and services at home
- Months - years: maintenance of physical condition and monitoring quality of life

Pathology
Body function and structure (impairments)
Activities (limitations)
Environmental factors
Personal factors
Participation (restrictions)
OUTCOMES

- 80% will obtain a benefit from rehabilitation
- 10% will have complete spontaneous recovery
- 10% will not benefit due to severity of injury
Frontal lobe (thinking, memory, behaviour and movement)

Temporal lobe (hearing, learning and feelings)

Brain stem (breathing, heart rate and temperature)

Parietal lobe (language and touch)

Occipital lobe (sight)

Cerebellum (balance and coordination)
HIPPOCAMPUS

- Consolidation of new memories
- Learning
- Spatial orientation
### Acute ischemic stroke: Estimated rate of nervous tissue loss without timely intervention

<table>
<thead>
<tr>
<th></th>
<th>Neurons lost</th>
<th>Synapses lost</th>
<th>Myelinated fibers lost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Per second</strong></td>
<td>32,000</td>
<td>230 million</td>
<td>200 meters</td>
</tr>
<tr>
<td><strong>Per minute</strong></td>
<td>1.9 million</td>
<td>14 billion</td>
<td>12 km</td>
</tr>
<tr>
<td><strong>Per hour</strong></td>
<td>120 million</td>
<td>830 billion</td>
<td>714 km</td>
</tr>
<tr>
<td><strong>Per stroke</strong></td>
<td>1.2 billion</td>
<td>8.3 trillion</td>
<td>7140 km</td>
</tr>
</tbody>
</table>

NEUROPLASTICITY

1) Structural plasticity → actual change of the neuron or the growth of a new neuron

- Neurogenesis occurs ONLY in the hippocampus

2) Functional plasticity → dormant area of the brain takes over a new function to replace injured brain tissue
EXERCISE INCREASES HIPPOCAMPAL VOLUME

Erikson et al. J Neuroscience. 2011
Neuroplasticity

“Neurons that fire together wire together.”

~ Hebb’s Rule

http://concentricleadership.com
FUNCTIONAL IMAGING

Functional imaging of stroke recovery corroborates this temporal pattern of activation shifts.
The area or somatosensory cortex (black) in a monkey before (A) and after (B) controlled tactile stimulation.
EXERCISE?  
i thought you said "Extra Fries"
IMMOBILITY IS THE ENEMY

During Daytime Hours patients are:

- ALONE 60%
- IN BED 89%
- Only 42% of patients receive skilled rehab

NeuroICU activity between 8 am and 5 pm

Bernhardt J et al. Stroke 2004
EARLY MOBILIZATION

I Like to Move it...Move it...
He Likes to Move it...Move it...
You Like To.....?
MOVE IT !
THE ACUTE PHASE

- Ischemia is a strong inducer of gene expression in the brain.

- More than 90 different genes are activated.

- Peak within minutes to hours following ischemia and a rapid return to normal or subnormal levels
  - Synaptic changes
  - Inc membrane excitability
  - Unmasking of pre-existing connections
HYPERPLASTICITY

- Plasticity: inhibited during adulthood but a crucial window opens in post-acute ischemic phase characterized by:
  - Intense neuronal sprouting
  - Brain capillaries sprout
  - Glial cells activated

- Exhibits a re-emergence of childhood organizational patterns
Mice Models: learned behavior of picking up a food pellet

Percentage of time the mouse is successful

Days required to train

Stroke

n = 7
Delayed Retraining After Stroke

- Stroke
- n = 7
Early Retraining After Stroke

Graph showing the percentage correct over training days with a dip indicating a stroke event.

- Percentage Correct vs. Training Days
- Graph indicates a significant decline around the 8th day, labeled as 'Stroke', followed by an increase.
- Data set size: n = 7
Sensitive Period Can be Reset with a Second Stroke
HYPERPLASTICITY

- In the post-acute ischemic phase these 3 processes take place:
  - Intense neuronal sprouting
  - Brain capillaries sprout
  - Glial cells activated

- Brain is primed to learn and adapt
USE OF SSRIS IN POST STROKE RECOVERY

- **Neurogenesis:**
  - Increases axonal sprouting
  - Promotes synaptogenesis
  - Stimulates pyramidal cells in the motor cortex

- **Neuroprotection**
  - Inhibits inflammatory cytokines

- **Autoregulation**
  - Upregulates BDNF
  - Drug induced cortex hyper-excitability
FLAME TRIAL

- Fluoxetine For Motor Recovery after Acute Ischemic Stroke
- Double blind, placebo-controlled trial
- 9 stroke centers in France
- Ischemic strokes with moderate deficits of hemiparesis
- Fugl-Meyer Motor Scale (FMMS) < 55
FLAME TRIAL CONT’

- Age: 18-85 years old
- 118 patients
- Fluoxetine 20 mg daily vs placebo on day 5-10 after the stroke
- 3 month duration
- Primary outcome was a change in the FMMS score @ day 0 and @ day 90

RESULTS:
- FMMS score improved significantly in the fluoxetine group
RESULTS

Fluoxetine = 34.0 points [95% CI 29.7-38.4])
Placebo = 24.3 points [19.9-28.7];
p = 0.003).

*Figure 2: Adjusted mean Fugl-Meyer motor scale (FMMS) total scores at days 0, 30, and 90. Mean was adjusted for centre, age, history of stroke (at days 0, 30, and 90), and FMMS score at inclusion (at days 30 and 90). Error bars represent 95% CI.*
fluoxetine significantly improved motor skills of the affected side

A single dose of fluoxetine was enough to modulate cerebral sensory-motor activation
POST-STROKE DEPRESSION

- Acute phase depression approx. 20%
- Chronic long term sequelae 55%
- Preventing an inevitable long term effect
INNOVATIVE REHAB TECHNIQUES

BENEFITS OF VIRTUAL REALITY FOR STROKE REHABILITATION
Rehab vs Wii-hab

- Task-oriented functional exercises

- Robot assisted technology can achieve a reward system

- Immersive vs non-immersive

- Provides a three-dimensional and direct sensorial (visual, sensory and auditory) feedback
BENEFITS OF VIRTUAL REALITY

Effectiveness of Virtual Reality Exercises in Stroke Rehabilitation (EVEST) trial

Int J Stroke 2010 Feb G. Saposnik,1,* M. Mamdani,1 M. Bayley,2 K.E. Thorpe,2 J. Hall,2 L.G. Cohen,3 and R. Teasell4

First randomized parallel controlled trial

- Allow for increased intensity of training while providing augmented sensory feedback

- Berg Balance Scale
- Functional Reach Test
- Improves UE function
- Gait speed
SUMMARY

- Neuroplasticity

- Neurons that fire together wire together

- Maximize the acute inpatient stay during hyperplasticity phase

- Use of SSRI to improve motor recovery and prevent depression

- Use of VR in stroke rehab
REFERENCES


Hatem, S. et al Rehabilitation of Motor Function after Stroke: A Multiple Systematic Review Focused on Techniques to Stimulate Upper Extremity Recovery


Hayes, M. Time Course of Functional Recovery After Stroke: The Framingham Study


Effectiveness of wii-based rehabilitation in stroke? A randomized controlled study. Utkan Karasu A¹, Balevi Batur

Virtual Reality for Stroke Rehabilitation Kate Laver, BAppSc (OT), MClinRehab, PhD Candidate; Stacey George, BAppSc (OT), MHS (OT), PhD; Susie Thomas, BPhysio (Honours), PhD; Judith E. Deutsch, BA, MS (PT), PhD; Maria Crotty, BA, BMed, MPH, PhD, FAFRM
improving upper limb function (standardised mean difference, SMD) 0.53, 95% confidence intervals [CI] 0.25 to 0.81)) based on seven studies, and activities of daily living (ADL) function (SMD 0.81, 95% CI 0.39 to 1.22) based on three studies. No statistically significant effects were found for grip strength (based on two studies) or gait speed (based on three studies).
Animals reared or housed as adults in complex environments with access to various toys and activities develop more dendritic branching and more synapses per neuron and have higher gene expression for trophic factors than animals housed individually or in small groups in standard cages.

Regularly have to perform a very skilled motor task, the cortical representation for the muscles involved will remain enlarged.
VR

manipulating mechanisms of learning and memory, neurogenesis and axonal regeneration, and neurotransmitters and growth factors can facilitate the recovery process in models

Responsivity
Task-oriented functional exercises

Enriched environment

motivation reward interaction enjoyment
Task specific training
RECOVERY TIME LINE

physiology of learning, relearning, training, and neuroenhancement.

Brain reorganization
PROCESS WHILE IN ACUTE REHAB

- Evaluation
- Establish Care Plan with PT/OT/Speech
- 3 hours of focused exercises
- Goal Setting
- Periodic Assessments
- Discharge Planning
- Community Reintegration
Predictable rule of recovery first 3 months, one can regain 70% of their max potential

SMARTS

Compelling evidence to rehab day 1 instead of waiting 1 week
**BENEFITS TO VR**

Virtual reality: interact with a multisensory simulated environment and receive “real-time” feedback on performance

Robot assisted technology

Immersive vs non-immersive

providing augmented three-dimensional and direct sensorial (visual, sensory and auditory) feedback
Shoulder pain– subluxation

CRPS/RSD

Muscle contracture

Spasticity: develop as early as 1 week after stroke and occurs in up to 50% of stroke patients
FALLS PREVENTION

Falls are a common outcome for patients recovering from stroke, with an incidence of over 40 percent for more than one fall in the first year.

Body weight-supported treadmill training (BWSTT) enables supervised, repetitive, task-related practice of walking.
SLEEP WAKE ACTIVITY

Improves memory