Enriching rehabilitation environments

Dr Heidi Janssen
Heidi.Janssen@hnehealth.nsw.gov.au

University of Newcastle
Hunter Medical Research Institute
Hunter Stroke Service (Hunter New England Health)

ACI Rehabilitation Education Forum 2015

NHMRC CENTRE OF RESEARCH EXCELLENCE
Stroke Rehabilitation and Brain Recovery

THE FLOREY
INSTITUTE OF REHABILITATION & MENTAL HEALTH

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LA TROBE NURSING RESEARCH INSTITUTE
Health Hunter New England Local Health District

THE UNIVERSITY OF NEWCASTLE AUSTRALIA
Co-investigators and Sponsors

A/Prof Neil Spratt
Prof Julie Bernhardt
Prof Louise Ada
Prof Michael Nilsson
Prof Patrick Mc Elduff
A/Prof Michael Pollack
Prof Leonid Churilov
Prof Sandy Middleton
Dr Julie Luker
A/Prof Chris Levi
Dr Annie Mc Cluskey
A/Prof Christine Paul

Kiriwina Investment Co
2013-2015
HMRI Bridging Scholarship (Anne Greaves) 2013
John Hunter Hospital Charitable Trust Grants 2010, 2013
NSW Cardiovascular Research Network Research Development Grant 2014
Jenni Thomas

Translation Pipeline

Preclinical

Modelling Phase I
Intervention Outcomes

Exploratory Trial Phase II
Feasibility (safety)
Defining intervention

Definitive RCT Phase III
Fully defined/ measured intervention
Does it work?

Long term implementation Phase IV
Can others replicate the intervention and results
Enriched Environment: The origins

Hebb (1947)

Rosenzweig (1960-70’s)

– EE + stroke


Enriched Environment: Definition

Enriched Environment  
Standard Conditions

Physical  
Cognitive  
Social

Essential Features

1. Enable socialisation (> occupants)

2. Inanimate objects which can be accessed & interacted with

3. Contents changed/rearranged → frequently to ensure novelty


Animal models: Effects post-stroke

**Behavioural**

- ↑ motor function
- ↑ BDNF (plasticity protein)
- ↑ learning

**Plasticity**

- ↑ neurogenesis
- ↑ dendrites & synapses

Enriched Environment: Efficacy

Enriched Environment

MA Results

↑ Sensorimotor function
0.9 SDs greater than control animals
(95% CI: 0.5-1.3, p<0.001, n=320)

↑ Learning
25% better
(95% CI: 4-47, p=0.002, n=130)


Effects Post-Stroke:

Stress

Stroke + EE → unknown
• no difference


Healthy animals
• EE higher corticosterone levels
• stressful events → EE animals corticosteroids ↓ to baseline quicker
• EE builds resilience?

Mechanisms: Theories

1. **Arousal**
   
   ‘*transient increase in electrical activity in the brain*’

   **OR**

2. **Learning**
   
   ‘*biochemical process of learning*’


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**Individual components**

**Physical**

![Physical](image)

VS

Johansson & Olofsson (1996)

Komitova, Zhao & Gido et al. (2005)

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**Cognitive**

![Cognitive](image)

VS

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**Social**

![Social](image)

VS

Risedal, Mattsson & Dahlqvist et al. (2002)
More....and reading

Physical


Social

Socially mediated neuroprotection - oxytocin

Reduce levels of anxiety & aggression, basal metabolism, heart rate and core body temperature

Socially mediated neuroprotection - oxytocin

Elements of design

Time to commencement
• 1-2 days post stroke
• 2 weeks
• ↑ time →
• ↓ sensorimotor gains


Dosage
• 24/7
• 3 hrs/day

Nygren & Wieloch (2005)

Age
• aged vs young – gains at a slower rate & lower level

Buchhold et al. (2007)
Enriching deprived environments

Institutionalised

- children
  - orphans + removal \(\rightarrow\) ↑ weight, height & IQ
    Winik et al. (1975)
  - w. intellectual disabilities + education & socialisation \(\rightarrow\)
    ↑IQ & behaviour
    Vogel et al. (1967) and Vogel et al (1968)

- elderly w. chronic psychiatric disorders + rehab conditions \(\rightarrow\)
  sm.↑ cognitive function
  Mishara (1979)

Children from impoverished villages
+ education & nutrition \(\rightarrow\) ↑ arousal & attention
Raine et al. (2001)
Multi-modal stimulation

**Autism**
RCT + daily olfactory & tactile stim & music
→
↓ autism symptoms
↑ cognition
parental assessment of behaviours
• 69% improve EE vs 31% control
Woo & Leon (2013) AND
Woo, Donnelly & Steinberg-Epstein (2015)

**Dementia**
• Inconclusive....
  – exercise + cognitive training
  – exercise + cognitive + support group
  delay cognitive decline in AD

EE in clinical (hospital) stroke: Individual components

**PHYSICAL ACTIVITY**

Greater amount (>700 repetitions) during first 5 days
↑ walking speed,
↓ time to unassisted walking (9 vs 30 days)
(Scrivener 2012, NNR)

16 hours within the first ~ 6 months (7 weeks)
↑ walking ability & speed and reduces dependency
(Kwakkel 2004, Stroke)

AVERE (n=2104, 56 centres)
Mobilised <24hrs ⇒ 0.73 (95% CI 0.59-0.90; p=0.004) odds of favourable outcome (mRS 0-2)
No difference to time to walking unassisted (p=0.459)
? Dose response- yet to be completed
EE in clinical (hospital) stroke: Individual components

**COGNITIVE ACTIVITY**

Playing musical instruments- ‘music therapy’
- emotional stability & mood
- social interaction
- participation in rehab


Listening to music
- ↑ verbal memory, focused attention & mood


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EE in clinical (hospital) stroke: Individual components

**SOCIAL ACTIVITY**

- > participation in social activities

(not in hospital but < 2mths post-stroke) ⇒ ↑ QoL


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**Communication Enhanced Environments to Increase Communication Activity Early After Stroke: Design and Protocol**

Sarah D'Souza1, Heidi Janssen2, Natalie Ciccone1, Deborah Hersh1, Elizabeth Armstrong1, Erin Godecke2

1. Edith Cowan University 2. University of Newcastle and Hunter Medical Research Institute

Combined Stroke 2015 Conference
EE in clinical (hospital) stroke: 

MULTI-MODAL ACTIVITIES

Reading groups
Higgins et al. (2005)
Clay & painting
Yaretzky et al. (1996)

Arts program
‘relieved boredom’, brought learning creativity, stimulation, ‘enjoyed’

Baumann et al. Disabil Rehabil. 2013;35:244-256

Interactive gaming (Nintendo Wii)
Feasible, fun/acceptable, ↑ strength & function  (non-controlled, n=16 subacute, 1mth post-stroke)

Feasible (time receiving intervention) ↑ motor function (speed on Wolf Motor Function Test)
(pilot RCT, n=22, 1mth post-stroke)
Saposnik et al. Stroke 2010; 41(7): 1477-1484

Single blinded RCT chronic stroke , n = 120 (results to be pub soon) (COMMUNITY DWELLING)
Rhythm & music based program vs horse riding vs control

Enriched Environment: Rationale

~20% physical activity
50% alone

Stroke Recovery - Time is brain (+ function)

80% of survivors reach functional peak 6 - 12 weeks post stroke  
(Jorgenson 1995)

~ 1 - 2 weeks post stroke → inpatient rehab

Average LOS in rehab ~ 4 weeks
• (20 working days)

Physical activity levels in hospital

[Graph showing physical activity levels in hospital]

Acute Stroke Units

Alone 60%
Stroke survivor experience in rehab

Luker JA, Lynch E, Bernhardsson S, Bennett L, Bernhardt J.

Stroke Survivors’ Experiences of Physical Rehabilitation: A Systematic Review of Qualitative Studies.

(Arch Phys Med Rehabil. 2015 Apr 3. doi: 10.1016/j.apmr.2015.03.017.)

SR of qualitative research

Physical activity (isolated/within rehab package)

N=31, 560 stroke survivors (6 Australian studies)

Thematic synthesis - 9 sub-themes

1. Physical activity valued
2. Bored & alone
3. Engagement in therapy
4. Recreation & social activity
5. Dependency & lack of control
6. Fostering autonomy
7. Power of communication & information
8. Motivation needs nurturing
9. Fatigue can overwhelm

Stroke survivor experience in rehab

1. Physical activity valued (n=26)
   
   More is better (17), Walking & mobility (10), Practice outside therapy (13)

2. Bored & alone (n=11)

   Need more things to do (10), Feeling alone (2)

3. Engagement in therapy (n=26)

   Boring meaningless (7), menial tasks (5) meaningful rehab (14), goal setting important (23)

4. Recreation & social activity (n=15)

   More recreational activity in free time (7), social opportunities (9), barriers to SA (6)

5. Dependency & lack of control (n=25)

   Independence & autonomy (7), purgatory (5), fear/anxiety/frustration (16), disempowering staff attitudes (11), organisational barriers to autonomy (7)

6. Fostering autonomy (n=23)

   Empowering r/ships with staff (14), balancing the help needed (10)
## Definitions of Activity

**Any activity** – physical, cognitive and or social activity.

**Physical activity** - as any purposeful physical action

**Cognitive activity** - non-physical activity involving active engagement in a mental task.

**Social activity** - any interaction involving verbal communication with people present or through telecommunication devices & other non verbal interactions

## Measuring Activity Levels

![Behavioural Mapping Spreadsheet and Protocol](image-url)
**Rehabilitation Environments: Non enriched?**

Janssen et al. (2014). Clinical Rehabilitation

![Graph showing FIM improvement and improved mood](image)

*Activity type: Physical, Cognitive, Social*  

<table>
<thead>
<tr>
<th>Week 0</th>
<th>Week 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical</td>
<td><img src="image" alt="Graph showing FIM improvement" /></td>
</tr>
<tr>
<td>Cognitive</td>
<td><img src="image" alt="Graph showing FIM improvement" /></td>
</tr>
<tr>
<td>Social</td>
<td><img src="image" alt="Graph showing FIM improvement" /></td>
</tr>
</tbody>
</table>

**Enriched Environment: Bench to bedside**

<table>
<thead>
<tr>
<th>Stroke Model</th>
<th>Enriched Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity</td>
<td>Function</td>
</tr>
<tr>
<td>Animals</td>
<td>YES</td>
</tr>
<tr>
<td>Humans</td>
<td>???</td>
</tr>
</tbody>
</table>
Translation Pipeline

Preclinical

Modelling Phase I

Exploratory Trial Phase II

Definitive RCT Phase III

Long term implementation Phase IV

Intervention Outcomes

Feasibility (safety)

Defining intervention

Fully defined/measured intervention

Does it work?

Can others replicate the intervention and results

Pilot Study

‘Bench to bedside’

Human equivalent model of EE

Dr Heidi Janssen, Prof Julie Bernhardt, Prof Louise Ada, Prof Patrick McElduff, A/Prof Michael Pollack, Prof Michael Nilsson, and A/Prof Neil J Spratt

Communal Individual
Enriched Environment: Bench to bedside

Determine if an EE:

1. $↑$ activity levels

2. $∆$ physical, cognitive and social activity levels?

3. $↓$ ‘inactive & alone’ and sleeping

Pilot Study: Stroke Patients

<table>
<thead>
<tr>
<th></th>
<th>EE (n=15)</th>
<th>Control (n=14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>78</td>
<td>78</td>
</tr>
<tr>
<td>Male</td>
<td>5 (33%)</td>
<td>9 (54%)</td>
</tr>
<tr>
<td>Right hemiparesis</td>
<td>6 (40%)</td>
<td>10 (71%)</td>
</tr>
<tr>
<td>NIHSS (0-42)</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Days post stroke</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td>Days on rehab ward</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Baseline function (FIM) (18-126)</td>
<td>56</td>
<td>77</td>
</tr>
<tr>
<td>Cognition (MoCA) (0-30)</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Mood (PHQ-9)</td>
<td>8</td>
<td>11</td>
</tr>
</tbody>
</table>
Pilot Study: Results

Incidence Rate Ratio

<table>
<thead>
<tr>
<th>Any</th>
<th>Physical</th>
<th>Cognitive</th>
<th>Social</th>
<th>Sleeping</th>
<th>Inactive &amp; Alone</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.67</td>
<td>1.19</td>
<td>0.54</td>
<td>1.22</td>
<td>0.71</td>
<td></td>
</tr>
</tbody>
</table>

More likely
Less likely

Qualitative data: Staff

Identify patients are inactive  “sitting and waiting for things to happen”  
(Focus Group)

Workload concerns  
“too much work” (Participant 5)  
“less likely to ring the bell” (Participant 3)  
“...expectation when the patients arrive ... direct patients that this is where you’ll be spending your time ... getting that as common practice, that’s something that we’ll work on.”  
(Participant 7)

Observed the benefits  
“better for [patients] than lying in bed” (Participant 8)  
“[The patients] get benefit out of that sort of interaction... there would be laughing and just general chit chat.”  
(Participant 3)


---

Qualitative data: Patients

Boredom  
“When I start to feel bored I just ask one of the nurses to take me to the common room and I find something to do there, generally other people are there already.” (Participant 4)

Socialisation  
“...you were there with other people too. So you got to talk to other people as well...everybody that sort of had the same problems as what you had so that was quite good.”  
(Participant 1)

Perceived barriers  
“They basically took you whenever you wanted to go providing there were staff free and available.” (Participant 8)  
“I didn’t think I was allowed to go there by myself” (Participant 6)  
“You have just got to put up with it. You don’t belong here, so you have just got to do what you are told.” (Participant 10)

Acknowledgements

- National Heart Foundation
- Emlyn and Jennie Thomas Post Graduate Medical Scholarship
- National Stroke Foundation
- John Hunter Hospital Charitable Trust 2010
- Hunter Stroke Service
- Staff and patients of rehabilitation unit in HNEH

Translation Pipeline

- Preclinical
- Modelling Phase I
  - Intervention Outcomes
  - Feasibility (safety)
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  - Does it work?
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  - Can others replicate the intervention and results
Aims

• determine **feasibility** and **safety** of our model of EE
• examine the **feasibility** of the planned assessment **protocol** (for larger Phase III efficacy trial)
• estimate the between- and within-hospital **variability** in outcome measures.

Phase II Trial

Hospitals

Kingston Centre, Cheltenham VIC

Royal Talbot Rehabilitation, Kew VIC

Bankstown Lidcombe, Sydney, NSW

Sacred Heart Rehabilitation Centre, Sydney NSW
**Altering the Rehabilitation Environment to Improve Stroke Survivor Activity (AREISSA): A Phase II Trial**

4 units – 2 in NSW and 2 in VIC (208 patients in total)

Dr Heidi Janssen, Dr Neil Spratt, A/Prof Julie Bernhardt, Prof Louise Ada, Prof Sandy Middleton, Prof Michael Nilsson, Prof Leonid Churilov, A/Prof Michael Pollack

<table>
<thead>
<tr>
<th>Before (Control)</th>
<th>Implementation (Uptake)</th>
<th>After (Intervention/EE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke rehab + normal rehabilitation environment</td>
<td>• Enrichment equipment Protocol ↓ Hospital</td>
<td>Stroke rehab + enriched environment</td>
</tr>
</tbody>
</table>

26 patients per site No recruitment 26 patients per site

Main Measure:
% of the day stroke patients spent being active

Main Measure:
% of the day stroke patients spent being active

Patient & Staff interviews: barriers/facilitators to activity

Patient & Staff interviews: barriers/facilitators to activity

1. Feasibility
- patient activity level 10+/-3 days post admission
- adherence to protocol (audit)

2. Safety (adverse events)

3. Between & within variability in outcome measures
- fatigue & boredom
- disability
- motor and thinking function
- mood
- self-efficacy
- quality of life
- activity participation

**Status:** n=55 (of 208)
In a nutshell: Unit level

<table>
<thead>
<tr>
<th>Before (Control)</th>
<th>Implementation</th>
<th>After (Intervention/EE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard care</td>
<td>Uptake of EE</td>
<td>Standard care + EE</td>
</tr>
<tr>
<td>Go about business as usual</td>
<td>EE Equipment Implementation Package</td>
<td>Communal Area set up as per EE Protocol</td>
</tr>
<tr>
<td></td>
<td>• EE Protocol</td>
<td>Supply Individual EE</td>
</tr>
<tr>
<td></td>
<td>• Education</td>
<td>Satchels</td>
</tr>
<tr>
<td></td>
<td>• EE Champions</td>
<td>Encourage and assist engagement in activity</td>
</tr>
<tr>
<td></td>
<td>• Site Support</td>
<td>Audit</td>
</tr>
<tr>
<td>Screen &amp; Recruit Pts Behavioural mapping</td>
<td>Screen &amp; Recruit Pts Behavioural mapping</td>
<td></td>
</tr>
<tr>
<td>N=26</td>
<td>No recruitment</td>
<td>N=26</td>
</tr>
<tr>
<td>9 months</td>
<td>~ 3 months</td>
<td>9 months</td>
</tr>
</tbody>
</table>

Inclusion Criteria

- Recent stroke (≤ 4 weeks)
- pre-morbid modified Rankin score ≤ 2 (minimal/no disability)
- able to stand with the A x 2 people or less (in physio)
- predicted estimated LOS ≥ 14 days
Exclusion Criteria

• pre-existing dementia
• other behavioural, medical or other problems which restrict safe participation in standard rehabilitation (as assessed by physician and/or MD team)

Sub-studies

1. Stroke survivors and Staff Informing Enrichment of Rehabilitation Environments (SaSIERE) — qualitative interviewing to identify survivor and staff perceptions of barriers and enablers to activity during stroke rehabilitation.

2. Investigating Boredom In Stroke (IBIS) — boredom levels pre- and post-enrichment. (Masters student- Ms Katrina Angus, UoN).

3. Embedding Environmental Enrichment with Multi-Disciplinary Teams (3EMDTs) — evaluating implementation strategies used in AREISSA.
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Long term implementation Phase IV

Bigger Picture

**Does recovering in a rehabilitation unit with an Enriched Environment improve stroke recovery?**

– we will need a much larger trial (2000+ patients)

– to determine if EE results in **better function, mood** and **quality of life after stroke**

– to determine if our model of EE is **cost effective**
Supporters

- Greater
- Kiriwina Investment Co
- HMRI Bridging Scholarship (Anne Greaves)
- John Hunter Hospital Charitable Trust Grants
- NSW Cardiovascular Research Network Research Development Grant 2014

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Jenni Thomas
Acute setting: Physical, cognitive and social

Ms Hannah Smith, Dr Heidi Janssen, Prof Louise Ada, Ms Jodie Marquez, Prof Patrick McElduff, A/Prof Neil J Spratt, A/Prof Michael Pollack, Prof Michael Nilsson

Clinical support: Alison Willett, Angela Royan and Ryan Gallagher

N= 15 (5 mild, 5 mod, 5 severe)

Stroke severity (NIHSS) (median, [range]) = 13 [1-21]

5 female, 72 yoa [27-92]

6 RIGHT hemisphere stroke

Days post stroke (median) = 5 GCS 13-15
Acute setting: Physical, cognitive and social

Activity 46% (+/- 17)
Physical activity 22% (+/- 14)
Cognitive activity 7% (+/- 9)
Social activity 29% (+/- 12)
**Acute setting: Physical, cognitive and social**

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>RELATION TO NIHSS</th>
<th>SIGNIFICANCE (* &lt; 0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% inactive</td>
<td>inactivity = 38 + 1.4 x NIHSS</td>
<td>r = 0.58, p = 0.02*</td>
</tr>
<tr>
<td>% active</td>
<td>activity = 62 − 1.4 x NIHSS</td>
<td>r = -0.58, p = 0.02*</td>
</tr>
<tr>
<td>% physical activity</td>
<td>physical activity = 34 − 1.1 x NIHSS</td>
<td>r = -0.55, p = 0.03*</td>
</tr>
<tr>
<td>% cognitive activity</td>
<td>cognitive activity = 13 − 0.5 x NIHSS</td>
<td>r = -0.40, p = 0.14</td>
</tr>
<tr>
<td>% social activity</td>
<td>social activity = 29 − 0.1 x NIHSS</td>
<td>r = -0.04, p = 0.88</td>
</tr>
</tbody>
</table>