Stroke: arm recovery (FS-23)

Steven Wolf (United States of America)
Gert Kwakkel (Netherlands)
Mark Bayley (Canada)
Michelle McDonnell (Australia)
Stroke Arm Recovery

Steven Wolf
Mark Bayley
Gert Kwakkel
Michelle McDonnell
Presentation Sequence

1. Wolf – Historical Perspective
2. Bayley – Implementation and Guideline Background
3. Kwakkel- Underlying Prognostic Algorithm
5. Team- Clinical Cases
6. Team – Next Steps
7. AUDIENCE – Discussion/ Q&A
Historical Perspective

- March 10, 2010 – Nottingham – Grantham – Norwich (UK)……Wolf, van Vliet, Pomeroy
- March 24, 2010 – Canadian Stroke Network (Ottawa, Canada)
- April – September, 2010 ---assemble team
- October 24, 2010 – Wolf/Bayley ASNR/ACRM meeting, Montreal)
- October 2011 – review stroke guidelines (Canada, USA, UK, Scotland, The Netherlands, Australia, New Zealand)
- October 2011 – define working groups to seek evidence (PEDro, PubMed, Cochrane, etc.) and define interventions; Outcome group to define associated outcomes
2011-2013: meet annually for updates and multiple international Web EX calls
2014: Bayley secures funds for securing app company
2015: App prototype completed
Developing the Algorithm

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Janice Eng, PhD, OTR, PT</td>
<td>University of British Columbia, Canada</td>
<td>1</td>
</tr>
<tr>
<td>Carol Richards, Ph.D., PT</td>
<td>Laval University, Canada</td>
<td>1</td>
</tr>
<tr>
<td>Sarah Blanton, DPT</td>
<td>Emory University, USA</td>
<td>2</td>
</tr>
<tr>
<td>Michelle, McDonnell, PhD, PT</td>
<td>University of South Australia Australia</td>
<td>2</td>
</tr>
<tr>
<td>Marilyn MacKay-Lyons, PhD, PT</td>
<td>Dalhousie University, Canada</td>
<td>3</td>
</tr>
<tr>
<td>Gert Kwakkel, Ph.D</td>
<td>Vrije University Medical Center The Netherlands</td>
<td>3,6</td>
</tr>
</tbody>
</table>
# Developing the Algorithm

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carolyn Baum, Ph.D, OTR/L</td>
<td>Washington University, USA</td>
<td>4</td>
</tr>
<tr>
<td>Lisa Connor, Ph.D, OTR/L</td>
<td>Washington University, USA</td>
<td>4</td>
</tr>
<tr>
<td>Katherine Lang, PhD, PT</td>
<td>Washington University, USA</td>
<td>4</td>
</tr>
<tr>
<td>Nancy Salbach, Ph.D. PT</td>
<td>University of Toronto, Canada</td>
<td>5</td>
</tr>
<tr>
<td>Carolee Winstein, PhD, PT</td>
<td>University of Southern California, USA</td>
<td>5</td>
</tr>
<tr>
<td>Mindy Levin, PhD, PT</td>
<td>McGill University, Canada</td>
<td>6</td>
</tr>
<tr>
<td>Mark Bayley, MD</td>
<td>University of Toronto, Canada</td>
<td>6</td>
</tr>
<tr>
<td>Charlotte Hager, PhD</td>
<td>University of Umea, Sweden</td>
<td>6</td>
</tr>
</tbody>
</table>
## Developing the Algorithm

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cathy Stinear, Ph.D.</td>
<td>University of Auckland, New Zealand</td>
<td>7</td>
</tr>
<tr>
<td>Leanne Carey, PhD, OT</td>
<td>La Trobe University, Australia</td>
<td>7</td>
</tr>
<tr>
<td>Judith Deutsch, Ph.D., PT</td>
<td>Rutgers University, USA</td>
<td>7</td>
</tr>
<tr>
<td>Paulette van Vliet, PhD, PT</td>
<td>University of Newcastle, Australia</td>
<td>8</td>
</tr>
<tr>
<td>Valery Pomeroy, Ph.D., PT</td>
<td>University of Norwich, UK</td>
<td>8</td>
</tr>
<tr>
<td>Steven L. Wolf, Ph.D., PT</td>
<td>Emory University, USA</td>
<td>8</td>
</tr>
<tr>
<td>Catherine Salter, PhD, PT</td>
<td>University of Western Ontario, Canada</td>
<td>ALL</td>
</tr>
<tr>
<td>Robert Teasell, M.D.</td>
<td>University of Western Ontario, Canada</td>
<td>ALL</td>
</tr>
<tr>
<td>Total Team</td>
<td></td>
<td>ALL</td>
</tr>
</tbody>
</table>
## Developing the Algorithm

**Contributing clinicians and scientists:**

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catherine Buetefisch, MD, PhD</td>
<td>Emory University</td>
</tr>
<tr>
<td>John Chae, MD</td>
<td>Case Western Reserve University</td>
</tr>
<tr>
<td>Alex Dromerick, MD</td>
<td>Georgetown University</td>
</tr>
<tr>
<td>Pamela Duncan, PhD, PT</td>
<td>Wake Forest University</td>
</tr>
<tr>
<td>Mark Goldstein, E ED</td>
<td>APTA</td>
</tr>
<tr>
<td>Ralph Nitkin, PhD</td>
<td>NIH</td>
</tr>
<tr>
<td>Nicole Korner Bitensky, PhD, OTR/L</td>
<td>McGill University</td>
</tr>
<tr>
<td>W. Zev Rymer, MD, PhD</td>
<td>Northwestern University</td>
</tr>
<tr>
<td>Krish Sathian, MD, PhD</td>
<td>Emory University</td>
</tr>
<tr>
<td>Susan Baracca, PhD, PT</td>
<td>McMaster University</td>
</tr>
</tbody>
</table>

---
Can the patient produce any voluntary muscle activity in the affected upper limb?

In a seated position, can the patient produce any shoulder abduction against gravity, and/or produce any elbow extension without gravity?

With the forearm prone on a table and the hand and fingers unsupported, can the patient initiate finger (and/or thumb) extension three times within a minute?

Can the patient produce any voluntary muscle activity in the affected upper limb?

**Box 1**
Compensatory Techniques
Hand Edema
- Passive ROM
FES
Spasticity mgmt.
US Neglect
Mirror Box
Shoulder (Box 9)

**Box 2**
Hand Edema
- Cryotherapy
- Passive ROM
Robotic
Motor imagery
Mirror Box
FES
Spasticity mgmt.
Shoulder (Box 9)

**Box 3**
Strengthen Shoulder and Elbow control by:
- Robotics
  - Trunk restraint
  - Motor imagery
  - Bilateral Arm Training
  - Video games
  - FES
  - Facilitate wrist finger Ext. By Exercise, FES, motor imagery,

**Box 4**
Task Specific Mod-CIMT or signature CIMT, trunk restraint mental practice functional Strengthening (e.g. GRASP)
Video Games Virtual Reality

**Box 5**
Compensatory Techniques
Hand Edema
- Passive ROM
FES
Spasticity mgmt.
Strength/Cardio Shoulder prevention (Box 9)

**Box 6**
Mirror Box
Hand Edema
- Passive ROM
Bilateral UE task
FES
Spasticity mgmt.
Strength/Cardio Shoulder (Box 9)

**Box 7**
Strengthen Shoulder and Elbow control by:
- Robotics
  - Trunk restraint
  - Motor imagery
  - Bilateral Arm Training
  - Video games
  - FES
  - Facilitate wrist finger Ext. By Exercise, FES, motor imagery,

**Box 8**
Task Specific Training CIMT,
trunk restraint mental practice functional Strengthening (e.g. GRASP)
Videogames and VR
Self management

**Box 9**
(Reassessment per week)
Shoulder Pain prevention and management

At 12 weeks Review goals and determine if a new approach is required

During late phase goal Achievement and progress must be reviewed regularly to determine if progress is still being made if not convert to independent program.
PONDER, DON’T PANIC!!

• We will explain the evolution and thinking behind the development of this app.
• We will explain the rationale behind selection and prioritization of interventions.
• You will experience use of the app and have an opportunity to try it on your own if it does not appear to be working now.
• We will be available for discussion after this meeting and beyond!
Bridging the knowledge-practice gap in Stroke Arm Recovery

Steven Wolf
Mark Bayley
Gert Kwakkel
Michelle McDonnell
How many articles would you have to read every day 365 days/yr to keep up?

A. 5
B. 10
C. 15
D. 20
E. 25
F. 30

Shaneyfelt JAMA 2001
The gap is 17 years

• More than 17 years to translate evidence generated from discovery into health care practice (Balas & Boren, 2000)

• Of that, only 14 per cent of it is believed to enter day-to-day clinical practice (Westfall, Mold & Fagan, 2007).

  — Mold and Fagan Practice-based research Jama 2007 297:403–6
Therapists

- Relied foremost on peers for information because of their availability, ease of access, and minimal cost.
- Sought information from research literature themselves or with the help of librarians or students.

Research
- Syntheses (e.g., systematic reviews) enabled access to a body of research.
- Older therapists insufficient search skills.
- Most considered appraisal and application of research findings challenging and identified insufficient time as organizational barriers to the use of research.

Physical Therapists’ Experiences Updating the Clinical Management of Walking Rehabilitation After Stroke: Salbach PHYS THER. 2009; 89:556-568
Clinical Practice Guidelines (CPGs)

“Systematically developed statements to assist both practitioner and patients’ decisions about appropriate health care for specific clinical circumstances”
(Field and Lohr 1990, p. 38)
**Practice Guidelines Evaluation and Adaptation Cycle**

1. Identify a clinical area to promote best practice

2. Establish an interdisciplinary guideline evaluation group

3. Establish guideline appraisal process

4. Search for and retrieve guidelines

5. Assess guidelines
   - Quality
   - Currency
   - Content

6. Adopt or adapt guidelines for local use

7. Seek external review (practitioner and policy maker feedback; expert peer review)

8. Finalise local guideline

9. Obtain official endorsement and adoption of local guideline

10. Schedule review and revision of local guideline

Practice Guidelines Evaluation and Adaptation Cycle

1. Identify a clinical area to promote best practice

2. Establish an interdisciplinary guideline evaluation group

3. Establish guideline appraisal process

4. Search for and retrieve guidelines

5. Assess guidelines
   a. Quality
   b. Currency
   c. Content

6. Adopt or adapt guidelines for local use

7. Seek external review (practitioner and policy maker feedback; expert peer review)

8. Finalise local guideline

9. Obtain official endorsement and adoption of local guideline

10. Schedule review and revision of local guideline

Practice Guidelines Evaluation and Adaptation Cycle*

1. Identify a clinical area to promote best practice

2. Establish an interdisciplinary guideline evaluation group

3. Establish guideline appraisal process

4. Search for and retrieve guidelines

5. Assess guidelines
   a. Quality
   b. Currency
   c. Content

6. Adopt or adapt guidelines for local use

7. Seek external review (practitioner and policy maker feedback; expert peer review)

8. Finalise local guideline

9. Obtain official endorsement and adoption of local guideline

10. Schedule review and revision of local guideline

Practice Guidelines Evaluation and Adaptation Cycle*

1. Identify a clinical area to promote best practice

2. Establish an interdisciplinary guideline evaluation group

3. Establish guideline appraisal process

4. Search for and retrieve guidelines

5. Assess guidelines
   a. Quality
   b. Currency
   c. Content

6. Adopt or adapt guidelines for local use

7. Seek external review (practitioner and policy maker feedback; expert peer review)

8. Finalise local guideline

9. Obtain official endorsement and adoption of local guideline

10. Schedule review and revision of local guideline

Practice Guidelines Evaluation and Adaptation Cycle*

1. Identify a clinical area to promote best practice

2. Establish an interdisciplinary guideline evaluation group

3. Establish guideline appraisal process

4. Search for and retrieve guidelines

5. Assess guidelines
   a. Quality
   b. Currency
   c. Content

6. Adopt or adapt guidelines for local use

7. Seek external review (practitioner and policy maker feedback; expert peer review)

8. Finalise local guideline

9. Obtain official endorsement and adoption of local guideline

10. Schedule review and revision of local guideline

Establish guideline appraisal process

AGREE II instrument

• Each item scored by 4 raters on a scale of 1 (absence of information or concept very poorly reported) to 7 (exceptional quality of reporting, all criteria for item met)

• Established construct validity and inter-rater reliability; quality ratings significant predictors of guideline adoption

Establish guideline appraisal process

The Appraisal of Guidelines for Research and Evaluation (AGREE II) instrument [http://www.agreetrust.org/]

- 23 quality appraisal items in six domains
  - (1) Scope and purpose
  - (2) Stakeholder involvement
  - (3) Rigour of development
  - (4) Clarity of presentation
  - (5) Applicability
  - (6) Editorial independence

- Stroke Think Tank Team took the 6-7 top guidelines from around the world
Assess Guidelines I: Quality

Why do it?

- Identify high quality guidelines
- Identify strengths and weaknesses of existing guidelines in the field to inform future guideline development

How do I do it?

- Guideline evaluation tool (AGREE II): examines guideline methodology, NOT guidelines recommendations

Assess Guidelines I: Quality

What are potential challenges?

• Human resources:
  – AGREE II requires four raters per guideline
  – 2-3 hours per guideline depending on size / rater experience

• Interpretation:
  – Level of methods description influences quality score
  – Low quality ≠ Poor recommendations
  – All AGREE items equally weighted – are they of equal importance?
Practice Guidelines Evaluation and Adaptation Cycle*

1. Identify a clinical area to promote best practice
2. Establish an interdisciplinary guideline evaluation group
3. Establish guideline appraisal process
4. Search for and retrieve guidelines
5. Assess guidelines
   a. Quality
   b. Currency
   c. Content
7. Seek external review (practitioner and policy maker feedback; expert peer review)
8. Finalise local guideline
9. Obtain official endorsement and adoption of local guideline
10. Schedule review and revision of local guideline

Adopt or adapt guidelines for local use

Why do it?

• Overall aim of the process is to create up-to-date guidelines that meet stakeholder needs

How?

• Convened the initial expert guideline group in Montreal to deliberate on:
  – adopting or adapting identified recommendations
  – grading / strength of recommendations in light of (new) evidence
1. Identify a clinical area to promote best practice

2. Establish an interdisciplinary guideline evaluation group

3. Establish guideline appraisal process

4. Search for and retrieve guidelines

5. Assess guidelines
   a. Quality
   b. Currency
   c. Content

6. Adopt or adapt guidelines for local use

7. Seek external review (practitioner and policy maker feedback; expert peer review)

8. Finalise local guideline

9. Obtain official endorsement and adoption of local guideline

10. Schedule review and revision of local guideline
First draft of Recommendations 2010

• Created a matrix of the best quality guidelines by extracting recommendations from New Zealand, UK, USA, Australian and Canadian Guidelines

• Experts Selected the recommendations across a variety of topics
1. Identify a clinical area to promote best practice

2. Establish an interdisciplinary guideline evaluation group

3. Establish guideline appraisal process

4. Search for and retrieve guidelines

5. Assess guidelines
   a. Quality
   b. Currency
   c. Content

6. Adopt or adapt guidelines for local use

7. Seek external review (practitioner and policy maker feedback; expert peer review)

8. Finalise local guideline

9. Obtain official endorsement and adoption of local guideline

10. Schedule review and revision of local guideline
What are the characteristics of good rehabilitation recommendations?

Ideally Should be Specific to:

• characteristics of the target population
• intervention – type, dosage
• time post injury or illness
• who should be delivering the intervention
• desired outcomes
## Evidence

### Level of Evidence Grading System for Recommendations

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>At least one randomized controlled trial, meta-analysis, or systematic review</td>
</tr>
<tr>
<td>B</td>
<td>At least one cohort comparison, case studies or other type of experimental study.</td>
</tr>
<tr>
<td>C</td>
<td>Expert opinion, experience of a consensus panel</td>
</tr>
<tr>
<td>NE</td>
<td>No evidence provided.</td>
</tr>
</tbody>
</table>
Barriers to implementation of the SCORE Recommendations

Theme 1. Lack of time
“the recommendations were all easy to apply individually, but can’t do them all in one package, it’s too time consuming.”

Theme 2 Problems with staffing
“Staff Turnover was constant”

Theme 3 -Education and Training – EBR written in “therapese”

Theme 4- Staff and patient Safety/prioritizing treatments
One nurse also voiced concerns over provider safety: “The sit-to-stand technique puts a strain on the nurses’ backs.”
HCP were hesitant to abandon previous treatments because there was “no research evidence to support them.”

Theme 5 Team Communication

Theme 6 Equipment

Bayley et al Disabil Rehabil. 2012 May 28
Generating “Outcomes” for Interventions within each “box”

- Create Outcomes Working Group chaired by Bob Teasell, M.D. (EBRSR).

- Review outcomes associated with every paper for each intervention for which substantial levels of evidence were deemed high by each group charged with reviewing evidence for interventions within its “box”.

- Prioritize suggested outcomes based upon the context for how outcomes used in those studies and affirming evidence to support their validity and appropriateness.
App Development

- Interviewed 5 app developer groups
- Selected Pivot Design Group (www.pivotdesigngroup.com) in Toronto because of their experience in app development in Health
- Worked with them to develop a prototype to show to team members for feedback
App Developers role

- User Experience - interviewed therapists
- Developed prototype designed for smartphones that could be used nearby the patient
- Excellent awareness of how to incorporate considerations like tailoring the evidence using “filters”
- Advised on role of icons and star system
Summary

- Recognized that therapists needed assistance with the wide body of literature
- Need patient specific recommendations
- Need a very time efficient solution
- Development of Algorithm was possible method to facilitate this
Stroke Arm Recovery

Steven Wolf
Mark Bayley
Gert Kwakkel
Michelle McDonnell
Random selection of patients with an upper limb paresis post stroke (N=10)
Assessment of clinical determinants

Inclusion criteria:
• Diagnosed with an ischemic, first-ever hemispheric stroke;
• Type and localization determined by CT or MRI scan;
• Suffering from monoparesis or hemiparesis
• First assessment < 72 hours post stroke;
• No or unsuccessful rTPA;
• No pre-morbid disability (BI ≥19);
• 18 years or older;
• Able to understand and provide verbal or written informed consent to participate.

The EPOS cohort study (9 hospital stroke units)

Outcome of capacity:
Upper limb (ARAT)

Outcome on ARAT 6 months post stroke (N=188)

- ARAT < 10: 30%
- ARAT ≥10: 70%

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

ARAT ≥ 10 at 6 months

<table>
<thead>
<tr>
<th>Finger Extension</th>
<th>Shoulder Abduction</th>
<th>True Negatives N</th>
<th>False Negatives N</th>
<th>False Positives N</th>
<th>True Positives N</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model at day 2:</td>
<td>P=1/(1+1*(EXP(-1.119+2.807<em>X₁+2.149</em>X₂)))</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FM-FE ≥1</td>
<td>MI-SA ≥9</td>
<td>38</td>
<td>12</td>
<td>8</td>
<td>98</td>
<td>0.98</td>
</tr>
<tr>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.89</td>
</tr>
<tr>
<td>+</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.71</td>
</tr>
<tr>
<td>-</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.71</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.25</td>
</tr>
</tbody>
</table>

34% full recovery

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

<table>
<thead>
<tr>
<th>Finger Extension</th>
<th>Shoulder Abduction</th>
<th>True Negatives N</th>
<th>False Negatives N</th>
<th>False Positives N</th>
<th>True Positives N</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model day 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FM-FE ≥1</td>
<td>MI-SA ≥9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>+</td>
<td>38</td>
<td>6</td>
<td>8</td>
<td>104</td>
<td>0.98</td>
</tr>
<tr>
<td>+</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.78</td>
</tr>
<tr>
<td>-</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.78</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.14</td>
</tr>
<tr>
<td>Model day 9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FM-FE ≥1</td>
<td>MI-SA ≥9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>+</td>
<td>38</td>
<td>6</td>
<td>8</td>
<td>104</td>
<td>0.98</td>
</tr>
<tr>
<td>+</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.80</td>
</tr>
<tr>
<td>-</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.65</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.14</td>
</tr>
</tbody>
</table>

P = 1/(1+1*(EXP(-1.874+3.070*X₁+3.075*X₂)))

P = 1/(1+1*(EXP(-1.815+3.224*X₁+2.449*X₂)))

Who shows upper limb recovery?

Probability (%) to achieve ARAT ≥ 10 points 6 months post stroke (N=188)

SAFE-model
<72 hours

Favorable prognosis
Unfavorable prognosis

Nijland et al, Stroke. 2010;41:745-50
Return of voluntary finger extension: Prognosis for recovery of upper limb capacity (N=91)

Time window < 3 months

False negatives at 6 months: ARAT ≥ 10 points (N=42)
True negatives at 6 months: ARAT < 10 points (N=49)
Prognosis for recovery of upper limb capacity following ARAT Stroke patients

SAFE model

1. Poor prognosis
2. Good prognosis

ARAT score ≥ 10 points

- Poor recovery
- Partial Recovery
- Partial recovery
- Full recovery

Time window ~12 weeks

True negatives
False negatives

34%

Winters et al. [in preparation]
Days – 12 Weeks: Restore impairments to regain body functions and activities back

> 3 Months: Allow task-oriented practice with adaptive learning & compensation strategies
Prognostic algorithm for the upper paretic limb

Can the patient produce any voluntary muscle activity in the affected upper limb?

Not yet

Box 1
Compensatory Techniques

Not yet

Box 2
- Hand Edema
- Cryotherapy
- Passive ROM
- Robotics
- Motor imagery
- Mirror Box
- FES
- Spasticity mgmt
- Shoulder (Box 9)

>12w

Return of shoulder abduction?

Not yet

Box 3
- Strengthen Shoulder and Elbow control by: Robotics
- Trunk restraint
- Motor imagery
- Bilateral Arm Training
- Video games
- FES
- Facilitate wrist finger Extn. By Exercise, FES, motor imagery,

>12w

With the forearm prone on a table and the hand and fingers unsupported: Can the patient initiate finger (and/or thumb) extension three times within a minute?

Not yet

Box 4
- Task Specific
- Mod-CIMT or signature CIMT , trunk restraint
- mental practice
- functional
- Strengthening
(e.g. GRASP)
- Video Games
- Virtual Reality

>12w

At 12 weeks Review goals and determine if a new approach is required

0-24 h
Early Rehabilitation

Late Rehabilitation

Chronic phase

12 weeks

WEEKLY MONITORING CHANGE OF VOLUNTARY MOTOR CONTROL
Stroke Arm Recovery

Steven Wolf
Mark Bayley
Gert Kwakkel
Michelle McDonnell
Decision making process

• Why an algorithm?
  – Decision making process
  – Based on clear assessment criteria, chosen because of the prognostic indicators
  – Considered the evidence for interventions in the early rehab phase (up to 12 weeks), then after this when rehab may be provided in a less intense manner
Can the patient produce any voluntary muscle activity in the affected upper limb?  
Yes, or not yet?  
– Determined on initial assessment, in any position
Step 2

In a seated position, can the patient produce any shoulder abduction against gravity?

Yes, or not yet?
Step 3

With the forearm prone on a table and the hand and fingers unsupported, can the patient initiate finger (and/or thumb) extension three times within a minute?

Yes, or not yet?
The interventions

• Reviewed the research evidence from a number of sources
  – Strokengine has already reviewed the literature
  – Compiled lists of interventions based on expert opinion from the working party
  – Each working group further reviewed the literature, new searches until March 2015
### Figure 3. Summary effect sizes for physical therapy interventions – arm-hand activities.

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Comparator arms (n) / Patients (N)</th>
<th>$I^2$ (%)</th>
<th>Hedges’ $g$ (95% CI)</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome: arm-hand activities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Therapeutic positioning arm</td>
<td>NA</td>
<td>0</td>
<td>0.060</td>
<td></td>
</tr>
<tr>
<td>Reflex-inhibiting/immobilization</td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air-splints</td>
<td>3 / 180</td>
<td>0</td>
<td>0.050</td>
<td></td>
</tr>
<tr>
<td>Techniques and devices GHHS/HSP</td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bilateral arm training</td>
<td>10 / 417</td>
<td>40</td>
<td>0.061</td>
<td></td>
</tr>
<tr>
<td>Original CIMT</td>
<td>11 / 222</td>
<td>0</td>
<td>0.027</td>
<td></td>
</tr>
<tr>
<td>High-intensity mCIMT</td>
<td>16 / 348</td>
<td>11</td>
<td>0.070</td>
<td></td>
</tr>
<tr>
<td>Low-intensity mCIMT</td>
<td>16 / 337</td>
<td>41</td>
<td>0.097</td>
<td></td>
</tr>
<tr>
<td>Robotics—unilateral shoulder-elbow</td>
<td>10 / 261</td>
<td>0</td>
<td>0.335</td>
<td></td>
</tr>
<tr>
<td>Robotics—bilateral elbow-wrist</td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mental practice with motor imagery</td>
<td>15 / 246</td>
<td>53</td>
<td>0.094</td>
<td></td>
</tr>
<tr>
<td>Mirror therapy</td>
<td>4 / 104</td>
<td>82</td>
<td>0.252</td>
<td></td>
</tr>
<tr>
<td>Virtual reality training</td>
<td>6 / 89</td>
<td>0</td>
<td>0.098</td>
<td></td>
</tr>
<tr>
<td>NMS wrist/finger extensors</td>
<td>3 / 82</td>
<td>79</td>
<td>0.090</td>
<td></td>
</tr>
<tr>
<td>NMS wrist/finger flexors/extensors</td>
<td>2 / 41</td>
<td>13</td>
<td>0.341</td>
<td></td>
</tr>
<tr>
<td>NMS shoulder</td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EMG-NMS wrist/finger extensors</td>
<td>14 / 162</td>
<td>49</td>
<td>0.971</td>
<td></td>
</tr>
<tr>
<td>EMG-NMS wrist/finger flexors/extensors</td>
<td>2 / 31</td>
<td>22</td>
<td>0.284</td>
<td></td>
</tr>
<tr>
<td>TENS</td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EMG-BF</td>
<td>6 / 102</td>
<td>0</td>
<td>0.146</td>
<td></td>
</tr>
<tr>
<td>Trunk restraint</td>
<td>3 / 58</td>
<td>0</td>
<td>0.096</td>
<td></td>
</tr>
<tr>
<td>Interventions somatosensory functions</td>
<td>15 / 246</td>
<td>0</td>
<td>0.388</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Comparator arms (n) / Patients (N)</th>
<th>$I^2$ (%)</th>
<th>Hedges’ $g$ (95% CI)</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome: motor function arm</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Therapeutic positioning arm</td>
<td>NA</td>
<td>0</td>
<td>0.056</td>
<td></td>
</tr>
<tr>
<td>Reflex-inhibiting/immobilization</td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air-splints</td>
<td>5 / 205</td>
<td>58</td>
<td>0.162</td>
<td></td>
</tr>
<tr>
<td>Techniques and devices GHHS/HSP</td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bilateral arm training</td>
<td>9 / 274</td>
<td>80</td>
<td>0.081</td>
<td></td>
</tr>
<tr>
<td>Original CIMT</td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-intensity mCIMT</td>
<td>4 / 50</td>
<td>57</td>
<td>0.097</td>
<td></td>
</tr>
<tr>
<td>Low-intensity mCIMT</td>
<td>15 / 333</td>
<td>39</td>
<td>0.887</td>
<td></td>
</tr>
<tr>
<td>Robotics—unilateral shoulder-elbow</td>
<td>17 / 327</td>
<td>0</td>
<td>0.343</td>
<td></td>
</tr>
<tr>
<td>Robotics—bilateral elbow-wrist</td>
<td>4 / 62</td>
<td>0</td>
<td>0.841</td>
<td></td>
</tr>
<tr>
<td>Robotics—shoulder-elbow-wrist-hand</td>
<td>2 / 36</td>
<td>75</td>
<td>0.053</td>
<td></td>
</tr>
<tr>
<td>Mental practice with motor imagery</td>
<td>11 / 149</td>
<td>29</td>
<td>0.154</td>
<td></td>
</tr>
<tr>
<td>Mirror therapy</td>
<td>3 / 112</td>
<td>52</td>
<td>0.434</td>
<td></td>
</tr>
<tr>
<td>Virtual reality training</td>
<td>8 / 158</td>
<td>0</td>
<td>0.183</td>
<td></td>
</tr>
<tr>
<td>NMS wrist/finger extensors</td>
<td>2 / 49</td>
<td>84</td>
<td>0.053</td>
<td></td>
</tr>
<tr>
<td>NMS wrist/finger flexors/extensors</td>
<td>2 / 41</td>
<td>0</td>
<td>0.697</td>
<td></td>
</tr>
<tr>
<td>NMS shoulder</td>
<td>2 / 32</td>
<td>33</td>
<td>0.219</td>
<td></td>
</tr>
<tr>
<td>EMG-NMS wrist/finger extensors</td>
<td>3 / 49</td>
<td>0</td>
<td>0.388</td>
<td></td>
</tr>
<tr>
<td>EMG-NMS wrist/finger flexors/extensors</td>
<td>2 / 31</td>
<td>0</td>
<td>0.315</td>
<td></td>
</tr>
<tr>
<td>TENS</td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EMG-BF</td>
<td>2 / 69</td>
<td>0</td>
<td>0.262</td>
<td></td>
</tr>
<tr>
<td>Trunk restraint</td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interventions somatosensory functions</td>
<td>4 / 179</td>
<td>51</td>
<td>0.716</td>
<td></td>
</tr>
</tbody>
</table>
Case study 1 - Kevin

• 56 yr old man suffered R middle cerebral artery territory ischaemic stroke on 4/2/15

• UL goals
  – Achieve independence with dressing, showering
  – Use L arm for meal preparation
  – Maintain active and passive ROM L arm
Current function

- Shoulder shrug and some active shoulder flexion
- Movement patterns dominated by compensatory trunk lean and shoulder shrug
- Experiences pain at rest, during night and on external rotation
- No swelling or significant spasticity
Kevin
Weblink

• Go to: http://tri-stroke.pivotdesigngroup.com/
Case study 2 - Mik

- 82 yr old man suffered R middle cerebral artery territory ischaemic stroke on 16/3/15
- UL goals
  - Eat with cutlery and feed himself
  - Dress himself independently
  - Return to making things in his shed
Current function

- Active shoulder Flexion and Abduction
- Weaker proximally than distally
- Good sensation, no increased muscle tone
- Able to perform some fine motor tasks but slow and poor coordination
Mik
The challenge

• What are the barriers to implementing best evidence in your practice?
  – Time with patients/length of stay
  – Cost of equipment e.g. ES, robotics
  – Resources -staffing e.g. CIMT

• If you had access to this app when you return to your clinical practice next week – would you use it?

• We look forward to your feedback!
Contact details

Steve Wolf:  swolf@emory.edu

Mark Bayley:  Mark.Bayley@uhn.ca

Gert Kwakkel:  g.kwakkel@fumc.nl

Michelle McDonnell:  michelle.mcdonnell@unisa.edu.au