UNIVERSITY OF Southampton
School of Health Sciences

Technologies for stroke rehabilitation: Clinical applications

Dr Sara Demain

shd@soton.ac.uk

Faculty of Health Sciences

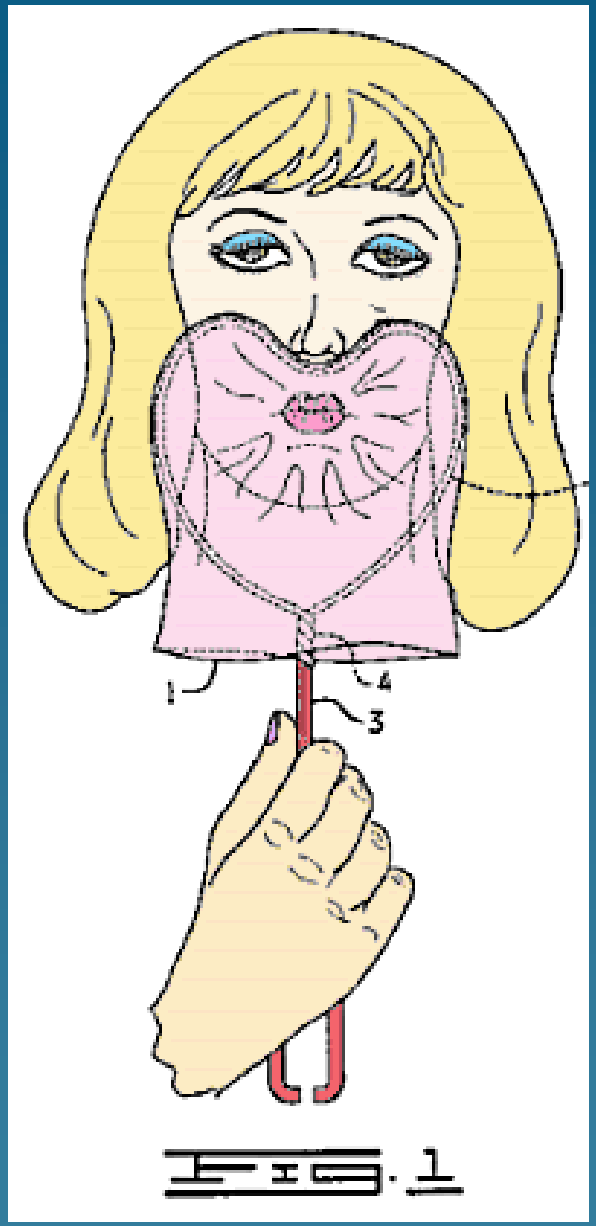
Outline

- What makes a good technology?
- What technologies exist for stroke rehab?
- What evidence is there for these technologies?
- What do people want from technologies?
- What is the future?

Ideal technologies…..

High on Benefits

- Solve a problem
  - that is important
  - to enough people
- Improve life – easier, more fun, more beautiful
- Clear that it is effective



- Solve a problem ?
- Improve life ?
- Clear that it is effective?

- Solve a problem ?
- Improve life ?
- Clear that it is effective?

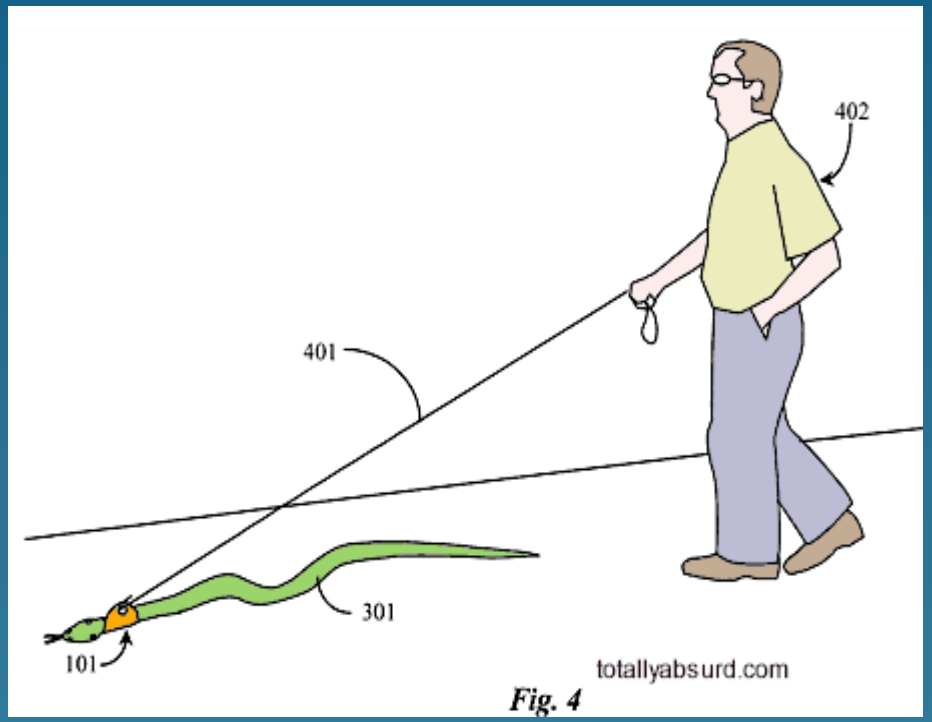
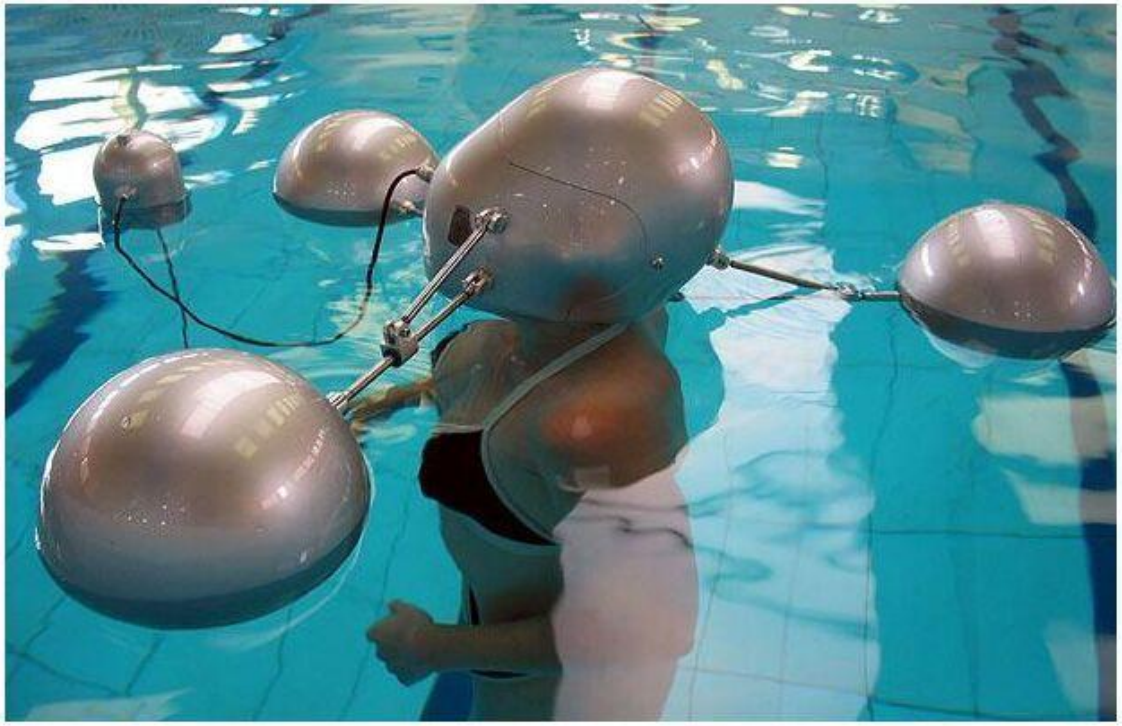


Fig. 4



The Isophone - an underwater telephone system designed by James Auger and Jimmy Loizeau. The space-age device means you can communicate with other swimmers while splashing around in the pool

The Isophone is essentially a telecommunications device providing a service that can be described simply as a meeting of the telephone and the floatation tank. The user wears a helmet that blocks out all peripheral sensory distraction whilst keeping the head above the surface of the water… a space is created for providing a pure, distraction free environment for making a telephone call.

Ideal Technologies….

Low on Costs

- Easy to use, learn to use, maintain
- Be reasonably priced (for benefits)
- Reliable, cheap and easy to run and maintain
- Fit 'identity' and lifestyle – appearance, stigma, others views, relationships
- Fit cultural beliefs and practices
- Minimally Disruptive

- Easy to learn to use and use?
-
- Be reasonably priced

- Reliable, cheap and easy to run and maintain

- Fit ‘identity’ and lifestyle

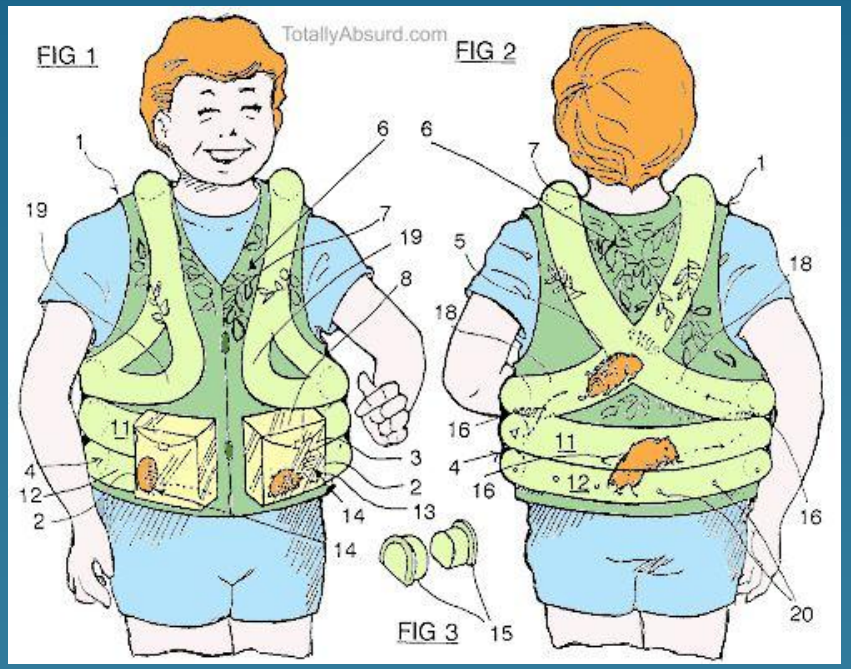
- Fit cultural beliefs and practices

Low on Costs

- Easy to learn to use and use
- Be reasonably priced
- Reliable, cheap and easy to run and maintain
- Fit ‘identity’ and lifestyle
- Fit cultural beliefs and practices

Low on Costs

- Easy to learn to use and use
- Be reasonably priced
- Reliable, cheap and easy to run and maintain
- Fit ‘identity’ and lifestyle
- Fit cultural beliefs and practices



Ideal technology?

High on Benefits

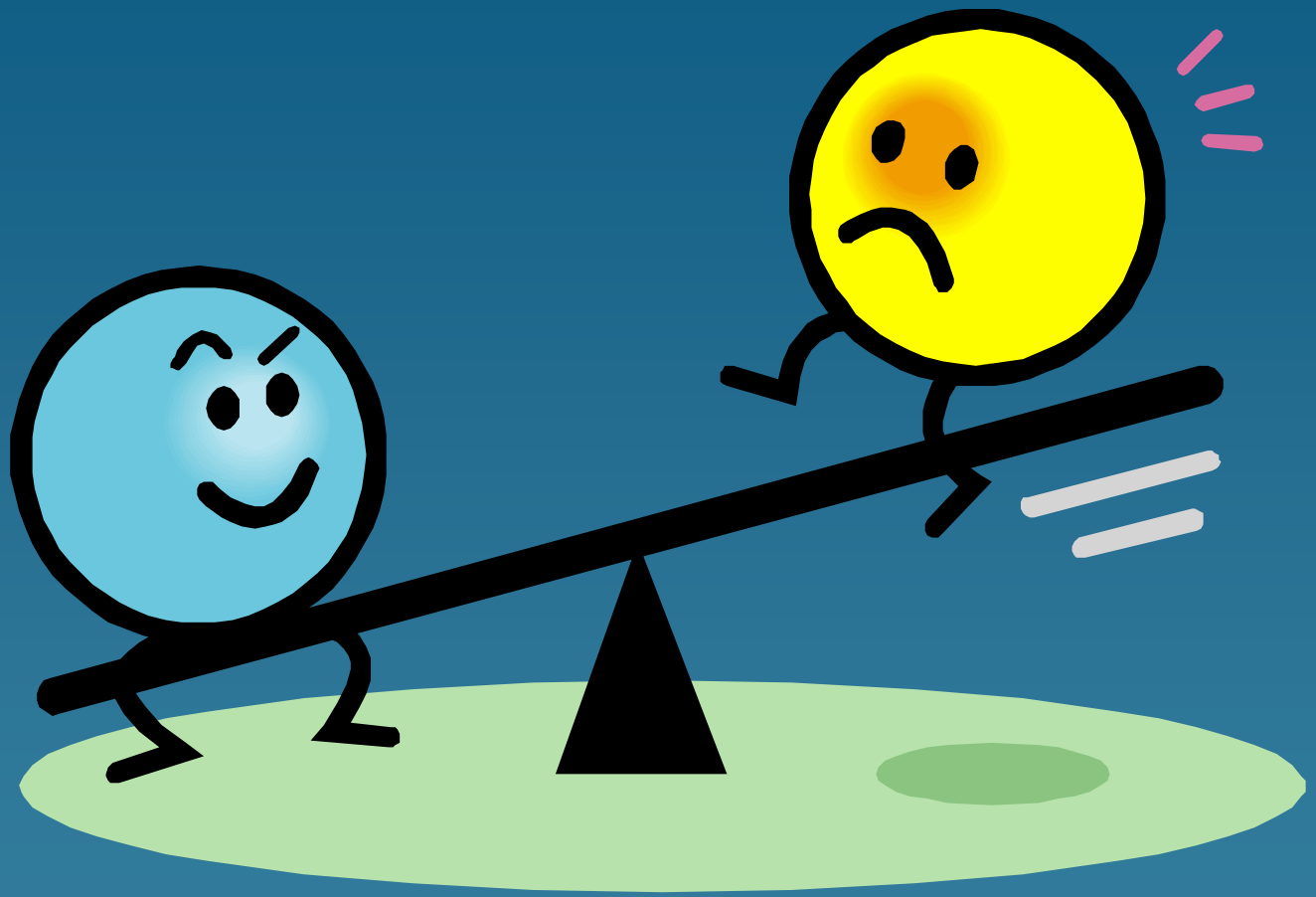
- Solve a problem
  - that is important
  - to enough people
- Improve life
  - easier, more fun, more beautiful
- Clear that it is effective

Ideal technology?

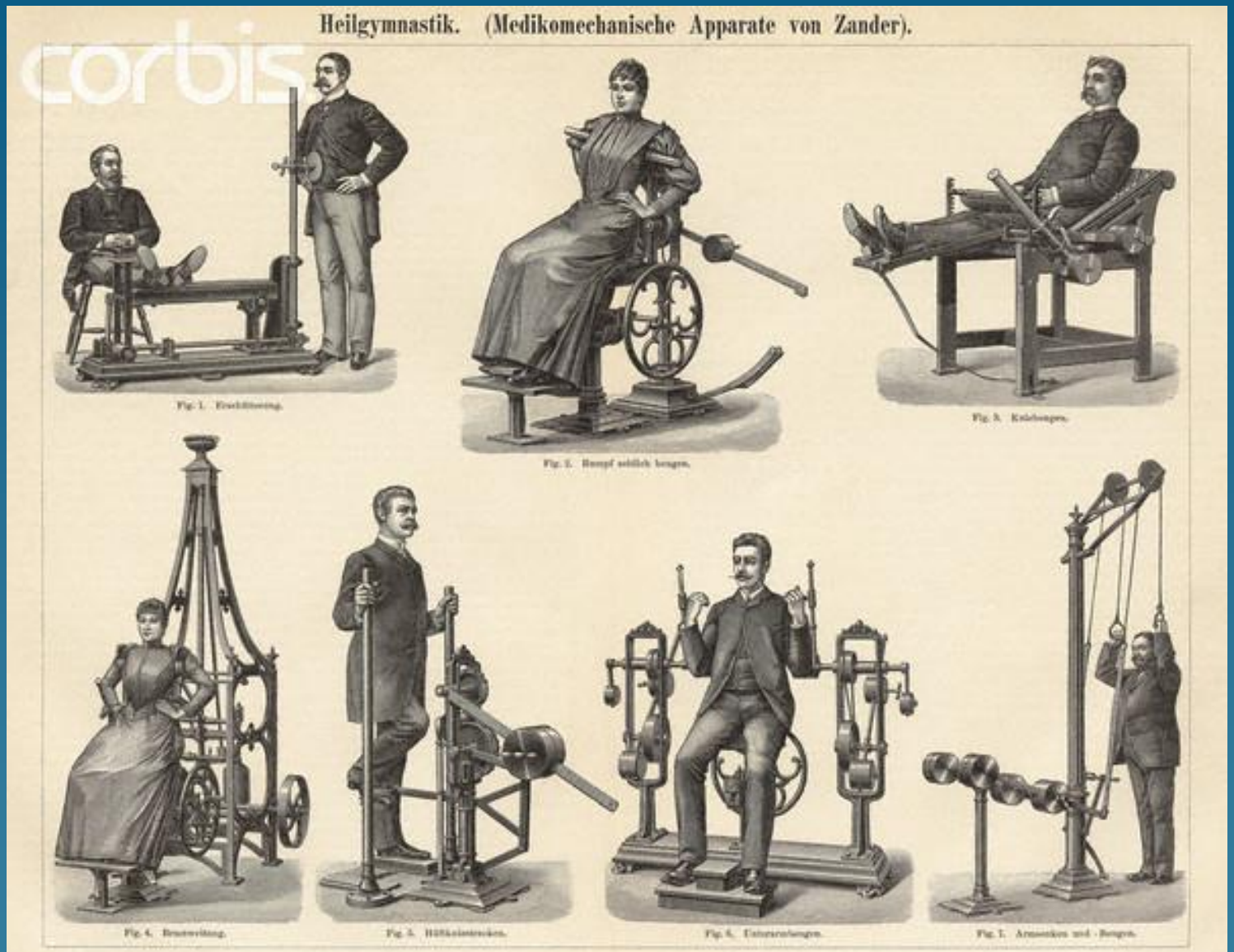
Low on Costs

- Easy to learn to use and use
- Be reasonably priced (for benefits)
- Reliable, cheap and easy to run and maintain
- Fit/change ‘identity’ and lifestyle – appearance, stigma, others views, relationships
- Fit/change cultural beliefs and practices

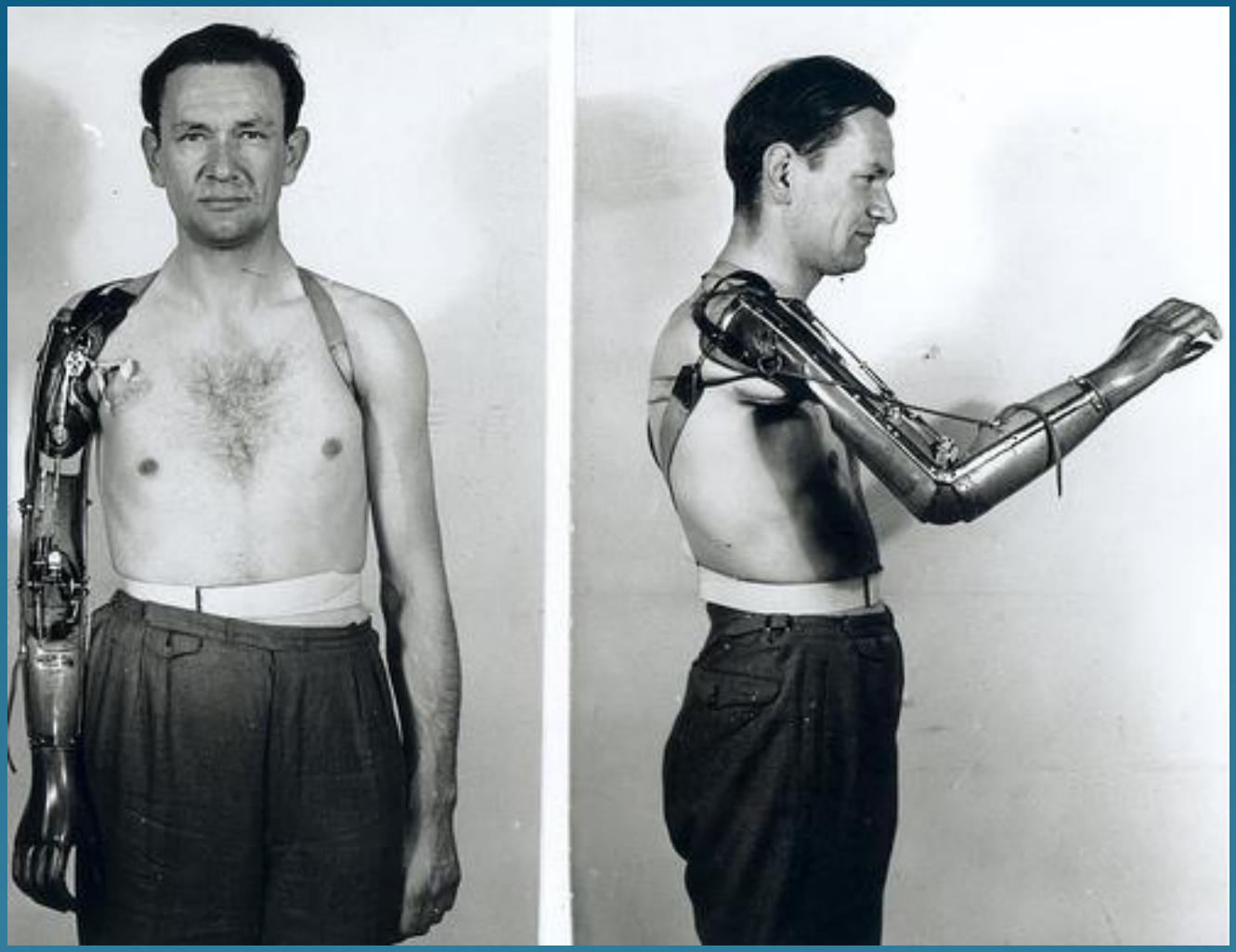
I-phone



Technologies in Rehabilitation


Heilgymnastik. (Medikomechanische Apparate von Zander).
corbis


FB45-23-6



Rehab Technologies Today

Market for Rehab Technologies

- Neurotech report estimates global market for neuro-rehab products:
  - $348 million 2010
  - $757 million 2014
- Lack of evidence will limit uptake by healthcare funders
- Costs borne by patients and families keen for recovery ?

What works in stroke?

Gait and mobility –SIGN 2010

Recommended
▪ ankle foot orthoses ▪ individualised interventions ▪ gait-oriented physical fitness training ▪ repetitive task training ▪ muscle strength training to improve muscle strength ▪ increased intensity of rehabilitation
Consider
▪ treadmill training in people who are independent in walking ▪ functional electrical simulation for drop-foot ▪ electromechanical assisted gait training
Not recommended
▪ routine treadmill training ▪ routine EMG biofeedback ▪ balance platform training with visual feedback
Insufficient evidence
▪ routine electrostimulation ▪ walking aids

Upper Limb – SIGN 2010

Consider
▪ constraint induced movement therapy ▪ mental practice ▪ electromechanical/robotic devices
Not recommended
▪ repetitive task training ▪ splinting ▪ increased intensity of rehabilitation
Insufficient evidence
▪ electrostimulation ▪ routine EMG biofeedback ▪ virtual reality ▪ bilateral training ▪ approach to therapy

Rehabilitation Robots

- Multiple functions
  - Gait
  - Ankle
  - Arm
  - Hand
- Currently expensive and cumbersome
- Complex to set up – time saving?


Lokomat


Armeo Boom
Hocoma


Armeo Spring

Robots in Rehab (Burridge and Hughes 2010)

- Not superior to intensive therapy
- Currently costs of robot therapy = intense therapy (Lo et al, 2010)
- Robots need to be cheaper, simple to put on and use at home
- Robots can give detailed info on motor performance for assessment, trials and patient motivation.

Robot v Robot + VR –Mirelman 2009

- Force feedback ankle robot
  - Ankle movements alone
  - Ankle movements to navigate virtual environment
- VR group significant improvements
  - Walking speed
  - ADL
- VR group more motivated, needed less encouragement, less fatigued, attended longer.
- Motivation key to sustained practice?

Virtual Reality

Wii-habilitation

- http://gamevideos.1up.com/video/id/16529

Wii Upper limb: acute – Saposnik 2010

- 22 people with stroke
  - mean age = 61 years
  - mild to moderate stroke
  - time since stroke mean =24 days
- Randomized to Wii (n=11) or standard recreational therapy (n=11).
- Chedoke-McMaster Arm Deficit Score: 4 or higher
- 8 x 1 hr sessions over 2 weeks
  - Wii sessions: virtual tennis and Cooking Mama
  - Regular therapy: card games, Jenga, stamping a card (as in a bingo)

Wii Upper Limb: acute - Results

- Assessed 4 weeks after intervention finished
  - Wolf Motor Function Test (WMFT)
  - The Box and Block Test
  - Stroke Impact Scale
- Wii group significant improvements in
  - Grip strength
  - 30% faster on WMT tasks (20secs v 27secs)

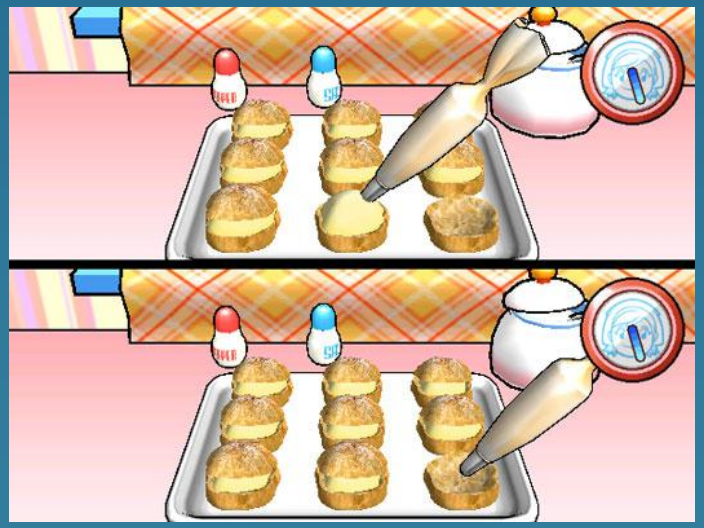
Wii upper limb: chronic – Christie et al, 2010

- Stroke patients (n=11)
  - completed standard upper limb rehabilitation
  - median age 55 years
  - mean time from stroke 216 days (7 months)
- Wii Sports daily for six weeks.
- Assessments were performed at baseline and after 6 weeks.
  - Jebsen-Taylor Hand Function Test
  - Action Research Arm Test
  - grip strength (E-Link Mule)
- A questionnaire was used to assess participant engagement in Wiihab


Chop up!
IGN.COM


Use the hand mixer!


Break an egg!
x 7



Wii Upper limb: chronic - results

- 9 people completed research.
  - 1 DNA;
  - 1 found console too challenging
- Grip strength doubled (21 to 42 lbs) (p=0.03)
- Trends improvement in all domains Jebsen-Taylor
  - picking up and placing small objects (p=0.008)
  - moving light large cans (p=0.05).
- High levels of enjoyment
- Majority (>75%) reported improved UL function in ADL
- Transient pain and upper limb stiffness reported by all

Commercial VR applications

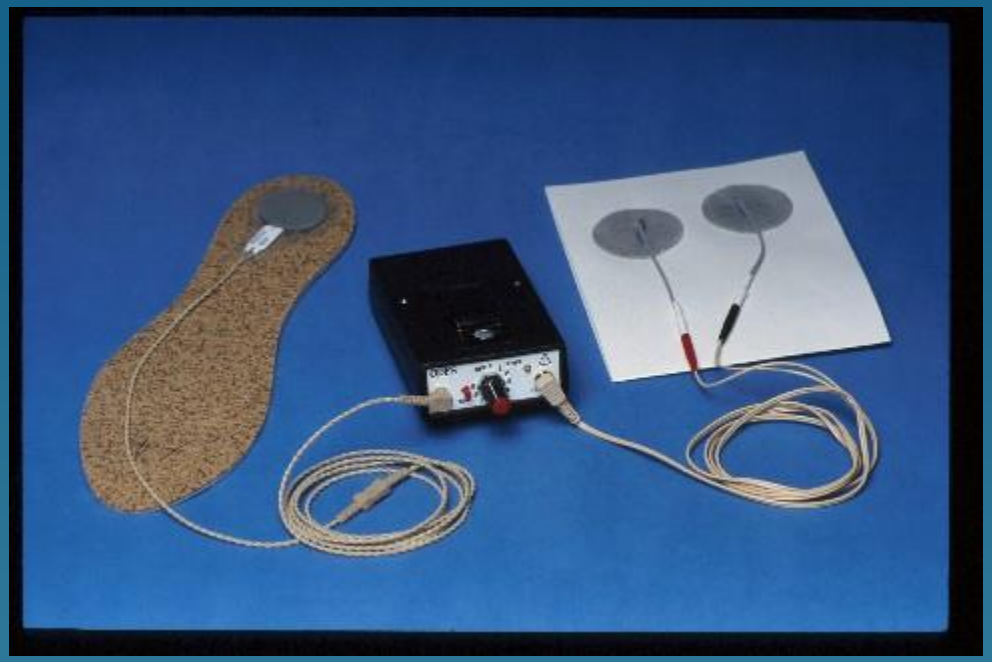
Advantages

- Relatively cheap to buy
- Well developed and designed (millions pounds investment)
- Fun
- Socially acceptable
- Feedback on success
- Motivation

Disadvantages

- Not designed with stroke in mind
  - Cognitive overload
  - Older generation
  - Complexity of tasks
  - Quality of movement?
  - Over-use injuries?
- Limited feedback health professionals

Electrical Stimulation - ankle



Electrical stimulation upper limb

Electrical Stimulation

- Drop foot stimulation recommended NICE
- Implanted DFS
  - easier to use, more acceptable
  - No more effective
- Insufficient evidence ES in UL
- BUT growing market UL devices, almost all purchased privately

Dynamic Splints

- Limited evidence
- No RCTs
- Cohort studies:
  - ↑grip strength
  - ↑wrist ext ROM
- Popular with therapists
- Sold to 55/320 NHS Trusts
- NAO report: reduced LoS

Constraint-Induced Movement Therapy
(from Burridge and Hughes, 2010; Sitori et al, 2009)

- Intensive training affected arm
- Prolonged restraint unaffected arm
- Substantial research
- Significant effects
  - arm motor function
  - amount and quality of mvt
  - impairments
- No effect QoL
- Results not maintained beyond 6/12 (NB small sample)

Assistive Technologies Rehabilitation Arm after Stroke

NIHR: Swain, Burridge, Jenkinson, Pandyan et al

Main objective of ATRAS

- To improve recovery of upper limb function following stroke
- Identifying technologies that have strong evidence for clinical and cost effectiveness and acceptability
- Comparing two complementary technologies with current treatment in a randomised controlled trial
- Develop a new NHS Care Pathway

How will we achieve this?

- Work Package 1: Define current practice
- Work Package 2: Review the research evidence
- Work Package 3: Examine user acceptability
- Identify the most promising technologies
- Work Package 4: Clinical trial
- Translate our findings into clinical practice

Understanding user acceptability

- Interactive Exhibition
- Focus groups
- Questionnaire

Interactive Exhibition - University of Southampton

- To raise awareness, publicise the project and establish links with stakeholders
- 12 commercial companies
- 27 technologies
- 204 attendees (clinicians and researchers, budget holders and commissioners, patients and carers) > 150 miles
- Interaction with technologies
- Queues! People missed lunch to try equipment

Focus groups

- 4 Focus Groups
  - Naïve patients
  - Experienced patients
  - Carers
  - Health Care Professionals
- Telephone interviews budget holders and commissioners
- Workshop at National ACPIN conference

Findings: Patients and carers
Lack of Rehab Stroke UL

- Frustration at lack of NHS provision UL rehab
- Focus on gait and getting out hospital
- Transition between hospital and home
- Lack of information about rehabilitation
- Poor recognition of the burden on carers (emotional, relational, practical, financial)
- Perceived lack of engagement with technology from healthcare professionals
- Fighting the system

Findings: Patients and carers
Devices

- Motivation to optimise recovery
- Hope in technology – informed by knowledge of neuroplasticity and importance of practice
- Belief in technology - because it's designed for purpose
- Desire for something which they can wear during daily life and use in ADL
- Easy to put on/off, many current devices difficult
- Prepared to purchase if they know it will work
  - "try before you buy" or lease purchase schemes

Findings: Healthcare Professionals

- Lack of evidence
- Frustration at the system
  - Wanted access to try for themselves
  - Does it work for this person?
  - Can't get funding
- Device practicalities
  - Cost – initial and running
  - On/off and set-up time
  - Storage
  - Maintenance and cleaning
- Not wanting to raise expectations
  - of recovery
  - of provision
- Knowledge, information and choice (NHS vs private approaches)
- Future role envisaged

Findings:
Budget Holders and Commissioners

- Stroke upper limb is unacknowledged problem
  - Not priority outcome? (LoS, Mortality, Recurrence)
- Commissioners buy services but therapists are not selling device based services to commissioners
  - Lack of evidence of benefit
  - Don't know the system
  - Don't think they would be able to make good enough case for devices
  - Effort
- No perceived clear route to market c.f. drugs
- Devices are the remit of therapists. They have no budget.

Current Position (Burridge and Hughes 2010)

- Lack robust evidence for technologies

→ limited translation clinical practice

- Interactions:
  - Clinical and cost-effectiveness
  - Commercial availability and scale
  - Funding
  - User acceptability

Current Position (Burridge and Hughes 2010)

- Mismatch between strength of research and uptake in clinical practice
  - ↑sales UL Electrical Stimulation and dynamic splints
  - Poor uptake CIMT despite good evidence
- Why ? – point for discussion
- Normalization Processes? (May et al , 2007) http://www.normalizationprocess.org/

Where are we and where next?

- Technologies look promising
- Increasing buy-in
  - Patients
  - Carers
  - Therapists
- Threats
  - Therapy resistance
  - Patient/carer competencies and views

Where are we and where next?

- More evidence
  - For whom?
  - When?
  - How to deliver (coming next)
  - Combinations of technologies
- Economies scale – off-shelf products
- Improve design and usability
- Buy in from people in power
  - Fund research, fund devices, change systems