

Using Technology To Assist With Rehabilitation After Stroke

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<http://www.rnhrd.nhs.uk/>

www.bath.ac.uk/health/research/rehabNet/index-new.html

SMART rehabilitation and motion tracking systems to support rehabilitation of people with stroke

'To examine the scope, effectiveness and appropriateness of systems to support home-based rehabilitation programmes for older people and their carers'

<http://hsc.shu.ac.uk/smart/>

<http://www.fp.rdg.ac.uk/equal/>

Why do people go into care ?

- Impact of Stroke @ 6 months
 - 49% need help bathing
 - 31% need help dressing
 - 33% need help with feeding
- Rehabilitation often targeted at early discharge.
- Locomotor disability and physical impairment account for 65% of those in care.



More effective rehabilitation will help
people remain at home

'My wife is 18 months since she came out home and I think we've had 3 visits from the physiotherapist 3 days and that was it.'

'I mean we're everything, aren't we, carer, nurse, doctor, cleaner, we're a, you know everything.'

'My husband can't walk, he can't talk, and he can't see properly and they've discharged him. I mean that's disgusting.'



Rehabilitation – some issues

- Rehabilitation traditionally hands on – technology that can enable and support rehabilitation is not being exploited.
- Repetition is primary contributor to functional recovery but compliance is poor.

'As I get older I am inclined to do less of the things I ought to do and more of the things I want to do.'

Quality and skill acquisition are important !

Basic types of intervention

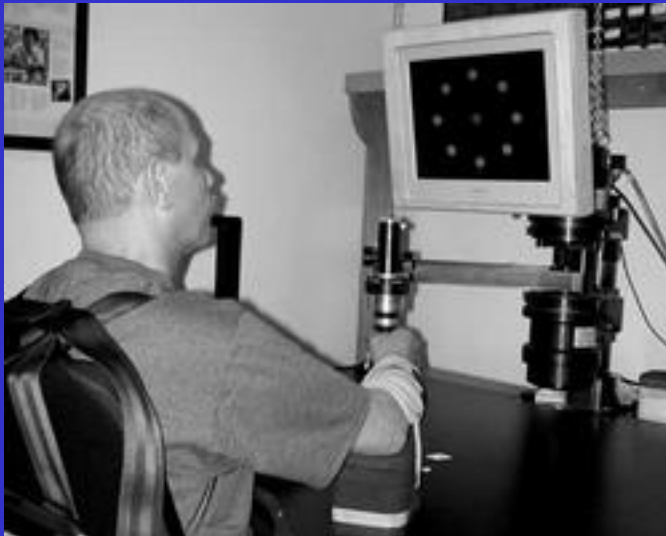
- Lateral weight transfer on sitting
- Weight transfer on standing
- Sit to stand
- Step forward with affected limb
- Reach forward and return upper limb
- Hand to mouth and return with object

Devices available for motion tracking and rehabilitation

- Switches (Pedometer)
- Position (radio frequency, magnetic field)
- Gyroscopes (angle / rate of turn)
- Accelerometers (velocity)
- Video systems
 - Passive (Vicon) or Active (CODA)
- Robot arms (MANUS/MIME)

Robot assisted rehabilitation

- MIT-MANUS, ARM guide, MIME, GENTLE
- USA 1995 –
- Cambridge, Reading, Newcastle, Leeds



Systematic review of assisted rehabilitation

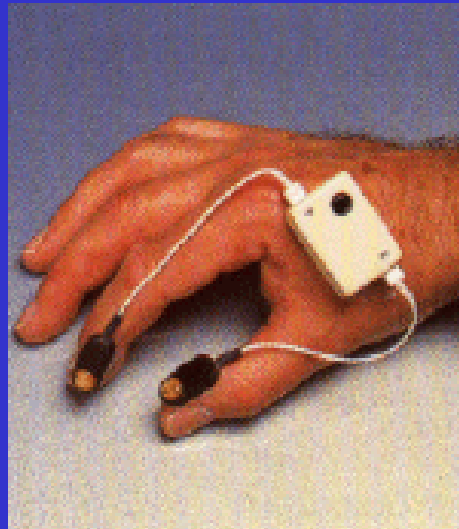
- Motion sensor technology / assistive device / robot / therapy
- Effectiveness - clinical trials, post acute, Stroke or Neuro
- 23 trials + 7 reviews
- MIT-MANUS (6) MIME (2) ARM-Guide (1)
- Poor sample size (median 27)
- Variable outcome measures

Systematic review of assisted rehabilitation

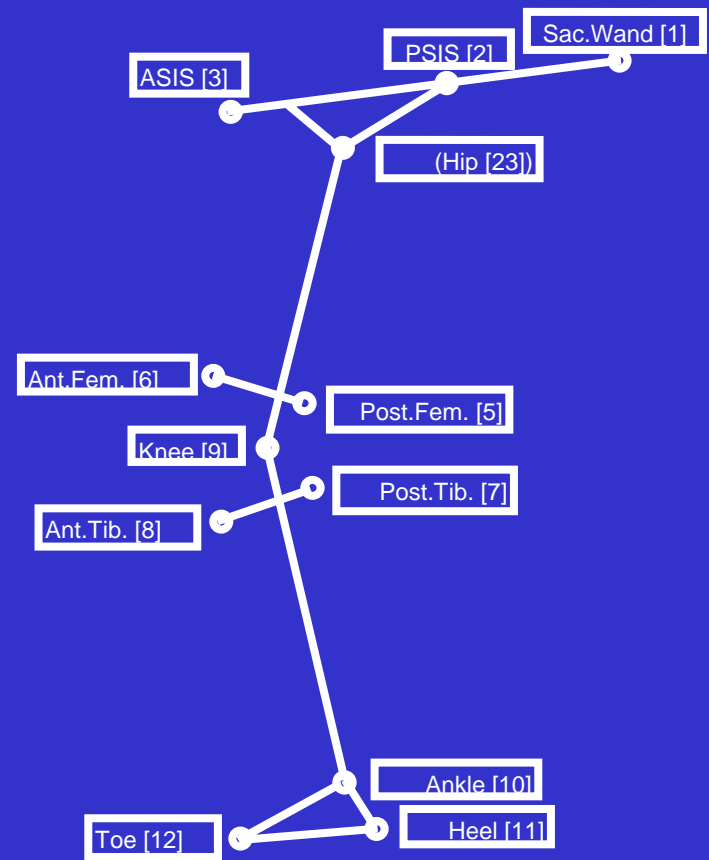
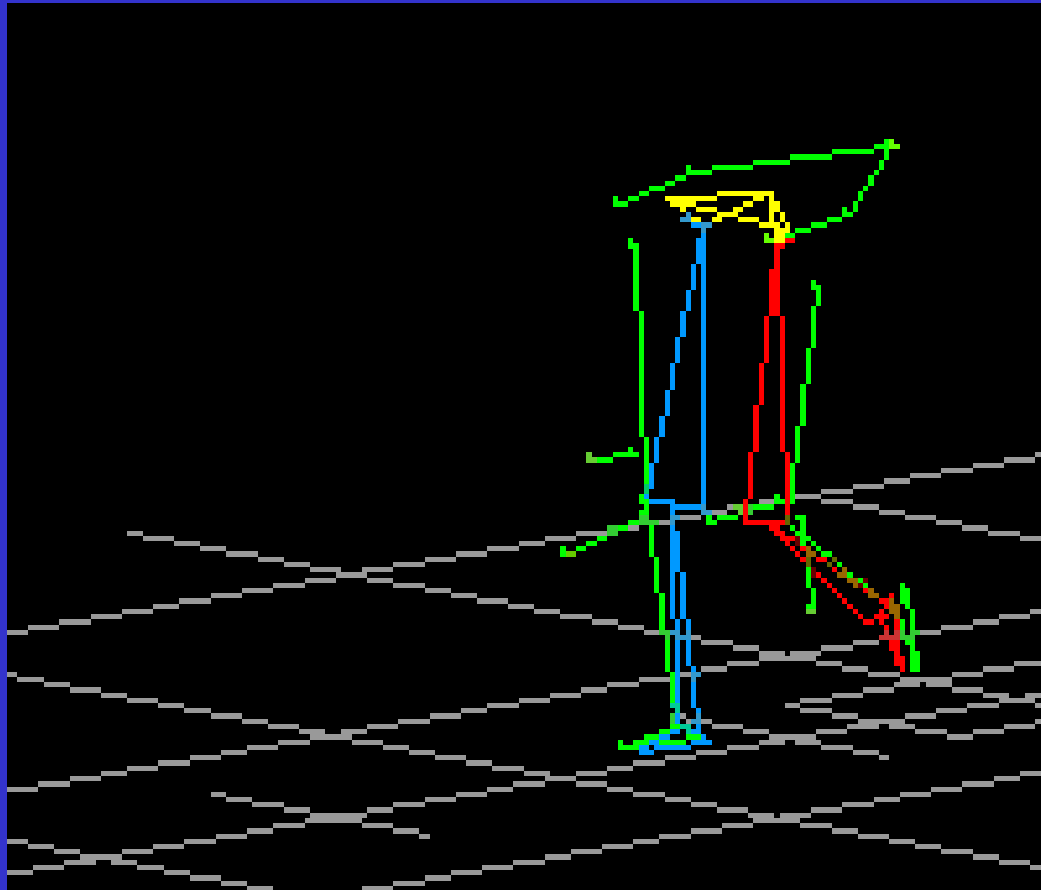
- 192 patients involved in 7 clinical trials
- Outcomes based on biomechanical parameters of impairment rather than clinical measures
- 2 devices demonstrated benefit compared with conventional treatment
- Cautions optimism that the technology can be developed
- Need independent trials using functional outcomes

Active video motion capture

Charnwood Dynamics *coda*



CODA marker placement for gait analysis

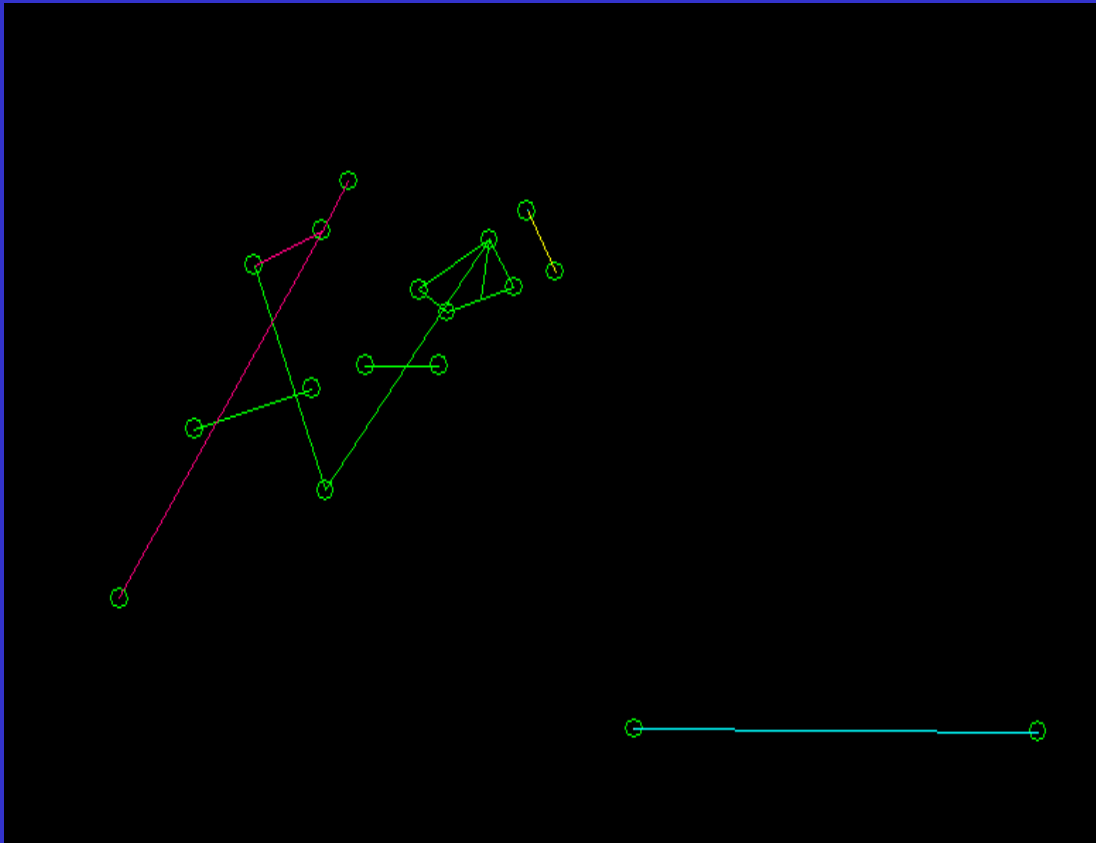


Reference data - functional upper limb activity following stroke

- Pilot investigation of older adult participants
- 1 trial of cyclic drinking activities
- Self-paced repetition

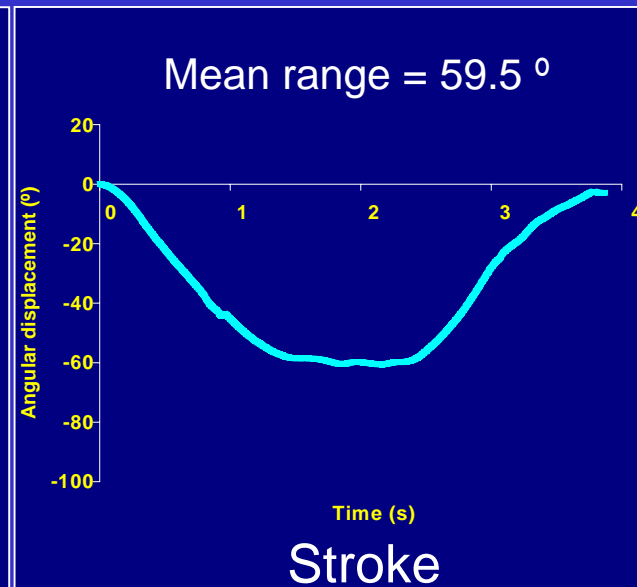
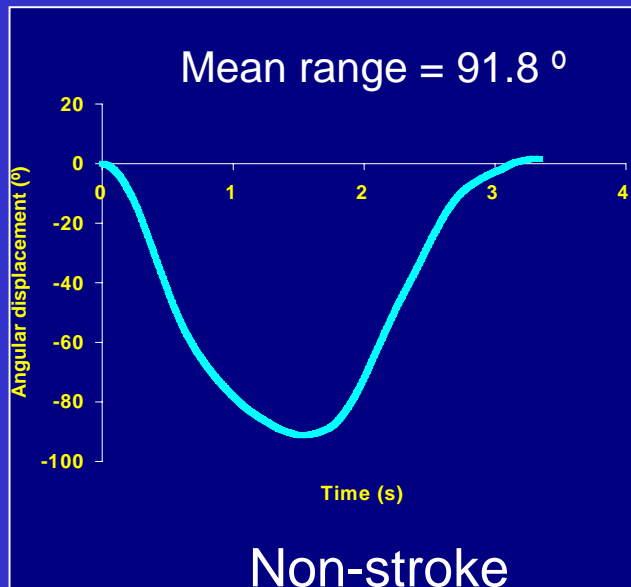
- 3D motion
- Linear and angular measures
- Time derivatives of linear and angular measures
- Joint and segmental measures

Upper limb drinking motion

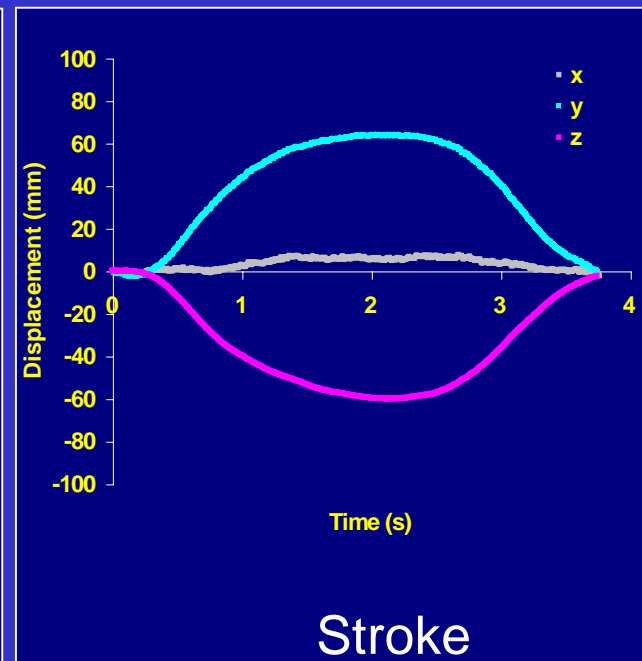
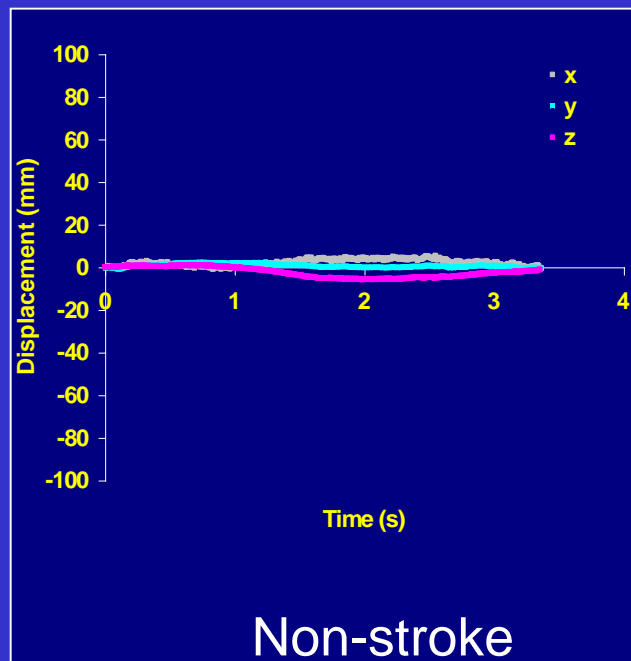


Marker	Marker name
1	C3
2	C7
3	T12
4	Acromian
5	UArm wandP
6	UArm wandD
7	Lateral epicondyle
8	LArm wandP
9	LArm wandD
10	Radial styloid
11	Ulna styloid
12	3mcp
13	5mcp

Elbow Flexion / Extension

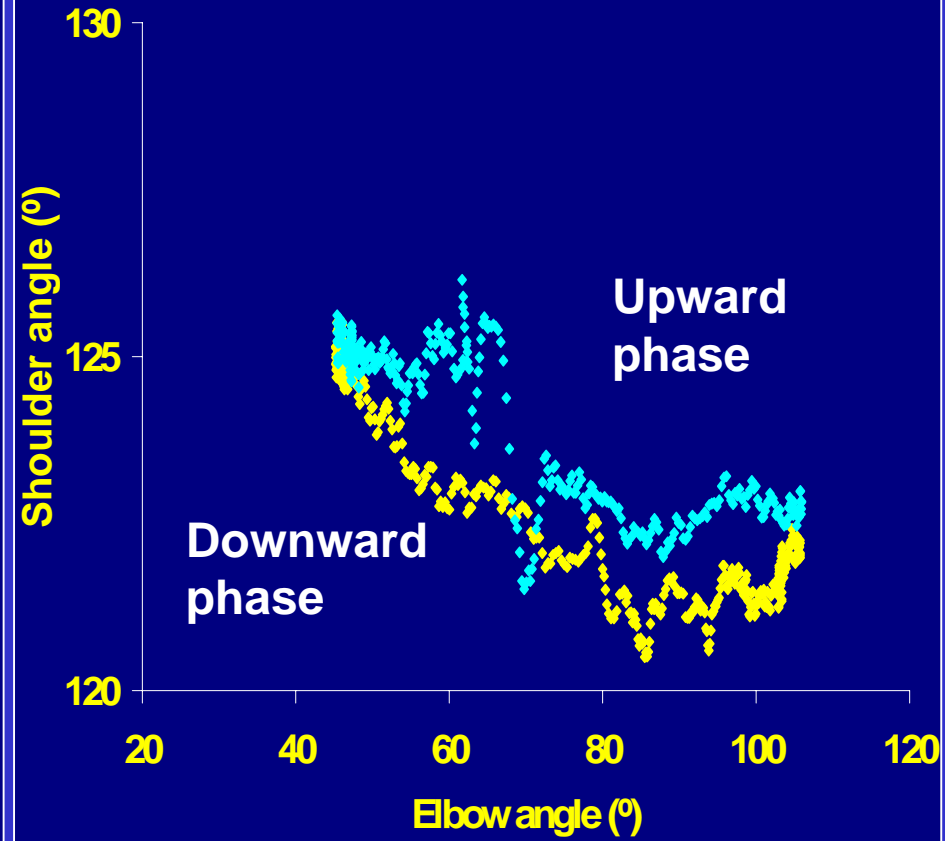
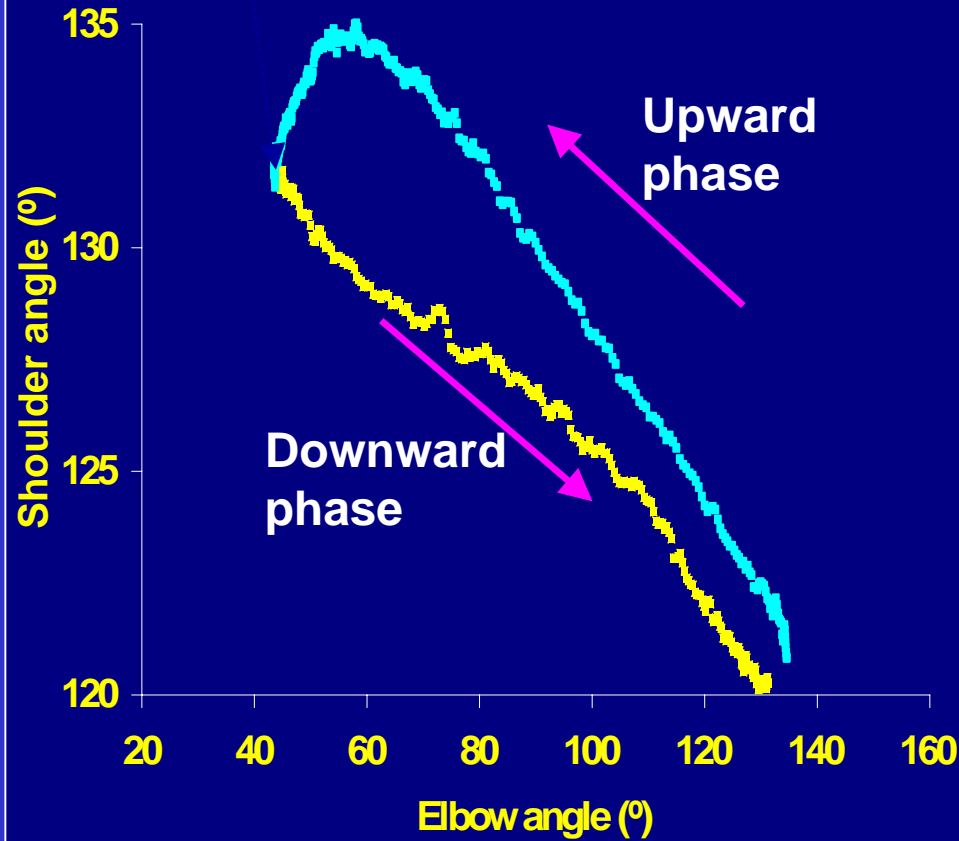


Trunk (T12) Deviation



CODA – angle angle plot

Cup to mouth

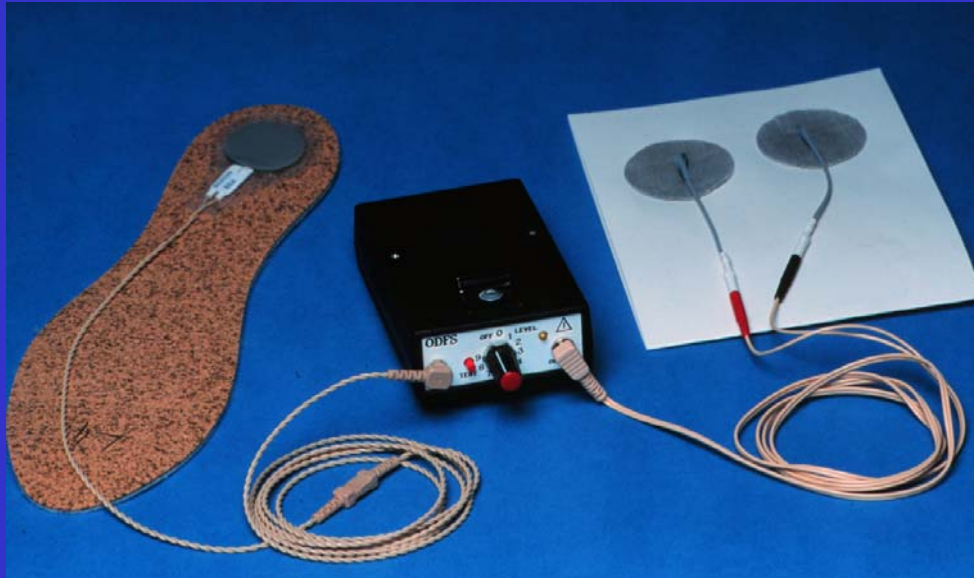


Key Outcome Measures

- Cycle durations
- Phase durations (e.g. cup to mouth)
- Range of joint motions (elbow flexion/extension)
- Segment deviation (trunk motion)
- Interaction of joint actions (coordination)
- End effector peak velocity

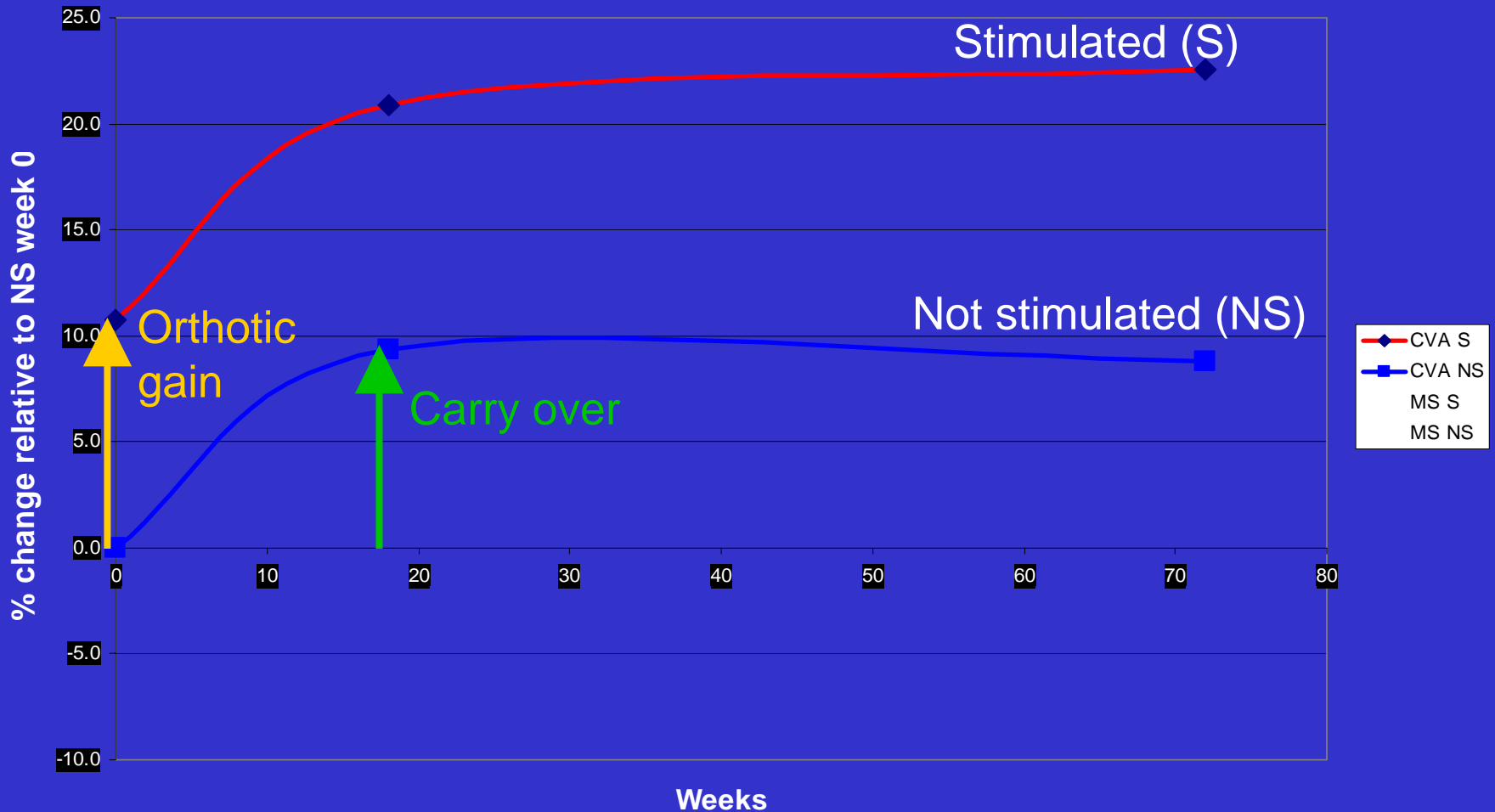
How much data, real time or summary ?

The Odstock FES Dropped Foot Stimulator



- FES = production and control of movement in paralysed muscle by application of electrical impulses.

% change in median walking speed for CVA – compared with Not Stimulated at week 0

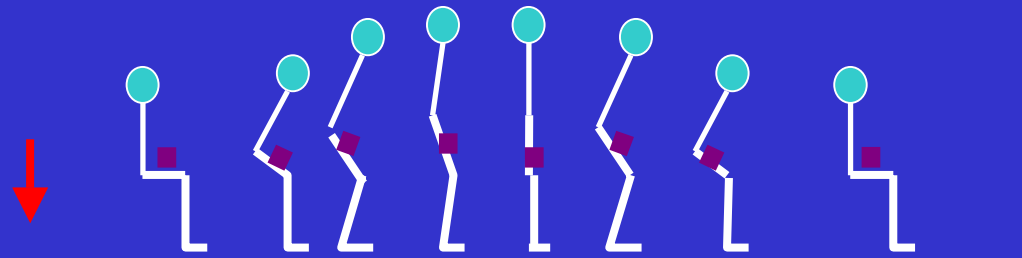
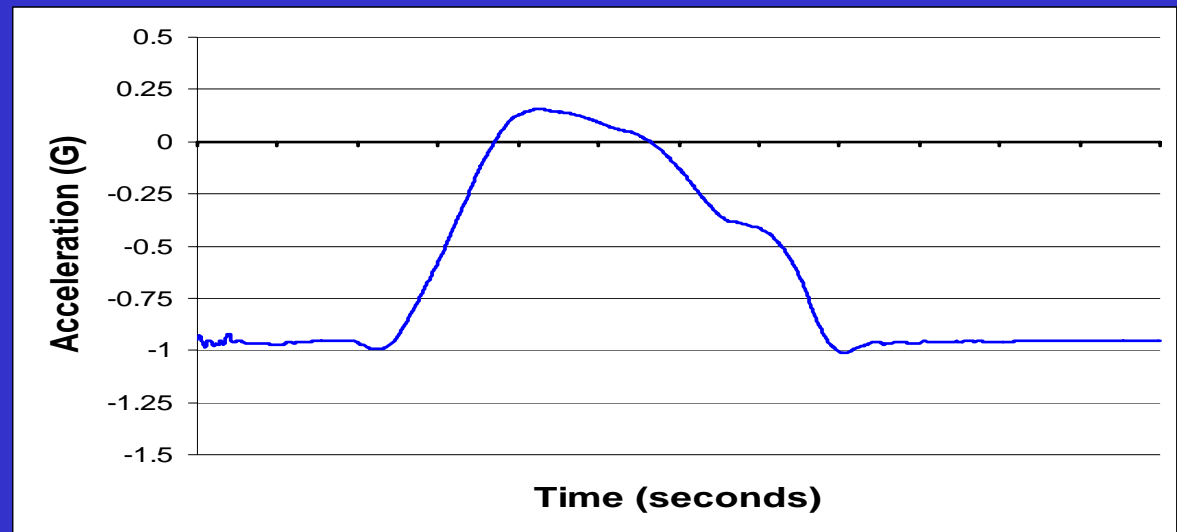
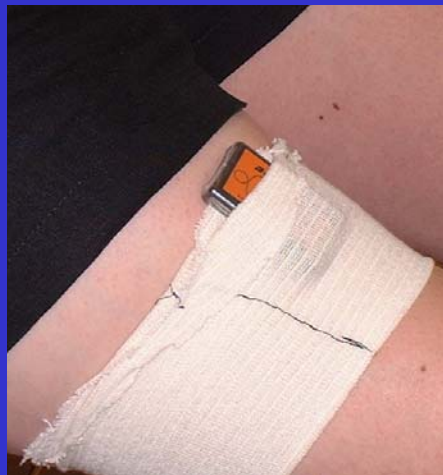


CVA (n = 116)

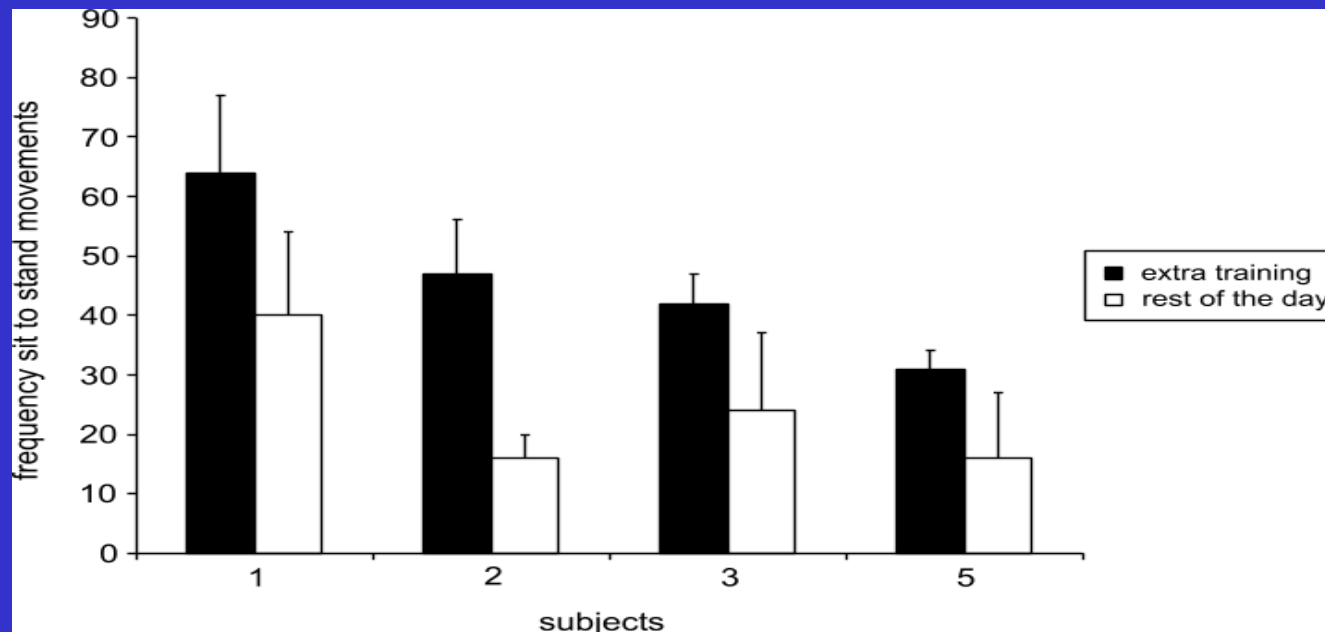
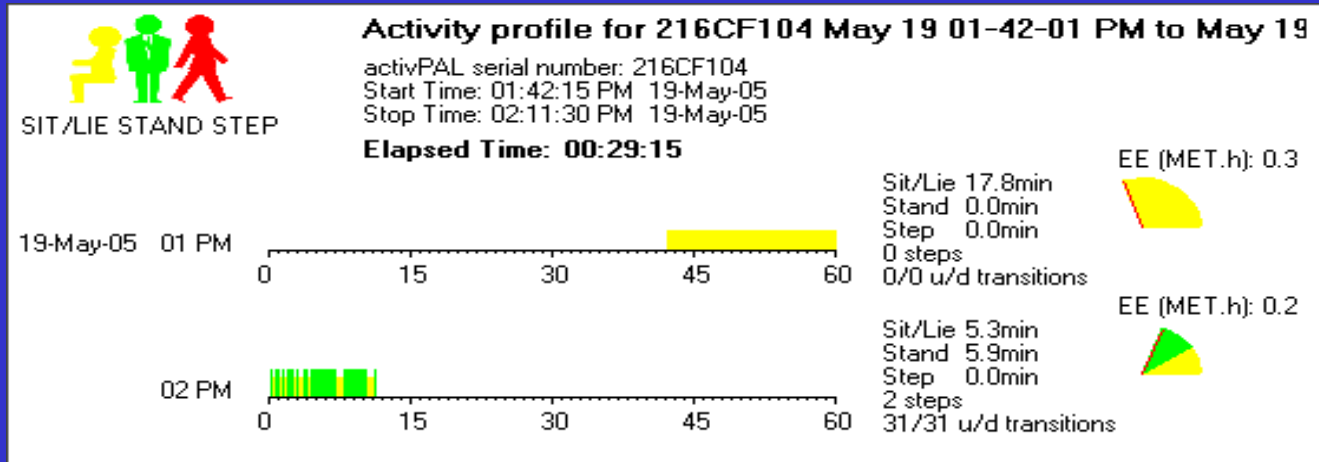
FES - Main conclusions

- Introduced 1995 – 1600+ patients
- Stroke: ODFS improves walking speed and PCI, both in its orthotic gain and also as a carry-over without stimulation [$p < 0.01$]
- Recommended by RCP Clinical Guidelines on Stroke (2000)
- MS: receive useful orthotic gain [$p < 0.01$], but no significant carry-over

Monitoring of additional in-patient sit to stand practice

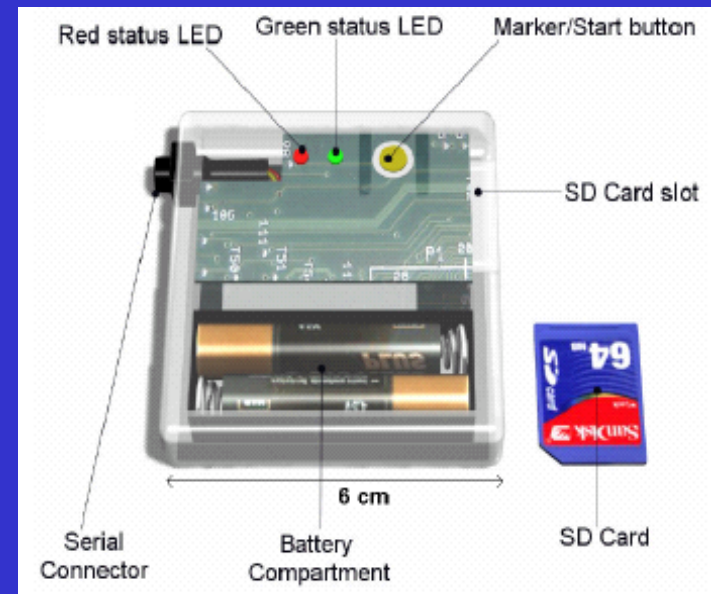


How much extra practice ?

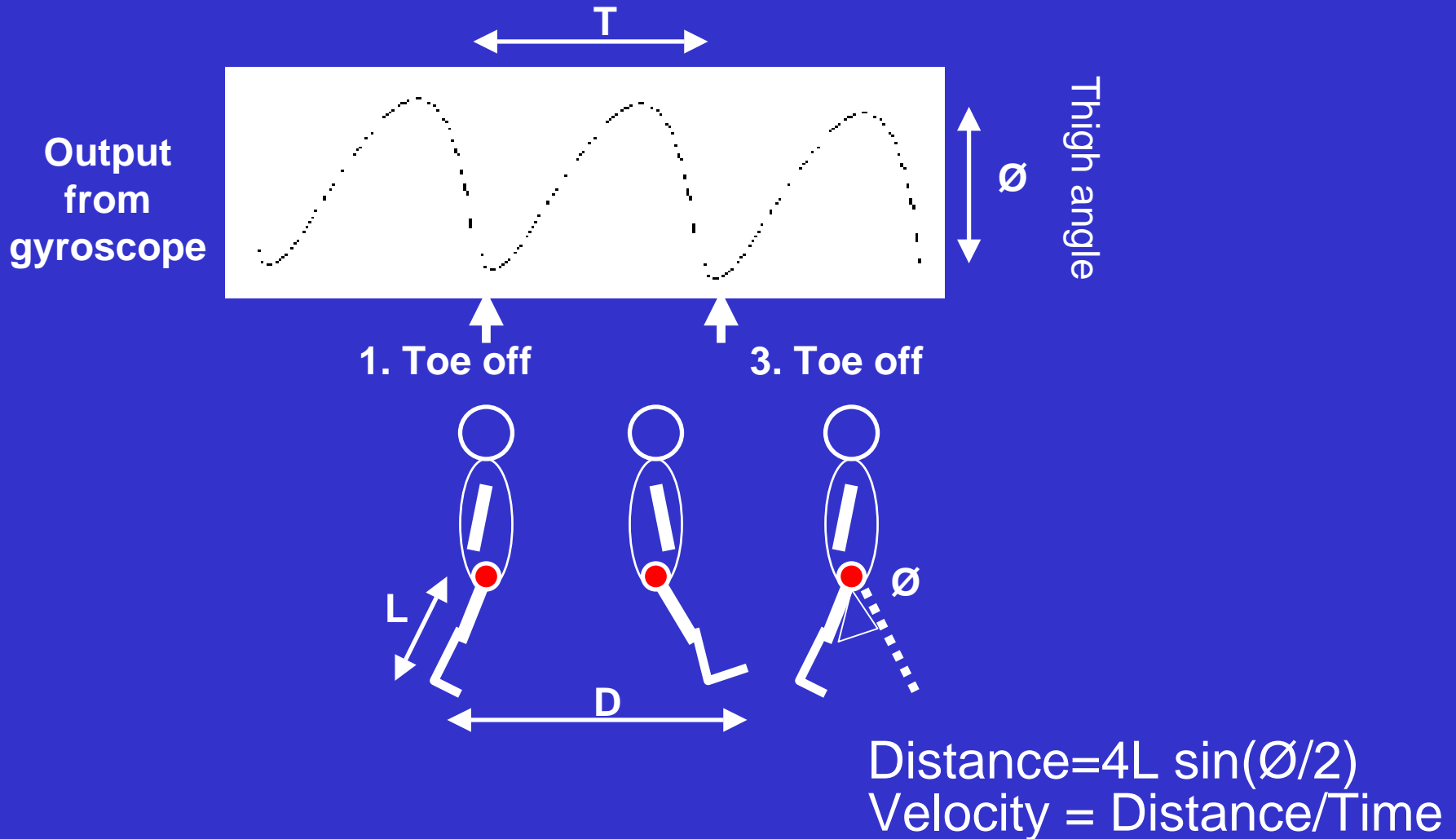


McRoberts MiniMod Accelerometer

- 3 Axis accelerometer
- Data stored on SD memory
- Download, artifact rejection
- Data analysis
- McRoberts gait test
- Assessment of sit to stand performance after Pain Management.



Measurement of walking speed



Smart Rehabilitation MTS Design Principles

1. It is an aid to therapy, not a stand-alone therapy.
2. It is not specific to any one model of therapy
3. It is a generic device applicable to a variety of rehabilitation aims for upper and lower limb
4. No two people who have had a stroke are the same: there must be flexibility in all elements of the device.
5. The device must be as simple as possible to use and adaptable to individual needs. Stroke patients may have complex impairments (perception, attention, information processing, language, memory).
6. The device provides accurate feedback on performance.

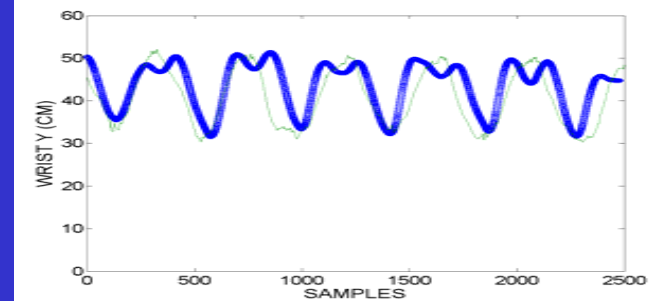
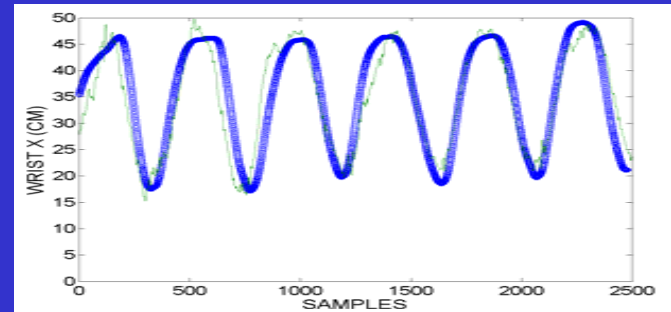
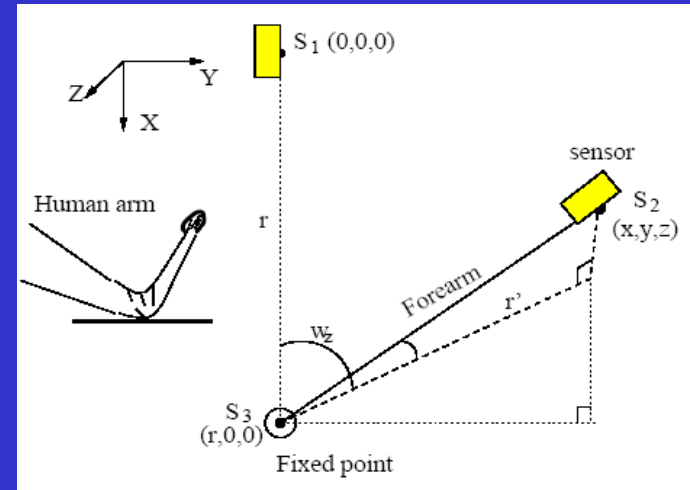
Motion Technologies Xsens

- Integrates:
 - Accelerometers
 - Gyroscopes
 - Magnetometers
- Acquires sensor orientation + raw accelⁿ, rate of rotaⁿ
- Low cost <£ 5k
- Low accuracy $\approx 3^\circ$



MT9 motion tracking system

MTS evaluation with CODA

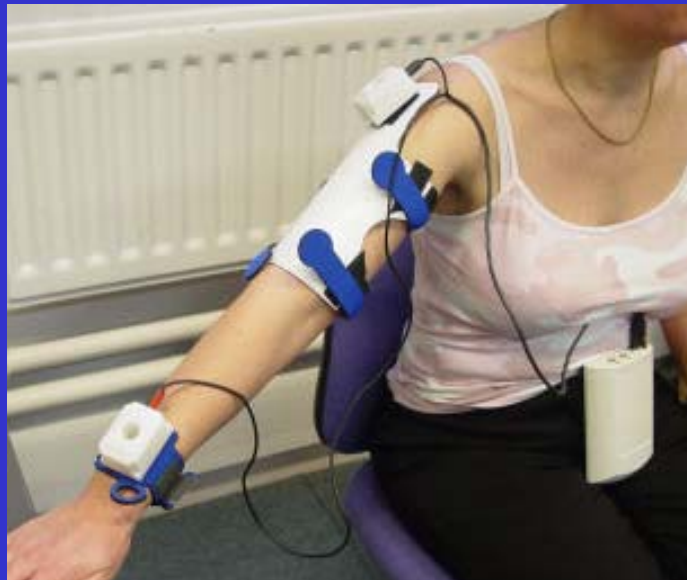


Motion Tracking System (MTS)

1. MTS built into clothing
2. Record target manoeuvre with therapist
3. Patient replicates the movement
4. System records data (quality and quantity)
5. Data downloaded to base station
6. Feedback to patient and carers
7. Feedback to HCP's

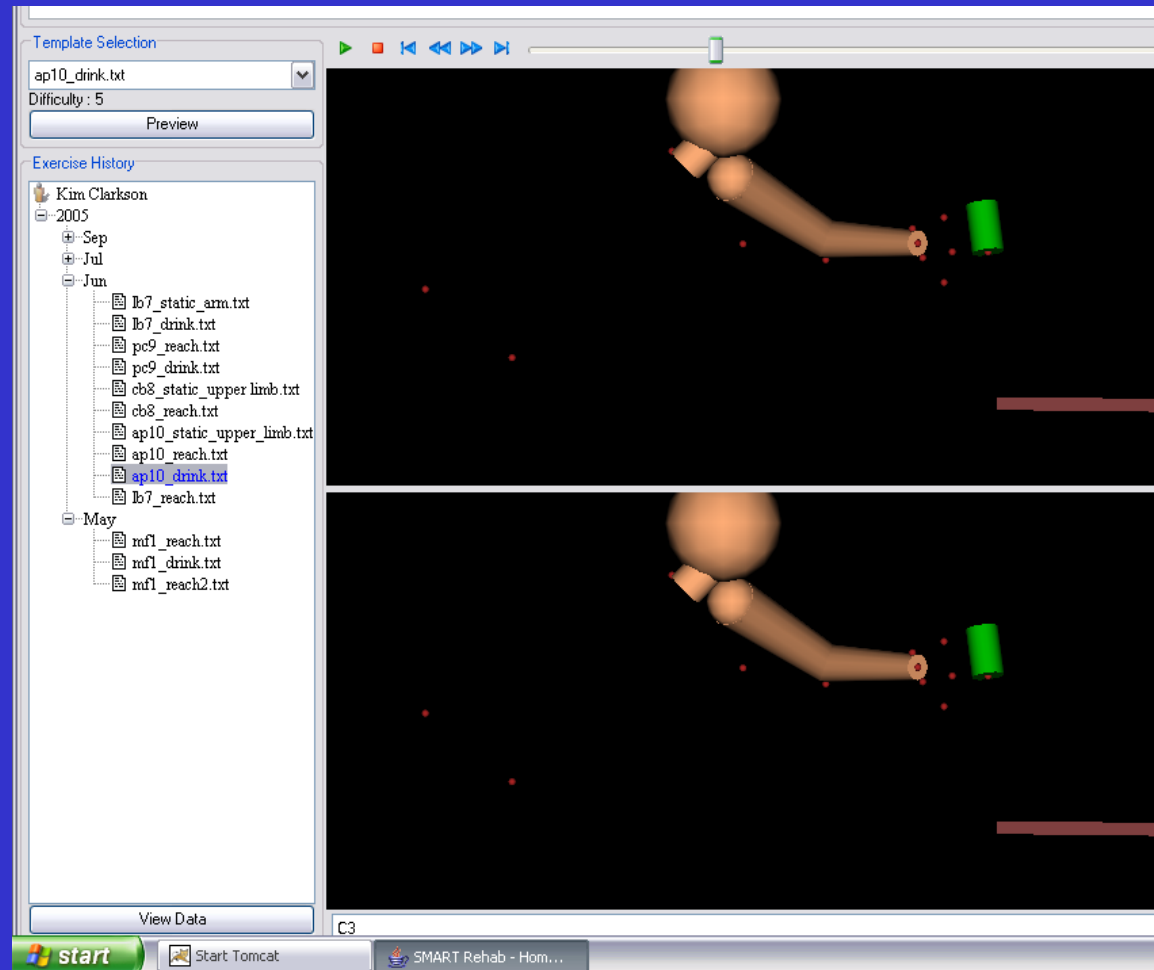
Sensor attachment

- Focus Groups with patients
- How do patients put on & take off the sensors?



MTS User Interaction

- GUI displays movement data
 - Target movement
 - Actual movement
- Exercise log
- HCP has remote access to data



Barriers to the use of technology by older users

- Negative self image
- Lack of understanding of technology
- Lack of trust in technology
- Operational anxiety following a bad experience

Does technology have a role to play in assisting therapy in a care or home environment ?

- There are benefits in using technology
- Need a stronger evidence base (more clinical trials)
- Better training of HCP's in the use of technology
- Practical issues of implementing a service

Organisational fragmentation + change !

Integration with existing services, staffing

Consumer awareness, Funding

'My wife is 18 months since she came out home and I think we've had 3 visits from the physiotherapist 3 days and that was it'.

'I think you need a certain form of goal setting because if not you just -you know apathy sets in doesn't it with them sometimes'.

'I don't care if it's seven feet tall if it helps'.

'the simpler the better because ...anything that takes some thought... he now sits and ponders...he can deal with so that he's in charge'. He's got his pride and he's got his independence'.



Some Resources

IEEE 9th International Conference on Rehabilitation Robotics (2005)

https://icorr.papercept.net/conferences/conferences/ICORR05/program/ICORR05_ContentListWeb_1.html

2004 2nd Cambridge Workshop on

UNIVERSAL ACCESS and ASSISTIVE TECHNOLOGY (CWUAAT)

<http://rehab-www.eng.cam.ac.uk/cwuaat/cwuaat04.htm>

The Stroke Association Rehabilitation Research Centre (Southampton)

<http://www.stroke.soton.ac.uk/>

Bipin Bhakter - Rehabilitation Technology (2002)

http://www.mech-eng.leeds.ac.uk/malse/imbe/bhakta_rrrl_23-10-02.pdf

Centre for Rehabilitation and Engineering Studies (Newcastle)

<http://www.ncl.ac.uk/crest/Researchlinks.htm>

UK Stroke Research Network (September 2005)

<http://www.uksrn.ac.uk/>