

Measurement of free living activity and its application

Nigel Harris

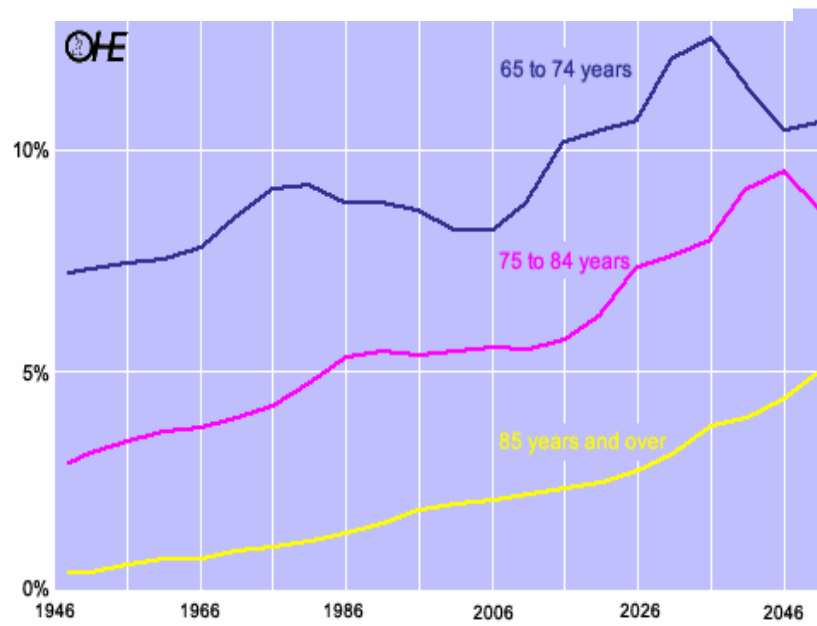
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NHS



Drivers for change – population

Growth of UK elderly population as a percentage of total UK population.



NHS

National Workforce Projects

What will the NHS of 2010 – 2015 be like?

- Same as now
- Collapsed under the strain
- Reinvented new systems and new locations for work but left the staff structure the same
- Implemented a range of innovative solutions and seen as a model employer

- One thing is for sure – more of the same will not work to deliver the NHS workforce of the future. We need to engage with our staff and plan effectively for the future.

PLANNING FOR A 21ST CENTURY WORKFORCE

Drivers for change - technology

the voice of NHS leadership THE NHS CONFEDERATION

Futures debate

JUNE 2008 PAPER 5

Disruptive innovation

What does it mean for the NHS?

Key points

- It is difficult to predict the pace, and extent, of innovation in healthcare.
- Disruptive innovations tend to appear from unexpected directions, and from outside the mainstream.
- Medical innovations in fields such as genetics, tissue repair, drugs and diagnostics may benefit some patients but raise difficult questions for commissioners.
- The NHS needs to plan now to embrace the challenges of care in the information age.

One of the most significant drivers of change in the NHS over the last 20 years has been innovation – in terms of both technology and new ways of working. The 60th anniversary of the NHS and the need for primary care trusts (PCTs) to develop their commissioning strategies has focused attention on predicting some of the major drivers that will shape healthcare over the next ten to 15 years. It is clear that change through innovation is going to continue, if not intensify. While the exact shape of these changes is difficult to predict, the NHS needs to plan now to embrace the challenges of care in the information age.

The pace of change

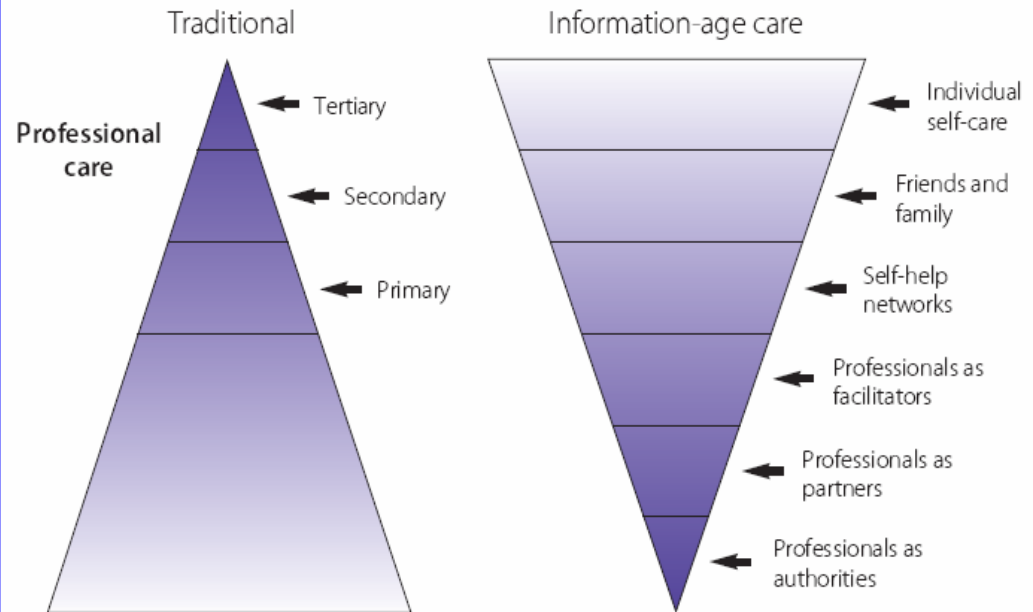
Making predictions about future innovation is hazardous. Past experience shows that many people tend to be over-optimistic about the pace and impact of change, while others expect seismic shifts. In the 1990s we were promised paperless offices, but we now have more paper than ever. Similarly, the hope that technology would lead to radically shorter working hours has not been delivered. In medicine, the promise of stem cells and of decoding the human genome seem to be in the same category. They probably will deliver some significant, even

and perhaps not in the way we initially expected.

Disruptive innovations that tend to come from left field, and from innovators who are not part of the mainstream, are even more difficult to predict. The personal computer is a good example of how a new product, quite unlike anything else in the market, can destroy existing businesses and create new opportunities and markets that the strategists had not even considered.

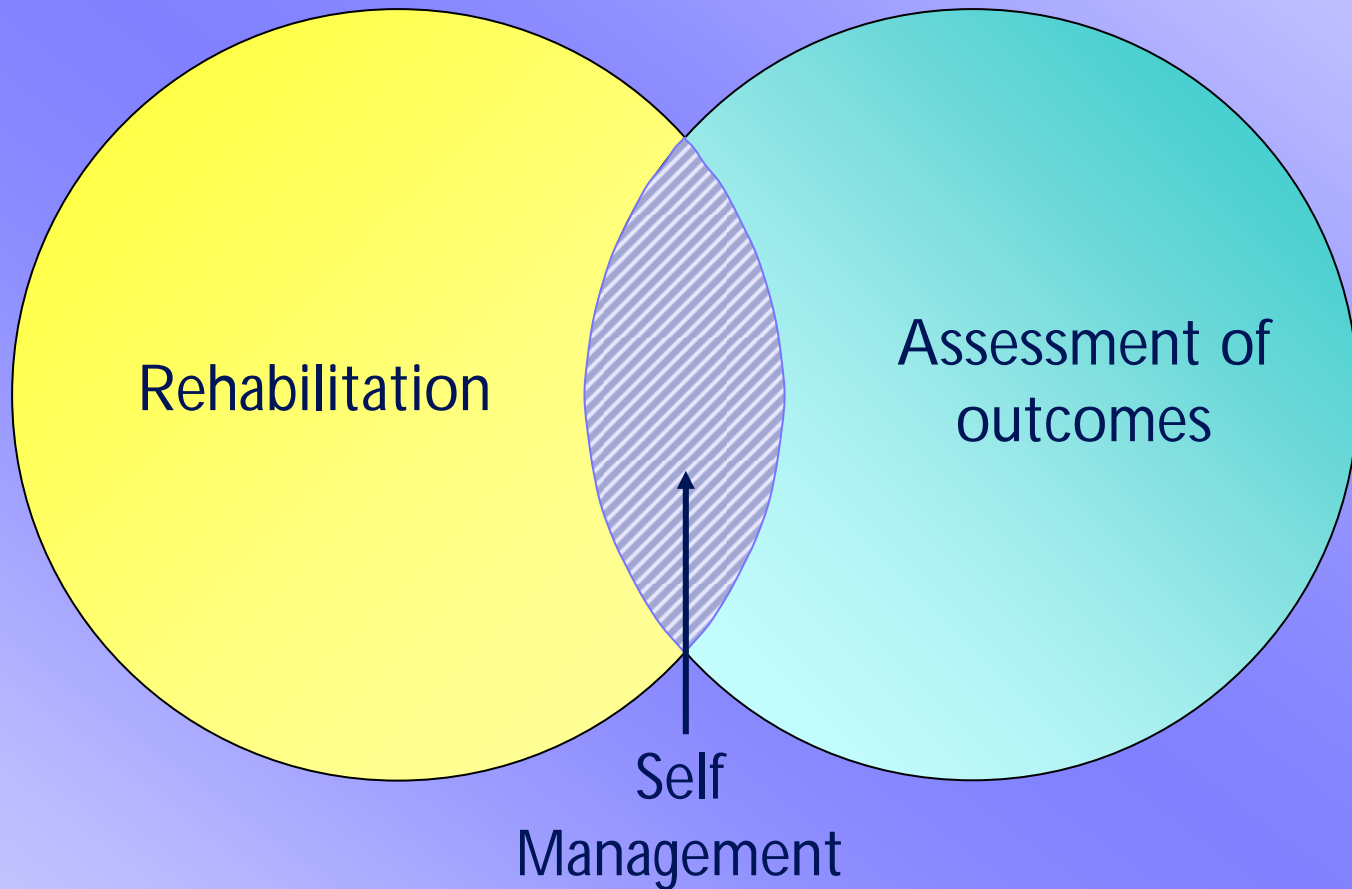
One of the key lessons for these shifts in the way industries work is that the

Leapfrog from pre- to post-industrial

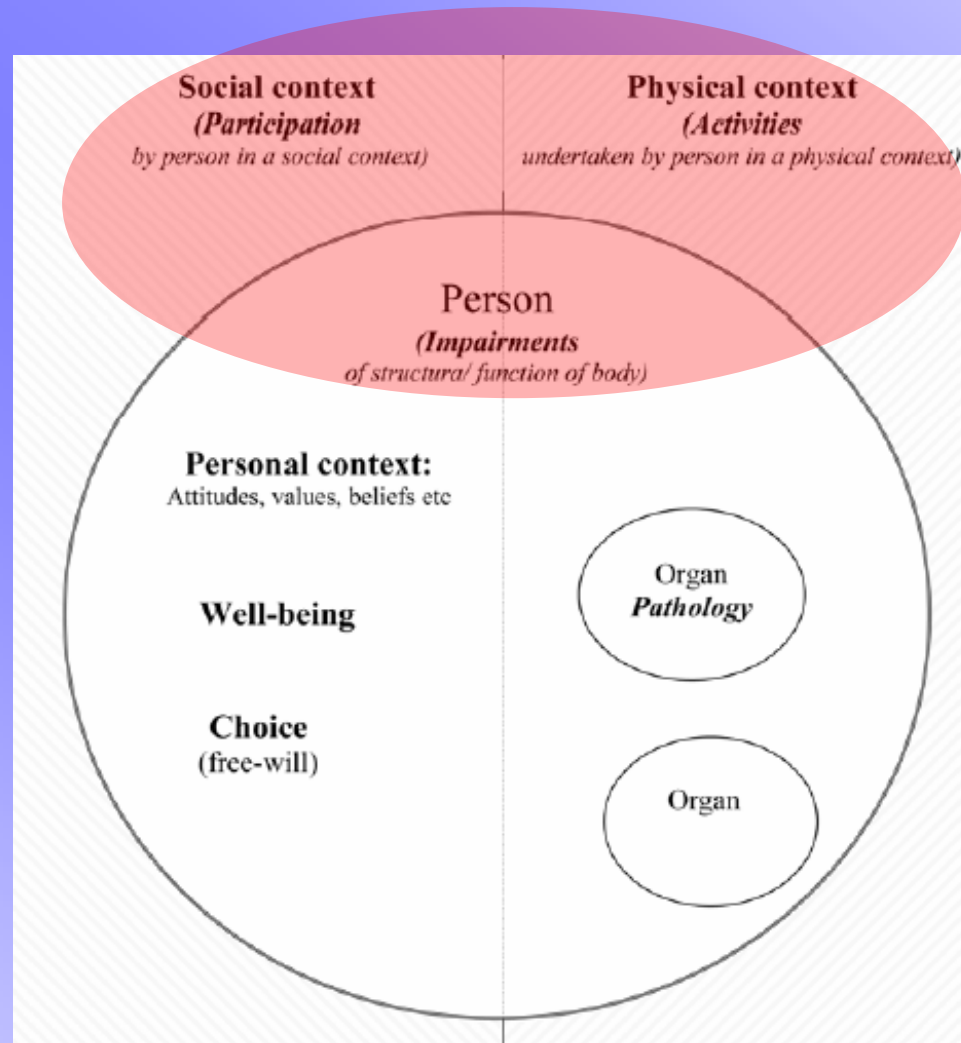


Source: Jennings, Miller and Materna. *Changing health care*. Santa Monica: Knowledge Exchange, 1997.

Why measure physical activity and function ?



WHO ICF model



(WHO 2001, Wade 2007)

Limitations of self reported measures

Automated compared with self monitoring

- 3 groups of 6 patients over 4 days
- Recorder with leg mounted switch
- Blinded study
- Control, Psychiatric, Chronic back pain
- All subjects reported less activity than occurred
- Pain group underestimated this by 50%

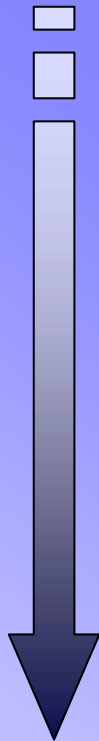
Limitations of direct measurements of physical performance

- Objective – if validated
- Specific
walking performance, sit to stand, balance
- Time consuming
- Only 'snapshot' at particular time

Can we collect data during normal every day activities ?

Which technology to use ?

MACRO



1. Decide on the most appropriate outcome measure
2. Select the sensor or device
3. Make sure it has been validated for that population

MICRO

Activities of daily life

- SMART houses
 - RFID, Webcam, Sensors

- Video recordings
Microsoft Sensecam

<http://research.microsoft.com/sendev/projects/sensecam/information.htm>

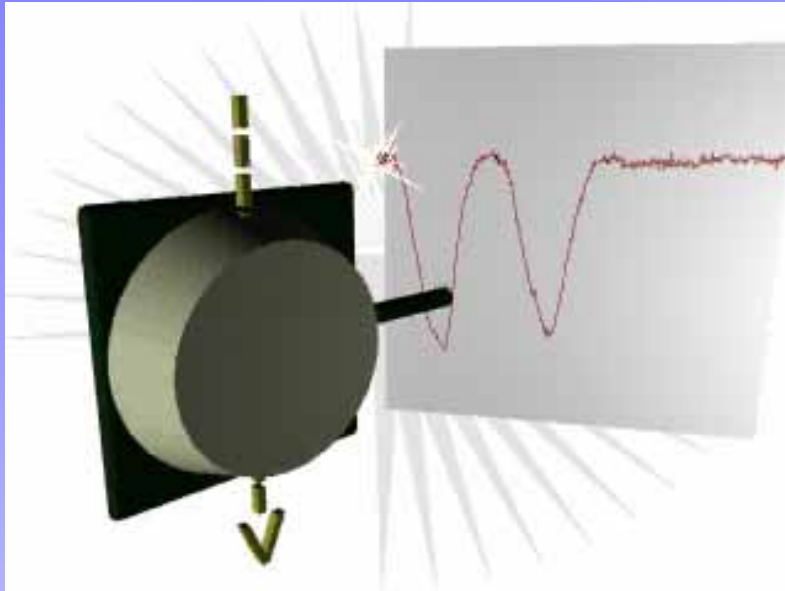


- GPS + GIS
Geographical
information
systems

<http://www.mobilelocate.com>

The screenshot shows the homepage of MobileLocate. At the top, there is a logo with two stylized figures and the text 'MobileLocate'. Below the logo is a navigation menu with links for HOME, SERVICES, TAG, CONTACTS, ABOUT, and NEWS. The main content area features a headline: 'MobileLocate is the leading UK provider of mobile phone tracking services. Our innovative service is highly affordable, easy to use and fully secure.' Below this is a photograph of a person pointing at a laptop screen displaying a map. A text block follows: 'Track your company or own mobile phones anywhere in the UK from as low as **£1.47** per mobile per month - or as little as **16p** per location'. A prominent orange banner reads '30 DAY FREE TRIAL!'. Below the banner, it says 'For a limited period we are offering a 30 day FREE trial! Includes 10 free location attempts - simply click on the Free Trial button below - registration only takes 2 minutes!'. At the bottom, there are two orange buttons: 'Start My Free 30 Day Trial Now!' and 'VIEW DEMO'. A small map is visible in the bottom left corner of the page.

Energy expenditure / Type activity



Technology – pedometers / accelerometers



EXAMPLE

An observational study to measure activity in patients with COPD

*Chris Dyer, Carol Langley, Elaine Jenkin, Nigel Harris
and Kevin Gruffydd-Jones, Chippenham Community Hospital*

- Affects 3M people in UK
- Peak incidence 60-80yrs age
- Negative spiral of symptoms
- Management
 - Optimise medication
 - Pulmonary rehabilitation
 - Support for self management



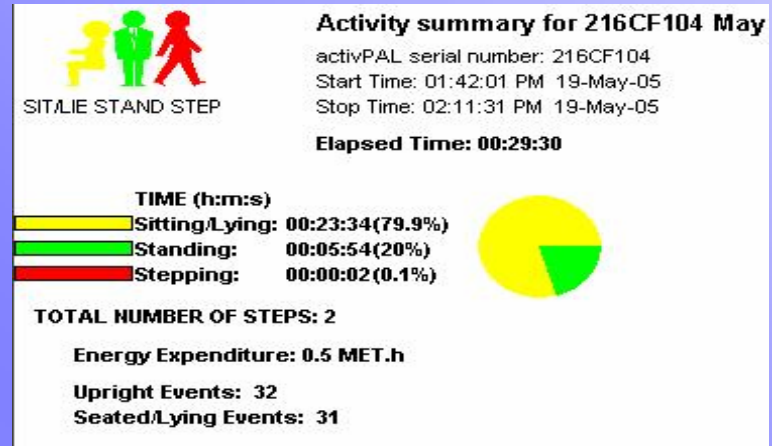
Can ambulatory monitoring be used to quantify, changes in physical activity following pulmonary rehabilitation ?

METHODS

- 33 subjects, aged 55-86 yrs
- Pre programme clinical assessment
- Pulmonary rehabilitation programme
- Baseline, 12 and 28 weeks clinical assessment
- Activity monitoring over 2 days every 6 weeks



ActivPal - single axis accelerometer



Attached to upper thigh

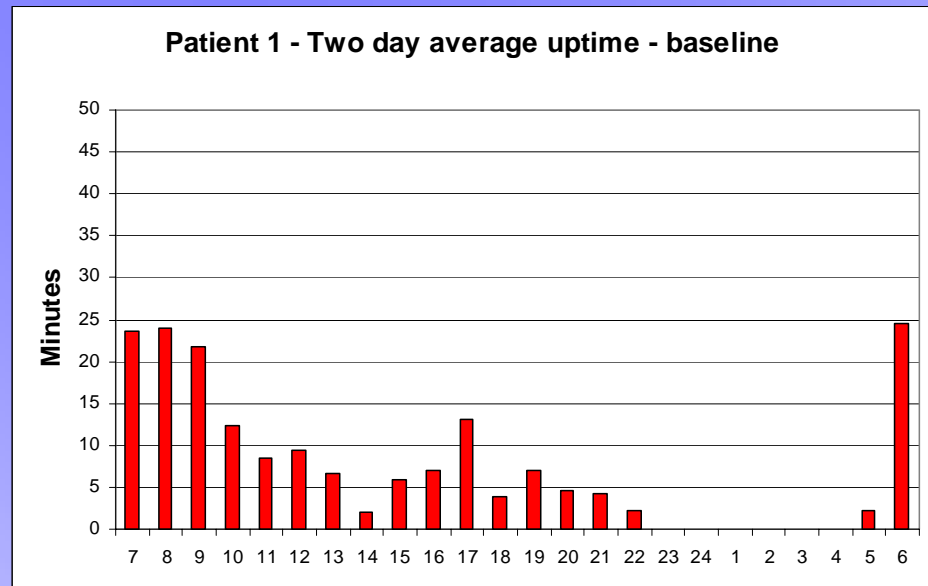
2 G range, 8 bit @ 10 Hz

1 sec time resolution

Worn ~15hrs day

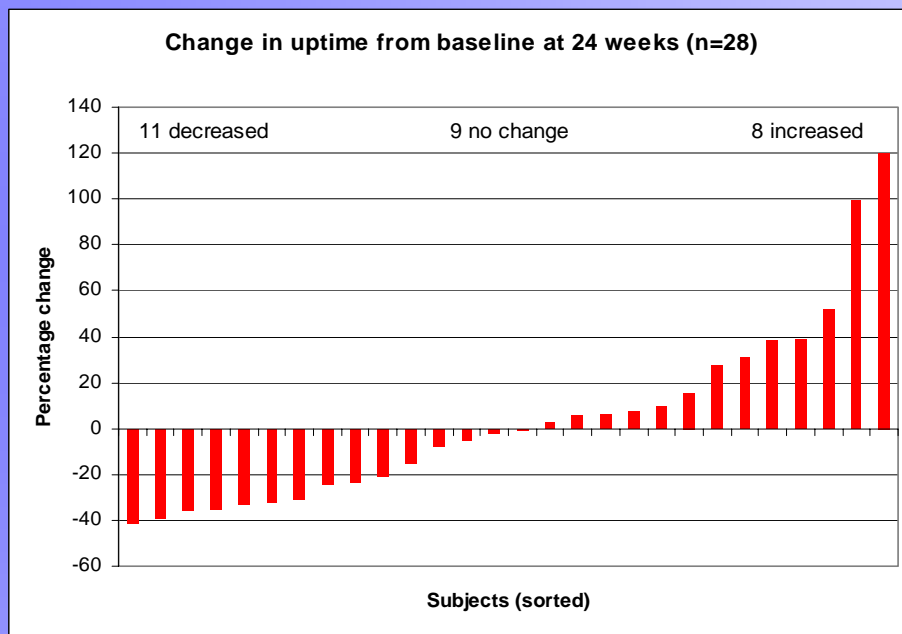
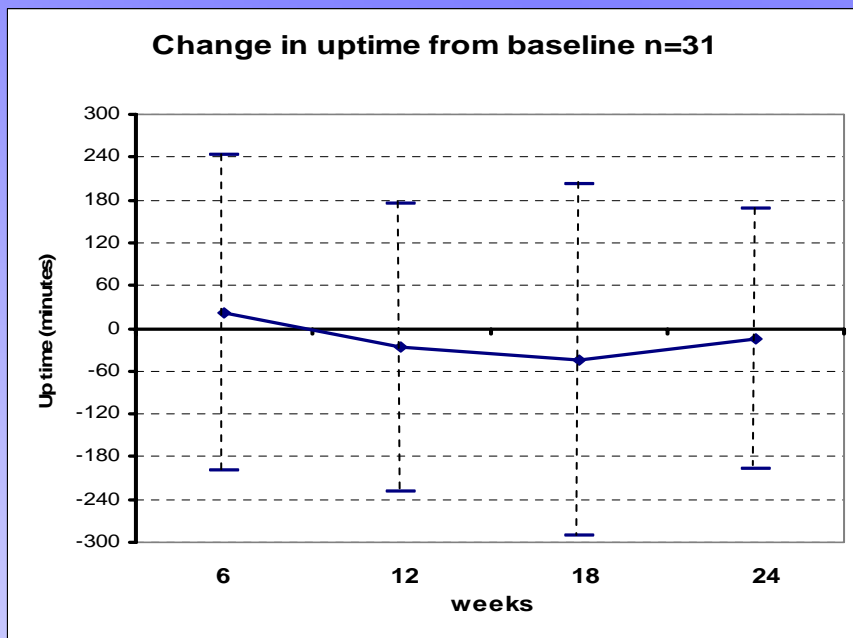
Uptime = standing + stepping

<http://www.paltech.plus.com/products.htm>



COPD Study - Preliminary Results

Change in uptime - base to 24 weeks



COPD study - summary

- Activity monitoring can be used to quantify the response to pulmonary rehabilitation
- Good reproducibility over 2 day monitoring period
- Increases in uptime are associated improvements in other outcome measures
- Further work:
 - Intervention study: will a weekly community exercise programme improve outcomes
 - Would patients benefit from feedback on physical activity levels

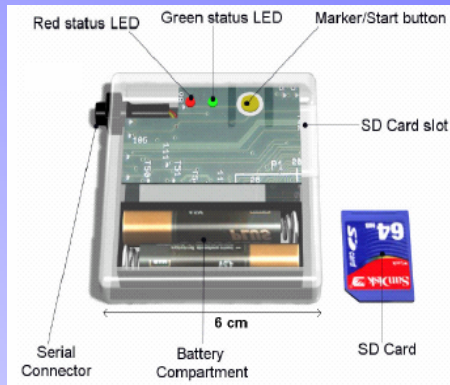
Measurements of Function

Available technology

Accelerometers

Gyroscopes

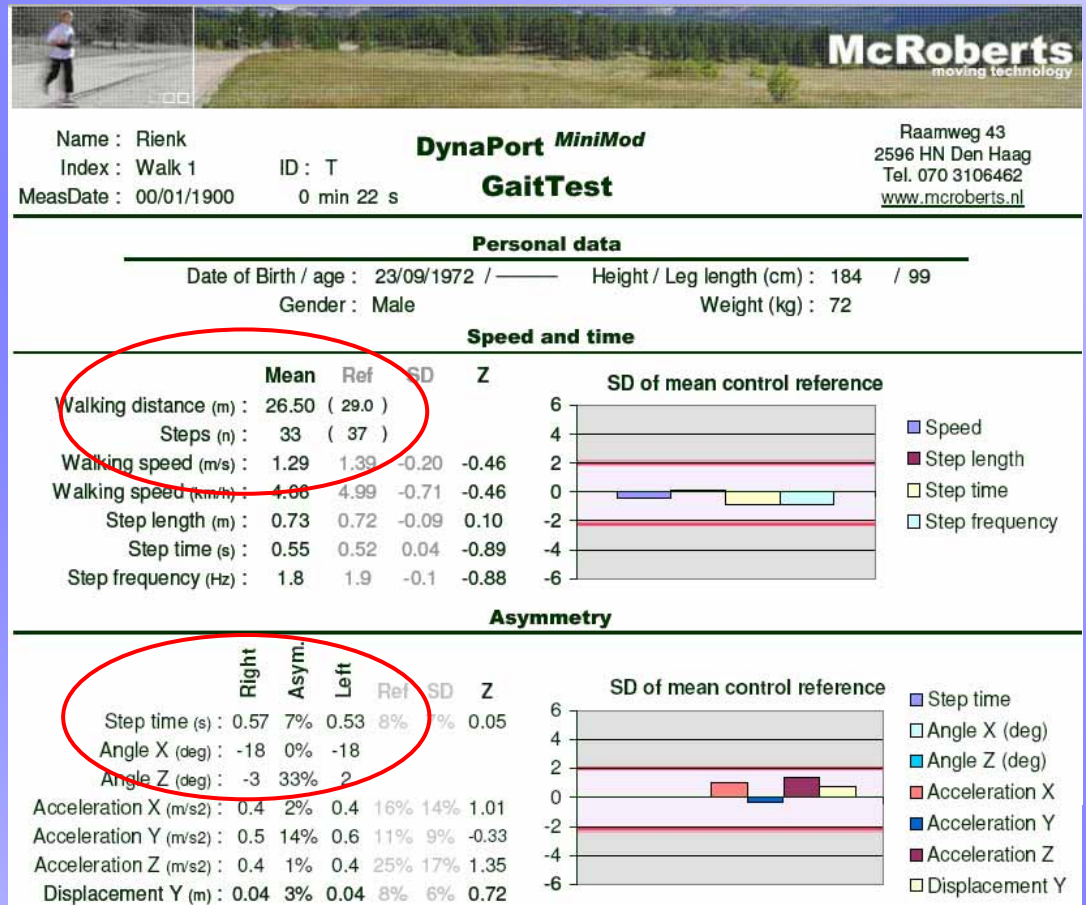
Magnetic field (orientation)



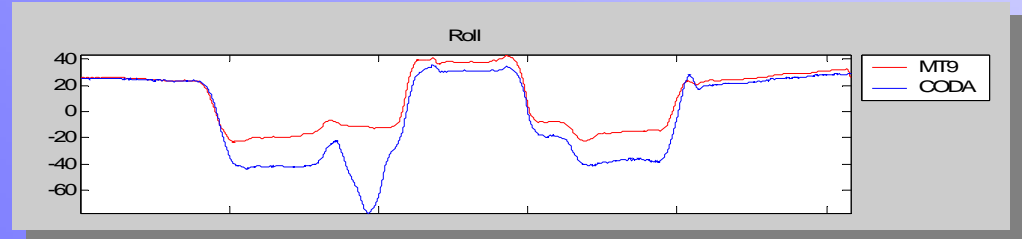
MiniMod measurements

Gait, Balance

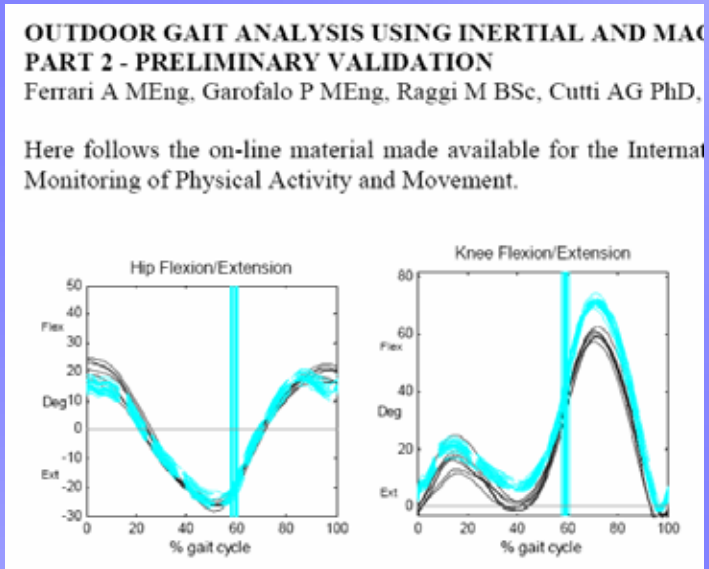
Sit to stand



Integrated sensors



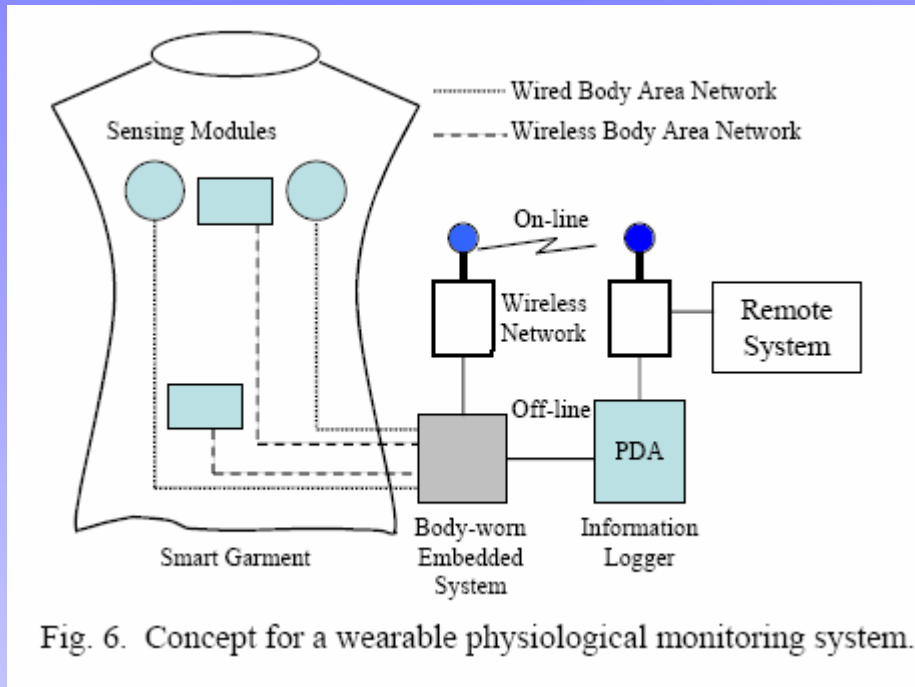
SMART1 – Upper limb rehabilitation



<http://www.thesmartconsortium.org/>

Gait analysis – Out Walk, Ferrari et al

Pervasive computing and new technologies ?



smart garment people

passionate about innovation

home about us services smart functions smart options smart stuff contact us

Home >> Smart Stuff

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NAVIGATION

Smart Stuff

- Nanotechnology
- Nanocomposites
- Nanosurfaces
- Carbon
- Nanotubes & Buckyballs
- Nanospheres
- E-spinning
- Nanotextiles

What are smart garments?

Smart garments have been made possible by a new generation of smart fabrics and related technologies. Smart fabrics are capable of sensing and even reacting to changes in their environments.

Imagine clothing that repels dirt, stains and odours, capable of "self-cleaning" with just a cup full of water every now and then?

Chemical and Biological protective clothing which is able to neutralise and detoxify harmful agents?

How about a garment that allows you to "plug in", use and charge mobile devices? Or clothing capable of regulating your body temperature, knowing to cool you when you get too warm or heat you when you cool down too far?

Kang 2006 , NCSU

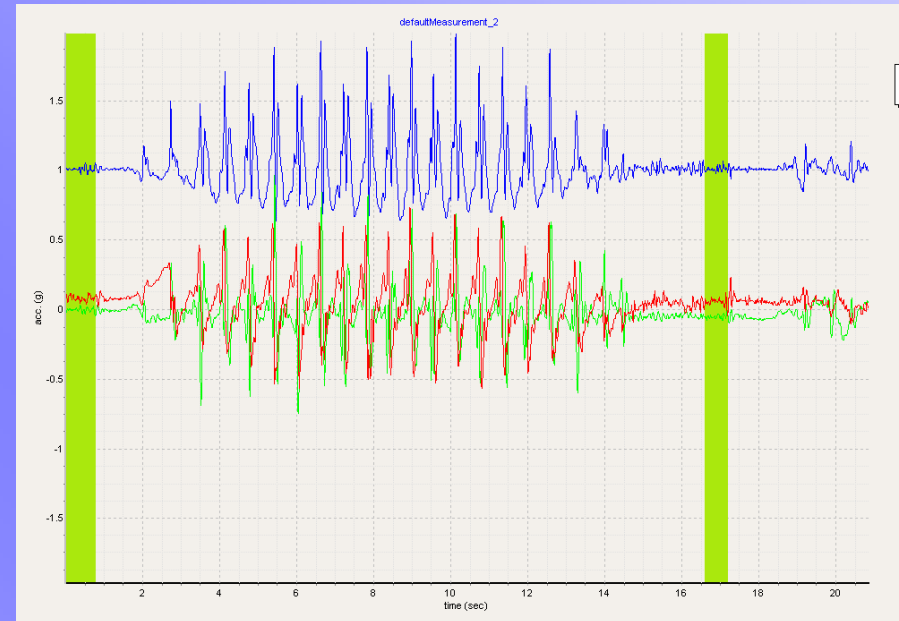
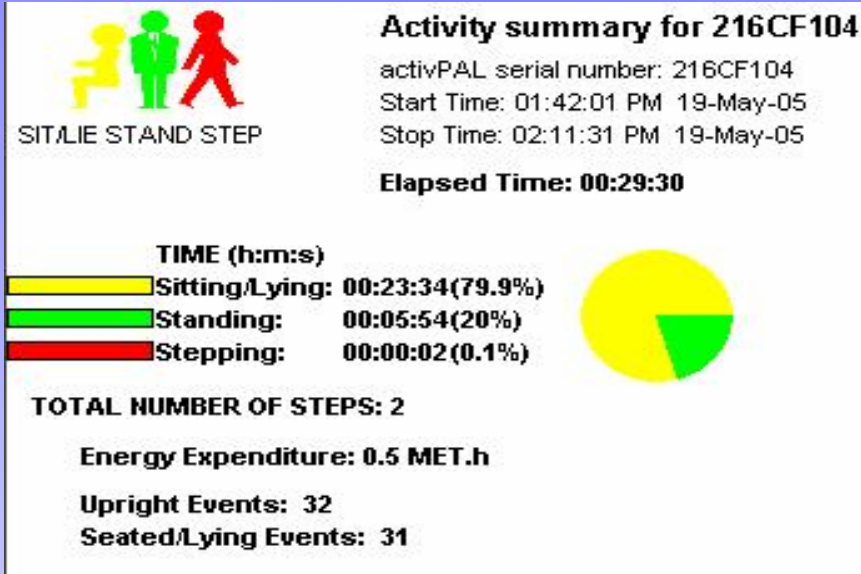
<http://www.lib.ncsu.edu/theses/available/etd-05192006-023724/unrestricted/etd.pdf>

http://icawww.epfl.ch/luo/WAMES%202004_files/wames_LiveNet.pdf

<http://www.smartgarmentpeople.com/>

Some problems # 1

Macro v Micro



Activities of daily life

v

Physical performance (velocity, asymmetry, ROM)

Some solutions 1

- Data processing
 - ‘Brute force’
 - Identification of ‘regions of interest’ within data
 - Artificial Intelligence
- Hardware
 - Mobile phone as common platform
 - Batteries and power sources
 - Wireless links
 - Web based data processing

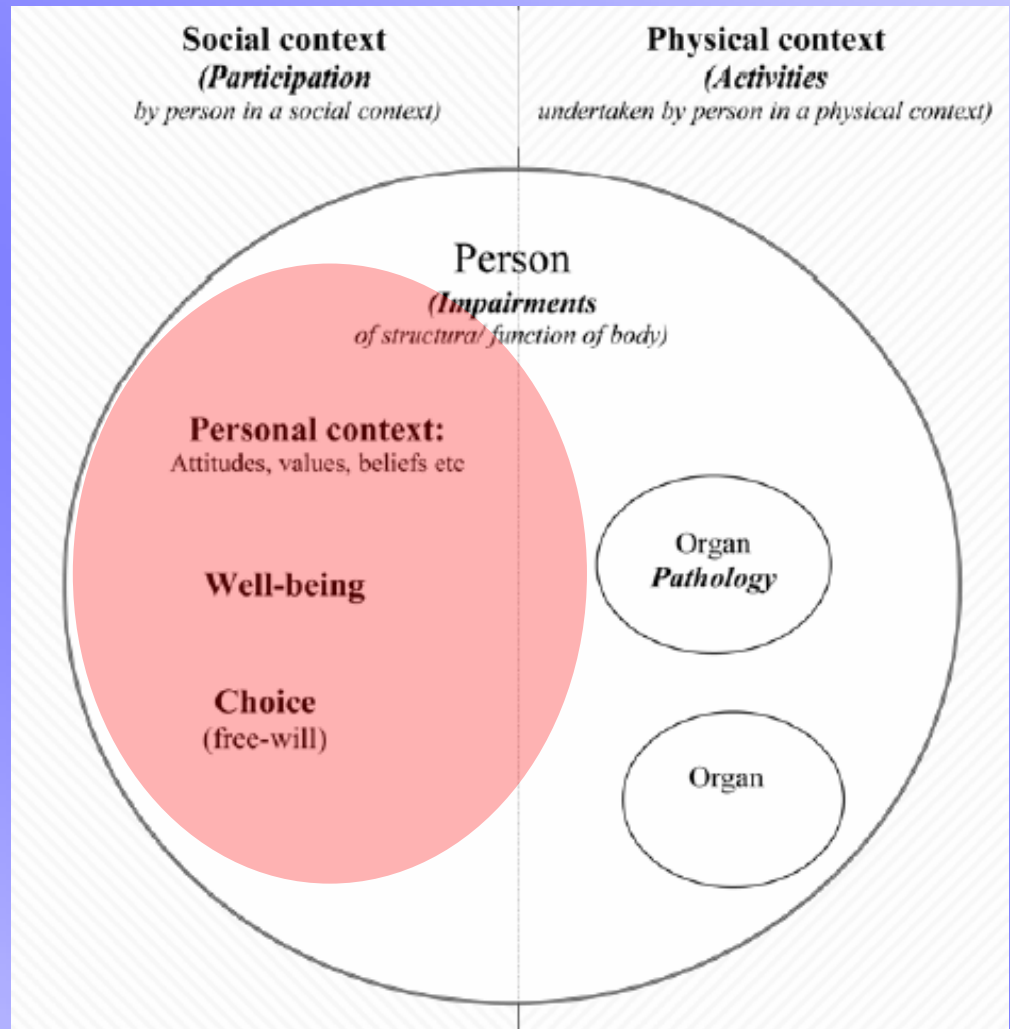
Some problems # 2

Rehabilitation and behaviour change

WHO ICF model

Focus on person

1. Function / disability
2. Context / environment



(WHO 2001, Wade 2007)

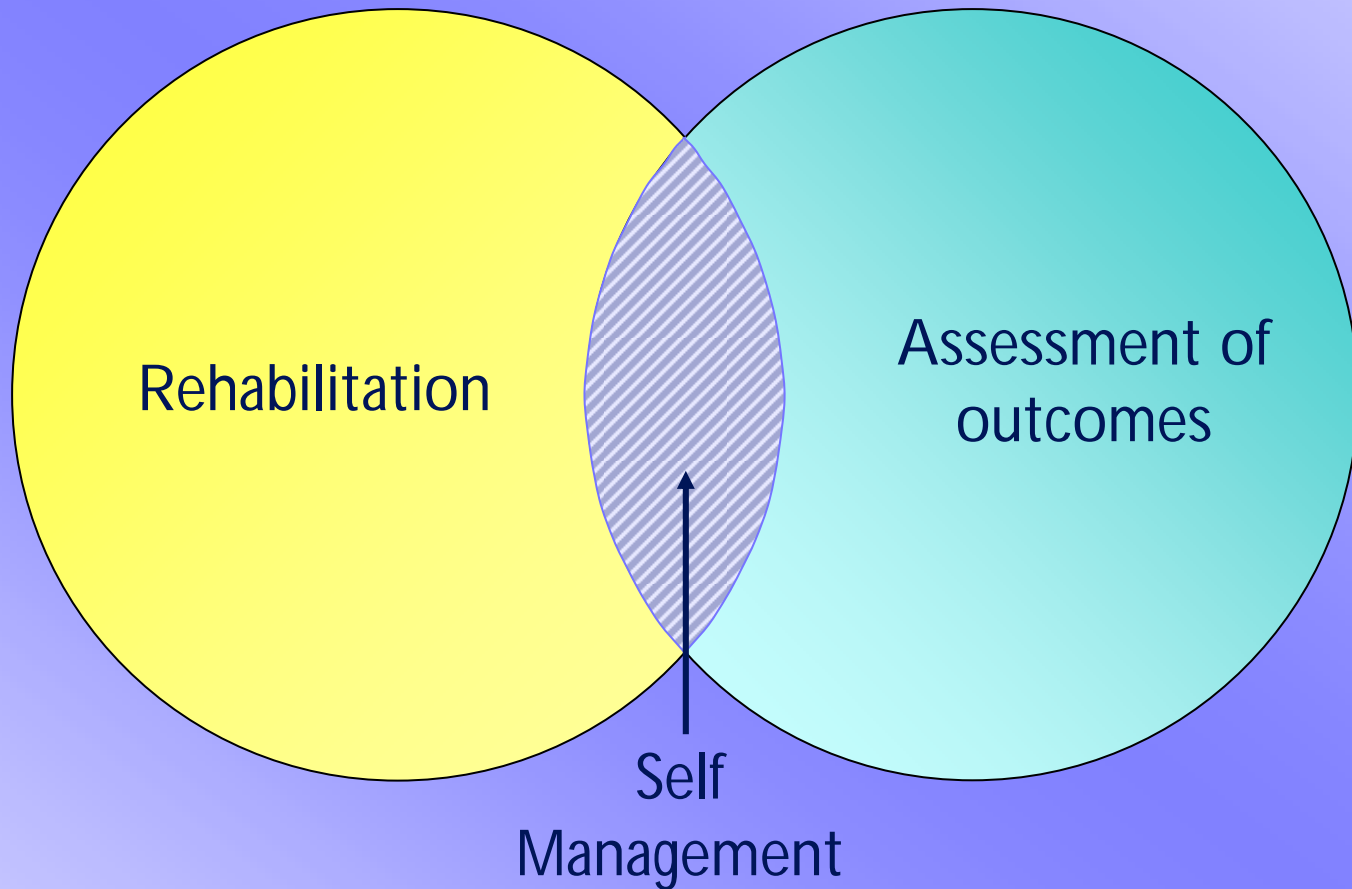
Some solutions 2

- Combination of body worn sensors and GPS
Geospatial analysis of physical activity –
Physical Activity and Locations Measurement
System PALMS – Patrick NIH 2007)
- Link between daily activities and life goals
- Better understanding of factors that influence
behavior change (Myotel, SMART2)

<http://www.thesmartconsortium.org/>

<http://www.myotel.eu/>

Why measure physical activity and function ?



The screenshot shows the homepage of the International Conference on Ambulatory Monitoring of Physical Activity and Movement (ICAMPAM) for 2008. The header includes the ICAMPAM logo, the conference title, and the dates (21-24 May 2008) and location (World Trade Center, Rotterdam, The Netherlands). A navigation menu contains links for home, registration, general information, conference program, abstract submission, organization, and sponsors exhibitors. The main content area features a 'Welcome to ICAMPAM's website' message, a 'registration sign in now' button, and a 'download pdf' link for an invitation. Two accreditation boxes are present: one for the European Accreditation Council for Continuing Medical Education (EACCME) and another stating that all participants are invited for Wednesday meetings starting at 15:00.

ICAMPAM
International Conference on
Ambulatory Monitoring of Physical Activity and Movement
21-24 May 2008
World Trade Center, Rotterdam, The Netherlands

home registration general information conference program abstract submission organization sponsors exhibitors

Conference program
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Invited speakers

important dates links contact

registration sign in now

invitation download pdf

Welcome to ICAMPAM's website, which provides information on the first conference to be held 21-24 May 2008 in Rotterdam, The Netherlands

ICAMPAM will be the first time that researchers, technologists, suppliers, users, clinicians, and other people interested from around the globe come together to present, discuss and debate all aspects of ambulatory monitoring. We expect this to be the first in a series of future events. The program of ICAMPAM will suit everyone in this field, not only those developing and validating technologies, but also researchers and practical workers in areas such as medicine, (physical) therapy, public health (fall prevention & detection and hypo-activity & overweight included), movement sciences & sports, ergonomics & occupational health, and psychology & psychophysiology.

Accreditation has been requested from the European Accreditation Council for Continuing Medical Education (EACCME)

All participants are invited for the Wednesday meetings starting at 15:00, and for the Welcome

<http://www.icampam.org/>

Thanks to:

Royal National Hospital for Rheumatic Diseases - <http://www.rnhrd.nhs.uk/>

Research collaborators and clinical teams

Bern Grimm - <http://www.ahorse.org/>

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