Digital Health Economy
The Public Health Frontier

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This Talk

• Whose eHealth? Whose Digital Economy?

  *Citizen, Patient & Population*

  ...top-down or bottom-up?

• Public & personalised eHealth challenges

  *Can the digital economy reach where the NHS can’t?*

• Digital Health Economy R&D needs
Increasingly Digital Economies

Physical supply-chain

Virtual supply-chain
Communities emerge quickly
Same human needs

Nicholas Negroponte 1995: “...from processing atoms to processing bits”
Self-organising Communities

Needs & wants of a geographical community

Needs & wants of on-line communities
Commissioner’s Dilemma

Society’s Health-Needs

- healthy choices opportunity & responsibility
- prevention or bust
- early intervention
- Self-care opportunity & responsibility
- “world class” commissioning
- personalised care & access
- reducing inequalities

Long-term

Sustainability reviews e.g. Wanless

Short-term
Pushing ‘care’ up-stream: Basics...

Health promotion is difficult, and requires:

– Personalisation
– Frequent reinforcement

Care organisations are unattractive to the citizen who is not seeking care
Do we choose health?
Can we choose health?

Millions of years of evolution:
Spend energy to eat
Store at times of plenty

Recently:
\( \uparrow \) energy-density of food
\( \downarrow \) energy required to get food
\( = \text{the obesogenic environment} \)
Situational Awareness of Rising Child-BMI: Example Wirral 3-yr-olds from 1988 to 2004

SDS = standard deviation score from 1990 British Growth Reference charts – adjusts for age and sex of the child
Wirral (0.3M), UK

BMI of 3 yr olds 1988 - 1989

Fifths of BMI
SDS BMI fifth
Red (light) = fattest
Red (dark)
Purple
Blue (dark)
Blue (light) = thinnest
BMI of 3 yr olds
1990 - 1991

Fifths of BMI
SDS BMI fifth
Red (light) = fattest
Red (dark)
Purple
Blue (dark)
Blue (light) = thinnest
BMI of 3 yr olds
1992 - 1993

Fifths of BMI
SDS BMI fifth
Red (light) = fattest
Red (dark)
Purple
Blue (dark)
Blue (light) = thinnest
Fifths of BMI

BMI of 3 yr olds
1994 - 1995

Fifth of BMI
SDS BMI fifth
Red (light) = fattest
Red (dark)
Purple
Blue (dark)
Blue (light) = thinnest
BMI of 3 yr olds
1996 - 1997

Fifths of BMI
SDS BMI fifth
Red (light) = fattest
Red (dark)
Purple
Blue (dark)
Blue (light) = thinnest
BMI of 3 yr olds
1998 - 1999

Fifths of BMI
SDS BMI fifth

Red (light) = fattest
Red (dark)
Purple
Blue (dark)
Blue (light) = thinnest
BMI of 3 yr olds
2000 – 2001

Fifths of BMI
SDS BMI fifth
Red (light) = fattest
Red (dark)
Purple
Blue (dark)
Blue (light) = thinnest
Signals: Rise in BMI at 2 & 3 years and infant length for children born on Wirral between 1990 and 2000
Secular trend to increasing BMI is much greater in taller children.

Source: Buchan et al. 2006
Rise in BMI and fall in cardio-respiratory endurance of Liverpool 10 year olds from 1998 to 2004

Data from G Stratton, Liverpool Sportlinx
Cardio-respiratory endurance levels of Liverpool 10-yr-olds fell in all BMI groups

Data from G Stratton, Liverpool Sportslinx
Type 2 diabetes incidence in a typical health economy

New type 2 diabetics in Salford

- 1997
- 1999
- 2001
- 2003
- 2005
...these were all signals from routinely-collected NHS data

Beware ‘data-tombs’...
Digital Dust (data deposit > use)
Cloud of millions of NHS messages in the local health economy

Organise

Structured Data

Transform & Examine

Structured Data & Metadata
Unclear Public Good

Research

Depersonalise

Health Records

Clear Public Good

Research Objects

e-Lab for a defined community

Local Ownership

Asset Enrichment

Health Records
What is an e-Lab?

...an information system bringing together data, analytical methods and people for timely, high-quality decision-making
North West e-Health e-Lab: Analytical Layer

Connecting for Health LSPs & ESPs: Core Services

Smart Summary Views of Care

Commissioning Intelligence

Research Assets

Clinical Audit Intelligence
Dataset vs. Digital Commodity

Serving health communities with high-quality health intelligence requires **metadata** from **local uses**...
Clinical audit question: “is diabetes care picking up enough treatable anaemia in patients with mild kidney impairment?”

→ Answer: No
→ Care pathway improvements
→ Next similar e-Lab query made easier
→ Deeper research...
Anaemia at lower levels of kidney impairment than commonly thought

Clinical (audit) questions leading to scientific findings: supporting sustainable NHS-academic partnership

Anaemia at lower levels of kidney impairment than commonly thought
Excellent research becomes a by-product of excellent service development

Federation of e-Labs → scalable & sustainable
Bio-Health Interface

Exploiting biological data for personalised care and public good in the digital economy
Local Biobanks Linked with e-Labs

Local research assets built around research-ready clinical data, consent and sample collections...

IGFBP-1 A4403G genotype

IGF-I genotype

**OR for nephropathy**

- A4403G AA
- A4403G GG

Non 192-bp homozygous

192-bp homozygous
Gene Association Studies

Which genetic variation is responsible for disease variation

...ATTAGGACCAATAAGTCT...

...ATTAGGATCAATAAGTCT...

Single nucleotide polymorphisms (SNPs)

Human genome = 3 billion bases $\Rightarrow$ 3 million sites of variation

The challenges of personalised medicine outstrip our ability to use the data from current biotechnologies
for( i = 1 to #random permutations)
{
  for( j = 1 to #SNPs)
  {
    for( k = 1 to #patients)
    {
      disease status vs. locus status $\chi^2$
    }
  }
}

Given a typical 5k patients, 0.5m SNPs and 10k permutations:
20k $\chi^2$ calcs per sec on modern single core $\Rightarrow$ 70 hrs  single SNPs;
$\Rightarrow$ $\approx$1,980 years for $[n*(n-1)]/2$ SNP pairs
Computational free-thinking, for insights from richly-observed health & environments

1) Simple Algorithms

\[ C = \sigma^2(I + ABB^T) \]

2) Simple Algorithms

\[ C = \sigma^2(I + ABB^T) \]

3) NIBHI & Microsoft Shared Genomics developing next generation software
...the e-Research Digital Economy
Developing Services in a Digital Economy

Real-time views of health(care) enriched by local knowledge, and smarter predictive models
Summarising care quality

Care improvement or case-mix change?
MRC IMPACT: Developing the maths and software to make complex scenarios easy for commissioners to explore

Outputs: Population-based incidence, prevalence; Deaths prevented; Life-Years; Life expectancy; Costs; Cost-effectiveness ratios
Connecting with citizens?

Digital health economies from a clinical perspective...
Figure 1. Photographs and Abdominal Magnetic Resonance Images Obtained before and after Liposuction.

The photographs of one study subject and images of another show the large amount of subcutaneous abdominal fat removed by liposuction.
Equipping citizens

Individuals and communities harnessing digital economy services for feeling well and preserving health
Do Nothing is Not an Option

• **Markets** offer more **unhealthy** than health products and services

• **Healthcare** is too **late** and **inaccessible** for maximum potential health gain

• **Wellbeing** and **healthcare** interventions are too **impersonal** to be fully-effective
Socially Networked Pedometer

My Physical Activity

Peer Support
Socialisation
Ubiquitous Display
Adaptive Interaction (Autonomic?)
Healthy Lifestyle Credits

ev-Health Service & Social Network
Clear Business Cases e.g. Nike+
e-Health/Wellbeing R&D

Promoting blue-skies research with a view to translation to the wellbeing industry
Energy Balance Wristwatch

Energy Balance Wristwatch

- Burning Fat
- Depositing Fat

(ketone/other) molecules on skin

Active Polymers in wristband
- +/- other signals & data

Frequent Choices
Personal Health Avatar

Open to e-Health+ Contact

Multiple Signals and Interfaces

Integration & Personalisation

Citizen / Wellbeing Consumer

Patient / Healthcare Consumer

6AM: Bathroom
8AM: Work PC
12PM: Mobile Phone
3PM: Work PC
8PM: Home PC
9PM: Digital TV

“A little but often makes a big difference, so e-Health must work with daily life”
Conclusions: Digital (Health) Economy

• Wellbeing services boom
• Health systems more citizen-driven
• Self-care opportunity & responsibility exposed
• Healthcare-wellbeing interface to explore
• Digital economy is the public health frontier

Turning (e)health-systems thinking inside out