Public Health ‘e-Labs’
for a Global Digital Economy

WHO-PHI 2008 (Asia-Pacific), Delhi, 3-4 Nov 2008

Prof. Iain Buchan
University of Manchester
PHI Targets

• Digital Deserts
  Building *e-readiness* for the public’s health

• Digital Dust
  *Turning digital commodities into actions* for the public’s health
Situational Awareness of Rising Child-BMI: Example Wirral 3-yr-olds from 1988 to 2004

Three-monthly rolling average BMI SDS

Month of measurement by Health Visitor

SDS = standard deviation score from 1990 British Growth Reference charts – adjusts for age and sex of the child
Secular trend to increasing BMI is much greater in taller children

Source: Buchan et al. 2006
Health data-silo anthropology

‘data-tombs’...
Digital Dust (data deposit > use)
Problems with Public Health Information

- Too little
- Too late
- Can’t find it
- Can’t reproduce it
- Consumes more resource than it needs to
- Benefits invisible to healthcare providers
- Cost savings not measured
Cloud of millions of messages in the local health economy

- Organise
- Transform & Examine

Structured Data

Structured Data & Metadata
Link on NHS number

Optometrist
Eye screening
Community nurses
Podiatry

Deaths, Demographics etc.

GP

GP

GP

GP

Hosp.

Data Repository in PCT

Real-time

Anonymised Data Repository in PCT

24-hourly updates

Trusted person poses question(s)

FIREWALL

Outputs

Patient-driven information into records

Person-identifiable and sensitive information removed

Biometrics

Data

Repository in PCT

Real-time

Person-identifiable and sensitive information removed

Anonymised Data Repository in PCT

24-hourly updates

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FIREWALL

Outputs

Patient-driven information into records
What is an e-Lab?

...an information system bringing together data, analytical methods and people for timely, high-quality decision-making
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 healthcare-academic partnership

Anaemia at lower levels of kidney impairment than commonly thought
Serving health communities with high-quality health intelligence requires **metadata** from **local uses**...
Excellent research by-products of excellent service development

Federation of e-Labs ➔ scalable & sustainable
Diabetes Specialist Nurses
Paediatric Diabetes Specialist Nurses & Doctors
Services for Young People
Joint Diabetes Antenatal Service
Clinical Psychology
Obstetrics
Ophthalmology Laser & Cataract Services
Specialist Vitreo-Retinal Services
Diabetes Specialist Nurses
Diabetologists
Hospital Dietetics
Optometrists
Nursing Homes
Primary Care Diabetes Teams
Community Dietetics
Community Podiatry
Nursing Homes
Direct Access Services
Primary & Community ‘Continuing Care’
Diabetes Specialist Services
Supporting Specialist Services
Diabetes Care
Receptionists and Support Workers
On Call Service
High Risk Foot-care Team
Vascular & Orthopaedic Surgery
Orthotists & Footwear Specialists
Nephrology
Rheumatology
NHS Direct
Web Based Services
Pharmacies
Call Centres
Summarising care quality

Care improvement or case-mix change?
Population Policies & Behaviours

Biological Risk Factors
- Physical Activity
- Diet
- Smoking
- Deprivation
- Obesity (BMI)
- Cholesterol LDL (& HDL)
- Blood Pressure

Combined CVD Risk

CVD Patient Groups

OUTPUTS

Developing models and software to make complex scenarios easy to explore in real time → democratise commissioning?

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

CHD Death
Non-CHD Death

From any State

SUDS
NON-SUDS
Increasing Expectation of Models

• Research
  – Multi-level stochastic
  – Machine-learning
    • Omics
    • Image analysis

• Service-development
  – Graphical models & discrete event simulations

• Clinical & self-care decision support?
Crude Pan-Genome Scans

Given a typical 5k patients, 0.5m SNPs and 10k permutations:

<table>
<thead>
<tr>
<th>Patients</th>
<th>S</th>
<th>N</th>
<th>P</th>
<th>S</th>
</tr>
</thead>
</table>

for( i = 1 to #random permutations)
{
    for( j = 1 to #SNPs)
    {
        for( k = 1 to #patients)
        {
            disease status vs. locus status \( \chi^2 \)
        }
    }
}

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
Simple Algorithms

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

1) Computational free-thinking, for insights from richly-observed health & environments
...the e-Research Digital Economy
Obesity Attributable Cancers

• What is & will be the obesity-attributable cancer burden?

• Setting: 30 countries

• Inputs needed:
  – site- and sex-specific cancer risk data
  – standardised risk estimation by site
  – sex- and age-specific risk exposure data (present & past)
  – up-to-date cancer incidence
  – trends in cancer numbers & population demographics

Thanks to: Andrew Renehan
Localising Evidence Needs PHI

Future Population Impact Numbers

Current Population Impact Numbers

WHO Infobase
GloboCan

Risk exposure trends
Tumour registries

Interpretation & Report

Meta-analysis

Systematic review

Protocol

Rising complexity & computational cost
Safety Blind-spot: Tamoxifen

• Question: Is there a substantial burden of recurrent breast cancer due to interaction of tamoxifen with anti-depressants?
  – Plausible CyP450-2D6 competition (tam $\rightarrow$ end-oxyifen)

• Blind-spots (missing from registers)
  – Recurrent cancers
  – Adjuvant therapies
  – Concurrent therapies
3 & 4 & 6 Broker
7
9
8 Research
Object
Repository
5. Per request keyed pseudonymisation
6. Data integration
7. Anonymisation and inference control
8. Storage
9. Data analysis and visualization
e-Lab Anatomy is Simple

e-Lab = **community** + work **objects** + methods
for building work objects

A **research object** is a story about an investigation.

A **decision object** is a critical mass of evidence to support a decision.
e-Lab Activity at Manchester

• >100 person years of activity planned for next 3-5 years
  – Healthcare and Public Health
    • North West e-Health: 19 fte to 2012
    • Care Pathway Simulators: 6 fte to 2013
    • Obesity e-Lab: 3 fte to 2011
  – Biology, Chemistry, Social Science, other...
    • Taverna, myGrid & myExperiment: 16 fte 2012

• Ethos
  – Use open-standards, service oriented arch., simple APIs
  – All software freely available in open source
  – Contribute to & learn from global family of innovation
Standards-based Health Information Systems

e-Lab: Sense-Making Layer

Care Service Development Research

Open Source Projects Sustained by the Value they Add through Crowd-Wisdom + Cloud Resources Shared

Powerful Models Agile Communities

Standards-based Health Information Systems
Conclusion

Vision: Global Network of e-Health e-Labs

- Sharing data, expertise & computational resources
- Free, open-source sense-making layer built on top of standards-based healthcare IT

- Innovation is local
- Inspiration is global
- Let’s keep talking