Public Health e-Labs for a Global Digital Economy

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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

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)

- Finance
- Clinical
- Public Health
- Research

Health District Data Tomb
Public Health Info-economics

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

Structured Data

Transform & Examine

Structured Data & Metadata
Unclear Public Good

Health Records

Audit; Research; Intelligence

Depersonalise

Local Ownership

Asset Enrichment

Clear Public Good

Research & Decision Objects

e-Lab for a defined community

Health 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
Summarising care quality

Care improvement or case-mix change?
Outputs: Population-based incidence, prevalence; Deaths prevented; Life-Years; Life expectancy; Costs; Cost-effectiveness ratios

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

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
...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**

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### Table: Summary of risk estimates by cancer sites in men

<table>
<thead>
<tr>
<th>Cancer site and type</th>
<th>Number of studies</th>
<th>RR (95% CI)</th>
<th>p</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oesophagus adenocarcinoma</td>
<td>5</td>
<td>1.57 (1.2-1.9)</td>
<td>&lt;0.0001</td>
<td>21%</td>
</tr>
<tr>
<td>Thyroid</td>
<td>1</td>
<td>1.32 (0.06-3.7)</td>
<td>0.62</td>
<td>77%</td>
</tr>
<tr>
<td>Colon</td>
<td>22</td>
<td>1.24 (1.0-1.28)</td>
<td>&lt;0.0001</td>
<td>22%</td>
</tr>
<tr>
<td>Rectal</td>
<td>11</td>
<td>1.24 (0.95-1.61)</td>
<td>&lt;0.0001</td>
<td>22%</td>
</tr>
<tr>
<td>Liver</td>
<td>4</td>
<td>1.32 (0.96-1.8)</td>
<td>0.82</td>
<td>82%</td>
</tr>
<tr>
<td>Multigland adenocarcinoma</td>
<td>6</td>
<td>1.37 (0.15-1.3)</td>
<td>0.904</td>
<td>44%</td>
</tr>
<tr>
<td>Multiple myeloma</td>
<td>7</td>
<td>1.21 (1.0-1.21)</td>
<td>&lt;0.0001</td>
<td>7%</td>
</tr>
<tr>
<td>Rectum</td>
<td>18</td>
<td>1.09 (1.06-1.12)</td>
<td>&lt;0.0001</td>
<td>3%</td>
</tr>
<tr>
<td>Gall bladder</td>
<td>4</td>
<td>1.09 (0.81-1.31)</td>
<td>0.32</td>
<td>9%</td>
</tr>
<tr>
<td>Lymphoma</td>
<td>7</td>
<td>1.08 (0.92-1.14)</td>
<td>0.009</td>
<td>9%</td>
</tr>
<tr>
<td>Prostate</td>
<td>12</td>
<td>1.09 (1.05-1.22)</td>
<td>0.023</td>
<td>7%</td>
</tr>
<tr>
<td>Non-Hodgkin lymphoma</td>
<td>6</td>
<td>1.66 (1.0-2.0)</td>
<td>0.0002</td>
<td>9%</td>
</tr>
<tr>
<td>Breast</td>
<td>27</td>
<td>1.09 (1.00-1.00)</td>
<td>0.11</td>
<td>7%</td>
</tr>
<tr>
<td>Gastrointestinal cancer</td>
<td>8</td>
<td>0.79 (0.68-1.0)</td>
<td>0.49</td>
<td>10%</td>
</tr>
<tr>
<td>Lung</td>
<td>11</td>
<td>0.79 (0.76-1.1)</td>
<td>&lt;0.0001</td>
<td>62%</td>
</tr>
<tr>
<td>Oesophagus squamous</td>
<td>3</td>
<td>0.71 (0.56-0.85)</td>
<td>&lt;0.0001</td>
<td>42%</td>
</tr>
</tbody>
</table>

Figure 3: Summary risk estimates by cancer sites in men.
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 → end-oxifen)

• Blind-spots (missing from registers)
  – Recurrent cancers
  – Adjuvant therapies
  – Concurrent therapies
1. User logs on and submits query
2. Access control module authorizes request
3. Broker performs distributed query; 4. generate pseudonym keys
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

\[
e-Lab = \text{community} + \text{work objects} + \text{methods} \text{ for building work objects}
\]

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

Care  Service Development  Research

e-Lab: Sense-Making Layer

Standards-based Health Information Systems

Powerful Models
Agile Communities
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