The economics of biobanking

International cooperation issues for optimization of quality improvement

Professor C Huttin and Dr Michael Liebman

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Main objectives

- ECONOMIC ISSUES FOR AN INTERNATIONAL COLLABORATION IN BIOBANKING FOR OPTIMIZATION OF QUALITY IMPROVEMENT
- REVIEW OF MAIN BUSINESS MODELS AND COST STUDIES (DISCUSSION OF COST STRUCTURES)
- CASE STUDIES AND DATA FROM STRATEGICMEDICINE TECHNOLOGY PLATFORMS AND DATAWAREHOUSE FOR TRANSLATIONAL RESEARCH (DW4TR)
Examples of research questions

What is the goal for developing a BioBank?
- Internal Research (Clinical and Molecular)
- External Collaborations (Scientific)
- Potential Commercialization (Pharma/Biotech)

Do the requirements differ depending on intended use?

Should guidelines be extended to more general databases (OECD discussion)?
Example of Genetic diversity and geographical proximities in Europe

Central European (CEU) Diversity

Genes mirror geography within Europe.

Individuals were genotyped at 500,568 loci using the Affymetrix 500K single nucleotide polymorphism (SNP) chip.

doi:10.1371/journal.pone.0005151
Case study: Swiss population
(Novembre et al., Nature vol 456 13 Nov 2008)
What is a Biobank?

The term "biobank" has been used in different ways but one way is to define it as "an organized collection of human biological material and associated information stored for one or more research purposes". Collections of plant, animal, microbe, and other nonhuman materials may also be described as biobanks but in some discussions the term is reserved for human specimens.
What is a biobank?

Biobanks usually incorporate cryogenic storage facilities for the samples. They may range in size from individual refrigerators to warehouses, and are maintained by institutions such as hospitals, universities, nonprofit organizations and pharmaceutical companies.
What is a biobank?

Biobanks may be classified by purpose or design. Disease-oriented biobanks usually have a hospital affiliation through which they collect samples representing a variety of diseases, perhaps to look for biomarkers affiliated with disease. Population-based biobanks do not need particular hospital affiliation because they samples from large numbers of all kinds of people, perhaps to look for biomarkers for disease susceptibility in population.

In Europe, the categorization of biobanks also include forensic biobanks.
The economic analysis of biobanking is a recent field in health economics. Main economic papers have investigated types of cost model. It is an important component of genomic medicine and for translational medicine.

example: National cancer institute studies from 2010 and 2012 for centralization of sites.
Economics of personalized medicine
(source Davis et al., Nature reviews, Vol 8, April 2009, 279-286)

<table>
<thead>
<tr>
<th></th>
<th>a Companion diagnostics</th>
<th>b Procedure-focused diagnostics</th>
<th>c Genetic risk markers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HER2</strong></td>
<td>40</td>
<td>80</td>
<td>2</td>
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<tr>
<td><strong>BCR-ABL</strong></td>
<td>2</td>
<td>4</td>
<td>25</td>
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<tr>
<td><strong>Warfarin</strong></td>
<td>35</td>
<td>75</td>
<td>25</td>
</tr>
<tr>
<td><strong>AlloMap</strong></td>
<td>70</td>
<td>5</td>
<td>20</td>
</tr>
</tbody>
</table>

- Savings from changed decision (US$ thousands)
- × probability that diagnostic changes treatment decision (percentage)
- = savings per test (US$ thousands)
- Cost of test (US$ thousands)
- Cost saving for the payers:

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<th>HER2</th>
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<th>Warfarin</th>
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<th>BRCA1</th>
<th>Familial BRCA1</th>
<th>KIF6 (statin)</th>
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<tbody>
<tr>
<td>Cost saving</td>
<td>✓</td>
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Main steps for a value chain in biobanks and cost models

2.1 Literature review on cost studies or economic analysis existing on biobanking
2.2 Types of useful cost structures or economics

On different steps:
- Patient consent and biospecimen handling in different types of sites
- Annotation
- Storage
- Transport
- Information management

2.3 Needs for further economic information on national cancer Human Biobank caHUB
In relation with:
- some data collections for Biospecimen collection according to types of sites
- Processing
- Storage
- Distribution
Types of cost models

Cost Recovery model

- Total life cycle of Ownership model (TLCO)
Biospecimens and biological information used for cancer

Biospecimens are tissues and fluids taken from the human body and used for cancer diagnosis, analysis and research.

Biological information is written in the language of:

1. Genes
2. Tissues
3. Protein (e.g. Protein HER2 for the AKP platform)
Main guidelines

- NCCN guidelines for prevention, prognostic and diagnostic
- OECD guidelines for genetic research and biobanks
Examples of variations in life cycle according to projects by therapeutic areas

Figure 3. Biobank total life cycle cost of ownership.

Journal of the National Cancer Institute Monographs, No. 42, 2011
Main variables for cost models of biobanks

V1 Scope: local, national, international
V2 Distribution: central, virtual
V3 Degree of sample annotation: low, medium, high
V4 Procedures: Quality Assurance (QA), Quality Control (QC)
V5 Types of users: high risk, low risk groups
V6 Types of uses
V7 Types of samples
V8 Complementary characterization of samples: yes, no, other
V9 Complementary characterization for annotation
Examples of different models of human biobanks and genetic research databases (OECD, 2009)

• Large scale collection of human biological material representative of a population or part of the population

• Epidemiological collections

• Collections of carriers of specific genetic mutations/markers/profiles

• Collections of samples and data from individuals with a certain disease or taking specific medications
DW4TR example
Data from translational warehouse: examples

• Sample Annotation (example on additional annotation issue with meanings in different languages?)

• Sample Ownership (issues? Cross border?)
  issue of cos saving software development and hospital ownership for example?

• Sample Quality indicators for improvement? Cos and quality improvement

• Sample Maintenance
Valuation of samples

Value of Samples = $F(\text{number of samples}) + F(\text{quality of samples}) + F(\text{quality of sample annotation})$

where

d\text{value (annotation quality)} >> \text{value (sample quality)} >> \text{value (number of samples)}$
• Preparing the Biospecimen Using the Biospecimen
  • Collection  Processing  Isolation  Storage  Purification  Preservation  Case studies
  • Extraction of biomolecules  Measuring quality
  • Fit-for-Purpose  Biomarker validation
  • Assay development  Assay validation
  • Case studies  Biomarkers of health and disease
  • Translation from laboratory to clinic
  • Diagnostic tools

Case studies

Targets for drug discovery

Tests for drug development

Clinical Trials
## Management of Biobanks

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<thead>
<tr>
<th>Resource Management</th>
<th>Data Management</th>
<th>Regulatory Management</th>
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<td>Collection and annotation</td>
<td>Storage and backup</td>
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<td>Requisition and withdrawal</td>
<td>Shipping and distribution</td>
<td>Informatics tools</td>
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<td>Specimen processing</td>
<td>Inventory control</td>
<td>Tracking and shipping</td>
</tr>
<tr>
<td>Protocols</td>
<td>Databases</td>
<td>Free text to structured data</td>
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<td>Databases</td>
<td>Chain of custody</td>
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<td>International harmony</td>
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- Resource Management
- Data Management
- Regulatory Management

Additional topics:
- Infrastructure and hardware
- Data integration
- Informed consent
- HIPAA/CLIA
- Hazardous specimens
- Custodianship and long-term storage
Contribution for the AKP adaptive technology Platform

\[ DI = F(Q(I), \text{Physician Experience, Research Data, Clinical Trials, Cost Analysis}) \]

DI = Decision Index

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Strategic Medicine

Endepus

Mayo Clinic (Breast Cancer)

MDLogix

Thomson Reuters Knowledge Bases

Patient

Endepus US research (creation) Business Plan
Clinical Practice: Breast Cancer

- Mammography/
- Ultrasound/MRI
- Surgery
- Pathologic
- Diagnosis
- ER/PR
- Testing
- her2/neu
- Testing
- Herceptin/
- Tamox/Relax
- Aromatase Inhib
- Outcome
Cost elements for a biobank for genomic breast cancer

<table>
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<th>CASES/ N</th>
<th>Number of sites: x</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Year 1: N1 Site 1</td>
</tr>
<tr>
<td></td>
<td>Site 2 Site i Site x1</td>
</tr>
</tbody>
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- data collection on and shipping types of samples (tissues, genes, protein)

**TISSUES**
- tissue acquisition costs
- pathology/histology review costs
- informed consent documentation costs
- data collection costs
- insurance cost
- kit collection
- shipping or courier costs
- type of containers
Her2/neu Testing

• Variation in Testing Procedures
  – Immuno-histochemistry (IHC)
    • Measures anti-body response
    • Large potential variability across laboratories
    • Attempts to standardize laboratory procedures
  – Fluorescent in situ hybridization (FISH)
    • Measures gene copy number in cell
    • More significant reproducibility
  – Overall Reproducibility
    • False Positive Rate: 14-16%
    • False Negative Rate: 18-23%
  – Variation between IHC and FISH
    • Approximately 20%

Strategic Medicine, 2010
Conclusions

• Limitation of TLCO models
• Additional annotation may be required in Europe: example different meanings of vocabulary in different languages
• Cross border and biological samples
• Transatlantic collaboration in biobanks and economics of biobanks
• Other issues (e.g. software development and ownership of data)