GMI: Global Microbial Identifier

The future of microbiology:

Identification and Surveillance will merge through the use of Whole Genome Sequencing (WGS)

Jørgen Schlundt
Professor
Technical University of Denmark
"There is a pathway from good science to publication to evidence, and to programs that work.

In this way research becomes an inherent part of problem-solving and policy implementation"

Julio Frenk
Former Mexican Minister of Health
Dean, Harvard School of Public Health
Do we have problems to solve

Detection and surveillance forms the backbone of systems to control, treat and prevent infectious diseases - in animal and man - worldwide.

However, surveillance is still typically targeted at a limited number of specified diseases.

- and there is a very significant global disparity in national disease detection systems and methodology between nations.

Animal and public health efforts (and animal and food export from developing countries) are hampered by lack of diagnostic capacities.

Thus, we have a HEALTH, ANIMAL HEALTH and ECONOMIC problem.
New Opportunities?

History

1953
Watson & Crick

1970
Frederick Sanger

1977
Walter Gilbert
Alan Maxam

1990
454 starts the next generation sequencing era

STAR WARS

2003 2004

454 starts the next generation sequencing era
History

2004

Next Generation Sequencing

454 Life Sciences: Parallelized pyrosequencing

Reduced costs 6 fold at the time – now much cheaper
History

2004

Next Generation Sequencing

Cost per Raw Megabase of DNA Sequence

Growth of GenBank

DTU Management Engineering
Paradigm Shift
from Pasteur to Watson

“It is likely that in 5 to 10 years all clinical microbiological laboratories will have a DNA sequencer in use - the costs for a complete bacterial genome sequence might be less than 50 EURO (or US$).

The capacity to exchange – and manage - large data quantities over web-based systems has likewise increased dramatically over recent years

Enabling the potential creation of global databases consisting of DNA-codes of all relevant microbiological strains”
Passing Past Pasteur

• Old school
  – One to several weeks to perform full typing
  – Very different typing systems for microorganisms
  – Very specialized knowledge base for different microorganisms

• New school
  – Hours (presently 12-24) to perform full sequencing
    – Minutes to get typing result
  – One test fits all (virus, bacteria, fungi, parasites)
  – Same-Same for all microbiology (human, animal, environment)
Whole Genome Sequencing advantages:

A single technique simplifying and facilitating collaboration and data comparison between animals, food and humans (One Health) between countries between fields of research

A generic outcome (sequence) enabling comparisons where not possible before
Whole Genome Sequencing advantages:

Diagnosis and Treatment of infectious diseases will be dramatically improved

Outbreak investigation will improve

Surveillance and Prevention will improve

Microbiological Research improved
Global Microbial Identifier

A global system enables two lines of action:

• Simple identification of all microorganisms (and resistance), enabling reduction in time and cost for a more correct characterization.

• A DNA database of all microbiological strains globally, enabling real-time global (and national) surveillance of disease and pathogen developments as well as AMR.
GMI – The idea

Describing Landscape
Creating Roadmap

Database(s) in the Cloud
Whole Genome Sequencing
Food & Disease Surveillance
Patient
Diagnosis
Global Prevention

DTU Management Engineering 10. oktober 2014
**Is something happening already?**

All publicly available DNA sequence data deposited in the International Collaboration

4 TeraBytes

**Inbound Daily**

America (NCBI)

Europe (EBI)

Asia (DDBJ)

24 Hour Exchange
Go Global

• The necessary research will contribute to the shift from traditional biological characterization systems to “Bio- Informatics” where genetic characteristics can be viewed holistically.

• This will likely contribute to build bridges between separate research areas (clinical microbiology, lab science, epidemiology, risk assessment, systemic and food microbiology).

And we have the potential to go global.
And why soon?

• Different researchers and different sectors are already starting to build separate databases with separate interphases and algorithms.

• If too many separate / different systems are built it will be increasingly difficult to agree to common format and common understanding.

• And we will – again – leave developing countries behind.
NGS leap-frog potential in developing countries:

A dramatic potential to improve animal & public health in developing countries

Current diagnostic methods are diverse and require specialized training

NGS is a simple one-size-fits-all tool for diagnosis of all infectious diseases

New Lab systems need not be separate

Microbio- and Epidemiologist work together
NGS leap-frog potential in developing countries:

At the systemic level use of NGS enable uniform lab-, reporting- and surveillance- systems

Same detection systems for microorganisms from humans & animals - a true ‘One Health’

Developing new diagnostic systems simplified -with real-time char. of microorganisms -in decentralized labs with sequencers + internet

(did you say mobile phones would not work in Africa?)
Virus – Bacteria – Parasites
Same - Same

www.globalmicrobialidentifier.org

Global Microbial Identifier
Open source – with problems

Building a global system sharing often sensitive data will create barriers, .... willingness of sharing sequence data and metadata. Sequence data-bases need to have open access to serve as an early warning system...

It should be realized that sequence data might also be attractive for any industry – However, important privacy issues concerning data mining potential clearly exist.

From: 1st international expert meeting on microbiological genomic identification systems Sep. 2011 Brussels, Belgium.

GMI 1 Meeting
Refusing global sharing – why?

- Concerns about national security and safety
- Institutional and management barriers
- Economic risks and IP-rights; financial barriers
- Socio-cultural and normative differences between populations
- Restrictive national regulations and laws
- Commercial confidentiality and Corporate protection
- Outbreak situation, data not public because potential for prosecution
- Who is the owner of the data – company, authority, laboratory?
- How to share when only part of the data (food / human / animal / ?)
- Potential for misuse by competitors (trade)
- Potential for misuse by others (drugs, diagnostic methods, vaccines)
- Fears of sharing with countries with different legal frameworks
- Freedom of information act (USA) – or similar legislation
Moving on:

GMI 5, Copenhagen, Feb 2013
Preparing a Road Map

GMI 6, California, Sep 2013
Agreeing a Charter

GMI 7, York UK, Sep 2014
Constructing an Organization

GMI 8, Beijing, May 2015?
Analyzing the Landscape
GMI Structure

Steering Committee

Five Working Groups:

**WG1**: Political challenges, outreach, network

**WG2**: Repository of sequences and meta-data

**WG3**: Analytical approaches

**WG4**: Ring trials and quality assurance

**WG5**: Pilot Projects
Political acceptance – will be key!

A dramatic opportunity to start this up globally

Local diagnostics and Global surveillance

Cheaper, better, faster Microbiology and Epidemiology

*First Global Machine with Local use - if we can move forward together??*