New cloud-based technologies for infectious disease organism and resistance tracking
Drug resistance

United Nations high-level meeting on antimicrobial resistance

Antimicrobial resistance summit to shape the international agenda

Date: 21 September 2016
Place: New York, USA

Antimicrobial resistance (AMR) has become one of the biggest threats to global health and endangers other major priorities, such as human development. All around the world, many common infections are becoming resistant to the antimicrobial medicines used to treat them, resulting in longer illnesses and more deaths. At the
% of Member States that had a national plan for antimicrobial resistance, a coordinating mechanism, a focal point, a policy or a strategy and had prepared a report in the previous 5 years, by region.
Summary:
Surveillance of Antibacterial Resistance

1. Gaps are largest where health systems are weak

2. There is no agreement on surveillance standards:
   • What samples and information to collect
   • How to analyse samples
   • How to compile and share data

3. Obtained national data was usually based on proportions of resistant bacteria rather than proportions of resistant bacteria causing specific diseases or affecting defined populations

4. The report provides a benchmark for future surveillance progress
WHO Collaborating Centre for Surveillance of Antimicrobial Resistance

Welcome to the WHONET Community website. Our mission is to build and support the community needed for tracking microbial populations worldwide and to provide the information base required for effective containment and control.

On this site, you will find information on the WHONET software and on activities by our collaborators around the world.

WHONET 2016 SCHEDULE

January 2016
- 1-2 Jan. Case (USF Hospital)
- 3-4 Jan. Dakota, Public Health Laboratory, WHO Office
- 5-6 Jan. New York, Doctors Without Borders - NYU Medical Center
- THCC, Trachoma Centre (AIDS Research Institute for Tropical Medicine, Thailand)
WHONET allows multiple ways to analyze data:

- **Resistant results for any organism or group**
- Scattergrams comparing 2 drugs
- **Patterns of antimicrobial results for a species**
- Histograms of zones of inhibition or MICs
- **% Resistant results for any organism or group**
- Results interpretation comparisons between 2 drugs
Automated use of WHONET and SaTScan to detect outbreaks of *Shigella* spp. using antimicrobial resistance phenotypes

J. STELLING*, W. K. YIH², M. GALAS³, M. KULLDORFF², M. PICHÉ¹, R. TERRAGNO³, E. TUDURI³, S. ESPETXE⁴, N. BINSZTEIN⁸, T. F. O’BRIEN¹, R. PLATT⁸ AND Collaborative Group WHONET-Argentina

**5 outbreaks reported to MoH by labs**

**19 identified by WHONET/SaTScan**

**But depends on manually manipulated lab results**

*Fig. 3. Location of outbreaks reported to the Ministry of Health (A–E) and statistical ‘events’ detected by SaTScan (A–H) in July 2006–June 2007.*
EARS data very comprehensive
Example: Carbapenem R+I – 2014 (19,589 isolates)

Map to region

Proportion of Aminopenicillins Resistant (R+I) Enterococcus faecalis Isolates in Participating Countries in 2014
CAESAR NETWORK
Central Asian and European Surveillance of Antimicrobial Resistance

Map to region

Data
- Collecting data (Excel)
  - Electronic system
- Pre-assessment
- Backlink-WHONET
- Data analysis
- Draft report
- Annual report (on-line)
Manual data management (or via Lab Information System transfer)

Table A.3.2 (continued)
Numbers of patients with positive and negative cultures, respectively, stratified according to individual data
This example covers reporting of aggregated data for only two of the ten age groups.

<table>
<thead>
<tr>
<th>Species</th>
<th>Age group (years)</th>
<th>Female</th>
<th>Hospital origin</th>
<th>Male</th>
<th>Community origin</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Hospital origin</td>
<td>Community origin</td>
<td>Hospital origin</td>
<td>Community origin</td>
</tr>
<tr>
<td>E. coli</td>
<td></td>
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<td>Community origin</td>
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</tr>
<tr>
<td>R. pneumonie</td>
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<td>A. baumannii</td>
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<tr>
<td>S. aureus</td>
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<td>Community origin</td>
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<tr>
<td>S. pneumonia</td>
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<tr>
<td>Salmonella spp.</td>
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<tr>
<td>Other spp.</td>
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<td>Community origin</td>
</tr>
</tbody>
</table>

But what about direct data transmission to network?
Need a system that does not rely on human-generated or transcribed laboratory results

- Results transmitted immediately as available
- No user interaction needed
- Data analysis in real time and geopositioned
- Ability to analyze and evaluate multiple parameters
EpiCollect: Linking Smartphones to Web Applications for Epidemiology, Ecology and Community Data Collection

David M. Aanensen¹*, Derek M. Huntley², Edward J. Feil³, Fada’a al-Own³, Brian G. Spratt¹

Spatial Epidemiology

Spatial epidemiology.net provides a map-based interface for the display and analysis of infectious disease epidemiological data, including molecular data, utilizing Google Maps and Google Earth.

Mapping together genetic and epidemiological data, utilizing the mapping tools provided by Google, is providing an important new way of analyzing and displaying epidemiological data. This approach is likely to grow as Google Maps and Google Earth are free resources which can easily be linked to epidemiological data and analysis programs via a simple to use and intuitive web interface.
Geographic Distribution of *Staphylococcus aureus* Causing Invasive Infections in Europe: A Molecular-Epidemiological Analysis

Hajo Grundmann, David M. Aanensen, Cees C. van den Wijngaard, Brian G. Spratt, Dag Harmsen, Alexander W. Friedrich, the European Staphylococcal Reference Laboratory Working Group

- 2890 invasive *S. aureus* collected over 6 months
- All characterized and entered into database
1. Major MRSA clones in Europe occur mainly in geographical clusters. MRSA, rather than spreading freely in the community, diffuses through regional health care networks.

2. This finding suggests that control efforts aimed at interrupting the spread within and between health care institutions may be feasible and also ultimately successful.
New Real-Time, Easy to use Molecular Technology
30 - 60 minute time to results

BioFire FilmArray RVP
GeneXpert various tests

1 sample/run
12 samples random access
Systems must safeguard data and protect patient and user privacy

- **Encryption**
  - Advanced encryption methods
  - Secure communication between Cloud and data centers

- **Control and Access**
  - Authentication and user controlled access
  - Quality results with control, visibility, and auditability

- **Data Segregation**
  - Multi-tenant database storage segregation

- **Physical Security and Vigilance**
  - Secure cloud hosting—fully managed and monitored 24/7
  - Data storage, back-up, and disaster recovery
BioFire FilmArray RVP

A cloud-based epidemiological database to track respiratory pathogens in real-time

Green: existing data export pathways.
Blue dashes: LIS connectivity of FA 2.0
Blue solid: FA export pathways (FilmArray Trend software)

RP Virus Prevalence (no HRV/Enter) overlaid with CDC ILI Rate

- Adenovirus
- Coronavirus 229E
- Coronavirus HKU1
- Coronavirus NL63
- Coronavirus OC43
- Human Metapneumovirus
- Influenza A H1
- Influenza A H1-2009
- Influenza A H3
- Influenza B
- Parainfluenza Virus 1
- Parainfluenza Virus 2
- Parainfluenza Virus 3
- Parainfluenza Virus 4
- Respiratory Syncytial Virus
Ebola Dashboards

CIDEIM

Ebola Rate and Trend for Liberia, Sierra Leone, and Guinea.
Stevens et al. 2016. Cloud-Based Surveillance, Connectivity, and Distribution of the GeneXpert Analyzers for Diagnosis of Tuberculosis (TB) and Multiple-Drug-Resistant TB in South Africa. In book: Molecular Microbiology: Diagnostic Principles and Practice
S. African NHLS C360 Cloud mapping

- Operational dashboard for real-time monitoring of results, errors, resistance and positivity rates
- Pre-configured on all newly installed GeneXperts

User Workshop held 5-9th November to improve usability and facilitate design changes, Johannesburg
Third Party Products for Data Management

Types of Alerts

1) SMS text message to NTP when an MDR-TB case is detected – get patient into therapy faster

2) Email sent weekly to lab managers showing error rates compared to those of other nearby GeneXpert labs.

3) Web dashboard alert for supervisors to see cartridge stockout forecasts to move inventory where it’s needed the most.
Outbreak Tracker

Number of Cases

1,309
This Month

1,889
All Time

ALERT

Number of cases exceeds Global Health Security threshold. Immediate action is necessary!

New Cases Diagnosed in Last 24 Hours

Slides courtesy Jeff Takle
The Future:

- Real-time results with minimal expertise
- Testing available any location; lab not needed
- Automatic data upload at end of test
- Automatic results delivery to caregiver
- Automatic analysis for trends, problems

Tests for Infectious Disease available today:

- Resp. viruses
- MRSA
- Carbapenemases
- Stool pathogens
- CSF (LCR) pathogens
- TB/Rifampin resistance
- HIV
- HCV
- Ebola