Public Health Informatics Tools for Electronic Disease Surveillance in Resource-Limited Settings

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Thursday, May 28, 2009

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Background

H5N1 Confirmed Cases and Deaths since 2003

Areas with confirmed human cases of H5N1 avian influenza since 2003 *

[Map showing areas with confirmed cases of H5N1]

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Concept

GOAL:
• Improve the timeliness and accuracy of health data collection and analysis in resource limited countries.
• Implement and evaluate low cost technology solutions appropriate for the target user community.

OBJECTIVE:
• Maximize the use of Open Source and free software components
• Minimize licensed and proprietary elements
• Design for sustainability
• Minimize recurring costs
Concept (continued…)

**Communications**
- InfoShare
- Data Export

**Analysis & Visualization**
- OpenESSENCE
- Enterprise ESSENCE
- Desktop ESSENCE

**Data Acquisition**
- IVR - Phone
- Digital logbook
- HL7, SFTP, Email
- Web Forms

**Modeling & Simulation**
- Pandemic Influenza Policy Model
- Predictive Modeling
- Outbreak Scenarios

**Suite for Automated Global Electronic bioSurveillance (SAGES)**

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Concept (continued…)

- Analysis & Visualization
  - OpenESSENCE
  - Enterprise ESSENCE
  - Desktop ESSENCE
  - IVR - Phone
  - Digital logbook
  - HL7, SFTP, Email
  - Web Forms

- Communications
  - InfoShare
  - Data Export
  - Pandemic Influenza Policy Model
  - Outbreak Scenarios
  - Predictive Modeling

Suite for Automated Global Electronic bioSurveillance (SAGES)

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DoD GEIS is currently funding projects in Peru and the Philippines to develop open-source tools.

**PERU**
- Develop open-source tool for remote data collection.
- Pair the remote data collection tool with an open-source, web-based analysis tool.

**PHILIPPINES**
- Work with AFRIMS/PAVRU to develop an electronic surveillance capability for the Ministry of Health National Epidemiology Center.
- Develop open-source tool to collect data at the clinic level.
- Pair with an open-source desktop tool for data analysis and detection.
Data Collection

Interactive Voice Response (IVR)

– Enable remote data collection using telephones. This tool is being piloted in Peru in conjunction with NMRCD.

Clinic Data Entry System

– Simple data entry tool created with the Open Office Database application that is designed to be used at the health clinic or health station level. This tool is being piloted in the Philippines in conjunction with AFRIMS/PAVRU.
Analysis Tools

OpenESSENCE

- Open-source, web-based version of ESSENCE.

ESSENCE Desktop Edition (EDE)

- Open-source, desktop version of ESSENCE which does not require internet connectivity.
• **Several types of reports, including:**
  – Individual (patient-level)
  – Collective (aggregate)

• **Features**
  – Supports prompts for multiple languages
  – Responds to/stores caller selections
  – Inputs patient counts
  – Records caller voice messages
  – Plays back report confirmation
  – Saves data to a MySQL database

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IVR Reporting Overview

Language Selection

1. English
2. Spanish

Caller Authentication

Main Menu

Reports Menu

1. Create New Report
2. Modify Existing Report

Create New Report
Enter Report ID

Modify Existing Report
Enter Report ID

Collective Report
Individual Report

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IVR and OpenESSENCE Integration

Support a Plurality of Voice Phone Devices

Independent of Intermediate Transmission Medium

Backend Phone and Web Interface Servers and Database Servers

Analysts, Administrators, and Users

Healthcare Worker

Healthcare Official

System Administrator
• **OpenESSENCE** functionality is derived from APL’s Enterprise ESSENCE which is currently operational in both CONUS and OCONUS for the U.S. DoD and in CONUS civilian health departments.
  
  - Features include anomaly detection, data visualization, query tool, ability to handle different languages, etc.

• Currently under development and will be piloted with the IVR software in Peru in the spring of 2009.

• Initial capability is focused on NMRC/Peru requirements

• Specifically designed for further extension

• Integrates APL’s experience in data analysis and reporting systems

• Includes lessons learned from current and past work in disease surveillance
OpenESSENCE

• **Design**
  – Incorporates extensive biosurveillance and information system experience
  – Deployed software incorporates only open source components
  – Intended to be released as open source (APL’s integrated application)
  – Includes security required features for authentication and encryption
  – Industry standard technologies (Java EE, Apache & Tomcat servers)

• **Extensibility**
  – Flexible design
    • Data driven query, reporting, and visualization
    • Database independence
  – Plug-in API for detection algorithms
    • Open source and proprietary algorithms

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OpenESSENCE

• Features
  – Configurable database and data sources
  – Synchronization with IVR system database, or any other data source
  – Language internationalization capability for user interface elements
  – Time series view with export
  – Data details view with Excel/CSV export
## ESSENCE - Data Query

### Current Data Query Selections

<table>
<thead>
<tr>
<th>Data Source</th>
<th>Patient</th>
<th>Geography System</th>
<th>Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region</td>
<td></td>
<td>Medical Grouping System</td>
<td>Syndrome</td>
</tr>
</tbody>
</table>

### Next Selections:

**Select Syndrome:**
- All Syndromes
- Bot_Like
- Fever
- GI
- Hem_III

**Select Age Group:**
- All Age Groups
- Unknown
- 00-04
- 05-17
- 18-44

**Select Detector:**
- Regression/EWMA 1,1

**Select Sex:**
- All Sexes
- Unknown
- Male
- Female

**Select Start Date:**
- 06
- Feb
- 06

**Select End Date:**
- 07
- May
- 06

[Submit][Adv Qry]

Questions or Problems?
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## OpenESSENCE
Sample Time Series Counts

<table>
<thead>
<tr>
<th>Data Link</th>
<th>Map Link</th>
<th>Date</th>
<th>Data</th>
<th>Expected</th>
<th>Detection</th>
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<tr>
<td>Data Details</td>
<td>Map View</td>
<td>07May06</td>
<td>66</td>
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<td>Data Details</td>
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<td>Map View</td>
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OpenESSENCE
Sample Graphs

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<table>
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<tr>
<th>Date</th>
<th>Time</th>
<th>Zipcode</th>
<th>Orig Zipcode</th>
<th>Region</th>
<th>AgeGroup</th>
<th>Age</th>
<th>Sex</th>
<th>Chief Complaint/Orig</th>
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</thead>
<tbody>
<tr>
<td>07May06</td>
<td>10:32 PM</td>
<td>18-44</td>
<td></td>
<td>Lac On Head</td>
<td>18-44</td>
<td>18</td>
<td>Male</td>
<td></td>
</tr>
<tr>
<td>07May06</td>
<td>06:55 PM</td>
<td>18-44</td>
<td></td>
<td>Male</td>
<td>Mouth Bleed</td>
<td>35</td>
<td>Male</td>
<td></td>
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<tr>
<td>07May06</td>
<td>04:38 PM</td>
<td>18-44</td>
<td></td>
<td>SPLIT UPPER LIP</td>
<td>31</td>
<td>Male</td>
<td></td>
<td></td>
</tr>
<tr>
<td>07May06</td>
<td>11:55 PM</td>
<td>18-44</td>
<td></td>
<td>HYPERGLYCEMIA</td>
<td>30</td>
<td>Male</td>
<td></td>
<td></td>
</tr>
<tr>
<td>07May06</td>
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<td>00-04</td>
<td></td>
<td>LIP LAC</td>
<td>3</td>
<td>Female</td>
<td></td>
<td></td>
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<tr>
<td>07May06</td>
<td>11:05 PM</td>
<td>18-44</td>
<td></td>
<td>HEAD INJ</td>
<td>27</td>
<td>Male</td>
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<td></td>
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<tr>
<td>07May06</td>
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<td></td>
<td>SOB/CP/COUGH/ASTHMA/PREGNANT/ABD PAIN</td>
<td>16</td>
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<td></td>
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<td>18-44</td>
<td></td>
<td>HA</td>
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<td>Female</td>
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<td>07May06</td>
<td>08:53 PM</td>
<td>18-44</td>
<td></td>
<td>R SHOULDER/BACK PAIN/CP</td>
<td>31</td>
<td>Male</td>
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<td>07May06</td>
<td>08:11 PM</td>
<td>18-44</td>
<td></td>
<td>VAG BLEEDING/ABD PAIN/LIGHTHEADED/DIZZY</td>
<td>38</td>
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<tr>
<td>07May06</td>
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<td>43</td>
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<td></td>
<td>SOB/CP/COUGH/ASTHMA</td>
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<tr>
<td>07May06</td>
<td>06:52 PM</td>
<td>45-64</td>
<td></td>
<td>HA/NECK/SHOULDER/COUGH/CP/SOB</td>
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<tr>
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<td>R ANKLE INJ/FLUTIKE</td>
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<tr>
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<td>05:49 PM</td>
<td>18-44</td>
<td></td>
<td>HEAD LAC/FALL</td>
<td>42</td>
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<td></td>
<td></td>
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<tr>
<td>07May06</td>
<td>06:03 PM</td>
<td>18-44</td>
<td></td>
<td>R FOOT INJ/INF/STOMPED ON NAIL</td>
<td>23</td>
<td>Male</td>
<td></td>
<td></td>
</tr>
<tr>
<td>07May06</td>
<td>05:52 PM</td>
<td>05-17</td>
<td></td>
<td>FALL</td>
<td>10</td>
<td>Male</td>
<td></td>
<td></td>
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<tr>
<td>07May06</td>
<td>05:19 PM</td>
<td>45-64</td>
<td></td>
<td>EYES/PENIS/DETOX</td>
<td>60</td>
<td>Male</td>
<td></td>
<td></td>
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<tr>
<td>07May06</td>
<td>05:02 PM</td>
<td>18-44</td>
<td></td>
<td>SEIZURE/HA</td>
<td>33</td>
<td>Male</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Proposed Enhancements to Philippines Surveillance Program

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Clinic Data Entry System (CDES)

- CDES is a software application used to enter clinic visit data
  - Written in Open Office Database application (freeware)
  - Contains an electronic version of each clinic logbook

- Used in conjunction with their logbook system
  - Enter cases at the end of each day in the electronic ‘logbook’
  - Produce daily tallies electronically instead of by hand

- Produces data summaries, statistics and forms needed by Municipal Epidemiology Surveillance Units (MESU)

- Enable electronic transfer of data from clinic to MESU

- Create a database easily integrated into current surveillance software, that will work with electronic disease monitoring applications, and provides the clinic with a patient database
Clinic Data Entry System
<table>
<thead>
<tr>
<th>Name of Child</th>
<th>Address</th>
<th>Date of Birth</th>
<th>Place of Birth</th>
<th>Birth Weight</th>
</tr>
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<tbody>
<tr>
<td>Los Angeles 2</td>
<td>123</td>
<td>01/01/81</td>
<td>01/01/81</td>
<td>0.00</td>
</tr>
<tr>
<td>San Francisco</td>
<td>456</td>
<td>10/10/89</td>
<td>10/10/89</td>
<td>0.00</td>
</tr>
<tr>
<td>Los Angeles 2</td>
<td>678</td>
<td>01/01/81</td>
<td>01/01/81</td>
<td>0.00</td>
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<tr>
<td>Chicago</td>
<td>F0006</td>
<td>05/15/80</td>
<td>05/15/80</td>
<td>0.00</td>
</tr>
</tbody>
</table>
ESSENCE Desktop Edition (EDE)

- EDE is a stand-alone software application that examines surveillance data for unexpected increases in disease/syndrome trends.
- Extracts data from several different databases, taking variable names and characteristics directly from the file.
- Applies customized algorithms to variables like disease & syndrome counts. The current algorithms work best with case-level data.
- Produces time series, with ‘alerts’ when observed cases counts of a disease/syndrome exceed the expected.
- Produces graphs describing selected variables & allows direct examination of record level data.

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EDE Map Made with EpiMap© Application, with Map Tips Pull-Downs
Dengue SMS Surveillance Project

- A protocol that uses Short Message Service (SMS) texts to send daily, person-based dengue surveillance data from the local health clinics (BHCs) to the MESU.

- BHCs in Cebu City, RP record id codes, age, sex, onset date and presenting signs/sx for each patient meeting the RP clinical dengue case definition.

- This information is sent to the MESU daily in a single SMS text message. Texts are transferred to an EpiInfo data file at the MESU. EDE is used to look for changes in case count.

- Success will be measured by the agreement between the EDE time series for the clinical cases and that from the RP hospital-based sentinel surveillance system.
Conclusions

• The suite of tools described here are freely available public health informatics tools that can be integrated to develop an end-to-end surveillance capability.

• The overarching goal of our work is to facilitate the development or enhancement of local, regional and national disease surveillance systems in resource-poor areas of the world.
Acknowledgements

Philippines Team

*Philippines-AFRIMS Virology Research Unit*
- In-Kyu Yoon
- Agnes Tomayao
- John Mark Velasco
- Maria Theresa Alera
- Jewernest Casul
- Danny Odidas

*National Epidemiology Center*
- Marlow O. Ninal

*Cebu City*

*Guadalupe Health Clinic*

US Naval Medical Research Ctr Detachment

- Joel Montgomery
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