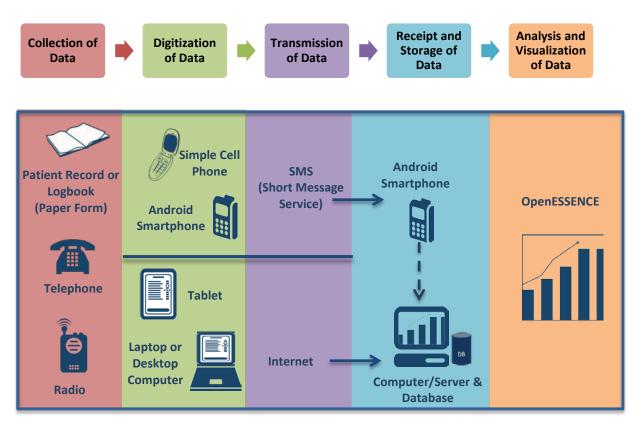# SAGES: The Suite for Automated Global Electronic bioSurveillance

Public health surveillance is undergoing a revolution driven by advances in the field of information technology. Many countries have experienced vast improvements in the collection, ingestion, analysis, visualization, and dissemination of public health data. Resource-limited countries have lagged behind due to challenges in information technology infrastructure, public health resources, and the costs of proprietary software. The Suite for Automated Global Electronic bioSurveillance (SAGES) is a collection of modular, flexible, freely-available software tools for electronic disease surveillance in resource-limited settings. One or more SAGES tools may be used in concert with existing surveillance applications or the SAGES tools may be used en masse for an end-to-end biosurveillance capability. This flexibility allows for the development of an inexpensive, customized, and sustainable disease surveillance system. The ability to rapidly assess anomalous disease activity may lead to more efficient use of limited resources and better compliance with World Health Organization International Health Regulations.

In resource-limited settings, it is imperative to select technology that is both easy to incorporate into existing health services and sustainable with little or no additional financial investment. Each implementation of SAGES is designed to fit the needs of the environment into which it is being installed, and to use the existing infrastructure. SAGES tools are scaleable to meet changing needs and increased availability of resources.

There are five basic processes in the SAGES framework. Within each process, several different component options are available.
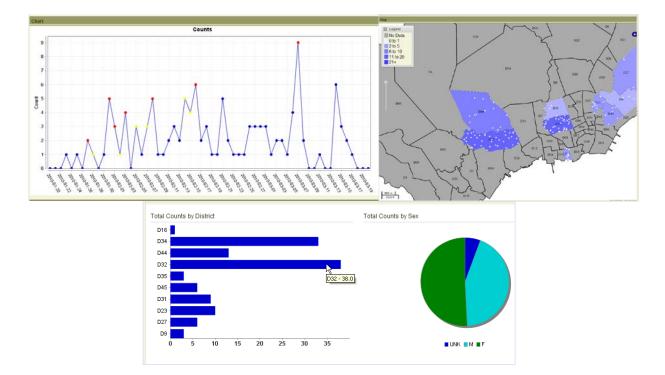

Rapid data acquisition is arguably the most challenging aspect of establishing a successful electronic disease surveillance system. In the SAGES system, data can be collected from multiple sources (such as paper-based patient records and clinic logbooks). The process of turning the paper-based records into electronic data depends on the available technology infrastructure:

http://www.jhuapl.edu/sages

> ➢ If internet access is available, then a laptop, desktop, or other web accessible device can connect to the OpenESSENCE web application to enter data directly into the OpenESSENCE database.

> ➢ If cellular coverage is available, then Android smartphones or simple cell phones can be used to manually enter the information into Short Message Service (SMS) text messages. The SMS messages are received at a central point on an Android smartphone which is connected to a computer hosting the OpenESSENCE database. The SMS messages are automatically pulled from the receiving phone and written into the database.

The data is now ready to be analyzed using the analysis and visualization capabilities of the OpenESSENCE web application. OpenESSENCE is a freely-available, web-based multi-user, data entry, analysis, and visualization tool for electronic disease surveillance. The basic OpenESSENCE architecture includes a central server (a server class computer, desktop, or laptop) which hosts the database and the OpenESSENCE web application. Any computer with an internet connection can log in to the OpenESSENCE server using a web browser and perform data analysis and data entry.

OpenESSENCE features include demographic characterization tools, temporal and spatial analysis, patient level information display, geographic mapping, anomalous event detection, and dynamic query capability. OpenESSENCE contains alerting algorithms developed by JHU/APL and Early Aberration Reporting System (EARS) algorithms developed by the U.S. Centers for Disease Control and Prevention (CDC) to identify anomalous events.

SAGES leverages electronic disease surveillance tools developed at JHU/APL with other freely-available, interoperable tools, and the available local technology infrastructure to enhance electronic disease surveillance capacity in resource-limited settings around the world.