# 2.5

# INNOVATIONS ADVANCING

## Health Surveillance at the Human-Animal Interface

### BACKGROUND

Understanding the connections among people, domestic animals and wildlife will help to improve the forecasting of disease outbreaks and facilitate surveillance and response. By exploring the methodological and technological innovations in the presented cases, planners of national and regional surveillance programs or networks can benefit from lessons learned and evaluate applications that may dramatically advance disease recognition and control.

### OBJECTIVES

Provide a thorough exploration of innovations in cross-sectoral surveillance tools through case presentations and panel discussion. Offer policy makers examples of effective on-the-ground applications of cross-sectoral surveillance that may be considered for inclusion in national and international systems to advance disease recognition and control. Topics include: advances in field simulation exercises, practicalities of One Health integrated disease investigations, advantages of sentinel surveillance, innovations in diagnostics for undiagnosed diseases, application of mobile technologies in participatory disease surveillance, and integration of information systems and mathematical modeling to control expansion of disease.

### MODERATOR

**Charlanne BURKE**

Senior Associate

*The Rockefeller Foundation*
*USA*

## SPEAKERS

- *Advances in field simulation exercises: Highly Pathogenic Avian Influenza control (simulated) between Kenya and Uganda*
  **Maurice Ope**, Medical Epidemiologist, East African Community (East Africa Integrated Disease Surveillance Network-EAIDSNet), Tanzania

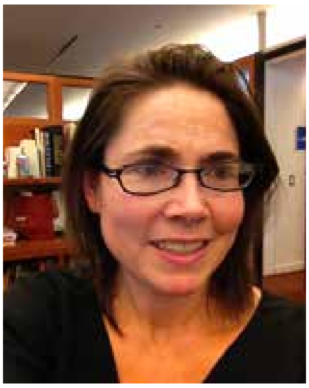
- *Joint Livestock, Wildlife and Public Health Investigation of Q fever in Chiang Mai,*
  **Teerasak Chuxnum**, Veterinarian,
  Bureau of Epidemiology, Thailand

- *Role of sentinel surveillance in the detection of emerging infectious diseases at the human-animal interface, Nigeria*
  **Clement Meseko**, Principal Veterinary Research Officer,
  National Veterinary Research Institute, Nigeria

- *Using a Conventional Strategy to Develop a New Paradigm for Novel Virus Detection and Building Capacity to Implement Globally*
  **Tracey Goldstein**, Research Faculty, UC Davis School of Veterinary Medicine One Health Institute, USA

- *Short Messaging Service based Diseases Surveillance System – Part of Integrated Disease Surveillance Project in Andhra Pradesh, India*
  **Vivek Singh**, Public Health Specialist,
  Public Health Foundation of Indian (PHFI),
  Indian Institute of Public Health (IIPH), India

- *Progress on a One Border One Health binational, multi-sectoral, collaborative system for simulating the spread of pathogens at the USA – Mexico frontier*
  **Rafael Villa-Angulo**, Professor,
  University of Baja California, Mexico



Charlanne Burke joined the Rockefeller Foundation in 1991. As a Senior Associate, she assists in developing strategic direction and providing administrative oversight for select Foundation initiatives. She is currently working on initiatives devoted to strengthening disease surveillance networks in southeast Asia and Africa, and improving the lives of workers in America.

Prior to joining the Rockefeller Foundation, Dr. Burke served in the Peace Corps in Lesotho, southern Africa.  She also has worked as an adjunct assistant professor of anthropology in the City University of New York (CUNY) system.

Dr. Burke received a bachelor's degree from the University of California, San Diego, a master's degree in education from Teachers College, and a Ph.D. from Columbia University.

**CHARLANNE BURKE**

Senior Associate

*The Rockefeller Foundation*
*USA*

Teerasak Chuxnum earned his Doctor of Veterinary Medicine degree from Chulalongkorn University in 1999. He received his Master of Arts degree in Library and Information Science in 2003 from the Khon Kaen University. According to work in Ministry of Public Health, he graduated the bachelor program in Public Health from Sukhothai Thammathirat Open University in 2007.

Dr. Chuxnum has been the Veterinarian at Bureau of Epidemiology, Ministry of Public Health, Thailand since 2002. His interest is basically in Zoonotic diseases as Rabies, Brucellosis, Avian Influenza, Leptospirosis, Trichinosis, Anthrax, Streptococcus Suis infection and Q fever. His research is focusing in Disease Surveillance System and Investigation.

His current position is the head of International Cooperation Center in Epidemiology. His duties are in International Health Regulations and International Cooperation and other Bilateral/Multilateral Epidemiology Cooperation.

**TEERASAK CHUXNUM**

Veterinarian

*Bureau of Epidemiology*
*Thailand*

Tracey Goldstein, PhD, is Research Faculty at the University of California Davis where she developed and oversees the One Health Institute Laboratory and the Marine Ecosystem Health Diagnostic and Surveillance Laboratory. She is also the Laboratory and Surveillance Capacity Coordinator for the new viral emergence early warning project, named PREDICT, developed with the US Agency for International Development's Emerging Pandemic Threats (EPT) Program. Her background is in Wildlife Molecular Epidemiology and in developing disease diagnostics to detect novel pathogens in wildlife. She focuses on solving global health problems using research, training, and capacity building. She provides service to government agencies and the public faced with emerging infectious disease challenges, including U.S. Agency for International Development, U.S. Fish and Wildlife Service, U.S. Geological Survey, National Oceanic and Atmospheric Administration, California Department of Fish and Game, National Marine Fisheries Service, and the U.S. Marine Mammal Commission.

Dr. Goldstein founded the Marine Ecosystem Health Diagnostic and Surveillance Laboratory, with the goal to provide timely, accurate diagnostic services to assess health and the impact of disease on marine wildlife and to identify the role of various pathogens in contributing to wildlife losses. Working with the academic and scientific community she performs high quality marine and terrestrial wildlife research, and partners with state, federal, profit and not for profit organizations to accomplish this goal; working to disseminate information to promote science-based decisions affecting living resources and their habitat.  As a co-investigator ofPREDICT projectshe leads the effort to build laboratory testing capacity within the participating countries collaborating laboratories to perform diagnostic testing for priority viral families.


**TRACEY GOLDSTEIN**

Research Faculty

*UC Davis School of*
*Veterinary Medicine*
*One Health Institute*
*USA*

Dr Clement Adebajo Meseko is a senior researcher at the Nigerian National Veterinary Research Institute (NVRI) in Vom. A recipient of NIH travel fellowship, he recently conducted advance molecular virology research on pandemic influenza virus at Instituto Zooprofillatico Sperimentale delle Venezia, Padova - Italy under the RSM World Bank Institute's fellowship and undertaken courses in serology with the immunology and pathogenesis branch/Influenza Division at the Center for Disease Control (CDC) Atlanta Georgia, USA.

He started his career in 1998 in the Technical Department of Animal Health industries- Pfizer PLC in Lagos - Nigeria where he later became a Field Technical Representative for 5 years. Currently, with over 15 years experience in infectious disease investigation, Dr Meseko acquired dual expertise in human and animal health intervention. In 2006, he prepared a research thesis in virology on the isolation of influenza virus from patients presenting influenza-like illness at the University College Hospital in Ibadan - Nigeria. He was later extensively involved in the diagnosis and control of the first introduction of highly pathogenic avian influenza (HPAI) to Africa leading to effective control of the outbreak in Nigeria in 2008. He received EU sponsored trainings at Veterinary Institute, Oldenburg, Germany, FAO funded training at NAMRU-3 Cairo Egypt and several in-country training courses in biosafety, disease surveillance, research methodology and advance diagnostic techniques. He has served in various technical capacities with the Federal Livestock Department, IFPRI, CIRAD, FAO, World Bank sponsored projects and participated at the WHO expert consultation on influenza at Geneva, Switzerland.

**CLEMENT MESEKO**

Principal Veterinary Research Officer

*National Veterinary Research Institute Nigeria*

Dr Meseko's research interest spans many infectious viral diseases at the human-animal interface. He is presently focused on influenza virus and has published some articles, presentations and reports in national and international journals. A member of Wildlife Disease Association (WDA) and International Society for Influenza and other Respiratory virus diseases (ISIRV), Dr Meseko is a family man and a passionate adventurer who loves mountain climbing.


**MAURICE OPE**

Medical Epidemiologist

*East African Community (East Africa Integrated Disease Surveillance Network-EAIDSNet) Tanzania*


Dr Maurice Ope is a medical doctor trained in Kenya with postgraduate specialization in Public Health and Epidemiology at Universite Libre de Bruxelles in Belgium and Jomo Kenyatta University of Agriculture and Technology (JKUAT) in Kenya respectively. He is also pursuing a PhD in epidemiology at JKUAT. Dr Ope is currently the medical epidemiologist at the East African Community Secretariat in Arusha, Tanzania.

He is currently involved in prevention and control of communicable and non-communicable diseases at the regional level in all the five East African Countries of Burundi, Kenya, Rwanda, United Republic of Tanzania, and Uganda. These include among others disease prevention and control in the cross-border regions; harmonization of surveillance protocols; disease prevention and control guidelines; evaluation of outbreak preparedness; disease outbreak investigation and response; designing and evaluating surveillance systems and strengthening of laboratory capacity in East Africa.

Dr Ope's recent publications include "Regional initiatives in support of surveillance in East Africa: The EAIDSNet Experience" in Emerging Health Threats of 2012, and "Risk factors for hospitalized seasonal influenza in rural western Kenya" in PLoS ONE of 2011. He has also co-authored recent publications including among others "The population-based burden of influenza-associated hospitalization in rural Western Kenya" in the Bulletin of the World Health Organization of 2012, "What are the most sensitive and specific sign and symptom combinations for influenza in patients hospitalized with acute respiratory illness? Results from Western Kenya, January 2007-July 2010" in Epidemiol. Infect. of 2012, "The global burden of respiratory infections due to seasonal influenza in young children: a systematic review and meta analysis" in the Lancet of 2011 and "High mortality in a cholera outbreak in western Kenya after post-election violence in 2008" in the American Journal of Tropical Medicine and Hygiene of 2009. Dr Ope has also written a book chapter on "Implementation of Biological Weapons Convention in Kenya" in the book Implementation of the Biological Weapons Convention: The 2007-2010 intercessional Process of 2011.

**VIVEK SINGH**

Public Health Specialist
*Public Health Foundation of Indian (PHFI)*
*Indian Institute of Public Health (IIPH)*
*India*

Areas of Interest: Public Health Surveillance, Communicable Disease Epidemiology, Field Epidemiology, Information Technology for Strengthening of Health Systems, Public Health Administration & Program Management

Dr. Singh is Assistant Professor at the Indian Institute of Public Health (IIPH) – Hyderabad. He is a graduate of Government Medical College in Nagpur, MH, India and Emory University in Atlanta, GA, USA. He is currently pursuing a fellowship from the Wellcome Trust on Disease Surveillance. He began his public health career as a medical officer in-charge of a Primary Health Center in a tribal region in Maharashtra. He then worked with the National Polio Surveillance Program of World Health Organization (WHO), providing leadership and technical support to the healthcare system at multi-district level in the states of Bihar and Maharashtra.

At IIPH, he coordinated the first two batches of Post Graduate Diploma in Biostatistics and Data Management (PGDBDM) program. He conducts and coordinates courses on applied epidemiology, public health surveillance, public health emergency preparedness and public health program management. He is involved in developing content and coordinating state and national level trainings of epidemiologists, surveillance officers and district and state public health managers under various national health programs. He also provides technical support to the Andhra Pradesh state government on disease control, surveillance and response programs. He is a member of the Immunization Technical Support Unit (ITSU) for the Ministry of Health, Government of India. ITSU has been constituted by the ministry of health in the year 2012 to guide the strengthening of routine immunization program in the country. He has been a member of the national Common Review Mission of the National Rural Health Mission (NRHM).

He has experience in providing leadership and technical support to the disease surveillance and vaccine preventable diseases elimination programs at the Ministry of Health in Kenya; he worked as a consultant with Center for Disease Control and Prevention (CDC), Atlanta's 'STOP' program and WHO country office in Kenya.

He has provided consultancy as public health systems domain expert to some high impact Information, Communication and Technology (ICT) projects in the domain of health information systems, public health surveillance and maternal & child health.

He is an active member of the International Society for Disease Surveillance (ISDS) and he represents the Global Outreach Committee and Global Health Informatics Group of the ISDS as a member. Dr. Singh is an associate edit of following journals, Springer Journal – Earth Perspectives, Internet Journal of Epidemiology and Indian Emergency Journal.

**RAFAEL VILLA-ANGULO**

Professor

*University of Baja California*
*Mexico*

Dr. Rafael Villa-Angulo, chief of the Laboratory of Bioinformatics, University of Baja California. Co-chair of the Informatics workgroup, USA-Mexico One Border One Health Consortium.

Dr. Villa earned his undergraduate degree in electrical engineering at the University of Baja California. He was awarded Master in Computer Science from the Center of Scientific Research and Higher Education of Ensenada, and he obtained his Phd in Bioinformatics from George Mason University. He has been a research scientist at the Engineering Institute of the University of Baja California since 2002. From his more relevant work: he participated in the International Bovine HapMap Consortium, characterizing the genetic structure of the Bos Taurus and Bos Indicus evolutions of Cattle, and generating a Haplotype Map of the Cattle Genome. The results of his research have been published in major journals as Science and BMC Genetics. In 2009 he receives the award “Outstanding Research in Bioinformatics” given by the College of Science of the George Mason University. Nowadays, Dr. Villa is collaborating with the Functional Genomics Laboratory of the USDA in Maryland, developing computational algorithms for the analysis of information of the Last Generation DNA Sequencers, and the analysis of High Density Genotype data from the Bovine Genome. He is the responsible researcher of the “Iniciativa Mexico 2010” for the implementation of Genomic Selection in Dairy Cattle from The State of Baja California. And he is coordinating the work for the creation of the first Mexican Bioinformatics Resource Center for Biodefense.

In 2011 Dr. Villa joined to the USA-Mexico One Border One Health consortium, as co-chair of the informatics workgroup. This consortium is working in the design and implementation of the first operational prototype for disease surveillance and response using One Health paradigms in the U.S./Mexico border. Dr. Villa and collaborators are developing a web-based Hybrid Geographic Information System which uses mathematical models to simulate how pathogens could spread in the border region and permits to visualize contingencies for different scenarios including information from past events such as pandemic H1N1 and other emerging and reemerging pathogens affecting surrounding areas of the USA-Mexico frontier.

# ADVANCES IN FIELD SIMULATION EXERCISES:

## Highly Pathogenic Avian Influenza Control (Simulated between Kenya and Uganda)

**Maurice OPE**
East African Community
(East African Integrated Disease Surveillance Network-EAIDSNet), Tanzania

Here we describe the experience of a simulation exercise conducted in 2010 to test the Kenyan and Ugandan national highly pathogenic avian influenza (HPAI) preparedness and response plans. The simulation exercise demonstrated EAIDSNet's role in facilitating multi-country joint testing of both national and regional preparedness plans for pandemic influenza; and highlighted areas for improvement.

First detected in Hong Kong in 1997, highly pathogenic avian influenza (HPAI) has been detected in over 22 countries. Approximately 566 cases and 332 deaths have been reported in 15 countries. In addition to its high case fatality rate (60 percent), HPAI has been associated with a high economic burden amounting to an estimated loss of USD 20 billion primarily due to the culling of several millions of birds. While international efforts have led to widespread control of HPAI, the disease persists in several countries, including Egypt and Indonesia, and continues to pose a threat to animal and human health. Although the East African Community (EAC) has not experienced any documented cases of HPAI, the region is vulnerable because of its location in the migratory pathway of birds, its shared borders with high-risk countries, and continued importation of poultry products that may carry the virus.

EAIDSNet conducted one of the first field simulation exercises (FSXs) designed to test the effectiveness and efficiency of EAC partner state national HPAI preparedness and response plans. The focus of the exercise was on Kenya and Uganda. The FSX was conducted in Busia, a metropolitan border town between Kenya and Uganda. Busia lies within the migratory pathway of birds, has a thriving informal cross-border live bird market, and is home to many poultry farms. The exercise involved assessing the investigation and response of both countries to an imaginary scenario of a zoonotic public health emergency. Specific objectives of the FSX were to determine whether procedures were realistic and understood by all stakeholders; to reveal weaknesses and gaps; and to clarify roles and responsibilities of all key stakeholders.

The scenario for the simulation exercise was developed by experts from Food and Agriculture organization with the participation of EAIDSNet and it involved a report of bird mortality in a fish farm, followed a few days later by reports of significant mortality in a nearby backyard poultry farm and in a nearby commercial poultry farm. Meanwhile, the backyard poultry farmer had sold some of his chickens in a live bird market in Kenya. Subsequently there was a massive death of caged poultry in the bird market. Two traders from the market complained of fever, cough and sore throat and were treated at a private clinic. A few days later, the traders developed severe chest complications. The district veterinary officer was made aware of the two traders during his routine inspection of the market, after which he informed the clinician in charge of the local health center about the situation and referred the two traders to the health center. An evaluation criterion to determine the success of each operation was developed prior to the simulation exercise.

Several teams composed of staff of various disciplines, from both countries were formed to respond to the situation: veterinary, public health, communication, and security and biosecurity. Each team had specific roles and responsibilities to carry out. The veterinary team conducted investigations among both domestic and wild birds; identified and isolated infected areas; collected fecal, oral and blood samples from suspected birds; and confirmed HPAI at the central laboratory. They subsequently arranged for quarantine of birds at the live bird market, safe and timely disposal of carcasses, installation of footbath devices, provision of personal protective equipment, and disinfection of cages and affected areas.

The public health team conducted investigations and clinical assessments; transported suspected human cases to a designated health facility; set up an appropriate isolation unit and isolated patients; took samples for testing; and disinfected the ambulance. The communication team was responsible for producing and distributing paper and media communication; preparing and installing notice boards at crossing points; and creating public awareness through fliers, posters, and drama. Finally, the security and biosecurity teams were responsible for controlling traffic at the border and checking to see whether poultry products were being carried on board; closing some routes to the informal live bird market in order to enable thorough inspection of the vehicles; installing car footbaths; and disinfecting vehicles.

The FSX proved to be an effective method of testing regional preparedness and response. It demonstrated that control of border trade is possible in the event of an outbreak; that the synergistic roles of the different teams can be realized if the teams are composed of human and animal experts from both sides of the border; and that it is possible to increase public awareness of the risk of emergence and spread of HPAI and of the identification of areas where appropriate responses are required.

However, the exercise also revealed some weaknesses: overall poor coordination of the response activities, inadequate biosecurity measures, poor communication, and minimal involvement of medical workers in response to the HPAI outbreak. To address these weaknesses, EAIDSNet recommended that each district set up permanent multi-sectoral rapid response teams; communication materials be translated into local languages that can be understood by illiterate communities; and instructions for roadblock operations be included in the preparedness and response plans.

# PROGRESS ON A ONE BORDER ONE HEALTH BINATIONAL, MULTI-SECTORAL, COLLABORATIVE SYSTEM

## for Simulating the Spread of Pathogens at the USA – Mexico frontier

**Rafael VILLA-ANGULO**

Laboratory of Bioinformatics, University of Baja California.
Co-chair of the Informatics workgroup, USA-Mexico One Border One Health Consortium.

## Abstract

One Border One Health (OBOH) is a binational, multisectoral initiative to build more resilient and healthy border communities by creating sustainable solutions to health risks at the human – animal – environmental interface along the California/ Mexico border. The coalition consists of over 50 institutions – >30 from the USA and >20 from Mexico – from government, military, public, private and academic sectors. Created in 2011 OBOH has organized into three committees - Surveillance, Informatics, and Training & Outreach – that are cooperating to design and implement the first operational prototype for disease surveillance and response using One Health paradigms. In this background paper, we present the progress in the development of a bioinformatics collaborative system for administering and doing research on multi-sectoral-relational databases to be fed and shared by the coalition. This web-based Hybrid Geographic Information System uses mathematical models to simulate how pathogens could spread in the border region and will assist in the design of binational strategies for controlling the spread of infection. The model input includes environmental, ecological, biological, socioeconomic, and demographic factors and is validated by data from historical disease outbreaks in the region. This is the first model of its kind to be used at the U.S./Mexico border. It models an area with large disparities between health systems, cultures, languages, socioeconomics, politics, animal management strategies, industries and ecosystems. The versatility of the system will permit us to visualize contingencies for different scenarios including information from past events such as pandemic H1N1 and other emerging and reemerging pathogens affecting surrounding areas of the USA – Mexico frontier.

## Background

Mexico and USA are two countries with large disparities: both have evolved within a very different culture, language and kind of government. However, both have evolved sharing the same problems in their frontier. The risk of emerging and reemerging pathogens affecting population in both sides of the frontier is latent. While the Mexican population is vaccinated at early age for some pathogens (e.g. Tuberculosis), the USA population is vaccinated for others (e.g. Diphtheria). However,

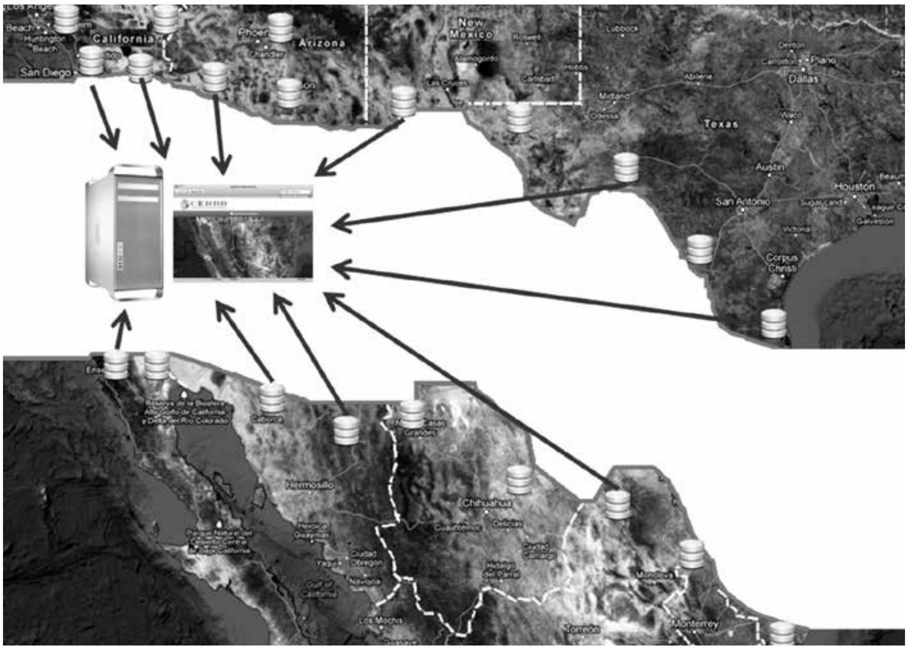



*Figure 1. A Web-based Geographic Information System Server will administer connectivity of databases from ten states along the Mexico-USA frontier.*

both populations are in jeopardy for different pathogens, in addition to those against which none of the population is protected. In recent years, emerging and reemerging infections have proliferated due to yet undiscovered reasons. In 2009 the H1N1 pandemic outbreak and an eruption of Rickettsia caused infection and deaths of many people in both sides of the Mexico-USA frontier [1-3]. These events uncovered our vulnerability in biodefense aspects, and helped us to establish as maximum priority to do research for designing operations to increment national security. OBOH is an initiative of collaboration for protecting, through surveillance, the surrounding areas of the Mexico-USA border line, adopting a One Health paradigm [4]. OBOH joins more than 50 institutions from both countries and is organized by three committees- surveillance, informatics, and training -that are cooperating to design and implement the first operational prototype for disease surveillance and response using One Health paradigm. This prototype input includes environmental, ecological, biological, socioeconomic, and demographic factors and is designed to be validated by data from historical disease outbreaks in the region. This is the first model of its kind to be used at the U.S./Mexico border. It models an area with large disparities between health systems, cultures, languages, socioeconomics, politics, animal management strategies, industries and ecosystems. In the following sections we present a description of the system.

## General concept

The system is being designed for hosting a set of relational multisectoral databases distributed all along both sides of the Mexico-USA frontier.

These databases belong to the members of OBOH. A Web-based Geographic Information System Server (WGISS) will administer connectivity for information access and sharing. The collaborative participation of members is achieved through targeted designation of specific information regarding the sector. The Web server for example, which is administered by academics, permits all members, though a personalized password, to access accounts for feeding, uploading, and running simulation of pathogens of interest. This web-based GIS uses mathematical models to simulate how pathogens could spread in the border region and will assist in the design of binational strategies for controlling the spread of infection.

The system will allow access from the general public with restricted capabilities and is designed to offer, besides the capabilities for OBOH members, a platform for notification and overcome the general confusion of who to contact regarding unusual infectious diseases in humans, companion animals (pets) and livestock animals. The first prototype is being implemented in two states (California from USA and Baja California from Mexico), but, as shown in figure 1, the main goal is to interconnect databases from four USA frontier states- California, Arizona, New Mexico, and Texas – and six Mexico-frontier states - Baja California, Sonora, Chihuahua, Coahuila, Nuevo Leon, and Tamaulipas.

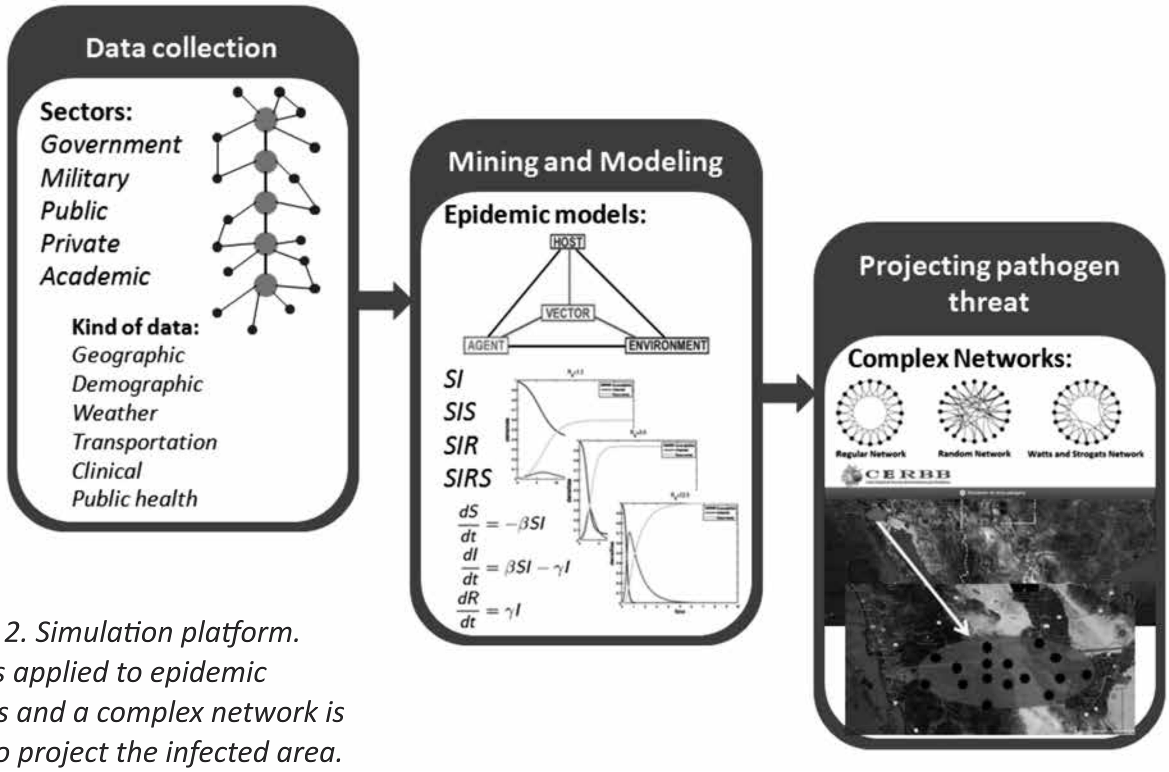
## Simulation platform

The simulation platform input includes environmental, ecological, biological, socioeconomic, and demographic variables and is validated by data from historical disease outbreaks in the region. The state health departments from both countries are allowed to upload information of public health and clinical status. Information regarding socioeconomic, geographic, and demographic is provided by government dependencies of statistics and geography. Transportation information is provided by urban planning and transportation departments, and pathogens information is provided by health and vector departments. Each member of the consortium will have access to the system under a password and is able to upload information for running specific simulations restricting access to her/his results as a convenience. Academic institutions do research in the data, generate epidemic models and update information needed to run simulations.

Figure 2 shows the simulation platform. Information is fed by members and the system administrator. Given the pathogen of interest, an epidemic model is selected for computing infected, susceptible, recovered, deaths, and immune people, through time. An interaction network model in conjunction with demographic information is used to estimate the affected area. As part of the Web-based GIS system, a projection will be done in Google maps for selecting the city and the number of initial cases, along with the projection of the affected area.

## Overall strategy

In its current version, the system is executed on the web-based GIS, integrating tools from Google maps V3, different layers of information provided by the Mexican Institute of Geography and Statistics (INEGI) [5], and three different epidemic models capable of implementing

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$$\frac{dI}{dt} = \beta SI - \gamma I$$
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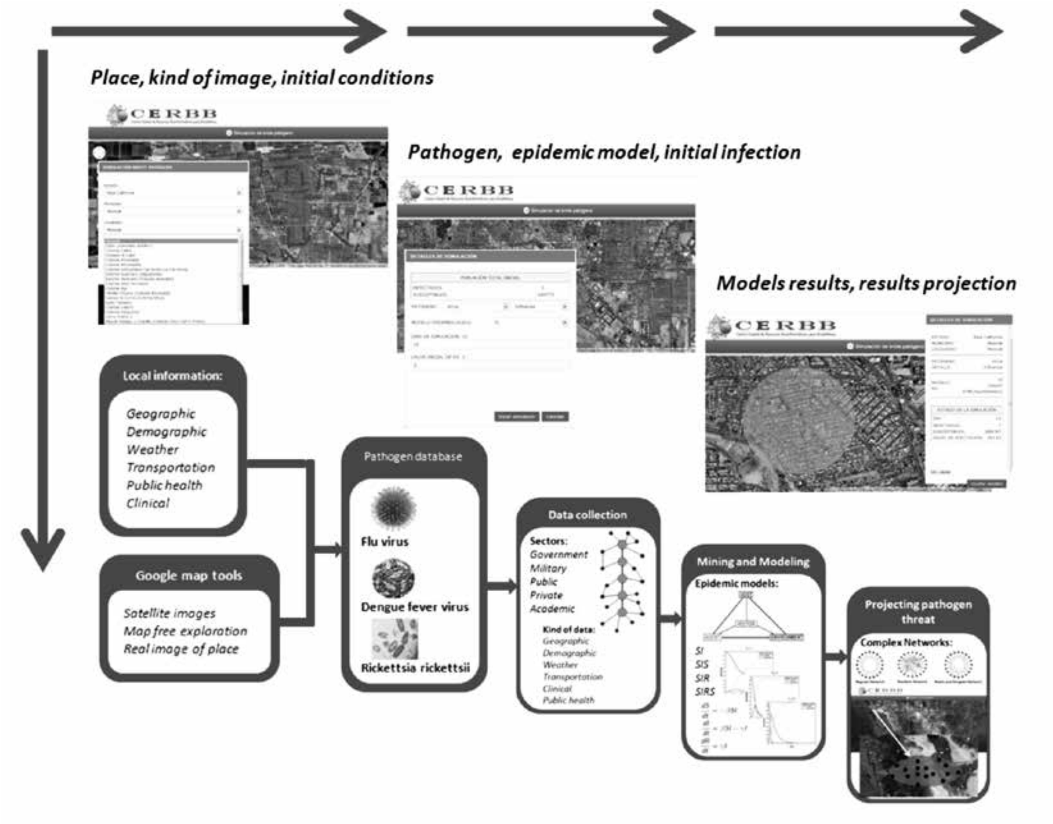
*Figure 2. Simulation platform. Data is applied to epidemic models and a complex network is used to project the infected area.*

vector-borne diseases. It can simulate the spread of pathogens all across the state of Baja California, Mexico. It is in process the inclusion of the state of California, USA. After this first stage is running and being used by the consortium, the next step is to gradually include the rest of states. As shown in Figure 3, a simulation starts with the selection of the place in which the infection would be simulated, along with the kind of Google maps image, and initial conditions of the place. Then, the pathogen is selected from a list which includes H1N1, Rickettsia, and Dengue. After this, the simulation is executed and the epidemic models along with an interaction network provides the number of people infected, recovered, and susceptible, and how they are distributed in the region around the initial infection.

## Preliminary conclusion

This is the first model of its kind to be used at the U.S./Mexico border. The versatility of the system will permit us to visualize contingencies for different scenarios including information from past events such as pandemic H1N1 and other emerging and reemerging pathogens affecting surrounding areas of the USA – Mexico frontier. Integration of web-based tools, information systems and mathematical modeling helps to reconcile disparities between health systems, cultures, languages, socioeconomics, politics, animal management strategies and ecosystems, and design strategies for controlling the spread of infection in surrounding areas of the USA-Mexico frontier.




One Health strategies for combating zoonoses effectively requires interdisciplinary collaborative models for prevention and control of infectious disease epidemics, as well as chronic illnesses. Physicians, veterinarians, ecologists, environmental scientists, laboratory animal specialists, and other health science-related disciplines are getting involved in this work, equally without regard to "turf" barriers. We aim to accelerate the rate of change in surveillance, research, prevention, and control measures for cross-species infections like influenza and dangerous bacteria emerging from antibiotic resistance, with the design and implementation of this kind of collaborative models in which experts can share, access, and manage information from both sides of the USA-Mexico Frontier.

*Figure 3. A Web-based GIS integrates all resources necessary for executing complete simulations, and provide a projection for results in a Google map based form.*

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[1] Mexican Health Department. Official site.http://portal.salud.gob.mx/contenidos/noticias/influenza/estadisticas.html

[2] Epidemic Department. Mexican Health Department, 'Rickettsia en Baja California'. http://www.dgepi.salud.gob.mx/boletin/2010/sem6/pdf/edit0610.pdf

[3] Centers for Disease control and Prevention. '2009 H1N1 Early Outbreak and Disease Characteristics'. http://www.cdc.gov/h1n1flu/surveillanceqa.htm

[4] One Border One Health. Official site. http://www.oneborderonehealth.com/

[5] National Institute of Statistics and Geography. Official site. http://www.inegi.org.mx/

# ROLE OF SENTINEL SURVEILLANCE
## in the Detection of Emerging Infectious Diseases at the Human-Animal Interface, Nigeria

**Meseko CLEMENT**
Virology Department, National Veterinary Research Institute, Vom, Nigeria

**BACKGROUND**

Climate change and global warming has altered the process and outcome of infectious diseases worldwide. This alteration in the environment and increase in urban agriculture in response to population growth cause intensification of livestock farms in confine feeding operations (CAFO) thereby contributing to emerging diseases at the animal-human interface. This is both an economic and public health risk to the society. However early detection and control of these emerging diseases hinged on effective surveillance system is important for sustainable development. Unfortunately disease surveillance is poorly organized in developing countries of Africa.

**OBJECTIVE**

Despite present challenges with the spread of infectious diseases in developing countries especially, there are no effective and sustainable national surveillance for early detection of emerging diseases at the human- animal interface in Nigeria. It in this presentation, I outline how adoption of sentinel surveillance had served effectively in the detection of emerging infectious diseases of both economic and public health importance at the human-animal interface in Nigeria.

**MAIN MESSAGE AND LESSON LEARNED**

Swine farming is one of the fastest growing sources of meat protein in the world today with 40% of the world meat protein consumption derived from pork and pork products and millions of metric tons traded across international borders. Nigeria accounts for about 30% of pig production in Africa and pig farms are widely spread in the country with higher concentrations in the Southern and Central agro-ecological regions, providing meat protein for Africa’s most populous nation. The industry has witnessed gradual growth over the years with the promotion of peri urban intensive farm estates but not without a number of challenges that ranges from diseases, nutrition to reproductive losses.

The recent pandemic of influenza A/H1N1 said to originate from swine is a cause for concern in the pig industry because pigs play significant role in the epidemiology of swine influenza and the emergence of pandemic virus. Constant monitoring of emerging virus among the animals and in persons occupationally exposed provides data for better public health policy.

Sentinel surveillance was designed and implemented in an intensive urban piggery production operation with over 5000 human concentration and 1 million pigs in a single site for over 24 months. Clinical specimens were collected from case presentation of swine influenza and human exposure. This was transported on ice to the laboratory for virus detection and isolation. Data on biosecurity practices were also collected with structured questionnaires and analyzed.

It was observed that the biosecurity practice in farm is far below acceptable standard. This obviously would encourage easy circulation and spread of swine influenza intra and inter species. Analyzed specimen confirms the circulation of human strain of swine influenza virus in pigs which may have been contracted from the farmers.

## ADVANCEMENT OVER PREVIOUS SYSTEM

Previous national surveillance in livestock is bedeviled by weak veterinary infrastructure, poor capacity and political will. This surveillance expended less resources, ensure close monitoring and took advantage of the peculiarity of the operation system.

This to my knowledge is one of the first effective surveillance at the human-animal interface in Nigeria where both animals and animal handlers were taken into consideration.

## PRACTICAL RECOMENDTION

Epidemio surveillance programme in developing countries should in addition to National surveillance be designed as focus groups of sentinel surveillance that would address unique terrain, culture, farm operation, diseases and population groups and observed over a period of time which is more effective in the detection of emerging infectious diseases.

The observation that human can readily be infected by viruses circulating in animals and vice versa, requires that diseases control measures such as biosecurity and vaccination should be targeted at this occupationally exposed group.

# JOINT LIVESTOCK,
## Wildlife and Public Health Investigation of Q fever in Chiang Mai, Thailand

**Teerasak CHUXNUM[1], Pattarin OPASCHAITAT[2], Sowapak HINJOY[1], Pranee RODTIAN[3] and Tanit KASANTIKUL[4], Susan MALONEY[5]**

## BACKGROUND

Q fever, a zoonosis caused by Coxiella burnetti. In animal, the majority of cases, abortions occur at the end of gestation without specific clinical signs until abortion is imminent. But in human, the acute disease appears like a flu-like infection, usually self-limiting illness accompanied by myalgia and severe headache. Complications, such as pneumonia or hepatitis, may also occur. Endocarditis in patients suffering from valvulopathy, as well as premature delivery or abortion in pregnant women, is the main severe manifestations of the chronic evolution of the disease. [1]

Q fever in Thailand is an emerging disease. There were nine clinical cases in a prospective study in patients with acute febrile illness who were admitted to four hospitals in northeastern Thailand were reported in 2003. [2] In 2011, a study in Khon Kaen focusing on zoonotic causes of endocarditis in humans identified four confirmed cases of Q fever endocarditis. All case-patients had a history of contact with farm animals such as dairy and beef cattle. [3] Little information exists on the incidence and prevalence of Q fever in animals. A serological survey in 1967 in Thailand showed seroprevalence of Coxiella burnetti of 28.1% in dogs, andseroprevalence in goats, sheep, and cattle varied from 2.3% to 6.1%. [4]

The One Health concept, the collaborative effort of multiple disciplines to attain optimal health for people, animals and the environment [5] is adapted in this study.

## MATERIALS AND METHODS

Based on the strategic framework of the One Health concept, its achievement involves the strengthening of animal, public health and environment surveillance. (Figure 1) Sharing information between each surveillance system is practical for response, prevention and preparedness system at the provincial level.

The public health authorities are including Chiang Mai Public Health Office, District Public Health Offices, Sub-district Health Promotion Hospitals

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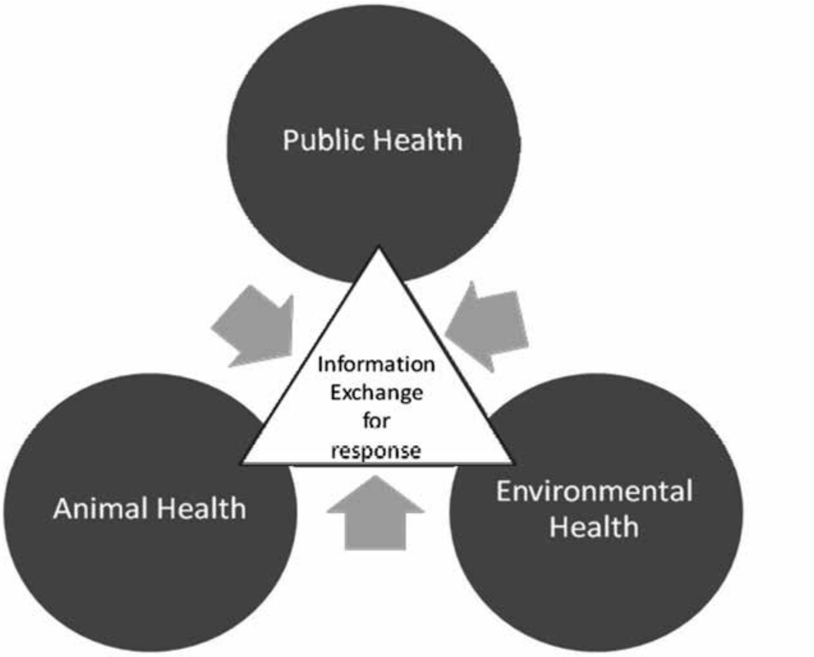


*Figure 1: The animal, public health and environment surveillance with sharing information for response*

and National Institute of Health. The animal health authorities are including Chiang Mai Livestock Office, The Fifth Regional Livestock Office and National Institute of Animal Health. Chiang Mai Zoo and Chiang Mai Night Safari are representatives for environmental health.

The joint surveillance and investigation of Q fever was conducted to develop network of animal health and public health surveillance and response at provincial level.

## RESULTS

A joint investigation of Q fever by livestock, wildlife and public health authorities aimed to determine the prevalence and risk factors of Q fever in animals and animal care takers in Chiang Mai, Thailand.

The One Health team was established at first in Chiang Mai provincial level. (Figure 2) The team is comprised with human and animal health, zoologist, epidemiologist and laboratorian as well as other professionals, would be charged with joint surveillance for Q fever and disease response.

The Q fever surveillance and investigation were set up. Blood samples from 271 dairy cows, 61 deer, 1 camel and 1 Indian bison were collected at two Chiang Mai zoos, Chiang Mai Zoo and Chiang Mai Night Safari, and ten dairy farms in April 2012. Three cow placenta and three buffalo placenta were also sampled from the fresh market in Chiang Mai during the same period. (Figure 3) Animal sera were tested for antibodies against Coxiella burnetii by ELISA at the National Institute of Animal Health.

*Figure 2:*
*One Health Team*


Of the animals tested, 22/334 (6.59%) had antibodies to C. burnetii: 22/271 (8.12%) in dairy cows. There is no antibody positive against Coxiella burnetii in zoo animal and cow placentas and buffalo placentas.

The response for Q fever in dairy farmer has been monitored. The blood samples will be collected after any symptom related to Q fever. Joint investigation will be conducted by the One Health team in order to prevent and control the disease.

*Figure 3: Placentas collection from the fresh market in Chiang Mai*

## DISCUSSION

The results of these animal surveys will be used in conjunction with the results of the ongoing zoonotic endocarditis study in Khon Kaen to develop and implement effective surveillance models for Q fever in humans and animals. This model of joint investigation can also be applied to other zoonotic diseases to strengthen collaboration among livestock, wildlife and public health officers working in the same area. Human laboratory test result will be reported once they are confirmed.

1. Rodolakis A. Q fever, state of art: epidemiology, diagnosis and prophylaxis. **Small Ruminant Res** 2006 Mar; 62(1) 121–4.

2. Suputtamongkol Y, Rolain JM, Losuwanaruk K, Niwatayakul K, Suttinont C, Chierakul W,et al. Q fever in Thailand. **Emerg Infect Dis** 2003 Sep;9(9):1186-7.

3. Pachirat O, Fournier PE, Pussadhamma B, Taksinachanekij S, Lulitanond V, Baggett HC, et al. The first reported cases of Q fever endocarditis in Thailand. **Infect Dis Rep** 2012;4:e7.

4. Sankasuwan V, Pongpradit P, Bodhidatta P. **Seato Medical Research Study on Rickettsial Diseases in Thailand.1967**:449-04

5. The American Veterinary Medical Association. One Health Initiative Task Force. **"One Health: A New Professional Imperative"** [online]. 2008 [cited 2012 July 15]. Available from https://www.avma.org/KB/Resources/Reports/Documents/onehealth_final.pdf.

# USING A CONVENTIONAL STRATEGY
## to Develop a New Paradigm for Novel Virus Detection and Building Capacity to Implement Globally

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Rapid identification of pandemic threats has recently become more feasible due to implementation of One Health approaches. Most genomic approaches for viral discovery are extremely expensive and available only in sophisticated laboratories with teams of diagnosticians and bioinformaticians. Therefore, more economical and technologically simple approaches were sorely needed to forecast novel pathogen emergence. Broadly reactive consensus polymerase chain reaction (PCR) assays have been used extensively for decades in research laboratories to detect and characterize novel pathogens. Through the Emerging Pandemic Threats PREDICT Project, this strategy for viral identification and pathogen detection has been newly initiated in diagnostic laboratories globally to detect both known and novel pathogens in tandem rather than sequentially. Consensus (genus/family level) PCR is a powerful tool that produces specific, high-resolution data and allows for quicker detection of potential pathogens, especially important for the diagnosis of mystery illnesses in medical hospitals and veterinary labs and in the event of an outbreak to respond appropriately to minimize both effect and spread. Because the PREDICT Project has focused on viral emergence from wildlife in remote areas, we have been working with laboratories in some of the most resource-constrained countries to develop local capacity to use consensus PCR. Testing of targeted samples based on the circumstances that promote disease and the potential route of exposure has already been implemented in 15 of 27 partner laboratories, and in less than two years the project has detected more than 200 novel viruses from wildlife that are related to those that cause illness, epidemics, and pandemics in people including SARS-like coronaviruses, novel human adenoviruses, and a new clade of Ebola. Not only have animal viruses shared by multiple animal hosts been detected, but also human viruses in animals and vice versa. Combining cutting-edge surveillance techniques with practical implementation of holistic, One Health approaches, the global health community has now contributed significantly to inexpensive diagnostic improvement for the individual, while realizing the original goal of step-wise improvement of pandemic prevention.

# SHORT MESSAGING SERVICE BASED DISEASES SURVEILLANCE SYSTEM

## Part of Integrated Disease Surveillance Project in Andhra Pradesh, India

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There is mounting interest in the field of mHealth - the provision of health-related services via mobile communications. This can be attributed to certain interrelated trends. In many parts of the world epidemics and a shortage in the health care workforce continue to present grave challenges for health care systems. Yet in these same places, the explosive growth of mobile communications over the past decade offers new hope for the promotion of quality healthcare. In many nations paper based surveillance reports must be submitted in person and manually entered into a central health database. Recent evidence from small scale pilots in developing countries have shown that the data collection process can be more efficient and reliable if conducted via mobile phones rather than in the previous paper based formats.

The overall objective of the Integrated Disease Surveillance Project (IDSP) launched in 2004 was to improve the timeliness and quality of the response to infectious disease outbreaks at district level, and to improve the quality of monitoring and surveillance of infectious disease at state and national level. Periodic reviews of the IDSP undertaken internally and by the Joint Implementation Support Review Mission (JISM), comprising of state officials and members from the development partners, have reported many challenges to improving the effectiveness of the IDSP. These include the lack of human resources, poor communications with the distant and remote reporting site locations, resource limitations and lack of analytical skills and capacity.

In the state of Andhra Pradesh (AP) the situation with the IDSP was not dissimilar. To address the challenges, a Short Message Service (SMS) based surveillance system was designed and piloted in six of AP's 23 districts, starting in August 2008.The SMS based surveillance system was an attempt to tackle the barriers to improving the IDSP by capitalizing on the exponential growth in numbers as well as reach of mobile phones in the state.. The system was jointly designed in the state by the Directorate of Health Services (DH) and the National Informatics Centre (NIC). The system used simple alpha-numeric codes to collect information compatible with the prescribed IDSP formats. Health workers across the state were trained to report the information via SMS to a central server in Hyderabad. To ensure data security the system was designed to identify every health facility

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(reporting unit) involved in the project with a unique identification number and the SMS was accepted only from registered mobile numbers. The system was also able to send automatic alerts to registered mobile numbers when the frequency of reports crossed pre-set threshold levels. Health workers in 3,832 reporting units (hospitals and health centres) across six pilot districts began using this system to send IDSP reports in August 2008. Anecdotal reports suggested some promising results such as improved reporting from the hard to reach areas, possibility of generation of more timely alerts regarding outbreaks, reduced burden of paper work and savings on resources such as stationery and postage. As a result of this promising feedback from the pilot sites, the SMS based system was rolled out to about 16,000 reporting units across the state.

*Health worker displaying Pocket flip card of SMS reporting procedures*

*Medical officer at a PHC training health staff on SMS reporting procedures*

In the conventional paper based surveillance system the reporting was done manually or semi-automatically, i.e. entirely by post or in person to the district level surveillance unit. From the district centre the data used to be consolidated and sent to the state level surveillance unit by email or by fax. Usually the information about the health events used to take a few weeks of time to travel from the field level to the state level. In the mHealth surveillance system, the field level health workers were given a messaging template, or a 'midlet' was stored in their mobile phones to capture the data with menu driven interfaces, which were converted into an SMS. The SMS thus created is sent to a central gateway, which gets processed at state level, and subsequently the national level disease surveillance servers get updated. SMS based alerts and early warnings get generated automatically to the registered stakeholders responsible for taking timely remedial measures. The State Surveillance Unit (SSU) printed and distributed pocket sized flip cards with SMS reporting procedures to aid the sending of SMS reports by the health workers. Flex posters of SMS reporting procedures were also printed

*Flex board of SMS reporting procedures in the laboratory*

and distributed to all reporting units, including the laboratories. The SSU has also hosted a website where web based customized reports generated from the SMS reports can be accessed by different stakeholders.

Results from an evaluation of the system have shown an increase in regular reporting from the hard to reach reporting sites. The health workers surveyed reported that they were receiving reminders through the SMS based surveillance system, and that these reminders have led to an improvement in the reporting frequency. The system acknowledged receipt of SMS reports in the proper format, and many health workers stated that the immediate acknowledgement of a report encouraged them to send regular reports. The system also generates automatic alerts based on thresholds set for the number of cases reported for various diseases. The threshold levels are set based on the definitions of outbreaks given in the IDSP manuals and are unique to a disease. These alerts can lead to a significant decrease in the response time to disease outbreaks in the state. Alerts to multiple stakeholders may also lead to better inter-sectoral coordination in responding to disease outbreaks in the state.

**Mobile phone of a health worker showing a reminder from the SMS surveillance System**


**Interactive state map with complete disease surveillance reports**

An evaluation of the system has shown that there is significant decrease in the time taken to report every week in a SMS based surveillance system as compared to the paper based reporting system. This system has also led to a significant reduction in the money spent on travel and stationery versus the conventional paper based reporting system.

Mobile phones in this system have also made availability of real time data from the field easily accessible on the hand sets in a user-friendly mode. District and state level managers are accessing real time reports from the field through their mobile handsets and making timely decisions. This has led to a significant increase in the number of situations in which


**District wise disease surveillance reports on mobile phone**

the managers have taken some preemptive measures to prevent outbreaks or control the spread of outbreaks.

Overall, the Short Message Service technology has been successfully utilized in Andhra Pradesh to create a disease surveillance system which is adept for timely and adequate response to disease outbreaks in a cost effective way. The evaluation of this system has shown that high mobile phone penetration in the population provides the opportunity for making public health programmes more community-centric.

Mobile phone based surveillance also offers an opportunity for linking human and animal health surveillance from the grass roots right up to the national level. Efforts need to be made to explore further possibilities for knowledge sharing and for forging appropriate collaborations to find solutions to health problems across the public health and veterinary sectors.

1. Suresh K. Integrated Diseases Surveillance Project (IDSP) through a consultant's lens. Indian J Public Health. 2001;52:136_43.

2. Challenges in improving infectious disease surveillance systems. Global Health, United States*General Accounting Office; 2001.

3. Beaglehole R, Bonita R. Challenges for public health in the global context*prevention and surveillance. Scand J Public Health. 2001;29:81_3.

4. Binder S, Levitt AM, Sacks JJ, Hughes JM. Emerging infectious diseases: Public health issues for the 21st century. Science. 1999;284:1311_3.

5. Health for development: the opportunity of mobile technology for healthcare in the developing world. Washington, DC and Berkshire, UK, UN-Vodafone Foundation.

6. Chretien JP. Electronic public health surveillance in developing settings: workshop summary. Disease Surveillance: Role of Public Health Informatics. Bangkok, Thailand; 2008.

7. Buehler JW, Hopkins RS, Overhage JM, Sosin DM, Tong V, CDC Working Group. Framework for evaluating public health surveillance systems for early detection of outbreaks: recommendations from the CDC working group. MMWR Recomm Rep. 2004;53(RR05):1_11.