Implementation of Real-Time Laboratory-Based Influenza Surveillance System, a Network of 20 Hospitals in Bangkok Dusit Medical Services Public Company Limited, Thailand

Phunlerd Piyaraj, MD, PhD[1,2] ; Nira Pet-hoi[3] ; Chaiyos Kunanusont, MD, PhD[2] ; Supanee Sangiamsak[2] ; Somsak Wankijcharoen, MD[3] ; Jarupa Kanjanakornhirun[3] ; Veerasak Kritsanapraphan[3] ; Supaiboon Chumai[4] ; Paithoon Boonma, MD[5]

Phunlerd Piyaraj, MD, PhD

[1] Department of Parasitology, Phramongkutklao College of Medicine, Thailand
[2] Bangkok Health Research Center (BHRC), Bangkok Dusit Medical Services Public Company Limited (BDMS), Thailand
[3] Chief Information Office, Bangkok Hospital Head Quarter, Thailand
[4] Department of Information Technology, National Healthcare Systems co ltd (n health), Thailand
[5] Department of Medicine, Bangkok Hospital Head Quarter, Thailand

*Address Correspondence to author:
Phunlerd Piyaraj, MD, PhD
Department of Parasitology,
Phramongkutklao College of Medicine,
315 Rajchavithe Rd, Payathai,
Bangkok, 10400, Thailand.
email: phunlerd.pi@bangkokhospital.com

Received: June 27, 2017
Revision received: June 29, 2017
Accepted after revision: July 18, 2017
BKK Med J 2017;13(2): 1-4
www.bangkokmedjournal.com

Abstract

OBJECTIVE: We describe the Bangkok Dusit Medical Services Surveillance System (BDMS-SS) and use of surveillance efforts for influenza as an example of surveillance capability in near real-time among a network of 20 hospitals in the Bangkok Dusit Medical Services group (BDMS).

MATERIALS AND METHODS: The BDMS has a comprehensive network of laboratory, epidemiologic, and early warning surveillance systems which represents the largest body of information from private hospitals across Thailand. Hospitals and clinical laboratories have deployed automatic reporting mechanisms since 2010 and have effectively improved timeliness of laboratory data reporting. In April 2017, the capacity of near real-time influenza surveillance in BDMS was found to have a demonstrated and sustainable capability.

RESULTS: : From October 2010 to April 2017, the real-time laboratory based surveillance system automatically uploaded test results and associated data which were 24 hours available to affiliated physicians, infectious nurses, local and national public health users. A total of 482,789 subjects were tested and 86,177 (17.84%) cases of influenza were identified. Of those positive cases, 40,552 (47.0%) were influenza type B, 31,412 (36.4%) were influenza A unspecified subtype, 6,181 (7.2%) were influenza A H1N1, 4,001 (4.6%) were influenza A H3N2, 3,835 (4.4%) were influenza A seasonal and 196 (0.4%) were respiratory syncytial virus.

CONCLUSION: This system was the first near real-time influenza surveillance system in Thailand. This illustrates a high level of awareness and willingness among the BDMS hospital network to report emerging infectious diseases, and highlights the robust and sensitive nature of BDMS's surveillance system. It demonstrates the flexibility of the surveillance systems in BDMS to adapt to major communicable diseases. BDMS can more actively collaborate with national counterparts and use its expertise to strengthen global and regional surveillance capacity in Southeast Asia, in order to secure advances for a world safe and secure from infectious disease.

Keywords: real-time surveillance system, influenza A H1N1, influenza A H3N2, influenza type B, respiratory syncytial virus (RSV)

Influenza is one of the significant causes of morbidity and mortality globally. The World Health Organization (WHO) reports that globally influenza accounts for 3 to 5 million severe cases and 250,000 to 500,000 deaths annually, with the majority of deaths occurring among high risk groups especially elderly populations.[1] The movement of international trade and travel worldwide has had an increasing influence on global transmission of emerging infectious diseases.[2] Thailand, a commercial and travel hub for Southeast Asia, has a risk of imported infectious diseases such as influenza. The long-standing national influenza surveillance system in Thailand known as the Thai national influenza center (NIC) was established by WHO as a national influenza laboratory in 1972. The primary objective of the Thai NIC is to surveillance emerging influenza viruses in public hospitals and to regularly provide newly insolated strains with WHO. Previous studies have demonstrated the benefit of laboratory surveillance and its capability to accurately detect influenza outbreaks earlier than syndromic surveillance.[3-9] Current laboratory surveillance has an approximately 4-week lag due to laboratory test turn-around time, data collection and data analysis.

As part of strengthening influenza virus surveillance in response to the 2009 influenza A (H1N1) pandemic, the real-time laboratory-based influenza surveillance system, the Bangkok Dusit Medical Services Surveillance System (BDMS-SS), was developed in 2010 by the Bangkok Health Research Center (BHRC). The primary objective of the BDMS-SS is to alert relevant stakeholders on the incidence trends of the influenza virus. Type-specific results along with patient demographic and geographic information were available to physicians and uploaded for public health awareness within 24 hours after patient nasopharyngeal swab was collected. This system advances early warning and supports better decision making during infectious disease events.[2] The BDMS-SS operates all year round collecting results of all routinely tested respiratory clinical samples from participating hospitals from the largest group of private hospitals in Thailand. In this article, we introduce the surveillance systems for infectious diseases in BDMS. We use influenza surveillance to describe a comprehensive surveillance structure that integrates information from relevant health information systems from our hospital network.

Materials and Methods

Study protocol

The real-time laboratory-based influenza surveillance system, the BDMS-SS constitutes a collaborative partnership between multidisciplinary teams within the BMDS. The partnerships involved in this surveillance system are the Bangkok Health Research Center (BHRC), Chief Information Office department of Bangkok Hospital Headquarters, Infectious disease control department of Bangkok Hospital Headquarters, Business Intelligence department of Greenline Synergy Co., ltd. and Information Technology department of National Healthcare Systems co., ltd. (N-health). A protocol for influenza surveillance was written with the technical support of clinical epidemiologists based on CDC criteria.

Study setting

A network of 20 private hospitals representing all 5 regions of Thailand is currently participating in the BDMS-SS. The surveillance sites were selected based on their accessibility to patients, adequate specimen storage capacity, and established transportation system to the N-health.

Sample collection

Laboratory tests are requested by clinicians in charge of patient care from each hospital. Clinicians decide the test each patient needs, and which types of samples need to be taken, and when. The most common sample types reported to this system are nasopharyngeal aspiration, tracheal secretion and nasal and throat swab. All samples for influenza virus testing were sent to N-health tested by rapid influenza diagnostic tests, multiplex real time polymerase chain reaction (PCR) and enzyme immunoassay (EIA) (approved by FDA and/or CE/IVD). Review meetings with all stakeholders were organized every four months, as part of a strategy to improve the surveillance system by identifying strengths and areas of concern during these meetings.

Data collection and management

The system systematically collected information from all influenza test results from N-health which provides medical laboratory results and shared services for a network of 20 hospitals. The test results were submitted automatically each day into the Bangkok hospital data warehouse by the Business Intelligence department of Greenline Synergy Co., ltd.. The next step is for the Lab Influenza surveillance business intelligence system, developed by the Chief Information Office department of Bangkok Hospital Headquarters, to retrieve those test results and integrate these with health information from the data warehouse, verify and transform the data and finally display the information on the business intelligence system (Intranet). Data submission is carried out through a secure online data submission tool. The process of data collection, management and application for BDMS-SS has been approved by the CIO of the Bangkok Hospital Headquarters.

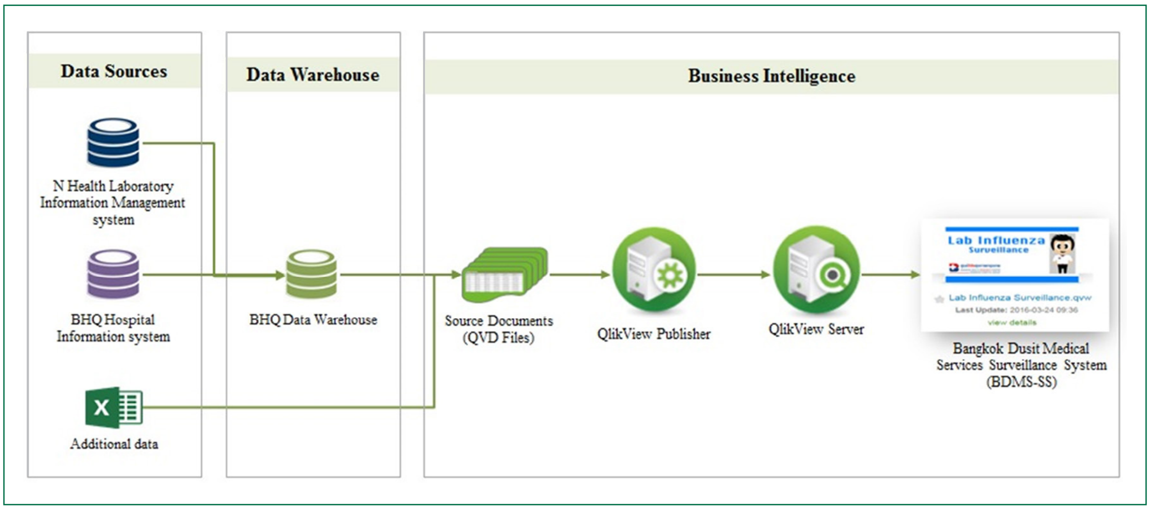

Figure 1: Bangkok Dusit Medical Services Surveillance System (BDMS-SS); System Architecture Design

ISSN 2287-0237 (online)/ 2287-9674 (print)

Laboratory testing

All samples from participating hospitals were tested by N-Health using rapid test and reverse transcription polymerase chain reaction (r-PCR). All laboratories validated their assays appropriately. Both positive and negative results of influenza are submitted to N-health every day throughout the year. In addition, the influenza subtyping results were reported by all 20 affiliated hospitals.

Statistical analysis and feedback

The proportion of samples positive (positivity) for viruses under surveillance is calculated (based on weekly samples tested) by virus type, sex, age group (<2, 2-4, 5-14, 15-49, 50-64 and >65 years) and residential area using weekly number of positive detections divided by the weekly total number of samples tested. The data are analyzed to determine the trends and predominant virus types. This information is essential for risk assessment and estimation of morbidity, mortality, and the potential impact of the influenza on the community and on healthcare services.

To detect outbreaks as early as possible, an alarm was triggered when the weekly count of proportion of positive cases was higher than 2 SDs of the mean of 5 year historical data. A statistical alarm is triggered if the observed value is significantly different from the expected value. After checking biological criteria, alarms were assessed as confirmed or unconfirmed by a senior epidemiologist during the weekly surveillance meeting. Alarms that were escalated into an alert (after further investigations that included descriptive analysis of cases in terms of time, place, and population) led to further epidemiologic investigations, which then had to be declared to the infectious unit of those sites if a real outbreak was confirmed.

For feedback, a weekly epidemiologic report is produced by the BHRC and addressed to all participating hospitals and Thai-MOPH. This report is based on the BDMS-SS data of influenza, to track the weekly number of positive results and weekly proportion of positives (positivity) by sampling week, age group, sex, location and virus type. This report is also provided on the website www.bangkokhealth.com.

Results

From October 2010 to April 2017, a total of 482,789 subjects were tested and 86,110 (17.8%) cases of influenza were identified. Of those who tested positive for influenza they were aged <2 years old (4.6%), 2-4 year old (10.9%), 5-14 years old (29.8%), 15-49 years old (41.9%), 50-64 years old (8.3%) and >65 years old (3.7%). Approximately 50% of subjects were male and female. Of these, 40,552 (47.0%) were influenza type B, 31,412 (36.4%) were influenza A unspecified subtype, 6,181 (7.2%) were influenza A H1N1, 4,001 (4.6%) were influenza A H3N2, 3,835 (4.4%) were influenza A seasonal and 196 (0.4%) were respiratory syncytial virus (RSV) (Figure 2).

The number of influenza-positive specimens reported by the real-time influenza surveillance system were from week 40, 2015 to week 39, 2016. A total of 117,867 subjects were tested and 17,572 (14.91%) cases tested positive for the influenza virus (Figure 3). Based on the long-term monitoring of collected information, this system can delineate the epidemiologic pattern of circulating viruses in near real-time manner, which clearly shows annual peaks in winter dominated by influenza subtype B in 2015-1016 season. This surveillance system helps to provide near real-time reporting, enabling rapid implementation of control measures for influenza outbreaks.

Discussion

This article presents the findings of a new laboratory-based influenza surveillance system, which was developed and implemented across 20 hospitals of BDMS. This novel, real-time laboratory-based surveillance system was automatically uploaded and an aggregated influenza test correlated with demographic information. The system provides useful information in a timely fashion which has contributed to describe the epidemiology of the influenza virus. The system was also successfully used for real-time, daily surveillance among hospitals of the BDMS group. This daily surveillance operation can pick up early signs of increased activity of influenza and this increases the ability to undertake a prompt response and to take appropriate action. Surveillance for influenza is common practice in many countries but near real-time surveillance is not common.[10] This system thus provides a new mechanism to monitor the epidemiology of influenza in a timely fashion in Thailand. Expansion of this near real-time capability to a public health agency could improve both local and national surveillance and response lead to reduce the need for syndromic influenza surveillance. With a large sample size from the BDMS networking hospitals, this system provides a robust supplementary mechanism, through the collection of routinely available laboratory data at minimum extra cost, to monitor influenza in private hospitals, Thailand.

Conclusion

This surveillance system was the first real-time, daily reporting surveillance system to report on the largest data base of private hospitals in Thailand and provides timely reports and feedback to all stakeholders. It provides an important supplement to the routine influenza surveillance system in Thailand. This illustrates a high level of awareness and willingness among the BDMS hospital network to report emerging infectious diseases, and highlights the robust and sensitive nature of BDMS's surveillance system. This system demonstrates the flexibility of the surveillance systems in BDMS to evaluate to emerging infectious disease and major communicable diseases. Through participation in the Thailand influenza surveillance network, BDMS can more actively collaborate with national counterparts and use its expertise to strengthen global and regional surveillance capacity in Southeast Asia, in order to secure advances for a world safe and secure from infectious disease. Furthermore, this system can be quickly adapted and used to monitor future influenzas pandemics and other major outbreaks of respiratory infectious disease, including novel pathogens.

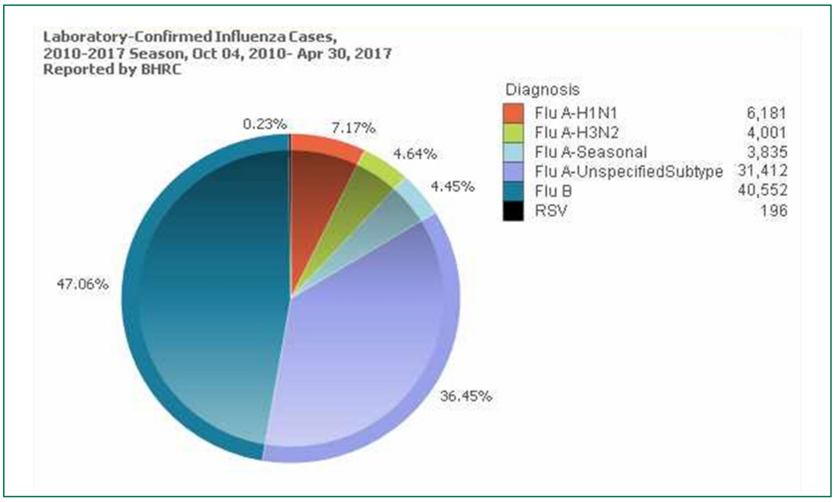

Figure 2: Laboratory confirmed influenza cases, Bangkok Hospital Group, Bangkok Dusit Medical Services Public Company Limited, October 2010 to April 2017 (RSV: Respiratory syncytial virus)

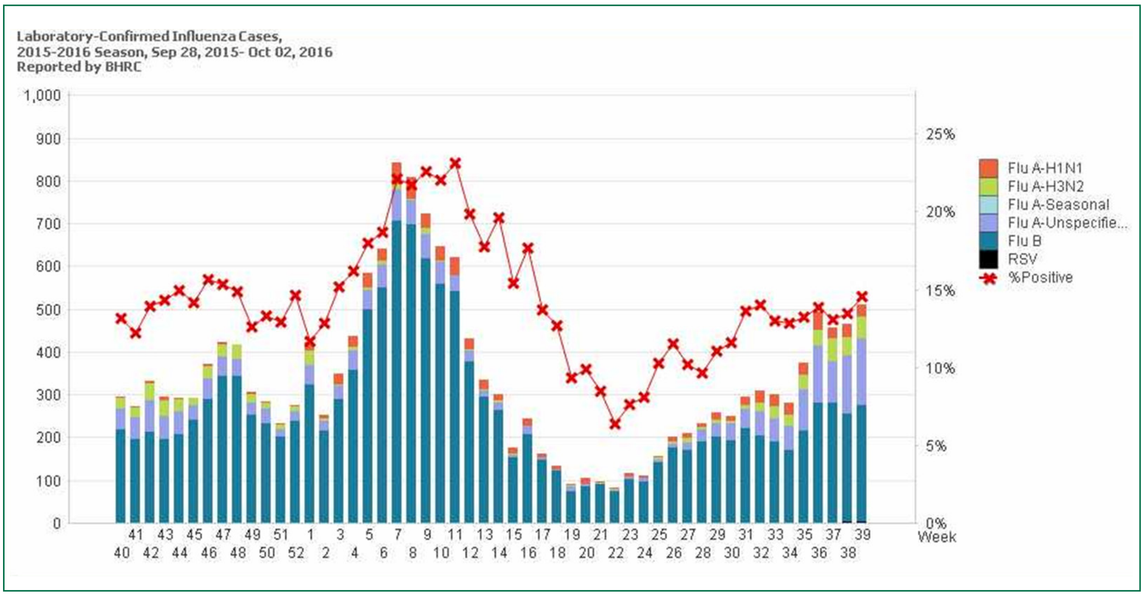

Figure 3: Weekly distribution of number of collected samples with influenza viruses, Bangkok Hospital Group, Bangkok Dusit Medical Services Public Company Limited, September 2015 to October 2016

References

1. Influenza Fact Sheet. World Health Organization (WHO). Influenza (Seasonal). 2016. (Accessed January 1, 2017 at http://www.who.int/mediacentre/factsheets/fs211/en/).
2. Jian SW, Chen CM, Lee CY, et al. Real-Time Surveillance of Infectious Diseases: Taiwan's Experience. *Health Secur* 2017;15(2):144-53.
3. Ghosh TS, Vogt RL. Active influenza surveillance at the local level: a model for local health agencies. *Am J Public Health* 2008;98(2):213-5.
4. Baumbach J, Mueller M, Smelser C, et al. Enhancement of influenza surveillance with aggregate rapid influenza test results: New Mexico, 2003-2007. Am J Public Health 2009;99 Suppl 2:S372-7.
5. Dalton CB, Carlson SJ, Butler MT, et al. Building influenza surveillance pyramids in near real time, Australia. *Emerg Infect Dis* 2013;19(11):1863-5.
6. Voldstedlund M, Haahr M, Emborg HD, et al. Real-time surveillance of laboratory confirmed influenza based on the Danish microbiology database (MiBa). *Stud Health Technol Inform* 2013;192:978.
7. Huart M, Bedubourg G, Abat C, et al. Implementation and Initial Analysis of a Laboratory-Based Weekly Biosurveillance System, Provence-Alpes-Cote d'Azur, France. *Emerg Infect Dis* 2017;23(4):582-9.
8. Yang JR, Teng HJ, Liu MT, et al. Taiwan's Public Health National Laboratory System: Success in Influenza Diagnosis and Surveillance. *Health Secur* 2017;15(2):154-64.
9. Maman I, Badziklou K, Landoh ED, et al. Implementation of influenza-like illness sentinel surveillance in Togo. *BMC Public Health* 2014;14:981.
10. Zhao H, Green H, Lackenby A, et al. A new laboratory-based surveillance system (Respiratory DataMart System) for influenza and other respiratory viruses in England: results and experience from 2009 to 2012. *Euro Surveill* 2014;19(3).

ISSN 2287-0237 (online)/ 2287-9674 (print)