

Establishment of International Organization for Standardization-accredited mobile diagnostic laboratory to enhance public health response against avian influenza

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Abstract

Recognizing that the turnaround time for a permanent laboratory service to analyse specimens for influenza viruses, especially those responsible for avian influenza, using the reverse transcriptase-polymerase chain reaction (RT-PCR) was three days, an innovative rapid-response mobile laboratory service was developed in Thailand. The aim was to enhance the response to the potential pandemic of avian influenza. The turnaround time of the whole process that included sample delivery to the mobile unit; sample processing and analysis; and the result report was reduced to 6–8 hours. The inter-laboratory comparison of results obtained by the mobile laboratory and the Thailand National Institute of Health was satisfactory and acceptable, and was documented. The results of specimens collected from a total of 130 patients in Kalsin and Nakhonphanom provinces showed absence of genetic materials of avian influenza H5N1 in all cases but detected influenza A/H1 in 25 cases (19.23%) and human influenza B in 9 (6.92%) cases. All requirements of the International Organization for Standardization (ISO) 15189:2003 were met. Formal recognition was then processed and the avian/human influenza mobile laboratory was accredited (ISO 15189) to meet the needs of patients and clinical personnel responsible for patient care. This study could be used as a public health strategy for global benefits.

Keywords: avian influenza, quality mobile laboratory, ISO 15189-accredited.

Introduction

The highly pathogenic avian influenza caused by certain subtypes of influenza A virus in animal populations, particularly chickens, poses a global public health risk. Direct human infection by an avian influenza A (H5N1) virus was recognized during the 1997 outbreak in China, Hong Kong Special Administrative Region. Subsequently, human infections with an avian strain of the H9 and H7 subtypes were documented. Outbreaks of

avian influenza A (H5N1) in humans and the apparent endemicity of this subtype in poultry in South-East Asia have also been reported.

The laboratory identification of human influenza A virus infections is commonly carried out through direct antigen detection, isolation in cell culture or detection of influenza-specific RNA by RT-PCR. For laboratories that receive requests to test specimens from patients with an influenza-like illness (in cases of clinical or epidemiological evidence of influenza A viral infection), the World Health Organization (WHO) recommends that the ideal specimen for detection is the nasopharyngeal aspirate obtained within three days of the onset of symptoms.¹

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Conventionally, laboratories receiving patient specimens suspected to be infected with influenza have been performing PCR and submitting reports in three–four days.²⁻⁴ Hospitals in remote areas might take even more time to transport the samples to regional reference laboratories, thus resulting in an inefficient control of a serious epidemic. Therefore, the need for a more rapid diagnosis was increasingly being felt.

The Regional Medical Sciences Centre, Khon Kaen, Thailand, in cooperation with the National Institute of Health, established an innovative rapid-response mobile laboratory service to serve the community in epidemic areas in the upper northeastern region of Thailand. The quality system of the avian influenza mobile laboratory was monitored in compliance with ISO 15189 requirements.⁵

Health technologies have recently been defined by the World Health Organization (WHO) as the application of knowledge and skills in the form of devices, medicines, vaccines, procedures and systems to solve health problems and thereby improve the quality of lives. WHO also advocates that researchers should use the latest advances in molecular and biological technology to develop simple, reliable and user-friendly kits that could be used in community settings.⁶

The Regional Medical Sciences Centre, Khon Kaen, Thailand, has developed a model of a quality, rapid-response avian/human influenza mobile laboratory that is not as expensive as the conventional reference laboratory.

Methodology

The study design comprised three components:

Firstly, it was planned in 2006 that a mobile laboratory be set up with the objective of ensuring access to laboratory services for aetiological diagnosis of diarrhoeal diseases in remote communities in Thailand where the

capacity to undertake bacteriological work was limited. A community mobile laboratory was thus launched in January 2006 to demonstrate its feasibility in Ajsamartampur, Roi Et province. Some requirements of ISO 15189 standards were met. The mobile laboratory successfully demonstrated that it could provide a “one-stop shop” comprehensive laboratory service similar to the one provided by any permanent laboratory. The community could receive official reports at the mobile site using the in-house sample information management programme. The mobile laboratory not only provided rapid-response service to the community but also trained and empowered laboratory personnel of the Ajsamart Community Hospital to perform the test by themselves.

Secondly, during the third and fourth waves of the highly pathogenic avian influenza poultry outbreak in Thailand, the Department of Medical Sciences’ mobile laboratory, which was well-equipped with influenza virus diagnosis instruments using RT-PCR techniques,⁷⁻⁸ was installed in Kanjanaburi, Nakornsawan. The diagnostic strategies were adapted to meet the local needs and operational realities, and were thoroughly communicated to all agencies responsible for health care.

Thirdly, selective studies in notifiable cases of poultry outbreak were undertaken in the upper north-eastern provinces of Thailand. These studies were preceded by activities to ensure coordination with community leaders and health personnel in epidemic areas regarding setting up of laboratory surveillance networks. All national guidelines in respect of laboratory protocols were clearly communicated and pre-tested, including sample collection; analytical methodology; data interpretation; and prompt reporting of results to hospitals and responsible health managers.

Rapid field investigations were conducted in epidemic areas of Kalsin and Nakomphanom provinces from April to August

2006. Well-trained medical technologists with good ISO 15189 knowledge were posted at the mobile laboratory. Nasal/nasopharyngeal swabs of patients suspected of carrying the avian influenza H5N1 virus were examined. The RNA extraction involving the patient's viral transport media was conducted in the local laboratory. The Regional Medical Sciences Centre, Khon Kaen, used the Phase I (initial) model of the avian influenza mobile laboratory that did not include the pre-RT-PCR function. The pre-RT-PCR laboratory function was essential for separating the extracted RNA amplification (RT-PCR amplification) from the post-PCR laboratory function in order to avoid contamination.

The extracted RNA was amplified by the RT-PCR amplification methodology in the mobile laboratory using the thermal cycle equipment. The DNA products were analysed in the mobile laboratory using the agarose gel electrophoresis technique under ultraviolet (UV) light.

The rapid field methodology was pre-tested in the mobile laboratory at Kalsin. The inter-laboratory comparison of analytical results obtained by the mobile laboratory and the Thailand National Institute of Health was also implemented there. An examination of the specimen collected from a suspected male patient in Kalsin Hospital revealed the absence of genetic materials of avian influenza H5N1. A total of 129 specimens were collected from Nakornphanom: 65 males (50.39%) and 64 females (49.61%), of whom 61 were chicken-exposed cases (47.29%), while the remaining 68 (52.71%) had no history of exposure. These were analysed as per the national protocol.

The quality of laboratory practices of the mobile laboratory was verified in Nakornphanom. Furthermore, quality improvement efforts were sustained in compliance with ISO 15189 requirements. Requests for corrective action in respect of the quality systems being practised by the mobile laboratory were reviewed and implemented.

Results

The turnaround time involving the handling, transportation and receiving of the sample, keeping it in safe custody, processing it for diagnosis, and officially reporting the results at the mobile "one-stop" service was found to be between 6–8 hours. This meant a reduction in the operation time of about 90%, as compared to the permanent laboratory, the service turnaround time of which was three days.

The system established by the mobile laboratory, and how it was being managed technically in compliance with ISO 15189, was fully demonstrated by the study. The inter-laboratory comparison of the same sample of analytical results obtained by the mobile laboratory and the Thailand National Institute of Health was found to be satisfactory and acceptable, and was documented. The avian/human mobile laboratory was therefore accredited as an ISO 15189:2003 laboratory on 26 September 2006.

The results of specimens collected by the mobile laboratory from 130 patients in the Kalsin and Nakornphanom provinces were analysed. These revealed undetected genetic materials of influenza A/H5N1 in all cases; detected influenza A/H1 materials in 25 (19.23%) cases and human influenza B in 9 (6.92%) cases. These results were compared with results of specimens of 117 cases (65 males and 52 females) sent from hospitals in north-eastern provinces. The latter were analysed at the permanent laboratory in Khon Kaen during the endemic period: 16 May to 19 October 2006. Results of genetic material detected the absence of H5N1 in all cases, influenza A/H1 in 43 (36.75%) cases and influenza B in 5 (4.27%) cases. Overall, the 82 patients suspected of carrying the influenza virus also showed a significant degree of illness: cough; sore throat; throat sputum; nasal excretion; headache; nasal congestion; bronchitis and breathing difficulties; and diarrhoea.

Discussion and conclusion

The “one-stop” rapid response ISO 15189-accredited mobile laboratory helped the community in solving its disease control problems effectively, besides performing diagnostic activities that were comparable to those undertaken at the National Reference laboratory. The activities and quality control system established by the Reference Laboratory could be easily replicated by the mobile laboratory through adequate training of medical technologists. It is believed that this category of laboratories will help solve health problems in the South-East Asia Region by assisting WHO in implementing its global influenza readiness plan in the future.

The rapid-response health technologies have become a critical component of health systems in Thailand. These evidence-based, cost-effective and feasible front-line health technologies are proving to be indispensable tools for meeting priority needs to tackle the serious challenge of avian and human influenza being faced by patients in the community setting. The efficient application of the quality rapid-response mobile laboratory model has drawn attention of international health administrators. The mobile laboratory may

become an important component of global healthcare services in the context of the serious emerging and re-emerging diseases of today.

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