H7N9 surveillance in South and Southeast Asia

Contributors: Guillaume Belot (FAO), Sophie Von Dobschuetz (FAO), Filip Claess (FAO), Akiko Kamata (FAO), Subash Morzaria (FAO), John Edwards (FAO), Tony Williams (FAO), Scott Newman (FAO), Chintana Chanthavisouk (FAO) and Nitish Debnath (FAO)

CONTEXT

Avian influenza A(H7N9), a zoonotic virus, emerged in China in March 2013. As of 1 August 2014, a total of 451 human cases had been reported, of which 167 had a fatal outcome (37 percent case fatality rate), but the true human infection is poorly documented. Eighty percent of cases reported a history of direct or indirect exposure to live domestic poultry (mainly chickens) at live bird markets (LBMs). Through surveillance, the H7N9 virus was detected in live birds, the LBM environment and, to a lesser extent, chickens on farms in affected areas of China. The main host of influenza A(H7N9) appears to be domestic poultry, in which the virus seems to be avirulent; epidemiological and experimental evidence shows that infected birds shed virus without showing any clinical signs. This “silent” infection increases the likelihood of undetected virus spread over wide geographical regions, and consequently of human exposure. Therefore, passive, event-based surveillance cannot be applied for the early detection of H7N9 in poultry populations. Instead, surveillance with active sampling and virological testing for early detection needs to follow a risk-based approach targeting the areas, markets and production systems at highest risk of virus introduction.

Since the emergence of the virus, the Food and Agriculture Organization of the United Nations (FAO), with the support of the United States Agency for International Development (USAID), has played a leading role in providing technical and policy-level support to China and neighbouring countries that are considered at high risk of influenza A(H7N9) incursion. This support has focused on planning and conducting surveillance in Bangladesh, Bhutan, Cambodia, Indonesia, the Lao People’s Democratic Republic, Myanmar, Nepal and Viet Nam, supporting the development of emergency preparedness and response plans as well as enhancing surveillance capacity. While prospective surveillance was designed for the early detection of H7N9 incursion, a second aim of these efforts was to assess whether incursion of the virus had already occurred and remained undetected and, if so, the extent of infection in different farm types, poultry species, other livestock (e.g. swine), wild birds or the environment. At the same time, the diagnostic capacity of animal laboratories in the region was increased to enable detection of this novel virus and timely reporting of results.

ADVANCES

Two approaches to surveillance were applied: retrospective testing on previously collected samples; and prospective collection of samples using a targeted, risk-based surveillance approach.

RETROSPECTIVE TESTING

Retrospective testing was performed in Bangladesh, Bhutan, China, Indonesia and Viet Nam on stored virological and serological samples collected as part of FAO’s H5N1 highly pathogenic avian influenza (HPAI) surveillance activities and the Emerging Pandemic Threats plus (EPT+) Program, both funded by USAID. Samples collected from poultry, wild birds and swine between January and April 2013 were tested for H7N9: a total of 6,323 duck and 4,237 swine samples from Bangladesh; 150 swabs from chickens and wild birds in Bhutan; 10,078 nasal swabs and 9,910 serum samples from swine in China; 380 chicken swabs in Indonesia; and 1,234 nasal swabs from swine in Viet Nam. All of these virological and serological samples were negative for H7N9 (Table 1).

RISK-BASED TARGETED SURVEILLANCE

Through FAO’s animal influenza surveillance networks already in place, new samples were collected from May 2013 along national and cross-border value chains in sites determined to be at high risk of H7N9 incursion. Using both value chain analysis and geographical/demographic assessments, the areas at highest risk of virus introduction were determined according to five criteria: i) presence of legal or illegal live poultry trade links from infected areas; ii) presence of a physical border with an infected area; iii) proximity to a migratory bird pathway; iv) high poultry density; and v) history of H5N1 HPAI outbreaks. In a second step, targeted LBMs were selected if they: i) traded imported birds; ii) had high throughput of poultry; iii) were closely connected within trade networks; and/or iv) showed a very low level of biosecurity. Farms with regular poultry imports and locations known to have had multiple introductions of H5N1 HPAI viruses or other avian influenza viruses were also included.

Risk-based, targeted surveillance was conducted in Bangladesh, Bhutan, Cambodia, the Lao People’s Democratic Republic, Indonesia, Myanmar, Nepal and Viet Nam. The surveillance framework (including frequency of sampling rounds, sampling size and target species) was adapted to the specific situation in each country. In some areas it was necessary to modify the surveillance design to adapt to changes in the poultry value chain.

In the Lao People’s Democratic Republic, Myanmar and Viet Nam, after high-risk areas had been identified, priority retail LBMs and poultry gathering points were targeted for surveillance. The majority of samples were oropharyngeal swabs from chickens, or environmental swabs. Other poultry species, including ducks and quail, were also sampled, but to a far lesser extent as their role in H7N9 virus transmission seems to be limited, according to the scientific information available to date. In Bangladesh, Bhutan and Nepal on the other hand, surveillance efforts focused on the interface between domestic and wild birds.

Table 1: Numbers of virological and serological samples tested retrospectively for H7N9

<table>
<thead>
<tr>
<th>Country</th>
<th>Virological samples</th>
<th>Serological samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangladesh</td>
<td>10,560</td>
<td>10,560</td>
</tr>
<tr>
<td>Bhutan</td>
<td>150</td>
<td>-</td>
</tr>
<tr>
<td>China</td>
<td>10,078</td>
<td>9,910</td>
</tr>
<tr>
<td>Indonesia</td>
<td>380</td>
<td>-</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>1,234</td>
<td>-</td>
</tr>
</tbody>
</table>
with the objective of ascertaining whether or not the virus could circulate in and be spread by wild bird populations. Collected samples were first tested for avian influenza, with positive samples undergoing further analysis to determine subtypes. In addition to scanning for H7N9, this laboratory algorithm also allowed screening for other avian influenza viruses.

No H7N9 virus was found in any of the samples collected and tested from the eight countries from May 2013 to June 2014 (Table 2).

The surveillance capabilities of countries were further strengthened through the training of staff at all participating animal health laboratories and the procurement of reagents and other materials. Skills and knowledge regarding correct virus sampling and submission procedures and H7N9 laboratory diagnosis were enhanced, increasing the capacity for future surveillance projects. National capacity in developing emergency preparedness and response plans for H7N9 was also strengthened, with emphasis on coordinated animal and public health activities.

Almost one year after the start of H7N9 surveillance activities, representatives of the animal and public health ministries of the Lao People’s Democratic Republic, Myanmar and Viet Nam came together in Yangon, Myanmar at the end of April 2014 to discuss major issues related to H7N9 surveillance and contingency planning. FAO and the World Health Organization (WHO), with the support of USAID, organized the meeting to provide an opportunity for sharing surveillance results and discussing difficulties encountered and lessons learned. Challenges discussed included adapting surveillance to ever-changing value chains, ensuring an adequate cold chain for sample transport and storage, and planning for timely laboratory testing of surveillance samples in an environment where many other endemic diseases with high economic or public health impact are common and therefore receive priority in investigation efforts. Country teams recognized that the timely sharing of surveillance data with neighbouring countries and the international community contributes to better preparedness. FAO and USAID will continue to support surveillance in the areas/countries that are at highest risk of incursion of influenza A(H7N9).

In conclusion, the risk-based approach described in this report increases the chance of early detection of influenza A(H7N9) incursion into domestic poultry populations, facilitating the efficient allocation of scarce surveillance resources. Longitudinal, risk-based surveillance of poultry ascertains the epidemiological status not only of H7N9, but also of other avian influenza viruses, such as H5N1 HPAI. In conjunction, advanced virological analysis can be applied to the field strains detected to assess mutations and reassortment events that increase the likelihood of human pathogenicity. The methods described for this field activity can be utilized to maximize the chances of detecting incursions or circulation of any poultry viruses of public health concern.

To address the H7N9 emergency, FAO Headquarters, in collaboration with the regional Emergency Centre for Transboundary Disease Operations (ECTAD) office for Asia and the Pacific Region (RAP), country teams and international experts, has developed a set of guidance documents. Guidelines for emergency risk-based surveillance aims to assist national authorities in implementing an efficient surveillance strategy for the rapid detection of virus incursion or spread. This risk-based strategy relies on the identification of high-risk poultry trade nodes and probable points of virus entry. Surveillance guidelines for uninfected countries in Southeast Asia and South Asia was published in November 2013 and describes a short-term, risk-based surveillance strategy based on current understanding of H7N9 epidemiology, identified modes of spread and the predicted risk of infection for non-infected areas or countries. A third document, Laboratory protocols and algorithms offers guidance on experimental protocols shown to be highly sensitive in detecting H7N9 viruses in surveillance samples. It includes an overview of primers and probes to test for H7 and N9, and validated reverse transcription polymerase chain reaction (RT-PCR) protocols for the testing of collected samples.

ACKNOWLEDGEMENTS

The authors would like to thank the Ministries of Agriculture of Bangladesh, Bhutan, Cambodia, China, Indonesia, the Lao People’s Democratic Republic, Nepal and Viet Nam. They also thank all the experts who contributed to the development and implementation of H7N9 surveillance activities, particularly Guo Fusheng and Li Yin (FAO China), Ken Inui, Leo Loth and Astrid Tripodi (FAO Viet Nam), Wantanee Kalpravidh (FAO RAP), Mat Yamage (FAO Bangladesh), Mohinder Oberoi (FAO Nepal), Vincent Martin (FAO Senegal), Guillaume Fournie (Royal Veterinary College, London), and Carlène Trevennec and Eran Raizman (FAO Emergency Prevention System).

Table 2: Numbers of virological samples collected from poultry, wild birds and the environment for H7N9 risk-based surveillance (from May 2013 to June 2014)

<table>
<thead>
<tr>
<th>Country</th>
<th>Poultry</th>
<th>Wild Birds</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viet Nam</td>
<td>33,480</td>
<td>12,844</td>
<td>11,333</td>
</tr>
<tr>
<td>Myanmar</td>
<td>2,204</td>
<td>1,822</td>
<td>1,800</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>2,204</td>
<td>1,822</td>
<td>1,800</td>
</tr>
<tr>
<td>Nepal</td>
<td>1,800</td>
<td>864</td>
<td>780</td>
</tr>
<tr>
<td>Lao People’s Democratic</td>
<td>1,800</td>
<td>864</td>
<td>780</td>
</tr>
<tr>
<td>Republic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cambodia</td>
<td>1,800</td>
<td>864</td>
<td>780</td>
</tr>
<tr>
<td>Indonesia</td>
<td>1,800</td>
<td>864</td>
<td>780</td>
</tr>
<tr>
<td>Bhutan</td>
<td>1,800</td>
<td>864</td>
<td>780</td>
</tr>
<tr>
<td>Total</td>
<td>65,127</td>
<td>45,127</td>
<td>47,127</td>
</tr>
</tbody>
</table>

Figure 1: South East Asian countries where retrospective testing and/or risk-based surveillance were conducted

1 http://www.fao.org/docrep/019/i3608e/i3608e.pdf
2 http://www.fao.org/docrep/019/i3601e/i3601e.pdf
3 http://www.fao.org/docrep/019/i3599e/i3599e.pdf