Managing an animal health emergency in Taipei China: foot and mouth disease

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Taipei China had been free from foot and mouth disease (FMD) over 68 years before the disease occurred in March 1997. The first suspected case was recorded on a pig farm in the Hsinchu Prefecture on 14 March 1997. Based on clinical signs, gross histopathological findings, and results of enzyme-linked immunosorbent assays and reverse-transcriptase polymerase chain reaction tests, diagnosis of FMD was confirmed by the Taiwan Animal Health Research Institute on 19 March 1997 and was reconfirmed by the FMD World Reference Laboratory in Pirbright (United Kingdom), on 25 March 1997. By the end of July 1997, 6,147 pig farms (about a quarter of the pig farms in Taipei China), were affected. The disease was well under control within two months by means of stamping-out and blanket vaccination. The Government purchased 21 million doses of inactivated oil-adjuvant FMD vaccine, which allowed for two injections per pig and one injection of other cloven-hoofed animals. Before the vaccine was used, the stamping-out policy was implemented, ensuring that all pigs in the affected farms were destroyed. After blanket vaccination, a partial stamping-out policy was adopted, i.e. only pigs showing clinical signs were destroyed.

Keywords
Diagnosis — Emergency management — Epidemiology — Foot and mouth disease — Pigs — Stamping-out — Taipei China — Vaccination.

Summary
Taipei China had been free from foot and mouth disease (FMD) over 68 years before the disease occurred in March 1997. The first suspected case was recorded on a pig farm in the Hsinchu Prefecture on 14 March 1997. Based on clinical signs, gross histopathological findings, and results of enzyme-linked immunosorbent assays and reverse-transcriptase polymerase chain reaction tests, diagnosis of FMD was confirmed by the Taiwan Animal Health Research Institute on 19 March 1997 and was reconfirmed by the FMD World Reference Laboratory in Pirbright (United Kingdom), on 25 March 1997. By the end of July 1997, 6,147 pig farms (about a quarter of the pig farms in Taipei China), were affected. The disease was well under control within two months by means of stamping-out and blanket vaccination. The Government purchased 21 million doses of inactivated oil-adjuvant FMD vaccine, which allowed for two injections per pig and one injection of other cloven-hoofed animals. Before the vaccine was used, the stamping-out policy was implemented, ensuring that all pigs in the affected farms were destroyed. After blanket vaccination, a partial stamping-out policy was adopted, i.e. only pigs showing clinical signs were destroyed.

Clinical observations
Clinical signs of foot and mouth disease (FMD) become apparent after an incubation period lasting two to four days. The disease is characterised by fever, depression, anorexia and the appearance of vesicular lesions on the coronary band of digits, in the mouth (including the snout, tongue and lips) and on the teats of sows. A very distinguishable sign at the beginning of the outbreak in Taipei China in 1997 was the extensive deaths of the suckling piglets from affected sows, followed by the loss of claws from one or more digits among the fattening or breeding pigs. Mortality was high (up to 100%) in the suckling piglets and much lower in the older pigs. Besides the vesicular lesions, multiple necrotic areas (stripes or spots) in cardiac muscle were frequently observed in suckling piglets.

Diagnosis
Vesicular fluids or epithelia from the clinically suspected pigs were subjected to reverse transcriptase-polymerase chain reaction (RT-PCR) tests (5), while serum samples were subjected to sandwich enzyme-linked immunosorbent assay (ELISA) tests (1, 2) in the Taiwan Animal Health Research Institute (TAHRI). Four sets of primers (P1, P2, P3, P4) (Fig. 1), designed (4, 5) and tested in the Foreign Animal
Disease Diagnostic Laboratory (FADDL) in Plum Island, New York, were used in the RT-PCR tests to amplify specific PCR products from different serotypes of FMD virus (FMDV) (Table I).

Table I
Four sets of primers designed and tested in the Foreign Animal Disease Diagnostic Laboratory (FADDL) in Plum Island (New York), used in the RT-PCR tests to amplify specific PCR products from different foot and mouth disease virus serotypes

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<th>Primers</th>
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Figure 2 shows that no PCR product was obtained in all even lanes (primers P₁), while PCR products of the expected size were found in all odd lanes (primers P₂), suggesting that the samples might contain FMDV type O₁.

The results of Figure 3 showed that the four suspected samples gave no PCR product using primers P₃ and P₄, while they were all positive in the RT-PCR test using primers P₁ and P₂. Therefore, the four samples were suspected to contain FMDV type Asia 1.

Suspected samples were sent to the Pirbright Laboratory, the World Reference Laboratory (WRL) for FMD in the United Kingdom, on 21 March 1997, and were confirmed as FMDV type O on 25 March. Additional samples were sent for further confirmation of the existence of other serotypes of FMDV. To date, all samples submitted to the Pirbright Laboratory were identified as serotype O only. The inconsistency between the serotyping of results from the TAHRI and those from the WRL was due to the primers. The primers used by the TAHRI in the RT-PCR test were not specific enough to serotype FMDV in Taipei China.

The ELISA test kit provided by the TAHRI also gave a cross-reaction result, showing positive results for types O and Asia 1. Nevertheless, it was valuable that both RT-PCR and ELISA tests could readily differentiate FMD from swine vesicular disease within 12 hours, which meant that action could be taken immediately.

Reverse transcriptase-polymerase chain reaction (RT-PCR) products amplified from suspect samples using primers P₁ and P₂ (Courtesy of the Taiwan Animal Health Research Institute)
The stamping-out and vaccination policy was adopted at the Council of Agriculture (COA) emergency meeting at which FMD diagnosis was confirmed (19 March 1997). The policy proposal was approved by the Premier on 20 March, and stamping-out was performed on the first affected farm on 21 March. Unfortunately, 28 farms had already been affected by FMD when diagnosis was made on 19 March. Although 40,000 doses of FMD trivalent vaccine (types O, A and Asia 1) had been reserved, quantities were insufficient to perform ring vaccination. The emergency purchase of the vaccine also caused some problems. The first order of 3 million doses of bivalent O/Asia 1 vaccine was made on 21 March and was delivered to Taipei China in five shipments, the first delivery arrived on 26 March, and the last on 4 April. The second order of five million doses of monovalent O vaccine was made in early April, but delivery was not completed until 3 May. The slow arrival of vaccine incited many complaints from legislators and farmers. The offer by the Government of Argentina of five million doses of monovalent O vaccine, delivered on 25 April, was of great value. Immediately on arrival of each batch, the vaccine was distributed free of charge to farmers who were allowed to vaccinate their pigs under the supervision of veterinary officers or private veterinarians. Vaccine stocks were depleted within 48 hours of delivery to the farmers. This meant that some of the susceptible animals (pigs, dairy cows, goats and deer) did not receive an injection until early May. To control the disease, the government purchased another eight million doses of the vaccine, and provided booster vaccines to farmers free of charge.

The disease spread rapidly among the pig farms before vaccination was completed, despite the strict restrictions imposed on pig movements. Only healthy pigs from unaffected farms were allowed to be transferred to markets. No pigs (or cloven-hoofed animals) from the west of Taipei China could be moved to the east (which was free of FMD). The speed with which stamping-out was conducted on the affected farms could not compete with the rate at which new outbreaks were occurring. Figure 4 indicates the number of pigs affected and destroyed every day.

The stamping-out policy ensured that all pigs on affected farms were destroyed (Fig. 5). The methods of carcass disposal included burying, rendering and incineration. Burying was the most common and efficient procedure (Fig. 6). Methods of disposal depended on the location of the affected farms. Carcasses were buried on farms or on nearby public lands. Authorisation was given to send carcasses to nearby rendering plants for the production of fertilizer. In water resource areas, only incineration using movable incinerators and open field burning was allowed. By the middle of April, a disposal capacity of 200,000 pigs per day had been reached. An important contribution was the order by President Lee to send military teams to help farmers to complete the work.

Compensation made to pig producers was as follows: NT$350 (US$12.5) per head for suckling piglets of less than four weeks of age, NT$2,400 (US$85) per 100 kg for fattening pigs and NT$4,800 (US$170) per head for breeding pigs.

Epidemiology

When the COA received the FMD outbreak report, 28 farms in 9 prefectures (counties) in the west of Taipei China were involved. With the central mountain range running length-wise through the centre of Taipei China, the disease did not spread to the eastern part of the country. Other offshore islands were not affected. Prefectures and cities in the west of the main island were declared affected in March. A ban was placed on the transportation of cloven-hoofed animals and animal products out of the affected area. After the vaccine arrived so late, the blanket vaccination could not be completed until early May. The disease spread very rapidly in the western area of Taipei China, especially in the six prefectures in the south-west which was the major pig-raising area. As shown in Figure 4, the outbreaks were not fully under control until about three weeks after the blanket vaccination had been completed, i.e. at the end of May. The three prefectures (Ilan, Taitung and Hwalian) on the eastern side of the island were not completely free of the disease. There was one outbreak reported in each of these prefectures on 21, 24 April and 3 May, respectively. Only one pig farm in each prefecture was affected. The three essential steps, namely: stamping-out, ring vaccination and the closing of livestock markets for several days, were implemented when clinical cases were confirmed. Ring vaccination was performed in...
such a way that all the pigs on farms within a 3-km radius around the affected farm were maintained without vaccination, while pigs on farms beyond a 3-km radius were all vaccinated. Fortunately, no further cases have been reported from these prefectures since then.

Fig. 4
The number of pigs affected and destroyed from 20 March to 24 May 1997 in Taipei China

Fig. 5
The destruction of affected pigs and sanitary measures were implemented by the military, under instructions from the Livestock Disease Control Center during the outbreak of foot and mouth disease in Taipei China (all personnel wore disposable clothes)

Fig. 6
Most of the pig carcasses were destroyed by burial following the outbreak of foot and mouth disease in Taipei China
It should be emphasised that at the very early stages of the outbreak (20 March), infected pigs were found on farms in five towns located near fishing harbours. As the police occasionally caught smugglers of animal products in fishing boats, the route of entry of the FMD virus was strongly suspected to be through smuggling by fishing boats. However, why the disease occurred almost simultaneously at five individual points remains unclear.

Transmission

The fact that the majority of the outbreaks of FMD occurred on farms located in proximity to livestock auction markets or slaughterhouses strongly indicated that the transportation of the pigs affected sub-clinically was the major source of dissemination of FMDV. In addition, the air-borne route was another major route of transmission; the disease often spread throughout a farm in a matter of a few days.

Host range

Clinical observations, together with experiments performed by the WRL, all strongly supported the fact that the virus strain in the Taipei China epidemic was pig-adapted. No outbreaks were detected in cloven-hoofed animals other than pigs.

Economic impact

The economic loss borne by the Government from this outbreak was approximately NT$11 billion (approximately US$400 million). The main items included compensation for destroyed pigs, low interest loans to farmers and pork exporters, costs of purchasing vaccines and carcass disposal. The indirect losses of related businesses, including feed mills, transportation, vaccine manufacture, were estimated to exceed NT$100 billion (approximately US$3,650 million). The impact of the outbreak might well lead to a drop of 0.4 of a point in the economic growth rate of the country in 1997.

Hygiene and movement control

Movement of cloven-hoofed animals and animal products from infected farms and areas was banned from 20 March by the COA. Disinfection was performed using NaOH, Na₂CO₃, acetic acid and citric acid. Other commercial disinfectants were also used on the infected and free farms in an attempt to lower the infection rate and to prevent the virus from spreading from the infected areas. Movement controls of trucks and people were made on farms. Monitoring and surveillance within a 6-km radius of infected farms were conducted by the Livestock Disease Control Centers (LDCCs). The strict movement controls of people, trucks and animals, together with frequent disinfection with acid on farms, were very effective in preventing the introduction of the virus.

Further control strategies

The last case of FMD which occurred in Taipei China was reported on 15 July 1997 in the Taichung Prefecture. One month later, the COA decided to lift the ban which had been imposed on the movement of cloven-hoofed animals and animal products throughout the country. This decision was made based on the fact that the pig-adapted FMD virus would not create carriers in pigs and no further outbreak had been reported since the last case on 15 July. The animal health authorities are confident that the disease has been controlled and the status of freedom from FMD with vaccination should be attained shortly.

To obtain FMD free status without vaccination, three rules have been promulgated to facilitate the speed of achieving this particular goal. These are as follows: a compulsory and massive vaccination programme, hygiene control of rendering plants and trucks used for the transportation of animals, and hygiene requirements for restocking previously FMD-infected farms. The importance of biosecurity on farms has also been re-emphasised.

Emergency task forces

Immediately after the announcement of the outbreak of FMD, emergency task forces were deployed at three levels of government, i.e. the central, provincial, and prefectural governments.

Members of the multi-ministerial Committee in the central government included the Council of Agriculture, Ministry of Economic Affairs, Ministry of Finance, Department of Health, Department of Environmental Protection, Department of Police, Taiwan Provincial Government, Taipei City and Kaohsiung City, etc. The Committee was chaired by the chairman of the COA and the deputy-head of each member organisation was included. The members met at least once a week to review budget proposals and policy-making and to supervise the policy progress.

The emergency task forces at the provincial level were organised by the Commissioner of the Department of Agriculture and Forests. The principal duties of the task forces were to implement the policy determined by the central government, diagnose the disease, conduct epidemiological surveys, purchase and distribute vaccines, and supervise the progress of the campaign, which included compensation of destroyed pigs and loans to farmers.
The actual working forces, supervised by the governor of each prefecture, included members of the Bureau of Agriculture and LDCCs. They carried out the epidemiological surveys, pig movement controls (only healthy pigs could be released to markets), stamping-out of pigs on the affected farms, vaccine distribution, compensation of the destroyed pigs, daily reports, etc.

Conclusions

The outbreak of FMD which occurred in Taipei China in March 1997, after a status of freedom from the disease which lasted 68 years, had serious economic repercussions on the pig industry and related industries. Fortunately the causal agent can only infect pigs. Cloven-hoofed animals other than pigs remained free from the disease. Rapid action taken soon after the outbreak occurred, including stamping-out of infected farms, blanket vaccination, movement control, disinfection and other emergency measures, have proved to be effective in the control of the spread of the disease.

According to the preliminary results of the epidemiological investigation on the source of infection, it has been concluded that the prevention of illegal movements of animals and animal products within the Asian region are the most effective strategies to prevent the spread of FMD from one Member Country to another.

Gestion d'une urgence en santé animale à Taipei China : le cas de la fièvre aphteuse


Résumé

Taipei China était indemne de fièvre aphteuse depuis 68 ans lorsque la maladie s'est déclarée, en mars 1997. Le premier cas suspect a été signalé dans un élevage de porcins de la préfecture de Hsinchu, le 14 mars 1997. Au vu des signes cliniques, des observations histopathologiques et des résultats des épreuves immuno-enzymatiques et de transcription inverse-amplification en chaîne par polymérase, le diagnostic de la fièvre aphteuse a été confirmé par le Taiwan Animal Health Research Institute, le 19 mars 1997, puis par le Laboratoire mondial de référence pour la fièvre aphteuse à Pirbright (Royaume-Uni), le 25 mars 1997. À la fin du mois de juillet 1997, 6 147 élevages porcins (environ un quart des élevages de porcins de Taipei China) étaient atteints. Deux mois plus tard, la maladie était parfaitement maîtrisée grâce à l'abattage sanitaire et à la vaccination générale. L'État a acheté 21 millions de doses de vaccin à virus inactivé et à adjuvant huileux de la fièvre aphteuse, ce qui représentait deux injections par porc et une pour les autres artiodactyles. Avant la vaccination, il a été procédé à l'abattage sanitaire de tous les porcs des élevages atteints. Après la vaccination générale, les autorités ont recouru à l'abattage partiel : seuls les porcs présentant des signes cliniques ont été abattus et détruits.

Mots-clés

La gestión de una emergencia zoosanitaria en Taipei China: el caso de la fiebre aftosa


Resumen
Taipei China llevaba 68 años libre de fiebre aftosa cuando, en marzo de 1997, sufrió un brote de esa enfermedad. El primer caso sospechoso se observó el 14 de marzo de 1997 en una granja porcina de la Prefectura de Hsinchu. A tenor de los síntomas clínicos, los hallazgos histopatológicos y los resultados al ensayo inmunoenzimático y la reacción en cadena de la polimerasa-transcriptasa inversa que deparó el examen de aquel primer caso, el Instituto de Investigación Zoosanitaria de Taipei China confirmó, el 19 de marzo de 1997, que se trataba de fiebre aftosa. El 25 de marzo de 1997, aquel diagnóstico fue ratificado por el Laboratorio Mundial de Referencia para la Fiebre Aftosa de Pirbright, Reino Unido.

A finales de julio de 1997, 6.147 granjas porcinas (cerca de una cuarta parte del total de explotaciones porcinas de Taipei China) habían resultado afectadas. Transcurridos dos meses, y gracias a la aplicación de sacrificios sanitarios y vacunaciones generalizadas, la enfermedad se hallaba bajo control. El Gobierno adquirió 21 millones de dosis de vacuna inactivada con adyuvante oleoso contra la fiebre aftosa, que permitieron administrar dos inyecciones a cada cerdo y una inyección a otros animales de pezuña hendida. Antes de empezar las vacunaciones se procedió a un sacrificio sanitario total en las granjas afectadas. Después de la vacunación generalizada se adoptó un sistema de sacrificio sanitario parcial, esto es, sacrificando únicamente a los cerdos que presentaban síntomas clínicos.

Palabras clave

References


