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Meta-analysis on the efficacy of routine vaccination against foot and mouth disease (FMD) in China

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ABSTRACT

Foot and mouth disease (FMD) outbreaks have been reported in China for many years. Recently, due to the rapid economic development, the price of meat and its demand have grown quickly. This trend has resulted in an increase in the number of livestock moving from south-east Asian countries into China. Foot and mouth disease is becoming one of the most important trans-boundary animal diseases affecting the livelihood of livestock owners in China. To contribute to the long term goal to control and eradicate FMD from China, the Chinese government has adopted a series of control measures which includes compulsory routine vaccination against the disease. In this paper, the surveillance results of the routine vaccination programme were systemically reviewed. The results from 28 published papers were combined and analysed through a meta-analysis approach. The results of the meta-analysis indicated that the vaccination programme has been very successful in China with more than 70% of animals protected against serotypes Asia-1 and O.

1. Introduction

Foot and mouth disease (FMD) is a highly contagious epizootic disease which has had a devastating effect on animal industries for many centuries (Mahy, 2005). There are seven serotypes of foot and mouth disease virus (FMDV) which contain numerous subtypes (Rodriguez and Gay, 2011). Measures recommended by the World Organisation for Animal Health (OIE) for the control of FMD include a zoning approach (dividing a region into zones and applying different control programmes in these zones), routine vaccination, a surveillance programme, a stamping out policy and emergency vaccination (OIE, 2011).

Routine vaccination, as one of the main FMD controlling steps, is a critical tool in controlling and eradicating FMD, particularly in countries where the disease is endemic (Doel, 2003). For the purpose of controlling infectious animal diseases in China, the China National Animal Epidemic Prevention Law was proclaimed on the 1st January 1998 and was revised in 2008 (Ye, 2008). In this law, Article 13 states that China applies compulsory vaccination to epidemic animal diseases which cause serious damage to the breeding and production potential or to human health. These epidemic diseases include highly pathogenic avian influenza (HPAI), Porcine Reproductive and Respiratory

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Syndrome (PRRS), foot and mouth disease (FMD), Classical Swine Fever (CSF) and Peste des Petits Ruminants (PPR) (Anonymous, 2010).

Compulsory routine vaccination against FMD in China involves vaccination of pigs against FMD serotype O virus, cattle, sheep (and goats), camels and deer against serotypes O and Asia-1, dairy and breeding cows against serotype A, and cattle and sheep/goats from Guangxi Zhuang Autonomous Region (Guangxi Province), Yunnan Province, Tibet Autonomous Region (Tibet), and Xinjiang Province against serotype A. In large scale livestock farms, piglets and lambs are initially vaccinated at 4–5 weeks of age and calves at approximately 90 days of age. After 1 month, animals should receive a secondary booster vaccination and then should be revaccinated at 4–6 monthly intervals. Backyard livestock are vaccinated biannually (in spring and autumn) by staff from local veterinary stations. However when outbreaks of FMD occur, emergency vaccination is implemented to prevent the disease from spreading. These emergency procedures involve vaccination of all susceptible animals in the outbreak and establishment of buffer zones by the government. The vaccines adopted by the Chinese Government for cattle, sheep and goats, camels and deer include serotypes O and Asia-1 bivalent inactivated vaccines, serotype O plus serotype A bivalent inactivated vaccine and serotype A inactivated vaccine. The vaccines used in pigs are inactivated and synthetic peptide serotype O vaccines. Empty capsid vaccines of serotype O are also administered to pigs in approved regions (Anonymous, 2010).

After a compulsory vaccination programme is completed, a surveillance programme is required to be implemented. The surveillance is designed to assess the vaccine coverage and its effectiveness. According to the standard of the Ministry of Agriculture, China, the liquid phase blocking ELISA (LPB-ELISA) is to be used for testing antibody to serotype Asia-1, with a titre $\geq$ 64 required to demonstrate protection. For serotype O the indirect haemagglutination assay (IHA) and the LPB-ELISA are used with effective titres assessed at $\geq$32 and 64, respectively. For serotype A a titre $\geq$ 64 on the LPB-ELISA is required. The indirect ELISA is also used for diagnosing antibody to the VP-1 structural protein (titre $\geq$ 32 required). This structural protein is used in synthetic peptide vaccines to protect pigs against serotype O (Anonymous, 2010).

This study was designed to evaluate the efficacy of the routine vaccination programme against FMD adopted in China through a systematic review and a meta-analysis approach.

2. Materials and methods

Literature on responses to vaccination against FMD in China was collected through searching literature databases. Three Chinese and one English literature databases were searched (Wan Fang Data (www.wanfangdata.com.cn), Wei Pu Information Network (www.cqvip.com) and China National Knowledge Infrastructure (CNKI) (www.cnki.net) and PubMed (www.ncbi.nlm.nih.gov/pubmed)).

The fuzzy inquiry option on the database searching engine was used in all three Chinese databases to search for the Chinese equivalent words for "vaccination", "surveillance" and "detection" in the papers' titles, key words and abstracts. After fuzzy searching, the published period of papers was limited to 1998–2012, since the compulsory vaccination policy was initiated only in 1998. One thousand eight hundred and thirty eight papers were recovered from Wan Fang Data, 6098 papers were found in Wei Pu Information and 5657 papers were listed in CNKI. The titles and abstracts of these papers were screened, and papers with information relating to FMD antibody level detection/surveillance after vaccination or FMD vaccination efficacy in field were selected. After title and abstract screening, 41 papers, 47 papers and 98 papers were chosen from Wan Fang Data, Wei Pu Information and CNKI, respectively.

In the English database PubMed, "Foot and mouth disease" and "China" not "hand foot and mouth disease" were input into the Advanced Search Builder for searching for papers. Three hundred and eighteen papers were recovered, of which 281 were completed in the period 1998 to 2012. After title and abstract screening, none of the papers included in the PubMed search introduced FMD antibody level detection/surveillance after vaccination or FMD vaccination efficacy in field.

The papers from the three Chinese databases were compared and combined to remove duplicated papers. This resulted in 132 unique papers, of which 128 were available in full text.

These publications were then assessed and selected if they fulfilled the following conditions:

(a) The aim of the study was to evaluate antibody titre to FMD after routine vaccination.
(b) The diagnostic methods used in the study were the standard methods required by the China's Ministry of Agriculture (MOA).
(c) The study clearly indicated the species of animals tested which must have included at least one domestic livestock animal (pigs, cattle and sheep/goats).
(d) The study clearly indicated the breeding condition of the tested animals, farms or households (small scale breeding in the farmer's backyard).
(e) If the animals tested included cattle and/or sheep/goats, then the study needed to clearly indicate the serotype tested.
(f) The study must have reported the number of animals with sufficient immunity and the total number of samples tested.
(g) The criterion used to determine sufficient immunity must have been clearly reported and was similar to that required by the Chinese Ministry of Agriculture.

Research studies were excluded if they were designed to:

(1) Test the efficacy of an FMD vaccine using comparative field trials.
(2) Test the dynamics of antibody to FMD.

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