Management of animal health data to inform policy in China

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Summary

In the past ten years, with the development of computer and internet technology, the informatisation level of animal health data management has been continuously promoted, which has improved the supporting role of animal health information in decision-making. This article outlines the legal basis, management system and collection procedure of animal health data in the mainland of China. Its development and application are also briefed. The future development is pictured based on the current situation.

Keywords

Animal health – Data – Management – People's Republic of China – Policy.

Introduction

China's territory spans nearly 50 latitudes from north to south. There is a difference of five time zones between the Wusuli river at the eastern end and the Pamir plateau at the western end. The vast territory and diverse ecological environment bring not only rich living culture and consumption habits, but also diverse livestock breeding species and modes, as well as a relatively complex situation of animal disease prevention and control. In the struggle against animal diseases, China's veterinary departments have constantly adjusted the management mode of animal health data related to animal disease situations. Especially in the past ten years, with the development of computer and internet

technology, the informatisation level of animal health data management has been continuously improved, which has promoted the supporting role of animal health information in decision-making.

Animal health data management systems

Legal basis

In addition to the Animal Husbandry Law and the Animal Epidemic Prevention Law, other laws related to the management of animal health data include the Law of the People's Republic of China (China) on the Entry and Exit Animal and Plant Quarantine and Biosecurity Law of China. The State Council and the competent authorities of animal production, disease prevention and control, and import quarantine have also promulgated some regulations and departmental rules on animal health data management. For specific important animal diseases, such as highly pathogenic avian influenza (HPAI) and African swine fever (ASF), the competent authorities have also formulated animal disease reporting and releasing regulations.

Authorities for animal health data management

The veterinary management system in the mainland of China is shown in Figure 1. The Bureau of Animal Husbandry and Veterinary Services, the Ministry of Agriculture and Rural Affairs (MARA), organises and implements the national animal disease prevention and control. Four technical supporting institutions directly affiliate to the MARA, including China Animal Disease Control Center (CADC), China Animal Health and Epidemiology Center (CAHEC), China Institute of Veterinary Drug Control (IVDC) and National Animal Husbandry Station. These institutions jointly undertake the collection and management of national animal health data according to their responsibilities. Among them, CADC is responsible for the establishment and management of the national animal disease prevention network information system, network traceability and emergency command platform, as well as the construction and maintenance of a slaughter management related information system and a network supervision platform; CAHEC is responsible for the

collection of international animal disease information, establishment of the national animal health and epidemiology database, and performance of early warning analysis of animal diseases; IVDC is responsible for the management of veterinary drugs and other related data; National Animal Husbandry Station is responsible for animal husbandry and breeding. Furthermore, unofficial associations and societies related to animal husbandry and the veterinary industry also collect animal husbandry data, animal disease data, and animal products processing data. Data management and analysis to provide guidance for the development of the industry are also conducted.

Evolution of information systems on animal health data

In order to improve the efficiency of data collection and management, we started to use animal health information systems more than 40 years ago. In the 1980s, the mainland of China began to apply computer technology to the production management of farms, such as the computer-aided management system for large-scale laying hen farms developed by Lu *et al.* [2, 3], and the National Animal Disease Information Computer Management Software developed by the Ministry of Agriculture (MoA) [4].

In December 1994, the Gold Agriculture Project was proposed in the third meeting of the National Economic Informatization Joint Conference. The animal disease database was included in the Gold Agriculture Project as part of the key agricultural basic database group. After that, the research and development of Animal Health Data Management Information System was started in different places in China.

China's 'No. 1 central document' for 2007 required the improvement of the agricultural informatisation level, which further promoted the informatisation level of animal health data management. In 2010, the National Animal Disease Surveillance and Information System was officially launched, which changed the previous management mode of animal health data mainly based on paper files [5]. Subsequently, the comprehensive information management system for animal health supervision was promoted and used nationwide. With the livestock

number and density increasing constantly, animal disease risk was becoming higher. For this reason, a number of animal health data management systems were developed in different places, such as the Beijing Animal Disease Emergency Command Platform [6], and the Zhengzhou Important Animal Disease Comprehensive Management Software [7].

In 2015, the National Animal Disease Surveillance and Epidemic Information System was replaced by the new National Animal Health Surveillance Information Platform. The new platform covered animal disease prevention and control institutions at four levels: nation, province, city and county, implementing the principle of 'county reporting, city review, and province confirmation'. The disease information is collected on the premises, and the information should be added to the system after it is received and verified.

In 2017, the State Council promulgated the Implementation Plan for Consolidation and Sharing of Government Information Systems. In order to solve the problems of data, application and service fragmentation in the informatisation management of national animal health data [8], MoA began to integrate animal health data management systems. In 2019, the national animal sanitary information platform was launched. The platform covers ten types of data including vaccination, detection, transportation, slaughter, and harmless disposal from breeding to slaughtering.

In addition, the mainland of China has also established the national veterinary drug and vaccine information platform [9], the national key protected aquatic wildlife information management system [10], and the exotic animal disease information system.

Animal health data categories and collection

Livestock breeding data

The breeding data collection procedures vary from place to place. In developed provinces such as Beijing and Jiangsu, local veterinarians conduct on-site inspections, and upload the data to the system by

scanning the QR code. The QR code of each farm corresponds to their unique animal disease prevention qualification certificate. The types of reported breeding data are similar all over the mainland, which include basic information of the farm (name, geographic coordinates, staff composition, scale, layout), production records (animal species, inventory, slaughter volume, restocking volume, number of culled animal), environmental parameters (stall temperature, humidity, ammonia concentration), real-time feed intake, water intake, consumables usage records (feed, veterinary drugs, vaccine), disinfection records, medical records, inspection declarations, harmless disposal records and so on [11, 12, 13].

Compulsory vaccination data

The mainland of China implements compulsory vaccination against some important animal diseases, like HPAI and foot and mouth disease (FMD), and implements electronic management for vaccination data to improve work efficiency. The most common practice is to add a vaccination information module to the existing animal disease information system. Village-level or farm veterinarians scan the ear tag through a mobile terminal to record the frequency, dose, name, type and manufacturer of vaccines, animal age and other information [12, 14, 15, 16].

Animal disease data

There are express, weekly and annual animal diseases reporting systems in the mainland of China. According to the Regulation on Handling Major Animal Epidemic Emergencies, an outbreak of HPAI, ASF, as well as other emerging animal diseases should be reported immediately. The report should include the infected premises, epidemic area, threatened area and control measures. Local animal disease prevention and control institutions at or above the county level must summarise the animal disease situation within their jurisdiction weekly and fill in the report through the animal disease information management system. The types of data in the weekly and annual report are consistent, which include 27 items, namely animal species, disease name, the number of

epidemic counties, infected premises, cases, deaths, and the number of culling and harmless disposal, emergency slaughter and treatments, etc.

Surveillance and epidemiological investigation data

The 'National Animal Disease Surveillance and Epidemiological Investigation Plan (2021–2025)' stipulates the data reporting and usage of active and passive surveillance for 17 diseases, including major animal diseases, such as ASF, HPAI, etc. and important zoonotic disease, such as brucellosis, schistosomiasis, echinococcosis, etc., and surveillance for compartmentalisation and disease-free zones. The surveillance data is submitted through the animal sanitary information platform, including source animal, farm information and testing information. Epidemiological data is more complex and is submitted by paper questionnaires and emails. The surveillance data of international animal disease is analysed by CAHEC, and the results are regularly reported to the Bureau of Animal Husbandry and Veterinary Services of MARA.

Animal movement inspection data

There are various types of animal movement inspection data involved in the current animal health supervision information systems of various provinces. At least ten types of data were stipulated in the 'Administrative Measures for Animal Health Supervision Information Reporting (temporary provisions)', such as institutional settings and law enforcement personnel, farm inspection, slaughterhouse inspection, market inspection, and harmless disposal of animals and animal products. All data are filled in by the staff of primary animal health supervision agencies through personal computer, laptop, or mobile equipment [13, 17, 18, 19].

Applications of animal health data

Performance evaluation

First of all, surveillance data from the vaccination information module of national animal sanitary information platform guarantees the monitoring on vaccine effectiveness and animal health status, which

assists to evaluate the effect of disease prevention and control measures [20]. Secondly, collecting, synchronising and analysing the data of local and national subsystems can evaluate and compare the work performance from different institutions [11].

Risk assessment for animal products

Most provinces have developed information systems meeting the local realities. The form and data items of these systems are similar to those of the animal sanitary information platform built by CADC. The mobile terminal connected to the systems above, is equipped with a risk assessment and management system. It can collect data on animal diseases, diagnosis, surveillance and harmless disposal. The risk assessment system and mathematical model can be applied to conduct a preliminary assessment for disease in animals or animal products. With the combination of the information for historical risk, geography, risk animal or animal product, the system can quickly locate the likely source after an event occurs, and support the economic assessment and sequential management [11, 21].

Develop animal disease prevention and control plans and programmes

Since March 2009, MoA has organised more than 20 institutions and set up 23 projects. Based on animal health data for decades, the 'National Medium-and Long-term Animal Epidemic Prevention and Control Plan (2012–2020)' was released [22]. It was the first animal disease prevention and control plan with a time span of more than five years since the founding of China. In 2017, the surveillance data showed that the spatial distribution of H7N9 influenza among poultry continued to expand, the speed of spread was accelerated, and the human cases far exceeded the previous year. H7N9 vaccination policy was becoming a hot topic. Fortunately, the pilot vaccination experiment showed the advantages of H7N9 vaccination, which promoted the promulgation of the 'National guidelines for the prevention and control of avian H7N9 influenza (2018–2020)' [23]. H7N9 was controlled effectively with the vaccination policy. Since the national compulsory vaccination of H7N9 among poultry was implemented in February 2018,

the number of human infection cases had rapidly decreased from 589 cases in 2017 to two cases in 2018.

Optimisation of animal disease prevention and control policies

In recent years, based on the data collected from surveillance and epidemiological investigation, important animal disease prevention and control policies were optimised with the application of mathematics, statistical modelling and economic analysis, which have achieved remarkable results. For example, in 2016, the simulation results from a model for FMD developed by CAHEC suggested that the risk of FMD Asia I reactivation would be very low after the withdrawal of FMD vaccination. Meanwhile, economic analysis shows that the benefit of withdrawal from compulsory vaccination in 2017 would be the best choice. Hence, China has shifted the FMD Asia I from 'mandatory vaccination list' to 'surveillance and culling list' since 2018. In August 2018, the first ASF outbreak was reported in China. Based on the analysis of epidemic data collected from early epidemiological investigations, it was found that the key risk factors for the spread of the epidemic were swill feeding, live pigs and product movement, contaminated personnel and vehicles distributing the virus. Biosecurity of farms is a key part of curbing the introduction of the virus as well [24]. The MARA has successively issued a ban on swill feeding, policies of controlling of the movement of live pigs and their products, strict supervision of the registration of live pig transport vehicles, and strengthening biosecurity of large-scale farms and pig breeding farms. Simultaneously, 'point-to-point' transportation was implemented to ensure the supply of live pig products [24].

Early warning

In order to predict the high-risk area and period for an epidemic, big data of animal health was widely used to analyse the epidemic pattern of animal diseases, since the outbreak of avian influenza in China in 2004. The effective early warning system should include the real-time tracking of the international epidemic situation, risk assessment, and a sound information collection mechanism [25]. In November 2009,

FMD was reported in a Banqiao pig farm in Beijing. The geographic information system (GIS)-based emergency response platform predicted the disease situation and guided the emergency response effectively. Since then, more research on early warning has been conducted for the management of animal health data [26].

Improve the efficiency of animal health management

CADC has established a remote surveillance platform, which includes the functions of real-time data recording, viewing, exporting, and rapid diagnosis in the field. The analysis results are supportive for decision-making. The platform meets the needs of remote real-time synchronisation, data interconnection and sharing, and improves data management efficiency [27]. The animal disease control materials management system established in many provinces has setup a top-down information circulation mechanism. The system ensured efficient, accurate and standardised materials management. It combines geographic coordinates to accurately mark the location of the outbreak, and automatically summarises the amount and types of livestock and farms in each region. The electronic map of the system dynamically displays materials on site and on time, and automatically reminds the use when materials need to be replenished. The refrigerator for reagents is linked with the temperature sensing probe, which can transmit any unusual information to the administrator for timely handling [28].

Zoning and compartmentalisation

A prerequisite for compartmentalisation qualification is constructing an effective traceability system, and regulatory control by veterinary agencies is an important aspect. To supervise the important items of applying for and maintaining disease-free status, all the related information needs to be well documented in accordance with the norms. Therefore, a large amount of data needs to be formed in the process of declaration and maintenance. In order to realise the whole-process traceability in disease-free areas, Jilin province and other regions have built a system for animal health supervision in disease-free zones of specific diseases. The system formed the specialised online reporting, summarisation and analysis of the animal health information, which

guarantees the efficient and standardised information submission [29, 30].

Future development

According to the requirements of the '14th Five-Year' National Informatization Plan, '14th Five-Year Plan for National Agricultural and Rural Informatization Development' and other files, China will continue to make progress in the development of intelligent agriculture and the informatisation of animal health management, so as to better serve the industry.

Diversity of animal health data sources and types

In the future, we will promote the integration of big data technology and the industry, broaden information collection channels, design the collection, storage and analysis functions suitable for multi-source heterogeneous data, and improve the ability of information extraction and utilisation. All of these will assist to strengthen collaboration among different agencies and regions, especially in the aspects of vaccination, surveillance, movement inspection, transportation supervision, slaughtering supervision and harmless disposal.

Smart data collection and management

In the future, in order to achieve the goal of smart data collection and management, we will explore from three aspects. To facilitating smarter data collection, an important pre-requisite is the strengthening of the infrastructure construction for animal health data collection. With the help of various sensors and Internet of Things technologies, real-time collection of animal disease prevention activities data from breeding to slaughtering, such as production and management, will be automatically classified, stored and processed. Following this, we aim to standardise the data format, formulate a unified national animal health data specification, a unified classification and coding, a unified exchange format, a unified terminology, a unified file format and a unified quality index system, so as to facilitate the interconnection of different information systems. Finally, we aim to combine the evolving

artificial intelligence algorithms and expert experience, and comprehensively use GIS technology and mathematical/statistical models to achieve scientific analysis and full mining of data/information, and to realise the visual output of dynamic disease-related analysis information. The overall goal is to use these smart data to optimise resource allocation, guide emergency response, and provide timely and reliable technical support for decision-making.

Diversity of users

Following the construction of digital government affairs and government cloud, we will promote the development and application of big data technology in the field of animal husbandry and veterinary medicine, further improve the efficiency of animal disease risk assessment, prediction and early warning, and better serve the decision-making of the industry. This should strengthen cooperation with public health and other relevant sectors, make full use of the advantages of extensive data collection channels and diversified information in the era of big data under the 'One Health' concept, and emphasise the role of veterinarians in zoonotic diseases, drug residues and antimicrobial resistance. It is important that we can provide fast and convenient animal health information services for practitioners of animal breeding, transportation and processing. Therefore, the use of the above big data technology can provide practitioners with timely interpretation of industry hotspots, early warning and prediction of animal product market conditions, so as to scientifically guide social expectations.

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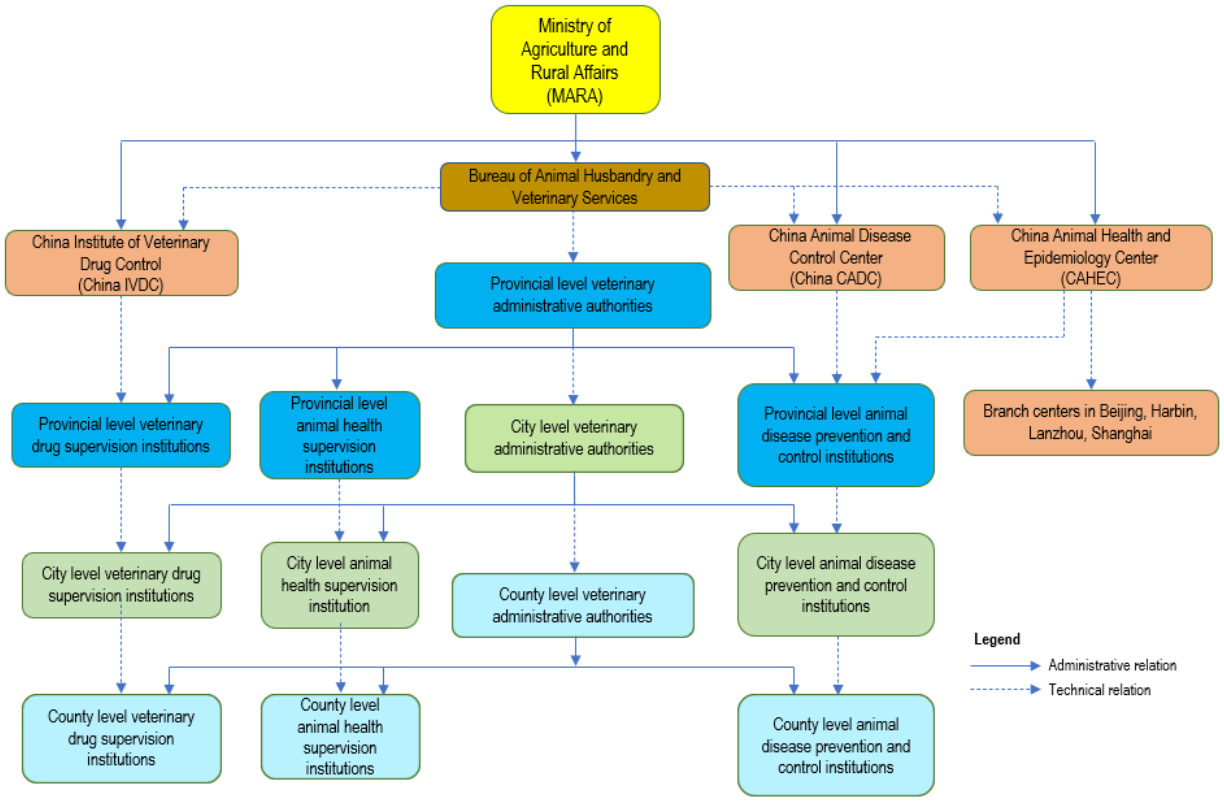

Figure 1

National veterinary system [1]