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Challenges and Strategies in the Prevention and Control of Animal Diseases: Trends and Pathways

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Abstract: The prevention and control of animal diseases is a critical factor influencing the sustainable development of animal husbandry and public health security. Its significance is undeniable. However, current challenges persist, such as an incomplete epidemic prevention system, a shortage of skilled epidemic prevention professionals, and insufficient dissemination of animal epidemic prevention knowledge, all of which hinder the quality of epidemic prevention and control efforts. This study examines the evolving trends in animal epidemic diseases, evaluates existing challenges in current prevention and control measures, and proposes strategies to address these issues. Recommended strategies include broadening publicity channels for animal epidemic prevention knowledge, improving the epidemic prevention management system, enhancing supervision and enforcement, refining monitoring and early warning mechanisms, and strengthening the development of epidemic prevention talent. To elevate the quality of animal disease prevention and control and improve the global competitiveness of China's animal husbandry sector, it is also essential to strengthen international collaboration on epidemic prevention within the framework of the Regional Comprehensive Economic Partnership (RCEP).

Keywords: Animal epidemics; Development trend; Epidemic prevention and control; Optimizing pathways

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1. Introduction

In recent years, significant advancements have been achieved in China's animal husbandry sector, including increased production scale, improved technical capabilities, and extended industrial chains. However, the emergence of new animal diseases, alongside the expanding impact and transmission of traditional animal diseases, has led to increasingly severe challenges from mixed infections. Consequently, the importance of effective disease prevention and control has become more pronounced.

To address these challenges, China has introduced several policies and regulations, such as the "National Guidance on Compulsory Immunization of Animal Diseases (2022–2025)," the "Work Plan for the Prevention and

Control of African Swine Fever and Other Major Animal Diseases (Trial)," and the "Animal Epidemic Prevention Law." Despite these efforts, practical implementation issues persist. It is imperative for relevant authorities and disease prevention personnel to optimize their operational frameworks and tailor prevention and control measures to the characteristics of specific animal epidemics.

Key actions include combining immunization with standardized quarantine procedures, minimizing epidemic occurrence, and engaging directly with farmers to provide guidance on animal disease prevention and control. This involves explaining the characteristics of prevalent epidemics and commonly used medications, assisting with vaccination efforts, and overseeing farm disinfection processes. Such measures ensure the healthy growth of livestock, thereby supporting the sustainable development of animal husbandry.

Overall, the trajectory of animal diseases in the new era is becoming increasingly complex and dynamic. To address these challenges effectively, continuous updates and refinements in prevention and control strategies are essential.

2. Current situation and development trends of animal diseases in the new period

2.1. Emergence of new animal epidemics

The further development of economic globalization and the growing international trade in China has resulted in the importation of foreign animal-derived foods and livestock breeds.[1]While this has contributed to the advancement of China's animal husbandry sector, it has also introduced foreign animal epidemics into the country. For instance, diseases such as bovine epidemic fever and highly pathogenic porcine reproductive and respiratory disorder syndrome (HPRDS), which are prevalent in other nations, have been introduced. Due to the lack of targeted vaccines and relevant treatment experience in China, these diseases pose a higher risk of widespread outbreaks, significantly threatening the economic interests of farmers and placing immense pressure on animal disease prevention and control efforts.

2.2. Atypical changes in severe infectious diseases

Inadequate foundational knowledge about animal epidemics has resulted in issues such as improper medication and treatment, leading to atypical manifestations of certain diseases. These changes in the typical characteristics of diseases hinder the effectiveness of follow-up treatments conducted by epidemic prevention personnel. Severe infectious diseases such as atypical Newcastle disease, atypical swine fever, and atypical avian influenza have shown non-standard initial symptoms. Additionally, viral structural changes have rendered existing treatment drugs ineffective, compromising treatment outcomes and increasing the likelihood of livestock fatalities [2].

2.3. Increase in the incidence of viral diseases

Viral diseases remain a significant challenge in animal disease prevention due to their high fatality rates. Alongside the rise in bacterial diseases and parasitic infections, the accelerated mutation of pathogenic microorganisms has further expanded the prevalence of viral animal diseases. This trend has presented new challenges to the breeding of pigs, cattle, sheep, and poultry [3]. Viral epidemics in livestock farms often result in inapparent infections and secondary infections, complicating disease prevention, control, and treatment. This complexity leads to higher mortality rates and significant economic losses for livestock operations.

2.4. Increasing requirements for animal disease prevention and control in international trade

The growing volume of international trade in animals and animal-derived products has heightened the risk of cross-border transmission of animal epidemics. For instance, outbreaks of diseases such as foot-and-mouth disease and avian influenza not only cause substantial losses to the livestock industries of affected countries but may also prompt other nations to impose import bans on animal products, thereby disrupting international trade.

Organizations such as the World Organization for Animal Health (OIE) and the World Trade Organization (WTO) have established international standards and rules that require member states to adopt stringent sanitary and phytosanitary measures. These include implementing regional management strategies for animal epidemics, enhancing port quarantine procedures, and improving animal epidemic monitoring and early warning systems.

2.5. Prioritization of purification and eradication in prevention and control strategies

To bolster animal disease prevention and control, the "National Guidance on Compulsory Immunization of Animal Diseases (2022–2025)" defines specific types and procedures for compulsory immunization. Similarly, the "Work Plan for the Prevention and Control of African Swine Fever and Other Major Animal Diseases (Trial)" outlines targeted strategies for managing specific diseases in various regions. Notably, the revised "Animal Epidemic Prevention Law of the People's Republic of China" incorporates "purification and eradication" as the core objectives of epidemic prevention efforts.

This policy shift emphasizes the complete elimination of epidemics through systematic and comprehensive measures, aiming to reduce or eradicate the threats posed by epidemics to agricultural production, animal breeding, and public health security [4]. The government's intensified focus reflects a commitment to implementing fundamental solutions to combat animal epidemics effectively.

3. Problems in the prevention and control of animal diseases

3.1. Limited awareness of epidemic prevention among livestock farmers

In some rural areas, small-scale farmers often have lower levels of education and limited knowledge of animal epidemic prevention. This is coupled with minimal investment in epidemic prevention measures. For instance, many farmers fail to regularly disinfect breeding sites or vaccinate their livestock and poultry, which increases the likelihood of animal epidemics. Additionally, some do not adhere to the relevant standards for epidemic control issued by regulatory authorities or fail to identify initial symptoms of diseases in livestock or poultry. This lack of timely action exacerbates the scale of outbreaks, potentially spreading the epidemic to other farms and hindering the healthy development of the regional aquaculture industry.

3.2. Inadequacies in the animal epidemic prevention and control system

The current animal disease prevention and control system in many regions lacks robustness, primarily due to two issues. First, there is insufficient coordination and communication between epidemic prevention departments and animal husbandry authorities. Prevention and control systems are not tailored to meet the specific developmental needs of local animal husbandry industries. Ambiguities in management responsibilities and inadequate guidance for grassroots farms hinder effective solutions to epidemic prevention and treatment challenges [5].

Second, the absence of emergency management plans for animal epidemics hampers timely responses to

large-scale outbreaks. Without rapid action, epidemics are likely to spread further, leading to significant economic losses for affected farmers.

3.3. Insufficient dissemination of animal disease prevention and control knowledge

Many farms, particularly those in remote rural areas, face logistical challenges that limit farmers' opportunities for external learning and access to animal disease prevention knowledge. Furthermore, grassroots epidemic prevention departments often fail to conduct outreach in these areas to provide technical guidance and education on animal epidemic control. Information regarding common diseases in livestock, such as pigs, cattle, sheep, and poultry, and practical knowledge, such as vaccination schedules, remains inaccessible to many farmers.

Additionally, epidemic prevention and control management departments have not fully utilized modern communication platforms such as WeChat public accounts or TikTok to disseminate prevention knowledge. A lack of online engagement, including question-and-answer sessions led by technical experts, further limits farmers' ability to access essential guidance. This shortfall affects the effective implementation of epidemic prevention measures in rural areas.

3.4. Lagging development of animal disease prevention and control talent

The increasing variety and complexity of animal epidemics, coupled with rising fatality rates, demand that epidemic prevention personnel possess advanced professional knowledge, strong service capabilities, and practical skills. However, primary-level epidemic prevention departments face a shortage of skilled personnel. Young, highly educated professionals with expertise in veterinary medicine are particularly scarce, leading to stagnation in the development of the epidemic prevention and control workforce.

Moreover, grassroots departments often lack comprehensive training systems for personnel. Regular training on the prevention and treatment of emerging animal diseases is not conducted, limiting professional development opportunities for technical staff. This deficiency impedes grassroots-level epidemic prevention efforts and affects the overall effectiveness of disease control measures [6].

3.5. Variations in standards restrict monitoring and certification in international trade

Strict standards for animal disease prevention and control are essential in international trade, as they ensure the safety and reliability of animals and animal products. While initiatives such as the construction of the Hainan Free Trade Port and the implementation of the Regional Comprehensive Economic Partnership (RECP) agreement provide growth opportunities for China's animal husbandry sector, they also highlight challenges arising from differences in international standards.

Disparities in prevention and control methods between countries and regions may create obstacles to monitoring and certification processes. Such inconsistencies complicate compliance with international trade requirements. Furthermore, the rapid growth in China's import trade of animals and animal products increases the risk of cross-border disease transmission, further emphasizing the need for standardized practices.

4. Optimizing the path of animal disease prevention and control

4.1. Publicizing epidemic prevention knowledge through multiple channels to enhance farmers' awareness

To improve farmers' awareness of animal epidemic prevention and control, epidemic prevention departments at various levels should actively disseminate relevant knowledge. Using the Internet to share prevention and control strategies and assisting farms with disinfection and vaccination efforts can significantly enhance epidemic prevention capabilities.

Firstly, epidemic prevention departments should establish service teams to provide regular on-site guidance in rural areas. These teams can offer door-to-door services to help farmers address challenges and reduce the incidence of animal epidemics. Secondly, leveraging digital platforms such as WeChat public accounts, microblogs, and TikTok to share knowledge about animal disease prevention can provide farmers with convenient access to educational materials online [7]. Additionally, technical personnel should actively respond to farmers' online queries, offering professional advice on vaccinations, site disinfection, and arranging on-site technical guidance. This approach facilitates problem-solving and promotes the sustainable development of the aquaculture industry.

4.2. Enhancing the management system for animal epidemics to improve prevention quality

Government authorities should develop animal epidemic prevention and control systems tailored to local aquaculture needs and characteristics. This includes clarifying departmental responsibilities, standardizing knowledge dissemination, epidemic reporting, and control measures to support the sustainable growth of local aquaculture [8].

Moreover, authorities should implement comprehensive monitoring systems to assess the epidemiological trends of major local outbreaks annually. These efforts should include formulating emergency management plans for significant epidemic events, and ensuring clear delineation of departmental responsibilities to enhance overall management efficacy.

4.3. Strengthening law enforcement and supervision to support aquaculture development

Epidemic prevention departments must intensify enforcement and supervision to ensure that farmers regularly administer vaccines and therapeutic drugs to livestock and poultry. This minimizes the risk of large-scale outbreaks, reduces economic losses, and enhances disease prevention.

Firstly, technical personnel should provide on-site services, educating farmers about the characteristics, symptoms, and transmission patterns of major animal epidemics. Secondly, prevention departments should combine immunization programs with standardized quarantine practices, focusing on mandatory immunization for diseases such as ruminant disease, foot-and-mouth disease, and avian influenza.

Health supervision departments must also strengthen oversight of the quarantine processes at the origin of animal products and during slaughter. Efforts to combat illegal activities, such as selling diseased or deceased animals and unauthorized slaughter, are essential. Collectively, these measures purify the epidemic prevention environment, elevate prevention standards, and promote industry health and safety.

4.4. Enhancing monitoring, early warning, and management systems to boost prevention capacity

Animal epidemic prevention departments should establish comprehensive monitoring and early warning platforms using technologies such as artificial intelligence, big data, and cloud computing. These systems enable real-time

monitoring, prompt identification of deficiencies, and informed guidance for farmers to strengthen epidemic prevention capabilities [9].

For instance, farms can adopt video monitoring systems to oversee critical activities, including feed management, vaccination, and site disinfection. Additionally, an animal disease monitoring and early warning platform allows quarantine departments to access real-time prevention data, focusing on high-risk diseases such as brucellosis, avian influenza, and foot-and-mouth disease.

Health supervision and epidemic prevention departments should also implement emergency drill systems for significant outbreaks, such as avian influenza and African swine fever. Simulated response exercises clarify the responsibilities of farms, technicians, and health supervisors, enhancing overall preparedness and response capabilities.

4.5. Strengthening the construction of epidemic prevention personnel teams

Qualified personnel are vital for advancing reforms in animal disease prevention and control. Government authorities should prioritize building professional teams by recruiting graduates in animal husbandry and veterinary medicine to introduce new expertise to grassroots departments.

Grassroots animal epidemic prevention departments should actively train young professionals through in-depth rural research, technical dissemination, and assistance programs. This approach enhances their practical experience, professional skills, and dedication.

Furthermore, epidemic prevention departments must establish comprehensive training systems aligned with the timing and characteristics of local outbreaks. Training programs should focus on identifying symptoms of common diseases, appropriate medication, and effective prevention measures. These initiatives ensure that grassroots personnel remain updated on new concepts and techniques, promoting their professional development and improving epidemic prevention at the local level [10].

4.6. Leveraging RECP policies to strengthen international collaboration

The RECP framework presents opportunities to enhance international cooperation in animal epidemic prevention, improving the global competitiveness of China's livestock industry.

Through RECP, China can collaborate with member states on policy alignment and standardization for epidemic prevention. By adopting international best practices, aligning local measures with global standards, and facilitating the free flow of livestock products, epidemic control efforts can be significantly strengthened.

Technical collaboration in areas such as vaccine development, surveillance strategies, and outbreak response can be fostered through technology sharing, regular seminars, and experience exchange. Additionally, establishing a regional information-sharing system ensures real-time access to epidemic data across RECP member states, bolstering monitoring and rapid response mechanisms. These initiatives collectively enhance public health security, elevate China's livestock sector competitiveness, and promote sustainable regional economic growth.

5. Conclusion

In conclusion, the prevention and control of animal diseases serve as a crucial foundation for ensuring the healthy development of animal husbandry and improving the economic benefits of farmers. Strengthening measures to prevent and control animal diseases remains an urgent priority. Government departments should actively

disseminate knowledge of epidemic prevention and control through various channels to raise awareness among livestock farmers, enabling them to effectively manage infectious disease prevention.

The management system for animal epidemics should be enhanced by clarifying the responsibilities of epidemic prevention and health supervision departments to improve the quality of prevention and control efforts. Law enforcement and supervision must also be intensified to support the sustainable development of the livestock industry.

Additionally, animal epidemic prevention departments should establish robust monitoring, early warning, and management systems to guide vaccination efforts and improve infectious disease prevention. Strengthening the workforce by developing a professional team of epidemic prevention personnel is essential. Efforts to build capacity and improve the quality of animal epidemic prevention and control will contribute significantly to the sustainable and healthy growth of the aquaculture industry.

Disclosure statement

The authors declare no conflict of interest.

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