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Lumpy skin disease as an emerging infectious disease

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ABSTRACT

Lumpy skin disease (LSD) is one of the most important emerging transboundary diseases. Recently, LSD has emerged in many countries in the northern hemisphere. The LSD virus has a huge genome and is highly resistant to environmental conditions. The virus is also host-specific and large ruminants, such as cattle and domestic water buffalo, are particularly susceptible. In addition, wild ruminants can serve as potential reservoirs for spreading the LSD virus. The emergence might be related to climate change in various regions because LSD is an arthropod-borne infectious disease. This disease causes enormous economic losses, such as leather damage, decreased milk production, abortion, and death in infected ruminants. The economic importance of LSD in the bovine industry has forced countries to develop and implement control strategies against the disease. With the recent global spread and the economic impact, LSD will be discussed intensively. In addition, effective preventive measures are suggested based on the presence or absence of LSD outbreaks.

Keywords: Contingency plan; emergence threat; lumpy skin disease

INTRODUCTION

The lumpy skin disease (LSD) virus is a member of the family *Poxviridae*, genus *Capripoxvirus* that causes LSD. This disease has recently emerged in most east European and Asian countries [1-4]. Bovine species (*Bos taurus* and *Bos indicus*) and water buffalo (*Bubalus bubalis*) are the primary hosts of this disease. In addition, the virus can infect some wild animals, such as giraffes, impalas, wildebeest, springboks, and oryxes [1,5]. Natural infections and antibodies against the LSD virus have been found in African wildlife species. Although the prevalence of LSD in wildlife is low, the role of wildlife as potential reservoirs for transmission to domestic ruminants should not be ignored [6]. LSD is a vector-borne disease transmitted by bloodsucking arthropods: mosquitoes (*Culex mirificens* and *Aedes natrionus*), biting flies (*Stomoxys calcitrans* and *Biomyia fasciata*), and male ticks (*Riphicephalus appendiculatus* and *Amblyomma hebraeum*) [1,5]. This disease is characterized by high fever, emaciation, enlarged superficial lymph nodes, lacrimation, conjunctivitis, and notable nodules on the skin and mucous membranes of the mouth, respiratory tract, and genitalia [1-4]. It can also cause reduced milk production, abortion in pregnant animals, and death. LSD has a high

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Conflict of Interest

The authors declare no conflicts of interest.

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morbidity of up to 90% and less than 10% mortality in infected cattle [1,5,7]. The World Organization for Animal Health (WOAH) has listed LSD as a notifiable disease because of its clinical and economic importance.

Resistance and survival of the LSD virus are well documented [1]. The resistance to heat is variable. The LSD virus can be inactivated at 55°C for 2 h and at 65°C for 30 min. On the other hand, the virus can be recovered from skin nodules after storage for 10 yr at −80°C. The virus remains viable for less than 42 d in the nodules on the animal [1]. It has excellent resistance to cold. In addition, the LSD virus is very sensitive to light. Therefore, the virus can persist in the dark in livestock buildings for several months [1]. The virus is stable at neutral pH, even though resistance to the pH depends on temperature. The virus is susceptible to high alkaline or acidic pH, but can survive at pH 6.6–8.6 for 5 d at 37°C [1]. This LSD virus is susceptible to several disinfectants, especially organic matter and detergents [1].

After the first outbreak of LSD in Zambia in 1929, the disease spread in most African countries until the first report in Israel in 1989. Since the outbreak in Israel, more outbreaks of the disease were reported in Middle Eastern countries, and LSD is currently considered an endemic disease in the region [1,5,7]. From the end of 2013, LSD invaded neighboring countries, such as Türkiye, Iraq, Iran, and Azerbaijan. Türkiye may serve as a crossroads connecting the Eurasian continent, facilitating the spread of LSD to the Balkans and some European countries [1]. After spreading to the Russian Federation in 2015, LSD has invaded several Asian countries, such as Kazakhstan, China, Nepal, Pakistan, India, Bhutan, Vietnam, Thailand, Myanmar, and Taiwan [3,4,8, 9]. Finally, the disease spread east and north to Mongolia and Eastern Siberia [1,4].

In wildlife, natural infections were reported in five Asian water buffalos (*B. bubalis*) during the LSD outbreak in Egypt in 1988 [6]. Antibodies to LSDV have been found in six out of 44 wildlife species in Africa: African buffalo, greater kudu *Tragelaphus strepsiceros*, waterbuck *Kobus ellipsiprymnus*, reedbuck *Redunca arundinum*, impala, springbok *Antidorcas marsupialis*, and giraffe [6]. The presence of antibodies in wildlife represents its susceptibility and epidemiological potential in LSD. Moreover, infected wildlife shows symptoms ranging from asymptomatic to mild clinical signs but may not always show detectable antibody levels. Hence, the actual number of wild ruminants infected with the LSD virus may be significantly higher than currently known.

Each country has implemented control measures to prevent the spread of LSD, considering the differences between countries, such as cattle distribution situation, region, and climate. In most countries, the control measures of LSD were surveillance, expert training, stamping-out, movement restriction, hygiene management, quarantine and bio-security, vector control, and vaccination [1,5]. The purpose of this survey was to enhance the awareness of LSD spread and provide information on control measures based on the country.

RECENT OUTBREAKS OF LSD

According to the WOAH report, outbreaks of LSD in susceptible animals have occurred and are increasing consistently (**Fig. 1**). LSD is endemic in most African countries. Since 2013, it has spread rapidly through the Middle East and Southeast Europe. Since 2019, several thousand outbreaks of LSD have been reported in Southeast Asian countries [1,7].

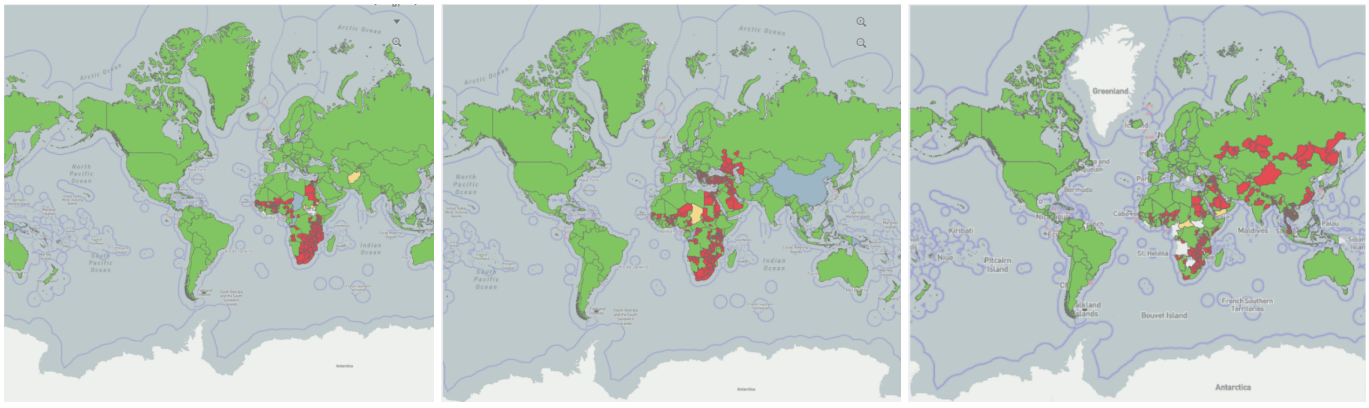

Fig. 1. World distribution of lumpy skin disease spread by the World Organization for Animal Health.

The number of LSD outbreaks in Asia reported was 28, 317, and 1,088 cases in 2019, 2020, and 2021, respectively [10] (**Supplementary Fig. 1**). Specifically, China first reported LSD in August 2019 and reported it in adjacent areas in June 2020 [8]. LSD first occurred in July 2020 in Kinmen island, Taiwan, neighboring China, and then in New Taipei City in April 2021 [2]. In addition, it first occurred in Thailand in March 2021 and spread rapidly throughout Thailand [9].

The spread of LSD outbreaks in Southeast Asian countries has been faster compared to the transmission period in African and Middle Eastern outbreaks. This phenomenon might be affected by the high temperature and humidity of the tropical climate in the region, which is a favorable environment for the reproduction of arthropod vectors [1]. The speed of LSD spread might differ according to the pattern of cattle raising and cattle movements. The speed at which the infection transmits was calculated to be 7.3 km per week, based on the spread pattern from Western Türkiye to the countries in the Balkans peninsula, from May 2015 to August 2016 [5]. On the other hand, a survey in Thailand showed that calculating the distance to the reported area was 50 and 100 d after the initial outbreak, the speed of LSD transmission in Thailand was estimated to be approximately 2 to 14 km/day [10].

CONTROL STRATEGIES AGAINST LSD

The principle of control strategies against LSD is similar regardless of the LSD outbreak. On the other hand, the implemented actions differ according to the countries with or without the LSD outbreak. In most countries with outbreaks, stamping out the positive cases, emergency vaccination, movement control of cattle, surveillance, and monitoring are the main control strategies (**Supplementary Table 1**) [11, 12]. On the other hand, legislation and risk assessment are the most important preparation against the LSD outbreak in countries without LSD outbreaks. Legislation includes surveillance and monitoring, stamping out policy, movement and disease control, and emergency vaccination policy. More detailed action plans, such as preparing vaccine banks and defining disease control zone, have been implemented based on the risk assessment in each country (**Supplementary Table 2**).

Although reports of LSD in wildlife have a low incidence, this disease should be controlled in wildlife because of the possibility of transmission and the difficulty of vaccinating wildlife.

The presence of LSD in wildlife can be easily missed because monitoring the clinical signs, such as skin lesions, is difficult due to wildlife migration. Therefore, surveillance of the clinical signs in wildlife and strict monitoring of wildlife movements are needed.

LSD CONTROL STRATEGIES BY COUNTRY WITH THE OUTBREAK

The current global situation of LSD outbreaks was intensively reviewed by the European Food Safety Authority, the Food Agriculture Organization of the United Nations (FAO), and other studies. In particular, the two organizations focused on the LSD outbreak in the Balkan and Caucasus countries [12]. On the other hand, epidemiological aspects and control strategies related to LSD in Asian countries remain to be analyzed, even though some studies have been done and reported [1-4,8,13].

As shown in **Supplementary Table 1**, the control measures implemented and applied to LSD outbreaks differed according to the economic, political, and social situation of each country. Most countries with outbreaks implemented the following control policies: stamping-out, animal movement control, vaccination, active surveillance, vector control, and compensation. The total stamping-out policy in the infected area was more effective in disease control than the partial stamping-out policy, which culled cattle with clinical signs and LSD virus positive. Regarding a vaccination strategy, live attenuated homologous vaccines (Neethling strain) were more effective than heterologous ones (sheeppox/goatpox virus-based vaccines), and the vaccination area was also very important in preventing the spread of LSD [14]. The area to be vaccinated should be determined according to the probability of LSD virus infection and LSD transmission [5]. Considering the above facts, stamping-out and vaccination policies should be conducted. Long-distance movement by infected or asymptomatic cattle is a rapid transmission factor and has been suspected of causing rapid spread throughout Thailand. Therefore, movement restrictions should be thoroughly enforced for disease management. Vector control might also use systemic or local insecticides (Ivermectin) and tick repellent (DEET and Permethrin). Compensation and awareness of the disease were also important factors in controlling LSD.

LSD CONTROL STRATEGIES BY COUNTRY WITHOUT THE OUTBREAK

In the countries without LSD outbreaks, as the first step, an LSD control strategy should be developed based on the status of LSD outbreaks in the surrounding countries. In addition, building up a vaccine bank or preventive vaccination is recommended in those countries.

The control strategy should include legislation, surveillance and monitoring, stamping-out policy, movement control, disease control zone, vaccination strategy, and education to related workers. The size of the vaccine bank should be determined based on the related factors of each country, such as disease control area, taking the incubation period into account, the distance of cattle movement, duration of full immunity development, the time needed to carry out vaccination, density of susceptible animals, and vector activities [5]. On the other hand, only a few countries have a contingency plan. France carried out a risk assessment of LSD and estimated the size of the vaccine bank (**Supplementary Table 2**).

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S. calcitrans, a bloodsucking arthropod, can travel up to 255 km by wind. After the outbreak of Türkiye, a safety quarantine zone of up to 10 km along the border was established to strengthen the monitoring of LSD in Greece [12]. Those reports suggest that control strategies should be considered in preparing for the spread by neighboring countries.

Several vaccines with homologous or heterologous strains against LSD are commercially available. Hence, each country should build up a vaccine bank for the emergence of LSD based on their current epidemiological situation.

CONCLUSION AND FUTURE PROSPECTIVE

LSD is a devastating infectious disease to the bovine industry and wildlife, both clinically and economically. Currently, LSD has invaded most Asian countries and is a hot spot of the outbreak, particularly in Southeastern Asian countries. The current situation of the disease makes LSD an emerging transboundary infectious disease worldwide, especially in Asian countries. Therefore, world organizations, such as FAO and WOAH, have intensively reviewed the outbreaks epidemiologically, clinically, and economically and provided guidelines to develop contingency plans for LSD. This survey summarized the control measures and contingency plans in various countries. Considering this survey, the author believes that vaccination and movement control of large ruminants are important factors for effective methods of LSD control. Vaccines should be established in advance in countries where there have been no LSD outbreaks, and in the outbreak of LSD, immediate total stamping-out in holdings and establishing a disease control zone should be done. Rapid vaccination and strict movement control of susceptible animals should be carried out according to the control area. Therefore, many countries should prepare a control plan for LSD regardless of the devastating infectious disease outbreak.

SUPPLEMENTARY MATERIALS

Supplementary Table 1

Control measures implemented in LSD outbreak countries

Click here to view

Supplementary Table 2

Recommendations legislated in countries without LSD outbreaks and international organizations

Click here to view

Supplementary Fig. 1

Annual reports of lumpy skin disease outbreaks by the World Organization for Animal Health.

Click here to view

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