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Bhoopendra Singh Mahor
(M.V.Sc), Department of Veterinary Medicine, College of Veterinary Science and Animal Husbandry, NDVSU, Jabalpur, Madhya Pradesh, India

Amita Tiwari
(Ph.D.), Assistant Professor, Department of Veterinary Medicine, College of Veterinary Science and Animal Husbandry, NDVSU, Jabalpur, Madhya Pradesh, India

Shivangi Udainiya
(M.V.Sc), Department of Veterinary Medicine, College of Veterinary Science and Animal Husbandry, NDVSU, Jabalpur, Madhya Pradesh, India

DK Gupta
Assistant Professor, Department of Veterinary Medicine, College of Veterinary Science and Animal Husbandry, NDVSU, Jabalpur, Madhya Pradesh, India

Brejesh Singh
(Ph.D.), Assistant Professor, Department of Veterinary Medicine, College of Veterinary Science and Animal Husbandry, NDVSU, Jabalpur, Madhya Pradesh, India

Ranbir Jatav
Assistant Professor, Department of Veterinary Medicine, College of Veterinary Science and Animal Husbandry, NDVSU, Jabalpur, Madhya Pradesh, India

Corresponding Author
Shivangi Udainiya
(M.V.Sc), Department of Veterinary Medicine, College of Veterinary Science and Animal Husbandry, NDVSU, Jabalpur, Madhya Pradesh, India

Lumpy skin disease: An economically devastating emerging viral disease

Bhoopendra Singh Mahor, Amita Tiwari, Shivangi Udainiya, DK Gupta, Brejesh Singh and Ranbir Jatav

Abstract
The clinical severity of Lumpy Skin disease depends on the susceptibility and immunological status. It causes significant economic problems in terms of reduced milk production, beef loss and draft animals, abortion, infertility, loss of condition and damage to the hide. The diagnosis of LSD is based on typical clinical signs combined with laboratory confirmation of the presence of the virus or antigen. Advanced diagnostic tools for LSD diagnosis can be conventional or real-time PCR methods. The treatment of LSD is only symptomatic and targeted at preventing secondary bacterial complications using antimicrobial therapy. Vaccination is the only effective method to control the disease in endemic areas as movement restrictions and removal of affected animals alone are usually not effective.

Keywords: Lumpy skin disease, emerging disease, vaccination

Introduction
Lumpy skin disease is an acute infectious disease characterized by fever, nodules on the skin, mucous membranes and internal organs, emaciation, enlarged lymph nodes, edema of the skin and sometimes death (Radostitis *et al.*, 2006).
It is one of the most economically significant transborder, emerging viral diseases. The disease is currently endemic in most Africa countries and expanded to Middle East region (Tuppurinen and Oura, 2011). It is a disease with a high morbidity and low mortality rate and affects cattle of all ages and breeds. It causes significant economic problems in terms of reduced milk production, beef loss and draft animals, abortion, infertility, loss of condition and damage to the hide (CFSPH, 2008) [7].
LSD is emerging and rapidly spreading disease in India too. As far as the outbreaks of LSD in India is concerned, it was first reported in Odisha state on 12 August 2019 and later on Jharkhand, West Bengal and Chhattisgarh have also been affected. The disease outbreak was also reported in Telangana, Karnataka and Kerala state in the month of February, April and June in the year 2020, respectively (Annarao *et al.*, 2020) [4]. Recently in August 2020, outbreak of LSD occurred in Balaghat district of Madhya Pradesh and in Sarguja, Surajpur, Balrampur, Jagdalpur, Narayanpur and Kondagaon in Bastar division in Chhattisgarh.

Etiology
Lumpy skin disease virus (LSDV) belongs to the genus *Capripoxvirus* and the subfamily *Chordopoxvirinae*. There is only one serotype of LSDV which is prototype strain of LSDV is the Neethling virus and it is closely related antigenically to sheep and goat poxvirus and can be distinguished by routine virus neutralization or other serological tests. The LSDV primarily affects cattle but can affect sheep and goats, experimentally. The virus will grow in tissue culture of bovine, ovine or caprine origin, although maximum yield is obtained using lamb testis cells. The members of this family are among the largest of all viruses. It is an enveloped, linear ovoid shape with a molecular brick shaped or ovoid virions measuring 220-450 nanometer (nm) by 140-266nm. LSDV has double stranded DNA genome of about 151kbp (Yehuda *et al.*, 2011) [21].
LSDV is remarkably stable for long periods at ambient temperature, especially in dried scabs. It can persist in necrotic skin nodules for up to 33 days or longer, desiccated crusts for up to 35 days and at least 18 days in air-dried hides. It can remain viable for long periods in the environment. The virus is vulnerable to sunlight and detergents containing lipid solvents, but in dark environmental conditions, such as contaminated animal sheds, it can persist for several months. The virus can be inactivated at temperature of 55 °C for 2 hours and 65 °C for 30

minutes. In contrast, it can be recovered from skin nodules kept at –80 °C for 10 years and infected tissue culture fluid stored at 4 °C for 6 months. The virus is susceptible to ether (20%), chloroform, formalin (1%), phenol (2% for 15 minutes), sodium hypochlorite (2-3%), iodine compounds (1:33 dilution) and quaternary ammonium compounds (0.5%) (OIE, 2013) [16].

Epidemiology

Risk Factors

The effect of agroclimate, communal share of the same grazing and watering points and unrestricted movement of animals across different borders following rainfall are some of the risk factors (Tuppurainen and Oura, 2011) [20]. The incidence of LSD occurrence is high during wet seasons when biting-fly populations are abundant and it decreases or ceases during the dry season (Gari *et al.*, 2010) [10].

The virus is also present in necrotic skin, nasal, lachrymal and pharyngeal secretions, semen, milk and blood and it may remain in saliva for up to 11 days and in semen for 22 days (Annandale, 2014) [3]. The virus may persist for months in lesions in cattle hides. LSD virus may persist for 6 months on fomites, including clothing and equipment but there is no evidence that virus can survive more than four days in insect vectors (Lefevre and Gourreau, 2010).

The clinical severity of disease depends on susceptibility and immunological status. The more susceptible breeds to LSD infection are related to fine-skinned breeds such as Holstein Friesian (HF) and Jersey breeds (Kumar, 2011) [12]. *Bos taurus* breeds are highly susceptible against LSDV, whereas indigenous (*Bos indicus*) breeds such as zebu and zebu hybrids are likely to have some natural resistance against the virus (Gari *et al*., 2011) [11]. Lactating cows appearing to be severely affected and result in a sharp drop in milk production because of high fever caused by viral infection itself and secondary bacterial mastitis (Tuppurainen and Oura, 2011) [20].

Source of Infection

The virus is present in nasal, lachrymal and pharyngeal secretions, semen, milk and blood and it may remain in saliva for up to 11 days and in semen for 22 days. It can also persist for up to 33 days in necrotic tissue remaining at the site of a skin lesion. Material from skin lesions also contains infective virus when shed (Barnard *et al.*, 1994) [5].

Transmission

LSD is generalized and epitheliotropic disease that causes localized and systemic reaction. Incubation period of LSD can vary from 2–4 weeks in naturally infected animals and vary from 5 days in experimentally inoculated animals (Barnard *et al*., 1994) [5]. Evidence from the different sources elucidate that LSDV can be mechanically transmitted by a variety of hematophagous arthropod vectors.

Recent studies in ticks have shown transstadial and transovarial persistence of LSDV in *Rhipicephalus decoloratus*, *Rhipicephalus appendiculatus* and *Amblyomma hebraeum* and mechanical or intrastadial transmission by *Rhipicephalus appendiculatus* and *Amblyomma hebraeum* (Lubinga *et al.*, 2014) [14]. On the other hand, mechanical transmission of LSDV has been experimentally demonstrated in female *Aedes aegypti* mosquitoes. However, clinical disease recorded in most of the animals exposed to infected mosquitoes was generally of a mild nature (Chihota *et al.*, 2001) [8].

The virus has been also recovered from Stomoxys, Biomyia, Musca, Culicoides and Glossina species that may have a potential to transmit LSD, as all feed voraciously upon domestic cattle (Carn and Kitching, 1995) [6]. In recent times, the potential role of the Culicoides spp. in the transmission of LSDV was investigated by Sevik and Dogan and revealed that *Culicoides punctatus* could have played role in transmitting LSDV during 2014-2015 outbreak in Turkey (Sevik and Dogan, 2015) [19]. Therefore, it is clear that various arthropods feeding on cattle can transmit the LSDV and spread the virus.

Studies suggest that LSDV is not transmitted by direct or indirect contact between infected and susceptible animals (EFSA, 2015) [9]. A recent study showed that experimental transmission of LSDV via semen from infected cattle is possible. However, whether transmission occurs during natural mating or artificial insemination needs further investigation (Annandale *et al.*, 2014) [3].

Clinical Signs

Lumpy skin disease is characterized by large skin nodules covering all parts of the body, nasal discharge, lachrymation, fever, enlarged lymph nodes, loss of appetite, reduced milk production, depression and reluctance to move. Young calves often have more severe disease than adults (CFSPH, 2011). The severity of clinical signs of LSD depends on the host immunity status, age, sex and breed type. Additional, the disease affects cattle and tends to be more severe in milking cows in the peak of lactation which can end up in mastitis (Gari *et al*., 2011) [11].

The disease may be manifested as acute, sub-acute and chronic forms (OIE, 2010) [15]. It has an incubation period of 2 to 4 weeks in the field (Tuppurainen and Oura, 2011) [20]. The nodules developed on skin vary from 2 cm to 7 cm in diameter, appearing as round, well circumscribed areas of erect hair, firm and slightly raised from the surrounding skin and particularly conspicuous in short-haired animals. In long-haired cattle, the nodules can only be recognized when the skin is palpated or moistened. In most cases the nodules are particularly noticeable in the hairless areas of perineum, udder, inner ear, muzzle, eyelids and on the vulva. However, other common sites are head and neck, genitalia, limb, udder, cutaneous tissues and sometimes underlying part of the muscle (Alemayehu *et al.*, 2013) [2].

Generally the major complications seen in lumpy skin disease are corneal opacity (keratitis), recumbency, mastitis, cellulitis and phlegmon, myiasis, abortion, dysentery (in calves), lameness and pneumonia. Sometime, in bulls due to acute orchitis temporary or permanent infertility or sterility occurs. Similarly, lesions in the reproductive tract of cows may result in infertility.

Diagnosis

The diagnosis of LSD is based on typical clinical signs combined with laboratory confirmation of the presence of the virus or antigen.

Histopathology can be an important tool to exclude viral, bacterial or fungal causes of nodular development in clinical cases and characteristic cytopathic effects (necrosed epidermis, ballooning degeneration of squamous epithelial cells and eosinophilic intracytoplasmic inclusion bodies) in cases of lumpy skin disease are well documented. Lesion of lumpy skin diseases showed presence of eosinophilic intracytoplasmic inclusions bodies was easily recorded due to

lumpy skin disease virus (Tuppurainen *et al*., 2011) [20].
Advanced diagnostic tools for LSD diagnosis can be conventional or real-time PCR methods. When compared to real-time PCR, gel-based PCR is more time and labor consuming. However, it is a cheap, reliable method and useful in countries with limited resources.
LSDV can grow in tissue culture of bovine, ovine or caprine origin, although primary or secondary culture of bovine dermis or lamb testis cells are considered to be most susceptible. It causes characteristic cytopathic effect and intracytoplasmic inclusion bodies and is distinct from BHV-2 which producing syncytia and intranuclear inclusion bodies.
The host immunity against LSDV is mainly cell mediated and therefore, serological testing may not be sensitive enough to detect mild and long-standing infections or antibodies in vaccinated animals.

Differential Diagnosis
There are many diseases causing similar signs as of LSD. It is important to obtain a definite diagnosis to ensure the best preventative and control measures for susceptible herds. It should be differentially diagnosed from the Pseudo-lumpy-skin disease, Bovine virus diarrhoea/mucosal disease, Demodicosis (Demodex), Bovine malignant catarrhal fever (Snotsiekte), Rinderpest, Besnoitiosis, Onchocerciasis, Insect bite allergies etc.

Treatment
The treatment of LSD is only symptomatic and targeted at preventing secondary bacterial complications using antimicrobial therapy. Among antimicrobials, enrofloxacin, ceftiofur sodium etc. can be used. In field conditions for young cattle, combination of Enrofloxacin + Ribavirin + Trimethoprim solution can be used at the rate of 1-2 ml/ 10 kg b.w. S/C once a day for 5 days. Long acting oxytetracycline also used intramuscularly at the dose rate of 1mg/10kg b.wt. (Salib and Osman, 2011) [18]. However, the treatment of LSD and its complications is costly as well as does not ensure full recovery. Therefore prevention is more beneficial to avoid the substantial economic losses due to hide damages, loss of milk due to mastitis and loss of animal product due to death, abortion, fever and myiasis.

Prevention and Control
Vaccination is the only effective method to control the disease in endemic areas as movement restrictions and removal of affected animals alone are usually not effective. Members of the capripoxvirus are known to provide cross protection. Hence, homologous (Neethling LSDV strain) and heterologous (sheep pox or goat pox virus) live attenuated vaccines can all be used to protect cattle against LSD infection (OIE, 2013) [16]. Commercially available capripoxvirus (CaPV) vaccine strains include LSDV Neethling strain, Kenyan sheep and goat pox virus (KSGPV) O-240 and O-180 strains, Yugoslavian RM65 sheep pox (SPP) strain, Romanian SPP, and Gorgan goat pox (GTP) strains (Abutarbush, 2017) [1].
Apart from vaccination, other control measures include restriction of the animal movement from one place to another, quarantine, keeping of sick animals well apart from the rest of the herd and by creating awareness among the farmers.
Animals older than six months must be vaccinated against lumpy skin disease. It is safe to vaccinate pregnant cows. All animals must be vaccinated once a year. When vaccinating the animals during a disease outbreak, it is important to use one needle per animal so that the virus is not spread from sick to healthy animals. Professional help and recommendation on vaccines must be carefully followed and practiced (CSFPH, 2008).

Conclusion
Lumpy skin disease (LSD) is an emerging vector borne disease caused by genus CaPV, is previously restricted to sub-Saharan Africa. However, in recent times it is slowly invading new territories. The lesions consequently, results in overwhelming economic losses due to chronic debility, reduced milk yield, weight loss, infertility, abortion and death. These may also impose dramatic effects on rural livelihoods, which are strongly dependent on cattle, with significant production losses. There is no specific treatment of the disease but it can be controlled by vector control, restricted animal movement during active period of insect and annual vaccination strategy with homologous strain of the LSDV.

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