REVIEW ON LUMPY SKIN DISEASE

Dnyaneshwar S Shrirame[1*], Amol V Sawale[1], Shraddha D Muneshwar[1], Sohan S Thipe[1], Vaishnavi S Honale[1]

[1] Vidyabharti College of Pharmacy, Naidu marg Camp, Amravati India

Corresponding Author
Dnayneshwar S Shrirame

Vidyabharati college of pharmacy
Naidu marg camp ,
Amravati 444602

Abstract
Lumpy skin disease (LSD) is a viral disease caused by lumpy skin disease virus (LSDV), a member of Capripoxvirus genus of subfamily Chordopoxvirniae, Poxviridae family. A lump like nodules in the external skin and mucous membrane with fever and swollen lymph nodes are the preliminary noticeable clinical signs of this devastating disease. The disease is transmitted by arthropod vectors and causes high morbidity and low mortality. It is a transboundary disease of the economic importance affecting cattle and water buffaloes. The incubation period ranges from one to four weeks leading to viremia The disease is endemic in African and Middle East countries but has started spreading to Asian and other countries. It has been recently reported from China and Bangladesh sharing borders with India. Starting from outbreaks in Gujarat and Rajasthan, in three months cattle in 15 states across India were affected. Vaccination along with strict quarantine measures and vector control could be effective for preventing the spread of the disease. The present review is designed to provide existing information on the various aspects of the disease such as its aetiology, transmission, outbreaks, diagnosis, prevention and control measures, vaccination.

Keywords : **Lumpy skin disease, Vaccine, Outbreak, Methylene Blue,**

INTRODUCTION

Lumpy skin disease (LSD) is an infectious disease in cattle caused by the lumpy skin disease virus of the family Poxviridae, also known as Neethling virus. Cattle and water buffalos are susceptible to LSDV virus and may develop pox lesions on the skin and internal organs when infected. Outbreaks are accompanied by high morbidity but low mortality, inflicting considerable economic losses. The disease is characterized by large fever, enlarged superficial lymph nodes and multiple nodules (measuring 2–5 centimetres (1–2 in) in diameter) on the skin and mucous membranes (including those of the respiratory and gastrointestinal tracts). [1] The virus is belongs to the genus Capri poxvirus, a part of the poxviridae family (smallpox and monkeypox viruses are also a part of the same family). The LSDV shares antigenic similarities with the sheeppox virus (SPPV) and the goatpox virus (GTPV) or is similar in the immune response to those viruses. It is not a zoonotic virus, meaning the disease cannot spread to humans.[2] LSD is a vector borne and transboundary disease with limited host range and currently restricted to ruminants viz. cattle and water buffaloes. The arthropod vectors responsible for the disease spread include biting flies, mosquitoes and ticks.[3]
Lumpy skin disease was first seen as an epidemic in Zambia in 1929. Initially, it was thought to be the result of either poisoning or hypersensitivity to insect even when kept in a close contact with infected cattle although typical skin lesions, without systemic disease, have been produced experimentally in sheep, goats, giraffes, impalas, and Grant's gazelles . Natural cases of lumpy skin disease were recorded in water buffalo (Bubalis bubalis) during an outbreak in Egypt in 1988, but morbidity was much lower than for cattle (1.6% vs. 30.8%). Among cattle Bos taurus is more susceptible to clinical disease than Bos indicus; the Asian buffalo has also been reported to be susceptible.[4]
LSDV has a limited host range and does not complete its replication cycle in non-ruminant hosts . Besides, LSD has not been reported in sheep and goats breeds of both sexes and all ages are susceptible to LSDV, but there is some evidence to support that young animal may be more susceptible to the severe form of the disease. LSD symptoms in cattle are mild to severe; characterized by fever, multiple skin nodules may also involve subcutaneous tissues and sometimes musculature and internal organs covering the neck, back, perineum, tail, limbs and genital organs, the mucous membranes; the lesion. Affected animals also exhibit lameness, emaciation and cessation of milk production. Edema of limbs and brisket, and lymphadenitis are highly prominent and sometimes affected animals may die. In addition, pneumonia is a common sequel in animals with lesions in the mouth and respiratory tract.[5]
The 2022 lumpy skin disease outbreak in India resulted in the death of over 97,000 cattle in three months between July and 23 September. Starting from outbreaks in Gujarat and Rajasthan, in three months cattle in 15 states across India were affected. On 21 September, out of 18,50,000 cases over 65% of cases were from Rajasthan. Over 50,000 deaths were reported from Rajasthan. India's cattle population according to the last livestock census was 192.5 million.[6]

HISTORY

Since the first observation of the disease in Zambia in 1929, LSD has spread progressively and extensively throughout Africa, the Middle East, Southeastern Europe, Central Asia, and more recently South Asia and China. Currently, the disease is endemic in several countries across Africa, parts of the Middle East (Iraq, Saudi Arabia, Syrian Arab Republic), and Turkey. July 2019 marked the first known introduction of LSD into South Asia, with Bangladesh officially reporting an outbreak . In August 2019, the disease appeared in India and western China, in the Xinjiang Uyghur Autonomous Region bordering Kazakhstan. In June 2020 LSD was again observed in China. Outbreak reports from other provinces, namely Fujian (1), Jiangxi (2), Guangdong (1), Anhui (1), Zhejiang (1) and Taiwan Province of China (34) followed, indicating the continued and widespread presence of the disease. This is supported by announcements on designation of control zones and implementation of LSD control measures also in Guangxi Autonomous Region and Yunnan Province . Although not yet officially reported to OIE, according to media reports LSD has spread to the southern part of India since January 2020.[7]

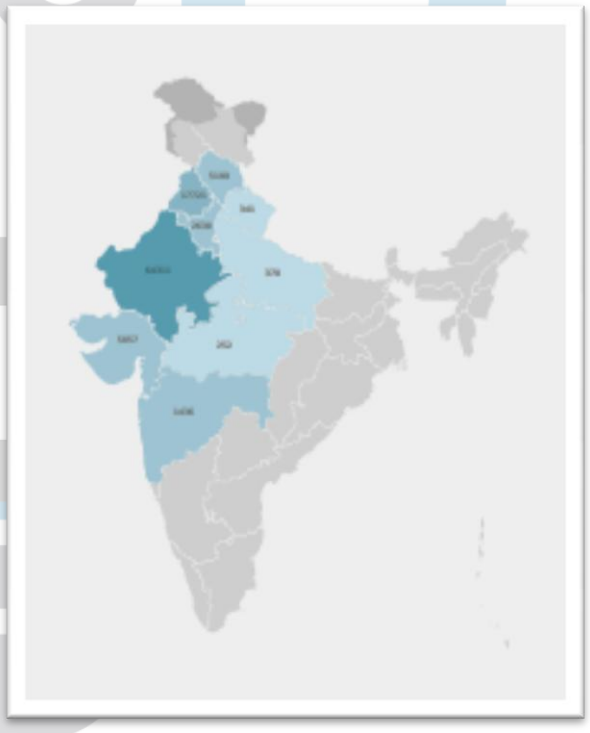
Outbreaks in India

In November 2019 lumpy skin disease in the country was confirmed in a lab. It was mainly restricted to sporadic cases in locations such as Odisha. The origin or source of the disease in India, as well as the outbreak in 2022 remained unknown. A comparison and analysis of the 2022 outbreak with the 2019 version found differences in the disease. States such as Kerala reported 30-40 cases each between December 2019 and January 2021. In August 2020 cases were reported from Assam.

Cases were first reported in April 2022 from Gujarat. In late July 2022 Gujarat introduced bans on cattle movement in select districts. Maharashtra's first case was reported on August 4 in Jalgaon district. On 6 August Rajasthan imposed restrictions on cattle fairs. On 20 August Panchkula district banned inter-district transport. On 24 August Uttar Pradesh started introducing restrictions. Affected districts in Madhya Pradesh saw movement bans. On 14 September cattle transport in Mumbai was banned; health certification is needed for movement. On 23 September Uttar Pradesh initiated more bans in movement of cattle. States such as Chhattisgarh initiated preventive measures even while it reported no cases of the disease. Delhi started free vaccinations on 26 September.[8]

Table no.1- LSD Outbreak 2022 [8]

2022 lumpy skin disease outbreak in India	
Date	July-September 2022
Location	India, 15 states 251 districts (as on 23 Sept)
Deaths	97,000+ cattle (as on 23 Sept)
Affected	20,00,000 cattle (as on 23 Sept)
Cattle vaccinated	1.66 crore (by 23 Sept)
Cattle population	192.5 million (2019)



Five states with the most cattle deaths- Rajasthan, Punjab, Gujarat, Himachal Pradesh, Haryana. Other states such as Madhya Pradesh reported its first death in mid-September 2022; there have been 1436 deaths in Maharashtra. UP has seen at least 378 deaths.[8]

Economic importance

The world organization for animal health (OIE) categorizes LSD as a notifiable disease due to its economic impact. LSD has been considered an agro-terrorism agent due to its ability to spread from Africa to other parts of the world. The economic implications of the disease are high due to morbidity rather than mortality, as the mortality rate is usually low. Lumpy skin disease has led to serious economic losses in affected countries. The disease causes a considerable reduction in milk yield (from 10% to 85%) due to high fever and secondary mastitis. Other consequences of the disease include damaged hides, decline of the growth rate in beef cattle, temporary or permanent infertility, abortion, treatment and vaccination costs and death of infected animal. The total cost of the LSD outbreaks in 393 surveyed herds was 822 940.7 GBP in Turkey. In Ethiopia, the estimated financial loss was 6.43 USD

and 58 USD per head for local zebu and Holstein Friesian, respectively. Total production losses resulting from the disease have been estimated at 45%–65% in industrial cattle farming. The causative agent, Capri poxvirus, can induce sheeppox and goatpox as well, and these diseases have economic significance, given that they present a major hindrance to international trade and may be abused as an economic bioterrorism agent. [9]

Aetiology

Lumpy skin disease virus (LSDV) causing Lumpy skin disease belongs to Poxviridae family that contains group of viruses causing diseases in most of the domestic animals except dog. The family contains two subfamilies: Chordopoxvirinae, infecting vertebrate host and Entomopoxvirinae infecting invertebrate hosts. The Chordopoxvirinae subfamily comprises 10 genera including Capripoxvirus genus. This genus contains viruses of three species, sheeppox virus (SPPV), goatpox virus (GTPV) and lumpy skin disease virus (LSDV) infecting sheep, goat and cattle, respectively . LSDV is a brick shaped enveloped virus, 320 × 260 nm size, with double stranded DNA have complex symmetry and replicates in cytoplasm of the host cell. The LSDV genome is 151 kbp large, consists of a central coding region surrounded by identical 2.4 kbp-inverted terminal repeats and contains 156 putative genes. LSDV contains 30 structural and non-structural genes homologous to sheeppox and goatpox virus sharing 97% nucleotide identity . Gene loss limits the host range of poxviruses in subsequent evolution and same pattern has been observed within Capripoxviruses when comparing SPPV, GTPV and LSDV. The terminal regions of LSDV virus encodes nine genes including IL-1 receptor, vaccinia virus F11L, N2L, K7 L genes, myxoma virus M003.2 and M004.1, LSDV unique gene LSDV132 with likely virulence and host range functions disrupted by accumulated mutations both in SPPV and GTPV. [3]

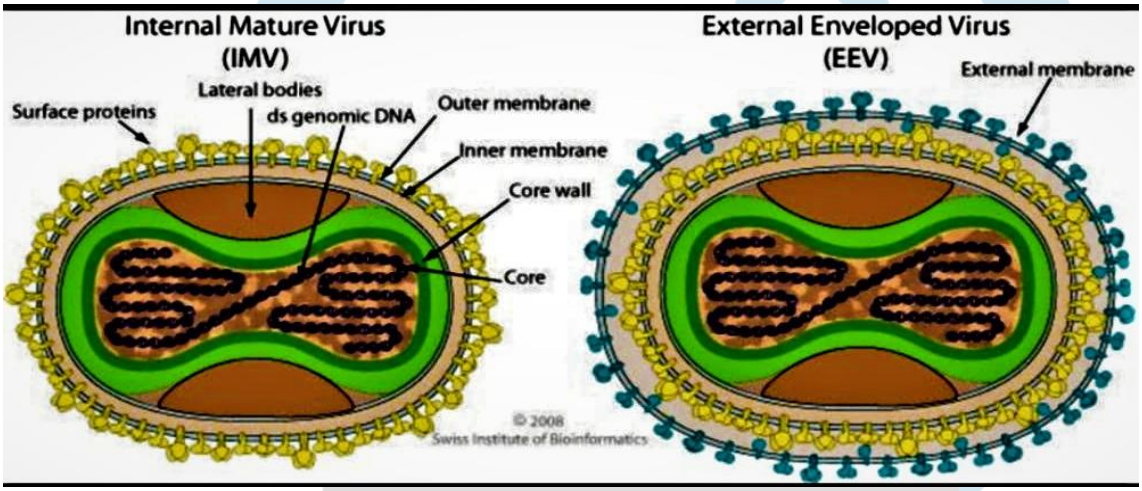


Fig.1: Morphology of LSDV [10]

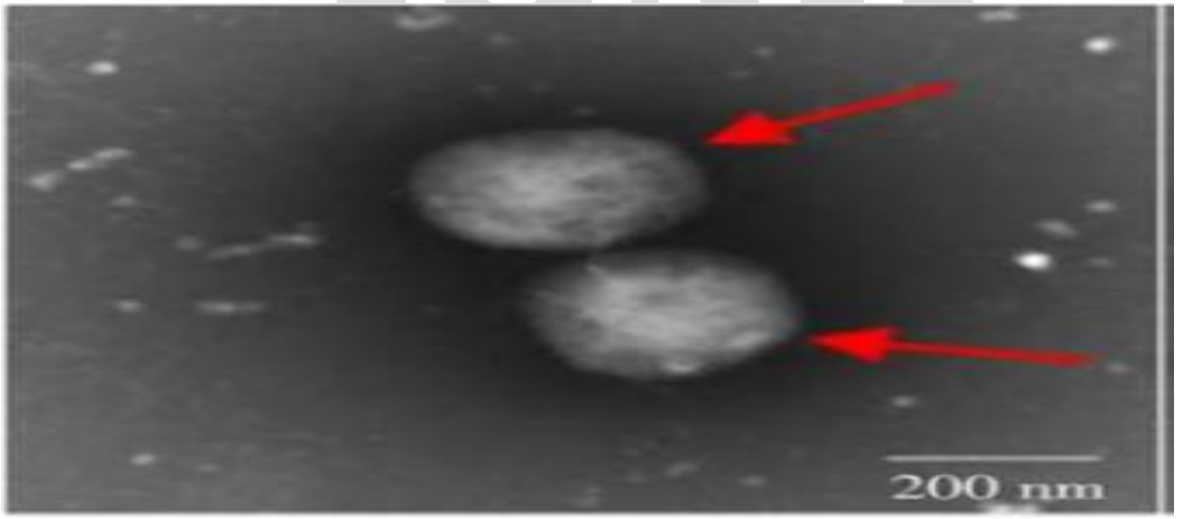


Fig. 2a: Visualization of negatively stained LSDV by electron microscopy [10]

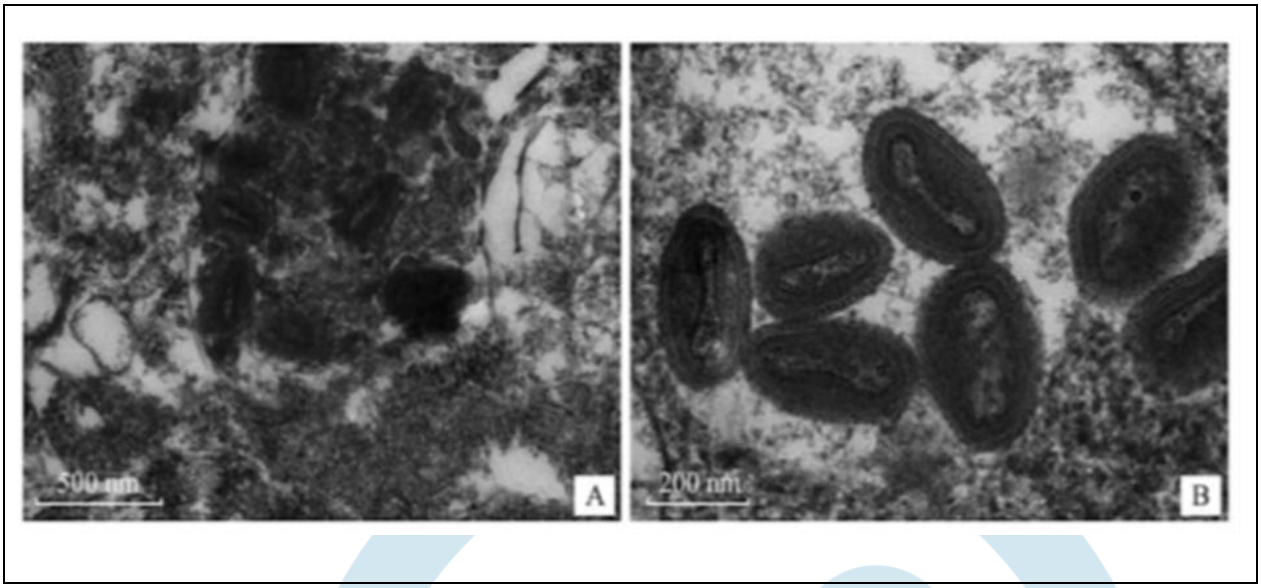


Fig. 2b: Transmission Electron microscope observation of LSDV [10]

Stability of virus

Although these three viruses are distinct, they cannot be differentiated with routine serological tests . LSDV is susceptible to 55°C/2 hours and 65°C/30 minutes. It can be recovered from skin nodules and kept at –80 °C for 10 years. The infected tissue culture fluid can be stored at 4°C for 6 months. The virus is susceptible to highly alkaline or acid pH. However, there is no significant reduction in titre when held at pH 6.6–8.6 for 5 days at 37°C. LSDV is susceptible to ether (20%), chloroform, formalin (1%), and some detergents, e.g. sodium dodecyl sulphate. In addition, it is also susceptible to phenol (2% /15 minutes), sodium hypochlorite (2–3%), iodine compounds (1:33 dilution), Virkon® (2%) and quarternary ammonium compounds (0.5%). LSDV has remarkably stable, surviving for long periods at ambient temperature, especially in dried scabs. LSDV is very resistant to inactivation. It is surviving 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. Meanwhile, the virus is susceptible to sunlight and detergents containing lipid solvents, while, in dark environmental conditions, such as contaminated animal sheds, it can persist for many months. [11]

Morbidity and mortality

There have been no reports on the incubation period of LSDV infection under field conditions. Although the morbidity rate varies between 5% and 45% (sometimes up to 100%), the mortality rate is usually under 10% (sometimes up to 40%). For instance, the morbidity and mortality rates of outbreaks were reported as 8.7% and 0.4%, respectively, in Greece and 12.3% and 6.4%, in Turkey. The severity of the clinical disease is often influenced by the animal's age, breed, immune status and production period. [12]

Transmission

Since the first occurrence of LSD in 1929 in Zambia, the disease spread to various countries of Africa in the following 50 years. Currently, the disease is endemic in Africa and has spread to various Asian and European countries. The transmission of LSDV generally occurs through vectors (insects and ticks) but sometimes it also occurs through direct/indirect contacts with infected animal . Experimental works and field observations have shown the possible transmission of LSDV via direct contact but the rates of transmission were considered low.[13]

Vector transmission

The virus can be transmitted through contaminated mouth parts of vectors without real replication of the virus inside arthropod cells or tissues. The common vectors involved in LSDV transmission include a stable fly (Stomoxys calcitrans), biting midge (Culicoides punctatus), Aedes aegypti mosquito, and, African tick species of Rhipicephalus and Amblyomma spp. A recent study demonstrated Stomoxys calcitrans as the most efficient vector for LSDV transmission, where Aedes aegypti was found as an efficient vector, but Culicoides nubeculosus, Anopheles stephensi, and Culex quinquefasciatus were inefficient for LSDV transmission. The study also showed that both Stomoxys calcitrans and Haematopota spp. can support mechanical transmission of LSDV and reported the failure of LSDV transmission by Culicoides nubeculosus. [13] [14]

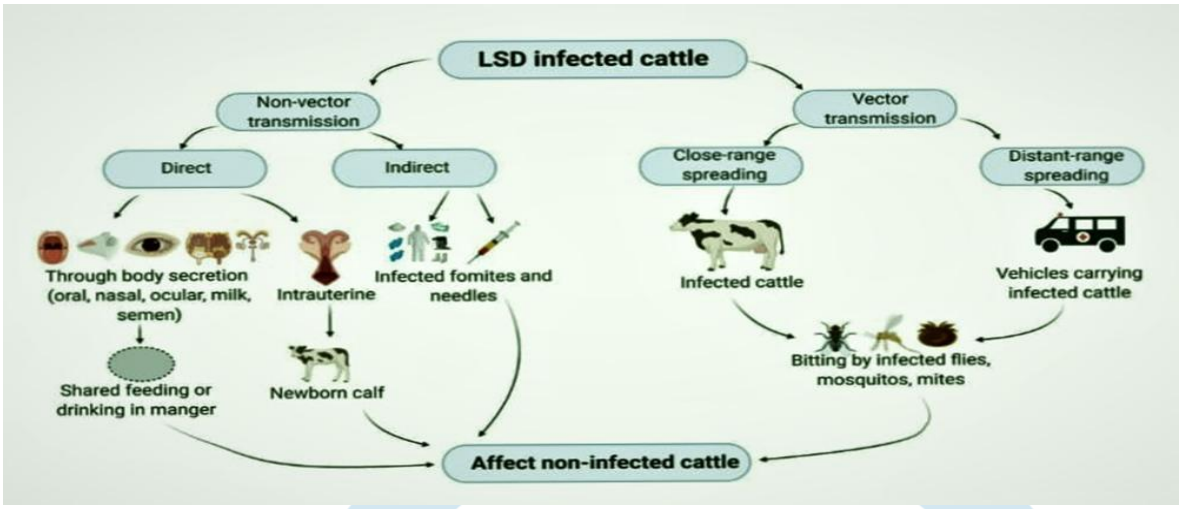


Figure 3. Epitome of possible modes of transmission of LSDV. LSD infected cattle may affect non-infected cattle through vector or non-vector transmission. [15]

Non-vector transmission

Although ineffective, non-vectored LSD transmission happens when clinically afflicted animals come into contact with contaminated materials, without the need of biological or mechanical vectors. Infectious LSDV is excreted in saliva, nasal and ocular discharges, contaminating communal eating and drinking areas and spreading the disease. Transmission through contaminated needles during vaccination, dispersion through infected semen during coitus, ingestion of milk, and intrauterine transmission may also act as a sources of infection. [15]

Host range

Lumpy skin disease is not zoonotic. The disease primarily affects cattle, both Bos taurus and Bos indicus cattle breeds are susceptible. Thin-skinned, high-producing B. taurus bovines are generally more severely affected than the zebu-type or cross-bred cattle. LSDV affects domestic buffaloes but this species seems to show limited susceptibility to LSD. Isolation of LSDV from skin lesions of Asian water buffalo (Bubalus bubalis) in Egypt has been described. Experimental inoculation of impala (Aepyceros melampus), Thomsons gazelle (Gazella thomsonii) and the giraffe (Giraffa camelopardalis) was followed by the development of LSD lesions in the skin. Laboratory animals such as rabbits, guinea pigs and mice are refractory to infection with LSD. The susceptibility of wild ruminants or their possible role in the epidemiology of LSD is not known. Lumpy skin disease does not affect humans. [16]

Clinical signs and lesions

The incubation period of disease in natural condition is between 2 and 5 weeks but in experimental condition, the duration ranges from 7 to 14 days. The LSD takes three forms: acute, subacute and chronic form. The illness begins with biphasic fever. The clinical manifestations in mild form of infection appears as one or two lumps of nodules within 2 to 3 days of onset of fever, emaciation, ocular discharge, agalactia. Later on, nodular lesions, which are painful and hyperemic may be observed on the animal body especially in the skin of the muzzle, nares, back, legs, scrotum, perineum, eyelids, lower ear, nasal and oral mucosa, and tail. In severe condition, more than hundred nodules developed on skin all over the body and this stage persist for 7 to 12 days. The nodules are firm and slightly raised from surrounding skin, separated by narrow haemorrhagic ring. The nodules involve dermis, epidermis, adjacent subcutis and musculature. The lesions then progress towards papules, vesicles, pustule with exudation and then slowly to scab formation. Healing of the lesions is very slow. With time lesions develop on mucous membranes of nostrils, respiratory tract, mouth and vulva. After 2-3 weeks, the cutaneous lesions become harder and necrotic causing discomfort to animals and they become reluctant to move. The sloughing of the lesions may create hole form “sitfast”, the characteristic lesion, which subsequently cause invasion by screwworm fly and bacterial invasion that can further lead to septicaemia. The generalized lymph node swelling also observed in infected animals. In histopathology, lesion of lumpy skin disease show ballooning degeneration of epithelial cells, presence of eosinophilic intracytoplasmic inclusions bodies. The sequela of LSD is pneumonia due to the inhalation of necrotic material by the animal itself. Abortion occurs in acute phase of infection. The infertility is another sequela of the disease in both male and female. Female remains in anoestrus for long time. Infected bulls with lesions on genital region also remain infertile for months. Recovery is very slow due to secondary bacterial infection, pneumonia, mastitis and fly strike in necrotic lesions leaving deep holes in the body.[3]

Fig. no 5- Clinical sign of LSD[18]

Diagnosis of LSD *[19]*

LSD is frequently diagnosed in the field based on the disease's typical clinical characteristics. LSD should be considered clinically when there are distinctive skin nodules, fever, and enlargement of superficial lymph nodes. Thus, the differential diagnosis of LSD is mainly based on distinctive clinical indications. Milder and subclinical forms, on the other hand, need fast and dependable laboratory testing to confirm the diagnosis. Detecting viral DNA using conventional or real-time polymerase chain reaction (PCR) is the most often utilized way of diagnosing LSD. Other different molecular assays are also favored diagnostic methods or serology-based diagnostic tests that identify antibodies to the LSD virus.

Virus isolation

Virus isolation is critical in the confirmation of clinical disease and determination of the isolate. This is the method used in the samples to test the virus's viability. To propagate LSDV, a number of primary cells or cell lines of bovine, ovine, or caprine origin are utilized. The virus may also grow on the chorioallantoic membrane of embryonated chicken eggs and African green monkey kidney (Vero) cells. It grows slowly in cell cultures, and the cytopathic effect (CPE) is generally detectable five to seven days after inoculation. LSDV induces a specific cytopathic effect (CPE) and intracytoplasmic inclusion bodies in cell culture, which differs from infection with Bovine herpesvirus 2, which causes pseudo-lumpy skin disease and causes syncytia and intranuclear inclusion bodies in cell culture.

Molecular detection methods

Molecular diagnostic testing is critical for monitoring the spread of these viruses and controlling disease outbreaks. LSD virus confirmation in the laboratory may be done quickly utilizing a Capripoxvirus-specific PCR approach or by demonstrating characteristic Capripoxvirions in biopsy material or dried crusts using tmissransion electron microscopy (TEM). The genome has been detected utilizing Capripoxvirus-specific primers for the attachment protein and fusion protein genes, and multiple conventional and real-time PCR technologies have been developed for use on blood, tissue, and sperm materials. For Capripoxvirus, the real-time PCR approach using primers and a probe was verified. Molecular assays employing loop-mediated isothermal amplification to identify Capripoxvirus genomes have been shown to have sensitivity and specificity comparable to real-time PCR, with a simpler approach and a cheaper cost.

Serological tests

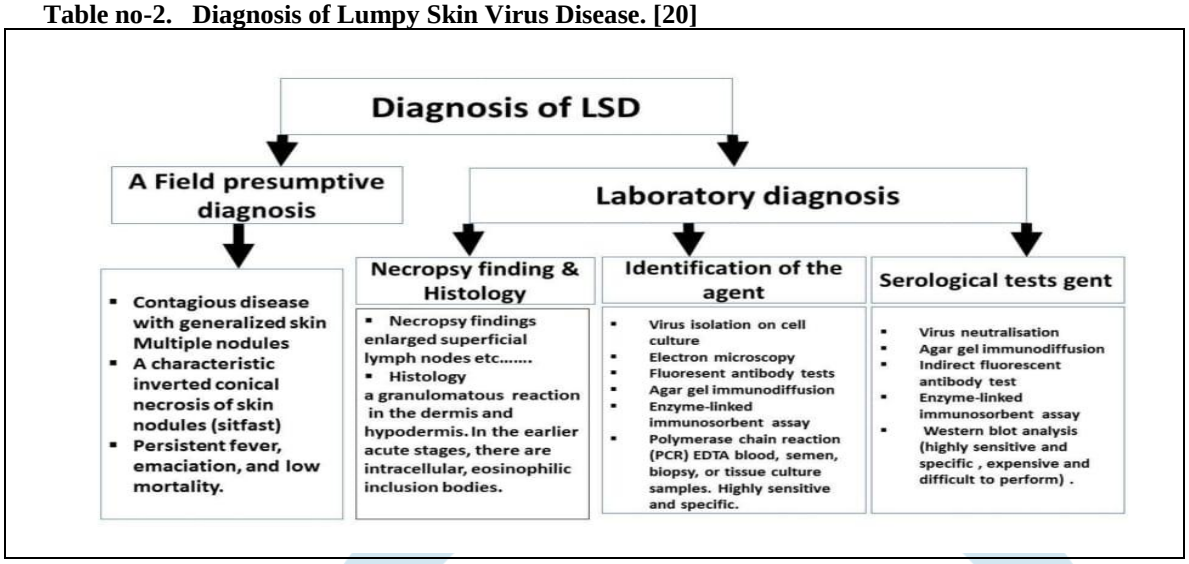
Serological assays for LSDV include the indirect fluorescent antibody test (IFAT), viral neutralization, enzyme-linked immunosorbent assays (ELISA), and immunological blotting (Western blotting). The only serologically approved test available is the Virus neutralization test (VNT). Neutralizing antibodies occur 3-4 days after the onset of clinical symptoms and reach maximal titer levels in 2-3 weeks. The agar gel immune diffusion test (AGID) and IFAT are less specific than VNT due to cross-reactivity with antibodies to other poxviruses. Western blotting is sensitive and specific, but it is difficult and expensive to perform. Some ELISAs for antibody detection have been identified, but none have been verified sufficiently to advise for use.

Differential diagnosis

The main differential diagnosis is pseudo-LSD induced by bovine herpesvirus 2 (BoHV2). Pseudo-lumpy skin disease (caused by herpes virus-2) cutaneous lesions involve only the epidermis and produce a scab after sloughing; systemic symptoms do not occur. This is usually a milder clinical disease with superficial nodules that resemble only the early stages of LSD. Histopathological features of BoHV-2 infection that are not found in LSD include intra-nuclear inclusion bodies and viral syncytia.

Other differential diagnoses include photosensitization, dermatophilosis, dermatophytosis, bovine farcy, actinobacilosis, actinomycosis, urticaria, insect bites, nocardiasis, besnoitiosis, demodicosis, onchocerciasis, cowpox, and pseudo-cowpox (for integumentary lesions). Bluetongue, foot and mouth illness, malignant catarrhal fever, bovine viral diarrhea, bovine popular stomatitis, and infectious bovine rhinotracheitis are all possible diagnoses for mucosal lesions.

Table no-2. Diagnosis of Lumpy Skin Virus Disease. [20]



Treatment [21]

1. Antiviral treatment with methylene blue.
2. Use of non-steroidal anti-inflammatory drugs to treat inflammatory diseases.
3. Use of paracetamol for high fever.
4. Prescribing antibiotics to control secondary infections.
5. Vaccination.

***How does Methylene Blue help in Lumpy*?**

Methylene Blue (MB) is a broad-spectrum antiviral agent and its anti-viral properties are well-known against a wide variety of viruses. Methylene Blue was recently also proven highly-effective in reducing the viral load of SARS-COV2.

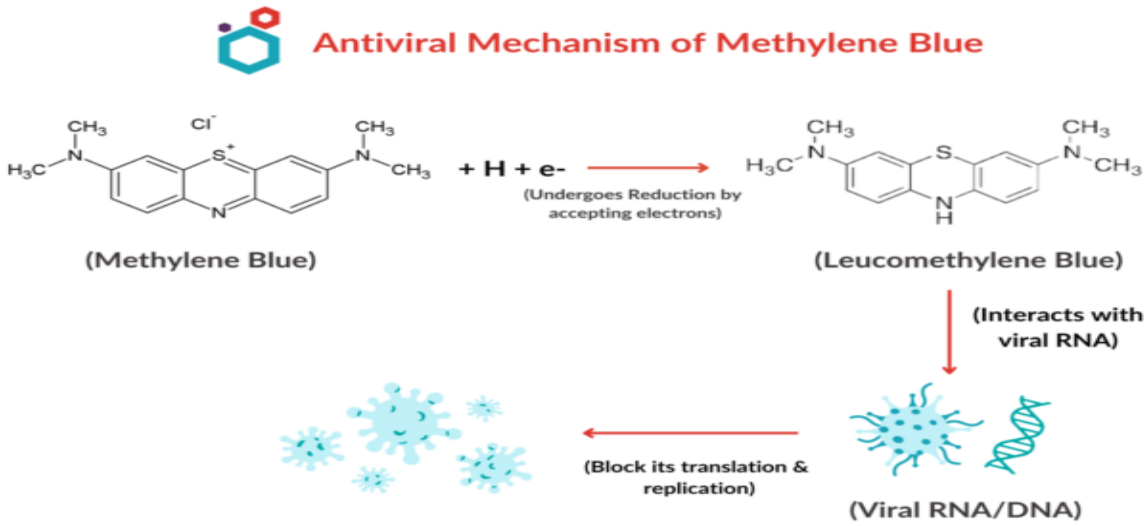
MB will help in the treatment of Lumpy Skin disease by reducing the viral load in the infected cattle, through its multi-mechanism antiviral action till the body triggers natural immune-response and thus helps in preventing any damaging excessive immune-response, protecting from further complications like multiple organ damage.

It helps in faster recovery (reduces recovery time span) and decreases the mortality rate.

Mechanism of action of Methylene Blue as an antiviral agent

Methylene Blue has broad-spectrum virucidal action in the presence and absence of light and has been demonstrated to be effective at inactivating a variety of viruses. The antiviral activity appears to rely on various pathways and is more effective against enveloped viruses (as in case for viruses belonging to the family of Poxviridae).

MB is known to corrupt DNA or RNA integrity due to a redox reaction in which the molecule accepts electrons on its aromatic thiazine ring, thus being reduced to leuko-methylene blue (MBH2) which in turn transfers electrons to other molecules such as nucleic acids.



In addition, MB in combination with oxygen and a source of energy produces singlet oxygen, a highly reactive reaction partner that triggers guanine oxidation (8-oxo-7,8-dihydroguanine (8-oxoGua) lesions) that damages DNA or RNA.

Other pathways responsible for nucleic acid damage include-

1. Modifying carbonyl moieties on viral proteins

2. Single-strand breaks (ssb) in the RNA genome of the virus
3. RNA-protein crosslinking

How is methylene blue treatment administered to Lumpy infected cattle? [22]

As per the document (D.O No. K-11053/69/2019-LH) released by the Government of India, Ministry of Fisheries, Animal Husbandry & Dairying, treatment by Methylene Blue (MB) may be administered as follows:-

Oral treatment with 0.1 % Methylene Blue (MB) solution (1 gram of Methylene Blue USP powder in 1 Litre of water) may be considered by the veterinarian, with dosage as follows:

Adult cows (of approximately 350 kg body weight): 300 ml at 8 hourly intervals (thrice in a day) for 4 days.

Calf: give approx. half dose.

MB solution/Preparations may also be used topically (eg. by spray).

Precaution: A milk withholding interval of 96 hours and a meat withdrawal interval of 14 days (if used in meat producing animals) is advised.

Safe dosage– upto 10mg per kg body weight/day

CAUTION: Methylene Blue dye or lab reagent should not be considered to be same/equivalent to the "Pharmaceutical Methylene Blue USP" and should not be used as an alternative to "Methylene Blue USP" for treatment.

Why is Methylene Blue treatment considered safe? [23]

- Methylene Blue being a very old drug having a well-established toxicology and safety profile.
- While Methylene Blue has been a part of the World Health Organisation (WHO) Model List of Essential Medicines for a long time, India also has recently included Methylene Blue in its National list of essential medicines, released as on 13 September 2022.
- Methylene blue is an FDA (food and drug administration) and EMA (european medicines agency) approved drug with an excellent safety profile.
- Due to its antimicrobial, anti-inflammatory and antitoxic effects, MB is also used for a wide range of applications including treatment of methemoglobinemia or malaria**.**

Control and Prevention [24]

Further, following preventive measures as well as isolation of the affected animal should be implemented immediately, to prevent future LSD Incidences.

a) Control of animal movement - In order to minimize the economic impact of the outbreaks and to control LSD, the movement of animals to and from the infected area and from affected states should be completely banned. This will check the transmission/spread of LSD.

b) Restriction with affected animals and persons dealing with such animals - Movement of people to and from the affected area should be restricted. The animal handlers and those attending to the affected animals should be advised to keep away from healthy animals.

c) Vaccination: The infected villages be identified so that precautionary plans are carried out in a specific area and ring vaccination carried out in villages upto 5 km around the affected village. Cattle and buffaloes should be vaccinated with available Goat pox vaccine (cattle and buffalo at the age of 4 months and above through S/C route) with 10 3.5 TCID50 of GTPV vaccine (Uttarkashi strain). However, affected animals should not be vaccinated.

Lumpi-ProVacInd[25]

It is a live attenuated vaccine for cattle, made by two institutes of Indian Council of Agricultural Research for prevention of Lumpy skin disease outbreak in India. It is planned for commercial launch in early 2023. It was launched by Prime Minister Narendra Modi and Agriculture Minister Narendra Singh Tomar. Studies concluded that it is 100 percent effective for the prevention of the disease, which complies with all government vaccine standards. It is similar to the vaccines for tuberculosis and rubella.

d) Bio-security measures:

- Immediate isolation of sick animal from the healthy animals. Symptomatic treatment of affected animals may be carried out with all precautions and biosecurity measures. Feeding of liquid feed, soft feed and fodder is recommended.
- Clinical surveillance against LSD in affected districts and around surrounding villages should be intensified.
- The buffaloes should be kept separately till complete recovery of the affected animals, if reared together.
- Dis-infection of premises at regular intervals.
- Ecto-parasiticide should also be applied to healthy animals on the infected and on surrounding farms.
- The persons dealing with the infected animal should wear gloves and face mask and carry out hygenic and disinfection measures at all time.
- Care should be taken to report any unusual sickness of other animals to nearest veterinary Hospital/Dispensary.
- Hygiene practices should be followed at the animal farm and by the people in area where animals are infected.
- Farms with affected animals should be visited regularly by the field veterinarians until all the cases are recovered. The veterinary staff should take all precautionary hygiene measures to avoid further spread of disease to other farms/households.
- In case of mortality, carcass should be disposed of by deep burial method observing all hygienic measures.
- Cattle markets located within 10 km radius of the epicentre of infection should be closed.

- Trade of live cattle, participation in fairs, shows should be banned immediately upon confirmation of the disease in the affected areas.
- Semen from LSD affected animals should not be collected and processed for production and distribution.

e) Vector control: Control of vector population (ticks, flies, mosquitoes, fleas, midges) in the premises and the animal body should be carried out using the insecticide, repellents and other chemical agents.
f) Disinfection and cleaning measures: Affected Premises, vehicles plying through the affected animal holdings should be carried out with appropriate chemicals / disinfectants [Ether (20%), chloroform, formalin (1%), phenol (2% /15 minutes), sodium hypochlorite (2- 3%), iodine compounds (1:33 dilution) and quaternary ammonium compounds (0.5%)].
g) Awareness programme: Mass awareness campaign to be taken up to make the public aware of the disease and report to the veterinary authority immediately when suspected cases are detected. This will help in prevention and control of LSD.
h) Regular training and sensitization of veterinarians including awareness to animal owners and other stake holders should be enhanced on clinical presentation of the disease along with surveillance strategy and control measures.
i) Animal Husbandry Department should maintain proper liaison with police and border agencies to check illegal entries of cattle from neighbouring countries (Wherever required).

CONCLUSION

The recent spread of the disease into disease-free areas indicates its epidemiological and economic significance. Considering the extensive boundaries of Middle East countries, animal movements among these countries should be attentively controlled by veterinary authorities. Furthermore, paying close attention to the different aspects of the disease, such as transmission and epidemiology, and the implementation of effective preventive measures such as vaccination, could result in better disease control. Therefore, accurate and timely diagnosis in endemic areas, vaccination with the homologous strain of the LSDV, vector control, animal movement restriction and LSDV testing of bulls used for breeding are highly recommended as tools to control further spread.

ABBREVIATION

AGID - Agar gel immune diffusion test
CPE - Cytopathic Effect
DNA – Doxy-ribonucleic acid
ELISA - Enzyme-linked immunosorbent assays
EMA - European Medicines Agency
FDA – Food and Drug Administration
GTPV - Goatpox virus
IFAT - Indirect Fluorescent Antibody Test
LSD - Lumpy skin disease
LSDV - Lumpy skin disease virus
MB - Methylene Blue
OIE - The World Organization for Animal Health (Office International des Epizooties)
PCR – Polymerase Chain Reaction
RNA – Ribonucleic acid
SPPV - Shippox virus
S\C – Subcutaneous
TEM - Tmissransion electron microscopy
USP – United State Pharmacopoeia
VNT - Virus neutralization test
WHO - World Health Organisation

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