



Lumpy Skin Disease in Dairy Cattle: Clinical Presentation, Diagnosis, and Therapeutic Management

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Lumpy Skin Disease (LSD) is a highly significant viral disease of cattle and buffaloes that has emerged as one of the most economically devastating transboundary animal diseases affecting the dairy industry worldwide. The disease is caused by the Lumpy Skin Disease Virus (LSDV), a member of the genus *Capripoxvirus* within the family *Poxviridae*. Characterized by fever, generalized skin nodules, lymphadenopathy, edema, decreased milk production, infertility, and occasionally death, LSD has spread rapidly from Africa to the Middle East, Europe, and Asia, including India. The disease primarily spreads through blood-feeding arthropods, although direct and indirect transmission may also occur. Outbreaks result in substantial economic losses due to reduced productivity, treatment costs, trade restrictions, infertility, hide damage, and mortality. Clinical diagnosis is often based on characteristic skin lesions; however, laboratory confirmation using molecular and serological techniques remains essential, particularly during the early stages or atypical presentations. There is currently no specific antiviral treatment, and therapeutic management relies mainly on supportive care, prevention of secondary bacterial infections, wound management, anti-inflammatory therapy, nutritional support, and strict biosecurity measures. Vaccination remains the most effective preventive strategy. This review discusses the epidemiology, etiology, pathogenesis, clinical manifestations, diagnostic approaches, therapeutic management, prevention, and future perspectives of LSD in dairy cattle.

Introduction

Lumpy Skin Disease (LSD) has become one of the most important emerging infectious diseases affecting cattle globally. Originally confined to sub-Saharan Africa, the disease has expanded dramatically over the past two decades into the Middle East, southeastern Europe, Russia, Central Asia, China, and the Indian subcontinent. The rapid geographical expansion of LSD has raised considerable concern among veterinarians, epidemiologists, livestock producers, and policymakers because of its devastating effects on dairy production, animal welfare, and international livestock trade. LSD is caused by the Lumpy Skin Disease Virus (LSDV), a large enveloped double-stranded DNA virus belonging to the genus *Capripoxvirus*. The virus shares close genetic and antigenic relationships with sheep pox virus and goat pox virus, allowing cross-protection between these viruses through

vaccination. Unlike many viral diseases, LSD primarily affects cattle and water buffaloes, while sheep and goats generally remain resistant under natural conditions. The disease is characterized by fever followed by the sudden appearance of firm, circumscribed nodules involving the skin, subcutaneous tissues, mucous membranes, and occasionally internal organs. These lesions often become necrotic, ulcerated, and secondarily infected, leading to prolonged recovery. Dairy cattle experience severe declines in milk yield, poor reproductive performance, weight loss, hide damage, and increased susceptibility to opportunistic infections. The emergence of LSD in India has transformed the disease into a major national livestock health concern. Large outbreaks have caused significant mortality among indigenous and crossbred dairy cattle, affecting millions of farmers. Besides direct production losses, restrictions on animal movement and trade further aggravate economic damage. Recent advances in molecular diagnostics, epidemiological surveillance, vaccine development, and vector control have improved disease management. Nevertheless, challenges remain due to vector abundance, climatic changes, incomplete vaccination coverage, and limited availability of effective antiviral therapies.

Etiology

LSD is caused by the Lumpy Skin Disease Virus (LSDV), a member of the genus *Capripoxvirus* in the family *Poxviridae*. The virus possesses a large linear double-stranded DNA genome of approximately 151 kilobase pairs encoding more than 150 proteins responsible for viral replication, immune evasion, and virulence. The virus demonstrates remarkable environmental stability. It survives for several weeks within dried skin scabs, necrotic tissue, and contaminated animal housing. The virus remains viable under cool conditions but is readily inactivated by sunlight, high temperatures, lipid solvents, and common disinfectants such as sodium hypochlorite, formaldehyde, phenolic compounds, and iodine preparations. Genetic studies indicate that LSDV evolves relatively slowly compared with RNA viruses because of its DNA genome, although recent recombination events among vaccine and field strains have been documented.

Epidemiology

LSD affects cattle of all ages, breeds, and production systems. *Bos taurus* breeds generally exhibit more severe disease than *Bos indicus* cattle, possibly due to differences in innate resistance. Lactating dairy cows, high-producing animals, pregnant females, and immunocompromised cattle are particularly susceptible. Transmission occurs predominantly through hematophagous arthropods including mosquitoes, biting flies, stable flies, horseflies, and ticks. Mechanical transmission by insects is considered the principal mode of disease spread during outbreaks.

Additional routes include:

- Direct contact with infected animals
- Contaminated feed and water
- Semen from infected bulls
- Shared needles and veterinary equipment
- Nasal, ocular, saliva, and milk secretions

Environmental conditions favoring vector proliferation, including heavy rainfall, flooding, and warm temperatures, substantially increase outbreak risk.

Pathogenesis

Following inoculation through insect bites or contaminated skin wounds, the virus initially replicates in local macrophages, dendritic cells, and endothelial cells before spreading to regional lymph nodes. Primary viremia develops within several days, disseminating virus throughout the body.

The virus exhibits marked tropism for:

- Skin
- Lymph nodes

- Blood vessels
- Mucous membranes
- Testes
- Mammary gland
- Respiratory tract

Replication within vascular endothelial cells causes vasculitis, thrombosis, ischemia, edema, and tissue necrosis. The characteristic skin nodules represent focal areas of inflammation involving the epidermis, dermis, subcutaneous tissue, and underlying musculature. Secondary bacterial invasion frequently complicates lesions, prolonging healing and increasing economic losses.

Clinical Presentation

The incubation period ranges from 4–14 days, although longer incubation periods have occasionally been reported.

General Clinical Signs

Early disease is characterized by:

- High fever (40–41.5°C)
- Depression
- Anorexia
- Lacrimation
- Nasal discharge
- Salivation
- Enlarged superficial lymph nodes
- Marked reduction in milk yield

Cutaneous Lesions

The hallmark of LSD is the appearance of numerous firm, round nodules measuring 1–7 cm in diameter distributed over:

- Neck
- Head
- Limbs
- Udder
- Perineum
- Tail
- Genital region
- Muzzle

The nodules extend deeply into the dermis and subcutaneous tissues and may become necrotic, ulcerated, or slough off, producing characteristic "sit-fast" lesions.

Reproductive Manifestations

Affected bulls may develop:

- Orchitis
- Epididymitis
- Reduced semen quality
- Temporary or permanent infertility

Cows may experience:

- Abortion
- Temporary infertility
- Delayed estrus
- Reduced conception rates

Ocular Manifestations

Severe cases may exhibit:

- Conjunctivitis

- Corneal opacity
- Keratitis
- Blindness

Respiratory Signs

Respiratory involvement includes:

- Pneumonia
- Tracheitis
- Nasal ulceration
- Dyspnea

Musculoskeletal Signs

Some cattle develop:

- Lameness
- Limb edema
- Arthritis
- Myositis
- Reluctance to move

Diagnosis

Clinical diagnosis relies on characteristic skin nodules combined with epidemiological history.

Clinical Examination

Typical findings include:

- Fever
- Generalized nodules
- Enlarged lymph nodes
- Edema
- Reduced milk production

Sample Collection

Samples include:

- Skin biopsies
- Skin scabs
- Whole blood
- Nasal swabs
- Semen
- Milk
- Lymph node aspirates

Molecular Diagnosis

Polymerase Chain Reaction (PCR) is considered the gold standard for laboratory confirmation.

Real-time PCR provides:

- High sensitivity
- High specificity
- Rapid detection
- Viral quantification

PCR can detect viral DNA before antibody production begins.

Virus Isolation

Isolation is performed in:

- Primary bovine cells
- Lamb testis cells
- MDBK cell lines

Although highly specific, virus isolation is laborious and mainly reserved for research laboratories.

Serological Tests

Available assays include:

- Virus Neutralization Test (VNT)
- ELISA
- Indirect Fluorescent Antibody Test

Serology is useful for surveillance and post-vaccination monitoring but cannot reliably distinguish infected from vaccinated animals.

Histopathology

Characteristic microscopic lesions include:

- Ballooning degeneration
- Intracytoplasmic inclusion bodies
- Vasculitis
- Epidermal necrosis
- Dermal edema
- Mononuclear inflammatory infiltration

Differential Diagnosis

Conditions resembling LSD include:

- Pseudo-Lumpy Skin Disease
- Bovine Papillomatosis
- Dermatophilosis
- Ringworm
- Photosensitization
- Insect bite hypersensitivity
- Allergic dermatitis
- Cutaneous tuberculosis

Therapeutic Management

No specific antiviral therapy has been approved for LSD. Treatment is therefore supportive and aims to reduce clinical severity, prevent complications, and enhance recovery.

Supportive Therapy

Management includes:

- Adequate hydration
- Balanced nutrition
- Vitamin supplementation
- Mineral supplementation
- Electrolyte therapy
- Rest

Antimicrobial Therapy

Broad-spectrum antibiotics are administered to prevent or treat secondary bacterial infections associated with ulcerated skin lesions and pneumonia. Antimicrobial selection should be based on veterinary judgment, local resistance patterns, and withdrawal periods for milk and meat.

Anti-inflammatory Therapy

Non-steroidal anti-inflammatory drugs (NSAIDs) help:

- Reduce fever
- Control pain
- Improve appetite
- Decrease inflammation

Wound Management

Skin lesions should receive:

- Daily cleaning
- Antiseptic dressing
- Fly repellents
- Topical antimicrobial preparations where indicated

Fluid Therapy

Severely affected cattle with dehydration require intravenous or oral fluid therapy along with correction of electrolyte imbalances.

Management of Mastitis

Lactating animals require:

- Frequent milking
- Intramammary therapy when bacterial mastitis is confirmed
- Udder hygiene

Nutritional Support

Supplementation with antioxidants such as vitamin E, selenium, zinc, and vitamin C may support immune function and tissue repair.

Control and Prevention

Successful LSD control depends upon integrated disease management.

Major preventive measures include:

- Vaccination
- Vector control
- Movement restrictions
- Isolation of infected animals
- Quarantine of new animals
- Farm biosecurity
- Proper carcass disposal
- Disinfection of contaminated premises
- Surveillance and rapid reporting

Vaccination using homologous live attenuated LSD vaccines provides the highest level of protection and remains the cornerstone of disease prevention in endemic regions.

Economic Impact

LSD causes significant economic losses through:

- Reduced milk production
- Weight loss
- Infertility
- Abortion
- Hide damage
- Treatment costs
- Increased labor expenses
- Mortality
- Trade restrictions
- Reduced market value of animals

The disease disproportionately affects smallholder dairy farmers, where even a modest reduction in milk yield can have major socioeconomic consequences.

Future Perspectives

Future research should prioritize improved vaccine safety and efficacy, development of DIVA (Differentiating Infected from Vaccinated Animals) vaccines, rapid pen-side diagnostics, antiviral drug discovery, genomic surveillance of emerging strains, and

integrated vector management strategies. Advances in precision livestock farming, wearable biosensors, artificial intelligence–assisted disease detection, and geospatial surveillance may facilitate earlier outbreak detection and more effective disease control. Collaborative international surveillance and coordinated vaccination programs will remain essential to limiting the spread of LSD and reducing its impact on the global dairy sector.

Conclusion

Lumpy Skin Disease has emerged as one of the most important viral diseases threatening dairy cattle production worldwide. Its rapid geographical expansion, vector-borne transmission, and profound effects on milk production, reproduction, animal welfare, and trade make it a disease of major veterinary and economic significance. Early recognition of characteristic clinical signs, prompt laboratory confirmation using molecular diagnostics, and timely implementation of supportive treatment can substantially reduce morbidity and limit complications. Although no specific antiviral therapy is currently available, comprehensive supportive care combined with effective control of secondary infections improves clinical outcomes. Long-term control depends on widespread vaccination, stringent biosecurity, vector management, movement control, and continuous surveillance. Continued research into improved vaccines, rapid diagnostics, and integrated disease-management strategies will be essential for mitigating the future impact of Lumpy Skin Disease on the global dairy industry.