

A review on Lumpy Skin Disease

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Abstract: The aim of this paper is to describe the epidemiology, clinical sign, diagnosis, economic significance, control and prevention of lumpy skin disease. Lumpy skin disease is an acute infectious disease of cattle endemic in most Sub-Saharan African countries. It is caused by lumpy skin disease virus in the genus *Capripoxvirus*. It is a disease with a high morbidity and low mortality rate that affects cattle of all ages and breeds. However, *Bostaurus* cattle breeds are more susceptible than *Bosindicus* breeds, and young animals often experience more severe disease than adults. The most important method of transmission is mechanically through biting flies. The incidence of lumpy skin disease is high during wet seasons when biting-fly populations are abundant. The disease is characterized by fever, development of firm, well demarcated nodules on the skin, mucous membranes and internal aspects of the body and enlargement of the local drainage lymph nodes. The diagnosis of lumpy skin disease is based on history, clinical signs and laboratory confirmation. There is no specific treatment for lumpy skin disease, but animals can be treated with antibiotics to prevent secondary infections. Vaccinations, animal movement restriction, quarantine, insect control, slaughter and proper disposal of animals and contaminated material are the basic methods to control lumpy skin disease. The disease has a significant economic importance to cattle industry due to reduction in production, damaged hides and deaths. Therefore, appropriate control and prevention methods should be carried out to overcome the economic loss associated with the disease.

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Key words: Cattle, Lumpy skin disease, lumpy skin disease virus, vaccination.

1. Introduction

Ethiopia is endowed with many livestock species and suitable for livestock production and believed to have the largest livestock population in Africa. The country is a home for about 54 million cattle, 25.5 million sheep and 24.06 million goats [1]. The subsector contributes about 16.5% of the national Gross Domestic Product (GDP) and 35.6% of the agricultural GDP [2]. Despite its large population size, the contributions of livestock production to agriculture and the overall economy of the country are low. This is associated with a number of complex and inter-related factors such as widespread diseases, limited genetic potential and husbandry standard [3]. Lumpy skin disease (LSD) is one of the most economically important livestock diseases in the country [4].

Lumpy skin disease is a serious skin disease of cattle caused by lumpy skin disease virus of the genus in the family Poxviridae [5]. It is currently endemic in most Africa countries and expanded to Middle East region [6]. It is a disease with a high morbidity and low mortality rate and affects cattle of all ages and breeds [7]. It is transmitted by insect vectors among the cattle

sharing similar grazing and watering areas and those congregate in the same barn. The disease is characterized by fever, enlarged lymph nodes, firm, and circumscribed nodules in the skin and ulcerative lesions particularly in the mucous membrane of the mouth [8]. Presumptive diagnosis is based on case history and apparent clinical signs [9] whereas confirmatory diagnosis is based on transmission electron microscopic (TEM), immunoperoxidase (IMP) staining, antigen trapping enzyme-linked immune sorbent assay (ELISA) and a polymerase chain reaction (PCR) test. There is no specific antiviral treatment available for LSD infected cattle. The control of LSD can be achieved through, the implementation of vaccination; strict quarantine measures and slaughter policies are successful in eradicating the disease [10].

In Africa and the Middle East countries, the disease has a significant economic importance to cattle industry due to reduction in milk production, abortion, temporary or permanent sterility, damaged hides and deaths [11,6]. As a transboundary disease, that causes international ban on the trade of livestock and their products [12]. The World Organization for Animal

Health (OIE) categorizes LSD as a notifiable list-A disease because of the substantial economic impact of an outbreak [13].

In Ethiopia lumpy skin disease was first observed in the northwestern part of the country (southwest of Lake Tana) in 1983 [14]. The disease has now spread to almost all regions and agro-ecological zones of the country. Because of the wide distribution of the disease and the size and structure of the cattle population in Ethiopia, it is likely that LSD is one of the most economically important livestock diseases in the country [4]. Reports from Ethiopia indicated that the financial loss estimated based on milk, beef, draught power, mortality, treatment and vaccination costs in individual head of local zebu were lost 6.43 USD and for the Holstein Friesian 58 USD [15]. Having a good understanding on the disease might aid to apply the appropriate prevention and control methods and to enhance the economic benefit from the species of livestock [16].

Therefore, the objectives of this seminar paper are:

- To briefly describe the etiology, epidemiology, pathogenesis and clinical and pathological findings of lumpy skin disease.
- To review the treatment, economic significance, control and prevention of lumpy skin disease.

2. Lumpy Skin Disease

Lumpy skin disease is an acute to chronic viral disease of cattle characterized by fever, nodules on the skin, mucous membranes and internal organs, emaciation, enlarged lymph nodes, oedema of the skin, and sometimes death [17]. It is one of the most economically significant transboundary, emerging viral diseases and currently endemic in most Africa countries and expanded to Middle East region [6].

2.1 Etiology

The causative agent of lumpy skin disease is lumpy skin disease virus of the genus *Capripoxvirus*, in the family Poxviridae. LSDV is a double-stranded DNA virus. There is only one serotype of LSDV, Neethling strain [18, 17]. The lumpy skin disease virus is antigenically and serologically indistinguishable from the virus of sheep pox and goat pox but distinct at the genetic level [19].

The virion of lumpy skin disease is enveloped, brick-shaped, 300×270×200nm [20]. All *Capripoxviruses* grow slowly on cell cultures and may require several passages. This virus can also grow in tissue culture of bovine, ovine or caprine origin [9]. They can be propagated on a variety of cells of bovine and ovine origin, causing easily recognizable cytopathic effects (CPE). The virus can be propagated in the chorioallantoic membranes of embryonated

chicken eggs, causing macroscopic pock lesions. The replication of LSDV occurs in the cytoplasm of the host cell in intracytoplasmic eosinophilic inclusion bodies. *Lumpy skin disease virus* is generally resistant to drying, and survives freezing and thawing [21].

2.2 Epidemiology

Lumpy skin disease is an economically devastating, notifiable disease, which brought production loss in cattle due to generalized malaises and chronic debility (Tuppurainen and Oura, 2011). Good understanding of epidemiological aspects LSD related to pathogen, host and environment might aid for prevention mechanisms [18].

2.2.1 Host range

Lumpy skin disease is primarily a disease of all cattle. Natural infections were also reported in Asian water buffalo (*Bubalus bubalis*) during the LSD outbreaks in Egypt in 1988, but the morbidity was significantly lower in buffalo (1.6%) compared to cattle (30.8%). The African Cape buffalo (*Synerus caffer*) and other wild ungulates have not been infected during epizootics of LSD in Africa [22].

2.2.2 Geographic distribution

LSD was originated from Sub Sahara Africa countries in 1929. Currently, lumpy skin disease occurs in most African countries (including Madagascar) and sporadically in the Middle East region. The only African countries still considered free of the disease are Libya, Algeria, Morocco and Tunisia. It occurs in various ecological zones from temperate areas to dry semi-arid and arid areas [23].

Outbreak of LSD in Egypt, Israel (2006 and 2007), Oman and Bahrain (2009) raise the possibility that LSDV might become established in the Middle East and spread to Asia and Europe [24].

In Ethiopia LSD was first observed in the northwestern part of the country (southwest of Lake Tana) in 1983 [14]. It has now spread to almost all the regions and agro ecological zones. Data investigations from the national disease outbreak report database during the period 2000-2009 showed that major epidemic outbreaks of LSD occurred in 2000/2001 in the northern parts of the country in Amhara and West Oromia regions. Then it extended to the central and the southern parts of the country in 2003 and 2004 covering large parts of Oromia and Southern Nation, Nationalities and Peoples (SNNP) regions. In 2006 and 2007 another extensive outbreak reappeared in Tigray, Amhara and Benishangul regions in the northern and north-western parts of the country. From 2007 up to 2009 the outbreak number progressively increased in Oromia Region situated in the central part of the country while it seemed to be gradually decreasing in the northern part of the country including Tigray, Amhara and Benishangul regions [4].

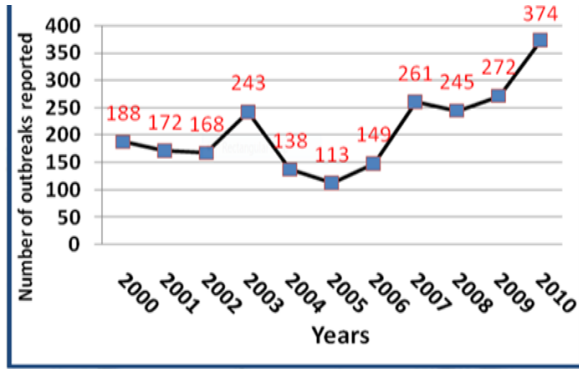


Figure 1. Lumpy skin disease outbreak frequency in Ethiopia from 2000-2010 [25].

Morbidity and Mortality

There is a great variation in the morbidity and mortality rates of LSD outbreaks. It depends on factors such as geographic location, climatic condition, management, breed and immune status of the animal, population levels and prevalence of the mechanical insect vector [26]. Generally, Morbidity rates vary between 1% and 20%. In a few outbreaks, it was

reported to be more than 50% although the mortality rates are usually less than 10% [21, 17].

2.2.3 Risk factors

Host susceptibility: Lumpy skin disease is primarily a disease of cattle and causes several disorders. Though all breeds and age group are susceptible, Bos Taurus is particularly more susceptible to clinical disease than zebu cattle. Among Bos Taurus, fine skinned Channel Island breeds develop more severe disease [9]. 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 [6]. Young animals are severely affected and clinical symptoms are rapid to appear [27].

Pathogen risk factor: Lumpy skin disease virus is very resistant to physical and chemical agents. The virus persists in necrotic skin for at least 33 days and remains viable in lesions in air-dried hides for at least 18 days at ambient temperature [17]. *Lumpy skin disease virus* is generally resistant to drying, and survives freezing and thawing [21].

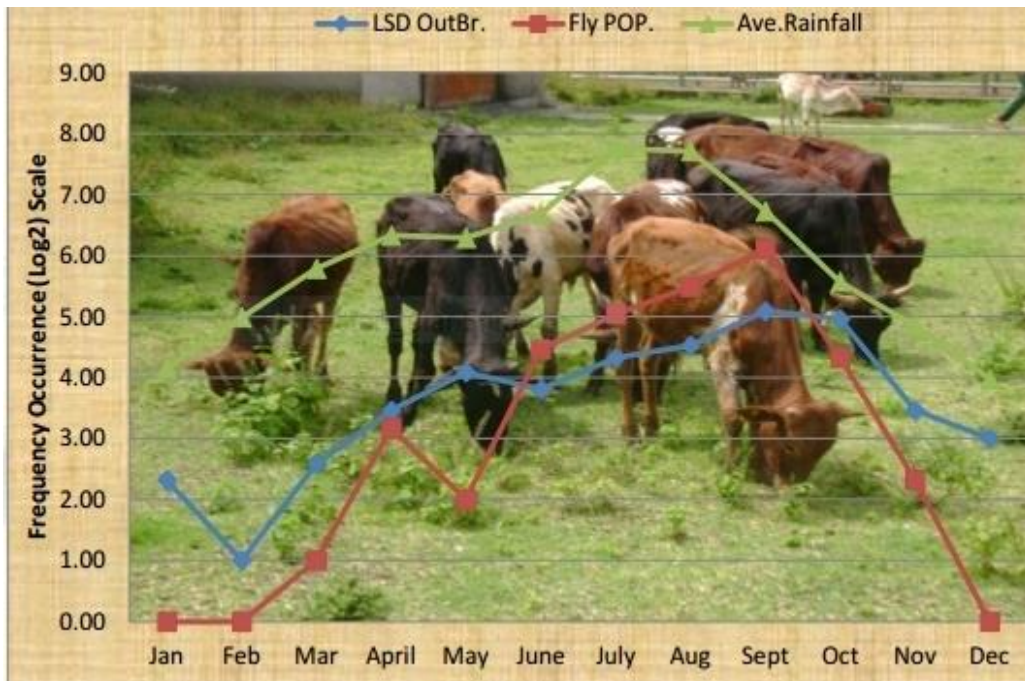


Figure 2: LSD frequency distribution showing strong link with seasonal (vector population) influence [28].

Environmental risk factor: Environmental determinants play a great role in the epidemiology of lumpy skin disease. It has major impact on the agent, host and vectors as well as interaction between them. These predisposing factors have a great role in maintenance of arthropod vector and transmission of the virus to susceptible animals. Herd contact and mixing is likely to occur in communal grazing and

watering points and these were found to be significantly associated with LSD occurrence [28]. Distribution of the disease in various agro climatic conditions, introduction of new animals to the herd and the presence water bodies are among the other risk factors that would facilitate the spread of outbreaks in various localities [6]. The potential risk of agro-climate variations in LSD occurrence showed that midland and

lowland agro-climates were more likely to be at risk for LSD occurrence than the highland agro-climate. The warm and humid climate in midland and lowland agro-climates has been considered a more favorable environment for the occurrence of large populations of biting flies than the cool temperature in the highlands [28]. Disease outbreaks usually occur during the rainy season when insect activity is high and epidemics are often associated with heavy rain fall [29].

Transmission

Different types of biting and blood feeding arthropods (including mosquitoes and other flies such as tabanids, Culicoides, biting midges and Glossinaspecies) are likely responsible for the mechanical spread of the LSD virus [30]. Disease incidence is highest in wet/warm weather. Incidence decreases during the dry season, which is possibly linked to decreases in insect vector occurrence/numbers. Minor sources of infection could include direct and indirect contact (e.g. through infective-saliva contaminated feed and water). Other potential transmission routes include the milk of lactating cows and the semen of infected bulls, since the LSD virus can persist for extended periods of time in both [31].

2.3 Pathogenesis

After the virus entering the susceptible host, usually through the skin, the virus multiplies at the site of entry, producing a local inflammation of skin and subcutaneous tissues. Thereafter, the virus reaches the lymph nodes and a second multiplication occurs in reticulo-endothelial system. A transitory viraemia is the responsible for hyperthermia and for the dissemination of virus in the cutaneous tissues, mucosa and several organs (salivary glands, udder, liver, kidneys, etc) [10]. And causes vasculitis and lymphangitis. In some more severe cases thrombosis and infarction may be the end result. Most animals that recover from clinical disease seem to develop a lifelong immunity. Immunity to LSD seems mostly cell-mediated but maternal antibodies acquired by calves may protect them from clinical diseases for approximately six months [17].

2.4 Clinical sign

Lumpy skin disease virus causes inapparent to severe disease in cattle. The severity of the disease - depends on the dose of the inoculum and the susceptibility of the host. A fever 40-41.5°C can occur and can be transitory or last up to 4 weeks. Depression, anorexia, excessive salivation, oculonasal discharge, agalactia, and emaciation are presented [9]. One to two days after the appearance of the fever, nodular lesions appear on the skin and mucous membranes. These nodules vary from 1 cm to 7 cm and penetrate the full thickness of the skin. They may occur anywhere on the body but especially in the skin of the muzzle, nares, back, legs, scrotum, perineum, eyelids, lower ear, nasal

and oral mucosa. The nodules are painful and involve the epidermis, dermis, and subcutaneous tissue and may even involve the musculature. As the disease progresses, nodules develop a characteristic inverted conical zone of necrosis. These cores of necrotic material become separated from the adjacent skin and are called "sit-fast" [32].

Where extensive generalization occurs, animals can become lame and reluctant to move. Lameness may occur from inflammation of the tendons, and severe swelling of the brisket and legs. This lameness can be permanent with severe damage to tendons and joints from secondary bacterial infections. Permanent damage may occur to teats and mammary glands due to secondary bacterial infections and mastitis. Abortion and intrauterine infection are possible; temporary or permanent sterility in both bulls and cows may occur. Superficial lymph nodes such as the mandibular, parotid, prescapular, and prefemoral nodes, draining affected areas of skin become enlarged 4 to 10 times normal size. The lesions may persist in various stages over a course of 4 to 6 weeks. Final resolution of lesions may take 2 to 6 months, and nodules can remain visible 1 to 2 years. Permanent damage to the hide is inevitable in clinical cases [9].

2.5 Pathological lesion

2.5.1 Macroscopic lesion

Characteristic deep nodules are found in the skin that penetrate into the subcutaneous tissues and muscle, and are congested, hemorrhagic, edematous and necrotic. Circumscribed necrotic lesions may also be found in muzzle, mucous membranes of the mouth, the pharynx, epiglottis, and throughout the digestive tract; nasal cavity, trachea and lungs [21]. Lymph nodes draining affected areas are enlarged up to 10 times normal size with extensive lymphoid proliferation, edema, congestion, and hemorrhage. Synovitis and tendosynovitis with fibrin in the synovial fluid can occur. Pox lesions may be present in the testicles and urinary bladder [33].

2.5.2 Microscopic lesion

Histopathological sections of early skin lesions of epidermis show an epithelioid cells, lymphocytes, macrophages, plasma cells and fibroblast proliferation appear in later stages and if secondary infection occurs, necrosis, polymorph nuclear and red cells seen. Typical eosinophilic, intracytoplasmic pox inclusion bodies may be seen in cells of epithelioid, hair follicles and cells of muscles and skin glands [34].

2.6 Diagnosis

2.6.1 Clinical diagnosis

The eruption of skin nodules involving the epidermis as well as the dermis, localization of the nodules on external mucosa and hypertrophy of the superficial lymph nodes are the basic indicators for clinical diagnosis [10]. Lumpy skin disease also

suspected when the characteristic skin nodules, fever and enlarged superficial lymph nodes are seen and the mortality rate is usually low. Nodules may appear anywhere on the body from the nose to the tail. Distribution is in a random pattern and not linear [7].

2.6.2 Laboratory diagnosis

Laboratory test of Lumpy skin disease can be made by identification of the agent, routine histopathological examination and immune histological staining [35]. For virus isolation and identification, skin nodules should be collected for live animals, whereas during post-mortem examination, nodules located in deep internal organs (Lungs, Esophagus, rumen, etc.) are used. On live animals, sampling nodule is painful and requires a small surgical operation. Sample for histopathology should always be collected and stored in a 10% formalin solution [10]. Virus neutralization, Agar gel immunodiffusion, indirect fluorescent antibody tests are commonly used serological techniques for the detection of antibody to *Capri poxvirus* structural proteins [9]. A confirmed diagnosis is based on transmission electron microscopic (TEM), immunoperoxidase (IMP) staining, antigen trapping enzyme-linked immune sorbent assay (ELISA) and a polymerase chain reaction (PCR) test [36].

2.7 Differential Diagnosis

Lumpy skin disease can be differentiated from other confusing diseases by the clinical signs, histopathology and other laboratory tests [7].

The followings are the diseases which resemble lumpy skin disease that should be distinguished accordingly. In Allerton disease (pseudo-lumpy skin disease), there is no hypertrophy of lymph nodes; but with flat nodules and depression in the center; affects only epidermis. Dermatochalasis is characterized by the papular lesions which are superficial; with scab; restricted to back; no reaction of lymph nodes. In the context of Leucosis (skin lesions), very variable size of nodules which may become ulcers and is not contagious. In onchocerciasis, nodules are localized on joints and tendons. Parafilariosis is known in cutaneous nodule with haemorrhages in the subcutaneous conjunctiva tissue, often on the side. To differentiate urticarial, there is no general symptom, but edematous plaques and keratosis are appreciated. In insect bites, painful nodules are appreciated and no surrounding necrotic zone is seen. Tuberculosis (skin lesion) is seen with localized nodule along lymph vessel of feet and neck; subcutaneous persisting nodule, with no hypertrophy lymph nodes [10].

2.8 Treatment

There is no specific antiviral treatment available for LSD infected cattle. But the risk of mortality due to secondary bacterial infections can be reduced with antibiotics [10]. Sick animals may also be removed from the herd and given supportive treatment consisting

of local wound dressing to discourage fly worry and prevent secondary infections [6].

2.9 Economic Significance

Lumpy skin disease is one of the economically significant diseases in Africa and the Middle East countries that cause severe production loss in cattle. The world organization for animal health (OIE) categorizes the disease as notifiable diseases because of its severe economic loss. The economic importance of the disease was mainly due to having high morbidity rate rather than mortality [9].

The financial implication of these losses is greatly significant to the herd owners, consumers and the industrial sectors which can process the livestock products and by products. In intensive farming of cattle, the direct and indirect production losses caused by LSD were estimated to be as high as 45-60% [6]. It was reflected that the severity of the disease was much more in developing countries, where the poorest small scale farmers was found. Reports from Ethiopia indicated that the financial loss estimated based on milk, beef, draught power, mortality, treatment and vaccination costs in individual head of local zebu were 6.43 USD and for the Holstein Friesian 58USD [15].

Major consequences of the disease are because of its ability to compromise food security through protein loss, draft power, reduced output of animal production, increase production costs due to increased costs of disease control, disrupt livestock and their product trade, result of reduced milk yield, weight loss, abortion, infertility in cows, mastitis and infertility in lactating cows, infertility in bulls [36, 9]. Permanent damage to the skin and hide greatly affect leather industry. It causes ban on international trade of livestock and causes prolonged economic loss as it became endemic and brought serious stock losses [15].

3. Control and Prevention

Lumpy skin disease could be kept under control by vaccination of cattle every year. Live, attenuated vaccines against LSD are commercially available. These have antigenic homology and there is cross protection among them. Local strain of Kenyan sheep and goat pox virus has been shown to effectively immunize sheep, goats and cattle against infection with *Capri poxvirus* with are markable success. The next one is attenuated South African LSD virus (Neethling strain) vaccine derived from cattle, freeze dried product is also available [9]. Ring vaccination of cattle, quarantine and animal movement should be restricted to control the disease from the area, but if the area coverage of the disease is large, the most convenient techniques for the control of the disease is mass vaccination of the cattle [37]. Local applications of insecticides to infected cattle have been made in an attempt to reduce further transmission, but to no

apparent benefit [38]. Outbreaks can be controlled by quarantines, depopulation of infected and exposed animals, proper disposal of carcasses, cleaning and disinfection of the premises and insect control [7].

4. Conclusion and Recommendations

Lumpy skin disease is a serious skin disease of cattle caused by lumpy skin disease virus. It is endemic in most Africa countries. Lumpy skin disease has now spread out of the African continent into the Middle East region. It is considered as one of the most important viral diseases of cattle that leads to significant economic loss. It causes temporary or permanent loss of milk production, infertility or even sterility in bulls, and of pregnant cows, reduced weight gain, permanent damage to hides, cost of treatment and dead abortion animals, and additional feed for diseased animals until their recovery. It also causes ban on international trade of livestock and their products and thereby it reduces foreign currency of a country. The epidemiology of LSD is largely concerned with factors which have a great role in maintenance of arthropod vectors and transmission of the virus to susceptible animals. Lumpy skin disease is most prevalent along watercourses and on low ground. The incidence of LSD is also high during wet seasons when populations of the insects are abundant. Lumpy skin disease virus is present in different secretions and products of animals, and resistant to environmental factors. There is no specific antiviral treatment for LSD infected cattle.

Therefore, based on the above conclusion the following recommendations are forwarded:-

- Appropriate and effective prevention and control strategies should be applied since it has not specific treatment.
- Animals should not be kept for long period along the side of watercourses especially during wet season.
- Good hygienic condition of the premises should be practiced.
- In LSD free countries, importation of livestock and their products from countries with LSD should be prohibited.
- Regular vaccination of cattle should be applied in LSD endemic areas.
- Ring vaccination and prophylactic immunization in high risk population should be implemented.

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