Food and Agriculture Organization of the United Nations

Epidemiology of LSD

Blagojcho Tabakovski DVM, Head of Unit for Animal Health

Content of the presentation

- Agent
- Impact
- Clinical sings
- Differential diagnostics
- Transmission
- Vectors
- Diagnostics
- Vaccine
- Challenges

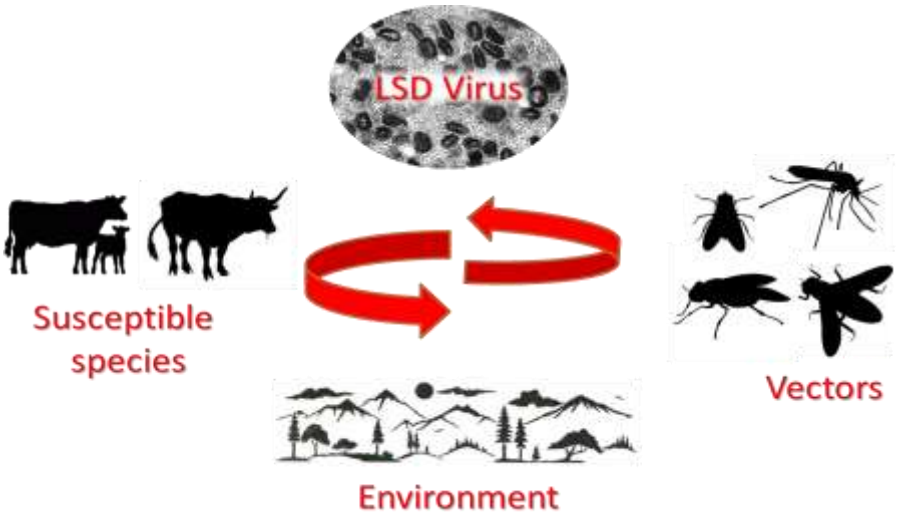
Agent

- *Lumpy skin disease virus* belongs to the ***Capripoxvirus*-genus** within the ***Poxviridae*-family**) (*Sheeppox virus* and *Goatpox virus)*
- **Vector-borne**, haematophagus arthropod vectors (flies, ticks), transmission is mechanical
- Spread with very low abundances of vectors may occur, thus direct and/or indirect **transmission** (fomites) may occur
- **Stable** virus, survives well in the environment protected from sunlight, in scabs, for up to six months, survival in dried hides of infected animals for up to 18 days, detectable in animal secretions (e.g. ocular, nasal discharge) up to at least 15 days post infection
- Most **disinfectants** are effective
- All infected animals can transmit the virus; ~**50** % infected animals develop generalised skin lesions

Impact

- **Morbidity** rate varies between 5 to 45% and **mortality** rate usually remains below 10%
- Sharp **drop** in milk yield and secondary mastitis, infertility and abortions, sterility in breeding bulls, reduced weight gain and permanently damaged skins and hides
- Long recovery period and **severely affected animals** may not regain the same level of production as before infection
- Restrictions to the **trade** of live cattle and their products
- **Costly** control and eradication measures
  - Total or partial culling of infected herds and compensation to farmers
  - Large-scale vaccination campaigns
  - Active clinical/virological/serological surveillance post-outbreak
- **Indirect** costs due to the compulsory movement restrictions of cattle (vaccinated/unvaccinated) from affected regions for trade or slaughter

Element for transmission of virus of LSD



Clinical sings

- **Incubation** time varies form 4-7 days up to 5 weeks
- High fever (40-41°C), stop eating and giving milk – start of viraemic stage
- Easily noticed in **dairy** cattle – not noticed in free-ranging beef cattle
- Markedly **enlarged lymph nodes** (particularly prescapular and precrural)
- **Skin lesions** start to develop following days - often in many animals at the same time
- **Salivation**, eye and nasal **discharge** due to the ulcerative lesions inside the mouth, also in nasal and ocular mucous membranes
- Later swellings in the leg and **lameness** may be detected
- **Oedema** of the dewlap
- Notice that not all affected animals show clinical signs although majority of them develop at least **short-lasting viraemia**

Early detection?

- **Severe** cases are highly characteristic and **easy to recognize**
- **Early** stages and **mild** cases **difficult to recognize** even for the most experienced vets
- In dairy cattle versus free-ranging beef cattle
- By the time severe cases are detected in the free-ranging herds the virus has already been circulating for weeks
- After a quiet winter period outbreaks may start again in spring time when skin lesions are well hidden under a long winter coat – difficult to detect without palpating the skin

Skin lesions

- Circular skin lesions of 1 to 5 cm in diameter (sometimes larger)
- Mild cases may show only a few lesions or lesions may cover the entire body in severely infected animals
- Within one to two weeks the top of the lesion forms a scab which then sloughs off, leaving a raw ulcer, prone to fly strike
- In some cases, the lesions remain for long

Clinical sings




Clinical sings





Clinical sings




Clinical sings





Clinical sings

Clinical sings

LSD or not?

LSD or not?

Differential diagnosis

- Pseudo lumpy skin disease; BHV-2 (Bovine herpes virus) - more superficial lesions and shorter course of the disease
- Parapox lesions (bovine papular stomatitis) in the mucous membranes of the mouth
- Insect bites and allergic reactions (urticaria)
- Early ringworm lesions – often ringworm gets worse during LSD infection
- Demodicosis
- Besnoitiosis (widely distributed in Africa, recently also in central and western Europe)
- Onchocerciasis
- Hypoderma

Host

- Domestic cattle and Asian water buffalo are susceptible
- Do sheep and goats play any role – Although mixed herds are common there is no epidemiological evidence/reports on susceptibility of small ruminants for LSD
- Wild ruminants as reservoir or susceptibility in Europe or Caucasus is not known
- Some evidence from Africa
  - Springbok, impala and giraffe can show clinical disease
  - Seropositive African buffaloes, blue wildebeest, eland, giraffe, impala and greater kudu

Host factors

- **Dairy** cows at peak of production are most severely affected
- **High-producing** and thin-skinned cattle breeds are highly susceptible
- **Silent** infections occur – some of the animals become vireamic but do not show any clinical signs
- Affected animals will eventually clear the infection and there is **no permanent carriers** of LSDV
- Long recovery time – infected animals may never regain the production level as before
- Both sexes as susceptible
- Age?

Vector transition

- Vectors are likely to vary between affected regions
- Climate, season, environmental temperature, humidity and vegetation
- Vector must bite/feed frequently and change the host between feedings
- Finding PCR positive vectors from the environment indicates that they have been feeding on infected animal – transmission should be demonstrated experimentally
- Experimental demonstration of the vector transmission is challenging
- **Difference between mechanical and biological transmissions**
- **The Big Question:** Does biological transmission occur by arthropod vectors?

Vector transmission

- Transmission has been demonstrated by mosquito (*Aedes aegypti*) (Chihota *et al* 2001)
- Suspected transmission by stable fly (*Stomoxys calcitrans*) – transmission of sheeppox/goatpox virus was demonstrated by Kitching *et al* 1986
- Further research is required to investigate the role of European insect species (fleas, lice, horn flies, horse flies, midges etc.)
- How long does the virus remain infective in arthropod mouthparts?
- Does the virus multiply in insects?

Vector transmission

- Mechanical transmission has been experimentally demonstrated
- African tick species: male *Rhipicephalus appendiculatus* (and *Amblyomma hebraeum*) ticks
- *Rhipicephalus (Boophilus) decoloratus* – venereal transmission during the copulation process – more evidence required to demonstrate biological transmissions
- European Caucasus tick species?
- Role of birds or air currents?

Other methods of transmission

- Contaminated drinking troughs or feeding sites
- Infected animals start to excrete the virus in saliva, ocular and nasal discharges soon after the onset of clinical signs
- Trans-placental transmission are reported - calves are known to be born covered by skin lesions
- Sucking calves may get infected via milk or from skin lesions in the teats (rare due to maternal antibodies)
- Iatrogenic transmission - by contaminated needles during veterinary treatments or vaccination campaigns
- Seminal transmission via natural mating or artificial insemination – real importance in the field needs to be investigated
- Is direct contact as ineffective as claimed???

Other ways of transmission

- Colostrum/milk originating from infected cows should not be used for calves
- No evidence or published reports on transmission of LSDV via milk and meat products, hides and skins
- Contact between the product and susceptible animal is unlikely as products are intended only for human use
- Milk from severely affected animals is not likely to end up for human consumption as there is a sharp drop in milk yield in affected animals
- Presence of the virus in milk
- Efficacy of pasteurization of milk
- Heat treatment of milk and meat products – 2 hours at 56° Celsius degrees or 30 minutes at 64° inactivates the virus

Identified risk factors

- Animal movements, particularly movement of unvaccinated cattle
- Nomadic and seasonal farming practises
- Slaughterhouses, cattle market places,
- Asymptomatic viraemic animals – risk of presence subclinical

Challenges preventive approach

- Cattle transport vehicles
- Vectors - responsible for local dissemination of the virus
- Presence of suitable breeding sites for insects – standing water and dung piles
- Veterinary equipment and dirty needles

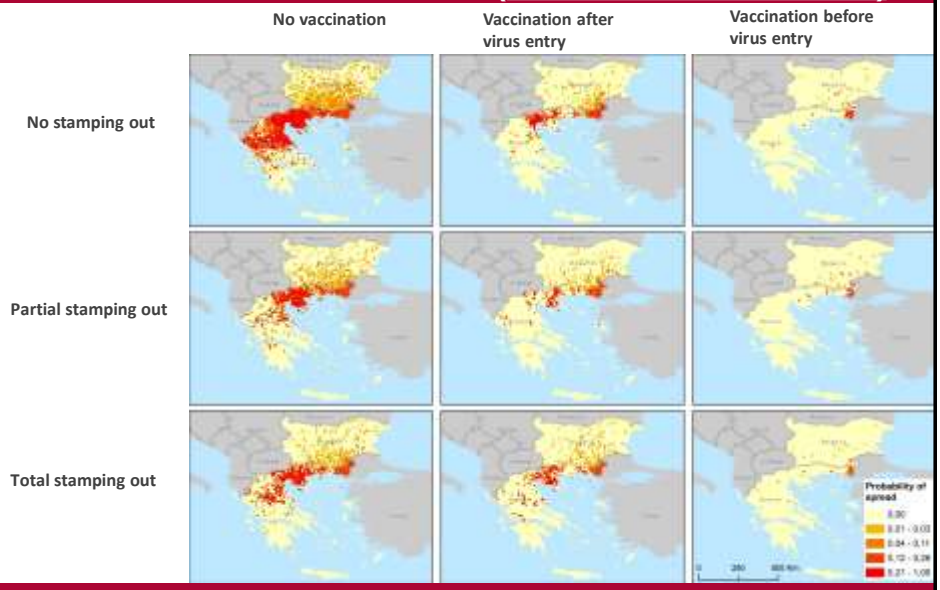
Control and eradication

- Feasible disease control/eradication varies in different countries and geographic regions
- Essential to have a contingency plan in place well in advance which is updated and practised
- Early detection of clinical cases – major issue - varies between countries and farming practises
- **Awareness campaigns** targeted to farmers, animal care staff, artificial inseminators, animal traders, vehicle drivers, field and meat inspection veterinarians
- Diagnostic capacity in place allowing swift laboratory confirmation of a tentative field diagnosis

Control and eradication

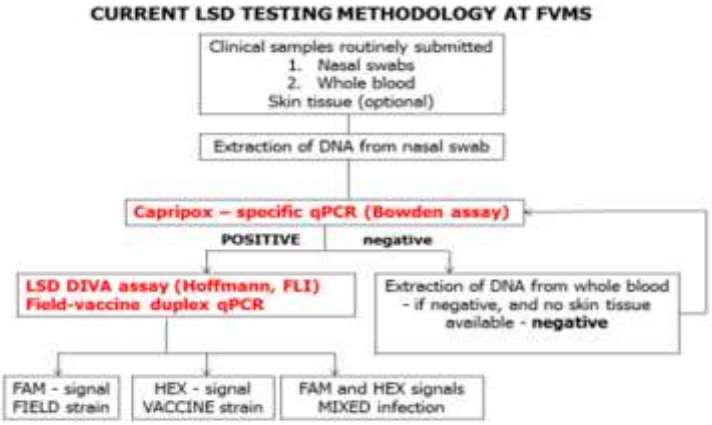
- **Large-scale vaccination campaign** around infected farms, slaughter houses, animal market and resting places
- Regional vaccination preferred to ring vaccinations
- Protection and surveillance zones with radius (50 km of diameter) appropriate for a vector-borne disease (3 km and 10 km)
- Strict movement restrictions or total standstill within the affected zone/country
- Disinfection of premises, equipment, vehicles
- Active and passive **clinical** surveillance

EFSA STATEMENT ON LSD 31 JULY 2016 (vaccination effectiveness 75%)



Diagnostics

- PCR, ELISA,
- DIVA?



Vaccine

- Only live vaccines currently available against LSDV – none of them authorised for use within the EU or RM
- No DIVA vaccines available (Differentiating Infected from Vaccinated Animals)
- Superiority of live attenuated vaccines compared to the killed ones or other *capripox* vaccines
- A replicating poxvirus generates better immunity than inactivated vaccines
- Other appropriate control measures such as movement restrictions are in place

Vaccine

- LSDV containing vaccines:
  - LSDV Neethling strain by Onderstepoort Biological Products (OBP)
  - Attenuated LSDV field strain Lumpyvac by MSD Animal Health
- Sheeppox virus (SPPV) vaccines against LSDV:
  - Yugoslavian RM65 SPPV vaccine (at a 10 times stronger dose than used for sheep) is commonly used for cattle in the Middle East
  - Romanian SPPV vaccine for cattle in Egypt
  - Bakirköy SPPV (3 times sheep dose) used in cattle in Turkey
- Gorgan goatpox vaccine (Lumpyshield, Jovac, Jordan) has been demonstrated to provide good protection against LSDV
- Confusing exception: Kenyan SGPV O-240 and 180 strains are used for cattle in some African countries - despite the name these strains are LSDV

Vaccine

- Regional vaccinations preferred over ring-vaccination (radius > 50 km diameter)
- Annual vaccinations with >80% vaccination coverage (all animals)
- All animals are vaccinated including pregnant females and young calves
- Local reaction at the vaccination site should be accepted
- Attenuated LSDV vaccines cause a general reaction in a minority of vaccinated animals ??? (Neethling disease)
- Attenuated SPPV and GTPV vaccines only rarely cause adverse reactions

Post vaccination clinical sings - why?

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- Delay in starting the vaccination campaign – herd is already incubating the disease
- Development of protection takes ~ three weeks during which time animals still may get infected by the field virus
- Insufficient vaccination coverage –pockets with unvaccinated animals left within vaccinated zones
- "Missing" of some animals during mass vaccination, particularly with free-ranging beef cattle
- Failure of the vaccine virus to protect or over-attenuated vaccine - Inappropriate storage or a failure of the cold-chain exposure to direct sunlight
- Poorly administrated vaccine or an incorrect dosage (mass vaccinations, free-ranging beef cattle not used to handling)
- Interfering maternal antibodies in calves less than three to four months of age
- Needles not changed between animals - contaminated needles or diluents

Vaccine coverage and Population immunity

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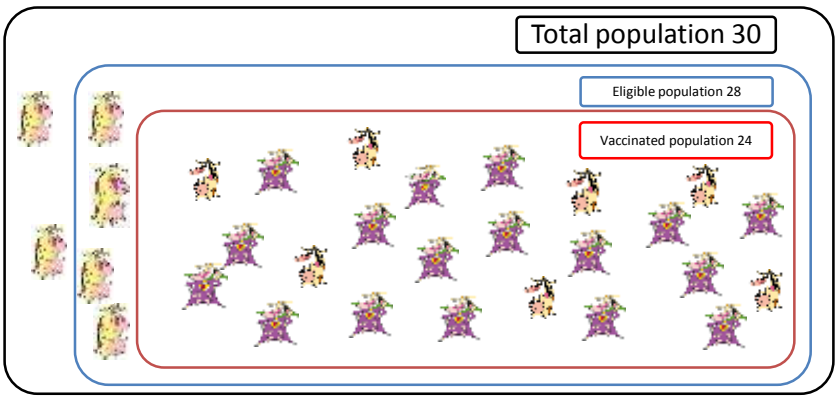

- Vaccine coverage (% of eligible animals actually vaccinated) is 24 out of 28 = 86%
- Vaccinated population is 24 out of 30 = 80%
- Vaccinated population immunity is 17 out of 24 = 71%
- Overall population immunity is 17 out of 30 = 57%

Surveillance

- Based on active and passive surveillance in vaccinated herds and PCR testing if suspected cases are found
- Serosurveillance in unvaccinated regions
  - In naturally infected herds antibodies can usually be detected for three to six months after infection
- Serosurveillance in vaccinated regions is not useful to detect outbreaks
  - Antibodies usually appear within 15 days and reach the highest level 30 days post-vaccination,
  - Vaccinated animals and those individuals showing mild disease may develop only a low levels of neutralizing antibodies that are undetectable using currently available serological tests – interpretation of negative result?
- Need for ELISA, cell-based assay and DIVA vaccines
- **Serology can be a useful tool to evaluate under-reporting or unnoticed infections at risk regions**

Knowledge gaps

- Transmission of LSDV
  - biological LSDV transmission by vectors ?
  - role of different European arthropod species ?
  - importance of direct contact between animals ?
  - ingestion of contaminated milk, water or feed ?
- Potential transmission routes for live virus from animal products to live naïve hosts?
- Immune response of cattle to LSDV infection ?

Questions

Thanks for your attention