Speaker: Dr. Hamid Reza Varshovi
Title: Sheep and Goat Pox – current situation in the region
Introduction

➢ Sheep pox and Goat pox are highly contagious viral diseases of small ruminants characterized by generalized pox lesions throughout the skin and mucous membranes.

➢ They cause high morbidity (70-100%) and mortality (50-100%) in affected animal.
History and Geographic Distribution

➢ Sheep pox was present in Asia, Central and North Africa and Europe in 2\textsuperscript{nd} Century AD.

➢ Its infectious nature was recognized in the mid-18\textsuperscript{th} century.

➢ Goat pox was reported first time by Hansen in 1879 from Norway

➢ Endemic in central and north Africa, central Asia, the Middle East, south Asia and some parts of the South-East Asia
clinical Signs & lesions
Poverty at the household level

Trade and Export restrictions

Lowers production efficiency

Socio-economic impact

Impediment of intensive livestock production
Sheep and goat pox in Asia, the Far East and Oceania 2007-2017
West Asia and South Asia

- **Present in** Turkey, Iran; Iraq; Jordan; Oman; Yemen, Saudi Arabia, Afghanistan, Pakistan, Bangladesh, India, Palestine, Israel, Egypt in 2017

- **Last occurrence reported for** Lebanon 2011, Kuwait 2016, Bahrain 2015, United Arab Emirates 2010, Nepal 2011, Azerbaijan 2009,

- **Not reported for** Qatar 1999, Sri Lanka 1996, Syria, Georgia 1997, Armenia, Bhutan since 2009
West Asia and South Asia

- Georgia 1997
- Azerbaijan 2009
- Armenia
- Qatar 1999
- Emirates 2010
- Nepal 2011
- Bhutan
- Sri Lanka 1996
- Turkey
- Saudi Arabia
- Pakistan
- India
- Bangladesh
- Jordan
- Iraq
- Iran
- Afghanistan
- Oman
- Yemen
- Maldives

- Not reported
- present
- Disease never reported
- Reported
North, Central and East Asia

- Present in China, Mongolia, Russia,
- Last occurrence reported for Korea (Rep. of) 2007,
- Disease never reported for Hong Kong (SAR - PRC),
- No information available for Macau
North, Central and East Asia

- **North Korea**: Disease never reported
- **Japan**: 1921
- **Russia**: Not reported
- **Turkmenistan**: 1996, 2014
- **Uzbekistan**: 1996
- **Tajikistan**: 1955, 1997, 2014

**Not reported**
- present
- Disease never reported
- Reported
South East Asia and Oceania

- Present in Indonesia 2017
- Last occurrence reported for Laos 2011
- Frequently occurrence reported for Vietnam (2005-2012)
- Disease never reported for Singapore, Thailand, Philippines, Maldives, Brunei, Micronesia (Fed. States of), New Caledonia, New Zealand, Fiji, Australia and Vanuatu
- Not reported for Malaysia 1935
- No information available for Cambodia, East Timor, Papua New Guinea
  - Myanmar have only provided information for certain years, indicating the absence of the disease: (2005, 2006, 2012)
Activities implemented for surveillance and control

➢ Vaccination

Egypt, Turkey, Iran; Iraq; Jordan; Oman; Yemen, Saudi Arabia, Afghanistan, Pakistan, Bangladesh, India, Israel, Palestine, China, Mongolia, Russia, Lebanon, Syria, Kuwait, Bahrain, Qatar, United Arab Emirates, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan, Azerbaijan, Chinese Taipei

➢ No vaccination

Nepal, Sri Lanka, Georgia, Armenia, Japan, Indonesia, Vietnam, Malaysia, Laos, Korea (Rep. of)
Activities implemented for surveillance and control

No information available

Vaccination

Disease never reported

No vaccination
Activities implemented for surveillance and control

➢ **surveillance in domestic**
  ➢ No surveillance specified
    Bahrain, Lebanon, Laos, Korea (Dem. People's Rep.), Turkmenistan, Chinese Taipei, Armenia, Georgia, Maldives, Hong Kong (SAR - PRC)
  ➢ General and targeted surveillance
    Kyrgyzstan, Azerbaijan, United Arab Emirates, Korea (Rep. of), Uzbekistan

➢ **surveillance in wildlife**
  ➢ General and targeted surveillance
    Kyrgyzstan, Azerbaijan, United Arab Emirates, Uzbekistan
  ➢ General surveillance
    Cyprus, Korea (Rep. of), Vietnam
EPIDEMIOLOGY ASPECTS
Highly host specific in sheep and goats but varies from isolate to isolate

- Isolates from the Middle East, India and Nigeria are host-specific in sheep or goats
- Kenyan and Yemen isolates and an Oman sheep isolate infect sheep and goats equally readily.
Transmission routes in animals

- mainly, respiratory tract via aerosol directly close contact
- Commonly, Skin abrasion
- possibly, Mechanically by biting insects
- Found in all secretions, excretions, and the scabs
- Experimentally by (ID), (IV) and (SC) inoculation
Persistence of virus in the environment

Resistant to desiccation; persistent for up to 2-3 months on wool and 3 months in dry scabs

Sensitive to direct sunlight but may persist for 6 months or more in a cool, dry and dark environment

Sensitive to high humidity
ETIOLOGY AND GENOMIC CHARACTERIZATIONS
Genomic characterizations

- Sheeppox (SPPV), and goatpox (GTPV) viruses along with Lumpy skin disease virus (LSDV) are closely related members of the Capripoxvirus genus belonging to the poxviridae family.

- Capripoxviruses are double-stranded DNA viruses with genomes approximately 150 kbp. Sheeppox and goatpox viruses genomes consist of at least 147 putative encoding genes.

- The central region with conserved genes involved in replication and transcription mechanisms.

- The terminal regions in both side of the genome are variable in nature involved in virulence and host-range functions.

- Although SPV and GPV antigenically closely related are highly similar to each other, at the genomic level they have average nucleotide identity of 96% over the length of their genomes.

Intra- species nucleotide identity was greater than 99%. 
Linear map of the LSDV genome. ORFs are numbered from left to right based on the position of the methionine initiation codon. ORFs transcribed to the right are located above the horizontal line; ORFs transcribed to the left are below. Genes with similar functions and members of gene families are colored according to the figure key. ITRs are represented as black bars below the ORF map.
Molecular epidemiology

- Usually, nomenclature of SPPV, GTPV and LSDV is based on animal species from which the virus was first isolated but cross-species transmission may complicate the situation.

- Sheeppox and goatpox are impossible to be distinguished in morphological and serological assays due to their structural and antigenic relatedness but possible at molecular level.
Molecular epidemiology

- Restriction enzyme pattern analysis, cross-hybridisation studies and, more recently, nucleic acid sequencing have shown that nearly all CaPVs can be grouped genetically according to their host origins.

- Full genome information, and also gene sequence and phylogenetic analysis of targeting host range genes, virulence genes and immunodominant genes suggest that SPV and GPV are phylogenetically distinct.
Figure 2. Phylogenetic analysis of 45 capripoxviruses including eight retrieved from GenBank. The consensus tree was constructed based on the nucleotide sequence alignments of the RP030 gene homologue using the Neighbor-Joining method and the MEGA4 software. The homologue gene sequences from one Deer poxvirus isolate and one Swine poxvirus isolate retrieved from GenBank were used as out-groups.
Le Goff, et al.
Molecular epidemiology

➢ GPV lineage:
  ➢ The first group: Middle Eastern and Asian isolates:
    ➢ The sub-group 1.1: Middle East and Southern Asia
      ➢ Bangladesh, India/83, Oman/84 GPV and Oman/84 SPV isolates
    ➢ The sub-group 1.2: Middle East and western Asia
      ➢ G20-LKV, Pellor, Iraq/61, Dessel GPV isolates
  ➢ The second group: Middle East and African isolates:
    ➢ Chad VC6, Chad VC8, Nigeria/99 and Yemen GPV isolates

➢ SPV lineage:

➢ Few viral isolates located outside the group corresponding to their host of origin providing evidence for cross-infection with CaPVs such as SPPV infecting goats or GTPV infecting sheep
LABORATORY DIAGNOSIS
Differential Diagnosis

- Contagious ecthyma
- Bluetongue
- Mycotic dermatitis
- Mange
- Photodermatitis
- Peste des petits ruminants
- Parasitic pneumonia
- Caseous lymphadenitis
- Insect bites
Virological methods

Identification of the agent

Antigen detection

Nucleic acid recognition methods
Serological tests

- VNT
- AGID
- Western blot analysis
- IFA
- ELISA
Table 1. Test methods available for diagnosis of sheeppox and goatpox and their purpose

<table>
<thead>
<tr>
<th>Method</th>
<th>Purpose</th>
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<tr>
<td></td>
<td>Population freedom from infection</td>
</tr>
<tr>
<td>Virus isolation</td>
<td>+</td>
</tr>
<tr>
<td>Antigen detection</td>
<td>++</td>
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<tr>
<td>PCR</td>
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**Agent identification**

**Detection of immune response**

Key: +++ = recommended method, validated for the purpose shown; ++ = suitable method but may need further validation; + = may be used in some situations, but cost, reliability, or other factors severely limits its application; – = not appropriate for this purpose; N/A = purpose not applicable.

PCR = polymerase chain reaction; VN = virus neutralisation; IFAT = indirect fluorescent antibody test
Laboratory Diagnosis

Agent identification / Serology methods depending on specified diagnostic purpose

➢ Population freedom from infection / Contribute to eradication policies/ surveillance
  ➢ Virus isolation limited application
  ➢ Antigen detection, PCR, require to be further validated and standardized
  ➢ VN require to be further validated and standardized
  ➢ IFAT, and ELISA limited application

➢ Individual freedom from infection prior to movement/ Confirmation of clinical cases
  ➢ Virus isolation, PCR recommended and validated
  ➢ Antigen detection require to be further validated and standardized
  ➢ VN require to be further validated and standardized
  ➢ IFAT, and ELISA limited application

➢ Immune status in individual animals / post-vaccination evaluation
  ➢ VN require to be more validated and standardized
  ➢ IFAT, and ELISA limited application
CONTROL AND ERADICATION
CONTROL AND ERADICATION

➢ Socio-economic and political stability, availability of veterinary services and adequate infrastructure and logistic supports are essential for implementing effective control programs

➢ The Needed tools:
  ➢ Information Systems
  ➢ Monitoring and Assessment Tool (MAT)
  ➢ Effective Surveillance
    ➢ clinical Surveillance
    ➢ Sero-surveillance
  ➢ Vaccines
  ➢ Post vaccination evaluation (PVE)
Molecular diagnostics tools

➢ Diagnostics tools should be enable

➢ Rapid detection

➢ It is essential in Early warning system to respond sudden outbreaks, monitoring/surveillance of the diseases and study the epidemiology of the disease in endemic regions.

➢ Accurate identification

➢ Determination of the responsible of CaPV isolates in outbreaks involving domestic ruminants, as well as in possible outbreaks involving wildlife is extremely important in determining which strategy is better suited to limit the spread of the disease and can be helpful in identifying suitable vaccine strains to prevent the further spread of disease, especially when different but closely related strains cause diseases with similar symptoms in the same or different hosts.
Molecular diagnostics tools

➢ **Agent detection**
  - Validated PCR-based assays
  - The real-time PCR assay
  - modern molecular PCR-based assays like LAMP assays, lateral flow assay

➢ **Seroologic tests**
  - Poor sero-conversion following vaccination or infection in target hosts
  - Cannot differentiate between infection and vaccination
  - development of high-throughput ELISA with enhanced sensitivity and specificity using recombinant antigen is needed
CONTROL AND ERADICATION

➢ **Disease- free countries**
  ➢ the early detection
    ➢ Identifying Emerging/ Re-emerging of the disease in areas free from disease
    ➢ Certify freedom from the disease

➢ **Non- Endemic area**
  ➢ Early warning system
  ➢ Appropriate diagnostics
  ➢ Radical stamping out policy
  ➢ Restriction on import of livestock and animal products from affected areas.
  ➢ Infected animal products should be decontaminated before entry into non-enzootic regions

➢ **Endemic area**
  ➢ Early warning system
  ➢ Appropriate diagnostics
  ➢ Modified stamping out policy
  ➢ Restricted animal movement and their products
  ➢ Use of effective vaccine(s) and Ring vaccination.
OPPORTUNITIES AND CHALLENGES
The existence of Molecular tool initiating molecular epidemiology

GF TADs

PVS

Effective vaccines are available

PPR global eradication program
Challenges

➢ No serologically difference between vaccinated animal and infected animal
➢ Minor difference in the genome of vaccinal strains and wild strains
➢ Weak epidemiological knowledge concern to CaPVs in wildlife and Livestock-wildlife interface
➢ Inadequate infrastructure and veterinary services in most of developing countries
Challenges

Socioecological factor

➢ Climate changes
  ➢ Drought, insect population movement

➢ Political conflicts and war
  ➢ Since 2011, Mass movement of refugees and farm animals without proper health control across Middle East increased the risk of spreading of (SPPV) and (GTPV) in the Middle and Near East
  ➢ Collapsed veterinary services to perform good practice in diagnosis and control measures on transboundary diseases

➢ Intensive regional trade
  ➢ especially uncontrolled trade (smuggling)

➢ Uncontrolled livestock movements
  ➢ Traditional extensive livestock production in nomadic farming practices and extensive pastoral systems associated with the mixing of large numbers of animals
Suggestion

➢ Endorsement of research to better understand CaPVs epidemiology including at the livestock/wildlife interface
  ➢ It is critical to fully understand the epidemiology of the virus in hosts’ production systems, and ecosystems, as well as the socio-economic factors impacting implementation of control measures

➢ Harmonized SOPs and guidelines for outbreak investigation, sero-monitoring and diagnostic tests

➢ Identify and validate diagnostic tests
  ➢ Several laboratories are currently working on the improvement of sensitivity/specificity of available diagnostic tests particularly in considering the need for standardising them

➢ Enhance vaccine research
  ➢ Multivalent vaccines, Recombinant vaccines (DIVA)

➢ Regional laboratory and epidemiology networks
  ➢ Improvement of information sharing in the Region, on not only disease reports but also technical information and lessons learned
Thanks for your kind attention