The Pathogenesis, Clinical Diagnosis and Differential Diagnosis of Rift Valley Fever in Animals

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The Pathogenesis, Clinical Diagnosis and Differential Diagnosis of Rift Valley Fever in Animals

Pathogenesis – General Pathways

- Port of entry
- initial replication sites
- vital organs (e.g. spleen, liver and brain)
  damaged directly via viral lysis
  or indirectly via immuno-pathological reactions
  or recovery via specific (Abs)
  or unspecific immune responses
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Pathogenesis – Viral Spread (assumed basic pattern)

- Port of entry – resorbtive viremia
  or via lymphatic vessels
to regional lymphnodes =

- initial replication sites – release into circulation
  causing primary viremia and thus systemic infection

- replication in target organs – release into circulation
  causing intensive (secondary) viremia

- Variations on species and individual level of disease manifestation
# Pathogenesis – Timeframe of Viremia

<table>
<thead>
<tr>
<th>Species, Age Group</th>
<th>Viremia detectable</th>
<th>Viremia persistence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheep &lt; 1 week</td>
<td>16hrs after infection</td>
<td>whole disease period (mortality poss. after 36 – 48 hrs)</td>
</tr>
<tr>
<td>Sheep, Goats, Cattle &gt; 1 week</td>
<td>24-48hrs After infection</td>
<td>Up to 7 d (peak on day 2 – 5)</td>
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</table>

Viral Persistence in Spleen of Sheep up to 21 days
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Pathogenesis – Viraemic Titres

Lambs : $10^{10.1}$ MIPLD$_{50}$/ml
Sheep : $10^{7.6}$ MIPLD$_{50}$/ml
Kids : $10^{8.2}$ MIPLD$_{50}$/ml
Goats : $10^{5.6}$ MIPLD$_{50}$/ml
Calves : $10^{7.5}$ MIPLD$_{50}$/ml
Ponies : $10^{2.5}$ MIPLD$_{50}$/ml

Correspondence with degree of species susceptibility

(MIPLD = mouse intraperitoneal lethal dose)
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Pathogenesis – Species Susceptibility

- **Extremely Susceptible (>70% Mortality):**
  e.g. lambs, kids

- **Highly Susceptible (>20%<70% Mortality):**
  e.g. sheep, calves

- **Moderately Susceptible (<10% Mortality):**
  e.g. adult cattle, goats, African Buffalo, Humans

- **Resistant (benign/inapparent infection):**
  e.g. equines, pigs, carnivores

- **Refractory (no infection):**
  birds, reptiles, amphibiae
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Pathogenesis – Disease Forms

- Extremely Susceptible Hosts (young lambs and kids):
  - peracute hepatic disease

- Highly (Sheep, Calves) and Moderately Susceptible Hosts (e.g. Cattle, Goats):
  - mostly benign infection
  - various percentage of severe hepatic disease

- Encephalitic Form in ruminants reported only from artificial, but not natural infection (immunopathological mechanisms discussed for encephalitic manifestation in rats and humans) but viral infection of brain of aborted fetus; CNS anomalies (porencephaly, hydrancephaly and microencephaly) reported after usage of Smithburn strain vaccine in ewes

- Ocular lesions not reported in animals

- Abortions: - due to febrile disease of dam or
  - due to foetal infection and death (majority)
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Pathogenesis – Organ/Tissue Preferences

- In Vitro: replication in almost all cell types (except e.g. primary macrophages; but macrophages infected in vivo)
- In Vivo: macrophages, spleen, adrenocortical cells, hepatocytes, renal glomeruli (+some tubules), endothelial cells, brain cells with encephalitic form (e.g. rats), lung tissue

Correspondence with respective organ lesions

Major Virus Replication: Liver & Spleen
Pathogenesis – Pathogenic Properties

- Direct viral cell lysis of target cells in (per-) acute form (e.g. in newborn lambs); cellhydrops, karyopyknosis etc.
- Haemostatic derangements:
  - moderate thrombocytopenia in benign infection in sheep
  - viral hemorrhagic fever with bleedings and disseminated intravascular coagulation
  impaired clearance of virus – widespread tissue damage causing a.o. vasculitis and hepatic necrosis as most critical lesions – hemorrhagic syndrome
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Pathogenesis – Pathogenic Properties 2

- Intravascular coagulation triggered by destruction of antithrombotic properties of endothel
- Procoagulants released into circulation by necrosis of a.o. hepatocytes
- Diminished production of coagulation proteins and reduced clearance of activated coagulation factors through critical liver damage – enhancement of DIC – drop of tissue perfusion – tissue damage extensive hemorrhages and fatalities through anemia, shock and hepatorenal failure
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Pathogenesis – Abortions

- No evidence of fetal infection (?)
  or
- Fetal infection and death
  massive hepatic necrosis
  often also infection of brain
  *no placentitis described (?) but virus retrievable*

Septic Metritis as consequence of retained placenta due to abortion
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**Pathogenesis – Host Response**

- Fatal hepatic form: Host immune system overrun by virus and weakened by lymphoid necrosis
- Recovering hosts: Macrophages (production of interferon and triggering cell-mediated immune response) and Abs (2-3 days after infection in rats and sheep) important for early defense
- Apparently genetic resistance inherited as simple Mendelian gene of large effect
- Mortality rate e.g. in gerbils not determined by infectious dose
- Apparently higher virus replication rates in hepatocytes of susceptible rat strains than in those of resistant rat strains – Difference in susceptibility on cell level (before reaction of immune system)
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Clinical Diagnosis

- History: Species, season, type of symptoms
- Clinical examination and signs
- Sampling live animal
- Post-Mortem
- Sampling during PM

Individual cases generally unspecific;
Key symptom: many simultaneously occurring abortions/stillbirths
death of new-bornes (after heavy rains and in conjunction with human
RVF disease) together with clinical disease in ruminants during
epidemic.
Does not exclude cases of smaller numbers during Inter-epidemic
times!
Clinical Diagnosis – small ruminants

- **Sheep**
  - new-born lambs: usually peracute course
  - Incubation period: 12-36 hrs, often biphasic fever
  - listlessness, increased respiration (can be abdominal in final stages),
  - abdominal pain,
  - mortality: up to and more than 90% in lambs < 1 week
Clinical Diagnosis – small ruminants (Sheep)

Animals >2 weeks: peracute, acute (mostly) or inapparent

Peracute course: sudden death without remarkable signs

Acute course: Incubation period: 24-72 hrs, fever for 24 – 96 hrs

Listlessness, increased respiration, anorexia

May have melaena or bloody/foetid diarrhoe, mucopurulent

Nasal discharge, icterus (few), (unphysiological regurgitation of ingesta)

Abortions (40-100% of pregnant animals) at any gestation stage (usually autolysed fetuses)

Mortality rate: 5-30%
Clinical Diagnosis – small ruminants

- **Goats**: as for sheep, but reportedly regional differences in susceptibility
Clinical Diagnosis – large ruminants

- **Cattle**: calves

  similar as in lambs and kids (febrile, anorectic, diarrhoe with bloody and/or foetid character), but more cases with icterus; fatalities 2-8 days after infection

  mortality rate: <10%, 20% (SP), 70% (experim.)
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Clinical Diagnosis – large ruminants

- **Adult Cattle**: acute or inapparent (frequently)
  Incubation period:
  Fever for 24-96 hrs
  Anorexia, bloody/foetid diarrhoe, weakness, discharge from cranial mucous membranes (lachrymation, salivation, nasal discharge), dysgalactia; icterus
  Abortion often only clinical signs (15-40% during epidemics)
  Mortality rates: +- 10%; 30% (Egypt)
Clinical Diagnosis – large ruminants

- Other reported (unusual findings):
  - dermatitis crustosa, catarhal and erosive stomatitis, coronitis, laminitis, exungulation (suspected to be primarily caused by concurrent infections, e.g. BT)
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Clinical Diagnosis – Abortions Ruminants

- due to febrile reaction or infection of fetus
- during all stages of gestation
- usually autolysis of aborted fetus
- fertility afterwards appears not be affected, if not complications due to retained placenta, purulent metritis and salpingitis
<table>
<thead>
<tr>
<th>Species</th>
<th>Age Gr.</th>
<th>Morbidity</th>
<th>Mortality</th>
<th>Abortions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheep</td>
<td>newborn</td>
<td>+- 90 %</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;2weeks</td>
<td>5- 30 % (SA)</td>
<td>40-100 % (SA)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>60 % (Eg. ‘77)</td>
<td>80-100 % (Eg’77)</td>
<td></td>
</tr>
<tr>
<td>Goats</td>
<td>all</td>
<td>as sheep (SP)</td>
<td>as sheep (SP)</td>
<td>as sheep (SP)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 % (Eg. ’77)</td>
<td>0 % (Eg. ’77)</td>
<td>0 % (Eg. ’77)</td>
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<tr>
<td></td>
<td></td>
<td>&lt;50% (Su. ’73)</td>
<td></td>
<td>100 % (Mau.’87)</td>
</tr>
<tr>
<td>Cattle</td>
<td>calves</td>
<td>&lt;10% (SP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>calves</td>
<td>70% (experim.)</td>
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</tr>
<tr>
<td></td>
<td>all (adult)</td>
<td>20 % (SP); 30% (Eg.’77)</td>
<td>15- 20 % (SP)</td>
<td></td>
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</tbody>
</table>
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RVF Outbreak 2008 Ehlanzeni – Observations and Calculations

- **Grootboom**
  40% seropositives (6/15 tested)

- **Vygeboom**
  53% seropositives (6/15 tested)

- **One Tree Hill**
  1.6% abortions (2/121 pregnant cows)
  (owner vaccinated before serosurvey)

- **Richtershoek**
  8% mortality (4/51); all < 2yrs
  bad overall condition, diarrhoe
  PM: icterus, swollen livers with mottled appearance
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RVF Outbreak 2008 Ehlanzeni – Observations and Calculations

- **Blinkwater:**
  - 31% seropositives (31/100)
  - 14% abortions (6/43)
  - +- 5% morbidity and mortality

- **Hoggelegen:**
  - 42% seropositive (3/7)
  - 50% abortions (2/4 previously pregnant animals)
  - Morbidity (abortions): 28% (2/7)
  - Mortality: 0%
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Epidemiological figures- Afr. Buffalo

Before Outbreak in DFBBP in Nkomazi area 2008:
371 buffalo (317 in bomas, 160 being adult cows) in the project at DFBBP in Nkomazi:
- 3 bulls, 11 cows and 1 calf in the TB positive;
- 5 bulls, 24 cows, 82 subadults and 4 calves in the TB suspect;
- 20 bulls, 126 cows and 27 calves in the TB free bomas;
- 14 calves in the hand-rear bomas;
- 54 buffalo in field camp

Results of RVF Outbreak:
- one adult female buffalo died from RVF on 14 January 2008
- very young calf died from or while suffering from RVF on 25 January 2008
- eight adult female buffalo aborted due to RVF from 27 January to 28 February 2008.
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Epidemiological figures- Afr. Buffalo

- Outbreak in DFBBP in Nkomazi area 2008:
- Morbidity (fatal cases and abortions) : 2.6 % (including buffalo in camp)
- Morbidity (fatal cases and abortions) : 3.1 % (excluding buffalo in field camp)
- Mortality (excluding abortions) : 0.5 % (including buffalo in field camp)
- Mortality (excluding abortions) : 0.6 % (excluding buffalo in field camp)
- Abortions : 6.8 %

8/117 over 33 days in January and February 2008 due to RVF (average inter-calving period in the buffalo project was determined at 462 days (1999-2007, n = 756), implying an average pregnancy prevalence of 73%, and thus 117 cows being pregnant pregnant at the onset of the outbreak out of total of 160)
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**Epidemiological figures- Afr. Buffalo**

Outbreak in DFBBP in Nkomazi area 2008:


<table>
<thead>
<tr>
<th>Bomas</th>
<th>Abortion</th>
<th>Stillbirth</th>
<th>Neonatal death (&lt;5w)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TB free</td>
<td>0 – 3 %</td>
<td>0 – 4 %</td>
<td>0 – 10 %</td>
</tr>
<tr>
<td></td>
<td>0 %</td>
<td>13%#</td>
<td>13%</td>
</tr>
<tr>
<td>TB suspect</td>
<td>0 – 9%*</td>
<td>0 – 10%*</td>
<td>0 – 10%</td>
</tr>
<tr>
<td></td>
<td>57%@</td>
<td>0%</td>
<td>14%@</td>
</tr>
<tr>
<td>TB positive</td>
<td>0 – 18%*</td>
<td>0 – 9%*</td>
<td>0 – 18%</td>
</tr>
<tr>
<td></td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

* enhanced by Brucellosis infection until 2007

# same boma!

@ RVF (abortions: 3/4 confirmed; neonatal 1/1 confirmed)
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Epidemiological figures- Afr. Buffalo

Outbreak in DFBBP in Nkomazi area 2008:

PERINATAL MORTALITY

NGWENYA TB FREE BOMAS

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>ABORTION RATE</th>
<th>STILLBIRTH RATE</th>
<th>NEONATAL DEATH RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
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<td>2006</td>
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<td>2007</td>
<td>0%</td>
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<tr>
<td>2008</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
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</tbody>
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Epidemiological figures - Afr. Buffalo

Outbreak in DFBBP in Nkomazi area 2008:

**PERINATAL MORTALITY**
NGWENYA TB SUSPECT BOMAS

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>ABORTION RATE</th>
<th>STILLBIRTH RATE</th>
<th>NEONATAL DEATH RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>0%</td>
<td>10%</td>
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<td>2003</td>
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<td>2008</td>
<td>60%</td>
<td>20%</td>
<td>10%</td>
</tr>
</tbody>
</table>
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Epidemiological figures- Afr. Buffalo

Outbreak in DFBBP in Nkomazi area 2008:

**PERINATAL MORTALITY**

**NGWENYA TB POSITIVE BOMAS**

<table>
<thead>
<tr>
<th>Year</th>
<th>Perinatal Mortality %</th>
</tr>
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<tbody>
<tr>
<td>2002</td>
<td>60%</td>
</tr>
<tr>
<td>2003</td>
<td>30%</td>
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<tr>
<td>2004</td>
<td>20%</td>
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<td>2007</td>
<td>0%</td>
</tr>
<tr>
<td>2008</td>
<td>0%</td>
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</tbody>
</table>

- **ABORTION RATE**
- **STILLBIRTH RATE**
- **NEONATAL DEATH RATE**
Epidemiological figures- Afr. Buffalo
Outbreak in DFBBP in Nkomazi area 2008:

**Seropositives:**
- **9/16 calves (56%);** 7-9 months old, 1st stage quarantine
  - weaned at 5 months of age: 8/11 (72%) seroconverted when 7-9 months old
  - handreared: 1/5 (20% seroconverted)
- **8/18 calves (44%);** in hand rearing facility seroconverted
- 6 month old: 33% seroconversion
- 3 month old calves: 40% seroconversion
- 1 month old calves: 50% seroconversion
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**Epidemiological figures- Afr. Buffalo**

Outbreak in DFBBP in Nkomazi area 2008:

**TB Suspect bomas:**

- 12/19 adults (61%) seroconversion All four cows which aborted were seropositive (highest titres of all: 57, 59, 69 and 96)
- 2 bomas with abortions: 91% and 60% seroprevalences
- 2 bomas with no abortions: 40% and 29% seroprevalences
- 6 calvings after vaccinations (pregnant animals with inactivated, others with live attenuated vaccine):
  - 3x negative titres, 2 x borderline positive titres of 10 and 1 x positive titre of 44
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Epidemiological figures- Afr. Buffalo

Outbreak in DFBBP in Nkomazi area 2008:

**TB positive bomas:**
- 6/13 adults (46%) Both cows which aborted were seropositive with titres of 22 and 52.
- boma with abortions : 75% seroprevalence
- boma with no abortions : 0% seroprevalence
- 3 calvings after vaccinations (pregnant animals with inactivated, others with live attenuated vaccine):
  - 3 x negative titres
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Epidemiological figures- Afr. Buffalo

Outbreak in DFBBP in Nkomazi area 2008:

**TB free bomas:**
- 40/124 cows (32 %)
- 3/19 bulls (16%)
- 21/ 26 unweaned calves (81%)
- 64/169 animals (38%) Both cows which aborted had high positive titres of 77 and 82
- 2 bomas with abortions: 27% and 31% seroprevalence
- One boma: 0% seroprevalence
- Other 15 bomas: 8 – 73 % seroprevalence
- 34 calvings after vaccinations (pregnant animals with inactivated, others with live attenuated vaccine):
  - Including 6 x positive titres
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RVF in Wild Animals

Species with documented positive serology:
a.o. African buffalo, black and white rhino lesser kudu, impala, African elephant, kongoni, waterbuck, gerenuk, eland

Clinical manifestations under natural conditions speculated
Intraspecific differences in susceptibility linked to environment and fitness (e.g. Afr. Buffalo)?
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Clinical Chemistry

- marked leukopenia first 3 to 4 days of infection (even in benign infections), simultaneously with viremia and fever peak can be picked up as additional finding on BS

- marked increases in the serum concentrations of some liver enzyme (sorbitol dehydrogenase, glutamate dehydrogenase, aspartat aminotransferas)

little practical value in routine field vet scenario
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Pathology (Macroscopical changes)

Hepatic lesions (variance according to age): hepatomegaly, focal necrosis, subcapsular hemorrhages, congested patches
Fibrinous perihepatitis; edema and hemorrhages in gall bladder wall, blood-tinged bile
Icterus
Hemorrhages in abomasum with dark luminal content (new born lambs); blood in intestinal lumen (adult sheep and cattle)
Splenomegaly, marginal infarcts (some)
Enlarged and edematous lymphnodes
Disseminated haemorrhages (sc, serosal ans visceral)
Bloody effusions into body cavities
Lung oedema and congestion
Nephrosis
Histopathology

**Hepatic necrosis** key characteristic finding

very extensive and diffuse in peracute cases of highly susceptible hosts, lesser degree and more focal in others

(multifocally in older sheep and calves; adult cattle
60% centrizonal necrosis, massive diffuse necrosis 30%; 10% focal necrosis)

Other findings:

Lymphoid necrosis (and depletion)

Nephrosis

Lung congestion, edema and hemorrhages
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Differential Diagnosis

- Abortion: Abortion storms
  Age and condition of aborted fetus
- Icterus/Liver Impairment
- Diseases with seasonally focussed appearance (and/or movements/congregations)
- Acute Deaths
Differential Diagnosis – Abortions (Cattle)

- **Brucella abortus:**
  - abortions around 7th to 8th month of gestation /last trimester (or weak newborns and/or retained placenta)
  - slightly viscous fluid with yellowish tinge between endometrium and chorion
  - placenta can have leathery appearance with fibrinous exudate (yellowish)
  - fetus: mostly s/c oedema, effusions in body cavities; purulent/fibrinous bronchopneumonia; **content of abomasum lemon coloured with flakes**
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Differential Diagnosis – Abortions (Cattle)

- **Campylobacter fetus ssp. venerealis:**
  abortions around 5\textsuperscript{th} to 6\textsuperscript{th} month of gestation / second trimester (or premature/weak calves)
  cotyledones often edematous, yellowish tinge, partly necrotic, brown exsudate
  often accompanying catarrhalic vaginitis, cervicitis and endometritis
  fetus: sc/ edema, effusion in body cavities, liver necrosis
Listeria monocytogenes:
abortions around 7th to 8th month / last trimester (also premature and or weak calves)
often retained placenta, endometritis and septicaemia
(History with abnormalities in food ?)
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Differential Diagnosis – Abortions (Cattle)

- **Leptospirosis (L. pomona, hardjo etc.):**
  abortions after 6th month of gestation
  atonic and yellowish cotyledones
  amnion and allantochorion edematous
  fetus: hemorrhagic effusions in body cavitis,
  inflammatory changes in kidneys
Differential Diagnosis – Abortions (Cattle)

- **Chlamydia psitacci:**
  - Abortions around 6th to 8th month of gestation (last trimester)
  - Placenta normal or necrotic (also hyperplastic placentitis)
  - Fetus: s/c edema, ascites, petechiation of esophagus and tracheas, liver degeneration
Differential Diagnosis – Abortions (Cattle)

- **Trichomonas fetus:**
  Abortions around 2\textsuperscript{nd} to 4\textsuperscript{th} month of gestation
  Often early death of fetus with partial maceration
  Thin, greyish fluid with purulent flakes characteristic
Fungal abortions (e.g. Aspergillus, Absidia, Mukor, Rhizopus etc.): Abortions mainly around 3rd to 7th month of gestation mostly diphteroid/necrotic placenta fetus: sometimes focally mycotic dermatitis
Wesselsbron Disease (WSL):
also arthropod- borne cirrhosis – clusters with same climatic/seasonal conditions
mortalities in young ruminants
abortions in ewes (never from field), but RVF with much higher percentages of mortality and abortion
WSL is less acute, causes less extensive liver lesions, regularly icterus
As with RVF: haemorrhages from musa and free blood in abomasum (dark brown if partially digested)
Diff. Diagnosis – Abortions (Cattle)

- Other viral:
  - BHV 1 (5<sup>th</sup> to 6<sup>th</sup> month; necrotic placentitis, multiple focal necrosis in liver of fetus)
  - BVD
  - Bluetongue
Differential Diagnosis – Abortions (Cattle)

- Other bacterial:
  - Haemophilus somnus (sporadic abortions)
  - Yersinia pseudotuberculosis (last trimester)
  - Salmonella spp
  - A pyogenes
  - Mycoplasma
  - Coxiella burnetti
Differential Diagnosis – Abortions (Cattle)

- Other: Parasites, e.g.
  - Sarcocystis cruzei
  - Babesiosis
  - Neospora caninum
  - Hammondia pardalis
Differential Diagnosis – Abortions (S. ruminants)

- **Brucella ovis:**
  only affects sheep, abortions in last trimester, changes similar as with B. abortus in cattle

- **Brucella melitensis:**
  mainly goats, rarely sheep and cattle abortions in last trimester
  changes similar as with B. abortus in cattle
  Dams often with fever, weight loss, diarrhoe, mastitis and lamenes
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Differential Diagnosis – Abortions (S. ruminants)

- **Salmonella abortus and dublin:**
  - Abortions in last six weekd of pregnancy or weak new-borns
  - Hemorrhagic-purulent, partly diphtheroid-necrotic placentitis
  - Allantochorion edematous, necrotic and hemorrhagic
The Pathogenesis, Clinical Diagnosis and Differential Diagnosis of Rift Valley Fever in Animals

Differential Diagnosis – Abortions (S. ruminants)

- **Listeria monocytogenes:** abortions in last trimester, similar as in cattle
- **Campylobacter fetus ssp. intestinales:** last two months of gestation, similar as in cattle
- **Yersinia pseudotuberculosis:** abortions at end of pregnancy
Differential Diagnosis – Abortions (S. ruminants)

- **Chlamydia psitacci:**
  abortions in last 2 – 3 weeks of gestation
  placenta either normal or with focal or diffuse
  diphteroid-necrotic inflammations
  fetus: s/c edema, effusion in body cavities, multiple petechiation

- Coxiella Burnetti:
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Differential Diagnosis – Abortions (S. ruminants)

- Other viral:
  - Border Disease
  - WSL (Wesselsbron Disease)
  - Bluetongue
  - Akabane Virus
Differential Diagnosis – Abortions (S. ruminants)

- **Toxoplasma gondii:**
  - abortions at end of gestation
  - keryledones reddish, edematous, multiple necrotic foci
  - fetus: mostly NAD

- Other parasites:
  - Sarcosporidia, Neospora caninum
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Differential Diagnosis – Hepatopathy

- Poisonous plants
- Bacterial Septicemias
- Protozoons
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Differential Diagnosis – Other symptoms

- Rinderpest
- Peste De Petits Ruminants
- Nairobi Sheep Disease
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Pathological Findings in Abortions of African Buffalo
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Male fetus +- 10 months
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Female fetus ± 11 months
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Female fetus +- 11 months- Exungulation
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Female fetus +/- 11 months - Decomposition
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Female fetus +- 4 months
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Female stillbirth, dystocia