Diagnosis of Pregnancy Loss

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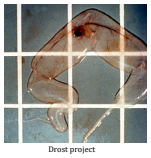
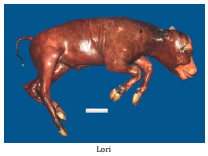
Overview

- Bovine pregnancy loss
- Producer education
- Diagnostic approach
- Samples
- Infectious agents
- Noninfectious agents
- Summary

Pregnancy Loss

- Early embryonic death = <42 days (before organogenesis)
- Abortion = >42 days (after organogenesis)
- Stillbirth


Drost project


Lori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Bovine Abortion

- Abortion rate of 1-2% is acceptable in beef cattle
  - Maybe as high as 10% in dairy cattle
- >3% = concern
- Abortion from mid-gestation to term = loss of $600-1000
- Infectious agents = at least 50-60% of abortions
- Noninfectious = genetic, hormonal imbalances, nutritional deficiencies or excesses, and toxic plants or chemicals

Diagnostic Approach

- Educate producers
- History
- Herd investigation
- Sample collection and submission
- Interpretation of results

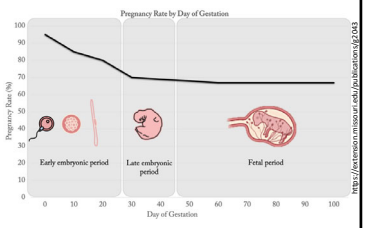
Protocol for Producer

- Identify and isolate the cow
- Collect fetus and **placenta**
- Call vet ASAP
- Package and chill samples and get to lab ASAP
  - NEVER freeze samples
- Records are important
  - Herd history
  - Biosecurity

Preparing the Producer

- Realistic expectation
  - Accurate diagnosis is difficult (<50%)
  - Time consuming
  - Expensive
  - Often unrewarding
- Can't fix what you don't know!

- Majority of pregnancy loss is in the first 30 days of gestation
- Stress
  - Transport – days 1-4 after AI or after 60 days
  - Heat
    - ↑ body temp by 2-2.5° for 9 hours can ↓ embryo development
    - 8-16days post breeding → ↓Progesterone, ↑PGF2α, and ↓embryonic weights

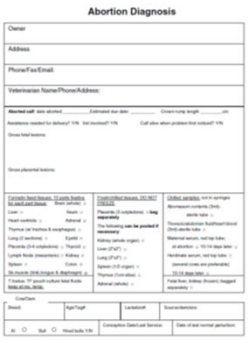


Get a Good History on the Case

- Number abortions/abortion rate
- Gestation age
- Age of the dam
- Duration
- Number of females at risk
- Weak calves
- Clinical signs
- Females sick/retained placenta
- Previous abortions

Broader Herd Investigation

- Vaccination protocol
- Breeding program
- Nutritional program
- Herd recently worked
- Weather
- New additions
- Abortions at neighbors?



Baumgartner: Bovine Reproduction

Before Sampling

- Create a "diagnostic kit" that includes:
  - Submission forms, pencil, pen
  - Double-chambered plastic courier bag
  - Slides, swabs, needles, syringes, scalpels
  - Blood collection tubes (not expired)
  - Slide holders/tube holders
  - Formalin containers
  - Tin foil, whirl-packs, culturette tubes

Slide courtesy of Dr. Krimer

Samples

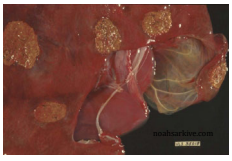
- **Placenta**
- Fetus
- Maternal blood

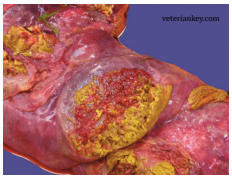
Placenta

Normal changes with time

Placenta

- Intercotyledonary opacities
  - Edema
  - Inflammation
  - Fibrosis
- Fibrin – yellow, friable
- Viral abortions rarely cause gross changes





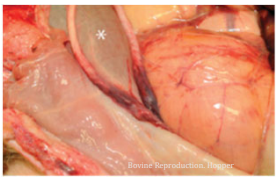
Fetus

- Submit whole fetus or do field necropsy

- Gestational age
- Condition
- Lesions
  - Raised skin plaques = mycotic infection
  - Meconium stain = fetal stress

Fetus

- Signs that was alive at birth
  - Inflation of lungs
  - Milk in abomasum
  - Thrombosis or hemorrhage of umbilical vessels



Fetus

- Liver lesions
  - Necrosis - *Listeria monocytogenes,* BHV-1, *Yersinia pseudotuberculosis,* and *Samonella enterica*

- Abomasal contents
  - *T. foetus, Campylobacter,* and Lepto


Bovine Reproduction. Hopper

Tissue Collection

Formalin fix
- Lung
- Liver
- Kidney
- Spleen
- Heart
- Brain
- Skeletal muscle
- Thymus
- Eyelid
- Abnormal tissue

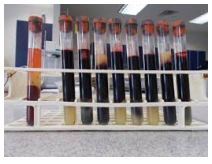
Fresh - chilled
- Lung
- Liver
- Kidney
- Spleen
- Heart
- Brain
- Abomasal contents
- Ocular fluid
- Thoracic fluid

Fetal Serology

- Blood or thoracic fluid
- Test:
  - IgG > 20mg/dL = immune response in fetus
  - BHV-1, BVD, *Leptospira, Neospora, Brucella*, bluetongue virus, and PI3

Maternal Blood

- Elevated titers indicates exposure ONLY
  - Natural exposure vs vaccination
- Many infectious agents cause elevated titer weeks prior to or after abortion
  - Normal levels at time of abortion
- Serial samples
  - 3 weeks post abortion
- Sample non-affected females

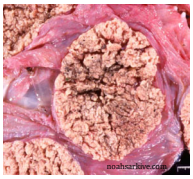


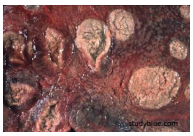
Diagnostic Test

- Bovine Abortion Serology Panel
  - Serum or clotted blood
  - BVD, IBR, *Lepto, Brucella abortus*
  - In state = $22, Out of State = $22
- Bovine Abortion/Reproductive PCR Panel
  - Preputial Wash, Vaginal Swab, Fetal tissue, Abomasum, Placenta
  - BVD types I & II, Brucella, IBR, *Tritrichomonas foetus, Campylobacter fetus, Campylobacter jejuni, Chlamydia, Leptospira, Neospora caninum*
  - In state = $85, Out of State = $100
- Bovine Abortion Panel 2
  - Serum
  - BVD, IBR, BT, Lepto, Neospora
  - In state = $25, Out of State = $30

Brucella abortus

- Abortion rate = 80+% in unvaccinated herd
- Time = 6-9 months
- Lesions
  - Placenta – necrotizing fibrotic placentitis
    - Moroccan leather placenta
  - Fetus – pneumonia
    - Cobblestone texture to the lung surface with small white foci
- Samples
  - Fetal – lung, abomasal fluid
  - Placenta





Campylobacter vaginalis fetus

Vibrio

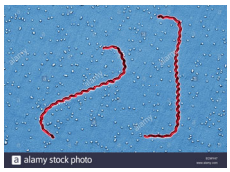
- EED > abortion
- Time = 5-8 months
- Abortion rate <10%
- Lesions
  - Placenta - mild placentitis
    - Hemorrhagic cotyledons & intercotyledonary edema
    - Not retained
- Samples
  - Fetal abomasal fluid and lung
  - Placenta

Chlamydophila abortus

- Sporadic abortions
- Time – late term
- Lesions
  - Placentitis – thickened brown exudate
  - Fetal – pneumonia, hepatitis
- Samples
  - Fetus, placenta

Leptospira

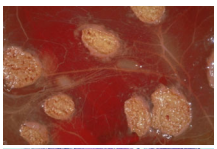
- Abortion rate = 5-40%
- Time – last trimester
- Lesions
  - Placenta – diffuse placentitis
    - Avascular, pale, tan cotyledons
    - Yellow, edematous intercotyledonary areas
  - Fetus – autolyzed
- Samples
  - Placenta, fetus (kidney)

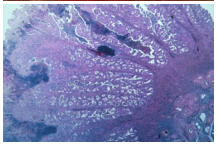


veteriankey.com

Listeria monocytogenes

- Abortion rate = sporadic to >50%
- Time – last trimester
- Lesions
  - Placenta – white necrotic foci on cotyledons
    - Often retained
  - Fetus – autolyzed fibrinous polyserositis, small liver with white necrotic foci
- Samples
  - Placenta, fetus (brain, lung, abomasal contents)





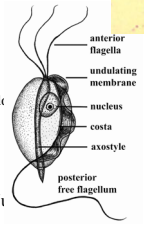
noahsarkive.com

Ureaplasma

- Natural inhabitant of reproductive tract
  - Opportunistic pathogen – takes advantage in stressed/sick animal
- Sporadic abortions
- Lesions
  - Placenta - retained
    - Intercotyledonary areas - thickened, opaque and white to brown
    - Amnionic lesions – multifocal/extensive areas of necrosis, hemorrhage, fibrosis, and mineralization
  - Fetus
    - Interstitial pneumonia
- Samples
  - Placenta, fetus (lung, abomasal contents)

Tritrichomonas foetus

- EED > abortion
  - Sporadic
  - Repeat breeders
- Lesions
  - Placenta – mild placentitis
    - Hemorrhagic cotyledons & thickened intercotyledo areas
    - Pyometra
    - Often retained
- Samples
  - Placenta, fetus (abomasal contents), vaginal/u fluid



www.k-state.edu/parasitology

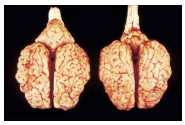
Neospora caninum

- Abortion rate = 30%
- Time – 5-6 months
- Lesion
  - Placenta – none
  - Fetus
    - Microscopic – focal encephalitis, hepatitis
    - Mummification rarely
- Samples
  - Placenta, fetus (brain, kidney, lung, liver, skeletal muscle), maternal blood

noahsarkive.com

BVDV

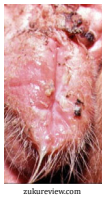
- Abortion rate = low
- Time – up to 4 months
- Lesions
  - Placenta – retained
  - Fetus – variable
    - Autolyzed, mummified, hydrocephalus, cerebellar hypoplasia, microphthalmia, retinal dysplasia, cataracts, brachygnathism
- Samples
  - Placenta, fetus (lung, liver, skin, heart)



Bovine Herpes Virus 1

Infectious Bovine Rhinotracheitis

- Abortion rate = 5-60%
- Time – 4 months to term
- Lesions
  - Placenta – usually none
    - Necrotizing placentitis
  - Fetus – autolyzed, focal liver necrosis
  - Maternal
    - Ulceration of nose, respiratory disease, genital lesions
- Samples
  - Placenta, fetus (kidney, adrenal, liver, lung), maternal blood



zukureview.com

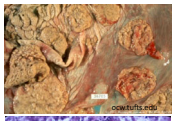
Bluetongue

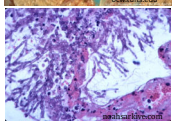
- Endemic in US ruminant population
- Abortion rate = low
- Time – variable
- Lesions
  - Fetus – autolyzed
    - Hydrocephaly, arthrogryposis, dwarfism, excessive gingival tissue, microphthalmia
- Samples
  - Placenta, fetus (brain, spleen)

calfology.com

Mycotic Infections

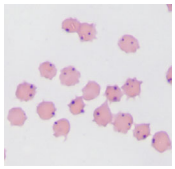
- *Aspergillus fumigatus* – most common
  - Also *Mucor, Rhizopus*
- Abortion rate = sporadic to 5-10%
- Time – 4 months to term
- Lesions
  - Placenta - severe necrotizing placentitis, enlarged cotyledons, leathery thickened intercotyledonary areas
  - Fetus – autolyzed
    - Gray round lesion on neck and head
- Samples
  - Placenta, fetus (abomasal contents, lungs, skin,)





Anaplasma marginale

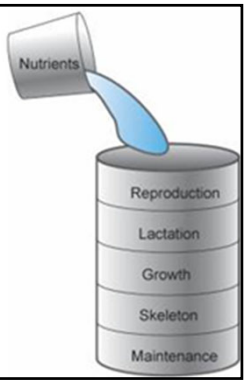
- Abortion rate = low
- Time – variable
- Progressive anemia
  - Abortion due to hypoxia in any stage of gestation
- Lesions
  - Fetus - splenic enlargement, lung and liver petechiation
- Samples
  - Blood, fetus, placenta



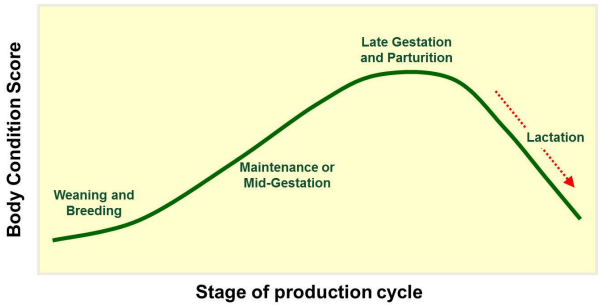
www.eclinpath.com/ngg_tag/anaplasma

Inadequate nutrition

- Can't starve a profit out of a cow
- What is BSC?
- When nutrients are scares, body has to make a decision of what functions it will support
  - What is the priority?



Normal Changes in Body Condition Score



Effect of body condition during the breeding season on pregnancy

	BCS ≤4	BCS 5	BCS ≥6
Percent pregnant after 150 days	58	85	95

Body Condition Score

- Optimal BCS for calving and breeding of beef cattle =6-7
- Scoring cattle 2 months before calving season starts allows for sorting and supplemental feeding of thin cattle +/- culling
- Thin cows < fertile
- Thin or fat cattle also have more dystocia and prepartent disease

Nutritional Deficiencies

- 'Can't starve a profit out of a cow'
  - Emaciation → abortion
- Protein
  - Late term gestation
  - Premature, dystocia, neonatal mortality

Herris Maxwell

Nutritional Deficiencies

- Vitamin A
  - Late term abortion
  - Weak, blind calves (retinal development)
- Iodine
  - Hyperplastic goiter
  - Hairless, weak calves
- Selenium
  - Nutritional muscular dystrophy, premature calves, placentas

pinsdaddy.com/goiter-in-cow

Nutritional Excesses

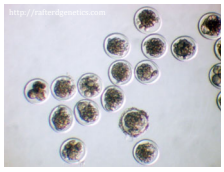
- Iodine
  - Abortion
- Selenium
  - Weak calves
  - Abortion

Hormonal Imbalances

- Endotoxemia & metritis
  - Inflammation → Endogenous PGF2α → CL lysis → Abortion
- Estrogen
  - Silage, Legumes, & Poultry litter → Abortion

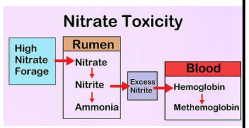
Heat Stress

- High ambient temperature contribute to early embryonic death
  - <30days
- Fetal hypotension, hypoxia, and acidosis



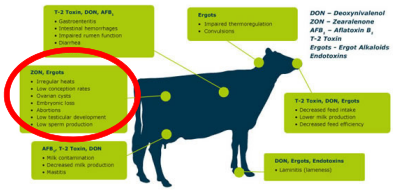
Toxins

- Nitrates
  - Methemoglobin → Hypoxia → EED & Abortion
  - Drought
  - Chocolate brown blood
  - Clinical signs – bluish mucous membranes, staggers, weakness, death
  - Treatment – methylene blue
    - 4mg/lb IV



Toxins

- Mycotoxins – zearalenone
  - Estrogen-like activity → Abortions
- Ergot alkaloids
  - Abortions



Genetic

- Happens <90 days in gestation
- Caused by:
  - Lethal genes
  - Chromosomal abnormalities

Summary

- Diagnosis can be difficult
- History and samples are key
- Clinical finding + diagnostic result + herd evaluation = BIG PICTURE
- More causes than on the abortion panel

Questions?

References

Understanding Heat Stress Through Bovine Assisted Reproductive Techniques

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Abstract

The development of Assisted Reproductive Techniques (ARTs) has been critical for determining the physiology underlying the negative consequences of heat stress on fertility. Fixed-timed insemination, cryopreservation of sperm, and embryo transfer are commonly incorporated clinically to preserve fertility rates. Outcomes of heat stress research highlight the need to manage hyperthermia, regardless of cause, particularly around estrus and the preceding estrous cycle. However, it is unknown if chronic heat stress is simply the cumulative effects seen in acute heat stress of multiple periods. To further understand heat stress and develop new solutions, it is likely that ARTs will remain a cornerstone.

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Routine Procedures of Small Ruminants in the Field

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Outline

- Procedure, anesthesia, post procedure care:
  - Physical exam and the client
  - Castration
  - Vasectomy
  - Epididymectomy
  - Disbudding

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Physical exam and the client

- Body condition score
- Parasite control
- Ensure vaccination status

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3

Sedation protocols

- Xylazine & ketamine (short term anesthesia)
  - Xylazine
    - 0.1-0.2 mg/kg IV or IM
      - IM must wait ~ 10 minutes before administering ketamine
  - Ketamine
    - 2-3 mg/kg IV or 6.6-11 mg/kg IM
- Xylazine & Midazolam (10-15minutes)
  - Xylazine
    - 0.05-0.2 mg/kg IV
  - Midazolam
    - 0.2-0.3 mg/kg IV

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Lin H, 2022: Field anesthesia

4

Sedation protocols

- Midazolam (15-20 minutes sedation)
  - 0.25-0.5 mg/kg IV
- Ketamine
  - 4 – 7.5 mg/kg IV
  - +/- Butorphanol 0.2-0.4 mg/kg IV
- Surgical anesthesia
  - Ketamine
    - 2 mg/kg IV
  - Medetomidine
    - 0.02 mg/kg

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Lin H, 2022: Field anesthesia

5

Castration

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Castration

- When can I castrate him? He's driving me CRAZY
  - **Ismail et al. 2007
  - 3 months versus 5 months
- Production animals
  - Meat animals destined for slaughter
- Ensure vaccination status

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**Ismail et al., 2007, Effects of castration on penile and urethral development in Awassi lambs

7

Castration: Procedure options

- Surgical Castration
  - Manual extraction
  - Henderson
  - Pinhole castration
- Bloodless
  - Banding
  - Burdizzo emasculatome
  - Pinhole

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Surgical Castration

- Identify both testicles are descended
- Local analgesia
- Incision of the distal 1/3 of scrotum
  - Allowing drainage
  - Scalpel
    - Horizontal incision
    - Vaginal tunic remains in place
    - No tissue flaps remaining
  - Newberry
    - Vertical incision
      - Incises lateral walls and median septum
    - Must ensure equal parts of scrotal skin included
      - Avoid pocket formation

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**Edmondson, Shipley 2021; Baird, Wolfe 1999

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Surgical Castration

- Exposure of both testes
- Closed castration
- Stripping up of fascia and pulling down on testicle
  - * both ME method and Henderson require some level of exteriorization*
- Pull method
  - Strip up fascia and pull ventrally on testicle
  - Want testicle to break proximal to pampiniform plexus
    - Long ductus deferens
  - Increased risk of herniation possible**
    - Place pressure on inguinal ring area

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**Edmondson, Shipley 2021

10

Surgical Castration

- Henderson tool method
  - "Bloodless" castration
  - Concave side proximal to testicle
  - Slowly begin to twist testicle
  - Twisting cranial to pampiniform plexus create hemostasis

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Photo: Courtesy of Jenna Stockler

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Surgical Castration: Complications

- Post operative infection
  - Most common with large amounts of fat in the incision
  - Myiasis
- Inguinal herniation
- Hemorrhage
  - Depending on method utilized
    - Panpiniform plexus
- Tetanus
  - Clostridium tetani
- Incomplete castration
- Penile involvement

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**Baird, Wolfe 1999

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Banding

- Necrosis of tissue→ sloughs
  - 7-10 days
- Young animals
  - < 1 week age lambs and kids
  - No > 3-4 months of age
    - Testicles maybe too large for the band
- Restraint
  - Wheelbarrow
  - Lateral with limbs restrained

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**Edmondson, Shipley 2021

13

Banding

- Procedure
  - Ensure 2 testicles present
  - Identify the penis
    - Avoid inclusion
  - Must ensure both spermatic cords are included in band
  - Testes distal to band
- Advantage
  - No advanced training to perform
  - Inexpensive

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Banding

- Complications
  - Only 1 testicle
    - Serous cord/ necrosing scrotum with 1 semi-intact testicle
    - Male like behaviors if testicle still intact
      - +/- fertility
  - If penile inclusion
    - Penile amputation
  - Band too loose
    - Edema of scrotum
    - Partial occlusion of blood and lymph
      - Pain

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**Edmondson, Shipley 2021

15

Banding

Advantages

- No advanced training to perform
- Inexpensive

Disadvantages

- 7-10 days to slough off
- Necrotic tissue
  - Tetanus
  - Flies
  - Infection

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Burdizzo

- Atrophy of testes with an intact scrotum
- Procedure
  - 2 testicles identified
  - Each testis pulled ventrally into apex of scrotum
    - Spermatic cord manipulated laterally
  - 2 crushing sides on each spermatic cord
    - 10 second crush time
    - Proximal and distal crushing zone
  - No not include median raphe

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**Edmondson, Shipley 2021

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Burdizzo

- Complications
  - Inclusion of median raphe
    - Necrosis and sloughing of scrotal skin
  - Fail to crush the spermatic cord
  - Penile inclusion

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**Edmondson, Shipley 2021

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Burdizzo

Advantages
- No advanced training to perform
- Inexpensive
- Decreased stressed & pain in older animals

Disadvantages
- Failure if done improperly

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Pinhole Castration

- Pinhole
  - Describedby Ponvijay, 2007
    - Calves
  - Rams: Fazili et al. 2009
- Procedure
  - Ring block at proximal 1/3 scrotal neck
  - Hypodermic needle placed medially
    - Suture put through
  - Needle removed and cord moved laterally
  - Needle replaced thorough original hole
  - Suture fed through needle and knots placed in subcutaneous tissue

Pinhole Castration: A Novel Minimally Invasive Technique for In Situ Spermatic Cord Ligation

KOMBAIRAJU S. PONVIJAY, MVSc

Evaluation of pinhole castration technique in rams

M.R. Fazili[a,*], H.K. Bhattacharyya[a], B.A. Buchoo[a], M.A. Kirmani[b], M.M. Darzi[c], I. Khan[d]

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Fazili et al, 2009: Pinhole castration in rams

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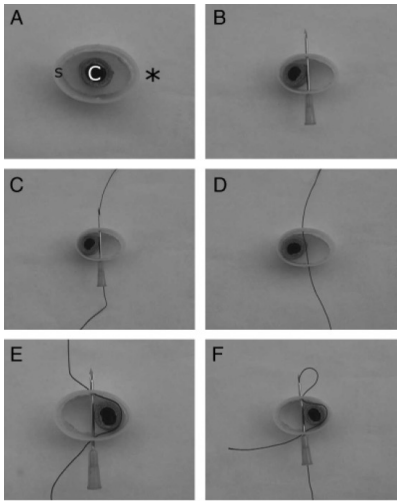
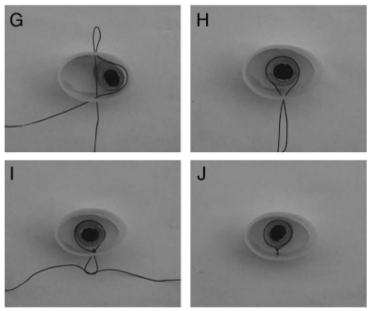


Pinhole Castration: A Novel Minimally Invasive Technique for In Situ Spermatic Cord Ligation

KOMBAIRAJU S. PONVIJAY, MVSc



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Fazili et al, 2009: Pinhole castration in rams

21

Castration: Post Operative Care

- NSAID
  - Banamine (labeled)
    - 1.1 mg/kg -2.2 mg/kg
    - Intravenous route
    - Q 12- 24 hours
  - Meloxicam (extra label)
    - 0.5-1 mg/kg
  - In conjunction with local anesthetics

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Castration: Local anesthesia

- 2% lidocaine
  - Young: Dilute to 0.5 - 1% final concentration
    - 1:1 ratio
  - Dose: 6-7 mg/kg*
- Spermatic cord
  - Each cord (cremaster muscle)
- Spermatic neck
  - Reported in large ruminant
- Scrotal incision line block

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*Venkatachalam, D. Toxicity and pharmacokinetic studies of lidocaine and its active metabolite, monoethylglycinexylidide, in goat kids. 2018

23

Castration: Anesthesia

- IV, IM, Intratesticular
- Sedation
  - Surgeon preference
    - Midazolam
      - 0.2-0.4 mg/kg IV
    - Xylazine
      - 0.05-2 mg/kg IV

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Vasectomy

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Vasectomy

- Teaser male
- Ligation of the ductus deferens
- Time to post op utilization
  - 1- 2 weeks

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Vasectomy: Procedure

- Aseptic preparation
- Positioning of animal
  - Rump
  - Right lateral recumbency
- Identify both spermatic cords
  - Ductus deferens readily palpable just distal to teats
  - Firm structure in spermatic cord
- Incision
  - Cranial
  - Proximal near teats

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**Edmondson, Shipley 2021

27

Vasectomy: Procedure

- Incision
  - Over ductus deferens 3-4 cm incision
  - Incise through skin and vaginal tunic
  - Ductus deferens is then elevated and exposed
  - Ligations placed proximal and distal 6 cm apart
  - 6 cm is excised
  - Tunic and skin closed routinely
  - Repeat on remaining side
- Confirm DD was taken
  - Histopathology
  - Spermiogram from DD
- Tag/Identify the teaser male

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**Edmondson, Shipley 2021, Baird, Wolfe 1999

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Vasectomy: Complications

- Sperm granulomas
  - ~80 rams
  - No apparent clinical concern
    - Gouletsou et al. 2008
- Post operative infection

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**Edmondson, Shipley 2021, Gouletsou et al, 2008

29

Vasectomy: Local anesthesia

- Local anesthesia
  - 2% lidocaine
  - Line block at sight of incision
- Lumbosacral epidural
  - Fractious animals
- Sedation

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**Edmondson, Shipley 2021

30

Epididymectomy

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31

Epididymectomy: Procedure

- Sedation
  - Surgeon preference
- Time to post op utilization
  - 2-3 weeks

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32

Epididymectomy: Procedure

- Sedation
- Distal 1/3 scrotum aseptically prepped
- Anesthesia
  - Lumbosacral epidural
  - Local
    - Skin covering tail of epididymis

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33

Epididymectomy: Procedure

- Incise through skin and ventral tunic
  - cranial to caudal ventrally over tail of epididymis
- Incision length should allow protrusion of epididymis through the skin
  - ~2.5 cm
  - Pressure placed on testicle to assist in exteriorization of the epididymis
- Retract the epididymis from incision
  - Towel clamp
- Adequate exteriorization
- Hemostats placed on proximal and distal
- Sharp excision of the epididymis

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**Edmondson, Shipley 2021, Wolfe 1999

34

Epididymectomy: Procedure

- Closure
  - Second intention
    - Preferred*
  - Skin suture

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**Edmondson, Shipley 2021, Wolfe 1999

35

Epididymectomy: Complications

- Hemorrhage
  - If tunica albuginea is incised
  - Avoid when excising the epididymis
- Infection
  - Especially with excess hemorrhage and second intention
  - Abscess formation

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**Edmondson, Shipley 2021, Wolfe 1999

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Disbudding

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Disbudding

- < 2 weeks of age
- Permanant removal of the horn and germinal epithelium
- If germinal epithelium is not appropriately removed abnormal horn growth can occur
  - Scur formation

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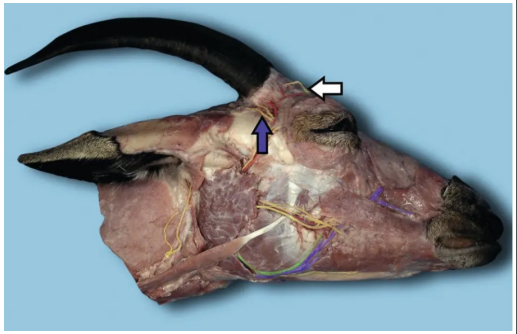
Disbudding: Analgesia

- Cornual block
  - Cornual branch of lacrimal duct
  - Small depression below zygomatic arch
    - ½ way between lateral canthus and horn base
- Infratrochlear
  - Cornual branch of the infratrochlear branch
  - Small divot can be palpated
  - ½ way between medial canthus and horn base



White arrow: Cornual branch of the infratrochlear nerve
Blue arrow: Cornual branch of the lacrimal nerve

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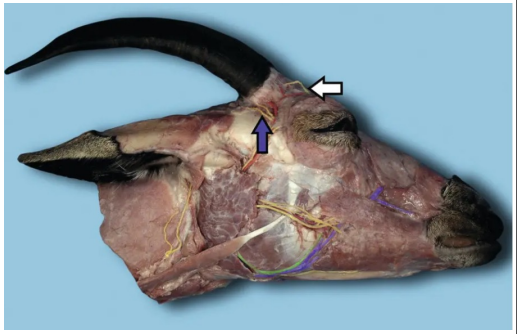
Photo: Rush and Stockler, 2022

39

Disbudding: Analgesia

- Line block
  - Caudal horn base (usually larger animals)
- Ring block
  - Circumferential around the horn base



White arrow: Cornual branch of the infratrochlear nerve
Blue arrow: Cornual branch of the lacrimal nerve

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Photo: Rush and Stockler, 2022

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A needle: Infratrochlear block
B needle: Cornual block

Photo: Rush and Stockler, 2022

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Disbudding: Procedure

- Sedation
- Clip hair surrounding horn bases
- Local analgesia
- Electric dehorning iron is rocked on the horn bud
  - NO MORE THAN 2 SECONDS
    - Cerebral necrosis
- The horn bud will be removed
- Continue burning until copper color

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Disbudding: Complications

- Heat induced meningitis and malacia
  - Neurologic signs
  - Blindness
  - Rarely reversable
  - Treatment includes:
    - Dexamethasone 1-2 mg/kg IV, mannitol 0.25-1 mg/kg IV over 5 minutes
- Retention of germinal epithelium
  - Scur formation

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Disbudding: Other options

- Surgical dehorn
  - Clip hair, sedation, prep, local analgesia
  - Circumferential incision around the horn base removing horn bud and germinal epithelium
  - Burn incision for hemostasis
- Caustic paste
  - Clip hair around horns and place petroleum jelly around eyes
  - Do not allow to nurse and keep put of rain for at least 6 hours

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Slide 1

Small Ruminant: Breeding Soundness Examination

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COLLEGE OF VETERINARY MEDICINE

Slide 2

Outline

- BSE: When and Why
- Parts of the BSE
- Scrotal circumference and its role
- Breeding potential classification
- Spermiogram abnormalities

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Slide 3

Breeding soundness examination

- When?
  - 60 days prior to the breeding season
  - Short day breeders
    - SE USA
      - Late September – late February
    - Season can alter results
      - Out of season
        - Rams→ decreased size and less firm testes
  - Post pubertal

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Slide 4

Breeding soundness examination

- Why?
  - Evaluation of the male
    - Ability to impregnant females in a defined period of time**
    - "Deliver and produce sperm in sufficient quality and quantity to achieve high conception rates and fecundity"**
  - Recover
  - Replace
    - 10% **

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**Tibary A, Bouhliq R, and El Allali K. Ram and buck breeding soundness examination. *Rev. Mor. Sci. Agron. Vét.* 2018; 6(2), pp.241-255.

Slide 5

Puberty

- Ram
  - ~ 6 months
  - Ewe exposure can hasten puberty onset
- Buck
  - Breed dependent
    - Boer→4-5 months
    - Pygmy → 2-3 months
    - Dairy → ~5-6 months

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Slide 6

Parts of the BSE

- Physical examination
- Reproductive examination
- Scrotal circumference
- Spermiogram

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Slide 7

Physical examination

- **PARASITES**
- Confirmation
  - Limbs and mouth
- Hoof health
- Systemically healthy
  - Caseous lymphadenitis
  - Dermatitis
- Eyes and Coat
- Body Condition Score
  - 3.5/5

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Slide 8

BSE: reproductive exam

- External genitalia
  - Penis
  - Prepuce
    - Preputial orifice
  - Testicles
    - Out of season changes
    - Ultrasound +/-
  - Epididymitis

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Slide 9

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Slide 10

Epididymitis

- Inflammation of epididymis
- Mature ram
  - *Brucella ovis*
- Young ram
  - *Histophilus somnii*
  - *Actinobacillus seminis, Haemophilus spp.*
  - Animals on increased nutrition plane

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Slide 11

Epididymitis: *Brucella ovis*

- ROI
  - Mucous membranes,
    - Oral ingestion, homosexual riding, naso-genital contact
  - Venereal transmission
  - Placental infection**
- Affinity for epididymis and accessory sex glands
- Semen quality
  - Decreased early as 2-3 PI
    - Reduced motility and concentration
    - Detached heads

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**Bulgin 1990, Picard-Hagen 2015

Slide 12

Epididymitis: *Brucella ovis*

- Diagnosis
  - Presumptive
    - Palpation
      - ~20 % clinical signs
    - Spermiogram
      - WBCs
      - Morphology abnormalities
  - Definitive
    - Serology
    - 2 tests 4-8 weeks apart**
    - Histopathology

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**Edmondson, Shipley 2021

Slide 13

Epididymitis: *Brucella ovis*

- Recommendations***
  - Annual BSE
  - Cull rams with epididymitis
  - Virgin rams
  - Biosecurity (vaccine not legal in US)

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**Ridler 2011

Slide 14

Systemic wellness

- Additional testing
- Buck
  - *Corynebacterium pseudotuberculosis*
  - *Caprine arthritis-encephalitis (CAE)*

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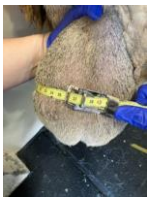
**Tibary et al. 2018

Slide 15

Scrotal circumference

- Estimates volume of testes
  - Testicular volume directly correlated with daily sperm output
- Volume → testicular parenchyma
  - Seasonal changes
    - ⇩ 2-3 cm difference
- Serving capacity



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Slide 16

Scrotal circumference: Rams

Age (months)	Minimal Circumference (cm)
5-6	29
6-8	30
8-10	31
10-12	32
12-14	33
14	33
18+	34

8-14 months Size (cm)	Score	Over 14 months Size (cm)
Less than 28 cm	Questionable	< 32
28-36	Satisfactory	32-40
>36	Excellent	>40

Adaptation from Tibary et al., 2018

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Diagram1: Purdue University Extension, Buck and Ram BSE

Slide 17

Scrotal circumference: Bucks

- Age in months
  - >14 months
    - SC: >25 cm
- Standards by weight
  - >40 kg breeds
    - ≥25cm
  - Dairy bucks ≥45 kg
    - 25-28 cm
  - Meat bucks ≥45 kg
    - 26-29 cm

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Purdue and Tibary et al.

Slide 18

Semen Collection & Evalution

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Slide 19

Collection methods

- Electroejaculation
- Artificial vagina

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Photo A: Tibary A, et al. 2018, Ram and Buck BSE

Slide 20

Electroejaculation

Advantages

- Readily available for single sample
- No training required
- Can collect while animal is sedated/anesthetized
  - 2-5 times , 5-10 minutes apart

Disadvantages

- Inconsistent sample
- ⇧ seminal fluid, ⇩ sperm conc.
  - Increased total volume
    - Compared with AV
- Stress on animal
  - Often vocalize

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**Edmondson, Shipley 2021.

Slide 21

Artificial vagina

Advantages

- ⇧ Physiologically normal sample
  - Compared to EE
- Less stress on animal
  - Post training
- Can help evaluate libido
- Faster than EE if trained

Disadvantages

- Training of animal required
- Unable to utilize in sedated animal
- Female in estrus
  - Usually required

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Slide 22

Collection: Electroejaculation

- Sedation if needed
  - Xylazine
    - 0.05-0.1 mg/kg IV or IM
    - Beware pulmonary edema
  - Reversal
    - Atipamezole

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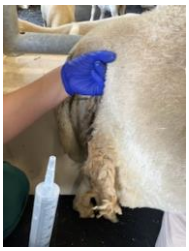
Slide 23



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Slide 24

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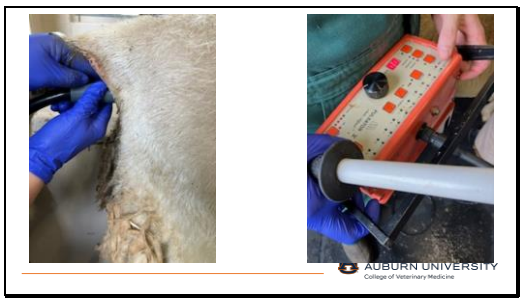
Slide 25



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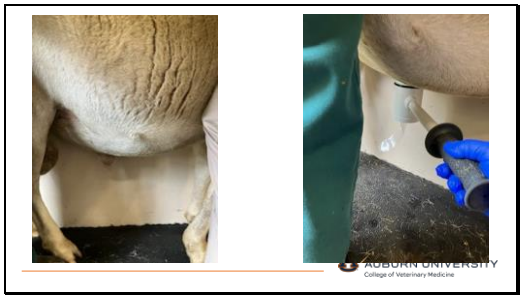
Slide 27



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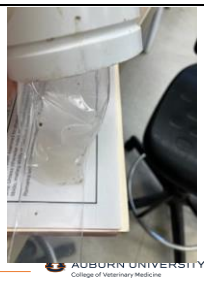

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Slide 29

Spermiogram

- Indicator of testicular and epididymal health
- Presence of a predominant abnormality/defect--> insult timeline
  - Spermatogenesis
    - 48 days seminiferous cycle
    - 12 days epididymal transport
    - 60 days → complete

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Slide 30

Spermiogram: Motility

- Motility
  - Gross
    - Hurricane/wave motion
    - 4x
  - Presence of round cells
    - Spheroids
    - White blood cells
  - Individual
    - Dilute
      - Saline or extender
      - Cover slip
    - Edge of cover slip
    - 4x-10x

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Slide 31

Spermiogram

- Stain/slide preparation
  - Eosin/nigrosin
  - Diff-quick
- 100 sperm @ 100x magnification
- Presence of a predominant abnormality/defect→insult timeline
  - Spermatogenesis
    - 60 days complete
    - 12 days epididymal transport
    - 48 days spermatogenesis

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Slide 32

Spermiogram: Morphology

- Morphology
  - Head
  - Midpiece
  - Tail

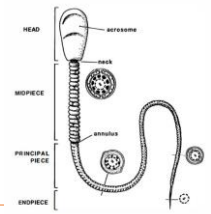

Figure: 3.5: Barth A., Oko R., Abnormal morphology of bovine spermatozoa

Slide 33

Spermiogram

- Head and midpiece defects
  - Testicular --> spermatogenesis
- Cytoplasmic droplets
  - Epididymal--> transport
- Improper semen handling
  - Not true defects
  - Tail defect
    - Stain osmolality
    - Cold shock

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Slide 34

Spermiogram: Concentration

Ejaculate appearance	Sperm concentration 10^9/ml	Comment
Watery	<0.5	Probably infertile
Cloudy	0.5-1	Probably infertile
Milky	1-3	Low fertility
Creamy	3-4	Probably fertile
Thick Creamy	4	Probably fertile

Photo and chart: Tibary, 2018 Ram and Buck BSE. Table 5

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Slide 35

BSE: Classification

- Ram
  - Excellent, satisfactory, questionable, unsatisfactory
- Buck
  - Excellent, satisfactory, questionable

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Slide 36

Classification requirements: Ram

- Unsatisfactory
  - Fails to meet minimum of single portion of examination
  - Morphology: < 50% normal
  - Motility: < 30%
- Questionable
  - One or greater questionable parameter (fixable)
  - "Deferred"
  - Recheck 60 days
  - Morphology: < 70% normal
  - Motility: < 30%

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Slide 37

Classification requirements:Ram

- Satisfactory
  - Meets all the minimum of all portions of the examination
  - Morphology: ≥ 70% normal
  - Motility: ≥ 30% progressively motile
- Excellent
  - Above and beyond all the minimum requirements
  - Morphology: ≥ 90% normal
  - Motility: > 50% progressively motile

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Slide 38

Classification: Serving Capacity

- Ram
  - Excellent
    - 1:100 ewes
  - Satisfactory
    - 1:50-60 ewes

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Slide 39

Serving Capacity:

Ram : Ewe Ratio	Management condition
1:50	Mature ram paddock mating
1:25	Young ram paddock mating
1:30	Rough terrain
1:15	Synchronized flock
1:10	Out of season breeding

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Recommendations from Tibary et al., Ram and Buck BSE, 2018

Slide 40

Reference ranges: Rams

Class	Scrotal Circumference (<14 months)	Scrotal Circumference (>14 months)	Motility	Morphology	Debris
Excellent	> 33 cm	> 35 cm	> 50 %	> 90%	no white blood cells
Satisfactory	> 30 cm	> 33 cm	> 30 %	> 70 %	no white blood cells
Questionable	< 30 cm	< 33 cm	< 30 %	< 70 %	may have white blood cells

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Diagram: Purdue University Extension, Buck and Ram BSE

Slide 41

Reference Ranges: Bucks

Class	Scrotal Circumference (<14 months)	Scrotal Circumference (>14 months)	Motility	Morphology	Debris
Excellent		> 25 cm	> 50 %	> 90%	no white blood cells
Satisfactory	(Information not	available)	> 30 %	> 70 %	no white blood cells
Questionable			< 30 %	< 70 %	may have white blood cells

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Diagram: Purdue University Extension, Buck and Ram BSE

Slide 42

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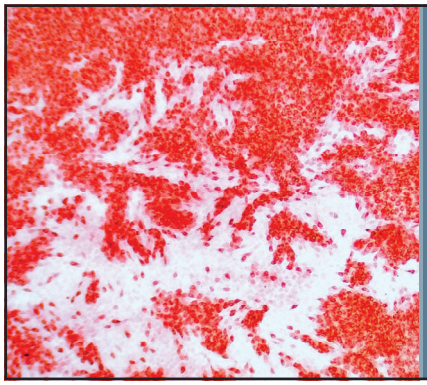


An Update on the World of Bovine Viral Diarrhea Virus

SHARI M. KENNEDY, THOMAS PASSLER, SHOLLIE M FALKENBERG, MANUEL F. CHAMORRO, CONSTANTINOS C. KYRIAKIS, PAUL H. WALZ, VIENNA R. BROWN, TIM LINDER.

1

Worldwide Antigen prevalence 2010-2021

(Su, Wang et al. 2022)

TABLE 2 Antigen prevalence of Bovine viral diarrhea virus of cattle in the word.

	No. studies	No. tested	No. positive	% (95% CI*)
Area*				
Asia	43	27,333	2,957	16.75% (11.27–23.04)
Europe	2	1,138	96	23.27% (0.00–89.41)
North America	1	7,544	24	0.32% (0.20–0.46)
South America	5	10,196	411	10.55% (2.63–22.82)
Sampling years				
Before 2017	30	26,608	1,625	17.18% (11.08–24.27)
After 2017	21	9,513	1,156	17.91% (10.33–26.99)

2

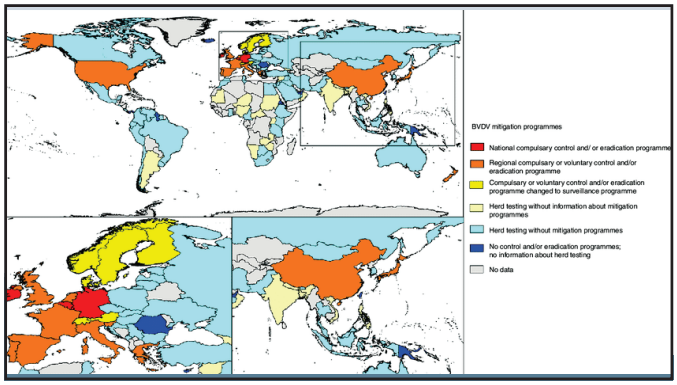
Worldwide Antibody prevalence 2010-2021

(Su, Wang et al. 2022)

TABLE 4 Antibody prevalence of Bovine viral diarrhea virus of cattle in the word.

	No. studies	No. tested	No. positive	% (95% CI*)
Area				
Asia	71	53,457	23,597	42.03% (35.99–48.18)
Europe	1	180	82	45.56% (38.32–52.88)
North America	1	385	184	47.79% (42.81–52.79)
South America	1	390	298	76.41% (72.06–80.50)
Africa	3	937	424	46.13% (26.82–66.06)
Sampling years				
Before 2017	55	33,177	15,345	43.63% (37.25–50.13)
After 2017	19	11,619	6,319	41.11% (27.05–55.95)

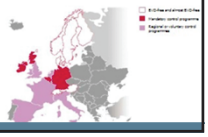
3



4

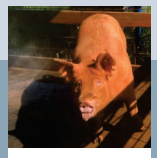
Implications of a resourceful virus

- The economic impact can be evaluated for BVDV by assessing differences in performance in the presence or absence of a PI animal
  - The average direct losses per:
    - naïve dairy cow were $199.50
    - beef cow $174.60
    - animal in the feedlot $93.52
- Cost of testing
- Exposure of heterologous hosts
  - sheep, goats, deer, camels, alpaca, pigs, and a wide array of ungulate wildlife
  - Seroprevalence varied from 0-45% among herding districts for Reindeer in Norway
  - Feral swine seroprevalence ~6%
    - Individual state range 0-6.7%
    - CA, OK, TX highest seroprevalence
- Fetal bovine serum (500 ml bottles)
  - Super value - $446
  - Value FBS - $676
  - Premium - $800 US, $1656 New Zealand, $1608 Australia
  - Specialty - FBS call for pricing



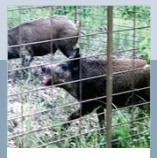
5

BVDV Heterologous hosts



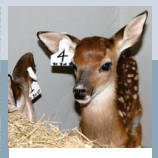
DOMESTIC SWINE

Genetic Changes PI vs CI



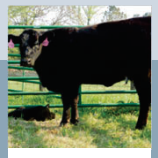
FERAL SWINE/WILD PIGS

Seroprevalence in US



WHITE-TAILED DEER

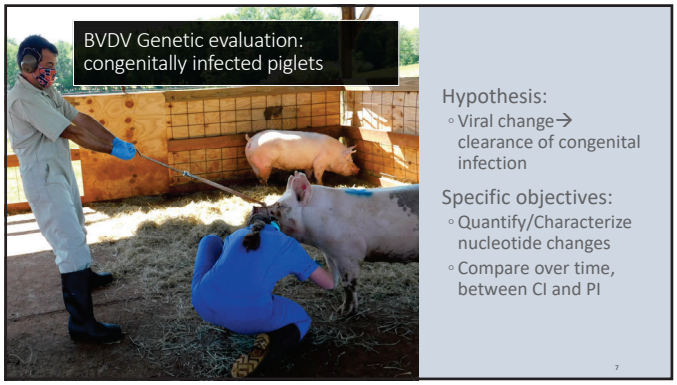
Commercial Test Comparisons



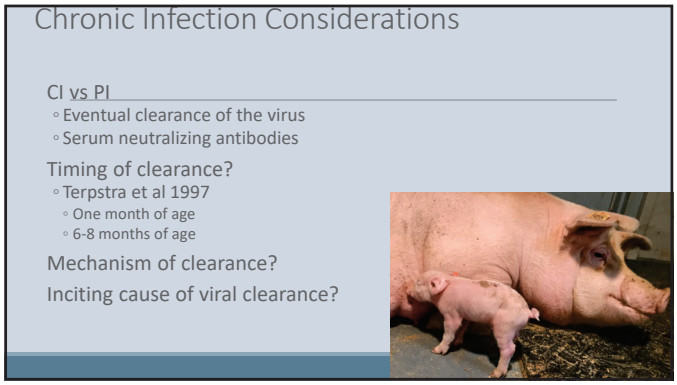
CATTLE

Swine vs Bovine BVDV PI Genetic

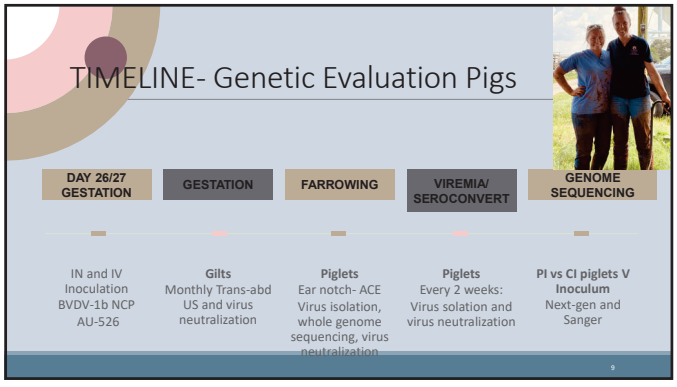
6


BVDV Genetic evaluation:
congenitally infected piglets
Hypothesis:
◦ Viral change→ clearance of congenital infection
Specific objectives:
◦ Quantify/Characterize nucleotide changes
◦ Compare over time, between CI and PI
7

7


Chronic Infection Considerations
CI vs PI
◦ Eventual clearance of the virus
◦ Serum neutralizing antibodies
Timing of clearance?
◦ Terpstra et al 1997
◦ One month of age
◦ 6-8 months of age
Mechanism of clearance?
Inciting cause of viral clearance?

8


TIMELINE- Genetic Evaluation Pigs
DAY 26/27 GESTATION
GESTATION
FARROWING
VIREMIA/ SEROCONVERT
GENOME SEQUENCING
IN and IV Inoculation BVDV-1b NCP AU-526
Gilts
Monthly Trans-abd US and virus neutralization
Piglets
Ear notch- ACE
Virus isolation, whole genome sequencing, virus neutralization
Piglets
Every 2 weeks:
Virus solation and virus neutralization
PI vs CI piglets V Inoculum
Next-gen and Sanger
9

9

Results

- 4 Litters- 2019
  - 26 live-born
  - 9 antigen positive at birth
    - Antigen Capture ELISA
    - PCR
  - 4D- chronically infected
    - Seroconverted ~5.5-6 months of age

10

Results: Repeat

- 3 Litters- 2020
  - 34 live-born piglets
  - 7 antigen positive at birth
    - Antigen Capture ELISA
  - 6 virus positive at birth
    - Virus isolation
  - 8H Chronic Infection
    - Seroconverted- ~6-8 weeks

11

Results- BVDV sequencing

WHOLE-GENOME/NEXT-GEN

98.8% Identical to AU526 460F6 inoculum

4s vs Inoculum
- 2 polymorphic sites E2

8s vs Inoculum
- 1 polymorphic site E^{RNS}
- 5 polymorphic sites in E2

SANGER

15 congenitally infected piglets
- Most of E1, E2, E^{RNS} Complete
- 1 polymorphic site E^{RNS}
- 5 polymorphic sites in E2

Compare to WGS/NGS- pending

M&M paper for lab tech

12

Phylogenic analysis

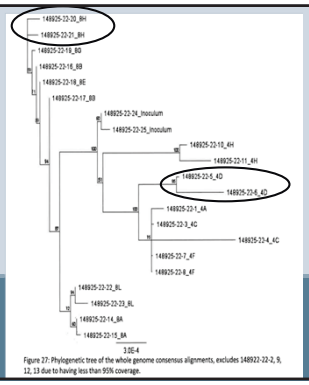


Figure 27: Phylogenetic tree of the whole genome consensus alignments, excludes 148922-22-2, 9, 12, 13 due to having less than 95% coverage.

13

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Feral Swine/wild pig seroprevalence

Manage the Damage
Stop Feral Swine

USDA Wildlife Services

Current US Feral Swine/Wild Pig BVDV knowledge:

- 0% Great Smokey Mountains National Park
- doi: 10.7589/0090-3558-30.1.103.

Seroprevalence rate for states with higher feral swine/wild pig or cattle population states

14

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Feral Swine Seroprevalence

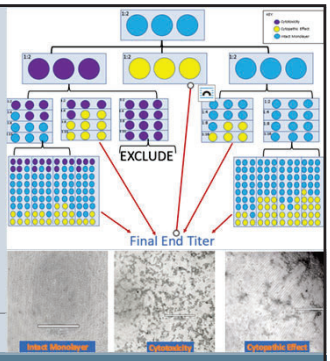
- Objective:
  - Determine BVDV seroprevalence in wild pigs in US
  - Determine if age, sex, or location associated with positive antibody titer

15

Methods

Approach:

- 945 serum convenience samples from 17 states collected by USDA-ARS NFSDM program and Auburn University College of Forestry, Wildlife and Environment
- Virus neutralization- 1:2 serial dilutions until final titer



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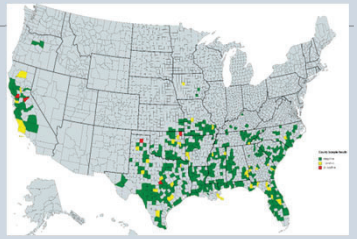
Feral swine BVDV seroprevalence: Results

- 67 samples excluded from cytotoxicity
- 878 samples analyzed
- Total BVDV seroprevalence= 5.8%
- BVDV-1b seroprevalence= 4.4%
- BVDV-2a seroprevalence= 3.6%
- Individual states 0-16.7%
- No difference in mean antibody titer BVDV-1b/2a by sex or age
- CA, OK, TX= greatest seroprevalence
  - Also, largest cattle and most established wild pig population states



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Review

Bovine viral diarrhea virus (BVDV) infections in pigs

ie Tao, Jinhu Liao, Yin Wang, Xinjun Zhang, Jianye Wang, Guoqiang Zhu *

ollege of Veterinary Medicine, Yangzhou University, China

Rev. sci. tech. Off. int. Epiz., 1990,

Ruminant pestivirus infection in pigs

Review

Bovine Viral Diarrhea Virus: Recent Findings about Its Occurrence in Pigs

Luís Guilherme de Oliveira [1,*], Marina L. Mechler-Dreibi [1], Henrique M. S. Almeida [1] and Igor R. H. Gatto [2]

[1] School of Agricultural and Veterinarian Sciences, São Paulo State University (Unesp), Jaboticabal. Via de Acesso Prof. Paulo Donato Castelanne s/n, Jaboticabal - SP 14884-900, Brazil; mlopesvet@gmail.com (M.L.M.-D.); henri_almeida2003@yahoo.com.br (H.M.S.A.)

[2] Ourofino Animal Health Ltda. Rodovia Anhanguera SP 330, Km 298. Distrito Industrial, Cravinhos – SP 14140-000, Brazil; igatto_10@hotmail.com

* Correspondence: luis.guilherme@unesp.br

isociated with the detection of BVDV
erds

rreia Lima Linhares [2] · Henrique Meiroz de Souza Almeida [1] · nos de Medeiros [1] · Zvonimir Poljak [3] · Samir Issa Samara [1] ·

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Seroprevalence and risk factors for the presence of ruminant pestiviruses in the Dutch swine population

W.L.A. Loeffen [a,*], A. van Beuningen [a,1], S. Quak [a], A.R.W. Elbers [a,b]

[a] Department of Virology, Central Veterinary Institute of Wageningen UR (CVI-Lelystad), P.O. Box 65, 8200AB Lelystad, The Netherlands
[b] Department of Swine Health, Animal Health Service, P.O. Box 9, 7400AA Deventer, The Netherlands

'2, China

transmission and full protection against
ission in pigs experimentally infected
iduces 'DV type 1b
ay highly , S. Quak, W.L.A. Loeffen

'IDC-Lelystad), P.O. Box 2004, 8203AA Lelystad, The Netherlands

evised form 12 June 2006; accepted 16 June 2006

18

Comparative BVDV COMMERCIAL TESTS

Commercially available and validated for Cattle

- RealPCR BVDV RNA Mix
- IDEXX SNAP BVDV Antigen Test ★
- IDEXX BVDV PI X2 Test
- IDEXX BVDV Total Ab Test
- IDEXX BVDV Ag/Serum Plus Test
- IDEXX BVDV p80 Ab Test
- IDEXX BVDV Ag Point-of-Care Test ★

Hypothesis:

- Heterologous hosts would have an elevated false-positive ACE results

★ Could easily be used by producers and veterinarians

https://www.idexx.com/en/livestock/livestock-tests/ruminant-tests/idexx-bvdv-pi-x2-test/

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Appropriate testing?- DR. PASSLER

Year	acELISA*	Immunohistochemistry	RT-nPCR
2006/07 440 deer	22 Positive		
2007/08 577 deer	7 Positive, 13 Suspect	5 Positive, 4 Suspect	2 Positive
2008/09 590 deer	4 Suspect, 3 Positive	Pending	0 Positive

*S/P ratios : Suspect 0.2 – 0.39, Positive: > 0.39

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Comparative BVDV COMMERCIAL TESTS

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Comparative test conclusion

Reliably detect negative or non-viremic animals.

High specificity between IDEXX BVDV PI X2 Antigen-capture ELISA with PCR

Unknown sensitivity- likely high false positives in previous studies?

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Swine vs Bovine BVDV isolate PI infection

Evaluate antigenic changes during immune recognition of pregnant cattle and creation of PI

- BVDV propagated in heterologous hosts
- BVDV propagated in cattle hosts

23

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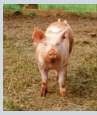

Swine Isolate

460f6

Pre-colostrum viremia PI calf

Acute Infection Heifer

Inoculum

VS

Bovine Isolate

AU-526

Pre-colostrum viremia PI calf

Acute Infection Heifer

Inoculum

Swine vs Cattle BVDV PI Genetics

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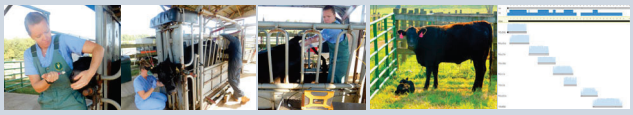
24

Research timeline- swine vs cattle

DAY 75 GESTATION | ACUTE INFECTION | GESTATION | PARTURITION | SEQUENCING



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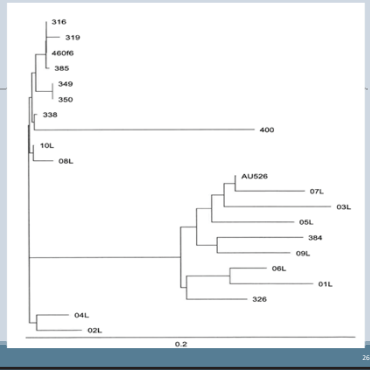
Swine vs Cattle Genetics Results



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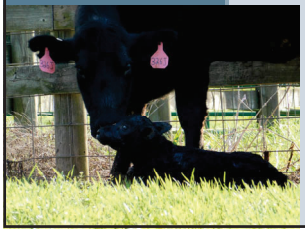
Cell-mediated immunity during pregnancy recognition with a PI fetus



Does pregnancy with a PI fetus alter the cell mediated immunity and the ability for the adaptive immune system to respond to both specific and non-specific challenges?

27

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CMI Assay Heifers

Materials and Methods

Measuring CMI responses using the PrimeFlow RNA assay: A new method of evaluating BVDV vaccination response in cattle

Shollie M. Falkenberg[a,*], Rohana P. Dassanayake[a], John D. Neill[a], Paul H. Walz[b], Eduardo Casas[a], Julia F. Ridpath[a], James Roth[c]

[a] Ruminant Disease and Immunology Research Unit, National Animal Disease Center, USDA, Agricultural Research Service, Ames, IA, 50010, United States
[b] Department of Pathobiology, College of Veterinary Medicine, 129 Sugg Laboratory, Auburn University, AL, 36849, United States
[c] Department of Veterinary Microbiology and Preventive Medicine, College of Veterinary Medicine, Iowa State University, IA, United States

- 76: Prior to Challenge; Early gestation
- 130: Early gestation; 50 days post challenge
- 190: Mid-gestation; 110 days post challenge
- 240: Late-gestation; 160 days post challenge

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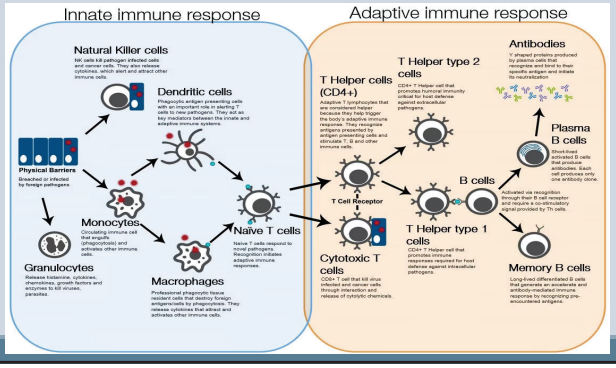

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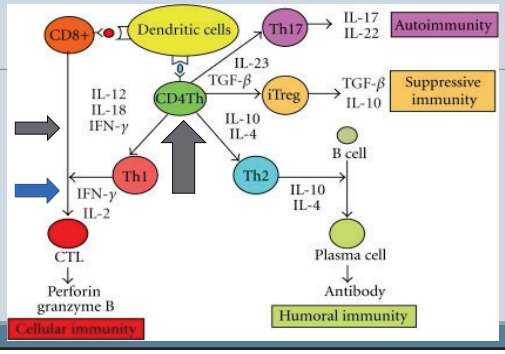

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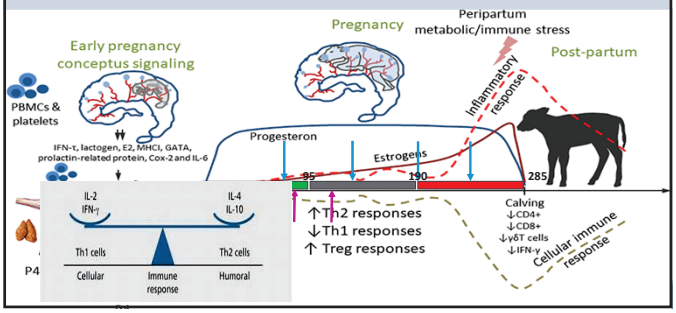
Immune response during pregnancy



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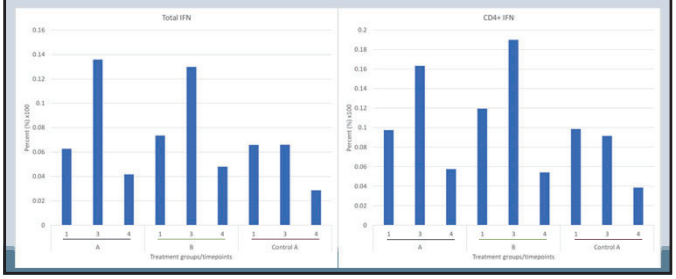
Heifers with PI and non-PI fetuses
Mitogen stim- Total IFN and CD4s



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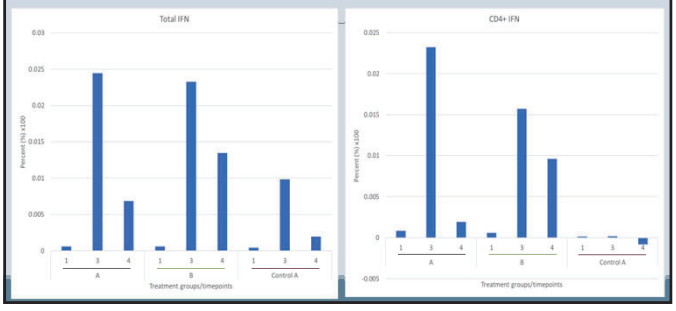
Heifers with PI and non-PI fetuses
BVDV stim – Total and CD4



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Thank you

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Effect of time and serum IgG levels on the diagnosis of persistent infection (PI) with BVDV in neonatal calves.

Background

Bovine viral diarrhea virus (BVDV) infection continues to cause major economic losses to cattle producers in the United States (US) due to pregnancy loss and increased morbidity resulting from viral infection.[1-3] Identification and elimination of calves persistently infected (PI) with BVDV shortly after birth to prevent exposure to pregnant cattle is of outmost importance in BVDV control and eradication programs across the globe.[4-6] Antigen detection tests such as antigen-capture ELISA (ACE), reverse transcription polymerase chain reaction (RT-PCR), immunohistochemistry (IHC), and chute-side ELISA snap tests (i.e., IDEXX Snap BVDV antigen text®, IDEXX, Fort Collins, CO) are commonly used by producers and veterinarians for the identification of PI cattle. Although the majority of BVDV PI antigen tests are highly sensitive and consistent identifying PI cattle, when testing neonatal calves, the presence of colostrum-derived BVDV antibodies interferes with the performance of some blood-based BVDV antigen tests.[7-9]

Materials and Methods

Ten Black Angus, 18-month-old, pregnant heifers were inoculated intranasally with BVDV 1b strain AU526 between 70 and 90 days of gestation. After calving, serum, whole blood [white blood cells (WBC)], nasal swabs (NS), and skin (ear notch) samples were collected from newborn calves before colostrum intake (T0), as well as 12h (T1), 24h (T2), 7days (T3), 14d (T4), and 28d (T5) after birth. At each time point, ear notch samples were tested for BVDV PI by antigen capture ELISA (ACE), RT-PCR, and the calf-side IDEXX Snap BVDV antigen text®. Serum and WBC samples were tested for PI with ACE, RT-PCR, and virus isolation (VI). Additionally, serum IgG and neutralizing BVDV antibody titers were evaluated at each time point) by single radial immunodiffusion (SRID) and virus neutralization (VN), respectively.

Preliminary results and impact

Between 12 and 24 hours of life, the false negative rate of the IDEXX Snap BVDV antigen text®, ACE, VI and PCR in serum samples from this population of neonatal BVDV PI calves varied from 10 to 100% depending on diagnostic test and testing time. Between 12 and 24 hours of life, the false negative rate of the IDEXX Snap BVDV antigen text® in skin (ear notches) varied from 30% to 40% depending on testing time. The mean serum levels of total IgG increased in all calves until 24 hours. There was a moderate but significant negative correlation between serum IgG and serum ACE results as the greater serum IgG levels the greater the chance for a false negative serum ACE BVDV PI result. These preliminary results demonstrate a significant interference of colostrum-derived immunity and BVDV PI diagnostic test performance.

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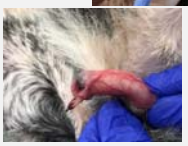
SMALL RUMINANT EMERGENCIES

Jenna Stockler, DVM, DACVIM
jew0027@auburn.edu

EMERGENCIES

- Abdominal Distention
- Diarrhea
- Dog attack
- Urinary obstruction
- Dystocia
- "ADR"
- Toxicity - vomiting
- Neurologic
- Fracture



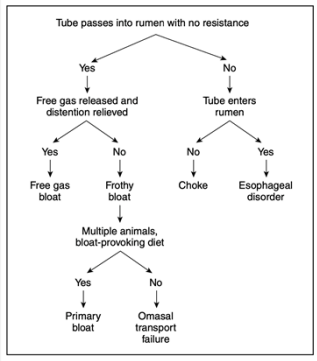
ABDOMINAL DISTENTION

- Normal variant
  - Pygmy, Toggenburg
- Bloat
- Pregnancy
- "Dropped stomach"
- Abomasal disease
- Uroabdomen

CAUSE → ABDOMINAL LOCATION

Left	Right	Bilateral

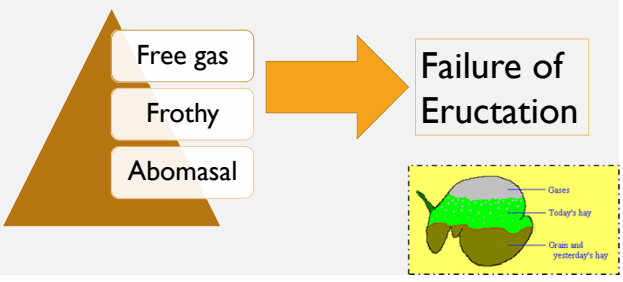
• Rumen impaction
• Overfeeding milk
• Frothy bloat
• Free-gas bloat
	• Late pregnancy
	• Abomasal disorders
	  • Impaction
	  • Phytobezoar
		• Pseudopregnancy
		• Acute duodenal obstruction
		• Ascites
		• Uroabdomen
		• Neoplasia



Current Veterinary Therapy: Food Animal Practice

Fig 5-1 Diagnosis of bloat.

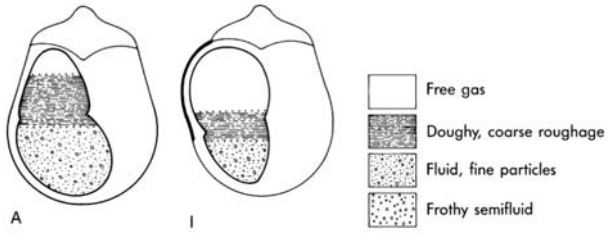
BLOAT



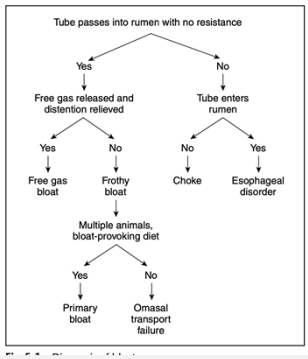
FREE GAS BLOAT

- Excessive production → does not cause bloat
- Volumes of gas eructated far exceeding amount produced
- Evacuation →
  - Physical
  - Mechanical

→ Esophageal foreign body, mediastinal lymphadenopathy, vagal nerve damage, hypocalcemia, grain overload, tetanus, thymoma



Large Animal Internal Medicine 6th ed. Pg 857



DIAGNOSIS

- History & PE
- Radiograph & endoscopy
- Laparotomy
- Necropsy
  - may be unlikely

IF THE TUBE DOESN'T PASS?

- Rumenostomy
- Rumenotomy
- Rumen trocar
  - Can be lifesaving
  - Use terminal stages of bloat
- Endoscopy
- Esophagotomy – not recommended

TREATMENT – FREE GAS BLOAT

- Treat the underlying cause
- Flunixin meglumine 1.1mg/kg IV
- Baking Soda
  - No effect on bloat
  - Acidosis sure

TREAT THE UNDERLYING CAUSE

- → Esophageal foreign body, mediastinal lymphadenopathy, vagal nerve damage, hypocalcemia, grain overload, tetanus, thymoma, respiratory disease

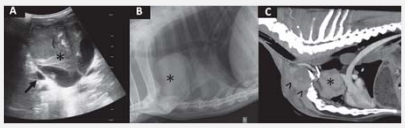
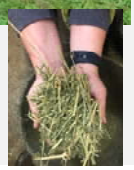
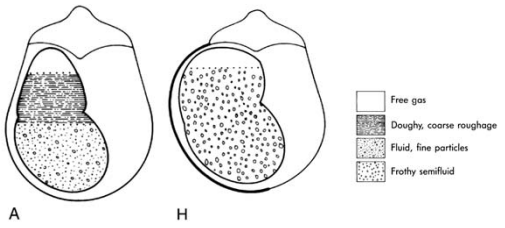


Figure 2—Ultrasonographic (A), radiographic (B), and CT (C) images of the thorax of a 10-year-old, mixed-breed intersex goat with 2 thymomas (goat A). A—Ultrasonography reveals a well-defined ventral cervical thymoma (asterisk) with mixed echogenicity that is close to the carotid artery (arrow). B—A lateral radiographic image reveals a thymoma in the cranial mediastinum (asterisk). The trachea is pushed dorsally, and the craniоventral lung field is obscured by a soft tissue mass. C—A sagittal CT image reveals the cranial mediastinal thymoma (asterisk) and ventral cervical thymoma (carets). Both masses are well-defined, with mixed soft tissue and fluid attenuation.
Citation: Journal of the American Veterinary Medical Association 251, 7; 10.2460/javma.251.7.829

FROTHY BLOAT (SLIME BLOAT)

- Nutritional bloat
  - Pasture or Feedlot
  - Alfalfa, clover, winter wheat, oats, grains
- Rapid breakdown of offending diets & rumen bacteria
- Gas does not freely coalesce in the dorsal sac
- Trapped in stable foam in liquid rumen content
- Stable foam cannot be eructated → more gas





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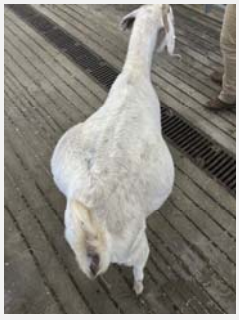
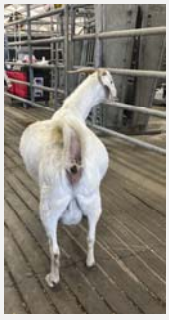




TREATMENT – FROTHY BLOAT

- Poloxalene → 100mg/kg BW
- Mineral Oil → 45-100ml/100lb BW
- Dioctyl sodium sulphosuccinate (DSS)
  - Dose - 15-30mL dose
- Other detergents
  - Liquid soap
  - Laundry

TREATMENT - FROTHY

- Exercise → make them move!
- Rumenotomy
- Removal of offending cause
  - May not be practical
- Anti-inflammatories
  - Flunixin meglumine 1.1mg/kg IV

PREVENTION

- Removal of offending feed source for a period of time → may not be pratical
- Supply poloxalene block or other detergents
- Good quality hay & browse → goats
- Good quality hay → sheep
- Gradual adaptation
- Feeding ionophores – monensin or lasalocid
- Pasture management

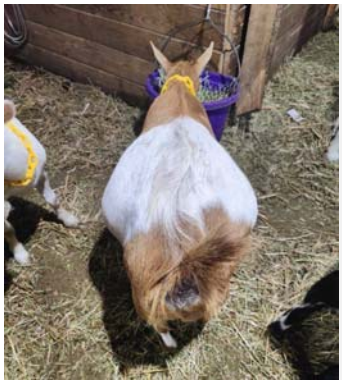
ABOMASAL BLOAT

- Impaction
  - Bezoars
- Displaced abomasum – rare but reported
- High fiber forage with low digestability
- Feed change milk → milk replacer
- Abomasitis

- Rapid fermentation → sugars by gas-producing anaerobic bacteria

DIAGNOSIS & TREATMENT

- Tube passed → may relieve some gas from the rumen but doesn't improve
- Ultrasound
  - Identify abnormal structure within abomasum
- CBC/Chemistry → inflammation/infection and elyte derangements
- Exploratory laparotomy
- IV catheter → antibiotics and NSAIDs
  - Especially if abomasitis & overfeeding



BILATERAL ABDOMINAL DISTENTION

- Pregnancy
- Vagal indigestion
- Neoplasia
- Hydrometra
- Uroabdomen
- Ascites
- Clostridial enteritis
- Parasites
- Ileus – peritonitis & GI accidents

DIARRHEA

- Treated at home → Repeated → Unresolved
- Given homeopathic remedies that work every time
- Spectogard®
- Not all diarrhea = parasites or coccidia
- Haemonchosis ≠ diarrhea → may be normal pelleted feces with heavy burdens

BOX 7.4

Causes of Diarrhea in Ruminants (Except Neonates; See Chapter 20 for Neonates)

Common Causes
Parasitism, worms
Coccidiosis
Salmonellosis
Colitis or typhlitis
Enteritis, unknown cause
Indigestion (spoiled feed, overfeeding, or sudden change)
Displaced abomasum (B)
Abomasal torsion (B)
Peritonitis
Intussusception
Sepsis or toxemia
Johne's disease
Enterotoxemia
Grain overload (rumen acidosis)
Bovine viral diarrhea (B)
Winter dysentery (B)
Liver failure
Malignant catarrhal fever (B)
Molybdenosis or copper deficiency
Heart failure
Uremia, renal failure
Xylazine, following large doses
Cathartics or laxatives
Parasympathomimetics
Toxins or poisonous plants (see Box 7.5)

Less Common Causes
Amyloidosis
Giardiasis (mainly calves)
Intestinal obstruction, partial
Intestinal neoplasia
Traumatic reticuloperitonitis (hardware)
Vagal indigestion
Selenium deficiency (white muscle disease)
Cecal dilation (B)
Liver abscess
Brisket disease (high-altitude disease) (B)
Sarcocystosis (B)
Bluetongue (O)
Bovine leukosis (BLV) (B)
Hemorrhagic bowel syndrome (B)

Uncommon Causes
Fat necrosis (B)
Abomasal impaction
Duodenal ulcers
Systemic candidiasis
Vitamin A deficiency
Volvulus, root of mesentery
Water intoxication (B)
Cholelithiasis
Cobalt deficiency
Zinc deficiency (baldy calf) (B)
Hydrops allantois (B)
Lethal trait A 46, keratogenesis imperfecta (parakeratosis) (B)
Zygomycosis, mucormycosis
Pregnancy toxemia
Bacillary hemoglobinuria
Rumen flukes, paramphistomosis
Pancreatic adenocarcinoma
Bee or wasp sting
Pseudorabies
Hemochromatosis of Salers cattle (B)
Rift Valley fever (exotic)
Rinderpest (exotic)[1]
Schistosomiasis (exotic)
Theileriosis (East Coast fever) (exotic)
Wesselsbron disease (exotic) (B, O)
Heartwater (exotic)

[1]Rinderpest was a cause of diarrhea in ruminants until 2011, when it was eradicated worldwide.
B, Bovine; *O*, ovine.

Large Animal Internal Medicine 6th ed. Pg 98

BOX 7.1

Mechanisms of Diarrhea

Malabsorption (villous atrophy)
Osmotic overload
Secretion
Abnormal motility
Increased blood-to-lumen hydraulic pressure
Inflammation
Decreased transit time

Large Animal Internal Medicine 6th ed. Pg 96

→ Increase in fecal water

MALABSORPTION

- Decreased or damaged absorptive surface area
- Villous blunting (atrophy) and/or microvillous damage in the small intestine
- Neonatal diseases → rotavirus & coronavirus
- Cryptosporidiosis
- Salmonella
- Johne's
- Loss of villous epithelial cells → maldigestion → cell → enzymes such as lactase

OSMOTIC OVERLOAD

- ↑numbers of osmotically active particles → intestinal lumen
- Disease → Maldigestion &/or Malabsorption
- Osmotic cathartics easy example
  - Dioctyl sodium sulfosuccinate (DSS)
  - Mg phosphates & sulfates

- Grain overload
- Lactase deficiency
  - Neonatal ruminants
- Undigested/unabsorbed nutrients → enter lower bowel
  - Increase bacterial fermentation
  - Increase osmotically active particles

SECRETION

- Increased volume of secretion of solutes & water
- Most important → neonate
- Enterotoxins → cAMP or other IC messengers → secretion Cl^-, Na^+ & other elytes → lumen
  - H20 follows → large volume feces
- Enterotoxigenic *E. coli*
- *Salmonella* spp. → many strains
- *C. perfringens*

ABNORMAL MOTILITY/DECREASED TRANSIT TIME

- Increased peristalsis &/or decreased segmentation → bowel irritation
- Peritonitis → scant feces
- Infectious diarrheas –abnormal motor patterns
- Nervous or excited animals → best example

- Gut defense mechanism?

INCREASED BLOOD-LUMEN HYDRAULIC PRESSURE

- Increased hydraulic or hydrostatic pressure → blood to intestinal lumen
- ↓ net fluid absorption

- Chronic diarrhea
  - Acute inflammation

- ↓ Oncotic pressure → hypoAlb
  - Liver - production
  - Kidney - loss
  - Intestine – loss
- ↑ capillary hydrostatic pressure
  - Heart failure
  - Portal hypertension
    - Liver disease
- ↓ lymphatic drainage
  - Lymphosarcoma

INFLAMMATION

- Increased mucous production
- Increased size of membrane pores
- Fluid & serum proteins → intestinal lumen → capillary & lymphatic hydraulic pressure → dysentery (hemorrhagic)

- Acute & chronic inflammatory bowel diseases
  - → Salmonellosis & Johne's → PLE
- *Clostridium perfringens* types A, B, or C
- Attaching effacing *E. coli*
- Coccidiosis
- PARASITISM
- Arsenic toxicity
- Oak toxicity
- Bowel Irritation

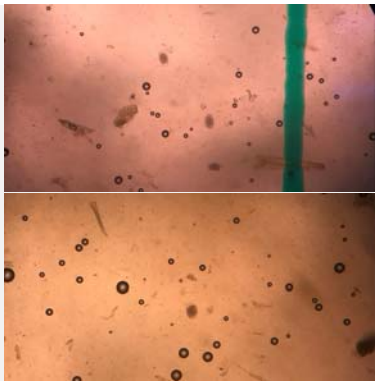
Malabsorption
Maldigestion
Osmotic effects
Intestinal motility disorders

DIAGNOSIS – DIARRHEA

- History & PE → provide pertinent info
  - Deworming, vacc, antibiotics, diet, weight loss
  - Individual or herd
  - Acute versus chronic
- BCS, fever, systemic signs, rumen motility, GI resonances
- Collect feces – color, consistency, odor
- Perform a fecal – always important
  - McMasters & float
- Minimum → PCV/TS
- Collect urine
- CBC/Chem
- Ultrasound
- Abdominocentesis
- Ruminal fluid analysis

PARASITES

- Strongyle-type eggs – HOTC complex
  - Still a major problem
  - Must rule out
- >1000 EPG → small ruminants
  - Cannot differentiate between ova seen
  - Recommend deworming
  - Combination deworming
    - Double or triple classes
- Strongyloides



FAMACHA

- Score 1-5
  - 1 = Best → Pink
  - 5 = Worse → White
- Doable
- Teachable

CPPR –DR. PATTY SHARKO

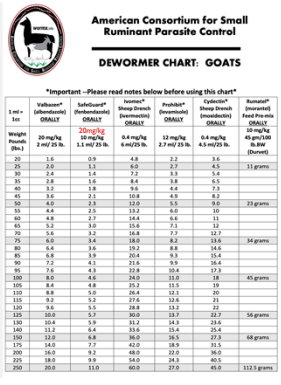
1. Cover the eye with lid
2. Push eye gently inward
3. Pull down the lower eyelid
4. Read

• **Fig. 1.3** To FAMACHA score sheep and goats, the practitioner gently pushes the upper eyelid medially and rolls the lower eyelid ventrally to access conjunctival membrane color.

FAMACHA© System

Clinical category	Color	PCV	Tx recommendation
1	Red	≥ 28	No
2	Red-pink	23-27	No
3	Pink	18-22	?
4	Pink-white	13-17	Yes
5	White	≤ 12	Yes

https://www.wormx.info/dewormers

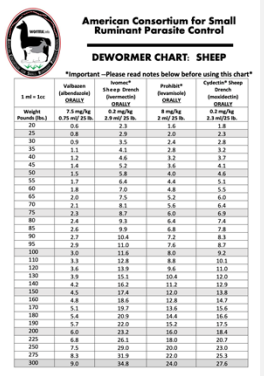


American Consortium for Small Ruminant Parasite Control

DEWORMER CHART: GOATS

Important –Please read notes below before using this chart

1 ml = 1cc	Valbazen® (albendazole) ORALLY	SafeGuard® (fenbendazole) ORALLY	Ivomec® Sheep Drench (ivermectin) ORALLY	Prohibit® (levamisole) ORALLY	Cydectin® Sheep Drench (moxidectin) ORALLY	Rumatel® (morantel) Feed Pre-mix ORALLY
Weight Pounds (lbs.)	20 mg/kg 2 ml/ 25 lb.	20mg/kg 10 mg/kg 1.1 ml/ 25 lb.	0.4 mg/kg 4 ml/25 lb.	12 mg/kg 2.7 ml/ 25 lb.	0.4 mg/kg 4.5 ml/25 lb.	10 mg/kg 45 gm/100 lb BW (Durvet)
20	1.6	0.9	4.8	2.2	3.6	
25	2.0	1.1	6.0	2.7	4.5	11 grams
30	2.4	1.4	7.2	3.3	5.4	
35	2.8	1.6	8.4	3.8	6.5	
40	3.2	1.8	9.6	4.4	7.3	
45	3.6	2.1	10.8	4.9	8.2	
50	4.0	2.3	12.0	5.5	9.0	23 grams
55	4.4	2.5	13.2	6.0	10	
60	4.8	2.7	14.4	6.6	11	
65	5.2	3.0	15.6	7.1	12	
70	5.6	3.2	16.8	7.7	12.7	
75	6.0	3.4	18.0	8.2	13.6	34 grams
80	6.4	3.6	19.2	8.8	14.6	
85	6.8	3.9	20.4	9.3	15.4	
90	7.2	4.1	21.6	9.9	16.4	
95	7.6	4.3	22.8	10.4	17.3	
100	8.0	4.6	24.0	11.0	18	45 grams
105	8.4	4.8	25.2	11.5	19	
110	8.8	5.0	26.4	12.1	20	
115	9.2	5.2	27.6	12.6	21	
120	9.6	5.5	28.8	13.2	22	
125	10.0	5.7	30.0	13.7	22.7	56 grams
130	10.4	5.9	31.2	14.3	23.6	
140	11.2	6.4	33.6	15.4	25.4	
150	12.0	6.8	36.0	16.5	27.3	68 grams
175	14.0	7.7	42.0	18.9	31.5	
200	16.0	9.2	48.0	22.0	36.0	
225	18.0	9.9	54.0	24.3	40.5	
250	20.0	11.0	60.0	27.0	45.0	112.5 grams



American Consortium for Small Ruminant Parasite Control

DEWORMER CHART: SHEEP

Important –Please read notes below before using this chart

1 ml = 1cc	Valbazen (albendazole) ORALLY	Ivomec® Sheep Drench (ivermectin) ORALLY	Prohibit® (levamisole) ORALLY	Cydectin® Sheep Drench (moxidectin) ORALLY
Weight Pounds (lbs.)	7.5 mg/kg 0.75 ml/ 25 lb.	0.2 mg/kg 2.0 ml/ 25 lb.	8 mg/kg 2 ml/ 25 lb.	0.2 mg/kg 2.3 ml/25 lb.
20	0.6	2.3	1.6	1.8
25	0.8	2.9	2.0	2.3
30	0.9	3.5	2.4	2.8
35	1.1	4.1	2.8	3.2
40	1.2	4.6	3.2	3.7
45	1.4	5.2	3.6	4.1
50	1.5	5.8	4.0	4.6
55	1.7	6.4	4.4	5.1
60	1.8	7.0	4.8	5.5
65	2.0	7.5	5.2	6.0
70	2.1	8.1	5.6	6.4
75	2.3	8.7	6.0	6.9
80	2.4	9.3	6.4	7.4
85	2.6	9.9	6.8	7.8
90	2.7	10.4	7.2	8.3
95	2.9	11.0	7.6	8.7
100	3.0	11.6	8.0	9.2
110	3.3	12.8	8.8	10.1
120	3.6	13.9	9.6	11.0
130	3.9	15.1	10.4	12.0
140	4.2	16.2	11.2	12.9
150	4.5	17.4	12.0	13.8
160	4.8	18.6	12.8	14.7
170	5.1	19.7	13.6	15.6
180	5.4	20.9	14.4	16.6
190	5.7	22.0	15.2	17.5
200	6.0	23.2	16.0	18.4
225	6.8	26.1	18.0	20.7
250	7.5	29.0	20.0	23.0
275	8.3	31.9	22.0	25.3
300	9.0	34.8	24.0	27.6

COCCIDIA

- *Eimeria* spp most common
  - Sheep more species than goats
  - Diarrhea → hemorrhagic, watery, or "dog-type"
- Sheep – 4-5 weeks of age MC
- Goats – weanlings
- Quantifying coccidia? → feces – Float? McMaster's?
- No approved treatment → sheep & goats in US
- Sulfadimethoxine (Albon)
  - 55mg/kg day 1, 27.5mg/kg day 2,3,4,5
- Amprolium – 50mg/kg for 5 days
- Toltrazuril and Ponazuril

TREATMENT - DIARRHEA

- Depends on disease & progression
- Parasites & coccidia – seemingly easy ?
- Fluid therapy with electrolyte supplementation
  - Typically start with Plasmalyte & change according to need
- Antimicrobials
  - Necessity vs Just because we can!
  - Many used
- Anti-inflammatories
  - Flunixin - 1.1mg/kg IV q12h not to exceed 3 days – re-evaluate
  - Dexamethasone – 0.1mg/kg IV/IM/SQ q24h for 3 days

DIARRHEA TREATMENT

- Vitamin B Complex – 2-5ml/100lb
- Thiamine – 10mg/kg IV/SQ q6-12h
- GI protectants –
  - Pantoprazole
    - IV versus SQ
    - 1mg/kg IV q24h
    - 2mg/kg SQ q24h
  - Sucralfate – 0.5-1 gram q8h oral
- Blood transfusion

DIARRHEA - TREATMENT

- Renal disease – stage & severity of azotemia & urinalysis & kidney change on ultrasound
- Liver disease – most often end stage & euthanasia recommended
- Clostridial enteritis – may depend on severity – I haven't pulled one through yet
  - Potassium penicillin IV SLOWLY q6H 22000-44000 IU/kg
  - Anti-toxin
  - Toxoid
- Enteritis – may or may not need antibiotics
  - Potassium penicillin - IV SLOWLY q6h 22000-44000IU/kg
  - Ceftiofur sodium - 2.2-5mg/kg IV/SQ q12h
- Euthanasia

4-YO NIGERIAN DWARF BUCK

RBC	13.70	x 10^6/uL	No Ref Interval	10/21/2019 12:47 PM
HGB	5.9	g/dL	No Ref Interval	10/21/2019 12:47 PM
HCT	18.0	%	No Ref Interval	10/21/2019 12:47 PM
MCV	13.1	fL	No Ref Interval	10/21/2019 12:47 PM
MCH	4.3	pg	No Ref Interval	10/21/2019 12:47 PM
MCHC	32.9	g/dL	No Ref Interval	10/21/2019 12:47 PM
RDW	37.3	%	No Ref Interval	10/21/2019 12:47 PM
PLATELET COUNT	1619	x 10^3/uL	No Ref Interval	10/21/2019 12:47 PM
MPV	6.8	fL	No Ref Interval	10/21/2019 12:47 PM
WBC	25.15	x 10^3/uL	No Ref Interval	10/21/2019 12:47 PM

Test	Diff %	Result	Units	Ref. Interval	Result Datetime
SEG	(69%)	17.353	x 10^3/uL	No Ref Interval	10/21/2019 12:47 PM
LYMPH	(12%)	3.018	x 10^3/uL	No Ref Interval	10/21/2019 12:47 PM
MONO	(4%)	1.006	x 10^3/uL	No Ref Interval	10/21/2019 12:47 PM
EOS	(0%)	0.000	x 10^3/uL	No Ref Interval	10/21/2019 12:47 PM
PLT.EST	ABOVE REFERENCE INTERVAL				
Plasma T/S	9.1 g/dL				
Fibrinogen T/S		700	mg/dl	No Ref Interval	10/21/2019 12:47 PM

TOTAL PROTEIN	8.64	g/dL	No Ref Interval	10/21/2019 12:14 PM
ALBUMIN	2.69	g/dL	No Ref Interval	10/21/2019 12:14 PM
GLOBULIN	5.90	g/dL	No Ref Interval	10/21/2019 12:14 PM
ALBUMIN/GLOBULIN RATIO	0.50		No Ref Interval	10/21/2019 12:14 PM
SDH	79.6	U/L	No Ref Interval	10/21/2019 12:14 PM
AST	87	U/L	No Ref Interval	10/21/2019 12:14 PM
GGT	72	U/L	No Ref Interval	10/21/2019 12:14 PM
TOTAL BILIRUBIN	0.16	mg/dL	No Ref Interval	10/21/2019 12:14 PM
CK2	537	U/L	No Ref Interval	10/21/2019 12:14 PM
BUN	110.2	mg/dL	No Ref Interval	10/21/2019 12:14 PM
CREATININE	4.3	mg/dL	No Ref Interval	10/21/2019 12:14 PM
CALCIUM	9.6	mg/dL	No Ref Interval	10/21/2019 12:14 PM
PHOSPHORUS	7.4	mg/dL	No Ref Interval	10/21/2019 12:14 PM
MAGNESIUM	3.0	mg/dL	No Ref Interval	10/21/2019 12:14 PM
GLUCOSE	54	mg/dL	No Ref Interval	10/21/2019 12:14 PM
BICARBONATE	8.4	mmol/L	No Ref Interval	10/21/2019 12:14 PM
SODIUM	132	mmol/L	No Ref Interval	10/21/2019 12:14 PM
POTASSIUM	3.5	mmol/L	No Ref Interval	10/21/2019 12:14 PM
CHLORIDE	84	mmol/L	No Ref Interval	10/21/2019 12:14 PM
ANION GAP	43.1		No Ref Interval	10/21/2019 12:14 PM
OSMOL(CALC)	297	mOsm/kg	No Ref Interval	10/21/2019 12:14 PM
S.IRON	16	ug/dL	No Ref Interval	10/21/2019 12:14 PM

AMM	551	ug/dL	No Ref Interval	10/21/2019 11:43 AM

5-YO LAMANCHA DOE

RBC	16.76	x 10^6/uL	No Ref Interval	08/13/2020 03:47 PM
HGB	10.9	g/dL	No Ref Interval	08/13/2020 03:47 PM
HCT	31.2	%	No Ref Interval	08/13/2020 03:47 PM
MCV	18.6	fL	No Ref Interval	08/13/2020 03:47 PM
MCH	6.5	pg	No Ref Interval	08/13/2020 03:47 PM
MCHC	35.1	g/dL	No Ref Interval	08/13/2020 03:47 PM
RDW	26.7	%	No Ref Interval	08/13/2020 03:47 PM
PLATELET COUNT	466	x 10^3/uL	No Ref Interval	08/13/2020 03:47 PM
MPV	5.2	fL	No Ref Interval	08/13/2020 03:47 PM
RETIC_PCT	0.10	%	No Ref Interval	08/13/2020 03:47 PM
RETIC_ABS	15.9	x 10^3/uL	No Ref Interval	08/13/2020 03:47 PM
WBC	8.96	x 10^3/uL	No Ref Interval	08/13/2020 03:47 PM

Test	Diff %	Result	Units	Ref. Interval	Result Datetime
SEG	(55%)	4.928	x 10^3/uL	No Ref Interval	08/13/2020 03:47 PM
BANDS	(1%)	0.090	x 10^3/uL	No Ref Interval	08/13/2020 03:47 PM
LYMPH	(42%)	3.763	x 10^3/uL	No Ref Interval	08/13/2020 03:47 PM
MONO	(2%)	0.179	x 10^3/uL	No Ref Interval	08/13/2020 03:47 PM
EOS	(0%)	0.000	x 10^3/uL	No Ref Interval	08/13/2020 03:47 PM
BASO	(0%)	0.000	x 10^3/uL	No Ref Interval	08/13/2020 03:47 PM
OTHER	(0%)	0.000	x 10^3/uL	No Ref Interval	08/13/2020 03:47 PM
NRBC		0	/100 WBC	No Ref Interval	08/13/2020 03:47 PM
PLT.EST	WITHIN REFERENCE INTERVAL				
Plasma T/S	6.6 g/dL				
Fibrinogen T/S		400	mg/dl	No Ref Interval	08/13/2020 03:47 PM

TOTAL PROTEIN	6.67	g/dL	No Ref Interval	08/13/2020 02:13 PM
ALBUMIN	2.41	g/dL	No Ref Interval	08/13/2020 02:13 PM
GLOBULIN	4.30	g/dL	No Ref Interval	08/13/2020 02:13 PM
ALBUMIN/GLOBULIN RATIO	0.60		No Ref Interval	08/13/2020 02:13 PM
SDH	28.8	U/L	No Ref Interval	08/13/2020 02:13 PM
AST	54	U/L	No Ref Interval	08/13/2020 02:13 PM
GGT	26	U/L	No Ref Interval	08/13/2020 02:13 PM
TOTAL BILIRUBIN	0.08	mg/dL	No Ref Interval	08/13/2020 02:13 PM
CK2	91	U/L	No Ref Interval	08/13/2020 02:13 PM
BUN	20.4	mg/dL	No Ref Interval	08/13/2020 02:13 PM
CREATININE	0.7	mg/dL	No Ref Interval	08/13/2020 02:13 PM
CALCIUM	7.9	mg/dL	No Ref Interval	08/13/2020 02:13 PM
PHOSPHORUS	6.6	mg/dL	No Ref Interval	08/13/2020 02:13 PM
MAGNESIUM	1.5	mg/dL	No Ref Interval	08/13/2020 02:13 PM
GLUCOSE	193	mg/dL	No Ref Interval	08/13/2020 02:13 PM
BICARBONATE	16.4	mmol/L	No Ref Interval	08/13/2020 02:13 PM
SODIUM	139	mmol/L	No Ref Interval	08/13/2020 02:13 PM
POTASSIUM	3.4	mmol/L	No Ref Interval	08/13/2020 02:13 PM
CHLORIDE	104	mmol/L	No Ref Interval	08/13/2020 02:13 PM
ANION GAP	22.0		No Ref Interval	08/13/2020 02:13 PM
OSMOL(CALC)	283	mOsm/kg	No Ref Interval	08/13/2020 02:13 PM
S.IRON	57	ug/dL	No Ref Interval	08/13/2020 02:13 PM

Momasters	4300 strongyloides eggs per gram of feces <100 trichostrongyle eggs per gram of feces Eimeria sp were seen but cannot be counted using this test
Comments	This sample was liquid. This can dilute the concentration of eggs and the numbers counted on McMasters may be less than what would normally be recovered (in formed stool).

3.5-YO BOER DOE

RBC	16.40	x 10^6/uL	No Ref Interval	07/03/2022 01:12 PM
HGB	10.7	g/dL	No Ref Interval	07/03/2022 01:12 PM
HCT	29.9	%	No Ref Interval	07/03/2022 01:12 PM
MCV	18.3	fL	No Ref Interval	07/03/2022 01:12 PM
MCH	6.5	pg	No Ref Interval	07/03/2022 01:12 PM
MCHC	35.7	g/dL	No Ref Interval	07/03/2022 01:12 PM
RDW	27.7	%	No Ref Interval	07/03/2022 01:12 PM
PLATELET COUNT	174	x 10^3/uL	No Ref Interval	07/03/2022 01:12 PM
MPV	10.7	fL	No Ref Interval	07/03/2022 01:12 PM
RETIC_PCT	0.55	%	No Ref Interval	07/03/2022 01:12 PM
RETIC_ABS	90.2	x 10^3/uL	No Ref Interval	07/03/2022 01:12 PM
WBC	9.00	x 10^3/uL	No Ref Interval	07/03/2022 01:12 PM

Test	Diff %	Result	Units	Ref. Interval	Result Datetime
SEG	(42%)	3.780	x 10^3/uL	No Ref Interval	07/03/2022 01:12 PM
BANDS	(15%)	1.350	x 10^3/uL	No Ref Interval	07/03/2022 01:12 PM
LYMPH	(38%)	3.420	x 10^3/uL	No Ref Interval	07/03/2022 01:12 PM
MONO	(5%)	0.450	x 10^3/uL	No Ref Interval	07/03/2022 01:12 PM
EOS	(0%)	0.000	x 10^3/uL	No Ref Interval	07/03/2022 01:12 PM
BASO	(0%)	0.000	x 10^3/uL	No Ref Interval	07/03/2022 01:12 PM
PLT_EST	The platelet count appears to be within normal limits, but clumping of the platelets in the sample precludes exact enumeration by either manual or electronic methods.				
Plasma T/S	7.4 g/dL				
Fibrinogen T/S		600	mg/dl	No Ref Interval	07/03/2022 01:12 PM

TOTAL PROTEIN	7.28	g/dL	No Ref Interval	07/03/2022 01:39 PM
ALBUMIN	2.49	g/dL	No Ref Interval	07/03/2022 01:39 PM
GLOBULIN	4.79	g/dL	No Ref Interval	07/03/2022 01:39 PM
ALBUMIN/GLOBULIN RATIO	0.52		No Ref Interval	07/03/2022 01:39 PM
AST	143	U/L	No Ref Interval	07/03/2022 01:39 PM
GGT	27	U/L	No Ref Interval	07/03/2022 01:39 PM
TOTAL BILIRUBIN	0.50	mg/dL	No Ref Interval	07/03/2022 01:39 PM
CK2	4156	U/L	No Ref Interval	07/03/2022 01:39 PM
BUN	65.7	mg/dL	No Ref Interval	07/03/2022 01:39 PM
CREATININE	3.7	mg/dL	No Ref Interval	07/03/2022 01:39 PM
CALCIUM	5.8	mg/dL	No Ref Interval	07/03/2022 01:39 PM
PHOSPHORUS	12.0	mg/dL	No Ref Interval	07/03/2022 01:39 PM
MAGNESIUM	4.0	mg/dL	No Ref Interval	07/03/2022 01:39 PM
GLUCOSE	68	mg/dL	No Ref Interval	07/03/2022 01:39 PM
BICARBONATE	23.9	mmol/L	No Ref Interval	07/03/2022 01:39 PM
SODIUM	132	mmol/L	No Ref Interval	07/03/2022 01:39 PM
POTASSIUM	4.2	mmol/L	No Ref Interval	07/03/2022 01:39 PM
CHLORIDE	86	mmol/L	No Ref Interval	07/03/2022 01:39 PM
ANION GAP	26.3		No Ref Interval	07/03/2022 01:39 PM
OSMOL(CALC)	281	mOsm/kg	No Ref Interval	07/03/2022 01:39 PM
S.IRON	19	ug/dL	No Ref Interval	07/03/2022 01:39 PM

950 EPG

PREVENTION

- Good parasite & coccidia management
- Consistent feed source
  - Hay, grain, browse
  - Pasture management
- Sheep = grazers
- Goats = browsers

- Sometimes you won't be able to prevent!




DOG/PREDATOR ATTACK

MECHANISMS OF DOG ATTACK

- Contamination & damage to tissue → not evident at skin surface
- Dirty & contaminated
  - Dog oral flora
  - Skin flora from bite area
  - Environmental microorganisms
- Dog's jaw –200-450 psi → perforate sheet metal

Chhabra S, Chhabra N, Gaba S. Maxillofacial injuries due to animal bites. J Maxillofac Oral Surg. 2015 Jun;14(2):142-53. doi: 10.1007/s12663-013-0593-5. Epub 2013 Oct 10. PMID: 26028828; PMCID: PMC4444665.

Fielding CL, Mayer JR, Dechant JE, Epstein KL, Magdesian KG. Clinical and biochemical factors associated with survival in equids attacked by dogs: 28 cases (2008-2016). J Vet Intern Med. 2021 Jan;35(1):532-

3 TYPES OF TRAUMA – DOG ATTACK

1. Puncture by canine teeth
2. Crushing by molars & premolars
3. Lifting & shaking → separation of skin from underlying structures

- Blood loss, capture myopathy
- Mixed population of bacteria cultured

Streptococcus sp., *Proteus* sp., *Enterobacter* sp., *Staphylococcus* sp.

PATIENT ASSESSMENT

- Location of bite wounds – head, neck, limbs, thorax
- Perforation
  - Thorax, abdomen, trachea
  - Emergency tracheostomy
- FAMACHA & PCV/TS
  - Shock
- Neurologic assessment
  - Down
  - CN affected
- Devitalized tissues

THERAPY

- Owner goals & budget → can be costly
- Sedation – Is it safe?
- IV catheter – repeated sedation, pain, IV fluids
- Clip & clean the wounds → need a baseline
  - Saline
  - Dilute betadine
- Pain control
- Antibiotics
  - Broad-spectrum & Anaerobic coverage
- Clostridial vaccination
- Euthanasia

THERAPY CONTINUED - PAIN

- Flunixin meglumine – 1.1mg/kg IV q12h 3 days – reassess after this
- Meloxicam – 0.5-1mg/kg orally q24h – long term
- Morphine – 0.4mg/kg SQ/IM q4-6 hours
- Butorphanol - 0.1-0.3mg/kg SQ/IM q4-6 hours
- Fentanyl patch – 2.0mcg/kg/h (S -48h), 2.5mcg/kg/h(G-72h)
  - Hyperthermia, dysphoria, muscle tremors
- Midazolam – safe for sedation - 0.2-0.4mg/kg IV
- Dexamethasone - 0.1mg/kg IV/IM/SQ q24h – 3 days

PATIENT STABILIZATION

- IV fluids – 40-60mL/kg/d
  - Isotonic fluid solution
  - Shock, inability to consume enough
- Blood or plasma transfusion
  - 20-40ml/kg
- Albumin – if really need to move the needle
  - Human product
  - 2g/kg

WOUND DEBRIDEMENT

WOUND DEBRIDEMENT

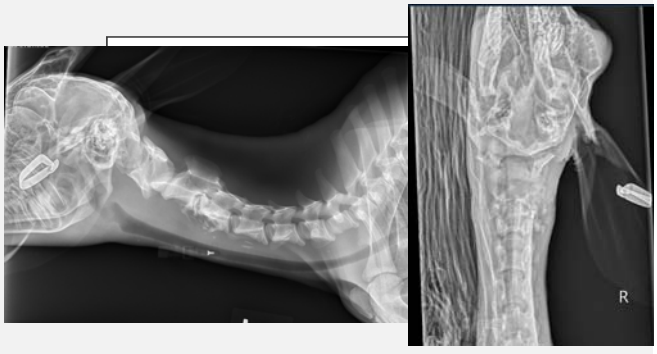
- Initial therapy
  - Cleaning, drain placement, releasing incisions
  - Amputation – limb, tail, toe, ear
- Days – declaration & devitalization of tissue
- Epsom salt soaks – skin slough
- Controlled surgical removal - necrotic skin
- Weeks - months until complete healing

WOUND THERAPY

Purulent material = Goals!
Honey
Underwood horse medicine
Silver sulfadiazine (SSD)
Fish skin
Tie-over bandages

ANTIMICROBIALS

- Penicillin – 22,000-44000 IU/kg for 5-7 days
- Ceftiofur sodium – 2.2-5mg/kg SQ/IV/IM q12-24h for 5-7 days
- Florfenicol
  - 20mg/kg IM q48 hours
  - 40mg/kg SQ q96 hours
- Tulathromycin
  - 2.5mg/kg SQ q5-7 days
- If you get to treat once do something broad spectrum!



CONCLUSIONS

- Many reasons why small ruminants present
- PE
- Availability & outcomes
  - Sedatives
  - Antimicrobials
- Phone call away!

Top 3 Small Ruminant Emergencies

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Abstract

Small ruminant emergencies are common in both referral and private practices. Common emergencies include bloat, diarrhea, trauma, urinary obstruction, and dystocia. These emergencies can be life-threatening and life-ending depending on owner awareness and treatment. Client education is imperative and necessary to prevent death.

Keywords: Bloat, diarrhea, trauma, frothy, free-gas, parasites

Introduction

Small ruminants, production and pets, will present to veterinary clinics for emergency care rather than routine herd maintenance. These emergencies are gateways to establish the VCPR and provide guidance on overall herd health and management. [1] Common emergencies of small ruminants include bloat, diarrhea, traumatic events, urinary obstruction, dystocia, neurologic disease, sick neonates, pregnancy issues, and recumbent animals. While these cases are challenging, common things are common and diagnosis and treatment sometimes parallel that of small animals.[1-14]

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Small Ruminant Dystocia

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Abstract

Dystocia's in small ruminants are considered uncommon. Owner intervention often leaves the veterinarian with a disaster and potentially unreasonable expectations. Determination of the most important component, dam, fetus(es), or both, and economics ultimately makes the veterinarians focus more defined. Utilization, availability, and comfort of drugs (anesthetics, analgesics, anti-inflammatories, and antibiotics) can be a source of frustration in these cases.

Keywords: Dystocia, small ruminant, c-section, neonate, colostrum

Introduction

Small ruminants are being kept as both production and pet livestock with current estimates in the United States of 5.02 million sheep and 2.51 million goats, respectively.[1] Emergencies, specifically dystocia, will arise and owners will consult social media, contact a veterinarian, intervene, and then ultimately present to the veterinarian. Owners with production small ruminants will likely have a very defined and tight breeding season, while pet owners may not. Timely intervention in dystocia cases likely provides a more favorable outcome for both the dam and fetus(es). Pre-and post-partum care of the dam and neonates is imperative to ensure health and livability.

Gestation Length and Maintenance of Pregnancy

Herd health, adequate nutrition, and previous dystocia's should be evaluated in the pre-partum female. Pet versus production will likely influence the retention of a female that has had multiple dystocia's. Vaccination (specifically with *Clostridium perfringens* type C & D and *Clostridium tetani*), FAMACHA scoring, and other stressful procedures (sheering, hoof trims, etc.) should be completed 3-4 weeks prior to the anticipated parturition. Exact breeding dates and anticipated breeding dates are not always easy to determine. Use of marking harnesses or grouping does/ewes can give a more defined lambing/kidding season in larger herds. Removal of the sire will also dictate a defined interval for parturition.[2]

Gestation length in the ewe and doe is 5 months. Ewes range in length from 145-150 days, while does range from 147-155 days.[2,3] Small ruminants have an epitheliochorial, cotyledonary placentation making the neonate agammaglobulinemic. Pregnancy in the doe is maintained by the corpus luteum (CL) throughout gestation. In contrast, maintenance of pregnancy in the ewe is both via the fetoplacental unit and CL depending on the stage of gestation.[2]

Parturition

Normal initiation of parturition occurs when there is no longer adequate room in the uterus for the fetus(es). Of course, this takes place through a series of pathways. The fetal pituitary-adrenal axis triggers parturition. Release of adrenocorticotropic hormone from the fetal pituitary gland stimulates release of corticosteroids from the fetal adrenal gland.[2,4] This increase of fetal cortisol stimulates placental estrogen production. Prostaglandins (PGF2alpha) are released from both the placenta and endometrium inducing luteolysis, resulting in decreased progesterone. Myometrial

activity is stimulated via the release of prostaglandin and ultimately beginning the parturition cascade.[2,4]

Impending signs of parturition include udder development, restlessness, segregation, relaxation of the sacrotuberous ligaments, vulvar discharge, enlarged or edematous vulva, tail flagging, and nesting.[3] Parturition is divided into three stages. Stage one is characterized by cervical softening with myometrial contractions leading to cervical dilation.[5] This stage can last from 2-12 hours depending on parity and ends when the chorioallantois ruptures. Once the fetus enters the pelvic portion of the reproductive tract stage two labor is initiated.[2,3,5] Stage two is accompanied by forceful abdominal contractions, expulsion of allantoic fluid, and delivery of the fetus.[5] Third-stage labor begins immediately after delivery of the last fetus and ends with expulsion of the fetal membranes. The placenta should be passed within four to eight hours depending on species and most small ruminants will pass the placenta within 15-20 minutes of giving birth.[2-6]

Dystocia

Dystocia is defined as slow or difficult labor.[5,7] Animals in dystocia do not progress appropriately from stage one to stage two, through stage 2, or signs of labor are missed by the owner/producer. Most commonly dystocia results from fetal mal-posture, fetal-maternal mismatch, inappropriate cervical dilation, multiple fetuses presenting at once, and fetal malformation or one of the 3 "P's."[5,8] Uterine torsion, uterine inertia, pregnancy toxemia, hypocalcemia, and vaginal prolapse can be causes of dystocia in small ruminants.

The three P's of dystocia are presentation, position, and posture. Presentation refers to the relation of the fetal spine to the dam.[9] Normal presentation in the small ruminant is cranial OR caudal longitudinal. Abnormal presentation would be dorsal or ventral transverse. Position

relates to the dorsum of the fetus with regard to the quadrants of the dam's pelvis.[9] The pelvis of the small ruminant can be thought of as quadrants including sacrum, right or left ilium, and pubis. Normal position is dorsosacral. The final "p" is posture and describes the relationship of the extremities in respect to the fetal body.[9] Normal posture would be that the forelimbs and head are extended. Finally, the normal presentation, position, and posture is cranial-longitudinal dorsosacral with the head and forelimbs extended.

Note:

1. Caudal-longitudinal presentation in the small ruminant is considered normal as long as both hindlimbs are extended.

2. Small ruminant fetus(es) can often be delivered with one forelimb retained.

Owner awareness and understanding of dystocia is important. In well managed herds, the breeding or parturition dates are often known, but this isn't necessarily true with pets. Intervention and timing in dystocias are crucial for both veterinarians and owners. Often, the mentality is the faster I can intervene the better, but the reality may be that the dam did not need help and the intervention may have worsened the outcome. A good rule of dystocia is the 30-minute rule with the understanding there are always exceptions.

30-Minute Dystocia Rule[8]

1. Wait 30 minutes until after the chorioallantois (water bag) has ruptured or abdominal press (contractions) is present
2. Fetal presentation normal – wait another 30 minutes before fetal manipulation
3. Wait another 30 minutes to check for multiples ("spares") after a normal delivery

Exceptions to this rule include yellow staining that indicates meconium, placenta passing without evidence of a fetus, non-progression, and presumed fetal distress.

Many dystocias can be corrected with transvaginal palpation and manipulation. Pelvic size of the dam and the obstetricians hand are two rate limiting factors that should give practitioner's pause. As with any dystocia, all manipulations or mutations should follow general cleanliness, lubrication, and gentleness.[2]

Evaluation/Preparation

Whether the doe/ewe is presented to you in a hospital or on an ambulatory call, the examination is still generally the same. Historical questions should include parity, previous dystocias, vaccination, deworming, treatments, breeding date, and any manipulation that has occurred on farm. It is important to remember that disease and dystocia can look similar in their presentations and sometimes breeding dates are unknown. The risk of zoonotic disease in small ruminant dystocias is high and personal protective equipment should be utilized. Often owners think that the doe/ewe is "overdue" but in reality this may not be the case. Baseline physical examination should be performed to determine patient stability. Blood parameters (blood glucose and ketones) and a quick ultrasound scan can be performed to evaluate fetal viability.

Preparation of the dam is clinician dependent but the principles of cleanliness and personal protection should be common across practitioners. The author performs either a sacrococcygeal or lumbosacral epidural before any palpation is performed.

The sacrococcygeal epidural is best utilized in those animals with a tail, such that the space can be easily palpated. The area of the tailhead is clipped and prepped with scrub (betadine or chlorhexidine) and alcohol. This epidural is performed at the sacrocaudal or the first

intercoccygeal space. Needle size is dependent on animal size but typically an 18- to 21-gauge, 4-cm needle is acceptable. The needle is placed through the skin and the "hanging drop technique" is utilized. The hub of the needle is filled and advanced in a cranioventral direction. The anesthetic should be drawn into the space. Doses for the sacrococcygeal epidural are 1ml/15-50kg body weight.[10] The sacrococcygeal epidural will allow for manipulation within the vulvovagina, but the practitioner should not expect that it will provide anesthesia to the flank.

The author prefers to perform the lumbosacral (LS) epidural with all small ruminant dystocias especially if there is potential for C-section. The LS space is located in a depression palpated on midline from a transverse line drawn with the wings of the ilium.[10] (See Image) Performing the LS epidural requires that the practitioner be directly on midline. The space is clipped and prepped similarly to the sacrococcygeal space. A 3.75cm – 7.5cm, 21-gauge needle is typically used for small ruminants. The needle is placed through the skin, the "hanging drop technique" is utilized, and the needle is advanced until the anesthetic is drawn into the space or cerebrospinal fluid is flowing from the needle. Often times a "pop" will be felt when the needle passes through the interarcuate ligament and the anesthetic is drawn into the space. If the "pop" is missed and cerebrospinal fluid is present, an intrathecal LS epidural is still acceptable.[11] LS epidural doses range from 1ml/10-20kg of body weight. The author typically will use 1ml/10kg. The dose for intrathecal administration is 1mg/kg or 1ml/20kg of body weight.[10,11]

Once the epidural is in place, the vulva is cleaned with betadine scrub and water or ivory soap and water. Use of gloves and lubrication is imperative in small ruminants. Obstetrical manipulation may be limited because of the practitioner's hand or patient size. If a tail is present, it should be held up such that contamination is minimal. The hand is cupped and introduced into the vulva to determine if the fetus(es) can be extracted vaginally. Pelvic size of the dam, cervical

dilation, and fetal size will likely influence whether a vaginal delivery is acceptable. If vaginal examination reveals a tight ring of tissue, the cervix is either closing or still dilating and one should not attempt to shove their hand through this opening. Misoprostal may, but most likely will not assist with dilation of the cervix due to the cartilaginous rings of the cervix. If the practitioner can safely go through the cervix, then fetal manipulation must occur. Fetal manipulation includes determining the "3 P's" and then trying to correct the abnormalities. The author will utilize bailing twine, dog leashes, or fingers as obstetrical chains. Make shift head snares can also be made with these devices. Similarly, rules apply with one loop above and a half-hitch below the fetlock when placing "chains." As with any dystocia, once traction has started, there must be progress. Small ruminant fetus' often can be pulled with one forelimb retained, if the head and other forelimb are progressing normally. Caudal presentation is also an acceptable way for the small ruminant fetus to be extracted. If the fetus appears to be "stuck" in the canal or half of its body is protruding and it will not budge with significant traction, then other options are necessary. This "stuck" sensation could mean there is a uterine or cervical tear, and the more traction placed the worse the tear could become.

If vaginal manipulation and traction are unsuccessful next steps should be considered. C-section, fetotomy, terminal c-section, and euthanasia are all viable options. C-section can be performed utilizing the left or right flank (not recommended), ventral midline, or the paramedian approach. The author's preference is to do the procedure from the left flank. The following steps are performed when doing a small ruminant c-section in this manner.

1. Weight of the patient, calculation of toxic dose (6, 7, 10mg/kg) lidocaine, IV jugular catheter
2. Lumbosacral epidural – 1ml/10-20kg of body weight

3. Clip and quick prep of the left flank
4. Inverted L block in the left flank utilizing remainder of lidocaine from toxic dose calculation
    a. Often will dilute to make the lidocaine a 1% solution (C1V1=C2V2)
5. Inverted L block should be performed with respect to where the incision will be made
6. Final prep of the surgical site and gathering of surgical equipment needed
7. Flow-by oxygen hooked up and ready
8. Drugs – I don't use all of these!
    a. Midazolam or Diazepam – 0.2-0.4mg/kg IV before blocking of the left flank and can be re-dosed in surgery
        i. If the epidural and block are effective redosing may not be necessary
        ii. Reversal - Flumazenil
    b. Butorphanol or Morphine – 0.1 – 0.4mg/kg IV, IM, SQ
        i. Can be utilized for pain and sedation
        ii. Reversal - Naloxone
    c. Ketamine 1-5mg/kg IV at the start of procedure
        i. NO reversal available
    d. Xylazine 20mg/mL – 0.05-0.1mg/kg IV ONCE fetus(es) is/are delivered
        i. Reversal
            1. Tolazolene – only compounded currently
            2. Atipamezole – 0.1mg/kg SQ
                a. May be cost prohibitive

9. Goat protocol – IV catheter, LS epidural, clip and prep surgical site and administer local anesthetic, administer 0.2mg/kg midazolam/diazepam to "tie down" goat, prep the goat, prep yourself, administer epinephrine, administer additional midazolam if needed, cut the goat
10. Sheep protocol – LS epidural, clip and prep surgical site and administer local anesthetic, depending on the sheep 0.3mg/kg of midazolam may be enough to "tie down" the sheep, prep the sheep, prep yourself, administer epinephrine, administer additional midazolam and ketamine, cut the sheep
11. Scrub you and your team
12. Epinephrine – 1ml/100 lb IM or IV right before skin incision
13. Midazolam – 0.2mg/kg IV right before skin incision depending on how sedate from initial administration
14. Cut → Skin, cutaneous trunci muscle, external abdominal oblique, internal abdominal oblique, transversus abdominus, and peritoneum
    a. **Caution should be taken when incising the muscle layers because they can be incised very quickly and you have entered the abdomen
    b. The rumen is closely associated to the peritoneum and if accidental incision occurs, pack abdomen, and suture it using an inverting pattern
15. Put on an ob sleeve and push rumen cranial
16. Carefully grasp the gravid uterine horn and bring to the incision. The abdomen can be packed, but the author does not routinely do this.
17. Incise the greater curvature of the uterus such that the fetus can be removed without tearing the uterus and have the neonatal receiving team ready

18. Check for another fetus ("spares") and attempt to remove it through the same incision. If this doesn't occur make another incision such that iatrogenic tears don't occur.
19. Check for tears and repair those once the fetus(es) is removed
    a. This is easier said than done and sometimes there can be excessive hemorrhage that is hard to control. The author has spoken with veterinarians who have spayed these animal using a zip tie and controlling the hemorrhage. Others have performed a "routine" spay. Tears that are located in the cervical region or uterine body can be difficult to fully repair and hemorrhage may be impossible to control. Blood transfusion, 20-40mL/kg, may be necessary in these cases.
20. Close the uterus in a Utrecht pattern utilizing monocryl or PDS (2-0 – 0). Catgut has been utilized for many years; however the author has gone away from its use. Some practitioners utilize a double layer closure and that is left to the comfort of the veterinarian and contamination of the uterus.
21. Check for tears again once the uterus is closed and repair them quickly
22. Lavage the abdomen with saline and begin closure
23. Closure of the abdomen is most commonly done in a 3-4 layer closure
24. The muscle fascia is grasped and is closed in a simple continuous patter using vicryl or PDS (0 or 1)
25. Normally, the author grasps the transversus and internal abdominal oblique and closes this layer, then the external abdominal oblique and closes this layer in a simple continue pattern
26. The skin is closed in a ford interlocking with two interrupted sutures at the ventral portion of the incision utilizing 1-0 nylon

27. Aerosol bandage spray applied

If the owner is only concerned about the fetus(es) and the practitioner deems a c-section necessary, a terminal procedure can be performed exactly as described above. The intent would be to euthanize the dam immediately after the birth. Some may choose to perform this after euthanasia of the dam, but caution should be taken, especially if you are not quick, because fetal death will occur quickly.

Fetotomy is another option and should only be utilized if the fetus(es) is deemed deceased. Subcutaneous fetotomy over a percutaneous approach is recommended.[5,12] The approach has been described and is safer for the dam.[5,12] If the fetus is emphysematous or dead with the head and neck extended, decapitation and neck amputation is a feasible option. If cost prohibitive, long duration of labor, dead fetus, or severe obtundation, euthanasia is a valid treatment option.

Post-operative care of the dam

Patient status, electrolyte, and metabolic disorders should be corrected if these weren't addressed before or during the procedure. Every case and thus treatment of these disorders will be different. If excessive hemorrhage occurred and there is need for a blood transfusion, 20-40mL/kg is recommended for administration.

Currently there are no drugs (antibiotics or anti-inflammatories) approved for surgical procedures in small ruminants. Small ruminants are still considered a minor species in the eyes of the Food and Drug Administration (FDA), but this does not mean that one should go rogue with drug use. It is important to remember these animals just had a major abdominal surgery and pain control is imperative. Flunixin meglumine, 1.1mg/kg intravenously, can be administered every 12 hours for three consecutive days if necessary. This can be tapered to once daily if pain

seems under control based on physical examination. Owner preference may be to treat the animal at home and meloxicam, 0.5-1mg/kg orally once daily, can be used. Opioid administration is often necessary for pain control. Butorphanol, 0.4mg/kg intramuscularly every 3-4 hours or subcutaneously every 2-3 hours, can be administered for pain.[13] Morphine, 0.2-0.4mg/kg every 4-6 hours by, intravenous, intramuscular, or subcutaneous route is recommended.[14] If pain control is needed quickly after the procedure, 0.1-0.2mg/kg morphine intravenously can be utilized.

Antibiotic administration is variable and often clinician dependent and it is important to remember that just because we can doesn't mean we should. Currently FDA approved injectable drugs in sheep include the following: procaine penicillin G, oxytetracycline, ceftiofur sodium, and tilmicosin. The only approved injectable drug in goats is ceftiofur sodium. Approved use of these drugs is for respiratory disease caused by either *Mannheimia haemolytica* or/and *Pasteurella multocida*.

Commonly administered antimicrobials at this institution and by the author include the following and are considered extralabel and withdrawal times should be followed:

a. Ceftiofur sodium (50mg/mL): 2.2-5mg/kg IV, IM, SQ every 12-24 hours for 5-7 days
b. Florfenicol (300mg/mL): 20mg/kg IM and then repeat in 48 hours, 40mg/kg SQ can be repeated in 96 hours
c. Tulathromycin (100mg/mL): 2.5mg/kg SQ once, can be repeated in 5-7 days
d. Oxytetracycline (200mg/mL): 20mg/kg SQ once, can be repeated in 48-72 hours
e. Ceftiofur crystalline free acid (200mg/mL):6.6mg/kg SQ once The author doesn't use this drug because ceftiofur sodium is approved for use in sheep and goats (other indication).

Fetal membranes should pass within 12 hours after parturition. The author administers oxytocin, 5-10 international units IM, SQ, or IV. Administration continues every three hours until membranes have passed or until 24 hours later.[5] Facilitating expulsion of the fetal membranes will reduce complications such as metritis and endometritis.

Complications following c-section include retained fetal membranes, metritis, incisional site infection and dehiscence, uncontrolled metabolic issues, and ultimately death. These conditions can each be treated on their own or in combination with the other. Obviously, death is not treatable. Future breeding and fertility may be thought of as a complication, but as it stands there is no long term prospective study that has evaluated this. 84-100% of postsurgical cases achieved pregnancy in the next breeding season in one report.[5,15,16]

Post-operative care of the neonate

The other component and sometimes most important is the neonate. After removal from the uterus, the neonate should be stimulated to breath and ensure there is no hemorrhage from the umbilicus. Stimulating the nose by using the great vessel (GV) 26 point will often cause them to take a breath. Coupage of the thorax, suction of the mouth and nose, brief hanging will also remove excess fluid and stimulate breathing. Some drying of the neonate is acceptable but should be left to the dam such that mismothering is minimized. If the neonate is not dried all the way, monitoring the temperature is important because hypothermia occurs quickly especially in a cold environment.

Drug reversal may be considered in the neonate. Ability to reverse drugs will depend on drugs administered during the procedure and if an antagonist is available, as well as, the drug availability at that clinic. Commonly used reversal agents by this author include flumazenil,

0.02-0.05mg/kg IM to reverse the benzodiazepines; naloxone, 0.03mg/kg IM to reverse opioids, and atipamezole 0.1mg/kg IM to reverse xylazine. (Personal communication with Dr. HuiChu Lin) Compounded tolazoline is available in various concentrations and it should be dosed accordingly. Drug reversal is not benign and more does not equal better. Ruminants are sensitive to reversal agents and worst-case scenario with their use is death.

Timely administration of colostrum or a colostrum replacer is imperative. Disease prevention is also important and will depend on goals of producer. Lentivirus status should be established in well managed herds. Johne's disease and caseous lymphadenitis free herds are harder to establish especially if there is movement of animals and one time testing. Administration and amount of colostrum to provide to small ruminants has not been intensively studied as it has been in calves. Variability of timing and amount exists in the literature. Because these neonates are born agammaglobulinemic it is important to provide colostrum or ensure they are suckling soon after birth. Cattle studies support that colostrum administration should be within 6 hours of birth because the apparent efficacy of absorption begins to decline after 12 hours.

Small ruminant females can be administered oxytocin and milked after the completion of the surgical procedure. Colostrum should be tested using the Brix refractometer. There is evidence with cutoff points to support the Brix use.[17] This allows for colostrum to be used, frozen, or stored especially if the neonate or dam dies. If the dam does not appear to be interested in mothering the neonate, then providing maternal colostrum or a replacer is important. Recommended amounts are 5% at the first feeding and then an addition 5% within a 12-hour period.[18] Other recommendations include 10-20% of body weight within the 12-hour period. Vigorous neonates will attempt to latch and suckle very quickly after the surgical procedure. 20% of body weight equilibrates to 50ml/kg (1oz/lb) of body weight.[3] Veterinarians and owners

alike should be confident in tube feeding the neonate to ensure adequate intake, especially if they are unwilling to suckle. The author prefers to use a 12–16-gauge red rubber catheter depending on size of neonate.

Dipping of the umbilicus is still up for debate and variable among farms and clinicians.

Finally, through learning and listening the rules of the neonate apply to all ruminants and should be followed immediately after the surgical procedure and within the first weeks to month of life.

Rules of the Neonate

1. Eyes
    a. Cloudy → indicating hypopyon or cataracts
    b. Normal reddening at the scleral/limbic junction after birth
    c. Other abnormalities noted
2. Joints
    a. Palpate every joint
        i. Non-painful, non-effusive is normal; small amount of joint fluid can be palpated in the normal neonate
        ii. Don't forget elbows and stifles – they will sneak up on you
    b. Aseptic sampling can be performed
3. Umbilicus
    a. Size
    b. Firm versus soft
        i. The first days after birth the umbilicus should be soft and non-painful

        ii. Within the first month it will <0.5cm and should continue to be non-painful
    c. Drainage or odor
        i. Abnormal after the first 1-2 days
    d. Hernia present – Y/N
4. Rectum
    a. Is it present?
        i. Digital exam
        ii. Don't forget about the possibility of recto-vaginal fistula
            1. Likely more rare than the calf
    b. Feces/meconium passed
5. Palate
    a. Run you hand along the entire palate
        i. Midline from the dental pad and caudal
    b. The dam often will kick at or not let the neonate suckle because the suckle is incorrect
    c. Milk may come from nose

Conclusion

C-section is a common procedure that can be performed in the field with local and injectable anesthesia. Maintaining a sterile field is important to decrease the risk of peritonitis and incisional infection. Control of post-operative pain is imperative. Not all c-sections and neonates

die and most often they don’t require long term hospitalization. Care of the neonate is important to ensure adequate transfer of passive immunity.

Image 1: Lumbosacral Space – where the two lines intersect

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Bovine Anaplasmosis

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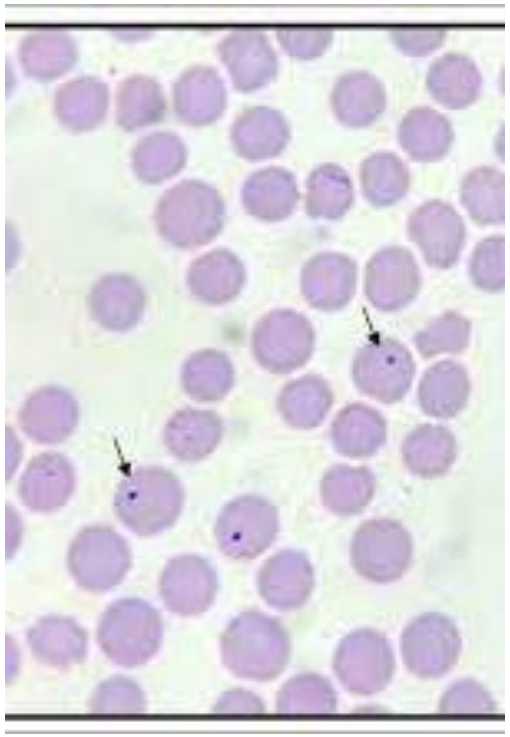
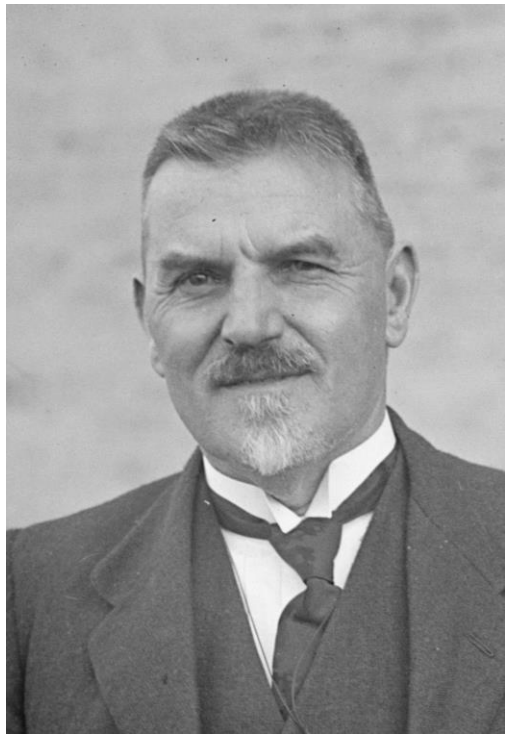
College of Veterinary Medicine

Background



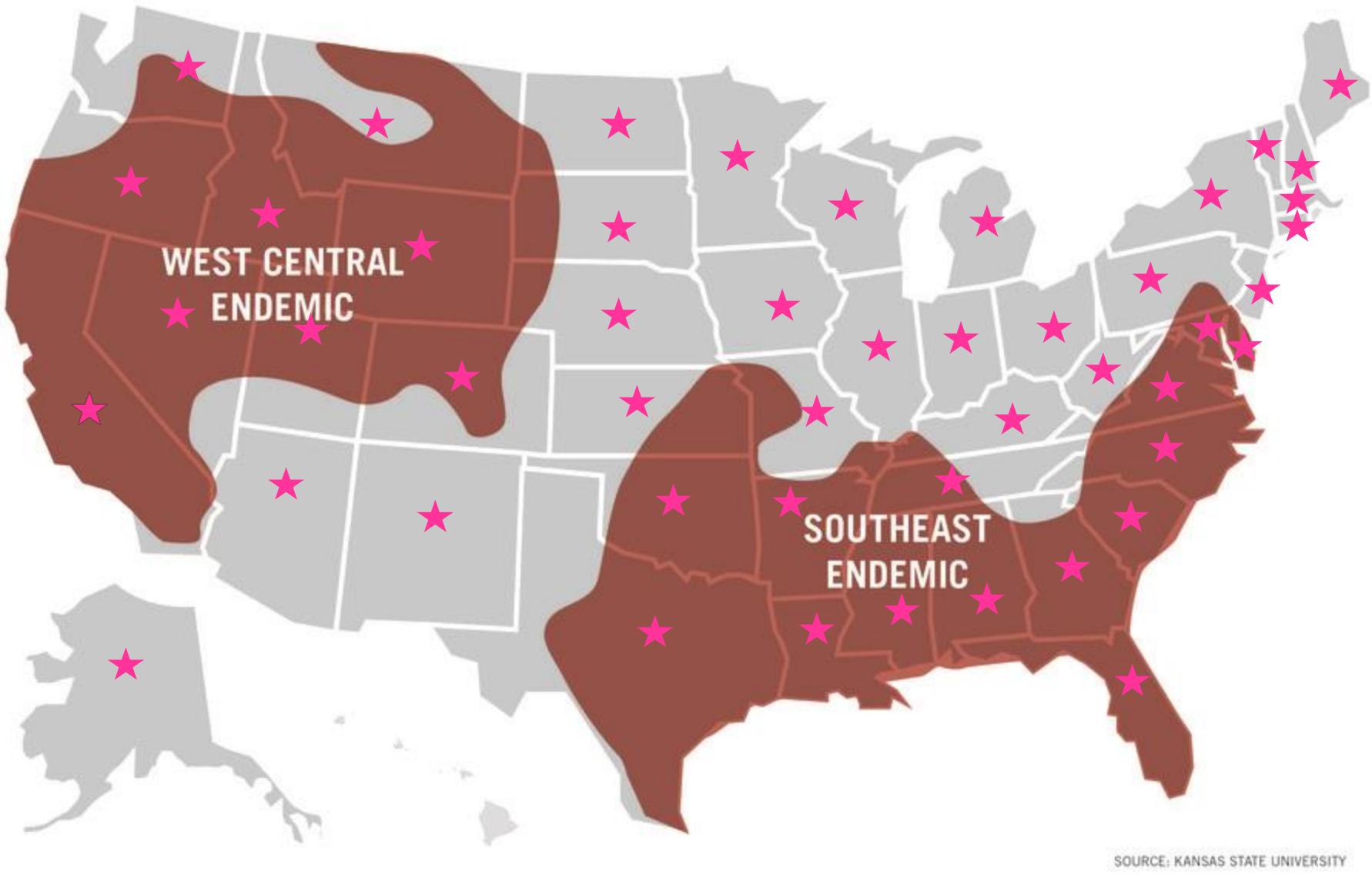


- Blood borne parasite
- Theiler, 1908
- Anemia through phagocytosis of RBC
- Fever, Anorexia, Jaundice, Production losses, Death

Introduction

Anaplasma marginale

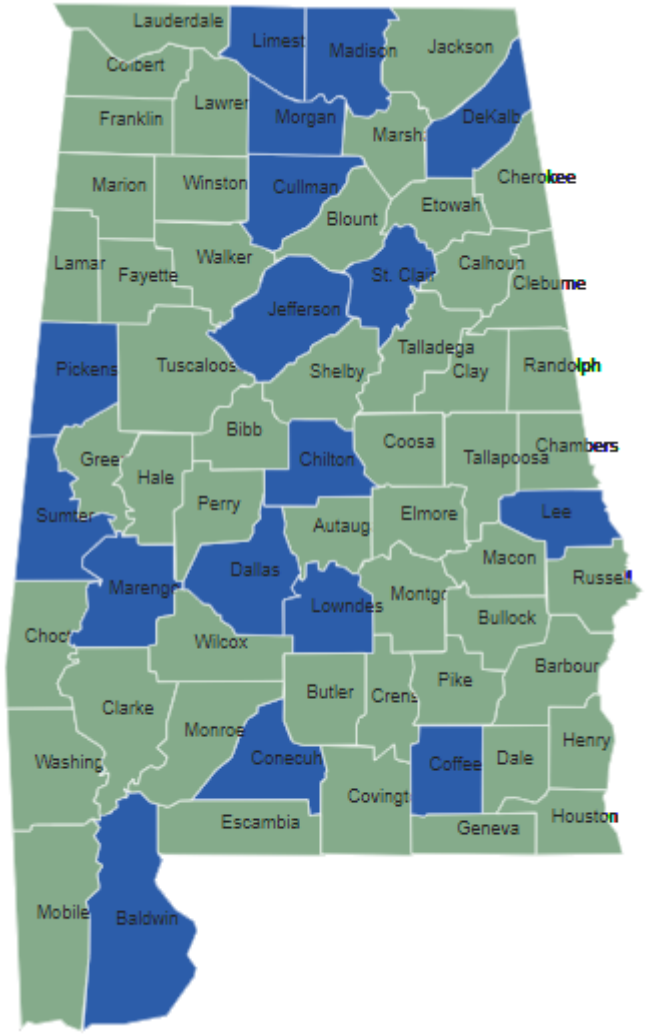
- 1st described in USA 1925 in Kansas
- production losses
  - calf crop: -3.6%
  - cull rate: +30%
  - mortality rate: 30%
  - persistent infections
- Cost to the U.S. Beef Industry
  - estimated losses of over $300 million/yr
  - $400/ clinical animal


WEST CENTRAL
ENDEMIC
SOUTHEAST
ENDEMIC
SOURCE: KANSAS STATE UNIVERSITY

Bovine Anaplasma Seroprevalence

Southern United States 1973 McCallon
2-24%

Lousiana 1984 Hugh-Jones et al.
5.6%



Rodning et al. 2010

cELISA (Se 95%, Sp 98%)

68 Herds

- 12-1263 hd

31 counties

7,524 samples submitted

1% seroprevalence

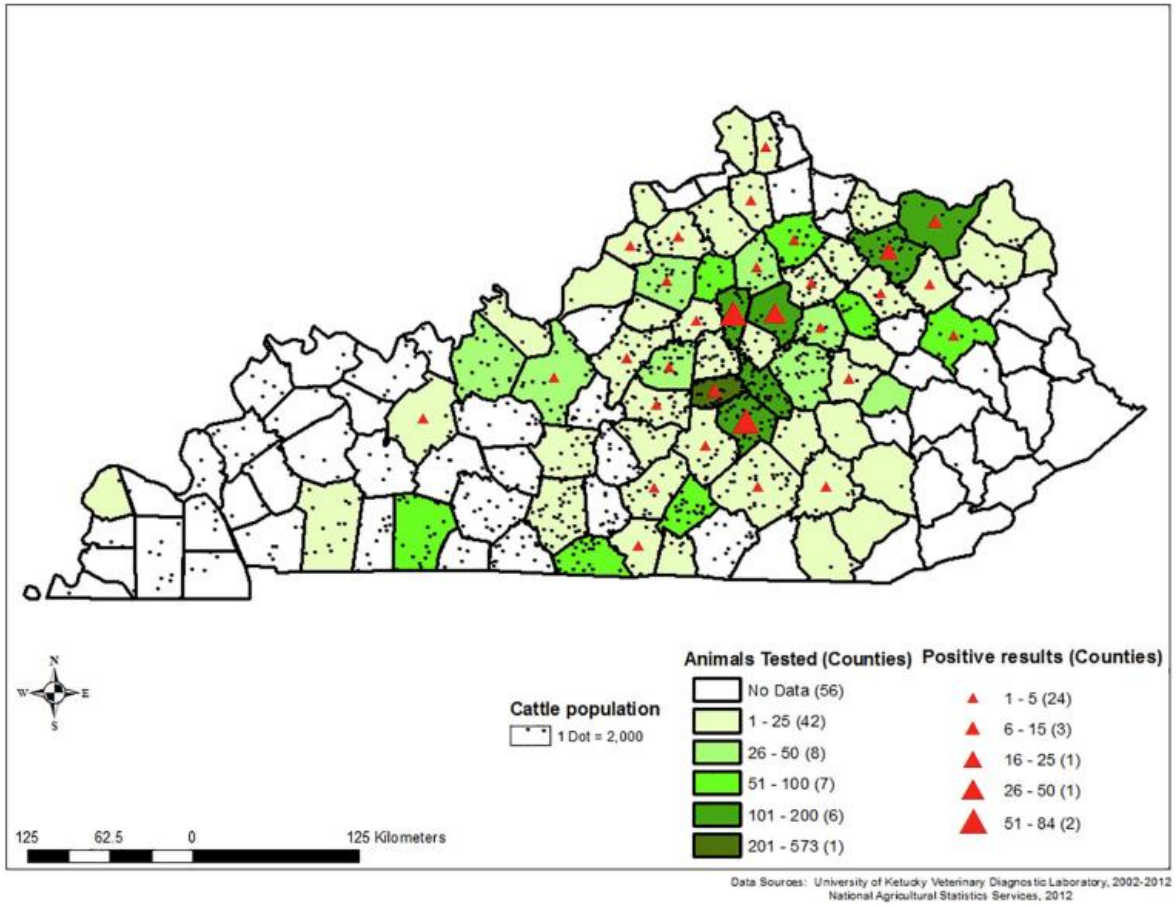
AAVLD Data
18.8% positive

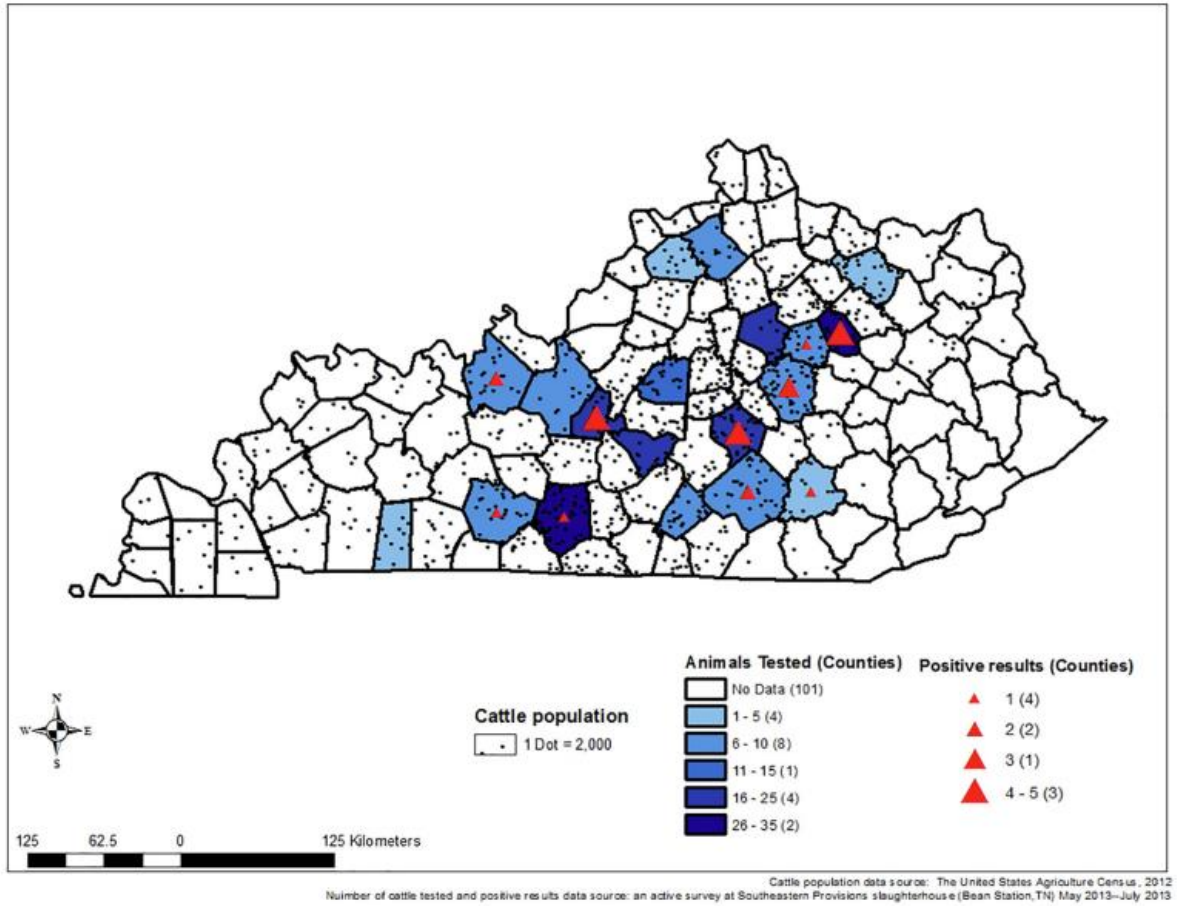
Slaughterhouse Data
13.5% prevalence

State	AAVLD % +	Current %	1973 %
AL	7.9%	9.0%	10%
AR	16.8%	15.8%	19%
FL	-	19.5%	10%
GA	-	4.6%	-
KY	10.6%	10.7%	5%
LA	-	20.8%	18%
MS	27.6%	29.1%	24%
MO	-	33.8%	13%
NC	10.9%	6.2%	12%
OH	-	9.1%	2%
SC	5.1%	10%	15%
TN	56%	10.5%	12%
TX	15.6%	5.3%	16%
VA	-	1.3%	3%

Whitlock et al. 2014

KY Prevalence Study 2018





Okafor CC et al. 2018

KY Prevalence Study 2018

Prevalence: 9.44%

Risk factors:

- adults vs juveniles
- Angus vs Holstein
- individual vs pooled samples
- summer vs other season

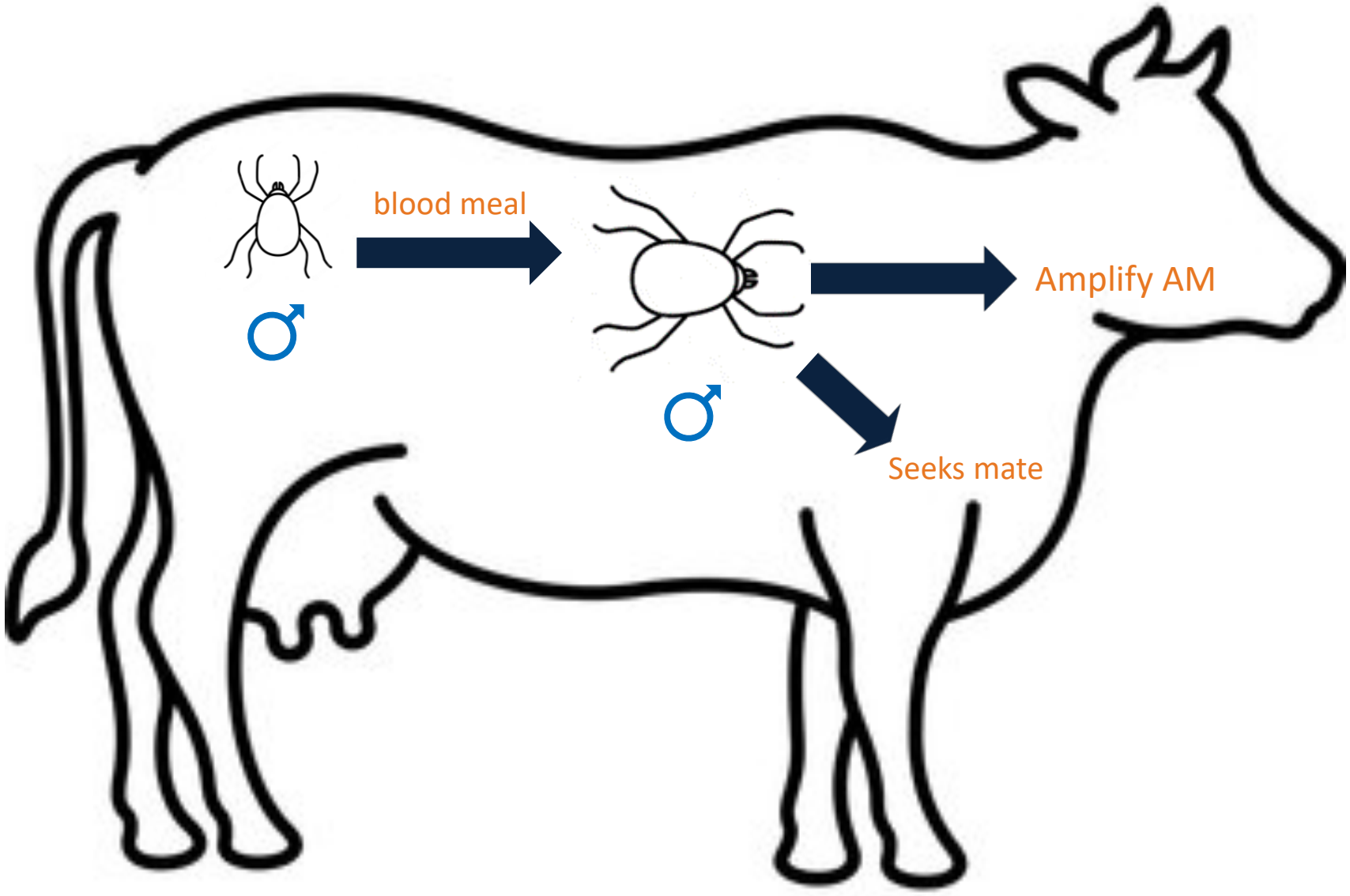
Okafor CC et al. 2018

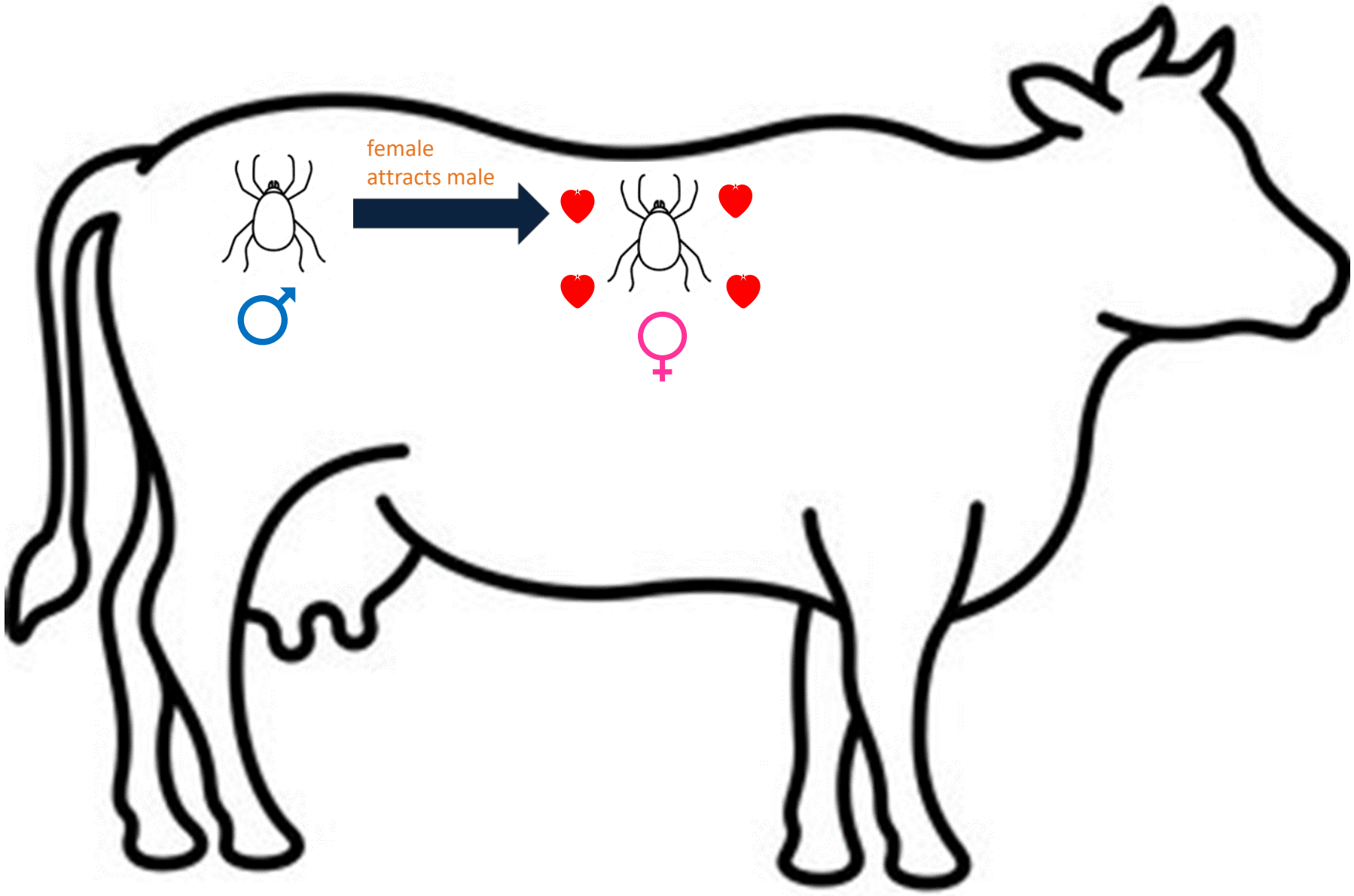
How did my herd acquire Anaplasmosis?

Biological transmission
- *Dermacentor spp* ticks

Mechanical transmission
- biting flies/mosquitos
- blood contaminated fomites

Vertical transmission
- *in utero*


blood meal
♂
♂
Amplify AM
Seeks mate

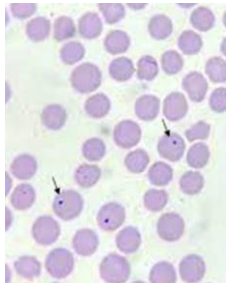

female
attracts male
♂
♀

Role of Flies in Anaplasmosis Transmission

Stable Fly- *Stomxys calcitrans*

Horse Fly- *Tabindae*

Pathogenesis



3-10 Weeks

Fever, anemia, jaundice, anorexia, infertility

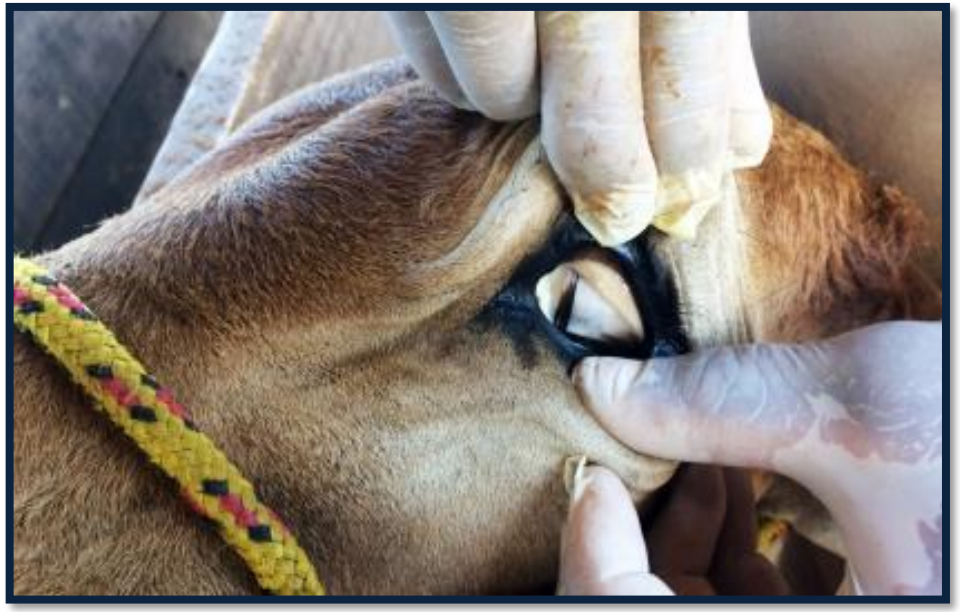
Infection → Prepatent Period → Acute Infection → Persistent Infection

Disease Characteristics

- young cattle (< 1 year of age) resistant to clinical disease
- peripartum period- disease more severe
- seasonal disease
  - vector season
  - fall after 6-8 weeks of exposure

Clinical Signs of Anaplasmosis

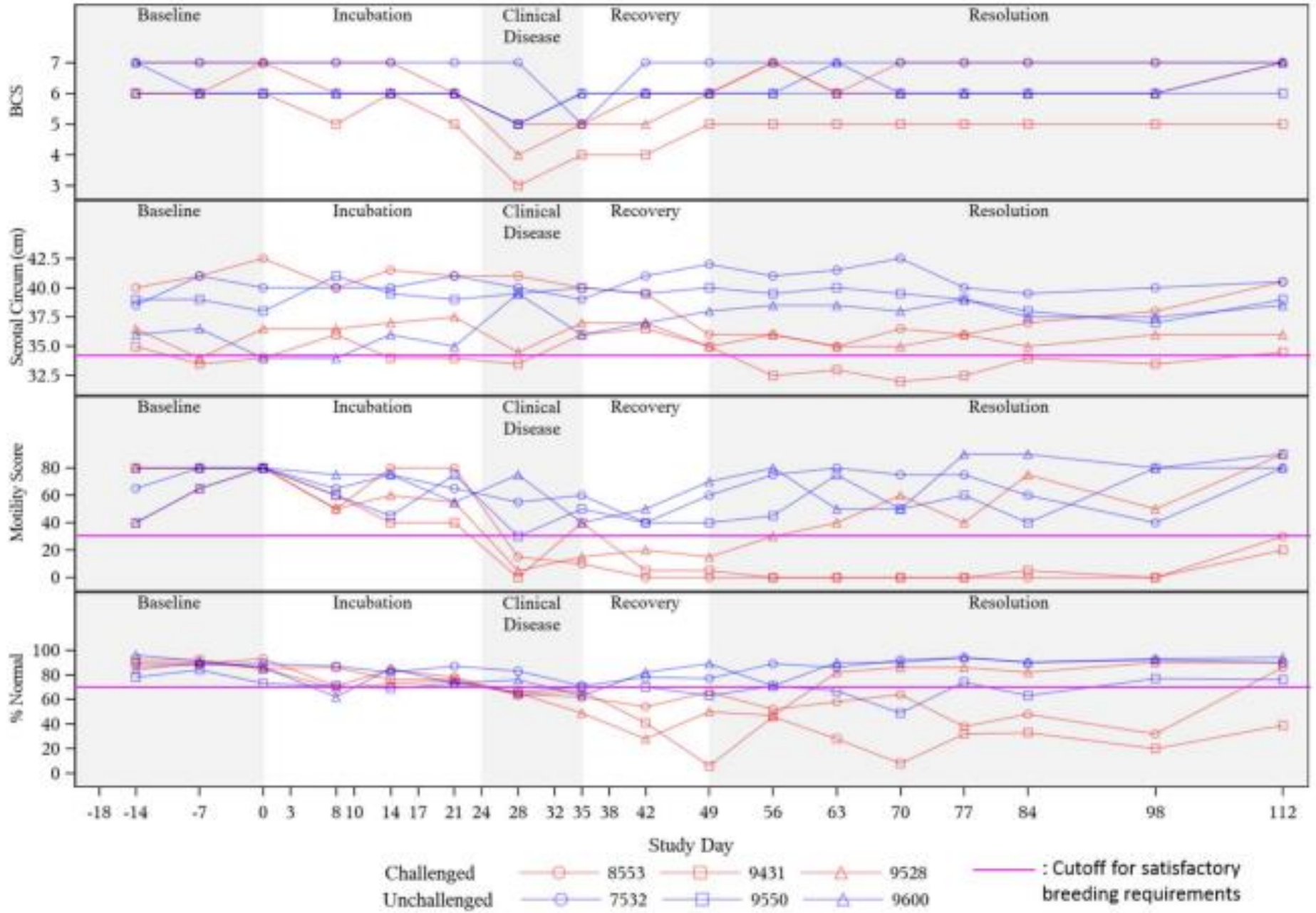
- Fever
- Anorexia
- Constipation
- Anemia
- Icterus
- Abortion
- Subfertility in bulls
- Ataxia
- Death

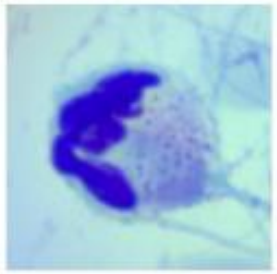


RESEARCH Open Access

Satisfactory breeding potential is transiently eliminated in beef bulls with clinical anaplasmosis

Anne C. Lovett[1,2], Emily J. Reppert[2], John R. Jaeger[3], Qing Kang[4], Macy R. Flowers[1], Naemi P. Bickmeier[1], Tippawan Anantatat[1], Shannon C. O'Day[1], Chance L. Armstrong[5] and Kathryn E. Reif[1*]


Baseline
Incubation
Clinical Disease
Recovery
Resolution
BCS
Scrotal Circum (cm)
Motility Score
% Normal
Study Day
-18 -14 -7 0 3 8 10 14 17 21 24 28 32 35 38 42 49 56 63 70 77 84 98 112
Challenged
Unchallenged
8553
9431
9528
7532
9550
9600
: Cutoff for satisfactory breeding requirements

Head Abnormalities	A. 	B. 	C. 
Midpiece Abnormalities	D. 	E. 	F. 
Tail Abnormalities	G. 	H. 	I. 
Other Cells	J. 	K. 	L. 

Conclusions

Results confirm that clinical anaplasmosis reduce breeding soundness especially in endemic areas

100% of infected bulls anemic & febrile at peak

- lost body condition during study

100% of infected bulls did not pass BSE after peak

100% of infected bulls experienced reductions in scrotal circumference, sperm motility, and morphology

Challenges with Anaplasmosis

- Subclinical carriers serve as a reservoir for disease
- Iatrogenic spread of disease
- *in utero* transmission
- Treated cattle still become carriers of disease
- No approved treatments for elimination of persistent infections
- No USDA approved vaccine

Outbreak Risk Factors

- Disease status unknown for the herd
- New additions to herd of unknown disease status
  - leasing bulls
  - show cattle
- Management & Environmental factors favor transmission
  - needles, rainfall, ticks, biting flies

Control of Anaplasmosis

Endemic herds

↓

medicate herd with Oxytetetracyline

- control of clinical cases/stabilize

↓

Pulse feed CTC 21 d on/21 d off (May-Oct)

↓

Vaccinate?

Goal = Endemic stability within herd

FDA Veterinary Feed Directive

Medicated animal feeds such as chlortetracycline medicated feeds may only be used as specifically indicated by the FDA and only under the direct supervision of a veterinarian

Control Measures

Biosecurity

Testing
- PCR, cELISA

Vaccination
- University Products LLC (Baton Rouge, LA)
- killed product
- $$$
- will be carriers following vaccination
- decrease in clinical disease

CTC pulsing

Fly Control

Questions

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Strategies to reduce bovine respiratory disease (BRD) in southeastern beef calves

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Introduction

The bovine respiratory disease (BRD) complex is the most important cause of morbidity and mortality in calves from U.S. beef and dairy herds.[1] Economic losses associated with clinical disease are more significant in beef calves around the time of weaning, young dairy calves under 3 months of age, and pre-weaning beef calves. The impact of factors such as failure in the transfer of passive immunity, decay of maternal antibodies, transport, commingling, biosecurity breaches, etc. in individual herds introduces variation in the clinical presentation of BRD in each calf group. The majority of weaned beef calves from southeastern US cow-calf production systems are marketed through auction barns and commingled with other cattle multiple times before reaching their next stage in production.[2,3] This results in multiple opportunities for single or simultaneous exposure to respiratory pathogens. Respiratory viruses such as bovine herpesvirus 1 (BHV-1), bovine viral diarrhea virus 1 and 2 (BVDV 1, BVDV 2), bovine respiratory syncytial virus (BRSV), bovine parainfluenza virus 3 (BPIV3), bovine coronavirus (BoCV), and Influenza D virus (IDV) play an important role in the pathogenesis of BRD and promote secondary bacterial infections.[4,5] Although whole-herd vaccination against BRD

pathogens is a common practice among producers and veterinarians to minimize calf losses associated with morbidity, some studies have reported inconsistent efficacy of commercially available BRD vaccines to reduce morbidity and mortality in calves.[6] Methaphylactic treatment with antimicrobials at the time of arrival of calves to stocker or feedlot operations is highly effective reducing BRD-associated calf morbidity and mortality; however, the diagnosis of subclinical BRD in cattle is challenging and identifying the calves that actually need antimicrobial treatment at arrival has been a controversial subject. This phenomenon has resulted in the overuse of antimicrobials under the metaphylactic label and therefore in an increased incidence of isolation of multidrug resistant bacteria from the lungs of cattle dying from BRD in feedlot farms. Alternative management strategies such as different weaning methodologies that minimize stress and boost calf performance could benefit southeastern cow-calf producers by increasing weaning weights and benefit stocker/feedlot producers through reduction of losses associated with BRD.

Key words: BRD, vaccination, antimicrobial, metaphylaxis, weaning, fence-line

1. MODIFIED-LIVE VIRUS VS. INACTIVATED VIRUS VACCINES

1a. Efficacy of MLV and KV vaccines reducing BRD in weaned beef calves

The most important goal of vaccination of beef calves around the time of conventional weaning (5-8 months of age) is to reduce clinical presentation of BRD after shipment and arrival to stocker/feedlot operations. Studies evaluating MLV and KV vaccines on the reduction of clinical disease caused by naturally occurring BRD after weaning were subjectively assessed. Modified-live and KV vaccines used in these studies contained at least one of the following pathogens, BHV-1, BVDV 1, BVDV 2, BRSV, BPI3V, *Mannheimia haemolytica*, *Pasterella multocida*, and

Histophilus somni. In all studies, vaccination of calves occurred in the transition from weaning to arrival to the feedlot. In general, reduction of BRD morbidity and mortality was reported in 75% and 67%, respectively, of the studies using MLV vaccines;[7-15] however, reduction of BRD morbidity and mortality was reported only in one study using KV vaccines. Vaccination protocols including BVDV 2, *Mannheimia haemolytica*, *Pasterella multocida* and early vaccination (before weaning, before arrival) resulted in a greater reduction of clinical BRD. Studies evaluating the use of MLV and KV vaccines on the reduction of clinical disease caused by experimental challenge of calves with respiratory pathogens were also assessed. Vaccination of calves occurred between 5-12 months of age and experimental challenge with one of the following agents, BVDV, BHV-1, BRSV, *M. haemolytica*, or *Mycoplasma bovis* occurred between 3-230 days after vaccination. Reduction of BRD morbidity and mortality among studies using MLV or KV vaccines or comparing MLV vs. KV vaccines was similar and varied between 80-100% for both, morbidity and mortality.[16-20] One study reported no effect of vaccination of recently weaned beef calves with a *M. bovis* vaccine on clinical disease, mortality, or pathologic lesions after experimental challenge.[21]

1b. Efficacy of MLV and KV vaccines reducing BRD in young dairy calves

Respiratory disease is the number one cause of morbidity and mortality of young dairy calves in U.S. dairy herds. Studies evaluating the effect of multivalent MLV vaccines on the reduction of natural occurrence of BRD in dairy calves between 1-3 months of age have not demonstrated significant reduction of morbidity and mortality.[22,23] One study reported that dairy calves with greater levels of colostrum derived serum antibody titers against BHV-1 and BRSV had lower odds of developing BRD signs compared with calves with lower titers.[24]

Studies evaluating reduction of BRD in vaccinated dairy calves following experimental challenge with respiratory viruses reported >80% reduction of BRD morbidity and >50% reduction of BRD mortality for MLV vaccines. Reduction of BRD morbidity was 33% for studies using KV vaccines.[25-29] Vaccination and experimental challenge of young dairy calves with a homologous BVDV strain resulted in protection up to 7 months after vaccination in one study;[30] in contrast, vaccination and experimental challenge with a heterologous BVDV strain 4.5 months after vaccination resulted in severe clinical disease in another study.[31]

1c. Efficacy of MLV and KV vaccines reducing BRD in pre-weaned beef calves

Different from U.S. diaries, the prevalence of BRD in pre-weaned beef calves is variable among U.S. cow-calf herds. There are few studies evaluating the effect of vaccination of young beef calves on the reduction of natural occurrence of BRD before weaning. Two studies evaluating the use of MLV or KV demonstrated no effect of vaccination on reduction of naturally occurring pre-weaning BRD morbidity and mortality.[32,33]

Studies evaluating the effect of vaccination of young beef calves with MLV or KV vaccines on the reduction of BRD following experimental challenge with respiratory viruses such as BVDV, BRSV, and BHV-1 have produced inconsistent results with the majority demonstrating no effect of vaccination.[34,35] Colostrum-derived antibodies provided clinical protection to unvaccinated control calves in these studies. The presence of greater levels of specific BVDV 1a and BVDV 2a antibodies in vaccinated calves before experimental challenge with BVDV resulted in reduction of viremia and BVDV shedding but did not improve clinical protection compared with unvaccinated calves with moderate to low colostral antibodies.[34] In a recent report, beef calves that nursed colostrum from vaccinated dams demonstrated lower rectal temperatures and reduced BRSV shedding after experimental challenge with BRSV at 3.5 months of age.[36]

2. METAPHYLAXIS

Despite the tremendous research efforts in the last 30 years to develop effective vaccination protocols for beef and dairy calves, the incidence of BRD-associated morbidity and mortality in this population of animals has not changed and some investigators believe it has rather increased.[37,38] In contrast, antimicrobial treatment of cattle with subclinical BRD at arrival to stocker and/or feedlot operations has consistently resulted in a reduction of BRD morbidity and mortality during the start of the feeding period.[7,39,40] The accurate diagnosis of subclinical BRD in dairy calves or beef calves arriving to stocker operations or feedlots is critical for effective antimicrobial treatment and to promote antimicrobial stewardship within bovine veterinary practitioners and producers; however, the diagnosis of subclinical BRD is very challenging and based on subjective (non-confirmatory) clinical scores.[41] Additionally, in the majority of cases the diagnosis and decision-making involving metaphylactic treatment of calves with suspect BRD is made by non-veterinary professionals. This has led to an increased use of mass treatment of calves considered at high risk of developing BRD with antibiotics during the arrival processing at stocker or feedlot operations. In the author's opinion, these factors are leading to antibiotic overuse and recently reports of multidrug resistance Mannheimia haemolytica and Pasteurella multocida in beef calves that received antibiotic treatment at arrival to stocker and feedlot operations are increasing.[42,43] The administration of antimicrobials to calves with subclinical BRD could effectively reduce losses associated with calf morbidity and mortality if used consciously and based on accurate diagnosis. Recently, the use of bilateral thoracic ultrasound examination in addition to a clinical score has provided some light on improving the diagnosis of subclinical BRD and therefore the decision making process for antibiotic treatment.[41,44] The use of metaphylactic antimicrobial treatment of calves without an accurate diagnostic

approach for the prevention of BRD morbidity and mortality is unsustainable due to the increased risk of developing multidrug resistant BRD-associated bacteria; however, if selectively used based on an accurate diagnosis, metaphylaxis can be a sustainable and effective alternative to reduce losses associated with BRD.

3. WEANING METHODOLOGIES

Beef calves in the United States are commonly weaned from their dams around 7 months of age. This separation from their dam usually occurs abruptly, which can cause extreme stress in the calf. Physiological responses to weaning including increases in concentrations of plasma cortisol, norepinephrine and synthesis of acute phase proteins that induce a pro-inflammatory state and increase the risk of disease such as BRD.[45] The behavioral and physiological responses associated with weaning reduce performance in calves and impair health. Weaning stress can be compounded by transportation, dietary changes, commingling/social challenges and environmental changes.

Alternative weaning methods reduce calf stress and help with the transition to the next stages of production. Results from some studies have demonstrated that calves weaned and allowed to have fenceline contact with their dams spend more time eating than calves that are weaned abruptly.[46,47] Other beneficial effect of fence-line weaning include decrease in calf weight-loss and improved performance at the feedlot compared to traditional weaning methods. In another study, calves weaned with nose-flaps for 14 days and then separated from their dams spent 79% less time walking and 96% less time vocalizing compared to abruptly weaned calves.[48] Another study demonstrated a clear performance advantage of fence-line weaned beef calves compared with nose flap and abruptly weaned calves.[47] Despite the potential performance and health

benefits of improved weaning methodologies, the adoption rate of these practices among southeastern producers is relatively low. The implementation of these practices has demonstrated extended beneficial effects on calf performance in all stages of production from the cow-calf farm, to the stocker/backgrounder to the feedlot.

CONCLUSION

A strategic combination of weaning management practices, strategic vaccination protocols that match the highest immune response at the time of highest risk of exposure, and an accurate-BRD-diagnosis based metaphylactic treatment program for calves with subclinical BRD should be the focus of BRD prevention in cattle.

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Supplementation Strategies in Forage-Based Beef Operations: Sense and Cents

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Beef cattle producers differ in their production goals depending on the nature of their operation. It is safe to say that a seedstock breeder will not have the same management goals as the cow-calf producer, and the stocker operator will not operate the same as the producer focused on heifer development. What these producers do have in common, however, is a desire to identify grazing management systems that enhance productivity while maintaining economic (and environmental) sustainability. Supplementation, the providing of feedstuffs other than forage, is a technique that may be employed to accomplish that goal. In this review, we will provide an overview of the scenarios in which supplemental feed may be offered, the goals of each of these systems, and some rules of thumb for their application.

Keywords: supplement, grazing management, nutrition

Supplementation Strategies

Supplementation is a small word with quite a large connotation in the world of beef cattle nutrition. According to Huston et al. [(1)], there are four strategies for supplementation of beef cattle, depending on the needs of the herd: supplemental feeding, substitution feeding, enhancement feeding, or supply feeding. The choice of supplementation strategy is primarily linked to two factors: the forage base on which the cattle are grazing, and the nutrient

requirements of each class of animal. Forage nutrient provision can be generally related to the class of forage provided (Figure 1), but it is also highly dependent on time of year as growing seasons differ by species (Figure 2).

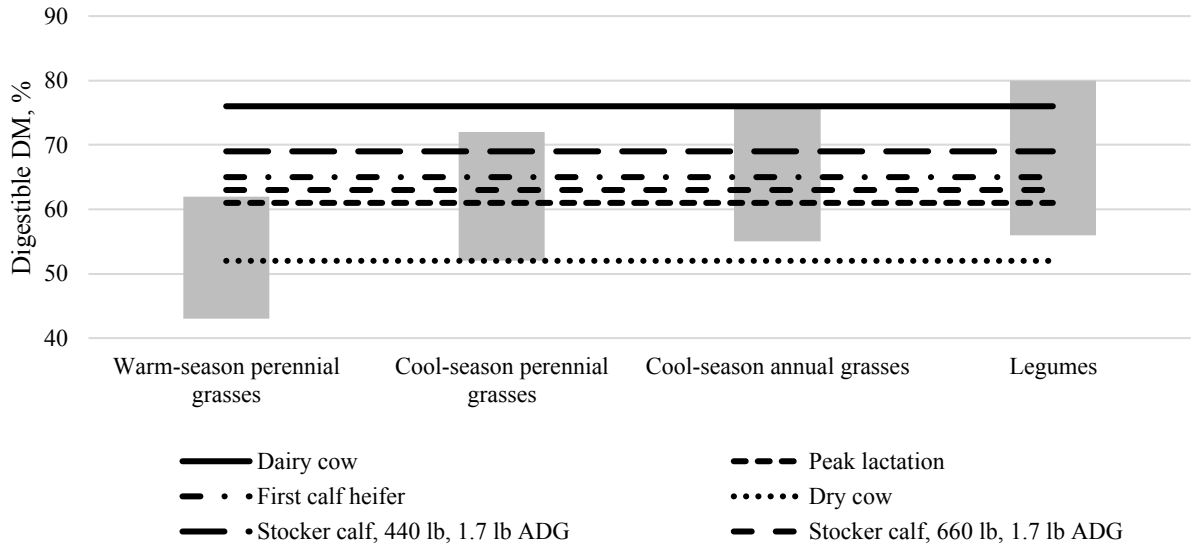

Figure 1 Nutrient requirements of selected classes of cattle and digestible dry matter of selected classes of forages (adapted from Riewe [(2)] and Ball et al. [(3)])

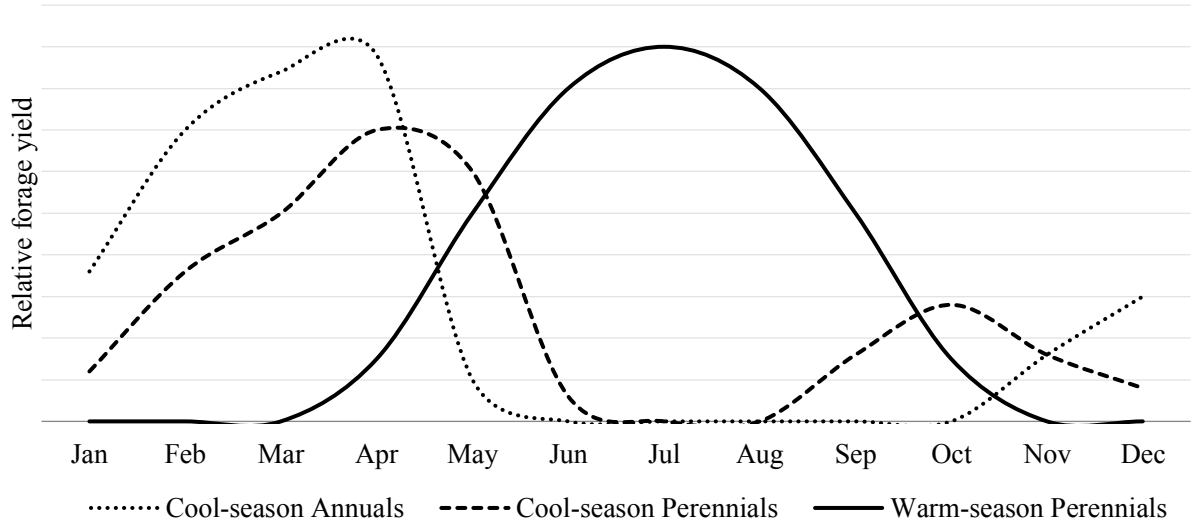

Figure 2 Forage growth distribution for Alabama (adapted from Ball et al. [(3)])

Supplemental Feeding

Supplemental feeding is a scenario in which the limiting nutrient(s) is supplied to stimulate intake and/or digestion of the available forage.[1] In this case, we would typically expect to observe an additive effect of supplementation as illustrated in **Error! Reference source not found.**.

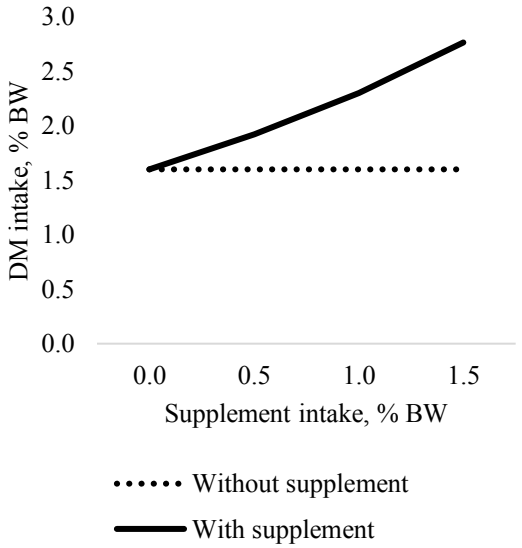

Figure 3 Additive effect of supplementation (adapted from Huston et al. [1])

Supplemental feeding is the typical scenario that we picture when we envision supplementing the beef herd; from a veterinary perspective, this will likely be the second most common scenario in which supplementation is recommended. The general idea behind supplemental feeding is that something in the forage provided to the animal is a limit to their production potential. In many Alabama pastures under "typical" or low-intensity management, this is the case. We are able to develop some general rules of thumb, then, to address the potential problems that might arise. In the warm-season (late spring through mid-autumn in most of the state), the perennial grasses tend to provide plenty of energy (not limited in dry matter production), but crude protein is marginal or deficient for most growing animals. Thus, the typical supplement to be offered in the warm season would be one that offers additional crude protein (e.g., corn gluten feed, dried distillers grains, soybean hulls). Conversely, in the cool season (late autumn through early spring), crude protein and non-structural carbohydrates are abundant, but energy is generally limiting due to the low dry matter

concentration (i.e., lush) of cool-season grasses. During this time of year, we commonly opt for energy-type feedstuffs (e.g., corn, dried distillers grains).

Enhancement Feeding

Enhancement feeding is a scenario in which supplemental feed is offered to increase intake (and quality) of the overall diet, either to satisfy higher nutrient requirements or to make more efficient use of resources.[1] Enhancement feeding differs from supplemental feeding in that there is no single nutrient that represents a limitation to production. Rather, it is the combination of nutrient interactions in the digestive system that causes an increase in efficiency that alters the overall nutrient requirements of the animal itself. Thus, enhancement feeding most likely represents the best opportunity for increased production under intensive management scenarios.

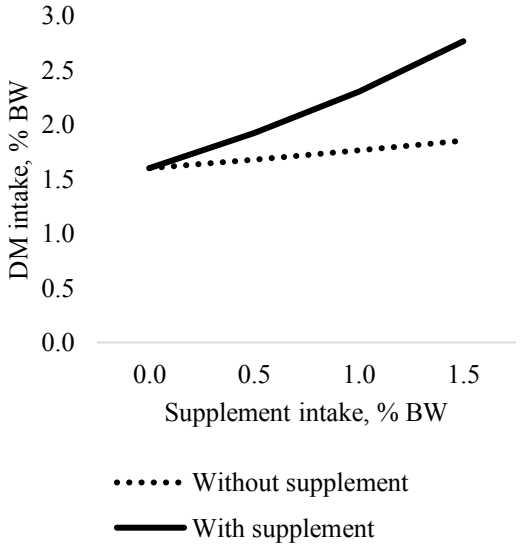

Figure 4 Positive associative effect of supplementation (adapted from Huston et al. [1])

There are some great examples in the literature where enhancement feeding has resulted in increased efficiency, both financially and from the perspective of resource management. Smith et al. [4] supplemented yearling stocker steers grazing Tifton 85 bermudagrass (a highly productive variety that is seldom limiting in nutrients) with dried distillers grains throughout a summer grazing period. In this experiment, the most efficient supplementation strategy was 0.25% BW (approximately 2.25 lb/d); this resulted in a supplement-to-gain ratio of 4.1:1 at a cost of approximately $0.40/lb of additional gain.[4] Increasing daily supplement to 0.05% BW

(approximately 5 lb/d) resulted in a supplement-to-gain ratio of 6.0:1 at a cost of $0.58/lb of additional gain.[4] This effect will vary from forage-to-forage and variety-to-variety, though. For instance, Smith et al. [5] found that 1% BW supplementation (approximately 8 lb/d) was necessary to achieve an added benefit (11.5:1 supplement-to-gain ratio) when steers were grazing Coastal bermudagrass, and this came at a cost of $1.07/lb of additional gain.

Substitution Feeding

Substitution feeding occurs when supplemental feed is offered in replacement of forages that would have otherwise met the nutrient requirements of the animal.[1] In this case, we often observe a substitution effect (Figure 5) in which there is decrease in forage intake with each incremental increase in supplement offered. There is seldom a scenario in which this type of supplementation is targeted. Rather, this is generally observed when supplemental feed is offered in excess of that necessary to obtain the positive associative effect. For example, the incremental increase in supplement-to-gain ratios observed in Smith et al. [4] illustrate a substitution effect (essentially, diminishing returns).

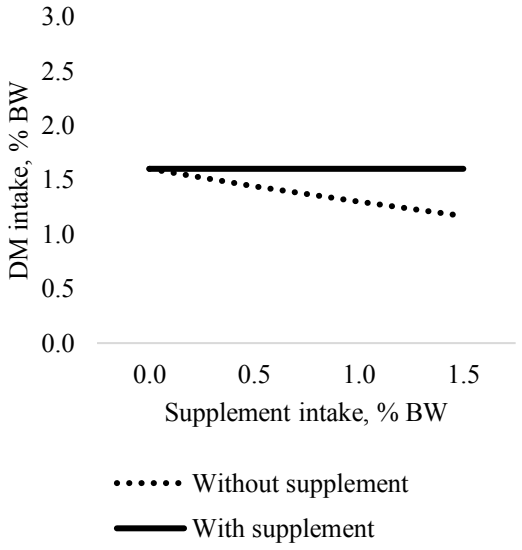

Figure 5 Substitution effect of supplementation (adapted from Huston et al. [1])

Supply Feeding

Supply feeding is a scenario in which the forage supply is limited, and supplemental feed is being used to maintain intake and nutrient requirements (think feedlot on pasture).[1] From a veterinary perspective, this is likely the most common scenario in which supplementation will be

recommended. Forage supply is most often limited when the pasture is overgrazed. Signs that supply feeding may be warranted include short stubble on pasture and thin animals.

Downstream Benefits of Supplementation

Thus far, we have discussed the scenarios under which supplementation may be used and how that benefits the animal in terms of nutrient provision and performance. However, there are also potential downstream benefits to introducing a supplementation program.

Land Use Efficiency

There is evidence to suggest that seasonal supplementation of beef cattle can improve land use efficiency in pasture-based systems by increasing carrying capacity [4, 5]. Land use efficiency is a key component to sustainability in agricultural systems. From 1945 to 2012, urban land in the southern United States increased from 3.5 million ac to 25.7 million ac (653% increase) while pasture and rangeland remained relatively stable (113.9 million ac vs. 134.2 million ac; 18% increase) [6]. Thus, it is imperative that sustainable beef production systems increase outputs while using the same or less land base.

Pasture Fertility

Research has shown that providing supplemental feed may have a benefit on pasture and soil fertility. Previous work has shown that increasing supplemental feed of grazing steers increases stocking density of pastures by up to 21% [4, 5], and steers excreted up to 0.5% N, 0.2% P, and 0.2% K through feces [7]. These strategies could result in excretions of 32 lb N, 15 lb P, and 15 lb K from each animal annually [4, 8]. This can also result in increased dry matter yield of subsequent forages to which the manure is applied [7]. This is especially important when fertilizer prices rise as they have in recent years.

Environmental Impact

Finally, use of supplemental feedstuffs in beef production systems has been demonstrated to reduce enteric methane production [8-10]. Methane has a global warming potential of 23 CO_2-eq [11]. Enteric fermentation from grazing livestock is implicated in the production of 27% of all methane emissions in the United States [12]. The predominant source of enteric methane production in beef cattle is the consumption of feedstocks dense in cell wall material (e.g., when cattle are grazing) [13]. Inclusion of non-forage feedstuffs (i.e., supplemental feedstuffs) dilutes the cell wall concentration of the dry matter while also increasing soluble carbohydrates. Smith et al. [8] found that as supplemental feed (e.g., dried distillers grains) is added to bermudagrass pasture, enteric methane production decreases linearly.

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Update on Obstructive Urolithiasis in Small Ruminants

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Key Points

- Obstructive urolithiasis in small ruminants is a complex, multifactorial condition, whose management must be considered with respect to regional variation, husbandry differences, and individual variability.
- A thorough workup of these cases may allow practitioners to provide clients with a more accurate prognosis and information for surgical planning.
- There is no single best surgical option for the management of obstructive urolithiasis and the procedure choice must be made on an individual basis, considering factors such as intended use of the patient, financial commitment of the client, and the resources available to the surgical team.

Obstructive urolithiasis continues to be a perennial challenge for veterinary practitioners despite a recent increase in peer-reviewed literature on the topic. Like the disease process itself, the reasons for this are multifactorial, including regional variability, financial commitment of the owner, and husbandry factors that are influenced by the intended use of the animal.

Case Workup

The diagnosis of obstructive urolithiasis in small ruminant patients can often be made based on history and presenting complaint alone; however, a thorough physical exam, including digital rectal exam should never be foregone. Lack of urination and signs of colic are among the most frequently reported in confirmed cases of obstructive urolithiasis. The heart rate is often elevated, consistent with levels of dehydration and pain; however, severe hyperkalemia may result in a falsely decreased value. Pulsation of the pelvic urethra, palpable on digital rectal exam or palpation of the perineum ventral to the anus, are also supportive of obstructive urolithiasis.

Diagnostic imaging provides diagnostic, prognostic, and surgical planning information in the workup of these cases. For practitioners with radiography capabilities, two radiographic views are recommended to identify radiopaque stones: (1) a lateral view with legs extended caudally and (2) a lateral view with legs flexed cranially. Common locations to visualize uroliths radiographically include the urinary bladder, distal to the sigmoid flexure, sigmoid flexure, and distal to the pelvic urethra. Lack of uroliths visualized on radiographs does not definitively rule out their presence, however, as some uroliths, such as struvite, are susceptible to being overshadowed by soft tissue material or lack significant radiopacity due to being small. Ultrasound can be used to estimate urinary bladder size and visualize sediment or uroliths within the lumen of the urinary bladder or urethra, which should be evaluated in its entirety from the pelvis to the prepuce. In addition, the kidneys should be evaluated for evidence of hydronephrosis and the ureters for evidence of dilation, both of which are associated with decreased likelihood of a positive outcome. Lastly, ultrasound may assist in the identification of free abdominal fluid or subcutaneous fluid, consistent with rupture of the urinary bladder or urethra, respectively.

Laboratory analyses have both diagnostic and prognostic value as well. Common electrolyte derangements include hyponatremia, hypochloremia, hypophosphatemia, and either hypo- or hyperkalemia. Another common finding is azotemia, defined by elevated BUN, creatinine, or both. Packed cell volume and plasma proteins are often elevated as well.

Examination of the preputial orifice, exteriorization of the penis, and amputation of the urethral process (vermiform appendage) is cursory to every examination. Visual inspection of these often reveals the presence of crystals, uroliths, and/or blood. Sedation is often needed, particularly for exteriorization of the penis. Alpha-2 agonists should be avoided because they promote increased urine production. Favorable substitutes include benzodiazepines and opioids, such as a combination of midazolam (0.3 mg/kg IV) and butorphanol (0.1 mg/kg IV).

Medical Management

Medical management may be pursued if amputation of the urethral process is successful in reinstating urine flow in patients with partial urethral obstruction or in patients with complete obstruction where surgical management is not an option based on owner preferences (often a financial decision). Initial medical management of patients with partial urethral obstruction is aimed at relaxation of the urethra and general pain management, which can include acepromazine (0.05 mg/kg IV or SQ q4 hours), midazolam (0.2 mg/kg IV or SQ q4 hours), and morphine (0.1 mg/kg IV or IM q6 hours). The use of nonsteroidal anti-inflammatory drugs (NSAIDs) in azotemic patients should be avoided and many practitioners delay use until obstruction is resolved and fluid diuresis is initiated.

In patients with resolved or partial obstruction, urine acidification can be used for urolith dissolution. Ammonium chloride (100-200 mg/kg PO) is given initially and the dose must be titrated based on urine pH due to variable individual response. Check urine pH 4-6 hours after oral administration using a urinalysis reagent strip of pH paper strip; urine pH should be below 6.5, with a goal range of 5.5-6.5. It may be necessary to increase the oral dose of ammonium chloride to 450 mg/kg PO q24 hours. It should be noted that calcium carbonate uroliths are unlikely to dissolve by urinary acidification.

Patients with complete obstruction without a surgical option may be provided medical management with either cystocentesis or an indwelling, percutaneously placed catheter can be utilized. A Bonanno™ suprapubic bladder drainage catheter provides an indwelling method of cystocentesis for approximately 24-48 hours. Under sedation, the patient is placed in right or left lateral recumbency. The skin (a 6cm x 6cm area) overlying the bladder, identified ultrasonographically, is clipped and aseptically prepared. It is recommended to anesthetize the skin at the intended insertion site with a small volume of local anesthetic and create a small stab incision using a #15 scalpel blade to ease catheter placement. Using ultrasound guidance and aseptic technique, the catheter and stylet are placed through the skin incision and advanced into the lumen of the bladder; once confirmed in the bladder by urine flow, the catheter is advanced off the stylet. The pigtail shape of the catheter tip helps to maintain itself within the lumen of the bladder. The catheter is secured with 2-0 nonabsorbable, monofilament suture on a straight needle. A one-way valve may be used, or one created by taping in place the cut finger of an examination glove. Common complications include dislodgement from the bladder and kinking or obstruction of the catheter, however, perforation of cecum with the catheter has been reported, thus necessitating ultrasound guided placement. This catheter should also be considered when referral is elected, as it may reduce the risk of bladder or urethral rupture, particularly if the surgical facility is far away.

Cystocentesis with Walpole's solution may also be pursued if previously attempted therapies have failed. Either through the Bonanno™ catheter or routine cystocentesis, urine is withdrawn from the bladder and replaced with 50 mL of Walpole's solution. The pH of the urine is tested after equilibrating for 2 minutes; the process of removing urine and replacing with Walpole's solution should be performed until pH reaches 4-5. The cystocentesis needle is left in place for the entirety of the procedure so the use of an extension set is recommended. Risks of this procedure include leakage of the solution into the abdomen or subcutaneous tissue through either bladder or urethral rupture, respectively. Therefore, this

procedure should only be pursued if euthanasia is the only alternative option. In animals with evidence of stranguria or abdominal pain and those that have not produced a stream of urine within 12 hours after treatment should be reevaluated and humane euthanasia considered.

Surgical Management

The tube cystostomy, first described in 1995, continues to be one of the most common ways of surgically managing obstructive urolithiasis. Recent literature reports improved outcome when combined with urethrotomy for urolith removal; however, it should be noted that the predominant urolith type in these studies is calcium carbonate, which may affect the improved prognosis (see following section for more information). It should be noted that of all surgical procedures reported for obstructive urolithiasis, the tube cystostomy is the only option that has the potential to regain urethral patency, and thus is the only option for breeding males. Perineal urethrostomy (PU), though less technically challenging, is typically considered a salvage procedure as stricture of the perineal stoma within 1-2 years of surgery is common. A modification of the traditional PU was reported in 2013, called the modified proximal perineal urethrostomy (MPPU). Briefly, the penile body is approached on midline, with the incision beginning about 2-3cm distal to the anus and the retractor penis muscle is transected. The penis is transected just proximal to the proximal bend of the sigmoid flexure and proximal and distal segments are oversewn as needed to control hemorrhage. Proximal penile attachments to the level of the pelvic brim are transected to allow the penile body to be elevated dorsally; ensure all ventral attachments of the penis are transected. Incise the distal 2cm of the urethra longitudinally and incorporate the spatulated urethra into the closure; the urethral mucosa is apposed to the skin on either side.

Prognosis

The prognosis for affected animals is generally considered to be guarded to moderate, due to complications associated with the acute management of the condition as well as the risk of reoccurrence. There is, however, significant variability in published survival data. Studies reporting on the success of the tube cystostomy procedure range from 48% nonsurvival to 100% survival to discharge. In the study reporting 100% survival to discharge, the patients primarily had calcium carbonate stones and the tube cystostomy procedure was combined with urethrotomy overlying urethral obstructions. Factors associated with nonsurvival may include advanced clinical disease at the time of presentation, moderate to severe lethargy at the time of presentation, obesity, evidence of uroperitoneum, abnormal PCV (increased or decreased), severe azotemia, and increased CK. Stone type may affect prognosis as well, however, sufficient data to identify a relationship is lacking at this time.

Urolith Composition

Recent improvements in mineral analysis techniques have allowed for differentiation between struvite and amorphous magnesium calcium phosphate (AMCP), both of which were formerly classified as struvite. AMCP/struvite combination is now being recognized as the most common urolith type, whereas pure struvite is considered rare. These uroliths more frequently appear as sand or grit rather than distinct stones. Calcium carbonate continues to be another commonly recognized urolith which has the classically described “gold BB” distinct spherical features. Silicate stones, though rare, are more common in animals housed in sandy soils of western North America, including the United States and Canada.

Prevention

Due to wide variability in management, intended use of the animal, regionality, individual susceptibility, and more, we are not likely to have a single prevention strategy that will be effective for all cases of urolithiasis. Thus, prevention strategies must be tailored uniquely to target the risk factors present.

Delaying castration until after the age of 4-6 months may result in maturation of a wider urethral diameter, which allows for the passage of larger formed uroliths. However, separation of animals by sex may be necessary, as they may reach sexual maturity by that time.

Struvite and AMCP uroliths have been more strongly correlated with animals under one year of age and those receiving concentrates in the ration. Excess phosphorus in the diet is a significant predisposing factor, and in one study, urinary calculi was inducible with a Ca:P ratio of less than 1:1.5. Therefore, it is recommended that the dietary Ca:P ratio of animals in this risk-based group be maintained at 2 to 3:1. Exceeding this ratio may, however, predispose to calcium-containing uroliths. Animals over one year of age and those receiving legumes in the diet are predisposed to calcium carbonate uroliths as well. Therefore, it is recommended that the dietary Ca:P ratio of animals in this risk-based group be maintained at 2:1 by excluding legumes, particularly alfalfa, from the diet.

Urinary acidification, discussed previously as a treatment for obstructive urolithiasis, may also be utilized for the prevention of struvite/AMCP urolith formation. Urinary acidification for the prevention of urolith formation should be done in a pulsatile nature, such as for 1 week once every 4 weeks, as renal adaptation to acidification and a subsequent increase in urinary pH does occur. As discussed in the Medical Management section, the dose must be titrated, up to 450 mg/kg PO q24 hours, to achieve urine pH below 6.5 (range: 5.5-6.5) when measured 4-6 hours after administration. This approach works well for small herds and control at the individual level, however, for herd level prevention, it may be necessary to work with a nutritionist to evaluate the dietary cation anion difference (DCAD) and employ strategies to reduce to 0 mEq/kg of feed using chloride salts.

Urine dilution of stones has been advocated and can be facilitated by both ensuring abundant accessibility to fresh, clean, palatable water sources. In addition, forages, as opposed to concentrates, promote water intake, and should be encouraged.

More research on this topic is needed, however, it appears that there is individual susceptibility to urolith formation and stone composition may be a familial trait.

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Field Stabilization and Management of Ruminant Fractures

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Key Points:

- Ruminants are excellent candidates for external coaptation for the healing of fractures.
- External coaptation is indicated for definitive fracture management of closed, transverse or short oblique diaphyseal fractures below the carpus or tarsus.
- Appropriate on-farm wound care and coaptation act to prevent further compromise of the fractured limb until referral can be pursued.

Appendicular fractures are commonly encountered in large animal practice and, fortunately, many ruminant patients are excellent candidates for treatment, even when less costly methods of fracture management are pursued. Factors for this include the following: external coaptation is generally well tolerated, ruminants spend a large amount of time lying down, decreased likelihood of contralateral limb breakdown and/or laminitis in ruminants, and an excellent capacity for bone healing.

The first step of the management of fractures is to provide patient first-aid. The cardiopulmonary status should be rapidly evaluated prior to administration of analgesic and/or sedative medications, which may be administered once the patient has been confirmed to be stable. While many patients require light to no sedation at all for the initial first-aid steps, some fractious or anxious patients require heavy sedation or general anesthesia. It is necessary to globally evaluate the patient for other fractures or injuries, and it is suggested to do this prior to focusing on the fracture for which they are presenting. All wounds should be covered with a light bandage to prevent further contamination until wound cleaning and debridement can be performed. The fracture of primary concern should be evaluated for being open, degree of comminution, and whether the fracture is suspected to be articular. Radiographs, while not strictly required for the management of all fractures, is recommended for those suspected to be articular and is required for all fractures to undergo internal fixation methods. The affected limb must also be evaluated for neurovascular compromise; palpating for an arterial pulse or an appropriate degree of warmth from the limb and response to a noxious stimulus, such as pinching with a hemostat, are simple methods of doing so, and additional diagnostics include doppler ultrasonography and angiogram radiographic study. Fracture stabilization should be performed, except in rare instances where it is contraindicated. Details on this follow a brief discussion on open fracture care. Lastly, in neonates, successful transfer of passive immunity must be confirmed and addressed appropriately if partial or complete failure is suspected.

It is important to identify open fractures for both treatment planning and prognostication purposes; as the degree of soft tissue loss, exposed bone, and contamination increases, the prognosis for healing generally decreases. Sterile water-based lubricant is applied to the wound and surrounding hair is clipped with a #40 blade. The wound is cleansed and aseptically prepared with dilute chlorhexidine or betadine solution and sterile saline, not scrub or alcohol since these items are cytotoxic. A local block or a regional limb perfusion containing a local anesthetic helps to facilitate these wound care steps, as well as sharp debridement and partially closing the wound, if indicated, and fracture reduction. When a regional limb perfusion is used, it is recommended to add an antimicrobial as well, bearing in mind this constitutes extra-label drug use and antimicrobials are selected accordingly. Regardless, systemic broad spectrum antimicrobial therapy is started at the initial presentation. The wound must be copiously lavaged with sterile saline at the conclusion of debridement. A sterile bandage is applied to the wound, consisting of a non-adhesive layer, roll gauze, and a light adherent elastic tape.

Fracture stabilization recommendations are based upon which bones are affected, with a general rule requiring immobilization of both the joint proximal and distal to the fractured bone. A Modified Robert Jones or traditional Robert Jones bandage may provide adequate immobilization in light animals; however, most require splinting or casting. Splints made of longitudinally split PVC pipe are ideal as they are light, strong, and re-useable; a less expensive option includes wooden boards or dowels. For most fractures, two splints should be used, and they should be applied orthogonal to each other, for example one lateral and one palmar/plantar. Casts, whether applied as a traditional cast or a bandage cast, and splints should always include the foot and extend to the proximal aspect of the bone to end near a joint, as opposed to mid-diaphyseal, which creates a stress-riser and increases likelihood of fracture at that site. These three options, bandage, splint, or cast, can be quickly and easily applied for any lower limb fractures (below carpus or tarsus). For fractures of the radius or tibia, the joint proximal is difficult to immobilize due to the musculature present and proximity to the body, and a Thomas-Schroeder splint and cast combination is recommended. No coaptation is applied for fractures of the humerus or femur due to inability to immobilize the shoulder or hip joints, respectively.

These simple types of coaptation may suffice as definitive treatment for fracture healing, but is dependent on fracture configuration, location, and other factors discussed as follows. At a minimum, these principles should be followed for fracture stabilization prior to transportation to a referral facility, as the initial fracture first aid provided may significantly affect the ultimate outcome. The goals of field stabilization for the purpose of referral include reducing patient pain and anxiety and preventing further compromise through the immobilization of adjacent joints. These goals are accomplished by adhering to the above-described practices. Lastly, patients should be encouraged to lie down during transportation.

Fracture configurations that are amenable to cast or splint coaptation are those that have axial stability when reduced, which include simple diaphyseal fractures in either transverse or short oblique configuration. Physeal fractures with a Salter-Harris (SH) classification of type 1 and most type 2 are amenable to external coaptation as well, however, SH type 2 fractures with a large metaphyseal spike may require additional stabilization. Fracture configurations that are not amenable to external coaptation include spiral, long oblique, and all comminuted fractures. Articular fractures require near-perfect reduction and rigid internal fixation to prevent articular callous formation and subsequent arthritis. Body weight is an additional factor to consider, with heavier or adult animals being more likely to require additional stabilization, regardless of fracture configuration or location.

If external coaptation alone is to be used for treatment, the animal should be individually housed in a small pen for 8 weeks, the duration of fracture healing. Comfort level is assessed daily and a recheck examination by a veterinarian is performed urgently if the patient shows signs of discomfort. Casts may be left in place for the duration of fracture healing in adult patients, however, a cast change at the mid-point of 4 weeks is preferred. In young animals the cast must be changed at 3–4-week intervals to accommodate skeletal growth. Complications to be aware of include cast sores, cast breakage, wound complications, malunion or delayed/non-union of fractures, and contralateral limb breakdown. Cast breakage must be addressed immediately as it poses a potential catastrophic complication that results in additional soft tissue damage and destabilization of the fracture. Cast sores can be prevented by providing adequate padding of boney prominences with felt underneath the cast, including the accessory carpal bone, the point of the calcaneus, the medial and lateral malleoli of the tibia, between the toes, and underneath the dewclaws. Following development, cast sores are treated as any other wound by performing debridement and lavage, then providing an ideal wound healing environment with the use of a bandage and minimizing motion. Contralateral limb breakdown results from compensatory overloading of the non-affected limb and is generally due to soft tissue laxity rather than a bone deformation. The most common is fetlock

hyperextension, which may partially or fully resolve once fracture healing is complete and the animal is able to fully load the formerly casted limb.

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School of Veterinary Medicine
UNIVERSITY OF WISCONSIN-MADISON

Complicated Wound Management: A Case-Based Approach

Auburn University Annual Conference &
J.T. Vaughan Equine Conference
October 2023

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1

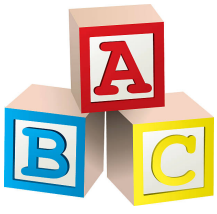
Lecture Objectives

- Recognize the role that wound location and severity play in management of wounds
- Be aware of anatomic locations where wounds may occur that commonly involve other structures and strategies to rule out their involvement.
- Select wound management techniques based on location, chronicity, contamination, and other wound factors.

2

Principles of Wound Evaluation

- **Assess**
  - Systemic health
  - Other wounds
  - Presenting problem
- **Body cavities/structures**
  - Thorax (trachea)
  - Abdomen
  - Joints, tendon sheaths
- **Clean**
  - Clip
  - Debride
  - Lavage



3

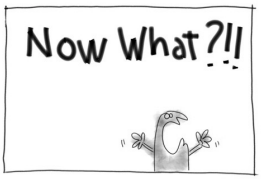
Bov Flank Laceration

- 4 mo HO heifer
- Laceration: >4 wks

4

Bov Flank Laceration

- Physical Exam
  - T: 100.3* F
  - P: 60 bpm
  - R: 44 bpm
  - CRT: 2 sec
  - MM: pink, moist
  - No murmur, arrhythmia
  - Normal bronchovesicular sounds
  - Normal GI sounds, rumen cont.
  - No other wounds



5

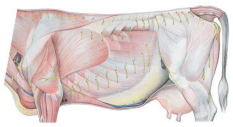
Bov Flank Laceration

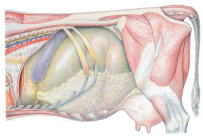
Body Cavities

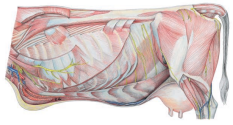
6

Eq Shoulder Laceration

- Concerns
  - Cranial superficial epigastric v
  - Body wall
  - Omentum
  - Rumen







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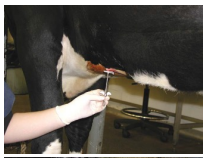
Bov Flank Laceration

- Rule out peritoneal involvement
  - Palpation
  - Abdominocentesis

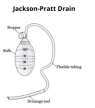


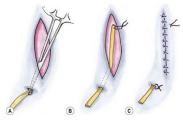
Images from Vet Clin Food Anim (2005) – Management of Peritonitis in Cattle

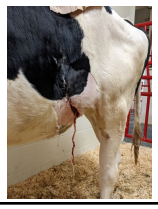
8

Bov Flank Laceration

- Large, open wound
  - Multi-layer closure
- Lots of dead space
  - Place drain
  - Bandage
- Contaminated wound
  - High volume lavage
  - Systemic antibiotics







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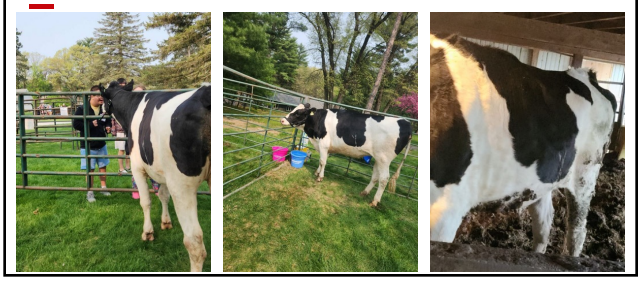
Bov Flank Laceration

10

Bov Flank Laceration



11

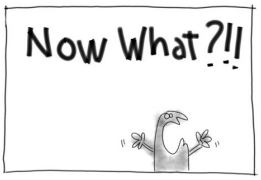
Bov Limb Superficial Necrosis

- 2 wk Hereford heifer
- ????????

12

Bov Limb Superficial Necrosis

- Physical Exam
  - T: 102.2* F
  - P: 84 bpm
  - R: 60 bpm (panting)
  - CRT: 2 sec
  - MM: pink, moist
  - No murmur, arrhythmia
  - Harsh bronchovesicular sounds
  - Lame on RH limb
  - No other wounds



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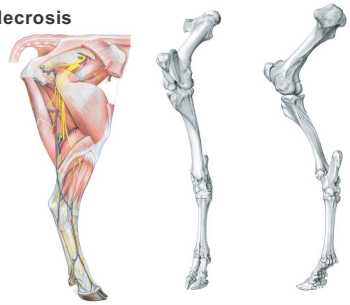
Bov Limb Superficial Necrosis

- Neonatal exam
  - Passive transfer
  - Congenital abnormalities
  - Umbilicus
  - Joints

14

Bov Limb Superficial Necrosis

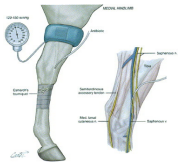
- Concerns
  - Quadriceps mm
  - Flexors of digit
  - Tibial, peroneal nn
  - Lateral saphenous v
  - Stifle joints
  - Tibia



15

Bov Limb Superficial Necrosis

- Plan
  - Regional limb perfusion
    - Antibiotic
    - Local anesthetic
  - Wound debridement
    - Sharp



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Bov Limb Superficial Necrosis

- Plan
  - Bandage
    - Cleanliness
    - Reduce edema
  - Delayed primary closure

17

Bandaging – Primary Layer

- "No single dressing may support the processes of wound healing in all phases." Equine Wound Management, 2016

Wound Characteristic	Dressing
Necrotic wounds	Wet-to-dry gauze
Desiccated wounds	Hydrogels
Wounds lacking granulation tissue	Alginates
Granulated wounds lacking epithelialization	Foams or silicone gel sheets
Excessively exudative wounds	Hypertonic saline dressings
Sutured wounds	Non-adherent gauze dressings
Infected wounds	Antibacterial dressings

18

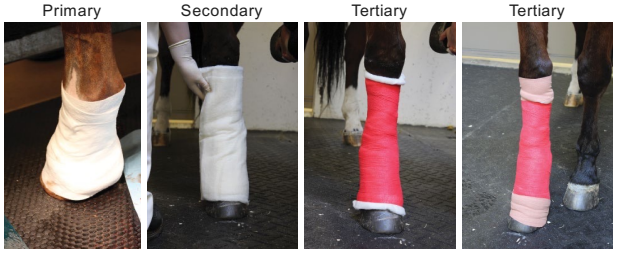
Bandaging Principles

- Bandaging Principles
  - Primary
    - Contact layer
  - Secondary
    - Padding
    - Immobilization
    - Absorption
  - Tertiary
    - Immobilization
    - Compression
    - Fix to limb

19

Bandaging Principles

Primary | Secondary | Tertiary | Tertiary



20

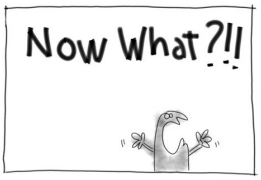
Bov vs Bale Spear

- 6 yo Angus cow
- Hit with bale spear

21

Bov vs Bale Spear

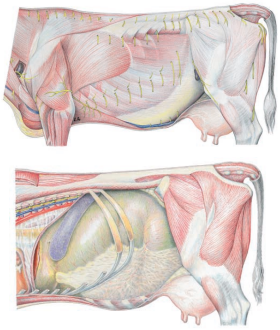
- Physical Exam
  - T: 102.6* F
  - P: 76 bpm
  - R: 44 bpm
  - CRT: 2 sec
  - MM: pink, moist
  - No murmur, arrhythmia
  - Normal bronchovesicular sounds
  - Rumen: 2 strong contractions per minute
  - No other wounds



22

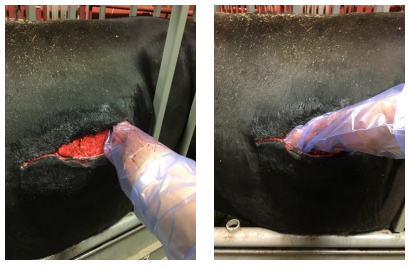
Bov vs Bale Spear

- Concerns
  - Pneumothorax
  - Ribs
  - Abdomen
    - Rumen



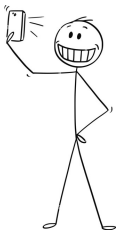
23

Bov vs Bale Spear



24

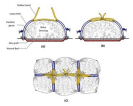
Bov vs Bale Spear

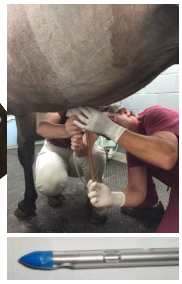


25

Bov vs Bale Spear

- Plan
  - Encourage drainage
  - Prevent ascending infection
  - Manage dead space
  - Encourage granulation
  - Promote epithelialization

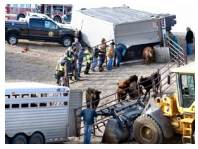




26

Bov Distal Limb Laceration

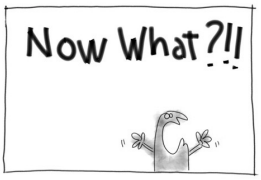
- Est yearling Angus steer
- Trailer roll-over
- LH medial claw amputated



27

Bov Distal Limb Laceration

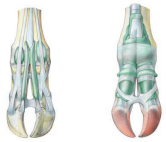
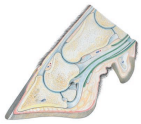
- Physical Exam
  - T: 99.4* F
  - P: 72 bpm
  - R: 28 bpm
  - CRT: 2 sec
  - MM: pink, moist
  - No murmur, arrhythmia
  - Normal bronchovesicular sounds
  - Non-weightbearing on LH
  - No other wounds



28

Bov Distal Limb Laceration

- Concerns
  - Middle and distal phalanges
  - Coffin joint
  - Pastern joint
  - Flexor tendon sheath

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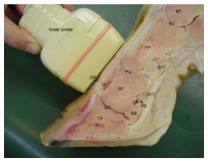
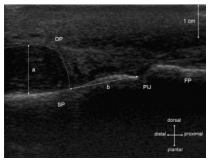
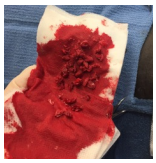
Bov Distal Limb Laceration


30

Bov Distal Limb Laceration

- Plan
  - Wound care
  - Facilitated ankylosis
  - Bone graft

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Bov Distal Limb Laceration



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Questions

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Acute Abdomen in Cattle: Decision Making and Case Management

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Key Points

- Systematic clinical exam and supportive diagnostic testing may yield diagnosis and/or determine need for surgery.
- Monitor frequently to evaluate response to therapy.
- Appropriate communication of prognosis and cost to owner maximizes outcome satisfaction.

The workup and management of cases of acute abdomen in cattle begins, as with many other disease processes, with the anamnesis. The type of husbandry system from which they present, the intended use of the patient, and of course their signalment, already begin to narrow and prioritize the list of differential diagnoses when presented with another vaguely described "ain't doin' right" case. Reaching the correct diagnosis to provide an appropriate recommendation for treatment, though challenging, still only represents a portion of the challenge these cases represent. Providing the anticipated prognosis of the condition following attempted treatment and an accurate estimate of costs make up the other two portions of the decision-making triad. The latter will be specific to the practitioner and not further discussed herein.

The ability to treat abnormal is predicated on the ability to differentiate it from normal, thus prompting the following anatomic reminders of the peritoneal cavity. The rumen occupies a majority of the abdomen (in the non-gravid patient), taking up the left half of the abdomen dorsally and ventrally, and crossing midline to the right, especially the ventral sac of the rumen. This results in a relatively short list of differential diagnoses when a left-sided percussible or succussible abnormality is identified as compared with the right side of the abdomen. Depending on husbandry system, left-sided differentials should include left displaced abomasum, rumen tympany or void, physometra, and pneumoperitoneum, whereas right-sided differentials include right displaced abomasum or volvulus, cecal dilatation +/- volvulus, small instestine, proximal colon, physometra, pneumorectum, and pneumoperitoneum.

The greater omentum is a combination of the superficial leaf and deep leaves, respectively originating from the left and right longitudinal grooves of the rumen, to create a potential space between them, the omental bursa. The greater omentum passes ventrally, laterally to the right, then dorsally to attach to the greater curvature of the abomasum and the descending duodenum on the right side of the abdomen, thereby creating a sling that much of the gastro-intestinal tract distal to the abomasum is contained within, called the supraomental recess. The right side of this omentum, which in the normal animal is immediately visible upon entry into the abdomen via right paralumbar fossa laparotomy, is termed the omental curtain. The lesser omentum arises from the lesser curvature of the abomasum and extends dorsally. This anatomic knowledge is helpful to keep in mind for surgical planning, particularly in cattle, on whom standing surgery is routinely performed. With the rumen in contact with much of the left abdominal wall, the left paralumbar fossa approach is best suited for surgery of the rumen and access to the lumen of the reticulum (via rumenotomy), correction of left displaced abomasum (LDA), and the peritoneal portions of genitourinary tracts. The right paralumbar fossa approach provides access to much of the rest of the GI tract, such as surgery of the small and large intestines and correction of right displaced abomasum or volvulus (in addition to LDA), and the peritoneal portions of the genitourinary tract. The omental curtain previously described, and the short mesentery of the ruminant intestinal tract does limit exteriorization. The following structures cannot be fully exteriorized through a right paralumbar fossa approach: abomasum, sigmoid flexure of the duodenum and the ascending duodenum, a portion of the

ascending and descending loops of the colon, and the rectum. When not limited to standing surgery, dorsal recumbency allows for ventral, paramedian and paracostal approaches that improve access to the genitourinary tract, GI tract, and abomasum.

When presented with a bovine patient for signs of "colic" or acute abdomen, it is important to keep in mind that these classic signs of pain may be attributed to any organ system within the abdomen. While often not as severe or obvious as their equine counterparts, cattle may paw the ground with a forelimb, lift their back limbs such as to kick at their abdomen, flank watch, and display restlessness or agitated behaviors such as frequent standing up from lying and vice versa. However, cattle are often stoic in nature and signs may be subtle to only include standing with an arched back, appearing depressed or lethargic, or display a decrease in feed intake. Production system will provide another set of factors to scrutinize, such as a drop in milk production or cessation of weight gain. A thorough history and physical exam will guide the selection of diagnostic tests to differentiate gastrointestinal from extraintestinal causes. Husbandry and production system begins to narrow the differential lists, such as a recently fresh dairy cow being susceptible to a displaced abomasum or a feedlot steer being at risk for urolithiasis.

Visual examination may further characterize location or organ system of involvement. Abdominal contour, as viewed from behind the animal, in the shape of a reverse capital "D" may indicate bloat or other causes of Type I vagal indigestion, whereas a "papple" shape of rounded abdominal distention on the left and low abdominal distention on the right may indicate omasal outflow obstruction or other causes of Type II vagal indigestion. A cow standing with an arched back, abducted elbows helps to localize pain to the thorax or cranial abdomen. This can be confirmed by an abnormal response to a withers pinch, where the normal animal will ventroflex away from the examiner, or a painful response to a bar test, when pressure applied to the sternum in the region of the xiphoid results in a grunt or teeth grinding. Percussion and succussion findings help to prioritize differential diagnosis lists, as previously discussed. Lastly, rectal exam findings may also identify and localize organ system of interest. A gas distended, blind-ended viscus may be palpable with cecal dilatation +/- volvulus. Firm, distended loops of jejunum may be palpable in cases of hemorrhagic bowel syndrome. Peritonitis often results in a tight rectum on palpation with poor mobility. Urinary tract disease may reveal pulsation of the pelvic urethra or pain on palpation of an enlarged kidney or ureter in cases of obstructive urolithiasis and pyelonephritis, respectively.

If chemistry or blood gas are available, proximal instestinal outflow obstruction is indicated by hypochloremic, metabolic alkalosis. A transition to metabolic acidosis may be seen later in the disease process, or may indicate strangulation, can be seen with severe diarrhea in cases of enteritis, or urinary tract disease. Proximal intestinal outflow obstruction may be confirmed by evaluating rumen fluid for elevated chloride levels (normal <25-30 mEq/L). This sample may be obtained by ororumen intubation, however, if rumen pH is to be evaluated as well, rumenocentesis is recommended to avoid false elevation of pH by salivary bicarbonate. Normal rumen fluid is green to brown in color with a pH of 6.0-7.0, however pH may vary significantly with diet. Abdominocentesis in cattle is typically performed in two sites, following routine clipping of hair and aseptic preparation. The first location is in the right paramedian region a handsbreadth caudal to the xiphoid and a handsbreadth from midline. The second location is in the right caudal abdomen immediately cranial to the udder below the right fold of the flank. Samples are collected via 18ga needle or metal teat canula, the latter requiring local anesthetic administration and a stab incision through the skin and body wall to be performed. In either case, penetration of the peritoneum is indicated by a distinct "pop" that is felt as the needle passes through. Fluid is collected into EDTA for cytology and cell count, whereas a sterile sample is collected for culture. Normal abdominal fluid is clear-yellow in color with low protein (normal <3.0 g/dL) and few cells (TNCC 2,000-5,000 cells/uL). Bowel necrosis is indicated by cloudy yellow to serosanguinous appearance with elevated protein, cell count, and lactate (>3 mmol/L).

Indicators of peritonitis include abundant, cloudy fluid with severely elevated protein and cell counts. Rupture of GI viscus is indicated by the presence of green colored fluid and feed material, while rupture of the urinary tract may reveal yellow colored, urine-smelling fluid.

While often limited to referral facilities, radiographs of the cranial abdomen may reveal the presence of metallic foreign bodies in cases of traumatic reticulitis/peritonitis/pericarditis. Ultrasound is growing in availability to practitioners and may yield a definitive diagnosis in some cases. The cranioventral abdomen is evaluated for the presence of fluid or fibrin and changes to the bi-phasic contraction pattern of the reticulum, both of which may indicate the presence of adhesions. Ultrasound may also be used to confirm left displaced abomasum, typically in the last two rib spaces on the left side. The appearance of dilated, hypo- to amotile small intestines with organized mixed echogenic material is consistent with hemorrhagic bowel syndrome. One may even be lucky enough to see the classic “target” lesion, characteristic of an intussusception.

For some disease processes, a specific diagnosis is quickly and easily achieved and appropriate medical and/or surgical treatment can be initiated to whatever degree the budget and desire of the client should allow. However, even in cases with an unlimited budget for diagnostics, a definitive diagnosis may fail to be achieved. There are several factors that urgently indicate the next diagnostic step should be exploratory laparotomy, including the following: continued severe signs of colic, rapid deterioration of vital parameters, heart rate >100 beats/min, pings compatible with cecal or abomasal conditions, suspicion of intestinal or cecal torsion, or abdominocentesis yields fluid consistent with bowel devitalization. In the absence of these, medical management is indicated, including supportive care to correct abnormalities in hydration and electrolyte status. Complete re-evaluation should be completed in 4-6 hours to determine response to therapy. Exploratory laparotomy is indicated in the face of deterioration or no improvement, while improvement warrants continued supportive treatments.

Whether responsive to medical management or if surgery has been pursued, the prognosis can be more accurately predicted when a definitive diagnosis is achieved. The following summarizes the general prognosis of several common diseases that are encountered in acute abdomen cases. When peritonitis is localized in cases of traumatic reticuloperitonitis, the prognosis is considered fair to good, with one study reporting 83% and 90% survival to discharge with medical and surgical therapy, respectively. Prognosis is poor to guarded in the presence of pericarditis, pleuritis, or generalized peritonitis. Left displaced abomasum cases are generally considered to have a good to excellent prognosis for survival, but one study revealed two factors that were associated with early removal from the herd (culled within 60 days): cows that had dystocia were 13x more likely and those that were not ketotic (BHBA < 1.2 mmol/L) at the time of surgery were 3x more likely. The association between nonketotic cows and early removal is hypothesized to be due to the decreased ability of this population to return to normal milk production, reflecting poor adaptation to support a return to economically viable level of milk yield in the short term. Following right paralumbar fossa laparotomy for correction of LDA, pyloro-omentopexy appears to have a lower rate of recurrence compared to omentopexy (4/29 vs 0/58). For right abomasal displacement and volvulus, prognosis for survival to discharge following surgical correction is 97% and 84%, respectively, and one year survival rates are better as well (86% vs 66%, respectively). Systemic lactate has been associated with outcome in cases of RDA; those having a positive outcome had a mean lactate of 3.2 mmol/L and those with a negative outcome had a mean lactate of 5.8 mmol/L. Small intestinal intussusception generally carries a poor prognosis and poor prognostic indicators include severe dehydration (>12%), severe tachycardia on presentation (>120 beats/min), and severe hypochloremia (<80 mEq/L). The prognosis of hemorrhagic bowel syndrome cases ranges from grave to fair, with surgery

appearing to be protective. The largest study available on the condition reported that manual clot dissolution was preferable to enterotomy or resection and anastomosis.

In summary, there are many factors that continue to make cases of acute abdomen in cattle a diagnostic and therapeutic challenge, including the stoic nature of the patient, the financial limitation that are associated with many cases, and the lack of diagnostics that are available, particularly in an ambulatory practice setting. These limitations place an emphasis on clear communication between practitioner and client regarding what constitutes a successful outcome for the patient in question and the associated cost estimate. It is the author's opinion that one of our greatest responsibilities as veterinarians is to provide our clients with understandable and accurate information that allows them to make an informed decision regarding their livestock.

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