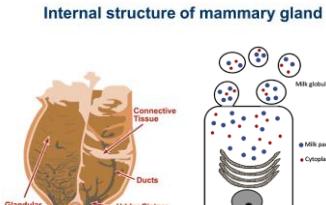


A Pathogen-Centric Review of Small Ruminant Mastitis

Marc Caldwell, DVM PhD DACVIM-LA
 University of Tennessee
 Food Animal Field Services
 Colorado VMA 2021



80% of the milk reservoir is within the glandular structure
 Without appropriate stimulation and milk ejection there is greater risk of overmilking

Milk is produced by alveolar cells in apocrine secretion

Particles may contain cellular contents like fat and DNA

More prone to develop ectopic mammary tissue

Exterior teat and gland skin
 Vulva

Outline

Udder health overview

Contagious pathogens

Coagulase negative Staphylococcus

Staphylococcus aureus

Mycoplasma spp.

Mannheimia haemolytica

CAE virus

Environmental

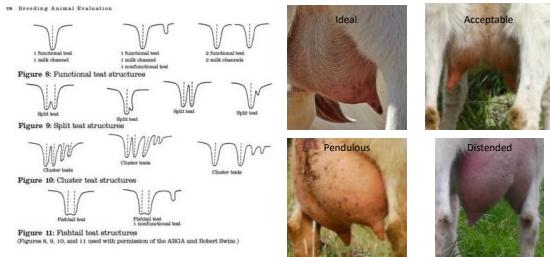
Streptococci

Coliforms

Fungal agents

Principles of therapy and control

Teat structure can be an important risk factor



The pattern of dairy production in SR is more seasonal

SR are short-day breeders
 Most lactations occur spring through fall
 Breeding for out-of-season lactation is possible, but affects production

The standard is a 305 day lactation with a 60 day dry period

Continuous milking is more common

Late lactation and/or extended lactations tend to have higher SCC, not related to infection

Combined nursing-milking is common, esp in sheep

Be careful comparing SR mastitis to cattle mastitis

Reported annual incidence of clinical mastitis is 5%
 Subclinical mastitis ranges from 5 – 30%

Probably under reported given the increase in backyard goat and sheep dairies

While some pathogens sound familiar, we observe strain and host differences in disease and control

Clinical Manifestations of Mastitis

Subclinical mastitis is the most common manifestation of disease

No apparent clinical signs
Character of the milk is unaffected



Only detected by elevation in SCC or bacterial culture
15 – 40 X more prevalent than clinical mastitis

Most commonly attributed to coagulase negative *Staph* (CNS) and environmental *Strep*



Clinical mastitis can be categorized as local or systemic

Local mastitis

- Hard swollen mammary gland
- Discoloration or flakes in the milk
- Apparent lameness
- Pain
- Loss of production

Systemic mastitis

- Fever
- Anorexia
- Depression
- Bruxism
- Abcessation

Necrotizing mastitis is the most severe presentation

8 – 10% of all clinical cases

Staph aureus most common
Pasteurella multocida
Mannheimia haemolytica

Serous to bloody discharge
Blue skin discoloration, cool to touch
“Blue bag”
Extremely sick doe/ewe
Sloughing of affected tissues



Mareques et al, 2018

Necrotizing mastitis is the most severe presentation



Necrotizing mastitis is the most severe presentation



Menzies, 2021

Contagious agalactia is caused by *Mycoplasma* spp.

Complete lack of milk production

Often associated with other signs

Pneumonia Abortion

Septicemia Weak kids

Arthritis Keratitis

Encephalitis



Adults and kids can be affected

The Contagious Pathogens

Coagulase Negative Staph are the most common mastitis pathogens

Staph epidermidis

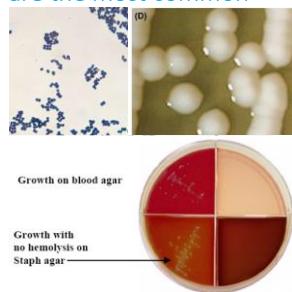
Staph caprae

Behave as contagious and environmental pathogens

Most commonly present as chronic subclinical infections

Largest impact is elevating SCC

Loss of milk production

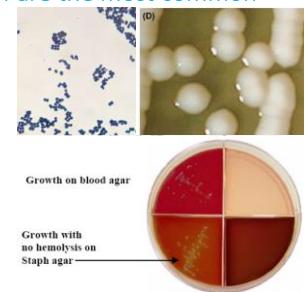


Coagulase Negative Staph are the most common mastitis pathogens

Some chronic infections are resolved during dry off

Does well with elevated SCC at dry off are less likely to clear the infection

60% of CNS positive glands were re-isolated/re-infected in the next lactation Poutrel et al. 1984



Not all *Staph aureus* spp are created equally

Staph aureus

Enterotoxins

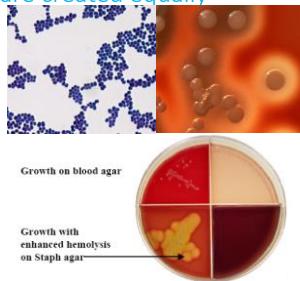
Leukotoxins

Subclinical infections

Acute severe and/or gangrenous mastitis "Blue Bag"

Virulence depends on toxin capacity

Zoonotic risks from consumption of heat stable toxins



Mycoplasma is dirty word to all dairy farmers

Mycoplasma mycooides subsp. *mycooides* LC type

Mycoplasma mycooides subsp. *capri*

Mycoplasma agalactia

Very contagious

Multiple age classes affected

Diagnosis is difficult

Culture by a specialized lab

PCR



Mycoplasma is dirty word to all dairy farmers

Multisystemic manifestations
Peracute to chronic
Mastitis – rice in dirty water appearance
Agalactia
Polyserositis
Bronchopneumonia
Acute encephalitis in kids
Septic arthritis
80 – 90% mortality among the kids

Few effective treatments



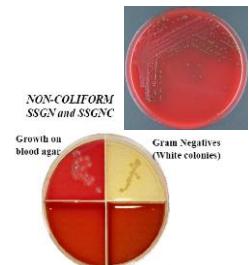
Mannheimia is a respiratory pathogen gone global

Mannheimia haemolytica

Not the same isolates associated with BRD
Most common in sheep

Gangrenous acute clinical mastitis
“Blue bag”
Respiratory and/or septicemia
Adults and kids

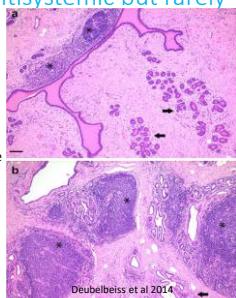
Perhaps transmitted from nursing lambs



CAE/OPP viruses are also multisystemic but rarely so severe

Caprine Arthritis Encephalitis
Ovine Progressive Pneumonia
Lentivirus retrovirus

Chronically infects macrophages
Altered macrophages invade tissue sites and induce
infiltrative inflammation
Adults
Arthritis
Mastitis “Hard bag” - Sterile
Interstitial pneumonia
Kids
Ascending myeloencephalitis



CAE/OPP viruses are also multisystemic but rarely so severe

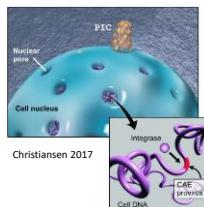


CAE/OPP virus: once infected always infected

Retroviruses insert the pro-viral genome into the host cell genome
Once infected always infected

Infections are commonly transmitted vertically
Dam to off spring
Occasionally horizontally transmitted in sheep

Diagnosis:
Antibody ELISA
PCR



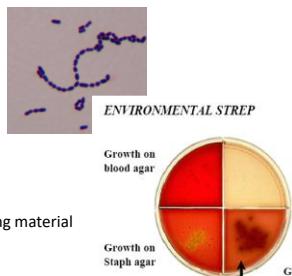
The Environmental Pathogens

Environmental Strep are not as common

Strep zooepidemicus
Strep uberis
Strep dysgalactiae

Subclinical infection
Mild clinical mastitis

Associated wet, contaminated bedding material
Improperly cleaned teat cups



Coliforms are just not a big deal in small ruminants

E. Coli
Klebsiella
Coliforms account for 1 – 14% of all cases

Appears more commonly in periparturient does

Drier fecal pellets translates to lower udder contamination



Coliform clinical signs are caused by endotoxin

LPS is released during the inflammatory response to the pathogen

Swollen painful gland
Fever
Tachycardia
Depression
Recumbency
Dehydration
Cytokine storm



Yeast mastitis is significant in that it doesn't respond to antibiotics

Candida albicans
Cryptococcus

Commonly an iatrogenic exposure
Occasionally associated with water

Clinical signs
Moderate to severe mastitis
Fever



Principles of Treatment and Control

Good udder health starts with good routines

Appropriate milking routine

Milkers should wear gloves

1. Fore stripping to evaluate milk character and stimulate ejection
2. Pre-dip with adequate coverage
3. Single use towel or paper towel
4. Application of milking unit or hand milking
5. Post-dip application that is left in place
6. Keep the animal standing for at least 30 minutes to ensure closure of teat sphincter

| Benchmarks for success |
|---|
| First contact to milking – no more than 2 minutes |
| Milk out time up to 3 mins |
| Peak milk within 1 min |
| Pulsation ratio of 50:50 or 60:40 |
| Peak vacuum – 10.5 – 11.5 in Hg |

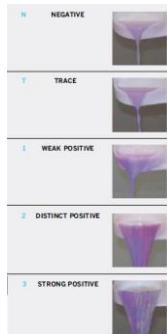
The interpretation of CMTs are more complicated in goats

SCC naturally increases in late lactation and in the fall

Minatare breeds tend to run higher

Best used to track individual trends rather than a point diagnostic

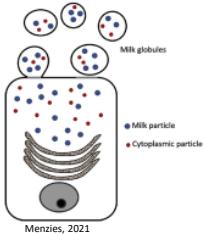
Half by half comparison is beneficial for discrimination



| CMT Score | CMT Interpretation | Visual Characteristics of the milk | SCC Range (cells/mL milk) | Suggested Interpretation | Somatic Cell Score | |
|-----------|---------------------|---|---------------------------|--------------------------|--------------------|-------------------------------|
| | | | | | Score | Mid-point SCC (cells/mL milk) |
| N | Negative | The mixture does not change, and remains the same liquid consistency of milk with bluish/purple tinges. | 0-200,000 | Healthy | 0 | 12,500 |
| T | Trace | The mixture will thicken slightly like very thin porridge; however, it can easily be poured out again when moving the paddle. | 150,000 - 500,000 | Suspect | 1 | 25,000 |
| 1 | Weak, but positive | There is slight thickening of the milk mixture, which remains liquid when stirred; the mixture will cling to the walls of the well, and when poured out again, some liquid remains in the well. | 400,000 - 1,500,000 | Mild mastitis | 2 | 50,000 |
| 2 | Distinctly positive | It is beginning to form when swirled, the gel tends to clump in the middle of the well, and when poured out, the gel will pour out first; less than some liquid is remaining in the well. | 800,000 - 5,000,000 | Mild mastitis | 3 | 100,000 |
| 3 | Strongly positive | The entire mixture is gelated when swirled, the gel tends to clump in the middle of the well, and when poured out, no liquid remains in the well. | >5,000,000 | Severe mastitis | 4 | 200,000 |
| | | | | | 5 | 200,000 |
| | | | | | 6 | 400,000 |
| | | | | | 7 | 400,000 |
| | | | | | 8 | 800,000 |
| | | | | | 9 | 1,600,000 |
| | | | | | | 3,200,000 |
| | | | | | | 6,400,000 |

Paula Menzies, 2021

Likewise, cytometric counts of SCC can be challenging



Menzies, 2021

The apocrine release of cytoplasmic buds makes machine counters over count somatic cells

This can be adjusted for with stains and lab calibrations

Ensure the lab the farm is working with is capable of handling SR samples

Bacteriologic culture is nice data to have

The same principles for collection and culture based treatment decisions in cattle generally exist for small ruminants

Quad- and tri-plate systems for on-farm/clinic culture

State and university labs can be valuable for difficult cases

Always, always base decisions on clinical signs as well as treatment

(Sometimes you have to throw away the thermometer)



Bewley and Harmon, 2014

Bacteriologic culture is nice data to have

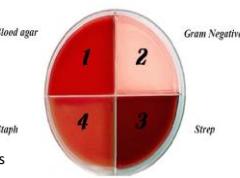
The same principles for collection and culture based treatment decisions in cattle generally exist for small ruminants

Quad- and tri-plate systems for on-farm/clinic culture

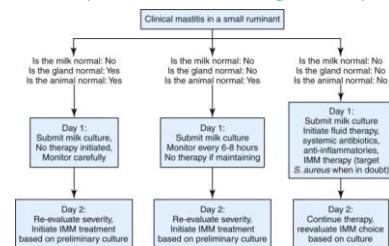
State and university labs can be valuable for difficult cases

Always, always base decisions on clinical signs as well as treatment

(Sometimes you have to throw away the thermometer)



You don't always have to treat right away



Plummer and Plummer, 2012

If AMDUCA sets you free, you are free indeed

There are no approved intramammary antibiotic products for sheep and goats

The minor species, minor use clause in AMDUCA provides veterinarians clinical justification to use products approved for cattle

One gland, one tube – no exceptions

If the label treatment for cattle is 3 – 5 days, consider extending it 2 -3 days to achieve a bacteriologic cure

FARAD is your friend: FARAD.org

Test before harvesting if available, use the same test kits available for cattle

7 days withdrawal time is a comfortable restriction when specific data is not available



Ancillary treatments often make all the difference

Supportive care for systemic cases is critical

Fluids – hypertonic or isotonic

HSS: 4.5 ml/kg = 300 ml for 150 lbs.

Electrolytes and dextrose may also be warranted

NSAIDs

Flunixin meglumine – 1.1 – 2.2 mg/kg IV SID to BID = 1.5 – 3.0 ml for 150 lbs.

Meloxicam – 0.5 mg/kg SID = 2 x 15 mg tablets PO SID for 150 lbs.



Vaccines attenuate the severity of signs but do not prevent infections

Lysigin – *Staph aureus* bacterin

Protects for life threatening gangrenous mastitis

J5 – Core antigen vaccines

Provides a similar level of protection against coliform mastitis as in cattle

Infrequently used because of low risk



If the disease is systemic, treat systemically

Treatment of severe or multisystemic infections

Parenteral antibiotics are warranted for rapid progressing and/or systemic mastitis cases

Macrolides
Tetracycline
Florfenicol



Adding IMM treatment may help, but will increase costs

Recovered animals should be culled to manage carrier reservoirs

Dry off therapy is the best treatment for subclinical mastitis

Dry therapy: 1 gland, 1 tube, products approved for cattle

Cures existing infections – sheep

Prevents new infections – goats

CNS infections are more responsive than *Staph aureus*

Selective therapy – flocks with < 30 – 40% prevalence

Blanket therapy – flocks with > 40% prevalence

In mycoplasma free flocks, any animal with SCC > 2 million SCC/ml are probably infected with SA and should be culled

