Mastitis: an inflammation of the mammary gland typically caused by bacterial intramammary infection (IMI)
Clinical mastitis: characterized by visible changes in the milk, mammary gland, and/or cow
Subclinical mastitis: lack of visible changes in milk but an increase in somatic cell count (SCC) and suboptimal milk production
**Subclinical mastitis: loss of production**

<table>
<thead>
<tr>
<th>Lactation Average</th>
<th>Decrease in Milk Yield (lbs./305 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCS (1000's/ml)</td>
<td>Lactation 1</td>
</tr>
<tr>
<td>0</td>
<td>12.5</td>
</tr>
<tr>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>200</td>
</tr>
<tr>
<td>5</td>
<td>400</td>
</tr>
<tr>
<td>6</td>
<td>800</td>
</tr>
<tr>
<td>7</td>
<td>1600</td>
</tr>
</tbody>
</table>

Even after cure, recovery of yield can be incomplete. Possibly due to involution and fibrosis of udder tissue, resulting in loss of secretory epithelium (St. Rose, et al, 2003).

Adapted from University of Wisconsin data.
### Subclinical mastitis: milk compositional changes

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Normal Milk</th>
<th>Mastitic Milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat, %</td>
<td>3.45</td>
<td>3.2</td>
</tr>
<tr>
<td>Protein, %</td>
<td>3.61</td>
<td>3.56</td>
</tr>
<tr>
<td>Lactose, %</td>
<td>4.85</td>
<td>4.4</td>
</tr>
<tr>
<td>Na, mg/100ml</td>
<td>57</td>
<td>104.6</td>
</tr>
<tr>
<td>K, mg/100ml</td>
<td>172.5</td>
<td>157.3</td>
</tr>
<tr>
<td>Cl, mg/100ml</td>
<td>80 – 130</td>
<td>&gt; 250</td>
</tr>
<tr>
<td>T Ca, mg/100ml</td>
<td>136</td>
<td>49</td>
</tr>
<tr>
<td>T Mg, mg/100ml</td>
<td>18</td>
<td>6</td>
</tr>
<tr>
<td>P, mg/100ml</td>
<td>26</td>
<td>6.4</td>
</tr>
<tr>
<td>pH</td>
<td>6.65</td>
<td>6.9</td>
</tr>
</tbody>
</table>

These alterations affect the finished product:
- Alterations to flavor of milk
- Increases rennet clotting time
- Decreases curd firmness
- Reduces starter activity

(Kitchen BJ, 1981)
Mastitis Control Program

1970s-1990s -> focus on contagious pathogens

Five point plan:
1. Maintaining a properly functioning milking machine
2. Dipping teats in a post-milking germicide
3. Appropriate therapy of clinical mastitis
4. Effective dry cow management
5. Culling chronically infected cows.

(Neave et al, 1969)
Mastitis Control Program

10 point mastitis control program:

1. Maintaining a properly functioning milking machine
2. Dipping teats in a post-milking germicide
3. Appropriate therapy of clinical mastitis
4. Effective dry cow management
5. Culling chronically infected cows.

6. Maintain a clean, dry comfortable environment
7. Good record keeping
8. Maintain biosecurity for contagious pathogens
9. Monitoring udder health status
10. Periodic review of herd mastitis control program

(Neave et al, 1969)
Mastitis Control Program

• Prevention program has resulted in improved control of contagious pathogens

• Proportion of IMIs associated with coagulase negative *Staphylococcus* spp. (CNS) have increased
Staphylococcal species

- **Staphylococcus aureus**
  - Major mastitis pathogen
  - Coagulase positive staphylococcus (CPS)

- **non-aureus *Staphylococcus* spp.**
  - Coagulase negative staphylococci (CNS) and non-aureus CPS
  - CNS most common non-aureus Staphylococci
  - Minor mastitis pathogens
  - Most frequently isolates microorganism from bovine milk
CNS Mastitis – Group level data

- **Most prevalent bacteria found in milk samples**

- **Induces mild subclinical mastitis as measured by SCC**
  (Schukken et al, 2009)
  - Below 500,000 cells/ml  (Djabrri et al, 2002, Fry et al, 2014)
  - Persistent infections >650,000 cells/ml  (Taponen et al, 2007)

- **Some reports of mild clinical mastitis**
Individual CNS infections may only have moderate impact on SCC

HOWEVER, many cows infected within a herd could prevent a producer from achieving a relatively low bulk milk SCC
At herd level, 15% of cows were infected with CNS, ranging from 0-100%.

Average within herd prevalence of cows with CNS IMI and SCC over 200,000 cells/ml was 2%, ranging from 0-50%.
SCC increased between 0.5-1 LS point in CNS infected cows relative to culture negative.
Schukken et al, 2009

Larger increase in LS noted in heifers with CNS IMI when compared to culture negative heifers

OVERALL, Impact of CNS IMI on SCC was intermediate when compared to culture-negative...
86/4200 (2.1%) in shaded area: represents herds where CNS infections contributed at least 10% of cells and were considered responsible for bulk milk SCC going over 400,000 cells/ml.

Fig. 4. Bulk milk somatic cell count (BMSCC, 1000 cells/ml) vs. contribution of somatic cell count to bulk milk of cows with coagulase-negative staphylococci intramammary infection. Each data point in the graph reflects a herd. The shaded area identifies the herds where CNS infections contributed at least 10% of cells and were considered responsible for bulk milk SCC going over 400,000 cells/ml. The dotted lines indicate that a bulk milk SCC of 800,000 must have at least 50% contribution due to CNS to consider CNS infections responsible for going over 400,000 cells/ml. There are a total of 86 herds out of 4200 (2.1%) in the shaded area.
CNS – herd level

- Contribution of CNS IMI to BMSCC decreased with increasing BMSCC

- CNS contribution to BMSCC was approximately 12% for herds with a BMSCC between 200,000-400,000 cells/ml and only 8% in herds with BMSCC higher than 400,000 cells/ml

- Herds striving for a low BMSCC: CNS contributed approximately 18% of BMSCC

Schukken et al, 2009
CNS – species level data

Top 5 most frequently identified species in bovine milk samples:

1. *Staphylococcus chromogenes*  
2. *Staphylococcus haemolyticus*  
3. *Staphylococcus epidermidis*  
4. *Staphylococcus simulans*  
5. *Staphylococcus xylosus*

Some labs will report CNS to the species level, so you may see these names.
CNS - species level data

• **Persistent infections**
  - *S. chromogenes*
  - *S. epidermidis*
  - *S. simulans*
  - *S. xylosus*

• **Host adapted species**
  - *S. chromogenes*
  - *S. epidermidis*

• **Substantial effect of SCC**
  (Supre et al, 2011, Fry et al, 2014)
  - *S. chromogenes*
  - *S. simulans*
  - *S. xylosus*

• **Environmental source**
  - *S. haemolyticus*
  - *S. equorum*
  - *S. saprophyticus*
CNS mastitis

• **OVERALL IMPACT:** Can affect BMSCC if high prevalence and contagious pathogens controlled

• *S. chromogenes, S. epidermidis, S. simulans, and S. xylosus* are the among the most prevalent CNS species and most associated with increased SCC and persistent infections

• In heifers, CNS major cause of IMI both pre and post calving
Heifer Mastitis
Precalving IMI: 18.5% of quarters

Post-calving IMI: 21.5% of quarters

Figure 1. Smoothed prevalence of quarter IMI by day relative to calving for major (—■—) and minor (—▲—) pathogens (A) precalving and (B) postcalving, in 708 pasture-grazed dairy heifers.

(Compton et al, 2007)
(McDougall et al, 2007; De Vliegher et al, 2012)
CNS and Heifer Mastitis

• **Most likely cause of IMI in heifers both pre and post partum** (Piepers et al, 2010)

• **Decline in prevalence reflects transient nature of CNS in early lactation heifers** (De Vliegher et al., 2004, De Vliegher et al, 2005)
  • Periparturient IMIs that clear shortly after calving are less harmful on future productivity

• **Most prevalent species: *S. chromogenes, S. simulans, and S. xylosus***
  • 60% of heifers with CNS IMI infected with the more relevant CNS species (De Visscher 2016)
Heifer Mastitis

• First lactation mastitis can have lasting impact on productivity

• Heifers with ↑ SCC in early first lactation
  • ↑ SCC throughout first lactation (De Vliegher et al, 2004)
  • ↓ Milk production throughout first lactation (Coffey et al, 1986, De Vliegher et al, 2005)
  • ↑ SCC between 5-30 DIM can negatively impact LIFETIME milk yield (Archer et al, 2013)

• Associated with increased culling rates (De Vliegher et al, 2005)

• Increased culling results in increased rearing costs (De Vliegher et al, 2012)
Heifer Mastitis

• General risk factors for heifer mastitis:
  • Hygiene
  • Flooring type in calving area
  • Bedding type
  • Rearing Facility
  • Season
  • Nutrition
  • Skin colonization

  - CNS IMI associated with poor heifer hygiene (Pieper et al, 2011)
  - Slatted floors having reduced odds of high SCC (De Vliegher et al, 2004)
  - New sand less risk than recycled sand or deep bedded manure solids (Rowbotham and Ruegg, 2016)
  - Off site rearing lower risk of environmental mastitis (Bludau et al, 2016)
  - In USA, heifer IMIs more prevalent in summer (Fox et al, 1995)
  - Increased growth rates from birth to weaning associated with decreased clinical mastitis around calving (Svensson et al, 2006)
Conclusion

- CNS mastitis is highly prevalent in cows and heifers
- More of a problem for herds that have controlled contagious pathogens
- Some labs already reporting CNS species-level identifications on lab reports
Conclusion

Overall CNS infected cows can have an impact on BMSCC because herds can have a large number of CNS infected cows present.

Individual animal management decisions (treatment, segregation, culling) will be easier and more cost-effective in cows infected with a major pathogen compared to cows infected with CNS.
Questions?