Mastitis

Therefore, mastitis is an inflammation of the mammary gland.

Or

Reaction to a tissue injury.

Therefore, inflammation can and does result in the loss of function characterized in mastitis by lowered milk production. Inflammation is a reaction to tissue injury, (change in composition), due to the cow’s immune response.

Mastitis is a result of the host, pathogen, environmental interaction. Control of the environment by "good" management is the key to the control of mastitis.
Mastitis

Bacterial Physiology

A. Gram positive:
   1. Cell membrane
   2. Thick outer wall

B. Gram negative:
   1. Cell membrane
   2. Thin cell wall
   3. Outer membrane

C. Toxin producers, G⁺ and G⁻

D. Grow well in milk:
   1. Lactose
   2. Protein
   3. Nucleic acids
   4. Fat

Mastitis

Bacterial Types

A. Staphylococcus:
   1. S. aureus (coagulase positive)
      a. Major pathogen - potent toxin producer, highly contagious
      b. Some strains penicillin resistant
      c. G⁺
      d. Habitat - skin

2. S. species (coagulase negative)
   a. Minor pathogen?, not contagious?, rarely causes clinical mastitis
   b. G⁺
   c. Habitat - skin
Mastitis

Streptococcus - G⁺
1. *S. agalactiae*
   a. Obligate udder parasite
   b. Penicillin sensitive
   c. Habitat - udder
   d. Highly contagious
2. *S. dysgalactiae* and *S. uberis*
   a. Environmental microbes
   b. Small minority with contagious nature

C. Coliforms G⁻:
   1. Environmental
   2. Very potent toxin producers
   3. Most are susceptible to immune systems
   4. Major species
      a. E. coli
Mycoplasma Mastitis

Mycoplasma mastitis
a. Cell wall less organism
b. Difficult to culture- bulk tank cultures
c. Often underdiagnosed
d. Not treatable
e. Contagious
f. Internal transmission

Question 1

- Mastitis is defined as:
  - A. Bacterial infection of the udder
  - B. Viral infection of the udder
  - C. General infection of the udder
  - Inflammation of the mammary gland
Question 2

• Why did you answer the way you did in Question 1?

Mastitis

Mammary Immune System

A. Skin and keratin lining are first lines of defense

B. Cellular - second line of defense:
   1. Leukocytes -
      a. PMNs - phagocytic - engulfment
      b. Macrophages - phagocytic - engulfment
      c. Lymphocytes - antibody producers + cytokine (hormones of the immune system) production

B. Alveolus - Milk Secretory Cell
   a. Histamine - an irritant attracting leukocytes and restricting blood flow
   b. Lactoferrin - keeps iron away from bacteria

C. Noncellular - humoral:
   1. Antibodies - specific proteins interfering with bacterial function.
   2. Blood proteins - non-specific agents which attract leukocytes, lyse some gram negative bacteria and support phagocytosis

Mammary/Bacterial Interaction

A. Bacteria enter through the streak canal.

B. Adhere to cell surfaces within the mammary gland; work their way up into the gland

C. Bacterial production of toxins attracts leukocytes and causes secretory tissue destruction.
Mastitis

Leukocytes

D. Leukocytes

1. PMNs and macrophages engulf and destroy bacteria
2. Lymphocytes produce antibodies
3. Leukocytes are the cells that leave the blood, and enter the milk to destroy the bacteria. They are the cells that chiefly make up the milk somatic cell count. As the somatic cell count increases, so does the likelihood of bacterial infection as more cells are moving into milk to fight the infectious agent.

Mastitis

Secretory cells:

1. Lactoferrin + histamine release
2. Drop in production
3. Some of these cells will add to the milk somatic cell count. The ratio of secretory cells to leukocytes as part of the somatic cell count increases as somatic cell count decreases.

F. Leakage of blood proteins

Question 3

What is the first line of defense against the invading mastitis pathogens:

1) The skin
2) The neutrophil
3) The macrophage
4) The secretory cell
Question 4

• What is the second line of defense against the invading mammary pathogen?
  1. The skin
  2. The neutrophil
  3. The macrophage
  4. The secretory cell

Mastitis

A. Definition:
  1. Inflammation of the mammary gland
  2. Inflammation is reaction to tissue injury

B. Identification of reaction to tissue injury
  1. Clinical - visible - macroscopic changes
     a. Swelling
     b. Redness
     c. Abnormal secretions
  2. Subclinical - microscopic changes - small changes in milk composition

C. Changes in milk composition:
  1. Cell influx: Somatic cell count, SCC, a count of body cells, chiefly leukocytes, in milk. Cell count of greater than 200,000 cells/ml indicates that IMI, intramammary infection, is probably present.
     a. CMT
     Score     SCC (cells/ml milk)
     Negative  0 - 200,000
     Trace     150,000 - 500,000
     1         4,000 - 1,500,000
     2         800,000 - 5,000,000
     3         >5,000,000
  2. Leakage of blood components
     a. Blood proteins
     b. Blood ions - Cl₂ - conductivity
  3. Decrease in secretory components
     a. Lactose
     b. Casein (affects cheese yield)

Mastitis

D. Electronically
  i. Coulter
  ii. Fossomatic
     iii. Bentley

White blood cells
**Mastitis**

**D. Interpretation**

1. **Tissue injury signifies loss in production**
   a. **Tissue destruction**
      i. Bacteria
      ii. Host cells
   b. Breakdown in blood milk barrier, loss of normal milk components, increase in blood components

2. **How much milk loss?**

<table>
<thead>
<tr>
<th>Somatic cell counts (X 1000)</th>
<th>Linear score</th>
<th>Loss in Daily yield (VA) lbs</th>
<th>Loss in lactation yield (WI) lbs</th>
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</table>

**Bacterial Isolation**

1. **Expensive**
2. No information on degree of inflammation
3. **Value in problem situations**
   a. Problem cows
   b. Problem herds
4. **Value in monitoring herd status**
   a. Sample all clinical cases pretreatment
   b. Sample all cows at freshening and/or drying off
   c. Sample the bulk tank periodically (weekly, semimonthly, monthly)

Very effective when examining herd *Strep. agalactiae* status; somewhat effective in *S. aureus* examination. Determine concentration of these organisms.

- Environmental organisms, coliforms and strep nonags, can be of cow origin or contamination from environment; therefore, these organisms can hide the problem.
- May be made more effective when SPC, coliform counts, and somatic cell count results are included with mastitis pathogen count. No definitive formula has been developed.
- Remember, a high SPC in bulk tank milk is not an indication that there is a mastitis problem in the herd. Learn what a SPC, PI, and LPC terms represent.
Detection of Mastitis

- Why is the detection of mastitis most often done by measuring the milk somatic cell count:
- 1) it can be done on the cow side by the Colorado Mastitis Test
- 2) it can be done at the cow side by the WMT
- 3) It is less expensive the bacterial isolation
- 4) It is a true measure of inflammation
- 5) It can be done electronically rather inexpensively and quickly

Diagnosis of Mastitis

- What are the advantages of bacterial culture in diagnosis of mastitis:
  a. It is very inexpensive
  b. It is very expensive but accurate
  c. It is can be used to determine the root of the problem
  d. It always works with bulk tank cultures

Mastitis Prevalence: By Country & Study

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Country</th>
<th>S. aureus</th>
<th>CNS</th>
<th>Env</th>
<th>Streps</th>
<th>Coliform</th>
<th>Other</th>
<th>No Growth</th>
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<tbody>
<tr>
<td>Nash et al.</td>
<td>2002</td>
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<td>Hoe and Ruegg</td>
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<td>Tenhagen et al.</td>
<td>2006</td>
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<tr>
<td>Bar et al.</td>
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<td>Bradley et al.</td>
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<td>Unnerstad et al.</td>
<td>2009</td>
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<td>Average</td>
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</table>
Mastitis

SCC Distribution

<table>
<thead>
<tr>
<th>Cow</th>
<th>Herd A SCC</th>
<th>LSCC</th>
<th>Herd B SCC</th>
<th>LSCC</th>
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<tbody>
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<td>1</td>
<td>50000</td>
<td>2</td>
<td>400000</td>
<td>14</td>
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<tr>
<td>2</td>
<td>100000</td>
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<td>0</td>
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<tr>
<td></td>
<td>1,315,000</td>
<td>3</td>
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<td>4.2</td>
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</tbody>
</table>

2. 200,000 cells/ml threshold

Mastitis Control

N.Y./British study examined the effect of hygienic milking practices.

a. Full hygiene - 50% less infections, control of contagious mastitis
   i. Disinfectant in udder wash
   ii. Individual udder cloths
   iii. Rubber gloves
   iv. Teat dip
   v. Cleaning clusters between milking

b. Control of environmental pathogens

Mastitis Control

Partial hygiene - 33% less infections (no cluster cleaning between milkings). Recent studies at Penn State and the Univ. of Kentucky demonstrate the effectiveness of back flushing on reduction of contagious mastitis infections, but not infections caused by environmental pathogens.

3. Predip: Dipping teats in disinfectant solution prior to milking, then wiping teats dry can serve as udder wash, yet also reduces environmental mastitis.
   a. Potential disinfectant milk residue contamination
   b. Control of environmental pathogens

Mastitis Control

4. Environmental mastitis primarily controlled by housing bedding management.
Mastitis Control

Vaccination
a. *S. aureus* vaccines - 2 in progress on commercialization. Some success, herd effect.
b. Coliform: J5 mutant, reduction in clinical signs.

B. Cure (Treatment)
1. Antibiotics
   a. Success of treatment of clinical cases
      i. Timeliness of treatment
      ii. Antibiotic specificity
      iii. Louisiana Study:

Mastitis Control: Antibiotic TX

<table>
<thead>
<tr>
<th>Pathogen</th>
<th># Quarters</th>
<th>Percent infected</th>
<th>Percent eliminated</th>
<th>% Clinical cases cured</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>S. aureus</em></td>
<td>121</td>
<td>24.8</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td><em>Strep. ag.</em></td>
<td>31</td>
<td>51.6</td>
<td></td>
<td>100</td>
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<tr>
<td><em>Strep. others</em></td>
<td>111</td>
<td>36.0</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Coliform</td>
<td>7</td>
<td>71.4</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

b. Success of treatment of subclinical mastitis
   i. During lactation may not be economically viable
   ii. Dry cow treatment most economical and effective

2. Frequent stripping of infected quarter

Mastitis Control

- Mastitis control is best summed by the quote: “An ounce of prevention is worth a pound of cure” because:
  1. It is costly to treat mastitis and less costly to prevent it
  2. Treatment is not very effective
  3. Benjamin Franklin said so
  4. All of the above

Dry cow therapy -- cures and protects during the period of greatest susceptibility.
Orbesal
Health

Generally not of major consequence

1. Milk pasteurization kills most bacteria and denatures most toxins
2. Proper cooling of milk selects against most mammary pathogens, the exception is Strep. agalactiae.

B. Staph. aureus
   1. Toxic shock syndrome
   2. Toxins are not affected by pasteurization

With proper cooling of milk, problem does not exist

Dollars and Sense

A. Mastitis on average is responsible for a loss of $180-$200/cow/year
   1. Loss of monies
      a. Discarded milk
      b. Treatment
         i. Drug treatment
         ii. Veterinary service
      c. Loss of production due to infection
      d. Extra labor

B. Control
   1. Prevention better than cure since treatment accounts for only 5-10% of the total cost attributed to mastitis
   2. Milking procedures followed
   3. Maintenance of the milking equipment
   4. Failure to control
      a. Treat
      cull