Bovine Mastitis

Guide to Bovine Clinics Pasquini & Pasquini, 4th ed.

Mastitis

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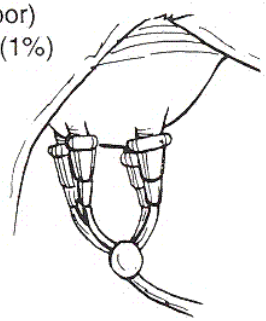
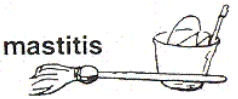
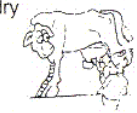
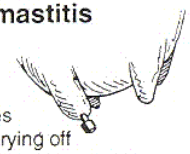
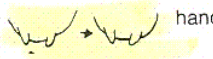
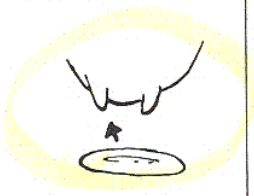
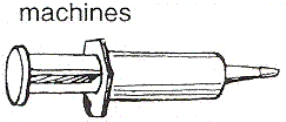
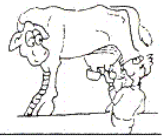
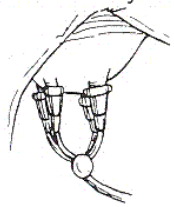
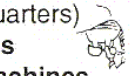
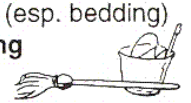
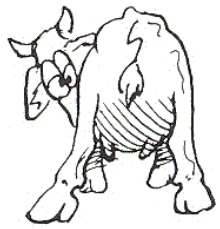
SKIN - EYE - MAMMARY

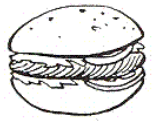
Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Mastitis Mk 687; C3T 762; IM 1181; BR-hb 251; BR 563; Br 289, 305; DC 279 ★★★ 	• **Most costly diz in adult dairy** (1/3 of all dizs) - ↓ Milk production - Economic losses $200/cow, 2 billion/yr USA, - 10% loss of total production - 40% of all cows - Will continue bec. of difficulty in controlling environmental pathogens • Causes - Milking hygiene (75%) - Equipment malfunction (20%) - Cow factors (5%) • Defense - 1st line is teat canal - Cell mediated: normally 0.5-20,0000 cells/ml (less more susceptible to mastitis)	• **Subclinical & clinical mastitis** - ↓ Milk production - Milk discard - Early culling (7% of affected) - Other economic losses (drugs, vet, labor) - Death (1%) 	• **CS inadequate for cause** • **Individual**, examine before milking - **Abnorm. milk** - **Hot udder** (swelling, heat & edema) - **SCC/culture** • **Herd - subclinical cases** - ↑ **SCC** (somatic cell count) . 80% of cows w/ SCC > 200,000 are infected  . Bulk tank SCC - **Cultures/AB susceptibility** . **Bulk tank** - ID pathogens monthly to monitor herd, cheap .. **< 250,000 cells/ml OK** . **Routine culture** all infected quar. .. Do routinely or at least whenever unusual mastitis . **Herd cultures** all cows in herd .. When contagious bact. suspected .. ID infected cow for isolation &/or Tx . **Selective survey cultures**: .. Indiv. testing on basis of elev. SCCs .. Finds infec. animal w/ less testing, but misses some positive animals • **Palpate** udder for symmetry, fibrosis, firmness, swelling, etc. - Acute: Inflammed, hot, swollen - Chronic: fibrosis, but no heat - Subclinical: only incr. no. of cells in milk - Palpate supramammary & inguinal lymph nodes	**Prevention rather than Tx most effective** • **Herd problem** • **Total dry period** therapy routinely done - Infusion of long-acting ABs in all quarters during dry period  • **Control contagious mastitis** - **Hygiene during milking** . Predip . Single paper towel/udder to wash & dry  . Disinfectant in wash solution . Rubber gloves . **Teat dip** - post milking **(#1 control)** . Test & maintain milking machine - **Dry cow therapy, long-acting ABs into all quarters**  - Culling - Tx clinical mastitis cases - **Isolate infected & milk last** (serve as source of contamination) sterilize cluster after affected cows - Properly functioning milking equipment • **Control environmental mastitis**  - Sanitation of environment - Predipping - Feed right after milking to keep cow standing as teat canal closes - Antibacterial teat sealant when drying off - Decr. trauma to teat, decr. potential for backflow of milk (esp. contaminated) - AB Tx of little use for environmental mastitis - Diet (Vit E & Selenium) improves resistance - Vaccines: coliform vaccines likely to be profitable . *S. aureus*, Strep: more research needed • **Cull cows w/ repeated mastitis**  • **Individual cows Tx**: see below
• **Contagious mastitis** VC/M 475 	• ***Staph. aureus* (7-40%), *Strep. agalactiae*, Mycoplasma spp**, *Corynebacterium bovis, Strep. dysglactia* • Transmission: Milking time (milking equipment, nursing calves or milker's hands)			
• **Environmental mastitis** 	• Bact. in environment other than mammary gland, do not need infected glands to perpetuate diz, therefore can't eliminate mastitis • Major mastitis on modern, well managed dairy farms - ***Coliform*** (gram neg., *E. coli*, Klebsiella spp, Enterobacter spp, Setaria, Pseudomonas, Proteus) - **Envir. Strep spp.** (*Strep. uberis* #1); ***Staph. aureus*** • Transmission: Usually when not milking: Feces, water, bedding, fomites - Incr. as contagious mastitis decr. - 80-90% coliforms & 40-50% of strep result in clinical mastitis as opposed to subclinical			
• **Contagious/ environmental**	• **Overlap**: Bacteria on mammary gland or in environment *Strep. uberis*, *Strep. dysgalactiae*, *Staph. aureus*			

#1 economically; Cause: Contagious & Environmental
CS: 90% subclin.; Clinical (Acute, Chronic, Gangrenous)
Dx: CS, SCC, Culture
Tx: Herd over indiv. (Hygiene, Dry cow therapy, Isolate, Cull)

Bovine Mastitis

• **SUBCLINICAL mastitis** 	• **90% of all mastitis** • **#1 cause of production loss** (10-26% milk loss) • Causes - Contagious: *Staph. aureus*, *Strep. agalactiae* - Envir.: Strep. spp (*S. uberis*, *S. dysgalactiae*)	• **Milk grossly normal** • No visible inflammation • In time - fibrosis of mammary tissue, firmer, larger gland • ↓ **Milk production**	• No CS since subclinical • ↑ SCC (somatic cell count) > 250,000/ml • CMT (Calif. mastitis test) • Routine culture of all quarters 	• Tx as above - Milking hygiene (teat dipping, 1 towel) - Dry cow therapy (ABs all quarters) - Semiannual test & maintain milking machines  
• **CLINICAL mastitis**	• Further divided into acute, chronic & acute gangrenous mastitis	• **Milk grossly abnormal** - **Gargets** (milk clots) - Serum w/ fibrin • **Udder inflammation** - Redness, fever, swelling & pain	• History, CS • Cell counts > 500,000 cells/ml • Isolate causal agent • Provisional diz by CS & knowledge of herd predominant pathogens - Confirm w/ culture & sensitivity tests (see above) • **Palpation for mastitis** - Inflammed, hot, swollen - Supramammary & inguinal lnn. 	• Tx herd as above - **Milking hygiene (teat dipping, 1 towel)** - **Dry cow therapy** (ABs all quarters)  - **Treat clinical mastitis cases** - **Test & maintain milking machines**  - **Cull repeated mastitis cows** - **Sanitize environment** (esp. bedding) - **Feed right after milking**  • **Individual cows Tx** - Frequent (QID minimum) stripping of quarter & injections of oxytocin QID - Subacute: intramammary Tx after each milking for 3 days - Acutely affected: systemic & intram. ABs minimum of 3 days - Peracute: systemic & intramammary ABs, oral fluids & anti-inflammatory drugs (aspirin, Banamine®) . Severe: hydrotherapy (spray quarter 15-30 min BID) - Fresh cow/ first lactation heifers: diuretics for edema - If no response in 7-10 ds won't respond . Cull
1. Acute mastitis	• Exacerbation of chronic or a new infection 	• **Swollen, painful gland** (difficult to walk) • **Abnormal milk** (clots or flakes, watery, serous or purulent) • **Systemic CS,** mild or severe - Anorexia, Depression, Elev. temp. • Toxic mastitis (coliform/*S. aureus*) - M/ have low serum Ca & paraplegia (resembling milk fever, no response to parenteral Ca)		
2. Chronic active mastitis	• **Intervals of no CS** • **Assoc.: *S. agalactiae*, coliforms, *S. aureus*** & *Salm. dublin*	• **Intervals or no CS** • **Intermittent acute mastitis manifestations** (see above) • ↓ Milk prod. over time due to destruction of gland alveoli & ducts	• SCCs chronically elevated • Asymmetry due to fibrosis, but no heat	
3. Acute gangrenous mastitis	• **Uncommon** • ***S. aureus* #1, *C. pyogenes***, coliforms, Staph. spp.	• See *Staph. aureus* pg 194		

Prognosis
- Environmental: eliminated in ds - 3 wks, except Klebsiella
- Contagious: tend to persist as subclinical infection



Bovine Mastitis

Mastitis

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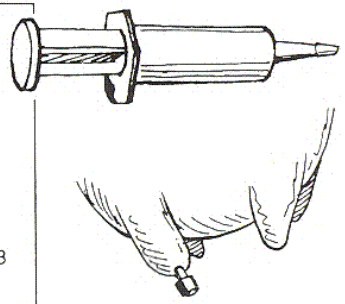
SKIN - EYE - MAMMARY

Condition	Fact/Cause	Presentation/CS	Diagnosis	Treatment

Intramammary preparations & compatible systemic ABs

C3T 767

Intramammary	Compatible systemic Rx	Dose	Drug withdrawal times	
Ampicillin (Hetaxcin®)	Procaine pen G	20,000 IU/kg SID IM	Milk: 96 hrs	Meat: 14 ds
	Ampicillin	10 mg/kg SID IM	Milk: 96 hrs	Meat: 6 ds
	Amoxicillin	10 mg/kg SID IM	Milk: 96 hrs	Meat: 6 ds
Cloxacillin or Penicillin & novobiocin,	Penicillin			
Penicillin & dihydrostreptomycin or Cephapirin	Penicillin			
Erythromycin	Erythromycin	12.5 mg/kg SID IM	Milk: 96 hrs	Meat: 28 ds
	Tylosin	12.5 mg/kg SID IV	Milk: 96 hrs	Meat: 28 ds
	Penicillin			
Oxytetracycline	Oxytetracycline	10 mg/kg SID IV	Milk: 96 hrs	Meat: 14-28 ds
	Sulfonamides	200 mg/kg SID PO	Milk: 73 hrs	Meat: 10 ds
	Potentiated sulfonamides	24 mg/kg EOD	Milk: 72 hrs	Meat: 12 ds



• Staph. mastitis

Mk 688; C3T 763; IM 1187; VC/M 432, 484, 496, 503, 529; BR-hb 251; BR 563; Br 296, 343; DC 280

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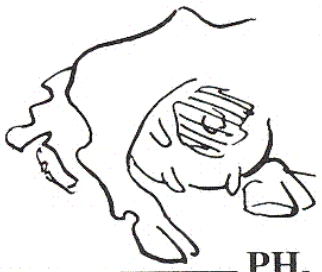
#1 cause of mastitis in most dairies bec:

- Both acute & chronic mastitis
- Responds poorly to Tx
- Easily transmitted at milking
- **Contag.**/Envir. (udder/body) contaminant
  - Adult udder infection
  - Cow to cow via milking machines, hands, fomites
  - Introduced into herd by newly infected animals
- Individual cases indicate subclinical problem in other herd members
- Exotoxin
- Chronic - walled off bact., hard to treat
- **Gangrene due** to alpha toxin causing vaso-constriction, ischemia & desquamation of tissue

#1 mastitis, subclinical, contagious, Exotoxin
- **CS: Chronic subclin., Toxemic; "Blue bag"**
- **Dx: Hx, CS, SCC, Culture**
- **Tx: Herd (hygiene, dip & isolate), Cull**

- **Usually chronic is subclinical**
- **Occasional clinical flare-ups** (usually mild, moderate)
  - Udder swollen, firm, redness, heat & pain (m/b up mammary vein)
  - Flakes & clots in milk initially
  - Purulent or watery milk
- **Severe mastitis** occasionally (esp. at parturition/first mo of lactation)
  - Systemically ill
    . Anorexic, depressed, ↓ milk prod., toxemia, ↑ temperature
- **"BLUEBAG"** - gangrene
  - Gland red, swollen & warm (early)
  - Few hrs. later gland cold, secretions watery & sanguinous
  - Delineated **blue discoloration** from teat to areas of gland
  - **Area sloughs** in 10-14 days
    . 2° infec. invade sloughed area = necrosis & continual sloughing
  - Systemic CS (anorexia, dehydration, depression, fever)
  - Moist gangrene, teat & udder oozes blood-tinged serum (thrombosis of large veins)

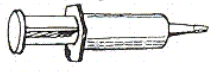
- History, CS
- Elev SCC (somatic cell count)
  - Strep >> Staph
- Culture all clinical cases, purchases, fresh & heifer cows routinely
- Microabscesses, necrosis



PH

Public Health
- Some Staph. produce entero-toxins in stored milk products which can multiply
  - Food poisoning

- **Herd Tx more important than individual**
  - Individual Tx of little or no value
  - Stop transmission basis of control
    . Sanitation (see preceding pg)
      .. Single towel, hygiene workers & machine
      .. **Teat dipping**, postmilking
      .. Machine function checked routinely
    . Segregate infec. from clean cows
      ..Cull infected cows, or
      ..Separate pos. & neg. groups
      ... Milk pos. last, cull as value goes down
  - Dry cow Tx, hi % of failures, still use bec. helps eliminate *Strep. agalactiae*; not *Staph. aureus*



- **Individual cows**
  - Lactating cow Tx limited (abscesses in gland hard for antibiotics to reach)
  - Dry off when no longer profitable & **Cull**
- **Blue bag**: amputating affected teat facilitates drainage & sloughing (weeks)
  - Recovered cows often sold for slaughter

Bovine Mastitis

• Strep. mastitis

Mk 687; C3T 763; IM 1188; VC/M 491, 496, 503; BR-hb 251; BR 563; Br 296, 345; DC 279

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- *S. agalactiae*
  - **Highly contagious**
    - . **Obligate** inhabitant of mammary gland, **thus it can be eliminated from herd**
    - . Cow to cow transmission
  - Doesn't invade mammary tissue, damages epithelium, causing PMN outpouring, blockage, fibrosis & decr. secretion
- **Environmental Strep.** (*S. dysgalactiae* & *S. uberis*)
  - Lower infec. rate bec. not contagious
  - Can't be eliminated from herd (environment)

- ***Strep. agalactiae***
  - Usually subclinical
  - Occasional flare-ups
  - Similar signs to Staph.

- History, CS
- SCC (somatic cell count)
- Culture

- ***Strep. agalactiae***
  - **Elimination possible 1-2 years**
    - . **Milk hygiene, 1 towel, gloves**
    - . **Teat dipping**
    - . **Dry or lactating cow AB therapy**
      - Intramammary penicillin G, highly effective (withholding times)

- **Environmental Strep.** spp. (*S. uberis*)
  - Can't be eliminated bec. environmental
  - M/ be more resistant to penicillin, other choices: chlortetracycline, oxytetracycline, cephalosporin, Na cloxacillin
  - Routine dry cow therapy
  - Sanitation of environment
  - Sand bedding

#1 *Strep. agalactiae* (Contagious; m/b eliminated)
CS: Subclinical w/ flare ups
Dx: Hx, CS, SCC, Culture
Tx: Sanitation, Teat dip, Dry/Lactating - Pen G

Control
Elimination of *S. agalactiae* possible:
- Susceptible to antibiotics
  - Obligate inhabitant of mammary gland, not environment
  - Doesn't invade tissue, susceptible to ABs

• Coliform mastitis; Gram-neg.

Mk 688; C3T763; IM 1189; VC/M 510, 490, 496, 503; BR-hb 251; BR 563; Br 297, 339; DC 286

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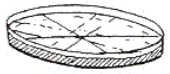
- **Environmental mastitis**
  - ***E. coli, Enterobacter aerogenes, Klebsiella pneumoniae, Pseudomonas aerugionsa, Pasteurella multocida,*** Setarria spp.
- Acute clin. mastitis in early lactation
- Transmission:
  - **From environment** (not like *Staph. aureus, Strep. agalactia*)
  - Milking wet udders incr. incidence
  - Low cell counts (SCC) in udder, predispose
  - Single quarter usually
  - Inflammation destroys coliforms & releases endotoxins

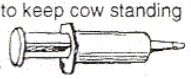
- **Acute clinical mastitis**
  - Uniform swelling of affected quarter
  - Watery milk
- Subclinical infection uncommon
- **Toxic shock**:
  - Acute, m/b peracute - death
  - High fever, anorexia, depression, milk ceases, rapid weight loss
  - Recumbency
  - Pulmonary hypertension
  - Abortion
  - Diarrhea
  - Death (5%)

- History, CS
- Little fibrosis or induration
- SCC
- Culture



- **Sanitize envir. over indiv. cow Tx**
  - Milking hygiene, individual paper towels, premilking teat dip? Postmilking dip does not prevent infec.
  - Sanitize environment
    - . Bedding: sand better than shavings or sawdust

  - Feed right after milking to keep cow standing while teat canals close



- **Individual cow mastitis**
  - **Spontaneous recovery** (most cases)
    - . Intramammary infusion
  - **Severe: Endotoxin/mediator shock**
    - Milk out every 2 hrs or allow calf to suckle (decr. endotoxins & inflam. mediators & bacteremia)
    - IV ABs, sulfamethazine or oxytetracycline
    - Intramammary ABs, following complete milking (cephalosporin, ampicillin, aminoglyc., polymyxin B)
    - IV fluids (initially 5-10 L/hr 2 hrs; then 5 L/hr)
    - Aspirin or Banamine® (cause abomasal ulcers)

Acute clinical mastitis in early lactation, Envir.
CS: Acute mastitis, Toxic shock
Dx: Hx, CS, SCC, Culture
Tx: Envir. sanitization, Feed after milking, Tx shock

Unique - upon recovery, gland returns to capacity

Bovine Mastitis

Mastitis

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SKIN - EYE - MAMMARY

Condition	Facts/Cause	Presentation/CS	Diagnosis	Treatment
Mycoplasma mastitis Mk 689; C3T 763; IM 1190; VC/M 475; BR-hb 251; BR 563; Br 298, 342; DC 283 ***	• ***Mycoplasma bovis***, *M. californicum, M. canadensis, M. bovigenitalium, M. alkalescens*) • Probable systemic phase (rapid spread to other quarters & to joints) • Extremely contagious • Chronic carriers **Extremely contag., Systemic phase (joints)** **CS: Outbreaks, Severe mastitis, Joints** **Dx: Nonresponsive to Tx** **Tx: No response to Tx, Elimination**	• **Possibility of explosive outbreaks** • **Usually severe mastitis** • Secretions watery to purulent • Spreads from quarter to other quarters • Tannish-brown milk, sandy flakes that float • Milk secretions m/ cease until next lactation • Not systemically ill, eats • Mild forms - indistinguishable from Staph., Strep. or coliform mastitis • Sequelae - Arthritis & lameness	• History, CS • **Nonresponsive mastitis** • Neg. milk cultures using standard microbial methods • Fibrosis & alveolar cell atrophy • Routinely culture bulk tank, fresh & new cows - Specific microbiological & serological tests • History of nonresponsive mastitis • Negative milk cultures	• **Eradication program** - Serial herd cultures - Slaughter or segregate for life • No Tx - Do not respond to therapeutic Tx
Salmonella mastitis C3T 764; IM 1191 **	• **Rare; *Salmonella dublin***, Public health problem, Neonatal health • Chronic, acute, or subclinical, Occasional flare-ups similar to chronic coliform mastitis • Dx: ELISA assay for *S. dublin* antibody levels • Tx: Cull carrier cows (public health & neonates)	**PH**		
Corynebacterium bovis mastitis Mk 689; C3T 764; IM 1191; Br 297 **	• Rare; Colonize teat canal, but cause little pathology; Consistent culturing indicates **ineffective teat dipping**, Questionable if protective to other infec. by raising SCC • **CS:** Asymptomatic, mild inflammation • **Dx:** Mild elev. SCC, Culture • **Tx:** Routine teat dipping prevents infection			
Leptospira mastitis, "Flabby bag" C3T 764; Br 298, 569 *	• Rare; Hematogenous dissemination; Causes vasculitis • CS: "Milk drop syndrome": abrupt termination of milk secretion, leakage of blood in milk (brownish orange), Flaccid udder ("Flabby bag")			
"Summer mastitis", "August bag" C3T 764; Br 301, 343; VC/M 512 *	• **Rare**; Common in N. Europe, reported in Florida; Dry cow & parturient heifers; mixed infec. (*Actinomyces pyogenes* + anaerobic bact. [Peptococcus indolicus]). Transmission: teat canal or biting flies (horn fly) • **CS:** Distended, swollen teat, hard gland, foul, thick yllw secretion, fever; Acute: toxemia - shock, DIC (disseminated intravascular coagulation), abortion & death • **Dx:** Hx, CS, Destroyed udder, Extensive necrosis of mammary tissue, abscesses & fistulous tracts; Abortions • **Tx:** Salvage; Prevention: Fly control, prophylactic dry-cow therapy			
Other mastitic agents IM 1191; VC/M 571, 572; Br 763, DC 292 *	• **Considered atypical, rarely problems** (*Cryptococcus neoformans, Bacillus cereus*, Nocardia spp, Mycobacterium, Clostridium spp, Candida spp, Pseudomonas, Setaria (check hot water supply) • **Zoonotic implications**: *C. neoformans*, Leptospira spp. & Nocardia spp., so handle infected samples w/ care			

Bovine Mastitis

Milk collection technique

- Sterile tubes, 15 ml, tight fitting seal
- Foremilk collection samples (better than during milking because more organisms)
- Wash udder & teat, let drain, dry w/ single use paper towel
- Strip each teat 2 or 3 times (initiates milk let down & removes some streak canal contaminants)
- Individual quarter samples (identify infected quarters, 1 or all 4)
- Quarter samples together - identify infected animals
  - Scrub teat end & orifice until clean w/ 70% alcohol (ethyl or isopropyl), using separate cotton ball or gauze for each
    . Clean 2 quarters furthermost away, then closest
    . Collect teats closest, then farthermost away
  - Fill horizontally-held tube 1/2 full & seal (do not touch teat to tube)
  - Clean & thoroughly dry hands between cows (germicidal sol.) or use disposable gloves

Transport collected milk

- Process ideally in 15 to 30 min. (sure!)
- Cool to 39.2-41° F (4-5° C) if > 30 min. to processing
- Freezing reduces no. of bacteria
  - Can't determine SCCs (somatic cell counts), but ok for cultural assays
  - CMT, WMT & Gelatin-based assay can be performed on frozen samples
  - Avoid repeated freezing & thawing
  - Staph. recovery m/b enhanced by single freeze, thaw
- Storage at 39.2° F (4° C) for 1 wk or frozen will not affect isolation of most common mastitis pathogens

Routine milk culture: determines cause of clinical mastitis in a herd

- Culture all infected quarters
- Freeze or refrigerate before culture
- Culture before therapy
- Antibody susceptibility testing for future Tx
- Do routinely or at least whenever unusual mastitis
- 25-30% will be negative
  - Coliform mastitis: short duration, cow's defense controls
  - Coliform mastitis: most common cause of mastitis even in herd w/ chronic Staph. or Strep. infection
- Culture m/ reveal presence of *S. agalactiae*, *S. aureus* or Mycoplasma

Herd cultures:

- Culture all cows in herd
- Done when contagious bact. suspected (*Strep. agalactiae*, *S. aureus*, *Mycoplasma bovis*)
- ID infected cow for isolation &/or Tx (*S. agalactiae*)
- Composite samples (all 4 quarters)

Selective survey cultures:

- Testing on basis of elev. SCCs
- Incr. chance of finding infected animal w/ less testing, but misses some positive animals

Bulk-tank milk cultures

- Monthly cultures of bulk-tank to monitor herd
- Inexpensive monthly monitor of herd mastitis status
- Negative test indicates no or low presence of pathogens
- Swab samples over entire blood agar plate

Plating milk samples

- Mix milk sample (gently inverting or shaken)
  - Do not vortex samples for SCCs (m/ rupture cells)
- Sterile swab swirled at bottom of tube (if contacts anything else, hand or counter top, throw away. Calibrated loop for estimating # of bacteria)

Streaking samples: a number of techniques

- 4 quadrants - BBA plate (5% bovine blood agar):
  - Divide bottom of plate into 4 & mark them A, rt. cran.; B, rt. caud.; C, lt. cran.; D, lt. caud.)
  - Open lid, streak a milk line from appropriate qtr. in center of quadrant, then streak side to side across quadrant, repeat for other quarters.
  - cAMP test for *S. agalactiae*: m/b done at same time
    . Sterile *S. aureus* hemolysis streaked across quadrants of blood agar plate
    . Streak milk as in 4 quadrant tech.
    . *S. agalactiae* causes synergistic ß hemolysis
- Half plates - for composite samples
- Entire plates - for bulk-tank samples

Interpreting test results

- **Single colony of *S. agalactiae*, *S. aureus*, or Mycoplasma spp. diagnostic for intramammary infection** (all assoc. w/ gland, not environ., highly contagious)
- Other isolates m/ be contamination from environment, confirm cause by:
  - Conc. of bacteria in sample
  - Purity of culture
  - Intramammary inflammation (elev. CMT)
  - Organism on repeat sampling

80% of cows w/ SCC > 200,000 are infected

Checking for mastitis - strip cup or strip plate - first milk used, so clean udder. Should see coagulation.