DS62

UNIVERSITY OF FLORIDA
IFAS EXTENSION

Milking Management I - The Udder[1]

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Mastitis is the most costly disease in the dairy industry, with the biggest loss from subclinical mastitis, when bacteria are already in the udder. These organisms destroy milk-secreting tissue and thus lower milk production.

Subclinical mastitis cannot be detected on a strip plate, but it is found through a high somatic cell count. A count of 1 million cells/ml indicates that over 30% of a herd's quarters are infected with mastitis.

Herds with high cell counts and many infected quarters will have losses in milk production and income in the range of 20 to 30%. A 500-cow dairy, averaging 50 pounds of milk per cow per day for 365 days a year, with a $16 per hundred pounds milk price that has a 20% loss would lose $292,000 a year because of mastitis (see Table 1).

Anatomy of the Udder

The cow's udder consists of four separate quarters containing a complex network of various sized ducts, blood vessels and capillaries, ligaments, and secretory tissue. Because milk is constantly being produced and is stored in the udder between milkings, it must be strong and well-attached to the cow. In high producing cows, 60 pounds of milk may be stored in the udder between milkings.

Udder Support System

The size and shape of the udder may vary considerably with the age and inheritance of the cow. Attachment of the udder to the cow is by elastic and nonelastic suspensory ligaments (see Figure 1). The median suspensory ligament is located in the center of the udder and holds the udder up in the middle. The other inelastic set of ligaments on the outer walls of the udder are called the lateral suspensory ligaments and also aid in udder support.

Udder Divisions

The udder is divided into halves by the central supporting ligament and each half into quarters by a fine membrane (see Figure 2). While each quarter is separate and no transfer of milk occurs between quarters, antibiotics can be transferred from one quarter to others through the extensive blood network throughout the udder. This is the reason that a cow treated in one quarter with antibiotic must have milk from all quarters discarded. Antibiotics administered

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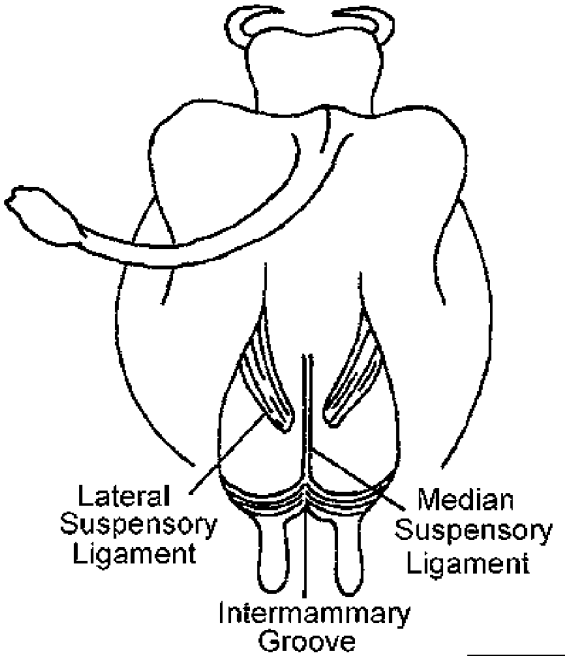

Figure 1.

in the muscle or other areas of the body will also end up in the milk through the blood supply system.

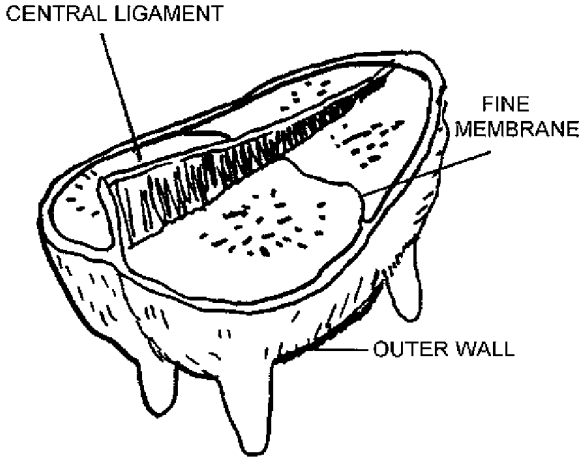

Figure 2.

Histology of the Mammary Gland

The mammary gland is a complex organ consisting of the aveolus, lobules and lobes, teats, a lymphatic system, and the circulatory system.

The Alveolus

The alveolus is the basic component of secretory tissue. It is composed of epithelial cells that surround a cavity, the lumen. Milk constituents (protein, fat, lactose) are synthesized and secreted by the epithelial cells into the lumen of the alveolus.

The alveolus is surrounded by numerous muscle cells known as myoepithelial cells (see Figure 3). These are activated by oxytocin and cause milk ejection from the lumen of the alveolus. Milk is ejected from the alveolus through the capillary milk duct which empties into a series of mammary (milk) ducts that get progressively larger until eventually the milk reaches the gland and teat cisterns. Myoepithelial cells also are found on smaller ducts in the mammary gland and aid in milk removal.

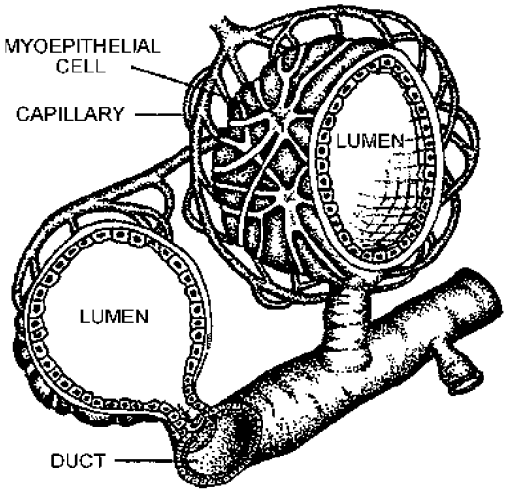

Figure 3.

Lobules and Lobes

Groups of alveoli form lobules that are drained by a common duct. One lobule may contain 150 to 250 alveoli. Lobules join together to form a lobe that is drained by a larger duct (see Figure 4). As described previously these also connect to form still larger ducts which eventually reach the mammary gland cisterns and ultimately the teat cistern and streak canal as milk exits the gland.

Teat Histology

The teat wall (Figure 5) contains an abundance of elastic connective tissue and two layers of muscle tissue (an inner layer of longitudinal muscles and an outer layer of circular muscles). The teat skin is covered with a normal squamous cell epithelium and is hairless. The teat or streak canal is lined with epithelium and has a particularly thick layer of flat cornified epithelial cells. This albuminous layer of

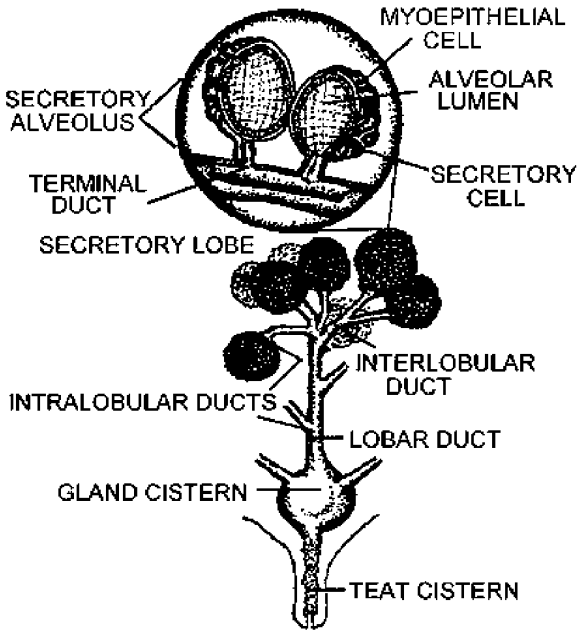

Figure 4.

cells is frequently referred to as keratin. Keratin is vitally important in preventing the entrance of mastitis causing organisms into the mammary gland.

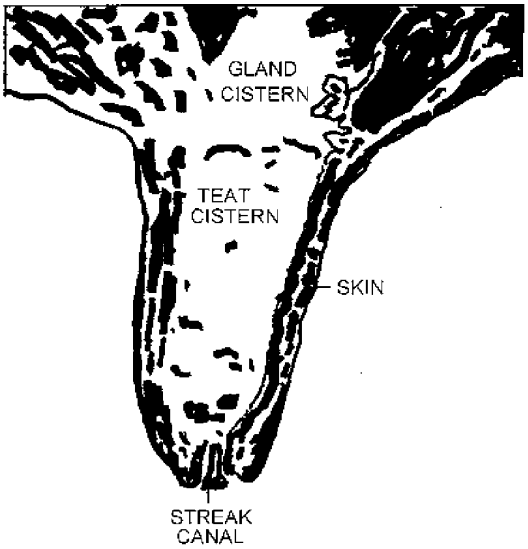

Figure 5.

The Lymphatic System

Lymph is a colorless fluid drained from tissue spaces by thin-walled vessels. These vessels have many one-way valves that allow lymph to move only in the direction of the lymph node (see Figure 6).

The supramammary and other lymph nodes in the cow's body are responsible for disease resistance

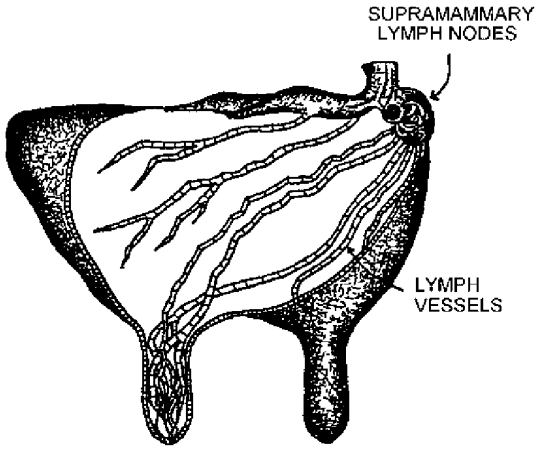

Figure 6.

by forming lymphocytes, which are a form of white blood cell involved in protection against diseases.

When a mastitis infection occurs, the lymph nodes increase their output of lymphocytes into the lymphatic vessels, which discharge them into the cow's blood supply. Lymphocytes then travel to the udder to combat mastitis infection.

The Circulatory System

The flow of blood to the udder is very important for milk production since it requires about 500 volumes of blood to produce one volume of milk. A cow producing 100 pounds of milk a day will require as much as 6000 gallons of blood to circulate to the udder. The extensive circulatory system needed to transport blood to the udder (as depicted in Figure 7) consists of: 1) heart; 2) abdominal aorta; 3) posterior vena cava; 4) external iliac artery and vein; 5) external pudic artery and vein; 6) internal iliac artery and vein; 7) perineal artery and vein; 8) sigmoid flexure of the external pudic artery and vein; 9) subcutaneous abdominal vein; 10) subcutaneous abdominal artery; 11) cranial mammary artery; 12) caudal mammary artery; 13) internal thoracic artery and vein; 14) anterior vena cava; and 15) diaphragm.

Milking

To harvest all the milk from the udder, you must have the cow's cooperation. To achieve this cooperation, treat the cow properly, not only during the milking process, but also from the time the cow is moved to the milking area.

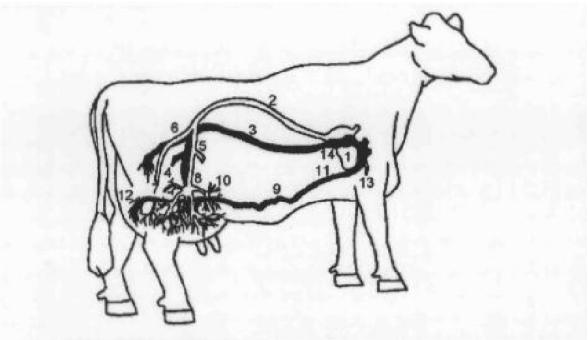

Figure 7.

The Milk Letdown Process

A cow lets down her milk if she is stimulated properly before milking. Since cows seem to be creatures of habit, this stimulation process need not be extensive but should be consistent. Stimulation can include washing or massaging the udder and forestripping milk out of each quarter. During stimulation nerve impulses cause the pituitary gland to discharge the hormone oxytocin into the blood system. Oxytocin then circulates in the blood to the udder and stimulates contraction of the myoepithelial cells surrounding the milk-filled alveoli. The milk is then forced into the duct system and into the gland and teat cisterns.

If the cow becomes excited or suffers pain either before or during the milking process, the cow's cooperation stops. This excitement or pain causes release of epinephrine (adrenaline) from the adrenal gland into the blood stream. This reduces the blood and oxytocin supply to the udder and inhibits myoepithelial cell contraction and milk ejection (see Figure 8). In order to remove as much milk as possible from the udder, it is very important to treat the cow in a routine and gentle manner, both before and during milking.

The Milk Removal Process

There is a positive pressure inside the cow's udder of about 0.4 pounds per square inch (psi) before the cow is stimulated; after stimulation the pressure increases to about 0.8 psi. The sphincter muscle at the end of the teat is tight enough to keep the milk inside, but if the muscle is not strong enough, milk will leak out even before the cow is stimulated.

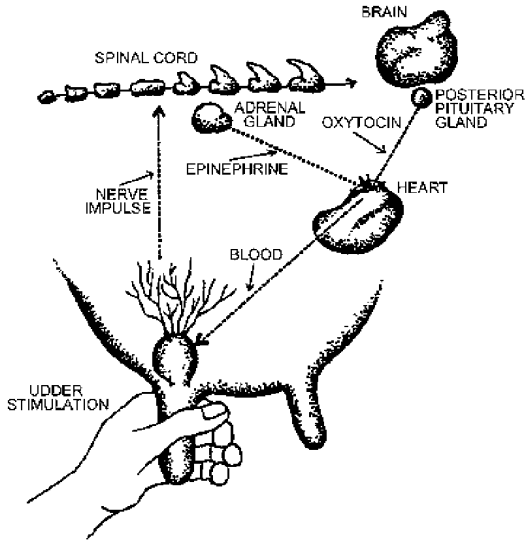

Figure 8.

Hand Milking

The outside pressure on the teat is one atmosphere or 14.6 psi. The act of hand pressure and internal pressure forces open the sphincter muscle and the milk is removed.

Machine Milking

The milking machine usually applies 12.5 to 15 inches Hg (mercury) of vacuum to the outside of the teat. This produces a pressure differential of 12.5 to 15 inches Hg negative vacuum pressure on the outside of the teat compared with the 0.8 psi positive pressure inside the teat. This pressure differential is great enough to open the sphincter muscle and the milk is ejected, even at the end of milking when the internal pressure diminishes.

Since the vacuum applied forces milk out of the teat, it also forces blood and body fluids to the end of the teat. If a constant vacuum is applied to the teat, damage will occur. The pulsator and the double-chambered teat cups are designed to prevent this from happening (see Figure 9). The stress is removed from the inner and middle tissues of the streak canal wall.

The role of the pulsator is to alternate atmosphere air and vacuum between the liner and shell. As already explained, the vacuum causes a pressure differential that removes the milk from the streak canal. When the pulsator admits atmospheric

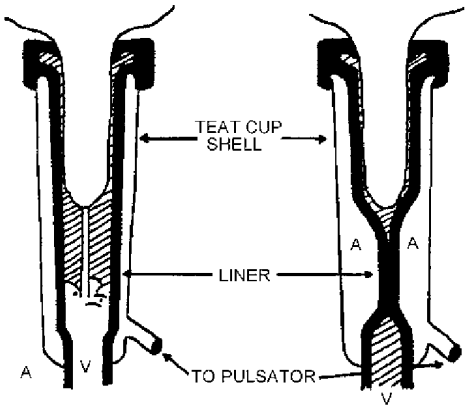

Figure 9.

air between the liner and shell, the liner closes around and below the teat, which in turn flattens the streak canal causing the milk flow to end.

The liner also applies a compressive force to the teat end during its collapsed phase, which relieves the effects of congestion at the teat end.

Table 1.

Table 1. Estimated potential dollar losses caused by mastitis on a 500 cow dairy with high cell count.

	Loss	
	%	$
Subclinical mastitis milk loss	73	213,160.
Clinical mastitis losses, drug cost, dumped milk and labor	22	62,240.
Culling	5	14,600.
Total potential mastitis losses		292,000.