

Clinical and Bacteriological Studies on Gangrenous Mastitis in a Primiparous Dairy Cow

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Introduction

Mastitis is the most common and economically important disease among dairy cows (Dodd *et al.*, 1977²⁾; Natzke 1981⁷⁾. It is well known that severe clinical and fatal mastitis occurs shortly after parturition in high producing cows and is different from the majority of cases of mastitis occurring in mid and late lactational period. Gangrenous mastitis is the most severe form reported in cattle resulting in the animal's death or in complete or partial sloughing of the udder (Schalm *et al.*, 1971⁸⁾.

A case of naturally occurring peracute gangrenous mastitis was observed in a primiparous cow in a dairy farm. It is generally recommended that affected animals showing systemic signs should be sent for slaughter because the prognosis of this type of mastitis is almost poor and the reason has an economical basis. However this cow was of an excellent grade, hence therapy and treatments were made over a long period, for the purpose of reproduction.

The present aim was to examine the clinical, blood biochemical and bacteriological findings of an affected cow during the course of gangrenous mastitis.

Materials and Methods

Case

A three year old primiparous cow was found in sternal recumbency showing clinical signs of severe depression and shivering at 5 days post partum in a dairy farm located in Ebetsu, Hokkaido. The affected quarters (left -front and -rear quarters, right -rear quarter) of the udder became swollen and secreted a watery, serous or serohemorrhagic secretion. Within 4 hours after the onset of mastitis the skin of the teat of left -rear quarter became purple in color and was cold to the touch. No other clinical abnormalities were found and a diagnosis of peracute clinical mastitis was made. Photograph of affected quarter was taken at onset, 3, 7, 14 and 30 days after the onset of mastitis.

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Clinical examination

The animal was examined clinically and rectal temperature, pulse and respiratory rates were noted. The nature of the secretions obtained from the infected quarters and the degree of udder swelling were checked. The clinical parameters and udder condition were noted. The criteria of clinical mastitis was based on typical systemic signs, the nature of the secretions obtained from the infected quarters, the degree of udder swelling, bacteriologic findings and California Mastitis Test (CMT) scores. For routine milk survey, the CMT (P-L tester, Zenyaku Co., Ltd. Tokyo) was performed and CMT scores (1~5) were evaluated.

Blood

Blood samples were obtained at day 1 (10:00, 17:00), 2 and 10 days after the onset of mastitis. Samples were taken into two tubes, one containing ethylene diamine tetraacetic acid for hematological examinations and another plain vacuum tube for blood biochemical analyses. The hematological parameters measured were packed cell volume, erythrocyte count and total and differential leukocyte counts.

Blood biochemical analyses

Serum was analyzed for calcium, phosphorus, magnesium, chloride, sodium, potassium, total protein, albumin/globulin ratio, glucose, blood urea nitrogen (BUN), non-esterified fatty acid (NEFA), glutamic oxaloacetic transaminase (GOT), lactate dehydrogenase (LDH) and creatinine phosphokinase (CPK).

Isolation of bacteria

The first few squirts of milk were discarded and 2 ml samples of quarter fore-milk were collected under aseptic conditions in sterilized plastic tubes. One-tenth ml of the milk was inoculated onto blood agar. After incubation at 37°C for 24 hours, number of colonies grown on blood agar plates was recorded. Identification for bacteria detected was made according to the methods reported by Brown *et al.* (1981)^p. Antibiotic susceptibility was determined by sensitive disk method. Antibacterial drugs used were Penicillin (P), Ampicillin (A), Oxytetracycline (O), Dicloxacillin (Px), Nafcillin (Pnf), Kanamycin (K), Cefazolin (Cez), Gentamycin (Gm) and Cefoperazone (Cpz).

Therapy

For the treatment of mastitis, steroid therapy with hydrocortisone sodium succinate (300 mg) in early stages, antibiotic treatment such as penicillin, streptomycin, teramycin and fluid therapy (such as 5% glucose, 25% xylitol and 7% sodium bicarbonate) were performed. Mastitic quarters were treated by intramammary infusion of a commercially available intramammary infusion product.

Results

Clinical findings of the affected cow during the course of mastitis are shown in Fig. 1. The major clinical features in the initial stage were pyrexia, depression, milk secretion cessation and absence of rumen contractions and also it was noted that the cow was recumbent for 2 days (Fig. 2 A). Respiration was more rapid

and shallow and sometimes shivering was observed. The rectal temperature was elevated at the onset of mastitis but rapidly descended (37.8°C) at day 2 and then it rose reaching 40.5°C after 4 days and the temperature was elevated to 39°C up to 40°C during the observation period. The appetite recovered gradually at day 3.

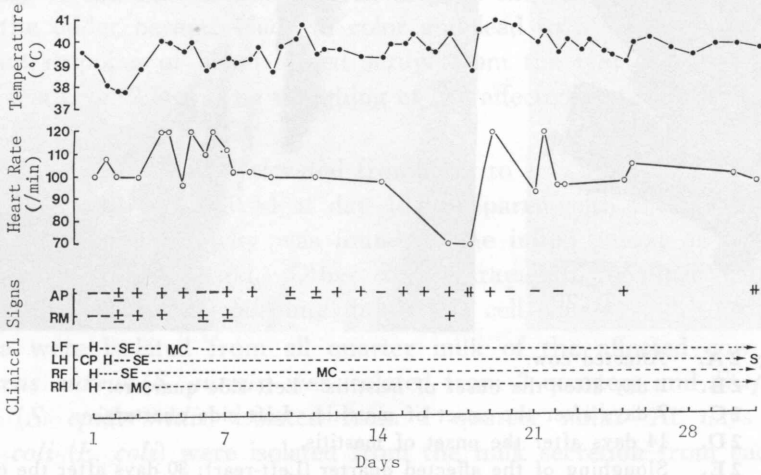
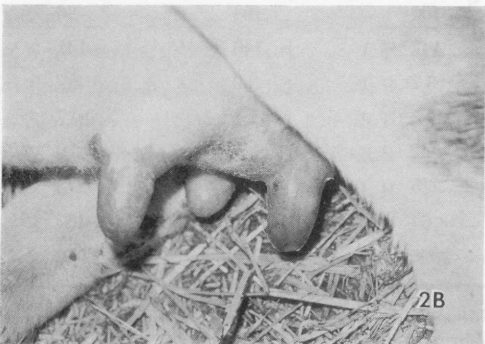
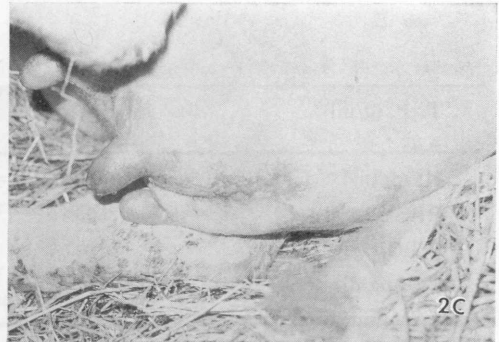


Fig. 1. The clinical findings of affected cow during the course of mastitis. AP: Appetite (-, ±, +, ++), RM: Ruminant motility (-, ±, +), Quarter: LF=Left-front, LR=Left-rear, RF=Right-front, RR=Right-rear, H: Hardening, CP: Purple in color, SE: Serous secretion, MC: Milk ceasing, S: Sloughing.



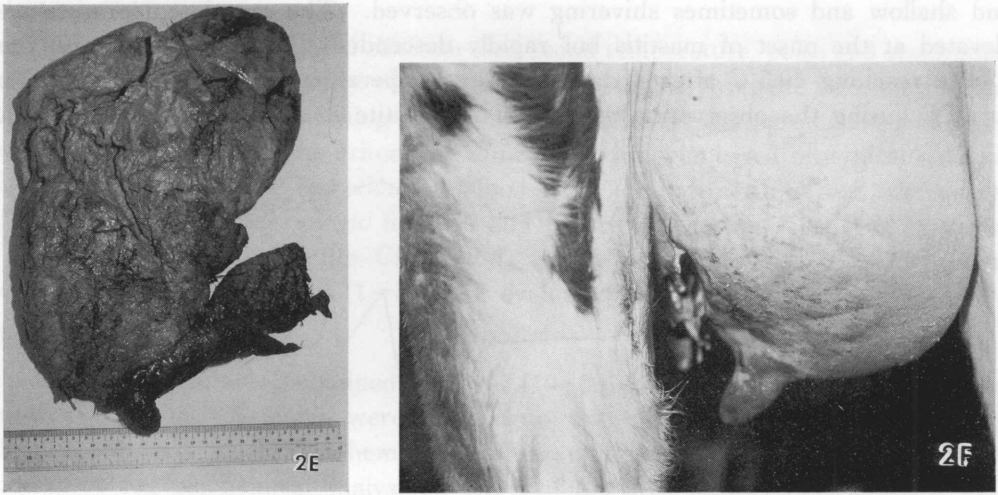


Fig. 2 A. Affected cow.
2 B. 1 day after the onset of mastitis. Left side quarters.
2 C. 7 days after the onset of mastitis. Left side quarters.
2 D. 14 days after the onset of mastitis.
2 E. Sloughing of the affected quarter (Left-rear); 30 days after the onset of mastitis.
2 F. The hind view of mammary gland after sloughing of affected quarter

Table 1. Serum biochemical findings of the affected cow during the course of mastitis

	Day			
	1 (10:00 am)	1 (17:00 pm)	2	10
T. P. (g/ml)	5.80	—	—	—
A/G	0.97	—	—	0.54
Ht (%)	33	31	—	—
RBC ($10^4/\mu\text{l}$)	600	—	—	—
WBC ($/\mu\text{l}$)	5100	—	12700	—
Ca (mg/dl)	8.2	11	10	8.6
I. P. (mg/dl)	4.8	5.5	5.7	4.5
Mg (mg/dl)	2.6	1.9	2.3	1.8
Cl (mEq/L)	99	100	104	96
Na (mEq/L)	141	142	146	141
K (mEq/L)	4.1	3.2	3.0	4.2
BUN (mg/dl)	20.9	19.8	15.1	10.7
Glucose (mg/dl)	53	42	—	70
NEFA ($\mu\text{Eq/L}$)	78	275	71	273
GOT (KU)	77	67	55	57
LDH (WRO)	1955	2095	2210	2555
CPK (IU/L)	74	58	7	12

The affected quarters in the initial stage was acutely swollen and milk secretion ceased (Fig. 2 B). A small quantity of serosanguinous fluid could be stripped from the quarters. At day 3, the skin of the left -rear teat and of the lower portion of the udder became purple in color, cold and moist with serosanguinous fluid (Fig. 2 C). At day 7, the skin of the affected area of the left- rear and of the lower portion of the udder became black in color and lead to a moist gangrenous state with constant dripping of blood tinged serum from the teat and skin around the base of the teat (Fig. 2 D). The sloughing of the affected teat and quarter occurred at day 30. (Fig. 2 E, 2 F).

Serum alpha globulin was elevated from 1.03 to 1.47 g/dl and albumin/globulin ratio decreased from 0.97 to 0.54 at day 10, compared with that of day 1 (Table 1). Higher serum CPK activity was found at the initial period of mastitis, compared to that of the late period. Other blood parameters remained within normal limits with the exception of total and differential cell counts.

Bacteria were isolated from all quarter milk of the affected cow (Table 2). *Staphylococcus aureus* (*S. aureus*) was isolated from 3 quarters and *Staphylococcus epidermidis* (*S. epidermidis*) isolated from 1 quarter milk. At days 5 and 9, *Escherichia coli* (*E. coli*) were isolated from the milk secretion from each quarter.

Table 2. Isolation of bacteria from mastitic milk

Days after onset of mastitis	Quarter			
	LF	LR	RF	RR
1	<i>S. aureus</i>	<i>S. aureus</i>	<i>S. aureus</i>	<i>S. epidermidis</i>
5	—	<i>E. coli</i>	<i>E. coli</i>	<i>E. coli</i>
9	<i>E. coli</i>			
10		<i>E. aerogenes</i>		
32	<i>P. mirabilis</i>			

Quarter: LF=Left front, LR=Left rear, RF=Right front, RR=Right rear. Number of bacteria isolated was more than 250 colony forming units per ml of milk.

Table 3. Antibiotic susceptibility of isolates from mastitic milk during the course of mastitis

Species	Days	Quarter	Antibiotic susceptibility								
			P	A	O	Px	Pnf	K	Cez	Gm	Cpz
<i>S. aureus</i>	1	LF	##	##	+	##	##	*	*	*	*
<i>S. aureus</i>	1	LR	##	##	+	##	##	*	*	*	*
<i>S. aureus</i>	1	RF	—	+	—	##	##	*	*	*	*
<i>S. epidermidis</i>	1	RR	##	##	+	##	##	*	*	*	*
<i>E. coli</i>	5	LR	—	—	—	—	—	+	##	##	##
<i>E. coli</i>	9	LF	—	—	—	—	—	*	*	*	*
<i>P. mirabilis</i>	32	LF	*	##	—	*	*	—	*	*	*

Days: Days after onset of mastitis. Quarter: LF=Left front, LR=Left rear, RF=Right front, RR=Right rear. *: Not determined.

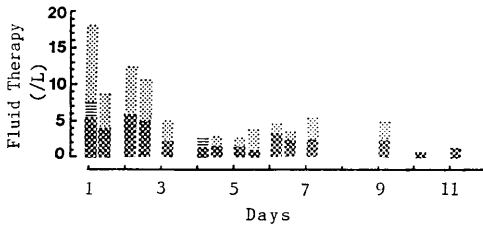






Fig. 3. Fluid therapy for affected cow.

 5% Glucose,  25% Xylitol,
 Linger,  7% Sodium bicarbonate
 and others.

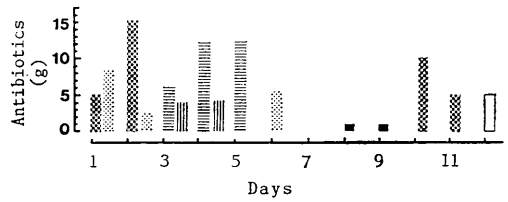








Fig. 4. Antibiotic therapy.

 Teramycin,  Chloromycetin,
 Ampicillin,  Bicillin (Ampicillin),
 Kanamycin,  Amicamycin.

The antibiotic susceptibility of isolates are shown in Table 3. *S. aureus* isolated from quarters (LF, LR and RF) were sensitive to Px and Pnf at day 1, and *E. coli* from quarter LR was sensitive to Cpz, Cez and Gm at day 5.

Discussion

The clinical features in the first 4 hours after signs of mastitis were characterized by elevated temperature, recumbency and the absence of ruminal motility with hard, swollen and painful infected quarters. After 4 hours rectal temperature dropped to 37.7°C and severe depression followed during the first 2 days after the onset. This fever pattern showed that the animal was in a severely depressed physical condition during the initial phases of peracute mastitis. This period appeared to be the shock phase in the animal. Systemic as well as local treatments seem to be very important in the early phase of peracute form. At day 9, the animal showed improvement in systemic signs of illness but the udder secretion remained abnormal. Characteristic biochemical changes were not observed in the serum from the affected cow, except when showing higher CPK activity at the onset of mastitis and increased gamma globulin content in the late period.

Staphylococci, particularly *S. aureus*, are the principal cause of bovine mastitis in many dairy herds. It is well known that the infection during early lactation often results in the appearance of the peracute form, with gangrene of the udder due to the acute necrotizing toxin such as alpha toxin, as reported by Schalm *et al.* (1971)⁹. The toxin produces vasoconstriction leading to ischemia and death of the tissue. There were profound circulatory disturbances in the affected quarter. The causative pathogen was changed from *S. aureus* to *E. coli* at 4 days after the onset of mastitis. The reason for this change is unclear. Sloughing of the affected teat and quarter occurred at one month after the onset of mastitis. The rectal temperature ranged from 37°C to 41°C during the observation period, indicating that secondary infection might have occurred.

Since this cow was an excellent grade, therapy and treatment were made for a longer period, at least for the purpose of reproduction. For the treatment of peracute and acute mastitis showing systemic signs in the early stage, fluid therapy (20~25 L/day) and antibiotics sensitive to isolates are essential. Large doses of

soluble corticosteroids, in this therapy hydrocortisone sodium succinate was used, this appeared to be effective in the initial treatment of early endotoxemic conditions. However the prognosis of this type of mastitis is almost poor. Consequently this cow was shipped for slaughter at approximately 2 months after the onset of mastitis for the reason of general unthriftiness.

The pathogenesis of the hyperacute gangrenous mastitis has not been fully investigated. The outcome of the infection may depend on the rate of growth of the organism within the gland, the elaboration, absorption and activity of toxins and susceptibility of the host (Schalm *et al.*, 1971⁸; Schalm 1974⁹). Among factors contributing to this susceptibility, the role of the leukocyte has received considerable attention (Hill *et al.*, 1979)⁴. One of the factors affecting the pathogenesis of peracute gangrenous and coliform mastitis in the immediate post partum period, the failure of the neutrophil response has been recognized (Nagahata *et al.*, 1988⁵; Kehrli *et al.*, 1989⁶). Hill *et al.* (1979)⁴ showed that in newly calved cows there is a delay in the diapedesis of neutrophils into the secretion compared with animals in mid lactation. Frost and Brooker (1986)³ examined the pathogenesis of hyperacute coliform mastitis in five postparturient cows and reported that in all infected quarters infiltration of neutrophils was negligible, and pointed out that neutrophils might play an important role for eliminating the pathogenic bacteria. The reasons for the failure of the gland to respond to inflammatory stimuli requires further study. The function of neutrophils would appear to be the most potentially important factor for causing this case of mastitis. Special care should be taken to improve methods of husbandry and to check the condition of cows in the postpartum period because the periparturient cow is susceptible to peracute mastitis (Nagahata *et al.*, 1988⁵; Kehrli *et al.*, 1989⁶).

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Summary

The clinical and bacteriological studies on a gangrenous mastitis in a primiparous cow were made for one month after the onset of mastitis. *S. aureus* was isolated from 3 quarters (Left- front, -rear and Right- rear) milk and *S. epidermidis* from 1 quarter (Right- rear) milk at the onset of mastitis as a primary pathogen and then *E. coli* were isolated as a secondary pathogen at 5~9 days later. The clinical features in the initial stage were pyrexia, depression, absence of rumen contractions and milk secretion cessation and it was noted that the cow was recumbent for 2 days. Characteristic biochemical changes were not observed in serum from the affected cow, except showing higher creatinine phosphokinase activity in the early stage and hyper gamma globulinemia in the late stage of mastitis. Sloughing of

the affected teat and quarter (Right- rear) occurred at one month after the onset of mastitis.

Key Words : Gangrenous mastitis, primiparous cow, clinical course

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要 約

初産乳牛（ホルスタイン種）の分娩後5日目に壊疽性乳房炎の発症を認め以後1カ月間にわたり臨床ならびに細菌学的検討を行なった。乳房炎起炎菌は三罹患分房（左前、後および右前分房）から *Staphylococcus aureus* が、また一分房（右後分房）から *Staphylococcus epidermidis* が分離された。発症後5~9日に全分房から *Escherichia coli* が分離された。発症時の主な臨床症状は初期の一過性の発熱、虚脱、第一胃運動停止、泌乳停止であり、発症後2日間は起立不能を呈した。血液生化学的所見として、発症初期のCPK (creatinine phosphokinase) 活性の上昇と発症後10日目の γ -globulinの上昇以外には明らかな変化は認められなかった。発症後1カ月で罹患分房（右後分房）および乳頭の脱落を認めた。