The Epidemiology of *Staphylococcus aureus* Mastitis in Dairy Heifers

Jerry R. Roberson, *DVM, PhD*
Virginia-Maryland Regional College of Veterinary Medicine, Blacksburg, VA

Abstract

The objectives of this study were to: (1) determine the significance of *Staphylococcus aureus* in heifers, (2) determine the sources of *S. aureus* on dairies, and (3) determine the most likely sources of *S. aureus* mastitis in heifers. Heifers from 23 herds were studied during objective 1 and 700 heifers from 7 herds were studied for objectives 2 and 3. The body sites sampled from prepartum heifers were: teat skin, muzzles, vaginas, rectums, and lacteal secretions. Milk samples were obtained from all females at parturition (milk samples were obtained from pastpartum heifers prior to first milking). The environmental sites sampled were: air, bedding, nonbovine animals, dairy personnel, tools, housing, flies, water, feedstuffs, and equipment. A typing procedure was used to determine if the *S. aureus* isolate from a source was the same strain as the *S. aureus* isolate from a heifer's intramammary infection at parturition. The overall conclusions were: (1) *S. aureus* mastitis in heifers can be an important disease in most dairy herds regardless of the lactating herd prevalence of *S. aureus*, (2) measures to eradicate this disease in heifers are likely to fail because *S. aureus* appears to be ubiquitous even in herds with low prevalence of *S. aureus* mastitis, and (3) intramammary antibiotic therapy in prepartum heifers may be a justifiable control measure.

Introduction

Staphylococcus aureus mastitis is probably the most prevalent major mastitis pathogen. *Staphylococcus aureus* is a contagious pathogen that usually causes chronic subclinical mastitis with occasional episodes of clinical mastitis. Implementation of mastitis control procedures, such as milking time hygiene, culling, and antibiotic intramammary therapy during the nonlactating period, has been successful in lowering the prevalence of *S. aureus* mastitis in many herds.[6] Although eradication of *S. aureus* mastitis has been reported,[12] many dairy herds have not been able to eradicate *S. aureus* mastitis from the lactating herd despite adherence to control measures.[6] Failure to eradicate *S. aureus* mastitis may be due to heifers that have *S. aureus* mastitis prior to entering the lactating herd. Although it has been suggested that heifers obtain *S. aureus* via the feeding of mastitic milk and suckling,[7] there is no documented evidence to support this theory. In fact, results from two studies suggest that feeding or not feeding *S. aureus* milk to preweaned heifers made little difference in the prevalence of *S. aureus* mastitis in heifers at first parturition.[2,4] Additionally, the lactating herd prevalence of coagulase-positive staphylococci (CPS) mastitis was not predictive of the CPS mastitis prevalence in heifers at first parturition.[11] If successful control measures for *S. aureus* mastitis in prepartum heifers are to be developed, the epidemiology of this disease must be understood. The objectives of the study were to determine the significance of *S. aureus* mastitis in heifers (objective 1), to determine sources of *S. aureus* on dairies (objective 2), and to determine which *S. aureus* sources are most likely involved in heifer mastitis (objective 3).

Materials and Methods

Because the materials and methods are extensive, only a brief description of each objective is presented. Complete information on materials and methods are available.[9]

Objective 1

Milk samples were aseptically collected by recommended methods[1] from all lactating cows from each of 23 herds at a one time sampling period to establish the prevalence of *S. aureus* mastitis in the lactating herd. Herds with a *S. aureus* prevalence of <6% were considered low prevalence herds (LP) and herds with a *S. aureus* prevalence of >10% were considered high prevalence herds (HP). Milk samples were aseptically collected from heifers after first parturition but before first milking. Significant differences in *S. aureus* mastitis prevalence in heifers at first parturition between herd groups was tested using the Wilcoxon rank test (Statistix 3.1, Analytical Software, St. Paul, MN).

Objective 2

Seven dairy herds were extensively sampled over a 4 year period to identify sources of *S. aureus*. The teat skin, the muzzle area, the vagina, the rectum, and the lacteal secretions (when available) of prepartum heif-

ers were sampled up to 5 times per heifer over an 18 month period. The body site sampling periods began with summer of 1989 and then corresponded to each season thereafter beginning with the winter of 1989-1990 and ending with the fall of 1990. All preweaned heifers were sampled during the first body site sampling period. A proportion of postweaned heifers were also sampled during the first body site sampling period. A proportion of heifers born between sampling period dates were sampled at each subsequent sampling period. Once a heifer was body site sampled, the same heifer would be sampled at each subsequent sampling period until first parturition. Thus, heifers could have been sampled as many as 5 times or as few as once. Environmental sites were sampled during the last 4 body site sampling periods. Environmental sites sampled were: air, bedding, nonbovine animals, dairy personnel, tools, housing, flies, water, feedstuffs, and equipment.

Objective 3

A 63 character "fingerprint" was established for each *S. aureus* isolate collected during objective 1 and 2. Nineteen biochemical (API Staph Trac, Analytab Products, New York City, NY), 32 phage,[8] and 12 antibiogram[3] characters established the "fingerprint". Methods for each fingerprinting method have been described. The "fingerprints" of *S. aureus* isolates collected from mammary secretions of heifers at first parturition were compared to all other *S. aureus* isolate "fingerprints" to identify the most likely sources. *Staphylococcus aureus* isolate "fingerprints" with a similarity coefficient of ≥ 90% were considered the same strain.

Identification of Staphylococcus aureus

Staphylococcus aureus isolates were defined as being tube coagulase positive,[1] identified as *S. aureus* via Staph Trac analysis (API Staph Trac, Analytab Products, New York City, NY), positive on P agar supplemented with acriflavin[5] and negative for the enzyme beta-galactosidase.[10]

Results

The prevalence of *S. aureus* mastitis in heifers at parturition was 6.9%. Twenty-one of 23 herds had at least one heifer freshen with *S. aureus* mastitis. There was no significant difference between the prevalence of *S. aureus* mastitis in heifers from LP herds and HP herds. Heifers with *S. aureus* mastitis at first parturition contribute nearly 1/3 of all new cases of *S. aureus* mastitis in the lactating herd.

Staphylococcus aureus was isolated at least once all sites sampled (Table 1). The most prevalent sites of *S. aureus* isolation were heifer body sites and milk. Thirty-five percent of 700 heifers (3 LP and 4 HP herds) that were body site sampled, had *S. aureus* on a body site at least once. Heifers with *S. aureus* on the teat skin were 3.6 times more likely to have *S. aureus* mastitis at first parturition than heifers not known to be colonized. A few heifers were persistently colonized on the same body site up to 1 year. All herds, regardless of the *S. aureus* mastitis prevalence in the lactating herd, had heifers transiently colonized by *S. aureus* with a range of 19 to 63% among the 7 herds. Heifers < 1 day old were colonized by *S. aureus*.

Table 1. Sites of isolation of *Staphylococcus aureus* from 3 LP[1] and 4 HP[2] dairies.

	LP Herds			HP Herds			All Seven Herds		
Source of *S. aureus*	n[3]	*Sa*[4]	%[5]	n	*Sa*	%	n	*Sa*	%
FH[6] IMI	778	31	4[a]	857	48	5.6[a]	1635	79	4.8
IMI > FH[7]	3014	117	3.9[b]	2046	802	39[a]	5060	919	18
udder skin of heifer[8]	890	47	5.3[b]	1132	122	11[a]	2022	169	8.4
muzzle area of heifer	803	55	6.8[b]	921	101	11[a]	1724	156	9
heifer rectum	414	6	1.4[a]	504	9	1.8[a]	918	15	1.6
heifer vagina	711	5	.7[b]	960	31	3.2[a]	1671	36	2.2
heifer IMI prepartum[9]	118	3	2.5[a]	137	8	5.8[a]	255	11	4.3
bedding	183	0	0[a]	208	4	1.9[a]	391	4	1
insects	468	0	0[b]	601	14	2.3[a]	1069	14	1.3
housing	180	1	.6[a]	199	4	2[a]	379	5	1.3
water	68	0	0[a]	81	3	3.7[a]	149	3	2
feedstuffs	203	1	.5[a]	249	6	2.4[a]	452	7	1.5
dairy workers	16	7	44[a]	21	2	9.5[a]	37	9	27
non-bovine animals	9	1	11[a]	104	5	4.8[a]	113	6	5.3
air	105	3	2.9[a]	144	2	1.4[a]	249	5	2
equipment	178	2	1.1[a]	205	6	2.9[a]	383	8	2.1

[1] LP = herds with < 3% prevalence of *Staphylococcus aureus* mastitis.
[2] HP = herds with > 10% prevalence of *Staphlyococcus aureus* mastitis.
[3] n = number of samples, except when specified below.
[4] *Sa* = number of samples from which *Staphylococcus aureus* was isolated.
[5] Values within rows without common superscripts are different ($P < .05$). Only columns titled LP or HPS Herds were contrasted.
[6] FH IMI = *Staphylococcus aureus* isolated from IMI of heifer at first parturition. n = number of heifers.
[7] *Staphylococcus aureus* isolated from an IMI from any lactating cow, including primiparous cows, other than an IMI of heifers at first parturition.
[8] *Staphylococcus aureus* isolated from the side of the teat, the teat orifice, or the teat canal; n = sum of the number of heifers sampled each period.
[9] *Staphylococcus aureus* isolated from a lacteal secretion of a heifer prior to parturition; n = sum of the number of heifers sampled each period in which lacteal secretions were obtained.

Seventy-five percent of 61 *S. aureus* isolates from heifer mastitis at parturition were the same as preexisting lactating cow mastitis isolates, 39% were the same as heifer body site isolates, and 28% were the same as environmental isolates. Sources were not identified for 23% of *S. aureus* isolates from heifer mastitis at parturition. Percentages do not total 100% because more than one source was identified for some isolates. Sources are identified by herd in Table 2.

Table 2. Sources of *Staphylococcus aureus* mastitis at parturition in heifers by herd.

Herd	Total no. Isolates	Source by Herd: Milk[1]	Milk[2]	Body site[3]	Environment	Unknown[4]
		%	%	%	%	%
A[5]	5	0 (0/5)	0 (0/3)	67 (2/3)	0 (0/3)	60 (3/5)
B	27	70 (19/27)	89 (16/18)	17 (3/18)	11 (2/18)	26 (7/27)
C	30	77 (23/30)	79 (19/24)	29 (7/24)	25 (6/24)	13 (4/30)
D	9	44 (4/9)	33 (1/3)	100 (3/3)	33 (1/3)	33 (3/9)
E	18	78 (14/18)	77 (10/13)	69 (9/13)	62 (8/13)	17 (3/18)
F	1	100 (1/1)	-	-	-	0 (0/1)
G	1	0 (0/1)	-	-	-	100 (1/1)
ALL	91	67 (61/91)	75 (46/61)	39 (24/61)	28 (17/61)	23 (21/91)

[1] Heifer *Staphylococcus aureus* isolate ≥ 90% similar to preexisting milk isolate.

[2] Heifer *Staphylococcus aureus* isolate obtained after the first environmental sampling period that were ≥ 90% similar to preexisting milk isolate.

[3] Heifer *Staphylococcus aureus* isolate obtained after the first environmental sampling period that were ≥ 90% similar to preexisting body site isolate.

[4] Heifer *Staphylococcus aureus* isolates that were not ≥ 90% similar with any preexisting *S. aureus* isolate from any source.

[5] Herds A, B, and G < 3% prevalence of *Staphylococcus aureus* mastitis and herds C, D, E, and F had > 10% prevalence of *Staphylococcus aureus* mastitis.

Conclusions

Staphylococcus aureus mastitis in dairy heifers can be a significant disease in dairy herds regardless of the lactating herd prevalence of *S. aureus* mastitis. *Staphylococcus aureus* is ubiquitous on dairies. The milk from infected quarters as well as heifer body sites appear to be the important sources of *S. aureus* that result in heifer mastitis. Individually penning preweaned heifers and feeding *S. aureus*-free milk is unlikely to control *S. aureus* mastitis in prepartum heifers because other sources are readily available in the indigenous heifer population. It would seem unlikely that any dairy can eradicate *S. aureus*. Thus, intramammary antibiotic therapy in prepartum heifers may be a justifiable control measure in herds in which heifer mastitis is a problem.

References

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