Comparison of Two Management Strategies for Retained Fetal Membranes on Small Dairy Farms in Germany

M. Drillich,¹ N. Klever, and W. Heuwieser

Clinic for Animal Reproduction, Faculty of Veterinary Medicine, Freie Universität Berlin, Königsplatz 65, 14163 Berlin, Germany

ABSTRACT

The objective of this study was to compare 2 strategies for the management of dairy cows having retained fetal membranes (RFM) with regard to clinical traits, milk yield, and reproductive performance. In contrast to recent studies evaluating optimal strategies for the management of cows with RFM, this trial was conducted on small dairy farms with 26 to 166 cows per herd. In the systemic (SYS) group ($n = 116$), cows having RFM and a rectal temperature $\geq 39.5^{\circ}\text{C}$ were treated with 1 mg/kg of body weight of ceftiofur on 3 to 5 consecutive days. The RFM cows without fever remained untreated. In the intrauterine (IUT) group ($n = 115$), all RFM cows received an intrauterine treatment with 6 g of tetracycline on 3 consecutive days combined with an attempt to remove the fetal membranes manually. The IUT cows with a fever received an additional systemic treatment with 10 mg/kg of body weight of amoxicillin on 3 to 5 consecutive days. Body temperature, daily milk yield, prevalence of vaginal discharge 28 to 35 d in milk (DIM), and reproductive performance traits within 200 DIM were monitored. The proportion of cows experiencing fever within 5 d after enrollment was greater in SYS compared with IUT. The proportion of cows with mucopurulent or purulent vaginal discharge 28 to 34 DIM did not differ between the groups. Furthermore, no significant differences between groups were found in daily milk yield in the first 10 d after enrollment, or in reproductive performance or proportion of cows culled. Significant differences in the proportion of cows with a fever in SYS and IUT have not been reported in studies with similar study designs conducted on large dairy farms. Further results on milk yield and reproductive performance, however, support findings that a management strategy for RFM based on a selective systemic treatment of feverish cows is at least as efficacious as a strategy based on intrauterine treat-

ments of all cows and a systemic antibiotic treatment of feverish cows.

Key words: retained fetal membrane, treatment strategy, reproductive performance

INTRODUCTION

The retention of the fetal membranes (RFM) in dairy cows is defined as the failure to expel fetal membranes by 12 to 24 h after calving (Fourichon et al., 2000). Retained fetal membranes are often associated with metritis (Correa et al., 1993; Eiler, 1997; Drillich et al., 2003), which has been identified as the main reason for reduced fertility of cows having RFM (Laven and Peters, 1996; Grohn and Rajala-Schultz, 2000). Puerperal metritis is characterized by fetid, watery, and reddish-brown to purulent vulvar discharge and an elevated body temperature $\geq 39.5^{\circ}\text{C}$ (Sheldon et al., 2006).

The treatment of RFM in dairy cattle has been a subject of controversy for several years. A common treatment of RFM in veterinary practices in Europe is the manual removal of the placenta and a local antibiotic therapy (Laven, 1995; Laven and Peters, 1996). Some studies, however, have shown that intrauterine manipulations decrease uterine defense mechanisms (Peters and Laven, 1996), impair subsequent fertility (Bolinder et al., 1988), or do not have positive effects on fertility (Drillich et al., 2006b). A recent study has evaluated the intrauterine antibiotic treatment with 5 g of chlortetracycline administered twice weekly for 2 wk in cows with clinical metritis and RFM. A total of 134 primiparous and multiparous cows with RFM were compared with 125 untreated RFM cows and with 1,456 non-RFM cows. Treatment had no effect on first-service conception rate in treated and untreated RFM cows. Compared with non-RFM cows, however, conception rate was less in untreated RFM cows, but not in treated cows. Other reproductive performance traits did not differ between the 3 groups. Milk yield was less in RFM cows than in non-RFM cows (Goshen and Shpigel, 2006).

Elevated body temperature related to uterine infection was a criterion for the administration of systemic antibiotics in numerous studies on RFM (Stevens et al.,

Received February 21, 2007.

Accepted May 25, 2007.

¹Corresponding author: author@bestandsbetreuung.de

1995; Drillich et al., 2003, 2006b,c; Overton et al., 2003; Risco and Hernandez, 2003). Because of the potentially life-threatening character of acute metritis (Eiler, 1997) and its negative effect on reproductive performance (Goshen and Shpigel, 2006), it is a questionable practice to leave feverish RFM cows untreated. In cows with RFM, treatment strategies without local therapy but with a systemic administration of ceftiofur only in case of fever have recently been described (Drillich et al., 2003, 2006b,c; Risco and Hernandez, 2003). In Europe, ceftiofur is approved for treatment of acute postpartum metritis at a dosage of 1 mg/kg of BW, whereas in the United States it is approved at a dosage of 2.2 mg/kg of BW. After the administration of 1 mg/kg of BW of ceftiofur in cows with RFM, mean concentrations of ceftiofur derivatives in serum and uterine tissues exceeded minimum inhibitory concentrations (MIC_{90}) for common uterine pathogens (Drillich et al., 2006a).

In a field trial including 501 RFM cows, Drillich et al. (2006b) did not find benefits in the manual removal of the placenta or a local antibiotic treatment or a combination of both, compared with a selective systemic application of 1 mg/kg of BW of ceftiofur solely in case of fever. Risco and Hernandez (2003) demonstrated that the administration of 2.2 mg/kg of ceftiofur to 31 RFM cows for 5 d after calving reduced the risk for metritis compared with 33 untreated RFM cows. In a study with 113 RFM cows, however, the preventive treatment of all cows with 1 mg/kg of ceftiofur regardless of body temperature did not show benefits concerning the prevalence of metritis and reproductive performance within 200 DIM compared with a selective treatment only of feverish cows (Drillich et al., 2006c).

Recent studies on the efficacy of a systemic antibiotic treatment of RFM, however, were conducted on large dairy farms. The study by Risco and Hernandez (2003) was conducted on a 1,200-cow dairy operation. Herd sizes in studies from our working group ranged between 650 and 1,570 cows (Drillich et al., 2003, 2005, 2006b,c). One hypothesis for this study was that small, family-owned dairy farms differ from large dairy farms in some aspects, such as in hygiene at calving and infectious pressure. Thus, results obtained from studies conducted on large dairy operations might not be transferable to small farms. The objective of our study was to compare 2 strategies for the management of RFM on small dairy farms in Germany based on a selective systemic antibiotic treatment or on intrauterine treatments; that is, local antibiotics and manual removal of the placenta and in case of fever, on a systemic therapy. With regard to its economic impact to the farmer, using the occurrence of fever as the basis for a systemic antibiotic treatment, reproductive performance and milk yield were chosen as outcomes of interest.

MATERIALS AND METHODS

The study was conducted on 28 commercial, family-owned dairy farms in northern Germany from September 2003 to December 2005. All participating farmers and veterinarians were informed about relevant characteristics of the study and agreed with the study design (informed consent). Average herd size was 65 Holstein cows, with a range from 26 to 166. All cows were kept on pasture from spring to late summer. For the remainder of the year, cows were housed in free-stall barns with slotted concrete floors and cubicles (22 farms) and in tie-stall barns (6 farms). Herd-average milk yield was between 6,100 and 9,500 kg per lactation. Lactating cows were milked twice daily. The voluntary waiting period varied between the herds from 42 to 80 DIM. In all herds, cows were inseminated on observed estrus. No timed breeding protocols (e.g., Ovsynch) were used. At the beginning of the study, median days to first insemination and days open in the participating herds were 105 d (interquartile range 77 to 160) and 128 d (interquartile range 85 to 163), respectively. Services per conception ranged between 1.4 and 2.7 (median 1.8).

Primiparous and multiparous cows that failed to expel the placenta for >2 h after calving were included in the study. The maximum day postpartum on which a cow could be enrolled was d 5. After RFM was diagnosed, cows were assigned to 1 of 2 groups in an alternating order on each farm; that is, every other cow identified with RFM received the same treatment on each farm. Cows that had a caesarean section or fetotomy and cows that were not supposed to be inseminated were not included in the study. All cows that received antiinflammatory or systemic antibiotic drugs within 10 DIM for purposes not related to the study (e.g., acute mastitis) were excluded from the trial. Daily milk yield, recorded automatically in the milking parlor, was documented for all cows from the day of enrollment to d 10 after enrollment.

Within the first 5 d after enrollment, rectal temperature was measured daily in all cows. In cows with a fever ($\geq 39.5^{\circ}\text{C}$), temperature was measured for at least 2 d after the end of a systemic antibiotic treatment. In the systemic (SYS) group ($n = 116$), all cows with a temperature $\geq 39.5^{\circ}\text{C}$ received a systemic antibiotic treatment consisting of 1 mg/kg of BW of ceftiofur (Excenel RTU, Pfizer Animal Health, Karlsruhe, Germany) for 3 consecutive days, applied subcutaneously. Cows with a fever for more than 3 d received ceftiofur (1 mg/kg) for another 2 d. In case of fever after 5 d of treatment with ceftiofur, cows received an escape therapy chosen by the local veterinarian. Cows without fever in SYS did not receive an antibiotic treatment. No attempt was made to remove the fetal membranes and no intrauter-

ine antibiotic pills were administered. Parts of the placenta extending out of the vagina were cut with a clean knife. In the intrauterine (IUT) group ($n = 115$), all cows received an intrauterine treatment with 3 antibiotic pills with 2 g of tetracycline per pill (Tetracyclin Uterusstab, Medistar Arzneimittelvetrieb, Holzwickede, Germany) for 3 consecutive days, beginning on the day of enrollment. In addition, an attempt was made to remove the fetal membranes manually. After cleaning the vulva using a dry paper towel, a clean, lubricated gloved arm was inserted through the vulva into the uterus. The removal of the fetal membranes was performed by separating cotyledons carefully from caruncles with the gloved hand and pulling on portions of the membranes present within the vagina. If the placenta was not removed successfully within 10 min, the attempt was repeated on the next 2 d. In case of temperature $>39.5^{\circ}\text{C}$, cows received 10 mg/kg of BW of amoxicillin (Veyxyl LA 20%, Veyx Pharma, Schwaenzenborn, Germany) for 3 consecutive days, applied intramuscularly. Cows with a fever for more than 3 d received 10 mg of amoxicillin/kg of BW for another 2 d. In case of fever after 5 d of treatment with amoxicillin, cows received an escape therapy chosen by the local veterinarian. The escape therapy in SYS and IUT cows was the same for all cows within a site.

In SYS and IUT, cows were examined by external inspection and rectal palpation between 28 and 34 DIM for the presence of mucopurulent or purulent vaginal discharge. All cows were treated with 0.5 mg of cloprostenol intramuscularly (PGF Veyx Forte, Veyx Pharma) after the examination 28 to 34 DIM and again between 42 and 48 DIM.

Decisions on eligibility of cows for enrollment, treatments, and postpartum examinations were made by research personnel. Rectal temperature was taken by the herdsmen. All diagnoses, treatments, and reproductive performance data within 200 DIM were documented on case report forms for each cow. These forms were monitored by research personnel regularly. The case report forms remained on farm to assure that all cows received the correct treatments on subsequent days. At the end of the study, case report forms were checked for compliance. Cows with incomplete treatments were retrospectively withdrawn from the study.

Reproductive performance was characterized by days to first AI, first-AI conception rate (number of cows pregnant after first AI divided by number of cows inseminated $\times 100$), first-AI pregnancy rate (number of cows pregnant after first AI divided by number of cows enrolled $\times 100$), services per conception, days to pregnancy, pregnancy rate (number of cows documented to be pregnant at 200 DIM divided by number of cows enrolled $\times 100$), days to culling, and proportion of cows

culled. Cows not pregnant by 200 DIM were classified as not pregnant, even if they remained in the herd and conceived later in lactation.

Statistical Analyses

Data were analyzed using SPSS for Windows (Version 12.0, SPSS Inc., Munich, Germany). Binary logistic regression models were calculated for the risk of fever within 5 d after enrollment and for the risk of conception after first AI as outcome variables. Survival analyses for the hazards of insemination and pregnancy within 200 DIM, respectively, were performed using Cox regression, censoring cows that were not inseminated and not pregnant, respectively. Logistic regression model for the risk of fever included treatment (0 = SYS, 1 = IUT), parity class (0 = primiparous, 1 = multiparous), and herd as covariates. For logistic regression model for the risk of conception after first AI as well as for survival analyses, treatment, parity, fever (0 = no, 1 = yes), vaginal discharge 28 to 34 DIM (0 = no, 1 = yes), and herd were included as covariates. Adjusted odds ratios, hazard ratios, confidence intervals, and P -values are reported. The proportion of cows with vaginal discharge 24 to 34 DIM was compared by χ^2 analysis. Milk yield in the first 10 d after enrollment was compared in a GLM for repeated measurements with treatment (0 = SYS, 1 = IUT), fever (0 = no, 1 = yes), parity (0 = primiparous, 1 = multiparous), and herd as fixed factors. Only cows with complete milk data sets were included in the analysis.

For logistic regression as well as for survival analyses, confidence interval was set at 95%. For all statistical analyses, level of significance was set at $\alpha = 0.05$.

RESULTS

A total of 243 RFM cows were initially enrolled in the study. Twelve cows (4.9%, 6 SYS, 6 IUT) were not treated according to the study protocol or were treated with antibiotics for other than study purposes, or the data were not documented consistently; those cows were withdrawn from the study. Thus, 231 RFM cows (116 SYS, 115 IUT) were eligible for the final analyses, with a range from 2 to 16 cows per herd. Mean days from calving to enrollment were 1.5 and 1.4 d in SYS and IUT, respectively.

In 54.3 and 52.2% of SYS and IUT cows, respectively, calvings were assisted by the owners. Of those calvings, 7 and 8 cases in SYS and IUT groups, respectively, were reported as dystocia; that is, requiring tractive force with a mechanical calf puller or extensive corrections of malpositions. The proportion of primiparous cows was 12.1 and 13.0% in SYS and IUT groups, respectively.

Table 1. Descriptive clinical traits identified after enrollment and 28 to 34 DIM in cows having retained fetal membranes

Trait	Treatment ¹	
	SYS	IUT
Cows, n	116	115
Cows with fever within 5 d after enrollment, % (n)	76.7 (89/116)	19.1 (22/115)
Cows with fever after 3 systemic treatments, % (n)	10.1 (9/89)	0.0 (0/22)
Cows with fever after 5 systemic treatments, % (n)	2.3 (2/89)	0.0 (0/22)
Systemic antibiotic treatments	302	66
Local antibiotic treatments	0	344
Daily milk yield at the day of enrollment, kg	16.5 ± 0.7	16.6 ± 0.7
Daily milk yield 10 d after enrollment, kg	31.1 ± 0.7	31.7 ± 0.7
Cows with vaginal discharge 28 to 34 DIM, % (n)	33.3	39.1

¹Treatment: SYS = no treatment unless cows developed fever during the 5 d following enrollment. If fever was detected, cows were administered 1 mg of ceftiofur/kg once daily subcutaneously for 3 d and if fever persisted, treatment was continued for 2 more days. IUT = intrauterine administration 6 g of tetracycline for 3 d plus manual removal of retained fetal membranes. If fever was detected, cows were administered 10 mg/kg of amoxicillin once daily subcutaneously for 3 d and if fever persisted, systemic treatment was continued for 2 more days.

Clinical traits are presented in Table 1. Logistic regression revealed that cows in SYS were at higher risk for fever within 5 d after enrollment than cows in IUT ($P < 0.05$). Within the first 10 d after enrollment, 302 antibiotic treatments were administered in SYS and 410 in IUT (344 local and 66 systemic treatments). Six cows were removed from the herds before the end of the observation period (5 SYS, 1 IUT). Average daily milk yield was not affected by treatment or fever ($P > 0.05$), but was affected by parity ($P < 0.01$) and herd ($P = 0.01$, Table 2). No differences were found in the proportion of cows with mucopurulent or purulent vaginal discharge between 28 and 34 DIM ($P > 0.05$).

Descriptive reproductive performance results are given in Table 3. Results of the logistic regression model showed that the risk of conception after first AI was not affected by any of the tested covariates (Table 4). Survival analyses revealed that the hazard for first insemination within 200 DIM was less in cows with vaginal discharge between 28 and 34 DIM ($P < 0.05$) and was affected by herd ($P < 0.05$). The hazard for pregnancy was affected by herd ($P < 0.05$), but not by other covariates (Table 5).

DISCUSSION

The objective of this study was to compare 2 strategies for the management of RFM based on either selective systemic antibiotic treatment only in case of fever (rectal temperature $\geq 39.5^{\circ}\text{C}$) or intrauterine treatments at the detection of RFM with additional systemic therapy in case of fever on small dairy farms in Germany. A secondary objective was to compare the results obtained from this study conducted on small farms with the results reported for other field trials previously conducted on large farms.

The occurrence of fever was chosen as an objective and comparable criterion for the initiation of a systemic antibiotic treatment. Elevated body temperature in cows with RFM can be regarded as one sign for acute or puerperal metritis. Metritis without systemic signs of illness but with abnormal vaginal discharge can be defined as clinical metritis (Sheldon et al., 2006). The quality of vaginal discharge was not assessed in this trial. The occurrence of metritis as defined in literature, therefore, cannot be evaluated in the present study. The proportion of cows with a fever was less in IUT compared with SYS. It remains unclear if the antibiotic treatment, the manual removal of the placenta, or the combination of both interventions resulted in a lower proportion of cows with a fever. Drillich et al. (2006b)

Table 2. General linear model with repeated measurements for daily milk yield within 10 d after enrollment in cows with retained fetal membranes

Factor	Daily milk yield within 10 d after enrollment			
	df	Square means	F	P-value
Treatment ¹	1	90.8	0.29	0.59
Fever ²	1	680.2	2.14	0.15
Parity ³	1	10,146.0	31.85	<0.01
Herd	28	746.7	2.34	<0.01
Constant	1	276,612.0	868.31	<0.01

¹Treatment: SYS = no treatment unless cows developed fever during the 5 d following enrollment. If fever was detected, cows were administered 1 mg of ceftiofur/kg once daily subcutaneously for 3 d and if fever persisted, treatment was continued for 2 more days. IUT = intrauterine administration 6 g of tetracycline for 3 d plus manual removal of retained fetal membranes. If fever was detected, cows were administered 10 mg/kg of amoxicillin once daily subcutaneously for 3 d and if fever persisted, systemic treatment was continued for 2 more days.

²Fever: 0 = $<39.5^{\circ}\text{C}$; 1 = $\geq 39.5^{\circ}\text{C}$.

³Parity: 0 = multiparous; 1 = primiparous.

Table 3. Descriptive statistics of reproductive performance during 200 DIM for cows having retained fetal membranes

Trait	Treatment ¹	
	SYS	IUT
Cows, n	116	115
Cows inseminated, % (95% CI) ²	73.3 (64.8–80.9)	70.4 (61.7–78.3)
Days to first AI (median, interquartile range)	88.0 (69.5–128.5)	92.0 (64.5–121.0)
First-AI conception rate, % (95% CI)	49.4 (38.2–59.5)	54.3 (42.9–64.6)
First-AI pregnancy rate, % (95% CI)	36.2 (27.0–44.5)	38.3 (28.9–46.7)
Services per conception	1.96	1.92
Days to pregnancy (median, interquartile range)	118.0 (77.0–143.0)	109.0 (83.0–140.0)
Pregnancy rate, % (95% CI)	59.5 (50.1–68.0)	56.5 (47.0–65.1)
Days to culling (median, interquartile range)	40.5 (4.0–91.5)	99.0 (21.5–130.0)
Cows culled, % (95% CI)	15.5 (8.5–21.7)	14.8 (7.9–20.8)

¹Treatment: SYS = no treatment unless cows developed fever during the 5 d following enrollment. If fever was detected cows were administered 1 mg of ceftiofur/kg once daily subcutaneously for 3 d and if fever persisted, treatment was continued for 2 more days. IUT = intrauterine administration 6 g of tetracycline for 3 d plus manual removal of retained fetal membranes. If fever was detected, cows were administered 10 mg/kg of amoxicillin once daily subcutaneously for 3 d and if fever persisted, systemic treatment was continued for 2 more days.

²CI = confidence interval.

demonstrated that the preventive use of intrauterine antibiotics reduced the proportion of cows experiencing fever within 10 DIM compared with RFM cows that received no local antibiotic treatment. Compared with studies conducted by our group on large dairy farms (Drillich et al., 2003, 2005, 2006b) reporting that 61.5 to 97.1% of RFM cows had fever after local treatment (antibiotic pills, manual removal, or both), the proportion of cows with fever in IUT was remarkably low (19.1%). Stevens et al. (1995) reported that 14% of RFM cows treated initially with 5 g of oxytetracycline intra-

uterinely had rectal temperatures that exceeded 39.5°C during the postpartum period, whereas 26% of untreated cows had a fever. In contrast to studies previously conducted by our group, in the present trial, rectal temperature was measured only for 5 d, not for 10 d. This study design was based on the findings that fever usually occurs within 5 DIM (Kristula et al., 2001; Drillich et al., 2003, 2006b). The results of the present study could support the hypothesis that infectious pressure might be lower on small farms compared with large farms, resulting in an improved efficacy of the local

Table 4. Results of logistic regression analyses for the risk of fever within 5 d after enrollment and the risk of conception after first AI in cows with retained fetal membranes

Factor	df	Fever within 5 d after enrollment			Conception after first AI ¹		
		OR ²	95% CI ³	P-value	OR	95% CI	P-value
Treatment ⁴	1	0.04	0.02–0.09	<0.01	1.63	0.71–3.75	0.25
Fever ⁵	1	—	—	—	1.59	0.66–3.79	0.30
Vaginal discharge ⁶	1	—	—	—	0.80	0.36–1.81	0.60
Parity ⁷	1	1.71	0.56–5.29	0.35	1.02	0.39–2.71	0.96
Herd	28	—	—	0.82	—	—	0.99
Constant	1	78.40	—	<0.01	0.17	—	0.30

¹No. of cows that conceived after first AI.

²OR = odds ratio.

³CI = confidence interval.

⁴Treatment: SYS = no treatment unless cows developed fever during the 5 d following enrollment. If fever was detected, cows were administered 1 mg of ceftiofur/kg once daily subcutaneously for 3 d and if fever persisted, treatment was continued for 2 more days. IUT = intrauterine administration 6 g of tetracycline for 3 d plus manual removal of retained fetal membranes. If fever was detected, cows were administered 10 mg/kg of amoxicillin once daily subcutaneously for 3 d and if fever persisted, systemic treatment was continued for 2 more days.

⁵Fever: 0 = <39.5°C; 1 = ≥39.5°C.

⁶Endometritis: 0 = no vaginal discharge 28 to 34 DIM; 1 = mucopurulent or purulent vaginal discharge 28 to 34 DIM.

⁷Parity: 0 = multiparous; 1 = primiparous.

Table 5. Results of the survival analyses (Cox regression) for the hazard of insemination and pregnancy within 200 DIM in cows with retained fetal membranes

Factor	df	Insemination			Pregnancy		
		HR ¹	95% CI ²	P-value	HR	95% CI	P-value
Treatment ³	1	0.81	0.53–1.24	0.34	1.00	0.65–1.54	0.97
Fever ⁴	1	0.76	0.49–1.19	0.23	1.09	0.68–1.74	0.72
Vaginal discharge ⁵	1	0.69	0.48–0.98	0.04	0.79	0.54–1.17	0.24
Parity ⁶	1	1.21	0.74–1.97	0.45	1.44	0.85–2.46	0.18
Herd	28	—	—	0.01	—	—	0.01

¹HR = hazard ratio.²CI = confidence interval.

³Treatment: SYS = no treatment unless cows developed fever during the 5 d following enrollment. If fever was detected cows were administered 1 mg of ceftiofur/kg once daily subcutaneously for 3 d and if fever persisted, treatment was continued for 2 more days. IUT = intrauterine administration 6 g of tetracycline for 3 d plus manual removal of retained fetal membranes. If fever was detected, cows were administered 10 mg/kg of amoxicillin once daily subcutaneously for 3 d and if fever persisted, systemic treatment was continued for 2 more days.

⁴Fever: 0 = <39.5°C; 1 = ≥39.5°C.

⁵Endometritis: 0 = no vaginal discharge 28 to 34 DIM; 1 = mucopurulent or purulent vaginal discharge 28 to 34 DIM.

⁶Parity: 0 = multiparous; 1 = primiparous.

antibiotic treatment with regard to the occurrence of fever. This hypothesis should be verified in future studies by bacteriological examination of the genital tract and of the cows' environment. In SYS, the proportion of cows with a fever before any antibiotic intervention was comparable to previous reports. In similarly designed studies on large dairy farms, we found 69.8 to 94.3% of previously untreated RFM cows experienced fever within 10 DIM (Drillich et al., 2003, 2005, 2006b,c). In a retrospective study, the prevalence of fever >(9.2°C) in RFM cows was 93% (Kristula et al., 2001). Risco and Hernandez (2003) found 42% of untreated RFM cows with fever and fetid discharge.

After 3 d of systemic antibiotic treatment, 10.1% of cows experiencing fever in SYS had an elevated temperature and were treated for another 2 d. In IUT, all cows were free of fever after 3 systemic treatments (and 3 intrauterine treatments). The study design does not allow evaluation of the efficacy of the antibiotics used in this trial; only the relative responses to the 2 strategies can be compared. Elevated rectal temperature, as an objective and measurable parameter, has been used as a criterion for administration of systemic antibiotics and as one outcome variable for the evaluation of treatment protocols in numerous studies on acute, toxic metritis, and RFM (Stevens et al., 1995; Dinsmore et al., 1996; Smith et al., 1998; Drillich et al., 2001, 2003; Zhou et al., 2001; Risco and Hernandez, 2003; Chenault et al., 2004). Fever, however, is only one sign for acute metritis. When fever is used as a single parameter it is not diagnostic for metritis. Vaginal discharge in the early postpartum period as an additional sign for acute

metritis was not evaluated or recorded in the present study.

Mucopurulent and purulent vaginal discharge at the end of the postpartum period can be regarded as a sign for chronic inflammation of the genital tract. The term endometritis is not used because it has been demonstrated and generally accepted that diagnosis of chronic endometritis >26 DIM without vaginal examination is not sufficient (LeBlanc et al., 2002; Sheldon et al., 2006). Vaginal inspection, however, was not a standard procedure on the farms and was not conducted in the present study. The proportion of cows with vaginal discharge between 28 and 34 DIM did not differ between SYS and IUT. Thus, positive effects of intrauterine treatments on the occurrence of fever early postpartum did not result in long-term effects on prevalence of chronic inflammation of the genital tract.

Treatment had no effect on any of the tested reproductive performance traits. This is in accordance with studies that compared similar treatment strategies (Drillich et al., 2003, 2006b). All cows enrolled in the study received PGF_{2α} during the voluntary waiting period. This treatment may have influenced reproductive performance (LeBlanc et al., 2002). The effect of PGF_{2α}, however, would be equal for both groups. It is important to note that with the total number of cows enrolled, there is a possibility of declaring no significant differences between the groups when in fact a difference exists; that is, a Type II error. A large variation in days to first AI can be explained by different voluntary waiting periods in the herds. With respect to median days to culling, it has to be noted in Germany that the with-

drawal period on meat is 8 d for cows treated with 1 mg/kg of BW of ceftiofur, and 28 and 50 d for cows treated with 6 g/cow of tetracycline and 10 mg/kg of BW of amoxicillin, respectively. These longer withdrawal periods in the IUT group could have influenced the culling decision in early lactation. Thus, days to culling should not be overinterpreted. Milk yield, as one focus of interest for dairy farmers, was not affected by treatment strategy. These results support our previous findings that local, intrauterine interventions have no additional beneficial effects compared with a selective systemic treatment strategy. Although a selective systemic treatment is not superior to a local treatment, the total amount of antibiotics used in food-producing animals can be reduced (Drillich et al., 2006b). With less antibiotic administered there is less chance of antibiotic resistance emergence that could result in ineffective treatments. Although the impact of antibiotic use in food-producing animals on antibiotic resistance in human medicine is controversial, veterinarians are obliged to use antibiotic drugs prudently. Without a significant positive effect on health, productivity, or both, the preventive use of antimicrobial agents cannot be justified.

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