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Short Communication

Association of the occurrence of some diseases with reproductive performance and milk production of dairy herds in southern Brazil

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ABSTRACT - This study analyzed associations between the occurrence of mastitis, metritis and retained placenta with the reproductive performance and milk production of four Holstein dairy herds of southern Brazil. Calving-to-conception intervals (CCI) and daily milk production were compared across herds, number of artificial inseminations and clinical occurrences and occurrence of mastitis, metritis and retained placenta. The CCI of cows with three or more clinical occurrences was longer than for those with no occurrences, but shorter for cows with retained placenta than for those without it. Cows with clinical mastitis up to 60 days post-partum had shorter CCI than those with mastitis after 60 days. Cows with retained placenta also had higher frequency of metritis. The daily milk production was higher for cows with three or more clinical occurrences than for those with one or none and for those without retained placenta than for those with retained placenta. A high number of clinical occurrences was related to prolonged CCI and increased daily milk production.

Key Words: dairy, mastitis, production, retained placenta

Introduction

Reproductive efficiency is critical for dairy herds because suboptimal fertility is related to reduction in milk production and in reproductive efficiency (Maizon et al., 2004). Calving and calving-to-conception intervals are commonly used as indicators of reproductive efficiency. Calving intervals of 365 days would be ideal, resulting in one calving per cow per year, but intervals of 13-13.5 months are considered acceptable (Weaver, 1992). Likewise, a calving-to-conception interval (CCI) of 50 days is desirable, but longer intervals (e.g., 110 days) may be accepted as more realistic (Weaver, 1992), considering conditions that commonly affect highly productive cows, such as post-partum infections, negative energy balance and prolonged lactations.

Although milk production has drastically increased since 1990 due to improvements in nutrition, management and genetics (Washburn et al., 2002), both calving and CCI have been prolonged (Rajala-Schultz & Frazer, 2003). That may be attributed to the occurrence of negative energy balance during the post-partum period, which has negative effects on the resumption of ovarian cyclicity (Reist et al., 2003). Thus, milk production and reproductive efficiency are negatively associated (Abdallah & McDaniel, 2000), indicating that genetic improvement prioritized milk production instead of fertility traits (Dobson et al., 2007).

Diseases, such as mastitis, metritis and retained placenta may influence negatively the reproductive performance in dairy herds and may also impair milk production (Rajala-Schultz & Gröhn, 1998; Huszenicza et al., 2005). In Brazil, few studies have investigated such associations, which may reflect the lack of efficient databases and the use of improper statistical tools (Gröhn & Rajala-Schultz, 2000). The objective of the present study was to evaluate the association of the occurrence of common diseases, such as mastitis, metritis and retained placenta, with reproductive performance and milk production in dairy herds.

Material and Methods

The four evaluated Holstein dairy herds were managed by the same veterinary consulting system. Two herds were at Castro (latitude: 24°47'24.40"S; longitude: 50°0'15.01"W) and the other two were at Carambeí (latitude: 24°55'60.00"S; longitude: 50°4'60.00"W), in Paraná, Brazil. All cows were in a free-stall system, milked twice daily (every 12 h), and fed three times daily, with corn and/or sorghum silage and a

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balanced diet (NRC, 2003). All cows were vaccinated against brucellosis, IBR, BVD, leptospirosis, clostridiosis, anthrax, foot-and-mouth disease and mastitis. Routine mastitis control included disinfection, pre and post-milking teat dipping and strip cup test, at milking, and somatic cells count monthly. The voluntary waiting period was 60 days.

During the postpartum period, cows were examined by ultrasound at two-week intervals. The cows presenting corpora lutea received 25 mg of a Prostaglandin F2α (PF2α) analogue (Lutalyse®, Pfizer Animal Health, São Paulo-SP), whereas those presenting dominant follicles received 0.25 mg of a GnRH analogue (Fertagyl®, Intervet do Brasil, São Paulo-SP). All cows presenting estrous within 50-90 days were inseminated, whereas those which did not present estrus were bred after estrous synchronization using an intravaginal device with 1.9 g of progesterone (CIDR®, Pfizer Animal Health, São Paulo-SP) along with 2 mg of Estradiol Benzoate (Estrogin®, Farmavet, São Paulo-SP). After 7 days, the cows received 25 mg of a PF2α analogue (Lutalyse®, Pfizer Animal Health, São Paulo-SP). The device was removed after 9 days and, 1 day later, the cows received 0.5 mg of Estradiol Cypionate (ECP®, Pfizer Animal Health, São Paulo-SP), for ovulation synchronization, so artificial insemination (AI) was done 56-72 h after removal of the device. Pregnancy diagnosis was done 25 days after the AI by ultrasonography with a linear probe. Cows diagnosed as not pregnant were submitted to a new estrous synchronization protocol, using analogue of either PF2α or GnRH, as described above.

Individual records were extracted from a database (Prodap®, 2006) for cows that calved from September, 2004 to September, 2006: 175 from Herd 1; 218 from Herd 2; 256 from Herd 3; and 164 from Herd 4. The CCI was calculated by the difference between the dates of the last calving and the last AI, for cows with positive pregnancy diagnosis. Daily milk production (DMP) per cow was calculated from monthly milking data for 661 cows, based on the mean values recorded from October, 2005 to September, 2006. Then, the highest values observed in the 2nd, 3rd or 4th collection post-partum were extracted and individual values were adjusted for each cow (Everett & Carter, 1968).

During the evaluated periods, metritis was diagnosed when cows presented purulent vulva discharge and liquid content inside the uterus, following ultrasound exams conducted every two weeks by veterinarians from the consulting system. Mastitis diagnosis was based on the presence of lumps in the milk, through the strip cup test, recorded by farm staff. Retained placenta was diagnosed when fetal membranes were observed after 12 h post-partum, also by the farm staff. All cows diagnosed with retained placenta received treatment with a PF2α analogue (Lutalyse®, Pfizer Animal Health, São Paulo-SP) and oxytetraciclin (Terramicina LA®, Pfizer Animal Health, São Paulo-SP).

The effect of the independent variables and of all possible interactions between them on the CCI and daily milk production was tested using General Linear Models. The same procedure was used to analyze the effect of the first episode of mastitis within the CCI (considering intervals of approximately two months: up to 60 days; 61-120 days; and after 120 days) on the CCI. The comparisons of means were made by the Fisher protected least significant difference test. The CCI was transformed into the logarithmic scale because it was not normally distributed according to the Shapiro-Wilk test, but the results were reported in the original scale for the purpose of interpretation. Associations between the diseases of interest were analyzed by chi-square tests. All analyses were conducted with Statistix® (version 9.0).

Results and Discussion

The frequency of clinical occurrences across the evaluated herds was: 14.4% for Herd 1, 26.6% for Herd 2, 31.5% for Herd 3 and 20.2% for Herd 4. Mastitis, metritis and retained placenta together corresponded to more than 72.0% of all reported clinical occurrences. The frequency of clinical mastitis in the present study (36.7%) is lower than that reported in other study in Brazil (Gonzalez et al., 2004), which probably reflects differences in management between the herds analyzed in both studies. Among the diagnosed cases of clinical mastitis, 7.9% occurred up to 60 days within the CCI, 5.5% occurred 60-120 days within the CCI, 4.4% were after more than 120 days within the CCI and 17.9% occurred after conception. The frequency of clinical mastitis was 12.8% for cows with or without metritis ($P>0.05$) and only 38 cows had both conditions. The frequency of clinical mastitis for cows with or without retained placenta (10.5% and 10.4%, respectively) was similar ($P>0.05$) and only 31 cows presented both conditions. However, the frequency of metritis was higher ($P<0.0001$) for cows with retained placenta (34.1%) than for those without it (10.3%). Considering the frequency observed in the present study (12.8%) and in other studies (Gilbert et al., 2005; McDougall et al., 2007), the occurrence of metritis is quite variable, which may reflect a variety of risk factors such as dystocia, stillbirths, twinning and retained placenta (Bell & Roberts, 2007). The frequency of retained placenta observed in this

study (10.5%) is similar to the 11.2% reported in a long-term analysis in a research farm in southern Brazil (Leite et al., 2001). All other clinical occurrences recorded in the present study represented together nearly 28% of the total occurrences, but their individual frequencies were all inferior to 6.0%. Such occurrences included: simple indigestion, displacement of the abomasum, claw lesions, ketosis, ovarian cysts, abortions and hypocalcaemia.

The calving-to-conception interval was 157.4±91.8 days. The CCI was influenced by herd, number of AI and of clinical occurrences and retained placenta. The CCI for Herd 2 was shorter (P = 0.002) than for the other herds (Table 1). The distribution of the number of AI per cow was: 214 cows with no AI (26.3%); 224 cows with one AI (27.6%); 114 cows with two AI (17.7%); 89 cows with three AI (10.9%); and 142 cows with four or more AI (17.5%). The CCI was longer (P<0.0001) as the number of AI increased; 104.6±4.1 days for one AI; 138.6±5.1 days for two AI; 173.8±6.5 days for three AI; and 263.6±5.3 days for four or more AI.

The calving-to-conception interval for cows with retained placenta was shorter (P = 0.03) than for those without it (Table 2). However, retained placenta may lead to secondary uterine infections (Morrow, 1986; Seguin & Troedsson, 2006), which may be related to reduced probability of subsequent conception and prolonged CCI (Maizon et al., 2004). A possible explanation for such contradiction would be the fact that, in the evaluated herds, all cows presenting retained placenta were treated with PF2α and oxytetraciclin. The PF2α stimulates uterine contractions and helps the expulsion of the placenta and the uterine involution, which may favor subsequent conception (Seguin, 1980; Morrow, 1986). Despite having no direct effect on the retained placenta, oxytetraciclin would prevent systemic secondary infections, avoiding loss of appetite and reduction in feed intake, which could impair the fertility of cows (Königsson et al., 2001). However, the efficacy of treatment with PF2α is controversial, because although beneficial effects for post-partum reproductive performance have been reported (Salasel & Mokhtari, 2011), other studies describe no effect of such treatment on post-partum reproductive performance (Archbald et al., 1990; Hendricks et al., 2006). Thus, further studies are necessary to investigate whether such treatment is truly effective and economically justified to improve post-partum reproductive efficiency in cows having retained placenta, since the retrospective data analyzed in the present study may have been potentially influenced by factors that were not controlled at the time of data recording.

Although cows having retained placenta also presented higher frequency of metritis, there was no effect of a potential interaction between the occurrence of both diseases on the CCI (P>0.05). Even though the higher risk of metritis for cows with retained placenta may be attributed to subsequent secondary infections (Bruun et al., 2002), that same study failed to associate metritis with reproductive performance.

Table 1 - Average calving and calving-to-conception intervals and daily milk production for four Holstein dairy herds

Herd	Calving-to-conception interval (days)		Milk production (kg/day)	
	n	Mean±SEM	n	Mean±SEM
1	112	176.5±5.4b	140	25.4±0.4b
2	159	138.1±4.4a	202	23.2±0.4c
3	157	147.7±4.6b	222	28.3±0.3a
4	77	151.2±6.3b	160	26.1±0.5b

a,b - Least square means followed by distinct letters differ by at least P<0.05; SEM - standard error of the mean.

Table 2 - Calving-to-conception interval and daily milk production according to the occurrence of mastitis, metritis and retained placenta in four Holstein dairy herds

	Calving-to-conception interval (day)		Milk production (kg/day)	
	n	Mean±SEM	n	Mean±SEM
		Mastitis		
Yes	174	164.2±7.0	162	26.4±0.3
No	331	156.4±5.0	306	24.5±0.3
		Metritis		
Yes	69	162.7±11.1	65	24.9±0.6
No	436	158.0±4.4	403	26.0±0.2
		Retained placenta		
Yes	59	131.9±11.9a	54	24.5±0.6a
No	446	167.5±4.3b	414	26.4±0.2b

a,b - Least square means followed by distinct letters differ by at least P<0.05; SEM - standard error of the mean.

However, McDougall et al. (2007) reported that cows presenting endometritis not only were at higher risk of not being detected in estrus subsequently, but also took longer to conceive, in comparison with those that did not present endometritis. Also, the CCI can be longer for cows presenting either endometritis or retained placenta than for those without such clinical conditions (Leblanc et al., 2002). Our results contradict those studies probably because 34.1% of the cows with metritis were also diagnosed with retained placenta.

Among the cows presenting clinical mastitis within the CCI, those diagnosed up to 60 days post-partum had the shortest CCI (132.4±7.2 days), followed by those diagnosed within 60-120 days (153.9±8.0 days) and by those diagnosed after 120 days (231.3±9.9 days) (P<0.0001). Thus, cows diagnosed up to 60 days post-partum probably recovered with no negative effects for their subsequent reproductive performance. Clinical mastitis may influence the pattern of hormonal secretion and follicular development, due to the release of substances that inhibit the expression of receptors for gonadotropins and other reproduction-related hormones (Moore et al., 1991; Gilbert et al., 2005). In cases of mastitis caused by Gram negative bacteria, other reproductive disorders may occur, such as reduced estrus expression and irregular cyclicity (Huszenicza et al., 2005; Dobson et al., 2007). Although effects of clinical mastitis on early gestation losses were not investigated in the present study, it would be important to evaluate such conditions, considering that the occurrence of clinical mastitis up to 45 days of gestation incurs in higher risk of abortion, because the corpus luteum is the only source of progesterone for pregnancy maintenance at that period (Risco et al., 1999).

The daily milk production was equal to 26.5±5.6 kg/day. The daily milk production was lower (P<0.05) for cows with retained placenta than for those without it (Table 2), but it was higher (P<0.0001) for cows diagnosed with three or more clinical occurrences than for those with none or only one occurrence. Additionally, the CCI was longer for cows diagnosed with three or more clinical occurrences (P = 0.023) than for those with no occurrences (Table 3). However, no association between mastitis or metritis and the CCI was observed (Table 2). Perhaps, cows facing clinical mastitis during long periods or having consecutive clinical episodes may have prolonged CCI, but, in the present study, only the first diagnosis of mastitis or clinical mastitis diagnosed within the CCI were considered. Also, Herd 3 had both the highest frequency of clinical occurrences and the highest daily milk production (P<0.05) (Table 1). Thus, highly productive cows are more commonly affected by diseases, probably due to their high metabolic demand during lactation (Mwaanga & Janowski, 2000; Dobson et al., 2007), which also has negative effects in milk production (Maizon et al., 2004). In cows having metritis or mastitis, prolonged CCI may be related to the release of endotoxins from an infected uterus or udder to the blood, which stimulates the production of PF2α, leading to premature luteolysis (Huszenicza et al., 2005). Endotoxins can also interfere in the secretion of gonadotropins (Moore et al., 1991) or thyroid hormones and insulin-like growth factors (Nikolic et al., 2003). In acute episodes, chemical mediators (cytokines, interleukins and tumor necrosis factor) and lypopolissacarides released by Gram negative bacteria may lead to reduction in appetite and feed intake (Ingvartsen & Andersen, 2000; Nikolic et al., 2003). In such cases, prolonged CCI would result from a negative energy balance due to the high metabolic burden needed for milk production (Roche et al., 2000; Dobson et al., 2007), which enhances the metabolic demand of many substances, such as estrogens (Butler, 2000; Lopez et al., 2004). So, cows with high daily milk production may present absent or irregular ovarian activity and, thus, less intense estrus expression than those with lower daily milk production (Roche et al., 2000; Lopez et al., 2004). Also, the negative energy balance may lead to ketosis, which impairs energy use and fertility (Mwaanga & Janowski, 2000). Thus, the association of the occurrence of diseases and both CCI and daily milk production would be mostly mediated by a negative energy balance.

Table 3 - Calving-to-conception interval and daily milk production according to the number of clinical occurrences in four Holstein dairy herds

Clinical occurrences	Calving-to-conception interval (days)		Daily milk production (kg/day)	
	n	Mean±SEM	n	Mean±SEM
0	194	138.0±4.0a	186	24.1±0.1z
1	146	153.6±4.6ab	139	25.2±0.4yz
2	75	153.9±6.4ab	72	26.0±0.5xy
3 or more	73	167.9±6.5b	71	27.2±0.5x

a,b - Least square means having distinct superscripts differ by P = 0.023; x,y,z - Least square means having distinct superscripts differ by at least P<0.0001; SEM - standard error of the mean.

Conclusions

Dairy cows with three or more clinical occurrences have prolonged calving-to-conception interval and increased milk production. Calving-to-conception intervals are shorter for cows with retained placenta than for those without it. Among the cows presenting clinical mastitis within the calving-to-conception interval, those diagnosed after 120 days post-partum have the longest intervals.

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