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Prevalence of Clinical Endometritis and its Impact on Reproductive Performance in Grazing Dairy Cattle in Argentina

J Plöntzke[1], LV Madoz[2,3], RL De la Sota[2,3], W Heuwieser[1] and M Drillich[1*]

[1]*Clinic for Animal Reproduction, Faculty of Veterinary Medicine, Freie Universität Berlin, Berlin, Germany;* [2]*Theriogenology Service, Faculty of Veterinary Sciences, National University of La Plata, La Plata, Argentina;* [3]*CONICET Avda. Rivadavia 1917, Buenos Aires, Argentina*

Contents

The objective of this study was to evaluate the prevalence of clinical endometritis and its impact on reproductive performance in grazing dairy cattle in Argentina to compare data with previous reports from herds kept in confinement housing systems. A total of 243 Holstein dairy cows from three commercial dairy farms in Buenos Aires Province (Argentina) were examined for the signs of clinical endometritis 18–38 days postpartum (dpp) by external inspection and manual vaginal examination. Vaginal discharge was scored into the categories VDS 0 (transparent, clear mucus), VDS 1 (mucupurulent discharge), VDS 2 (purulent discharge) and VDS 3 (purulent discharge with fetid odour). Cows diagnosed with VDS 1 to VDS 3 were regarded as affected with clinical endometritis and cows with VDS 0 as free of clinical endometritis. All cows were re-examined 14 days later following the same examination protocol. Prevalence of clinical endometritis 18–38 dpp was 35% and decreased to 18% at re-examination. Cows with no palpable ovarian structures or periparturient disorders were at higher risk for clinical endometritis. Hazard for pregnancy was significantly lower in cows with purulent or fetid odour discharge compared with reference cows with no discharge (HR = 0.49; p = 0.01), resulting in a lower proportion of cows pregnant by 360 dpp (66% vs 78%). Furthermore, the number of services per pregnancy was higher for cows with clinical endometritis than for cows without clinical endometritis (4.4 vs 3.1; p = 0.04). Cows with clinical endometritis were 1.6 times as likely to be culled as cows with no signs of clinical endometritis. In conclusion, the prevalence and the impact of clinical endometritis in a pasture-based, extensive dairy production system in Argentina were similar to previously published data from dairy farms with confinement production systems.

Introduction

The key approach of successful dairy farming is the management of the periparturient period. Aspects of uterine health, resumption of ovarian cyclicity after parturition as well as nutrition and housing conditions are in the focus of interest. The complex interactions at individual and herd level have been the object of investigations for years.

In the first 2 weeks after calving, the uterus of 80–100% of the cows is contaminated with bacteria (Elliott et al. 1968; Griffin et al. 1974; Sheldon et al. 2002b). In the normal postpartum period, bacteria are eliminated within 3 weeks postpartum (Sheldon et al. 2004). Persisting bacterial infection leads to metritis and endometritis and impaired subsequent reproductive performance (Griffin et al. 1974; LeBlanc et al. 2002). Metritis is an acute disease in the early postpartum period, associated with reddish-brown, watery and fetid vulvar discharge and systemic signs of illness, e.g. fever and depressed attitude. Clinical endometritis can be defined as an inflammation of the endometrium later than 3 weeks postpartum (Sheldon et al. 2006). It is associated with a chronic bacterial infection and characterized by mucupurulent or purulent uterine discharge detectable in the vagina, with no systemic signs of illness (Földi et al. 2006; Sheldon et al. 2006; LeBlanc 2008). Williams et al. (2005) showed that character and odour of vaginal mucus is correlated with bacterial load of the uterus and immune response. Several risk factors for clinical endometritis such as retained foetal membranes, assisted calving, stillbirth, vulval angle, primiparity and male offspring have been identified (Potter et al. 2010). Most relevant pathogen bacteria involved are *Arcanobacterium pyogenes, Escherichia coli, Fusobacterium necrophorum* and *Prevotella melaninogenicus* (Huszenicza et al. 1999). Recently, bovine herpesvirus 4 (BoHV-4) has been demonstrated to play a role in the aetiology of endometritis (Donofrio et al. 2007). Prevalence of clinical endometritis reported vary from 17% under intensive production conditions (LeBlanc et al. 2002) to 21–29% in extensive dairy farming (De la Sota et al. 2008; Mee et al. 2009).

Examination of the vagina and the evaluation of vaginal mucus is the most reliable method for the diagnosis of endometritis (Sheldon and Noakes 1998; LeBlanc et al. 2002). Vaginal examination can be performed manually withdrawing vaginal mucus with a gloved hand, using the metricheck device (a silicon hemisphere screwed on a rod) (McDougall et al. 2007) or by vaginoscopy, inspecting the vaginal lumen (LeBlanc *et al*. 2002). Recently, Pleticha et al. (2009) found significantly more cows affected with vaginal discharge using the metricheck device, than by examination with a speculum or a gloved hand (47.5 vs 36.9 and 36.8%).

Negative effects of clinical endometritis on reproductive performance have been shown in several studies. Prolonged days open, decreased first service conception and pregnancy rates and a higher risk of culling were reported (Fourichon et al. 2000; LeBlanc et al. 2002; McDougall et al. 2007). The impact of clinical endometritis on fertility is caused by a delayed uterine involution (Sheldon and Noakes 1998) and altered ovarian activity and hormonal pattern (Huszenicza et al. 1999; Sheldon et al. 2002b; Sheldon and Dobson 2004; Williams et al. 2007).

Most data on the prevalence and the effects of clinical endometritis were obtained from herds in confinement housing systems resulting in recommendations for dairy farming worldwide. Only little information exists about the relevance of clinical endometritis in dairy cows kept in extensive housing systems. It can be hypothesized that prevalence and impact of the disease vary with different housing, climatic and feeding conditions. Thus, the objective of this study was to describe the occurrence and factors associated with the prevalence of clinical endometritis diagnosed by manual vaginal examination and its impact on reproductive performance in a pasture-based, extensive dairy production system in Argentina.

Materials and Methods

Study farms

The study was conducted in two periods of 4 months (September to December) in two consecutive years (2006 and 2007) on three commercial dairy farms in Buenos Aires Province, Argentina. The surface area of the three dairy farms was 10 000, 6400 and 236 hectare, and numbers of milking cows were 1545 (farm 1), 1200 (farm 2) and 96 (farm 3) per herd. All cows were of commercial Holstein breed type. The average daily milk yield was 29, 22 and 18 l per cow, respectively. Cows were kept in extensive pasture system on grasslands, rotating for fresh pasture lots when grazed, as typical for this region. Calving areas of approximately 0.5 hectare were close to the accommodation of farm personnel. Feed consisted of mixed pastures with alfalfa, festuca, lolium or bromegrass and summer annual grasses, e.g. white and red clover, ryegrass or soybeans. Feeding was supplemented with sorghum or corn silage according to animals' requirements. Concentrates were offered twice daily during milking. Veterinarians visited the farms routinely every week or every second week for fertility service. This included diagnosis of pregnancy and the examination of non-pregnant cows by rectal palpation, followed by treatment according to the diagnosis, e.g. induction of oestrus with prostaglandin $F_{2\alpha}$ (Bioprost D, Biotay S.A., Grand Bourg, Argentina). After a voluntary waiting period of 40–45 dpp, cows were bred by artificial insemination (AI) after observed oestrus or by timed insemination after oestrus synchronization with prostaglandin $F_{2\alpha}$ and intravaginal progesterone releasing devices (CIDR, Pfizer S. R. L., Buenos Aires, Argentina) as a part of the fertility service by the veterinarians. Pregnancy diagnosis was performed by transrectal palpation of the uterus and its contents later than 35 days after AI. Relevant data were recorded with a herd management software (Syscord-Tamb, Lincoln, Argentina, and Protambo Master, Santa Fe, Argentina).

Study design

Two study periods were conducted between September and December in both 2006 and 2007. Farms were visited every 14 days. Enrollment of the cows, clinical examination and evaluation and data collection were performed by the same investigator.

Lactating Holstein cows were enrolled at a first visit (exam 1) between 18 and 38 dpp. Animals were re-examined at a second visit (exam 2), 14 days later.

Clinical examination

In each cow, a clinical examination of the reproductive tract was performed by manual vaginal examination and transrectal palpation of the uterus and the ovaries.

Before manual vaginal examination, the vulva was cleaned with water and an arm-length glove was taken from a dispenser box. The gloved hand (guantes largos descartables, Flex, Buenos Aires, Argentina), lubricated with gel for ultrasound examinations (Gel para ultrasonido, PharmaClean, Buenos Aires, Argentina), was inserted into the vaginal lumen. The open hand was moved in a circular direction to collect vaginal mucus, closed, withdrawn and with spread fingers, vaginal discharge was scored on a scale from 0 to 3. Clear, transparent mucus without any particles of pus was equivalent to a vaginal discharge score of 0 (VDS 0), indicating cows not affected by clinical endometritis (CE−). Cows diagnosed with mucupurulent discharge (VDS 1), purulent discharge (VDS 2) and purulent discharge with fetid odour (VDS 3) were regarded as affected by clinical endometritis (CE+). Transrectal palpation was performed immediately after vaginal examination. The gloved hand was inserted into the rectum, ovaries were located and palpated with the thumb, while fixing the ovary with the fingers. The presence of follicles, a corpus luteum or the absence of those was recorded. Body condition of all cows was scored according to a 5-point scale with 0.25 intermediary steps (Edmonson et al. 1989). At second visit, 14 days later, cows were examined following the same examination protocol.

Data

All data were recorded on case report forms on farm and transferred into a spreadsheet (Excel 2003; Microsoft Corporation, Redmond, WA, USA). Data included results from vaginal examination and transrectal palpation findings of the ovaries (corpus luteum, follicle, acyclic). Animal-specific data (parity, date of parturition), periparturient disorders (assisted calving, retained foetal membranes, hypocalcaemia and abortion) and reproductive data (first insemination, last insemination, number of inseminations, outcome of pregnancy diagnosis and date of culling) were obtained from the herd management software.

Reproductive performance was characterized by days to first service, conception at first AI (number of cows pregnant after first AI divided by number of cows inseminated ×100), days to pregnancy, proportion of cows pregnant (number of cows documented to be pregnant at 360 dpp divided by number of cows enrolled ×100), services per pregnancy (total number of inseminations divided by number of pregnant cows) and proportion of cows culled within 360 dpp. Follow-up period was set at 360 dpp to compensate for a 2 -month interruption of the breeding period in April and May, which is common in Argentina to avoid calvings during the hot summer months.

Statistical analysis

Data were analysed using SPSS software (Version 16.0; SPSS Inc., Munich, Germany). Prevalence of clinical endometritis was calculated for all cows enrolled and separately for herds. Further analysis was conducted in cows diagnosed with clinical endometritis between 18 and 38 dpp (exam 1). Relative risks (RR) were calculated for herd prevalence of clinical endometritis, with farm 1 (highest number of animals) as reference. Frequency distribution of VDS showed that only five cows were categorized as VDS 3. As previous reports (LeBlanc et al. 2002) did not reveal differences between purulent and foul smelling discharge on reproductive performance, for further analyses VDS 2 and VDS 3 were collapsed into one category VDS 2 + 3. Relative risks for the diagnosis of clinical endometritis in cows examined at 18–38 dpp and binary logistic regression models for the chance of conception at first AI as outcome variables were calculated. Survival analyses for the chance of insemination and pregnancy within 360 dpp were performed using Kaplan–Meier survival analysis and Cox regression, censoring for cows not inseminated and not pregnant, respectively. For logistic regression models and Cox regression, VDS (with VDS 0 as reference) reported periparturient disorder (0 = no, 1 = yes), parity (0 = primiparous, 1 = multiparous), body condition score (0 = BCS < 2.75; 1 = BCS 2.75–5.00), palpable ovarian structures (0 = corpus luteum or follicle palpable, 1 = no palpable corpus luteum or follicle) and study period (0 = September to December 2006, 1 = September to December 2007) were included as factors. The number of services per conception was analysed using Kaplan–Meier survival analysis, regarding each service as a ''time period'' and pregnancy as the principal outcome, as described by Gilbert et al. (2005), and log rank test was performed to compare between CE− and CE+ cows. Adjusted RR, odds ratios, hazard ratios, confidence intervals (CI) and p-values are reported. For RR, logistic regression and survival analyses, CI was set at 95%. For all statistical analyses, level of significance was set at $\alpha = 0.05$.

Results

During the two study periods, a total of 243 Holstein cows between 18 and 38 dpp were enrolled in this study, 107 cows in the first study period in 2006 and 136 in the second study period in 2007. Six cows were enrolled in both study periods. Follow-up of all cows was completed 360 days after the end of the second observation period in December 2008. Cow parity ranged from 1 to 9, with a median of 2.0 (Interquartile range: 1–3).

Prevalence

The overall prevalence of clinical endometritis (CE) on the three commercial dairy farms was 34.6%. Stratified by farm, prevalence was 31.9% (60/188), 46.2% (18/39) and 37.5% (6/16) on farm 1, 2 and 3, respectively. The likelihood for clinical endometritis did not differ between farms (farm 2: RR = 1.45, 95% CI = 0.97–2.15; farm 3: RR = 1.18, 95% CI = 0.60–2.29, with farm 1 as reference). Proportion of cows with clinical endometritis was 36.4% (28/77) and 33.7% (56/166) in primiparous and multiparous cows and 37.4% (40/107) and 32.4% (44/136) in the study period of 2006 and 2007, respectively.

The frequency distribution of vaginal discharge scores was 65.4% (159/243), 18.5% (45/243) and 16.0% (39/243) for VDS 0, 1 and 2 + 3, respectively.

At clinical examination 2, 80.2% (195/243) of the cows enrolled at first visit were re-examined. A total of 19.8% (48/243) of the cows enrolled at first visit were not re-examined because they had died or were sold or other reasons. The overall prevalence of clinical endometritis had decreased to 17.9% (35/195). Of 159 CE− cows at first visit, 72.3% (115/159) remained CE− at re-examination and 6.9% (11/159) were found CE+, while 20.8% (33/159) were not re-examined. Of 84 cows with clinical endometritis at first visit, 28.6% (24/84) remained CE+, 53.6% (45/84) were found CE− and 17.9% (15/84) were not re-examined.

Cows with clinical endometritis had a higher likelihood to be diagnosed with no palpable corpus luteum or follicle at examination than cows without clinical endometritis (57.7% vs 39.4% of cows; p = 0.01, Table 1). Proportion of cows with periparturient disorders was 18.9% (30/159) and 31.0% (26/84) in CE− and CE+ cows, respectively. Periparturient disorder was a significant risk factor for clinical endometritis (RR: 1.50, 95% CI: 1.05–2.13, p = 0.03, Table 1).

Impact on reproductive performance

Descriptive reproductive performance traits are shown in Table 2. Conception at first AI was 25.7% (18/70) and 31.9% (43/135) in CE+ and CE− cows, respectively. Further analyses by logistic regression revealed that conception at first AI was not affected by the form of VDS (p = 0.21, Table 3). Risk for conception at first service was only numerically lower for VDS 2 + 3 compared to VDS 0 (OR = 0.37, 95% CI: 0.12–1.11, p = 0.08, Table 3).

The outcome of Cox regression for insemination and pregnancy is reported in Table 4. The chance of pregnancy was affected by VDS (p = 0.03), with VDS

Table 1. Relative risk for the diagnosis of clinical endometritis in cows examined 18–38 dpp, considering periparturient disorders, parity class, body condition, palpable ovarian structures and study period as factors

Factor	RR	95% CI	p
Periparturient disorders[a]	1.50	1.05–2.13	0.03
Parity class[b]	0.93	0.63–1.35	0.70
BCS group[c]	0.80	0.57–1.13	0.21
Ovarian structure[d]	1.62	1.10–2.37	0.01
Study period[e]	0.87	0.61–1.22	0.41

RR, relative risk; CI, confidence interval.
[a]Periparturient disorders: 0 = no periparturient disorders; 1 = periparturient disorders.
[b]Parity class: 0 = primiparous; 1 = multiparous.
[c]BCS group: 0 = BCS < 2.75; 1 = BCS 2.75–5.00.
[d]Ovarian structure: 0 = palpable follicle or corpus luteum; 1 = no follicle or corpus luteum palpable.
[e]Study period: 0 = September to December 2006; 1 = September to December 2007.

Table 2. Descriptive reproductive performance traits of 243 cows examined 18–38 dpp for clinical endometritis

Trait	Clinical endometritis	
	Yes	No
Number of cows	84	159
Cows inseminated, % (95% CI)	83.3 (74.8–90.7)	84.9 (79.0–90.2)
Median days to first AI (IR)	59.0 (53.8–66.0)	58.0 (53.0–63.0)
Days to first AI (min – max)	41–144	21–203
First service conception rate, % (95% CI)	25.7 (14.8–35.2)	31.9 (23.6–39.3)
Services per pregnancy	4.4	3.1
Median days to pregnancy (IR)	123.0 (62.0–233.0)	125.0 (60.0–212.5)
Days to pregnancy (min – max)	41–359	21–356
Cows pregnant, % (95% CI)	65.5 (54.7–75.0)	78.0 (71.2–84.1)
Cows culled, % (95% CI)	34.5 (23.8–44.1)	22.0 (15.3–28.1)

CI, confidence interval; IR, interquartile range.

Table 3. Results of binary logistic regression analysis for the risk of conception at first AI, in cows examined for clinical endometritis between 18 and 38 dpp

Factor	Conceiving at first AI		
	OR	95% CI	p
Vaginal discharge score[a]			0.21
Score 0		Reference	
Score 1	0.85	0.37–1.95	0.69
Score 2 + 3	0.37	0.12–1.11	0.08
Periparturient disorders[b]	2.14	0.98–4.67	0.06
Parity class[c]	1.16	0.56–2.41	0.69
BCS group[d]	0.88	0.42–1.85	0.75
Ovarian structure[e]	1.73	0.88–3.40	0.11
Study period[f]	0.78	0.38–1.60	0.50
Constant	0.52		0.32

OR, odds ratio; CI, confidence interval.
[a]Vaginal discharge score: 0 = clear, transparent mucus; 1 = mucupurulent discharge, 2 + 3 = purulent and fetid odour discharge.
[b]Periparturient disorders: 0 = no periparturient disorders; 1 = periparturient disorders.
[c]Parity class: 0 = primiparous; 1 = multiparous.
[d]BCS group: 0 = BCS < 2.75; 1 = BCS 2.75–5.00.
[e]Ovarian structure: 0 = palpable follicle or corpus luteum; 1 = no follicle or corpus luteum palpable.
[f]Study period: 0 = September to December 2006; 1 = September to December 2007.

2 + 3 cows at lower chance for pregnancy than reference cows with VDS 0 (HR = 0.49, 95% CI: 0.28–0.84, p = 0.01). The chance of insemination was affected by study period (HR = 1.69, 95% CI: 1.21–2.37, p = 0.002). Survival curve for CE+ and CE− cows pregnant is illustrated in Fig. 1.

Kaplan–Meier curve shows number of services per pregnancy (Fig. 2). Cows with clinical endometritis required significantly more services per pregnancy than CE− cows (4.4 vs 3.1 services, Log rank test: χ^2 = 4.69, p = 0.03). Cows with clinical endometritis were 1.6 times as likely to be culled as CE− cows (RR = 1.57, 95% CI: 1.04–2.38, p = 0.04).

Discussion

Prevalence of clinical endometritis

This study is one of few reports on clinical endometritis in Holstein dairy cows under extensive housing conditions in Argentina. The prevalence of clinical endometritis in the present study was 35%. In the discussion of prevalence of endometritis in different studies, the time of examination postpartum, definition criteria of clinical endometritis, i.e. quality of vaginal discharge, and diagnostic technique have to be considered. In the herds in the present study, the voluntary waiting period was

Table 4. Results of the survival analyses (Cox regression) for the risk of insemination and pregnancy in cows examined for clinical endometritis at 18–38 dpp

Factor	Insemination			Pregnancy		
	HR	95% CI	p	HR	95% CI	p
Vaginal discharge score[a]			0.99			0.03
Score 0		Reference			Reference	
Score 1	1.02	0.69–1.51	0.94	0.80	0.51–1.20	0.28
Score 2 + 3	0.97	0.61–1.54	0.90	0.49	0.28–0.84	0.01
Periparturient disorders[b]	1.06	0.75–1.51	0.75	1.25	0.86–1.81	0.25
Parity class[c]	0.77	0.55–1.08	0.13	0.72	0.51–1.02	0.06
BCS group[d]	1.03	0.73–1.45	0.86	1.06	0.73–1.53	0.76
Ovarian structure[e]	0.81	0.59–1.22	0.21	1.18	0.84–1.66	0.33
Study period[f]	1.69	1.21–2.37	0.002	0.74	0.52–1.05	0.09

HR, hazard ratio; CI, confidence interval.
[a]Vaginal discharge score: 0 = clear, transparent mucus; 1 = mucupurulent discharge, 2 + 3 = purulent and fetid odour discharge.
[b]Periparturient disorders: 0 = no periparturient disorders; 1 = periparturient disorders.
[c]Parity class: 0 = primiparous; 1 = multiparous.
[d]BCS group: 0 = BCS < 2.75; 1 = BCS 2.75–5.00.
[e]Ovarian structure: 0 = palpable follicle or corpus luteum; 1 = no follicle or corpus luteum palpable.
[f]Study period: 0 = September to December 2006; 1 = September to December 2007.

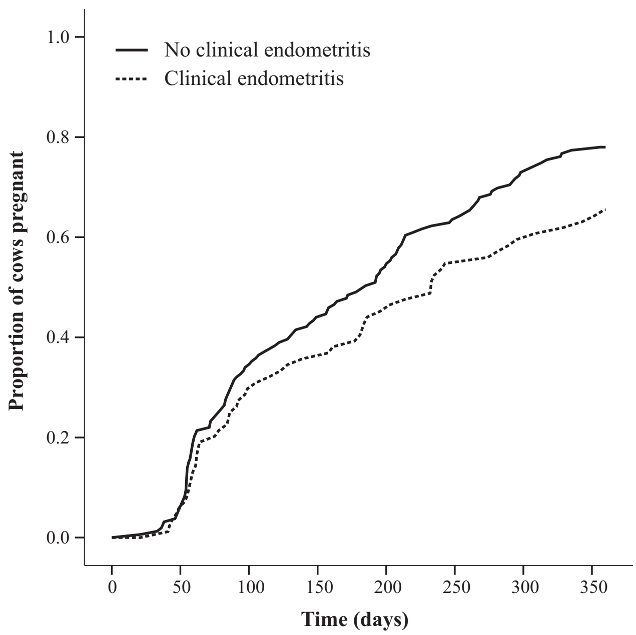

Fig. 1. Kaplan–Meier survival curves for the proportion of cows pregnant by clinical endometritis status (clinical endometritis: n = 124; no clinical endometritis: n = 55). The proportion of cows censored was 34.5% and 22.0% for cows with clinical endometritis and with no clinical endometritis, respectively

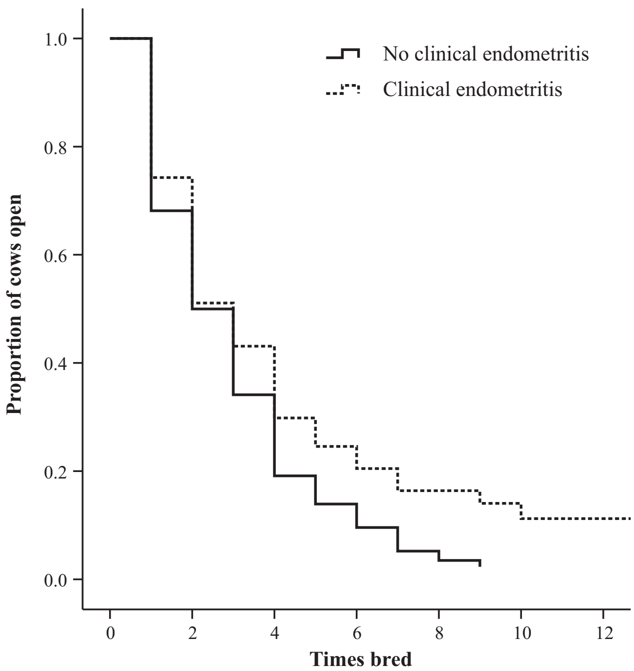

Fig. 2. Survival analysis for times bred per conception by clinical endometritis status (clinical endometritis: n = 124; no clinical endometritis: n = 55). Log rank test: $\chi^2 = 4.69$, $p = 0.03$. The proportion of cows censored was 34.5% and 22.0% in cows with clinical endometritis and with no clinical endometritis, respectively

relatively short. Thus, it was necessary to examine cows earlier postpartum than in some other studies. Examination of cows between 18 and 38 dpp may have resulted in the inclusion of cows that not have completed the uterine involution process.

The prevalence of endometritis in our study was higher than in previous reports. In intensive dairy farming in North America, LeBlanc et al. (2002) reported a prevalence of 17% diagnosed by vaginoscopy and cervical diameter between 20 and 33 dpp. Previous Argentinean reports described prevalence of 21–22% between 15 and 62 dpp diagnosed by manual vaginal examination (De la Sota et al. 2008; Madoz et al. 2008). Recently, Mee et al. (2009) reported for 62 pasture-based, seasonal calving dairy herds in Ireland with a total of 5751 cows an average prevalence of endometritis of 29.4%. In that study, cows were examined by ultrasound >14 days postpartum. The overall prevalence of clinical endometritis at the second visit 32–52 dpp was 18%. This decrease in prevalence with increasing time postpartum is in accordance with other studies from confinement production systems (Griffin et al. 1974; LeBlanc et al. 2002; Williams et al. 2005) and with findings from Argentina (Mejia and Lacau-Mengido 2005). In the present study, purulent and fetid odour discharge, but not mucupurulent discharge, was associated with a decreased chance for pregnancy compared with cows with no discharge. This result is in accordance with findings from confinement housing conditions (LeBlanc et al. 2002). In contrast to this, Williams et al. (2005) reported for cows with mucupurulent discharge diagnosed at 28 dpp a prolonged calving to conception interval. The predictive value of different uterine discharge categories for subsequent reproductive performance depends on the interval from calving to diagnosis (LeBlanc et al. 2002). Results of the present study indicate that purulent or fetid odour discharge after 18 dpp may identify cows at risk for reduced subsequent reproductive performance in a pasture-based extensive housing system. For the same housing conditions, De la Sota et al. (2008) reported impaired reproductive performance for cows diagnosed with any vaginal discharge between 15 and 30 dpp. LeBlanc et al. (2002) found that purulent vaginal discharge or a cervical diameter > 7.5 cm after 20 dpp or mucupurulent discharge after 26 dpp identifies cows at risk for reduced subsequent reproductive performance in confinement housing.

The technique of manual vaginal examination applied to diagnose clinical endometritis is simple to perform and with high repeatability (Sheldon et al. 2002a). Pleticha et al. (2009) reported that different techniques of vaginal examination, vaginoscopy, manual examination or examination with the metricheck device can be used interchangeably. Any technique to detect uterine discharge in the vagina, however, may lead to false-positive results caused by vaginitis, cervicitis, cystitis or purulent nephritis, or to false-negative results. For the diagnosis of clinical endometritis, vaginal examination is more sensitive and similarly specific than transrectal palpation (LeBlanc et al. 2002).

Significant differences in prevalence between herds as reported for confinement housing from North America (LeBlanc et al. 2002) were not present in our study. It could be hypothesized that in confinement housing, the pathogen density in the calving areas varies more between herds, dependent on various factors such as quality of bedding material or crowding of cows. Further studies on the herd prevalence of clinical endometritis in extensive housing condition, however, with a larger number of farms are necessary to confirm our findings.

Relative risk analysis did not reveal a significant effect of parity or body condition on the occurrence of clinical endometritis. In contrast to our findings, a higher risk for endometritis has been reported for cows in third or higher lactation from confinement housing (LeBlanc et al. 2002) and contrary for primiparous cows from extensive farming (De la Sota et al. 2008). Bell and Roberts (2007) found calving assistance to be highly associated with subsequent uterine infections. In the present study, reported periparturient disorders, including assisted calving, had a significant effect on the occurrence of endometritis. Acyclic cows, i.e. cows with no palpable corpus luteum or follicle, were at higher risk for clinical endometritis. It has been demonstrated that cows with vaginal discharge are at higher risk for delayed resumption of ovarian cyclicity or prolonged postpartum luteal phases (Opsomer et al. 2000). A suggested mechanism for anovulatory conditions is that the endotoxin LPS produced by uterine pathogen *Escherichia coli* interferes with the hypothalamus–pituitary–ovarian axis (Battaglia et al. 1999) and enhance luteotropic prostaglandin E2 synthesis (Herath et al. 2009).

Impact of clinical endometritis on reproductive performance

For a successful and economically efficient reproductive management, it is necessary to achieve a high proportion of cows pregnant in an adequate period of time (Dijkhuizen et al. 1985; Plaizier et al. 1997). Therefore, at the end of voluntary waiting period, the ovaries should have resumed cyclicity and the uterus should be completely involuted, free of inflammation or infection to be capable for conception, implantation and embryo survival. There is general agreement that clinical endometritis impairs subsequent reproductive performance of dairy cows kept under intensive housing conditions (LeBlanc et al. 2002; Sheldon et al. 2006). Recent research has demonstrated that not only clinical but also subclinical endometritis has a negative impact on fertility (Kasimanickam et al. 2004), which could be associated with the production of local cytokines and may help to explain long-term effects of endometritis on fertility (Gabler et al. 2009; Fischer et al. 2010). In several studies, the negative effect of endometritis was demonstrated, although cows received a treatment with prostaglandin F2α or local antibiotics (LeBlanc et al. 2002; Sheldon et al. 2006). Our findings for cows kept on pasture-based, extensive housing conditions showed that the negative impact of clinical endometritis on reproductive performance was similar for most reproductive traits as previously reported for intensive housing systems. Cows with clinical endometritis were at lower chance for pregnancy and required more services to become pregnant than cows without clinical endometritis. A meta-analysis by Fourichon et al. (2000) summarized the effects of endometritis on reproductive performance from 24 studies in confinement housing conditions. The impact of endometritis on reproductive performance was quantified as a decrease in 20% for conception at first service, an increase in additional 19 days open, a 31% decrease in risk of pregnancy at 150 dpp, and a 6% decrease in overall pregnancy rate. A large scale study by LeBlanc et al. (2002) in Canada found that cows with clinical endometritis had an additional 28 days open, decreased pregnancy and first service conception rates, and increased number of inseminations per pregnancy. The decrease in first service conception rate of 6.2 percentage points in the present study was less pronounced than described for confinement housing systems of 8.3 percentage points (Fourichon et al. 2000) and 8.1 percentage points (LeBlanc et al. 2002). In a large scale study conducted in a seasonal breeding dairy system in New Zealand (McDougall et al. 2007), cows with clinical endometritis had a reduced first service conception rate, decreased pregnancy rate and an increase from 7 to 27 days from the start of the breeding programme to pregnancy. In a study from Argentina, De la Sota et al. (2008) described an increase in days open and a significantly lower proportion of cows pregnant at 100 and 200 dpp in cows with clinical endometritis. Although culling reasons were not recorded, in the present study, cows with clinical endometritis were 1.6 times as likely to be removed from herd as cows without clinical endometritis. Similarly, LeBlanc et al. (2002) found cows with clinical endometritis to be 1.7 times more likely to be culled for reproductive failure.

Conclusions

The prevalence and impact of clinical endometritis in a pasture-based, extensive dairy production system in Argentina was similar to previously published data from dairy farms with confinement production systems. Cows with periparturient disorders or no palpable ovarian structures were at higher risk of clinical endometritis. Affected cows were less likely to become pregnant, required more services per conception and were more likely to be removed from the herd. Further studies should evaluate the infectious agents involved in the development of clinical endometritis and proof treatment recommendations under extensive dairy farming conditions.

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Conflict of interest

None of the authors have any conflict of interest to declare.

Author contributions

J Plöntzke has contributed to the acquisition of data, statistical analysis and interpretation of data and draft of the manuscript. LV Madoz has contributed to the acquisition of data and revised the manuscript. RL de la Sota has contributed to the design of the study, interpretation of data and revised the manuscript. M Drillich has contributed to the design of the study, statistical analysis, and interpretation of data and draft of the manuscript. W Heuwieser has contributed to the design of the study, acquisition of funding and revised the manuscript.

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Author's address (for correspondence): W Heuwieser, Clinic for Animal Reproduction, Faculty of Veterinary Medicine, Freie Universität Berlin, Königsweg 65, 14163 Berlin, Germany. E-mail: heuwieser.wolfgang@vetmed.fu-berlin.de

*Present address: Clinic for Ruminants, Section for Herd Health Management, University of Veterinary Medicine Vienna, Veterinärplatz 1, 1210 Vienna, Austria.