Risk Factors for Postpartum Endometritis and the Effect of Endometritis on Reproductive Performance in Dairy Cows in Korea

Ill-Hwa KIM¹ and Hyun-Gu KANG¹

¹College of Veterinary Medicine, Chungbuk National University, Cheongju, Chungbuk, 361–763, Korea

Abstract. The objectives of this study were to determine the risk factors for postpartum endometritis by evaluating several reproductive factors in individual cows, and to determine the effect of endometritis on the subsequent reproductive performance in dairy herds in Korea. The data, including health status, parity and body condition score (BCS) of cows, and calving date, were collected from 320 cows in eight dairy herds calving from January 2001 to October 2002. We used logistic regression to evaluate the effects of these factors on endometritis. A stepwise procedure, used to obtain the appropriate model with $\alpha=0.05$, revealed that retained placenta, metabolic disorders and parity are the important risk factors for endometritis. The mean intervals from calving to first service and conception were prolonged ($P<0.01$) by 23 and 36 days, respectively, in the endometritis group compared to the non-endometritis group. The first service conception rate was lower ($P<0.05$) in the endometritis group (47.6%) than in the non-endometritis group (62.6%). The number of services per conception was higher ($P<0.05$) in the endometritis group (1.9) than in the non-endometritis group (1.6). We conclude that retained placenta, metabolic disorders and cow parity are strongly correlated with the development of postpartum endometritis, which decreases reproductive performance in dairy herds in Korea.

Key words: Holstein dairy cows, Postpartum endometritis, Risk factors, Reproductive performance

Endometritis is a common reproductive disease that causes economic loss [1, 2]. Bartlett et al. [1] showed that the cost to producers for each lactating dairy cow with endometritis was $106. Various risk factors related to the development of endometritis in individual cows have been identified, although some are controversial. The foremost, retained placenta, is associated with an increased risk of endometritis [3–7]. Calving problems including dystocia [4, 6, 8], stillbirths [6] and multiple births [9, 10] are also related to increased incidence of endometritis. Other diseases associated with the development of endometritis include metabolic disorders, such as abomasal displacement, milk fever, and ketosis [4, 6, 10]. In addition to these postpartum diseases, cow parity [10], BCS [7, 11, 12], and calving season [13, 14] are also considered as risk factors for endometritis, but some researchers have found no association between age or parity [1, 8, 15], BCS [16], or calving season [1] and the incidence of endometritis.

Endometritis adversely affected reproductive performance in dairy cows in several studies [17–20], but Martinez and Thibier [21] and Markusfeld and Ezra [22] found that endometritis did not negatively affect subsequent fertility. Gröhn et al. [14] described endometritis as a risk factor for cystic ovarian disease, anoestrus and other reproductive
disorders. Recently, LeBlanc et al. [23] reported that endometritis prolonged the average calving-to-first insemination and calving-to-conception intervals, and reduced the first service pregnancy rate after calving in dairy cows, but they found that endometritis did not negatively affect the number of AI per conception.

Risk factors for endometritis vary among different regions or countries because of differences in general management, environment and herd health control conditions. In addition, effects of endometritis on reproductive performance have varied in previous studies. Our first objective was to determine the risk factors for postpartum endometritis by evaluating several factors: calving condition, postpartum diseases, cow parity or BCS, and calving season in dairy herds in Korea. The second objective was to determine the effect of endometritis on subsequent reproductive performance.

Materials and Methods

Herds

This study was performed on Holstein dairy farms located in Boeun county, Chungbuk province, in central Korea. All herds contained 50 or more cows and received regular reproductive health checkups every 4 weeks from veterinarians at the College of Veterinary Medicine at Chungbuk National University, Korea. The regular reproductive health checkup included diagnosis and treatment of reproductive disturbances, pregnancy diagnosis and measurement of BCS (based on criteria developed by Edmonson et al. [24]). Average milk yield was 8,800 Kg per year per cow. The cows were maintained in free-stall facilities and fed a total mixed ration. The average monthly air temperature in the area was 4.2–17.6 C in Spring (March to May), 19.9–24.7 C in Summer (June to August), 4.5–18.8 C in Autumn (September to November), and −3.5–0.3 C in Winter (December to February).

Case definition

An abnormal partus included dystocia (veterinary-assisted calving or pulling with extreme force), caesarean section, twins or stillbirth [20, 25]. The postpartum reproductive and metabolic disorder definitions used in this study are similar to the definitions used in previous studies [6, 26, 27]. Retained placenta was defined as the retention of the fetal membrane for > 24 h. Metabolic disorders (abomasal displacement, milk fever and ketosis) were diagnosed by clinical signs observed by the veterinarian and/or farmer within 4 weeks postpartum. Abomasal displacement was diagnosed by a pinging sound upon abdominal auscultation by a veterinarian and all cases were corrected by surgery. Milk fever was diagnosed by the presence of the following clinical signs: weakness, cold skin, and favorable response to calcium therapy. Ketosis was defined as the presence of the following clinical signs: anorexia, depression, and odor of acetone on the breath. Endometritis was diagnosed 4 weeks postpartum by examination by the corresponding author and diagnosed by the presence of the following clinical signs: cloudy discharge and enlarged uterus observed by rectal examination with or without other clinical signs. Therefore, endometritis included cases of metritis and pyometra as well as endometritis [7, 28]. Repeat occurrences of these conditions in a single cow were included.

Data collection and processing for determination of the risk factors for endometritis

Data were collected from 320 Holstein cows from eight Korean dairy herds calving from January 2001 to October 2002. Table 1 lists independent variables that describe health status, parity and BCS of the cow, and calving season. All diseases were coded as dichotomous variables (no=0, yes=1). In order to evaluate the influence on development of endometritis of abnormal partus (total cases of dystocia, caesarean section, twins and stillbirth), retained placenta, metabolic disorders (total cases of abomasal displacement, milk fever and ketosis), cow parity and BCS at 4 weeks postpartum, and calving season, we used logistic regression with the SAS program [29]. Initially, to determine which independent variables influence endometritis, simple logistic regression was applied to each independent variable separately. Later, a stepwise procedure was used to obtain the appropriate model with α=0.05.

Evaluation of the effect of endometritis on reproductive performance

Cows were grouped based on the incidence of endometritis 4 weeks postpartum into the
endometritis group (n=117) or the non-endometritis group (n=203). The cows with endometritis were treated with one intrauterine infusion of 1,500 mg oxytetracycline hydrochloride solution (Metrijet 1,500, Intervet, U.K.) or 2% povidone-iodine solution (Betadine solution™, Korea Pharma Co. Ltd, Hwasung, Kyounggi, Korea), and retreated if necessary. All cows received the regular reproductive health examination every 4 weeks. The cows were bred at observed estrus more than 50 days after calving. Artificial insemination (AI) was done according to the a.m.-p.m. rule. The conception to AI ratio was determined per rectum 60 to 70 days after calving. Statistical analysis was also performed with the SAS program. Data on the interval calving to first service, interval calving to conception and number of services per conception for the two groups were analyzed by t-test. Data on the first service conception rate for the two groups were compared by chi-square analysis. For all tests, a P value <0.05 was considered significant.

**Results**

The overall incidence of endometritis, in a total of 320 calvings in eight herds, was 36.6%. The final model identified retained placenta, metabolic disorders and cow parity as risk factors, whereas abnormal partus, BCS at 4 weeks postpartum, and calving season were not identified by the model (Table 2). The effect of endometritis on reproductive performance is shown in Table 3. The intervals from calving to first service and conception were longer (P<0.01) in the endometritis group (100.9 ± 4.1 and 149.2 ± 7.2 days) than in the non-endometritis group (80.8 ± 3.6 and 126.7 ± 4.1 days). Statistical analysis was performed with the SAS program.
non-endometritis group (77.6 ± 2.5 and 113.1 ± 5.3 days). The first service conception rate was lower (P<0.05) in the endometritis group (47.6%) than in the non-endometritis group (62.6%). The number of services per conception was higher (P<0.05) in the endometritis group (1.9) than in the non-endometritis group (1.6).

Discussion

The data presented here show that retained placenta, metabolic disorders and cow parity are important risk factors for postpartum endometritis, which increases the intervals from calving to first service and conception, decreases the first conception rate, and increases the number of services per conception in dairy herds in Korea. The incidence of postpartum endometritis in this study (36.6%) was similar to those reported by Markusfeld [30] and Heuwieser et al. [31], but the incidence was higher than some previously reported rates (16.9–22.4%; [1, 23, 32]) and lower than the rate (61.6%) reported by Gilbert et al. [15]. The different incidence rates of endometritis in these studies might be explained by the different diagnostic methods employed, different times of endometritis detection, different characteristics of the cows, or varied herd management practices [8, 23, 31, 33].

Endometritis was significantly associated with retained placenta, metabolic disorders and cow parity in this report. Increased risk of endometritis (odds ratio=5.67) in cows with retained placenta was consistent with the results (odds ratio=5.8) of Erb et al. [18] as well as most previous studies [4, 6, 8, 25, 34]. Retained placental membranes may serve as a perfect medium for bacterial growth [35], so that any treatment that reduces the severity of the ensuing endometritis would be beneficial in cows with retained placenta. Metabolic disorders (total cases of abomasal displacement, milk fever and ketosis) were also related to an increased risk of developing endometritis, consistent with previous reports [6, 10, 30]. Most metabolic diseases, including milk fever, ketosis and abomasal displacement, occur within the first two weeks of lactation [7, 36, 37]. During this period, the high demand for nutrients causes the body fat in cows to mobilize, which may result in the development of metabolic diseases such as milk fever and ketosis-fatty liver complex [38]. These unfavorable nutritional and metabolic conditions [4], in addition to decreased immune activity [39, 40] coupled with the common invasion of pathogens [41], during the periparturient period may increase the occurrence of endometritis. Our findings of an association between endometritis and increased parity were discordant with the results of Markusfeld [30] demonstrating a link between decreased parity and development of endometritis. On the other hand, parity and

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>S.E.M.</th>
<th>P</th>
<th>Odds ratio</th>
<th>95% Confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-1.58</td>
<td>0.31</td>
<td>&lt; 0.0001</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Retained placenta</td>
<td>1.73</td>
<td>0.31</td>
<td>&lt; 0.0001</td>
<td>5.67</td>
<td>[3.087, 10.387]</td>
</tr>
<tr>
<td>Metabolic disorders</td>
<td>1.26</td>
<td>0.57</td>
<td>0.0273</td>
<td>3.52</td>
<td>[1.152, 10.762]</td>
</tr>
<tr>
<td>Cow parity</td>
<td>0.24</td>
<td>0.12</td>
<td>0.0470</td>
<td>1.27</td>
<td>[1.003, 1.603]</td>
</tr>
</tbody>
</table>

Table 2. Risk factors for endometritis analyzed by a stepwise selection procedure on data from 320 Korean dairy cows

<table>
<thead>
<tr>
<th>Endometritis</th>
<th>Yes (n=84)</th>
<th>No (n=171)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interval from calving to first service (day)</td>
<td>100.9 ± 4.1</td>
<td>77.6 ± 2.5</td>
<td>P&lt;0.01</td>
</tr>
<tr>
<td>Interval from calving to conception (day)</td>
<td>149.2 ± 7.2</td>
<td>113.1 ± 5.3</td>
<td>P&lt;0.01</td>
</tr>
<tr>
<td>First service conception rate (%)</td>
<td>47.6</td>
<td>62.6</td>
<td>P&lt;0.05</td>
</tr>
<tr>
<td>Number of services per conception</td>
<td>1.9 ± 0.1</td>
<td>1.6 ± 0.1</td>
<td>P&lt;0.05</td>
</tr>
</tbody>
</table>

Table 3. Effect of postpartum endometritis on reproductive performance in Korean dairy cows

Values are means ± S.E.M.
endometritis have also been shown to have a u-shaped association [10, 35]. Specifically, Bruun et al. [35] reported that heifers are more susceptible to developing endometritis than second-parity cows, because damage to the uterus is more common in heifers, and third-parity cows are more likely to develop endometritis than second-parity cows due to delayed involution of the uterus and increased risk of infection. We speculate that the heifers in this study had less uterine damage than those evaluated in other studies, and increased parity, especially more than third parity, might predispose cows to postpartum uterine infection, which subsequently develops into endometritis.

Abnormal partus, BCS at 4 weeks postpartum, and calving season were eliminated from the final model, as these three factors did not influence the incidence of endometritis. Our finding that abnormal partus is not related to increased risk of endometritis is consistent with the study by Erb et al. [34], but previous studies reported a link between abnormal partus and endometritis [6, 10, 25, 30]. Markusfeld and Ezra [22] reported that damage inflicted on the uterine wall by an oversized fetus or over-conditioning might be a major factor in the etiology of endometritis. BCS at 4 weeks postpartum, at the time of endometritis diagnosis, did not significantly affect the incidence of endometritis in our study, which is consistent with the report of Waltner et al. [16], but Gearhart et al. [12] reported that cows over-conditioned at 30 days postpartum were more likely to have endometritis. Furthermore, Heuer et al. [7] reported that endometritis occurred between calving and 20 days postpartum more often in thin cows. These conflicting results suggest that BCS around 1 month postpartum is not consistently related to endometritis. In agreement with Bartlett et al. [1], we found that the calving season was not related to increased risk of endometritis, but Bamounin and Chacornac [42] and Bruun et al. [35] reported that during the winter months, cows are generally less healthy and thus more prone to infections, including endometritis. Different temperature ranges or management environments of countries or regions may account for these varied results.

Effects of endometritis on the intervals from calving to first service and conception, conception rate at first service and number of services per conception were evaluated. The intervals from calving to first service and conception were longer in the endometritis group than in the non-endometritis group, which is consistent with other reports [2, 17, 19]. In some studies, however, the interval from calving to first service was not different, but the interval from calving to conception was longer in cows with endometritis than in cows without endometritis [15, 43]. The conception rate at first service also was lower in the endometritis group than in the non-endometritis group. Most reports are consistent with our results [2, 18, 44], but some researchers found that endometritis did not negatively affect the conception rate at first service [11, 22]. A negative effect of endometritis on the number of services per conception has been reported previously [19, 45], but, in other reports, the number of services per conception in cows with endometritis and cows without endometritis did not vary [15, 46]. A recent meta-analysis revealed that endometritis was associated with more days to first service, lower conception rate at first service, and more days to conception, which is consistent with our results [20]. More recently, the results of LeBlanc et al. [23] also support our findings for the most part, as endometritis increased the average calving-to-first insemination and calving-to-conception intervals, and decreased the pregnancy rate to first service after calving, but they found no negative effect of endometritis on the number of AI per conception.

In conclusion, retained placenta, metabolic disorders and cow parity are important risk factors for postpartum endometritis, which increases intervals from calving to first service and conception, decreases the first conception rate, and increases the number of services per conception in dairy herds in Korea.

Acknowledgements

This work was supported by grant No. R11-2002-100-02002-0 from the ERC program of the Korean Science & Engineering Foundation. The authors thank Dr. Daehyun Chung, Department of Statistics, Chungbuk National University, Korea for statistical analysis of the data.
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