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F-AH-1: Mastitis Effects on Reproduction

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Mastitis is the inflammation of the mammary gland, which is usually correlated with intramammary infection most commonly caused by bacteria. Clinical mastitis is manifested by visible signs of infection like secretion of abnormal milk (i.e. watery milk, presence of flakes in milk, etc.) and/or inflammation (i.e. redness, swelling, hardness, etc.) of the mammary gland. Sub-clinical mastitis, on the other hand, has no visible signs and is defined by composite milk samples with >200,000 somatic cells/mL of milk (linear somatic cell count - **LSCC** >4) The costs associated with mastitis are many and include antibiotic treatment, discarded milk, reduced milk quality (i.e. increased SCC and reduced fat and protein content), increased culling rates, and reduced milk yield. Another cost that is often taken for granted is reduced fertility.

Before discussing what the existing literature demonstrates in regards to the association between mastitis and reproductive performance, it is important to note that these are mostly retrospective studies in which diagnosis of clinical mastitis and recording of mastitis events were performed by farm personnel. Therefore, inherent variations in diagnosis and recording of mastitis events among dairies/studies exist and may account for differences in reported findings. Regardless of possible variations in diagnosis and recording of mastitis, compelling data demonstrate a significant negative association between mastitis and reproductive performance.

A few studies have evaluated the association between mastitis and reproductive performance. In these studies, cows were classified as having had mastitis before first postpartum AI (MG1), mastitis between first postpartum AI and pregnancy diagnosis (MG2), mastitis after pregnancy diagnosis (MG3), or no mastitis (control). These studies demonstrate that occurrence of mastitis is associated with prolonged interval to first postpartum AI, increased service per conception, and prolonged interval from calving to conception (Table 1).

Table 1. Association between occurrence of mastitis and reproductive parameters.

	MG1[1]	**MG2**[1]	**MG3**[1]	**Control**[1]	**MG3+ Control**[1]	**Reference**
Days in milk at first AI	75.7 ± 1.8^{a}	$75.2 \pm 4.4^{a,b}$	---	---	67.8 ± 2.2^{b}	Schrick et al., 2001
	68 ± 1.9^{b}	58.5 ± 2.3^{a}	$62.3 \pm 2.6^{a,b}$	$64 \pm 1.4^{a,b}$	---	Santos et al., 2004
Services per conception	1.6 ± 0.3^{a}	2.9 ± 0.3^{b}	---	---	1.7 ± 0.1^{a}	Barker et al., 1998
	2 ± 0.3^{a}	3.1 ± 0.1^{b}	---	---	1.6 ± 0.2^{c}	Schrick et al., 2001
	2.6 ± 0.1^{a}	3.1 ± 0.2^{b}	$2.5 \pm 0.2^{a,b}$	$2.6 \pm 0.1^{a,b}$	---	Santos et al., 2004
Interval to conception	113.7 ± 10.8^{a}	136.6 ± 13.3^{a}	---	---	92.1 ± 4.6^{b}	Barker et al., 1998
	106.2 ± 4.8^{a}	143.5 ± 11.4^{b}	---	---	85.4 ± 5.8^{c}	Schrick et al., 2001
	165 ± 5.7^{a}	189.4 ± 7.2^{b}	118.4 ± 6.4^{c}	139.7 ± 3.7^{d}	---	Santos et al., 2004

[1]Classification of mastitis occurrence: MG1 = mastitis between calving and first AI, MG2 = mastitis between first AI and pregnancy diagnosis, MG3 = mastitis after pregnancy diagnosis, Control = no mastitis, MG3+Control = mastitis after pregnancy diagnosis+no mastitis.

[a,b,c,d] Within row, different superscripts indicate difference ($P < 0.05$).

In the study by Santos et al. (2004), it was also demonstrated that the percentage of cows pregnant to first AI and percentage of cows pregnant at 320 days postpartum was smallest for MG1 (22.1 and 72.3%) and MG2 (10.2 and 58.5%) cows, whereas MG3 (37.9 and 93.1%) and control (28.7 and 85.4%) cows did not differ. Furthermore, cows that had mastitis at any interval relative to first postpartum AI were more likely to have abortion (MG1 = 11.8%, MG2 = 11.6%, MG3 = 9.7%, control = 5.8%; Santos et al., 2004).

Other studies have also clearly demonstrated the association between occurrence of clinical and subclinical mastitis and pregnancy losses. Figure 1 demonstrates the association among clinical (Risco et al., 1999; Chebel et al., 2004) and subclinical mastitis, defined as LSCC $\geq$4.5, and pregnancy losses (Moore et al., 2005). It is interesting to note that these studies demonstrated that a cow diagnosed pregnant at 30 to 45 d after AI that had mastitis before first pregnancy diagnosis were still at higher risk of pregnancy loss/abortions than those that did not have mastitis. These are important findings because they demonstrate that mastitis that occurs during early pregnancy (before 30 to 40 d after AI) may not only cause immediate embryonic death and reduced pregnancy per AI as demonstrated by Santos et al. (2004) but may also have deleterious effects to fetal development, consequently increasing incidence of abortions.

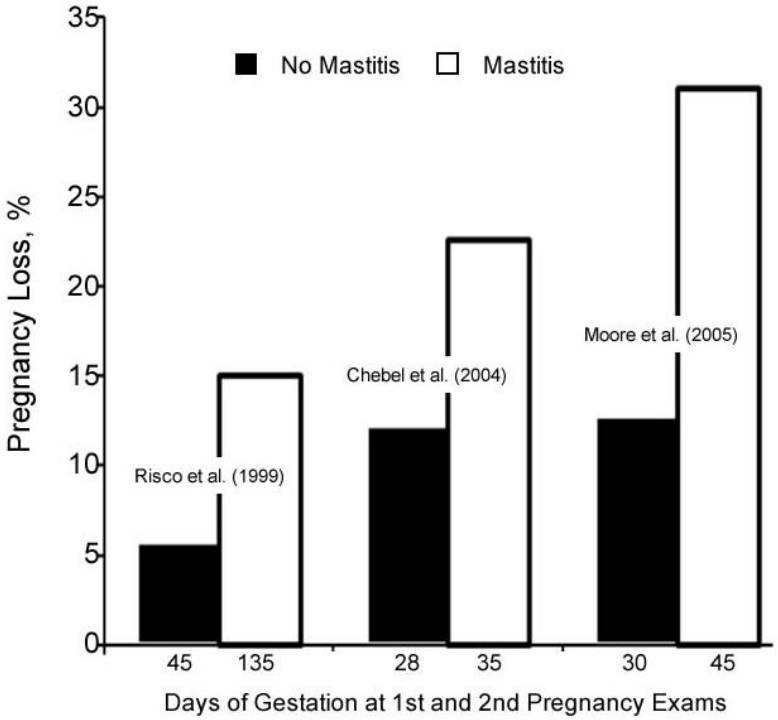

Figure 1. Incidence of pregnancy loss according to occurrence of mastitis. Days of gestation at the first and second, respectively, pregnancy exams according to studies were: Risco et al. (1999) = 45 and 135 d; Chebel et al. (2004) = 28 and 35 d; Moore et al. (2005) = 30 and 45 d.

Ultimately, because mastitis prevents ovulation and resumption of cyclicity after calving (i.e. extended interval to first AI), reduces fertilization rates and embryo development (i.e. reduced pregnancy per AI), and compromises embryonic development and pregnancy establishment and maintenance (i.e. reduced embryonic/fetal survival and increased incidence of abortions) cows that have mastitis at any interval after calving have reduced pregnancy rate, which results in significant economic losses to dairy herds. In a recent study conducted in two dairy herds in CA in which approximately 9,000 lactations were evaluated we demonstrated that the hazard ratio for pregnancy was 1.25 (95% CI = 1.19, 1.32) for cows without mastitis, which means that the speed at which cows without mastitis became pregnant was 25% faster than cows with mastitis (Mendonça and Chebel et al., 2011). The median interval from calving to pregnancy (interval after calving at which 50% of cows are pregnant) for cows without mastitis was 128 d, whereas cows that had mastitis had a median interval from calving to pregnancy of 154 d (Figure 2; Mendonça and Chebel et al., 2011).

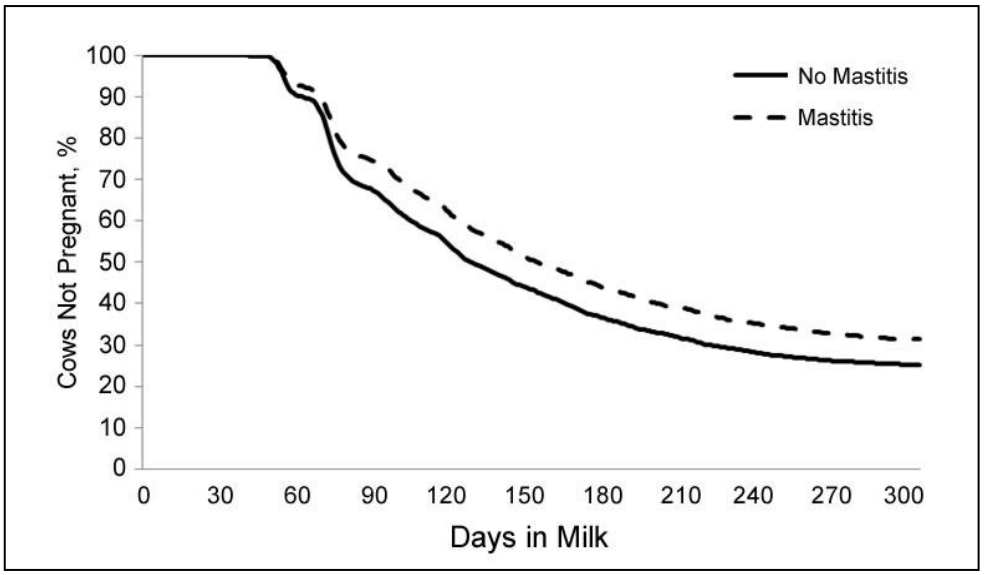

Figure 2. Association between occurrence of mastitis and speed at which cows become pregnant (Mendonça and Chebel et al., 2011).

The same graph displayed in Figure 2 can easily be generated on farm using Dairy Comp 305 by using a command such as "GRAPH DOPN FOR XMAST = 0 WITH XMAST > 0\S" in which "DOPN" stands for days open and "XMAST" stands for number of mastitis cases in the current lactation. Although Dairy Comp 305 is not statistical software this graph can be used to understand the impact of mastitis at a herd level.

Ultimately, reducing mastitis incidence must be a goal for dairy producers not only because of milk quality and the direct costs of mastitis, but also because of the indirect cost of mastitis and its effects on reproduction. For example, in the study by Mendonça and Chebel (2011) the yearly incidence of mastitis was approximately 35% and the median interval from calving to pregnancy was 26 d longer for cows with mastitis compared with cows without mastitis. If the average cost of one day open is $ 2/d, the 'reproduction' cost of mastitis was $ 52/case in that study. Therefore, in a herd of 1,000 lactating cows, by reducing the yearly incidence of mastitis from 35% to 25% the expected savings due to improved reproductive performance is approximately $5,000.

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