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Effects of artificial insemination on the incidence of long return intervals

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ABSTRACT

The Phantom Cow Syndrome is a major impediment to achieving compact conception patterns in Victorian herds. Some inseminated cows fail to return for a further insemination even though they are not pregnant because the corpus luteum formed following insemination is maintained for an extended period. Five years of records were obtained from a herd of Holstein cows in Northern Victoria. Each cow was fitted with a hock tag that combined electronic identification with pedometer monitoring for oestrus. It was the only detection method used within a herd of up to 550 cows that had three AB programs of 6 to 8 weeks in each year. There were periods when cows detected in oestrus would be inseminated and others when they would not. Records were available for 2777 inseminations. The return intervals following these inseminations were classified as: Short (<18 days); Normal (18 to 24 days); or Long (>24 days). The overall conception rate for the 2777 inseminations made from 41 days to 160 days post-calving was 41.7%. The 417 Long intervals represented 15% of all inseminations and 25.8% of cows not confirmed pregnant to a preceding insemination. Only 54 of 1459 oestrus events (3.7%) not associated with an insemination were followed by a Long cycle ($p<0.001$). The proportion of Long returns declined linearly from 19.9% among the 738 cows inseminated from 41 to 60 days post-calving to 7.4% among the 189 cows inseminated from 141 to 160 days post-calving. These results demonstrated that the percentage of Long return intervals increased significantly following insemination. The magnitude of this increase declined with an increase in the interval from calving to insemination.

Keywords: Holstein cows; insemination; return intervals; oestrous cycles

INTRODUCTION

A significant result from the Australian InCalf Project was that the average submission rate (SR) during the second 3 weeks of the AB program in 123 seasonally calving herds was less than during the first 3 weeks (69% vs 77%; Morton, 2000). This decline included cows inseminated during the first 3 weeks but confirmed as not being pregnant to that insemination. Their 4-to-6 week SR was 72%. Subsequent studies in Victorian herds in which cows were synchronised using a CIDR insert combined with injections of oestradiol and prostaglandin $F_{2\alpha}$ (Cavalieri *et al*., 2006) showed that around 25% of cows palpated as not being pregnant to a first insemination did not re-cycle around 3 weeks after that insemination. This incidence was similar in herds where cows were allowed to re-cycle spontaneously, or where they were re-synchronised (Cavalieri *et al*., 2003a). This failure to re-cycle was not observed in cows that had not been inseminated following initial synchronisation (Cavalieri *et al*., 2003b). It has been described as the Phantom Cow Syndrome and it affects around 13% of Holstein cows in Victorian herds (Cavalieri *et al*., 2006). The factors associated with the incidence of this Syndrome include: interval from calving to the start of the AB program (Mating Start Date; MSD), milk protein concentration, age, previous breeding history (carry over cow) (D.P.Nation, pers. comm.) and breed (personal observation). The effect of each of these identified factors on the Syndrome's incidence has been derived mainly from records in herds that relied on visually observing cows for oestrus combined with the strategic use of tailpaint and heat-mount detectors. An opportunity arose to use computerised records derived from a herd in Northern Victoria that relied entirely on a pedometer within a transponder strapped to the hock of each cow to continually monitor for oestrus. This had the advantage of eliminating the incidence of human error in the detection of oestrus within this herd.

Five years of records from this herd were analysed to test the following hypotheses:

(i) that the percentage of normal oestrous cycles (of 18 to 24) days will be higher in cows that are not inseminated and are allowed to re-cycle than in cows that have been inseminated but are subsequently palpated as not being pregnant; and,

(ii) that the percentage of extended cycles (> 24 days) will be higher in the inseminated non-pregnant cows, with the frequency being associated with the post-calving interval at the time of insemination.

MATERIAL AND METHODS

Herd details

A data base was developed from the use of a farm management computer program (Afi FARM^{TM}, Afi Kim, Israel) when used in a herd of up to 600 Holstein cows located in Northern Victoria. Records were retrieved for 1999 through 2003 during which time average 305-day yield increased from 6500 to 7900 litres. One module of the computer program (Afi ACT) was an oestrus detection system that utilised a hock transponder as a pedometer for measuring changes in cow activity as well as for cow identification. The herd had three periods of AB-use of 6 to 8 weeks throughout each year. This meant oestrus "events" were recorded when cows cycled without being inseminated as well as following a first insemination or re-insemination.

Data classification

Each transponder was interrogated twice daily as a cow entered a bail on a rotary milking platform. An algorithm specifically modified for use in this herd transformed activity data into indices that were associated with increased activity during the period of oestrus. Pregnancy status was confirmed following an interval of 7 to 12 weeks without re-insemination. The inter-oestrus intervals were classified as "With AB" or with "No AB" depending on whether the initial record of oestrus (i^{th}) was associated with an insemination. They were then classified according to the post-calving interval on the date of the i^{th} record into six 20-day periods (41 to 60 days was Period 1; 141 to 160 days was Period 6). Within each Period, every inter-oestrus interval was classified as being Short (<18 days), Normal (18 to 24 days) or Long (>24 days; Macmillan, 1975).

Statistical analyses

Fisher's exact test was performed to study the effect of AI on the patterns of inter-oestrus intervals for "No AB" vs "With AB". The 'binreg' procedure with the risk-difference option in Stata statistical software (StataCorp, Release 9.1.2005) was used to assess trends over the six Periods for each of the three classified intervals (Short, Normal and Long), as well as changes in conception rate associated with post-calving interval. This procedure fits generalized linear models to the binomial family.

RESULTS

The database provided results associated with 1459 inter-oestrus intervals without insemination as well as results following 2777 inseminations (Table 1). The overall conception rate for these inseminations was 41.7% with no significant effect due to post-calving period (Table 1; p=0.44). There were 1618 post-insemination intervals for cows that failed to conceive (Table 1).

TABLE 1: Number of inseminations and number of return intervals in cows classified "With AB" and number of cycles in cows classified as "No AB" during six 20-day periods from 41 days (Period 1) and up to 160 days (Period 6) post-calving as well as the conception rates (CR) and 28-day non-return rates (28d NR) for the inseminated cows.

Period	With AB				No AB
	No. insems.	No. returns	CR (%)	28d NR (%)	No. cycles
1	738	435	41.1	61.0	384
2	616	364	40.9	57.5	320
3	553	315	43.0	56.2	276
4	401	240	40.1	53.9	230
5	280	158	43.6	52.9	148
6	189	106	43.9	51.3	101
1 to 6	**2777**	**1618**	**41.7**	**56.7**	**1459**

The overall percentage of Short cycles was similar for both groups of cows (1.9% vs 1.4%; p=0.25) with no trends associated with post-calving period (Table 2). By contrast, the "With AB" cows not confirmed pregnant had fewer Normal cycles (72.9% vs 94.4%; p <0.001) and more Long cycles (25.8% vs 3.7%; p<0.001; Table 2).

TABLE 2: Percentage distribution of Short (< 18 days), Normal (18 to 24 days) and Long (> 25 days) returns following inseminations (+AB; n=1618) made during six periods each of 20 days from 41 days (Period 1) to 160 days (Period 6) post-calving and the distribution of inter-oestrus intervals in cows not inseminated (-AB; n=1459).

Period	% < 18 days		% 18 to 24 days		% > 24 days	
	+ AB	- AB	+ AB	- AB	+ AB	- AB
1	1.6	2.3	64.6	93.7	33.8	3.9
2	0.8	1.9	71.1	94.4	28.0	3.7
3	1.9	1.4	74.9	94.6	23.2	4.0
4	1.3	0.9	75.8	95.2	22.9	3.9
5	1.3	2.0	82.3	95.3	16.5	2.7
6	0.9	4.0	85.8	93.1	13.2	3.0
1 to 6	**1.4**	**1.9**	**72.9**	**94.4**	**25.8**	**3.7**

The percentages of Normal and Long cycles among the "No AB" cows were not

influenced by post-calving period (Table 2). By contrast, time trends were significant with the Normal and Long cycles recorded among the inseminated cows ($p<0.001$). In the case of Normal cycles, they increased linearly from 64.6% to 85.8% (Table 2). Conversely, Long intervals decreased linearly from 33.8% to 13.2%. Although the percentage of Long cycles was always greater among cows classified "With AB", they declined from being 29.9% higher in Period 1 down to 10.2% higher during Period 6 (interaction: $p<0.001$).

Every cycle or return interval of more than 24 days was classified as a Long interval. However, none of the inseminated cows that failed to conceive had a return interval of 25 to 27 days. This meant that a 28-day non-return rate could be calculated for each Period by adding the percentage of Long intervals for all of the inseminated cows in that Period to the conception rate. The overall 28-day non-return rate for the 2777 inseminations was 56.7% (Table 1). It decreased linearly from 61.0% in Period 1 to 51.3% in Period 6 ($p<0.01$).

DISCUSSION

No alternative system for detecting oestrus was used to assess the reliability (sensitivity and specificity) of the pedometers as the sole system for detection among cows in this herd. However, the distributions for each of the three types of interval were highly repeatable for monitoring behavioral oestrus among the "No AB" cows across the six post-calving periods. The prevalence of Short cycles among these cows was remarkably low (1.9%; Table 2). They recorded almost twice as many Long cycles (3.7%), but there was no indication that the pedometer system missed many oestrus events around 21 days to then record a Long cycle of around 42 days duration. The percentage of Long cycles in this herd was not as high as that reported among Holstein cows in British herds monitored using milk progesterone concentrations (Lamming & Darwash, 1998).

The higher percentage of Long return intervals was expected among inseminated cows. The effects of embryonic or foetal death can occur only as a sequel to inseminating. The lowest percentage of Long intervals was 13.2% amongst cows inseminated during Period 6. This was equivalent to 7.4% of all of the 189 inseminations made during this Period compared to 3.0% of Long cycles among the 101 "No AB" cows in this same Period. The highest percentage of Long intervals was among cows inseminated during Period 1 (19.9% of all inseminations and 33.8% among cows not confirmed pregnant to these inseminations). The average rate of decline in Long intervals over the six Periods was 2.4% per Period for all inseminations, or 4.0% among cows that were not confirmed pregnant.

Cows that had failed to return to oestrus following inseminations made during a period of AB-use of 6 to 8 weeks were routinely pregnancy tested by palpation of uterine contents about 6 weeks after the AB period when they were expected to be from 6 to 12 weeks pregnant. If a cow was not confirmed pregnant, it was treated with a single injection of a prostaglandin to luteolyse the persisting corpus luteum and to ensure the cow recommenced cycling. This practice meant that the frequency of Long cycles (>24 days) could be measured but not their distribution.

Herd owners frequently use a 4-week non-return rate as an indicator of a herd's likely conception rate. This practice is based on the assumption that most cows that fail to conceive to a preceding insemination will be detected in oestrus from 18 to 24 days later. The data derived from this particular herd showed that the conception rate remained relatively constant from Periods 1 to 6 (41.7%; Table 1) while the non-return rate declined from 61.0 % in Period 1 to 51.3 % in Period 6 (Table 1). The differences between the two measures of reproductive performance were due to the association between the percentage of Long returns post-insemination and the post-calving interval to insemination (Table 2).

The increasing awareness of conceptus failure occurring after the maternal recognition of pregnancy at about 17 to 20 days post-insemination, but before placentation has been substantially completed at about 42 days, has been described as "late embryonic" death or "early foetal" death (Santos *et al.,* 2004). The former losses occur immediately following the maternal recognition of pregnancy after the embryo has inhibited the initiation of luteolysis by interferon tau (Thatcher *et al.,*2001). "Early foetal" deaths occur during the period of placental attachment. The results derived from this single herd could not be used to distinguish between these two forms of loss. However, the absence of return intervals of 25, 26 or 27 days among the inseminated cows may indicate that early foetal death was the more common form of loss.

The results from this study have produced at least three outcomes of practical significance to herd breeding management. The first is that any increase in the prevalence of Long return intervals associated with the Phantom Cow Syndrome will compromise the likelihood of achieving a concentrated conception pattern for a herd of Holstein cows. Secondly, later calving cows are

more likely to be inseminated within 60 days of calving and they are also more likely to become victims of this Syndrome (Cavalieri *et al.*, 2006), consequently failing to conceive during a seasonally concentrated AB program. Finally, the use of the 28-day non-return rate as an indicator of a herd's reproductive performance following the first 3 weeks of an AB program will prove to be misleading in many cases, especially in herds where Holstein cows are being inseminated within 60 days of calving.

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