New Information on Timed Breeding Protocols for Lactating Dairy Cows

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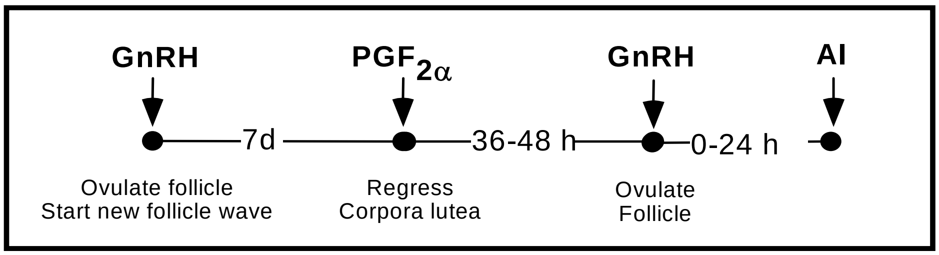
Take Home Messages

- Synchronization of ovulation and timed AI improves pregnancy rate in a dairy herd by increasing AI service rate.
- Timed AI to synchronization of ovulation results in conception rates similar to that of AI to a standing estrus.
- Timed AI after synchronization of ovulation can be conducted any time from 8 to 24 hours after the second GnRH injection of the protocol.
- Ovsynch is a cost-effective tool for managing reproduction in lactating dairy cows.
- Reducing the dose of GnRH by 50% can reduce the hormone costs associated with using Ovsynch.

Synchronization of Ovulation Using Ovsynch

The Ovsynch protocol involves two hormones that are approved for use in lactating dairy cows and are available to producers through a veterinarian. Figure 1 illustrates the injection protocol and the purpose of each injection. Administered at a random stage of the estrous cycle, the first injection of GnRH induces ovulation in 65% of cows and causes emergence of a new follicular wave in 100% of cows. The $PGF_{2\alpha}$ injection regresses the spontaneous and/or GnRH-induced corpora lutea, and the second GnRH injection synchronizes the time of ovulation of the dominant follicle of the follicular wave that began growing after the first GnRH injection.

Because Ovsynch synchronizes ovulation rather than estrus, dairy managers no longer need to rely solely on estrus detection, which is inefficient on most dairy operations, to breed their cows. Second, because ovulation is precisely synchronized using Ovsynch, lactating dairy cows can be bred by appointment while maintaining a conception rate similar to that of cows bred to an estrus.



Third, Ovsynch may induce anestrus cows to ovulate and initiate cyclicity.

Figure 1. Timing and purpose of hormonal injections for synchronizing ovulation in lactating dairy cows (Ovsynch).

▪ Ovsynch Increases Service Rate

Service rate is defined as the percentage of eligible cows bred during a 21-day period. In herds using AI, the service rate directly reflects estrus detection efficiency because a cow must first be detected in estrus before she can be bred. Unfortunately, less than 50% of all estrus periods are accurately detected on an average dairy farm in the United States (Senger, 1994). This inefficiency in estrus detection not only increases time to first AI but can increase the average interval between services to 40 to 50 days (Stevenson and Call, 1983).

To determine the effectiveness of using Ovsynch for reproductive management of lactating cows, cows (n = 333) from three Wisconsin dairy herds were randomly assigned at parturition to one of two groups (Pursley et al., 1997a). Reproduction for control cows was managed using the typical reproductive management procedure in place on each farm (i.e., estrus detection, AM/PM breeding, and periodic use of $PGF_{2\alpha}$). Reproduction for Ovsynch-treated cows was managed by timed AI after the Ovsynch protocol on the same day each week. Pregnancy status was determined 32 days after AI for both groups by using transrectal ultrasonography. Nonpregnant cows were reinseminated using the same treatment until diagnosed pregnant or culled from the herd.

Median days to 1st AI (Figure 2 left panel; 54 vs. 83 days) and average days open (Figure 2 right panel; 99 vs. 118 days) were less for Ovsynch-treated cows than for control cows. Pregnancy rate to first AI was similar (37% vs. 39%) for both groups even though Ovsynch cows were bred earlier postpartum. Service rate is dramatically improved using Ovsynch because all eligible cows are routinely serviced on a given day of lactation regardless of estrus detection.

Thus, Ovsynch improves reproductive performance of lactating dairy cows by increasing service rate, allows for timed AI, and eliminates reliance on estrus detection for AI compared with standard reproductive management.

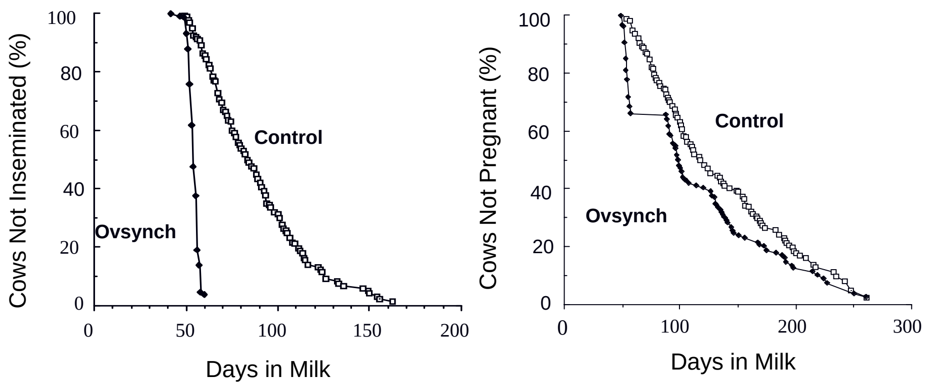


Figure 2. Survival curves for days to first AI (left panel) and days open (right panel) for cows that received AI after a detected estrus (Control) and cows that received appointment AI after synchronization of ovulation (Ovsynch). Median days to first AI and average days open were less for Ovsynch than for Control cows, and pregnancy rate to first AI was similar for both groups. (Adapted from Pursley et al., 1997a).

▪ Ovsynch Does Not Alter PR/AI

Dairy cow fertility commonly is measured by calculating the percentage of cows that conceive after a single AI service, also known as the pregnancy rate per artificial insemination (PR/AI). Pregnancy rate per AI in lactating dairy cows has decreased from 66% in 1951 (Spalding et al., 1974), to about 50% in 1975 (Spalding et al., 1974; Macmillan and Watson, 1975), to about 40% in 1997 (Butler et al., 1995; Pursley et al., 1997a), whereas PR/AI in heifers has remained at 70% during this same period (Spalding et al., 1974; Foote, 1975; Pursley et al., 1997b).

Ovsynch improves reproductive efficiency of lactating dairy cows by increasing service rate, however, PR/AI in response to timed AI after Ovsynch is similar to PR/AI in response to AI after a detected estrus. Table 1 shows the results from two experiments comparing PR/AI of lactating cows receiving AI after a detected estrus (Control) or timed AI after synchronization of ovulation (Ovsynch; Pursley et al., 1997b). For both experiments, PR/AI did not differ between groups. Thus, timed AI after Ovsynch results in normal fertility without the need for estrus detection.

Table 1. Pregnancy rate per AI (PR/AI) of lactating cows and heifers receiving AI after a detected estrus (Control) or timed AI after synchronization of ovulation (Ovsynch).

		Number of	**PR/AI**	
	Experiment	**Animals**	**Control**	**Ovsynch**
Lactating Cows	1	546	42%	39%
	2	311	39%	39%
Heifers	2	155	74%	35%*

*Differs from Control, $p<0.01$.
(Adapted from Pursley et al., 1997b)

In addition, the effectiveness of Ovsynch for synchronization of ovulation in dairy heifers was assessed in Experiment 2 (Table 1). PR/AI was greater ($p<0.01$) for heifers receiving AI after a detected estrus (Control) compared with heifers receiving timed AI after synchronization of ovulation (Ovsynch). Based on these results, Ovsynch is not recommended as a method for synchronizing and breeding dairy heifers. Although not fully understood, the difference in the efficacy of Ovsynch between lactating cows and heifers is related to differences in the patterns of follicular growth between lactating cows and heifers during the estrous cycle.

▪ Cows are Bred at the Voluntary Waiting Period

Many dairy producers designate an early voluntary waiting period (e.g., 40 to 50 days) to reduce the number of non-pregnant cows in their herd during late lactation. This is problematic because cows that conceive shortly after this early voluntary waiting period spend fewer total days in lactation and, therefore, may be as costly to an operation as cows that conceive later during lactation. An important advantage of using Ovsynch for managing reproduction in lactating dairy cows is that first AI service occurs at or near the voluntary waiting period selected by the producer because all eligible cows are serviced regardless of estrus detection. Reducing days to first AI with Ovsynch reduces average days open in a herd because many cows in herds that rely on estrus detection for breeding do not receive their first service until later during lactation (see Figure 2, right panel) because of inefficient estrus detection and anestrus cows. Ovsynch may also induce anestrus cows to ovulate, thereby increasing the opportunity for these cows to conceive earlier during lactation and closer to the voluntary waiting period.

Table 2. Days-in-milk (DIM) and pregnancy rate per artificial insemination (PR/AI) after first and second service for lactating cows receiving AI after a detected estrus (Control) or timed AI after synchronization of ovulation (Ovsynch).

	Control		Ovsynch	
Service	**DIM**	**PR/AI**	**DIM**	**PR/AI**
1^{st}	83	39%	54*	37%
2^{nd}	128	45%	96*	42%

*Differs from Control, $p<0.01$.
(Adapted from Pursley et al., 1997a)

Table 2 shows days-in-milk (DIM) and PR/AI after first and second service for lactating cows receiving AI after a detected estrus (Control) or timed AI after synchronization of ovulation (Ovsynch). Reproduction for control cows was managed using the typical reproductive management procedure in place on each farm (i.e., estrus detection, AM/PM breeding, and periodic use of $PGF_{2\alpha}$), and reproduction for Ovsynch-treated cows was managed by timed AI after the Ovsynch protocol on the same day each week. Pregnancy status was determined 32 days after AI for both groups by using transrectal ultrasonography, and nonpregnant cows were reinseminated using the same treatment until diagnosed pregnant or culled from the herd.

First and second service AI occurred earlier ($p<0.01$) for Ovsynch cows compared with Control cows, whereas PR/AI did not differ between groups. For this experiment, the voluntary waiting period was 50 days, however, PR/AI was 5 to 6% less for first service compared with second service AI. Thus, it may be more profitable to breed cows with Ovsynch after 70 DIM because of the improved PR/AI and the extended length of lactation.

Another interesting observation from the data in Table 2 is the interval from first to second service between groups. Because cows in the Ovsynch group were not allowed to be bred to an estrus, the 42-day interval between first and second service was experimentally determined by the 32-day interval from AI to the pregnancy diagnosis using ultrasound plus the additional 10-day interval to resynchronize the cows using Ovsynch. In contrast, the interval between first and second service for Control cows was 45 days despite the fact that these cows could be bred at any detected estrus. Thus, an average of one estrus period was not detected between services when managers relied on estrus detection alone to breed their cows.

▪ Timing of AI after Ovsynch

Table 3. Pregnancy rate per artificial insemination (PR/AI), pregnancy loss, and calving rate after timed AI at 0, 8, 16, 24, and 32 hours after the second GnRH injection of Ovsynch.

	Hours from second GnRH injection to AI				
Item	**0**	**8**	**16**	**24**	**32**
# of cows	149	148	149	143	143
PR / AI (%)	37[a]	41[a]	45[a]	41[a]	32[b]
Pregnancy Loss (%)	9[a]	21[b]	21[b]	21[b]	30[c]
Calving Rate (%)	32[a]	34[a]	36[a]	32[a]	23[b]

[a,b,c]Within a row, means with different superscripts differ ($p < 0.05$)
(Adapted from Pursley et al., 1998)

To assess the optimal time of AI in relation to synchronized ovulation, lactating dairy cows (n = 733) from Wisconsin dairy herds with 22,000 to 26,000 pound rolling herd averages were randomly assigned to five groups by stage of lactation and parity (Pursley et al., 1998). Ovulation was synchronized using Ovsynch, and cows received AI at 0, 8, 16, 24, or 32 hours after the second injection of GnRH. As determined in a preliminary study, all cows ovulate 24 to 32 hours after the second GnRH injection. Injection times were varied so that all cows were inseminated at the same time, and the inseminators were blind to treatment groups. Pregnancy status was determined 25 to 35 days after AI for all groups by using transrectal ultrasonography. PR/AI and calving rate was greater (p<0.05) for cows in the 0, 8, 16, and 24 hour groups compared with the 32 hour group (Table 3). Pregnancy loss was less (p<0.05) for the 0 hour group compared with all other groups, and there was a tendency for greater pregnancy loss in the 32 hour group (p<0.1; Table 3). Thus, no statistical difference in PR/AI occurs when breeding from 0 to 24 hours after the second GnRH injection, however, breeding too late (i.e., at 32 hours) decreases PR/AI. These results agree with data indicating that timing of AI can vary widely in relation to onset of estrus behavior (Dransfield et al., 1998) but may result in optimal conception rates when conducted from 7 to 12 hours (Hall et al., 1959) or 4 to 12 hours (Dransfield et al., 1998) after the onset of estrus behavior.

▪ Economics of Using Ovsynch

One of the most common objections to using Ovsynch is the overall cost of the hormones needed to synchronize ovulation. A recent study compared reproductive management using Ovsynch and timed AI with reproductive management using $PGF_{2\alpha}$ and AI after a detected estrus in a large, confinement-housed dairy herd in east-central Wisconsin (Britt and Gaska, 1998). Lactating cows eligible for breeding were rectally palpated by a veterinarian and randomly assigned to one of two groups. Cows in the first group (Ovsynch) received an injection of GnRH on Day 0, $PGF_{2\alpha}$ on Day 7, and a second GnRH injection on Day 8. Cows in the other group (PP) that had a palpable corpus luteum received an injection of $PGF_{2\alpha}$, and an estrus detection device (Kamar, Portland, ME) was affixed to the cow's tail head. Cows in the Ovsynch group received AI 17 hours after the second GnRH injection without regard to estrus behavior, whereas cows in the PP group received AI only if they were observed in estrus or if they had an activated heat detection device. Pregnancy status was determined for cows in both groups by rectal palpation 34 to 41 days post-AI.

Table 4. Variables for two groups of cows in two estrus synchronization programs*

Item	**Ovsynch**	**PP**
No. of Cows	98	99
Service rate (%)	100[a]	58[b]
Conception rate (%)	47	32
Pregnancy rate (%)	47[a]	18[b]
Services / conception	2.13	3.17

[a,b]Within an item, means with different superscripts differ (p<0.05).
(Adapted from Britt and Gaska, 1998)

Table 4 compares reproductive performance between cows in each treatment group. Service rate was greater for cows in the Ovsynch group because cows in the PP group only received AI if detected in estrus, whereas all cows in the Ovsynch group received timed-AI without regard to estrus behavior. Although conception rate did not differ statistically between groups, differences in service rate resulted in a dramatically improved pregnancy rate compared with cows in the PP group.

Table 5 shows an economic analysis of costs per pregnancy associated with cows in each treatment group. Costs included in the analysis were for hormones, estrus detection devices, semen, labor for estrus detection, and costs for additional days open. Costs for hormones were estimated by surveying veterinarians at four clinical practices in Wisconsin. Additional labor costs were not assigned to the Ovsynch group for the additional injections, because it was estimated that the time required for the injections would equal the time required to affix the estrus detection device on cows in the PP group. Analysis of results from this study revealed an economic advantage of $29.14 per pregnancy for cows in the Ovsynch group compared with cows in the PP group.

Table 5. Economic analysis of two estrus synchronization programs*

		Ovsynch		PP	
Variable	**$ / Unit**	**No. of Units**	**Cost ($)†**	**No. of Units**	**Cost ($)‡**
GnRH	5.52	4.26	23.52	0	0
$PGF_{2\alpha}$	3.30	2.13	7.02	5.56	18.35
Estrus detection device	1.00	0	0	5.56	5.56
Semen	6.00	2.13	12.78	3.17	19.02
Labor	10.00	0	0	1.90	19.00
Additional days open	1.00	0	0	10.53	10.53
Total cost			43.32		72.46

†Cost per pregnancy determined by analyzing data from 47 pregnancies.
‡Cost per pregnancy determined by analyzing data from 18 pregnancies
(Britt and Gaska, 1998)

Reducing the cost of Ovsynch

The current recommendations for Ovsynch call for using the standard doses of $PGF_{2\alpha}$ (5 ml or 25 mg) and GnRH (2 ml or 100 μg) recommended by the product manufacturers. The retail cost of GnRH contributes the majority of the hormone costs associated with using Ovsynch. Based on previous research, we felt that reducing the dose of $PGF_{2\alpha}$ would probably decrease the effectiveness of the Ovsynch protocol. However, our preliminary data suggested that one half the dose of GnRH might work equally as well as the full dose of GnRH in the Ovsynch protocol.

To determine if reducing the dose of GnRH would be an effective way to decrease the cost of using Ovsynch, we conducted a field trial on a 630-cow dairy herd located in south central Wisconsin (Fricke et al., 1998). Lactating dairy cows were randomly assigned so that 119 cows received the full-dose (100 μg) of GnRH for both injections, and 118 cows received a half-dose (50 μg) of GnRH for both injections. The amount of $PGF_{2\alpha}$ given to cows in both groups was the same (25 mg). All cows in the study were bred by timed AI at 12 to 18 hours after the second GnRH injection without regard to estrus behavior.

The first method we used to compare the effectiveness of the full-dose and half-dose Ovsynch protocols was to determine the percentage of cows in which ovulation was synchronized in response to the second GnRH injection. We call this the synchronization rate, and we determined it by using ultrasound to detect the presence of a follicle on the day of the second GnRH injection and ovulation of that follicle at an ultrasound examination 48 hours later. There was no difference in synchronization rate between the full-dose and half-dose treatment groups (Table 6).

Table 6. Synchronization rate and conception rates in lactating dairy cows in response to timed-AI after Ovsynch using either 100 μg (full-dose) or 50 μg (half-dose) of GnRH per injection.

	Treatment group	
Item	**Full-dose of GnRH**	**Half-dose of GnRH**
Synchronization rate	84.9%	83.1%
(synchronized / total)	(101/119)	(98/118)
Conception rate		
28 days post AI	41.0%	41.1%
(pregnant / total)	(48/117)	(46/112)
56 days post AI	33.6%	35.1%
(pregnant / total)	(38/113)	(39/111)

(Adapted from Fricke et al., 1998)

Ovsynch synchronized about 84% of the cows receiving the protocol in this study. This synchronization rate is similar to that of 87% recently reported by our laboratory (Vasconcelos et al., 1997a) but appears lower than that reported in the first study using Ovsynch (Pursley et al., 1995). The synchronization rate is less than 100% because cows respond differently based on the stage of the estrous cycle when Ovsynch is begun and on the number of follicular waves that occur during each cycle within a cow (Vasconcelos et al., 1997b). So far, no practical method has been developed to improve the synchronization rate to Ovsynch. Fortunately, an 84% synchronization rate results in acceptable conception rates when using Ovsynch under most field conditions.

A second method we used to compare the effectiveness of the full-dose and half-dose Ovsynch protocols was to determine the conception rate at 28 and at 56 days after the timed-AI by using ultrasound to diagnose pregnancy. Again, there was no difference in conception rates at 28 or 56 days post AI between cows in the full-dose and half-dose Ovsynch groups (Table 6). Conception rate to timed AI after synchronization of ovulation in this study was greater than that reported in one study (Burke et al., 1996) but less than that reported in another study (Britt and Gaska, 1998). Although some pregnancy loss occurred from 28 to 56 days post AI in both treatment groups, the rate of loss did not differ between groups.

The fertilization rate after AI in beef cows is 90%, whereas embryonic survival rate is 93% by Day 8 and only 56% by Day 12 post AI (Diskin and Sreenan, 1980). In dairy cattle, only 48% of embryos were classified as normal on Day 7 after AI (Weibold, 1988). Thus, substantial pregnancy losses probably occurred before the ultrasound examination conducted at 28 d post AI. Nevertheless, pregnancy loss from 28 to 56 d post AI was 13.5%, or 0.5% per day. This rate of pregnancy loss is similar to the 20.5% reported by Smith and Stevenson (1995) and the 16.8% reported by Vasconcelos et al. (1997a) during a comparable stage of pregnancy in lactating dairy cows. Pregnancy loss after 56 d post AI was not evaluated in our present study but was found to be 3.6% from 56 to 98 d post AI and 5.5% from 98 d to calving (Vasconcelos et al., 1997a). Specific physiologic mechanisms responsible for pregnancy loss in lactating dairy cows are not known, but may include lactational stress associated with increased milk production (Oltenacu et al., 1980; Nebel and McGilliard, 1993), negative energy balance (Butler and Smith, 1989), toxic effects of urea and nitrogen (Butler et al., 1995) or reduced ability to respond to increased environmental temperature (Stevenson et al., 1984; Hansen et al., 1992).

These results support that the dose of GnRH used in the Ovsynch protocol can be reduced by half without compromising the effectiveness of the protocol. It is important, however, that the full dose of $PGF_{2\alpha}$ is used in the half dose Ovsynch protocol. Next, let's look at the cost savings associated with using the half-dose Ovsynch protocol.

Per cow and per pregnancy costs reduced

The cost savings associated with using the half dose Ovsynch protocol for your farm depends on the amount you pay for a dose of GnRH. Retail costs of GnRH vary widely and generally have been decreasing over the past several years. For our calculations, we used a cost of $6.40 per 100 μg GnRH and a cost of $3.30 for $PGF_{2\alpha}$. These cost estimates are based on two independent surveys of bovine practitioners; one conducted in Wisconsin (Britt and Gaska, 1998), the other in Virginia (Nebel and Jobst, 1998). For the sake of comparison, we calculated hormone costs on a per cow and a per pregnancy basis.

Per pregnancy cost estimates were based on the observed conception rates at 56 days post AI for each treatment group in the study (Table 6). At 56 days post AI, there were 38 pregnant cows out of 113 cows that received the full-dose Ovsynch protocol (33.6% conception rate) and 39 pregnant cows out of 111 cows that received the half-dose Ovsynch protocol (35.1% conception rate). Table 7 summarizes our cost estimates for this study. The total cost of hormones for the full dose Ovsynch protocol was $16.10 compared with only $9.70 for the half dose Ovsynch protocol. This represents a per cow savings of $6.40, which is equal to the retail cost of a full dose of GnRH. The total cost of hormones per pregnancy for the full dose Ovsynch protocol was $47.88 compared with only $27.61 for the half dose Ovsynch protocol. This represents a per cow savings of $20.27 per pregnancy. If reproduction for all of the 630 cows in this herd was managed using the half dose Ovsynch protocol, this farm would realize an annual savings of over $12,000 per year in hormone costs compared with using the full dose Ovsynch protocol.

Table 7. Estimated hormone costs of synchronization of ovulation in lactating dairy cows using either 100 μg (full-dose) or 50 μg (half-dose) of GnRH per injection.

	Treatment group	
Item	**Full-dose of GnRH**	**Half-dose of GnRH**
Cost of GnRH		
Per cow	$12.80	$6.40
Per pregnancy	$38.06	$18.22
Cost of $PGF_{2\alpha}$		
Per cow	$3.30	$3.30
Per pregnancy	$9.81	$9.39
Total cost of hormones		
Per cow	$16.10	$9.70
Per pregnancy	$47.88	$27.61

(Fricke et al., 1998)

These cost estimates only take into account the hormone costs of using the full dose or the half dose Ovsynch protocols. For the purposes of this study, no semen or labor costs were included because these costs were similar for both treatment groups. You can make similar calculations for your farm by using the amount you pay for hormones and the current conception rate for your herd. No matter what you currently pay for a dose of GnRH, you can save money by using the half dose Ovsynch protocol.

▪ Maximizing Reproductive Efficiency

In practice, managers should combine timed AI after Ovsynch with an aggressive estrus detection program to further reduce days open in their herds. The following protocol for maximizing reproductive efficiency in lactating dairy cows using Ovsynch is recommended:

- Generate a list of all eligible cows > 70 DIM
- Begin the half-dose Ovsynch protocol at a random stage of the estrus cycle
- AI cows 0-24 h after the 2nd GnRH injection without regard to estrus

- Check heat intensively 18-24 days after AI and rebreed any cows showing estrus
- Conduct pregnancy diagnosis > 40 days after AI
- Resynchronize nonpregnant cows using Ovsynch

Conclusion

If you currently use Ovsynch to manage reproduction in your herd, you can save money by switching to the half dose Ovsynch protocol without sacrificing the effectiveness of the protocol. One consideration when using the half dose Ovsynch protocol, is that it is important to ensure that each cow receives the entire volume of GnRH. To accomplish this, we recommend using a 20-gauge 1½-inch needle for administering the GnRH injections. Furthermore, we routinely administer half doses of GnRH using intramuscular injections into the gluteus maximus muscle. It is not necessary to administer GnRH intravenously for effective results. Finally, using the half dose Ovsynch protocol to manage reproduction is a cost-effective method for improving reproductive efficiency in your dairy operation.

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