

Large Animal VETERINARY Rounds

AS PRESENTED IN THE ROUNDS OF THE DEPARTMENT OF LARGE ANIMAL CLINICAL SCIENCES
OF THE WESTERN COLLEGE OF VETERINARY MEDICINE, UNIVERSITY OF SASKATCHEWAN

Artificial insemination without heat detection in beef heifers

by Marcelo Martinez, DVM, MSc, Gregg Adams, DVM, MS, PhD, John Kastelic DVM, MS, PhD, and Reuben Mapletoft DVM, MS, PhD

The use of endocrine analysis and real time, transrectal, ultrasonography has improved our understanding of bovine ovarian follicular dynamics and how ovarian follicular function may be precisely controlled. The thesis of this review is that ovarian response to exogenous hormones is contingent on the physiologic status of the ovaries at the time of treatment. This information is applied to the induction and synchronization of ovulation in cattle.

Follicular and luteal dynamics in nonpregnant cattle

Ultrasonography shows that follicles in cattle develop in a wave-like fashion. Estrous cycles are composed of 2 or 3 follicular waves that consist of a group of growing antral follicles from which a dominant follicle is selected, while the remaining follicles become subordinate and undergo atresia (Figure 1).¹ In both 2- and 3-wave estrous cycles, emergence of the first follicular wave occurs on the day of ovulation (Day 0), while the second wave emerges on Day 9 or 10 in 2-wave cycles, and on Day 8 or 9 in 3-wave cycles, with a third wave emerging on Day 15 or 16. Duration of the estrous cycle is approximately 20 days in 2-wave cycles and 23 days in 3-wave cycles. The dominant follicle present at the time of luteolysis becomes the ovulatory follicle and emergence of the next wave is delayed until the ensuing ovulation. The proportion of animals with 2- versus 3-wave cycles is probably more or less equally distributed; fertility is not affected by the number of follicular waves per cycle. It has been shown that cattle fed a low energy ration had a greater proportion of 3-wave cycles than those fed higher energy rations.² Follicular waves have also been reported in heifers before puberty,³ and in postpartum cows before the first ovulation.⁴

Role of gonadotropins in follicular wave development

Recruitment of follicular waves and selection of a dominant follicle is based on differential responsiveness to follicle-stimulating hormone (FSH) and luteinizing hormone (LH).⁵ Surges in plasma FSH are responsible for eliciting the emergence of a follicular wave (Figure 1).⁶ FSH is subsequently suppressed by products of the growing follicles. In each wave, the follicle that first acquires LH receptors becomes the dominant follicle, while subordinates undergo atresia.⁷ Suppression of LH as a consequence of progesterone secretion by the corpus luteum (CL) causes the dominant follicle to eventually cease its metabolic functions and it begins to regress. This leads to FSH release and emergence of a new follicular wave. Regression of the corpus luteum allows LH pulse frequency to increase, the dominant follicle increases its growth, and



WCVLM
WESTERN COLLEGE OF
VETERINARY MEDICINE



Department of Large Animal
Clinical Sciences
Western College of Veterinary Medicine

Jonathan M. Naylor, DVM (*Editor*)

Reuben J. Mapletoft, DVM (*Head*)

Ken Armstrong, DVM, Professor Emeritus

Sue Ashburner, DVM

Jeremy Bailey, DVM

Spence M. Barber, DVM

Albert D. Barth, DVM

Frank Bristol, DVM, Professor Emeritus

John Campbell, DVM

Claire Card, DVM

Terry D. Carruthers, DVM

Chris Clark, MRCVS

Jule Dechant, DVM

Peter B. Fretz, DVM, Professor Emeritus

Jon Gudmundson, DVM

Jerry Haigh, DVM

Eugene D. Janzen, DVM

Steve Manning, DVM

Colin Palmer, DVM

Andre Palasz, PhD

Lyall Petrie, DVM

O. M. Radosits, DVM

C. S. Rhodes, DVM

Fritz J. Schumann, DVM

Joseph M. Stookey, PhD

Hugh G. G. Townsend, DVM

Cheryl Waldner, DVM

David G. Wilson, DVM

Murray R. Woodbury, DVM

Western College of Veterinary Medicine
Department of Large Animal Clinical Sciences

52 Campus Drive
University of Saskatchewan
Saskatoon, Saskatchewan S7N 5B4

The editorial content of *Large Animal Veterinary Rounds* is determined solely by the Department of Large Animal Clinical Sciences, Western College of Veterinary Medicine



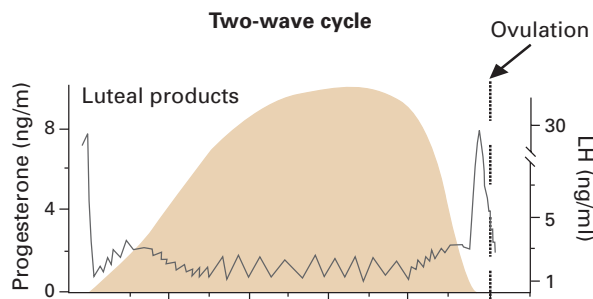
The Canadian Veterinary Medical Association recognizes the educational value of this publication and provides support to the WCVLM for its distribution.

Case Report

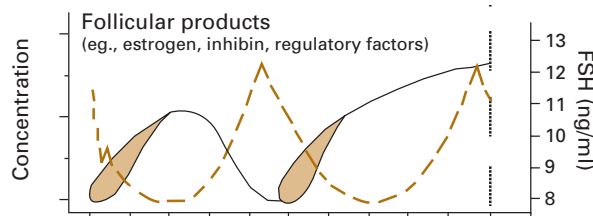
Three years ago, a beef producer came to us with a breeding problem; he wanted to artificially inseminate (AI) a group of 125 replacement heifers. He wanted to breed his heifers before his main cow herd and to use a bull known to be easy calving. We recognized that estrus detection is time-consuming and because of time constraints at breeding on this farm, it was not possible

to perform accurate heat detection. We decided that manipulation of ovarian follicular wave dynamics and synchronization of ovulation followed by fixed-time AI, without estrus detection, would be the best alternative. However, it was necessary to review current knowledge on bovine reproductive physiology in order to propose alternative methods to the producer.

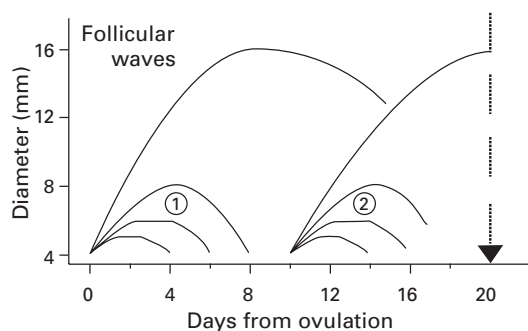
FIGURE 1: Bovine ovarian follicular wave dynamics during a 2-wave estrous cycle. (Modified from Adams.⁷)



Luteal products – Progesterone in beige and pulses of LH with solid line. When progesterone concentrations are low, LH pulse frequency is high; when progesterone levels are high, LH pulse frequency is low and amplitude is high.



Follicular products – estrogen, inhibin, regulatory factors (solid line). Shaded area represents contribution of subordinate follicles. FSH (dashed line) is suppressed by follicular products. FSH surges precede emergence of each follicular wave.



Follicular growth dynamics – Lines correspond to the follicular diameter. New follicular waves emerge on Days 0 and 10. In approximately 3 days, one follicle becomes dominant while the others (subordinates) undergo atresia.

dramatically higher concentrations of estradiol result in a positive feedback on the hypothalamo-pituitary axis and a surge of LH, followed by ovulation.

Synchronization of estrus

Prostaglandin

Prostaglandin F2 α (PGF) has become the most commonly used treatment for estrus synchronization in cattle.^{8,9} PGF is not effective in inducing luteolysis in the first 5 or 6 days following estrus. When luteolysis is effectively induced by PGF, the ensuing estrus is distributed over a 6-day period.¹⁰ This variation is due to follicular status at the time of treatment.¹¹ In a 2-dose PGF synchronization scheme, an interval of 10 or 11 days between doses has been used because it represents the midpoint of the estrous cycle and theoretically, all cows should have a PGF-responsive CL at the time of the second treatment. However, a higher conception rate has been reported with a 14-day interval.¹² Because of two- or three-wave cycles, a growing dominant follicle is more likely to be present 14 days after an initial treatment with PGF. There are two commercial PGF analogs sold in Canada, cloprostenol and dinoprost.

Methods of synchronizing follicle development

Follicle ablation

Ablation of the dominant follicle hastens the emergence of the next follicular wave by removing the suppressive effect of antral follicle products on FSH.¹³ Transvaginal ultrasound-guided follicle aspiration induces synchronous wave emergence within 2 days in heifers; ovulation occurred when PGF was given 4 days later.¹⁴ Although follicle ablation in combination with PGF and gonadotropin releasing hormone (GnRH) or LH to induce ovulation is a reliable method for the

synchronization of follicular growth and ovulation, it is not practical in the field.

Progesterone

Progesterone alters ovarian function in cattle; it suppresses estrus and prevents ovulation.¹⁵ Progesterone suppresses LH pulse frequency¹⁶ which, in turn, causes suppression of the growth of the dominant follicle in a dose-dependent fashion; but it does not suppress FSH secretion.¹⁷ Thus, follicular waves continue to emerge in the presence of a functional CL. Progestogens given for longer than the CL life span (ie, for more than 14 days) result in synchronous estrus upon withdrawal, but fertility is low (Figure 2).¹⁸ The types and dosages of progestogens used to control the estrous cycle in cattle have relatively less suppressive effects on LH secretion than the CL-secreted progesterone and are associated with high LH pulse frequency and development of “persistent” follicles¹⁶ that contain aged oocytes.¹⁹ Ovulation of an aged oocyte results in poor fertility after insemination.

There is an oral progestogen – melengestrol acetate – that is widely used in Canada for prevention of estrus in heifers on feedlots and for estrus synchronization. The progesterone-impregnated controlled internal drug release intravaginal device has recently been approved in Canada for synchronization of estrus in beef cattle. Label directions (for AI) state that the device should be in the vagina for 7 days; PGF is given 24 hours before device removal to induce luteolysis and estrus detection begins 48 hours after device removal. Because of the

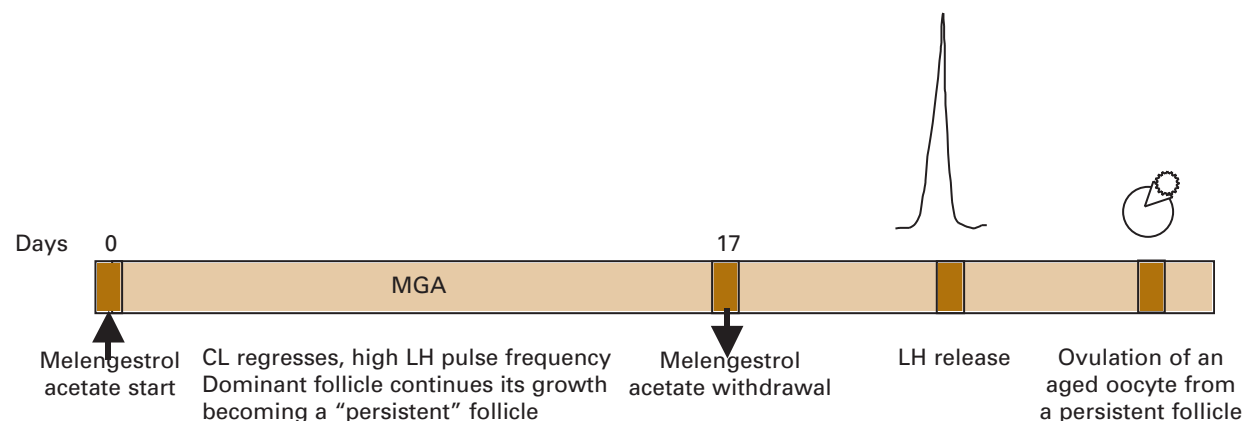
short treatment period (7 days), the problem of persistent follicles is reduced. The intravaginal device is well suited to various approaches used to synchronize follicular development and ovulation.

Progesterone and estradiol

Traditionally, estradiol has been administered near the beginning of progestogen treatment to induce luteolysis and allow for shortened progestogen treatment periods.⁹ Therefore, the probability of the development of a persistent follicle is reduced and although pregnancy rates have been variable (33% to 68%), overall results have been acceptable. The lower pregnancy rates are usually attributed to problems with body condition or postpartum interval; in some problem animals, this treatment will also induce cyclicity, ie, resumption of regular estrous cycles.

More recently, we have shown that the benefit of estradiol in shortened progestogen treatment protocols is that it also causes follicular regression.²⁰ The mechanism involves suppression of FSH and possibly LH. The use of a short-acting estradiol (estradiol-17 β) in progestogen-implanted cows is followed by the emergence of a new follicular wave, approximately 3 to 5 days later, regardless of the stage of follicular growth at the time of treatment.²⁰ Estradiol-17 β or estradiol benzoate^{20,21} is normally injected with 50 to 100 mg of progesterone at the same time as placement of a progesterone-impregnated device.²² The progesterone prevents an estrogen-induced preovulatory-like LH surge in those animals that do not have a

FIGURE 2: A schematic representation of the progestogen melengestrol acetate synchronization program with the development of a persistent follicle and ovulation of an aged oocyte.



functional CL. The estradiol/progesterone treatment is now commonly used to synchronize follicular wave emergence for superstimulation of donor cows.²⁰ In estrus synchronization programs, a second, lower dose of estradiol is given 24 hours after progesterone/progestogen removal to induce LH release. This occurs approximately 16 to 18 hours later, synchronizing ovulation for fixed-time AI.

GnRH

Gonadotropin releasing hormone (GnRH) became available in the 1970s as a treatment for follicular cysts.²³ Treatment of a cow with a growing dominant follicle with GnRH induces ovulation with emergence of a new follicular wave approximately 2 days later.²⁴ Treatment with PGF 6 days²⁵ or 7 days²⁶ after GnRH results in ovulation of the new dominant follicle, especially when a second GnRH injection is given 36 to 48 hours after the PGF.²⁷

There are four GnRH products sold on the Canadian market; they are used at a 100 µg dose.

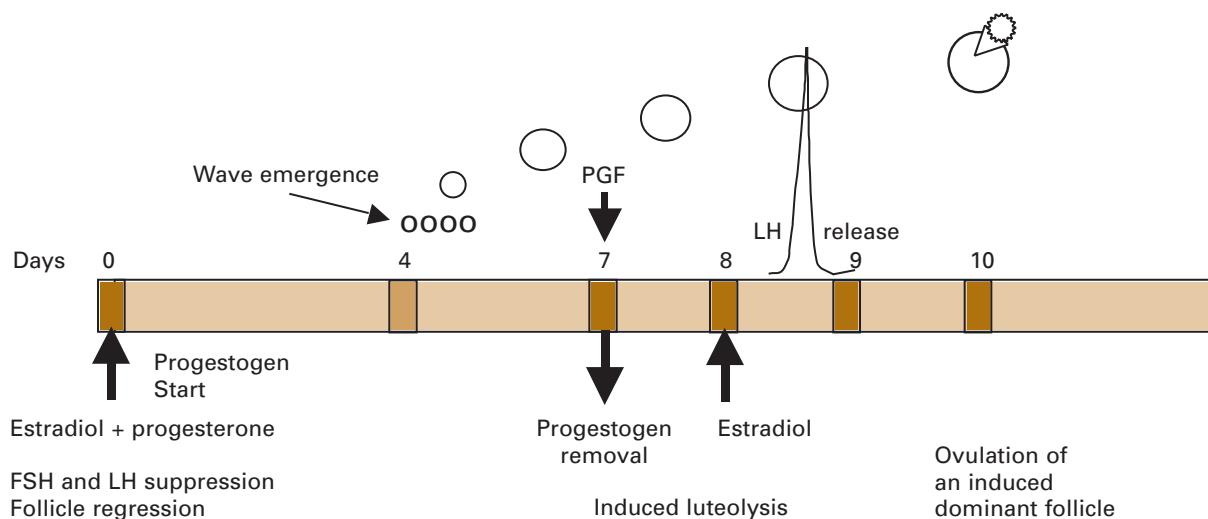
The Ovsynch protocol

An ovulation synchronization scheme utilizing GnRH for fixed-time AI called “Ovsynch” was developed by Pursley et al.²⁸ The first injection of GnRH is followed 7 days later with an injection of PGF, followed

in 48 hours by a second injection of GnRH; fixed-time AI is performed 0 to 24 hours later. The Ovsynch protocol has been more efficacious in lactating dairy cows than in heifers. The cause for this variability is not known, but ovulation with the first injection of GnRH occurred in 85% of cows and in only 54% of heifers.²⁸ In addition, 19% of heifers returned to estrus before the injection of PGF, making fixed-time AI impossible.²⁷ Results from our laboratory confirm that a first dose of GnRH does not always result in ovulation of the dominant follicle in heifers (56% ovulation); hence, it does not consistently induce the emergence of a new follicular wave.²⁹ Despite the apparent incongruent expectations raised by our model of ovarian follicular dynamics and the Ovsynch protocol in heifers, the protocol has been widely used on dairy cows over the last 4 years.³⁰

We have recently investigated the use of Ovsynch-type programs in beef heifers.³¹ We found that the use of a progesterone-impregnated device between the first injection of GnRH and the injection of PGF in an Ovsynch fixed-time AI program will result in a near doubling of pregnancy rates in beef heifers. In two different studies, the use of an intravaginal progesterone-impregnated device in a 7-day Ovsynch-type program improved pregnancy rates from 39% to 68% in a GnRH-based regimen and from 38% to 65% in a LH-based regimen.

FIGURE 3: Diagram of a program using estradiol and progesterone to synchronize follicular wave emergence; a progesterone-impregnated device is put in place for 7 days with PGF injection at removal, and a second injection of estradiol 24 h later to induce LH release and synchronize ovulation of the induced dominant follicle.



Combined programs

There are several alternatives available for the synchronization of estrus and ovulation for fixed-time AI in beef heifers. Figure 5 contains the schedule of protocols used recently to examine the efficacy of the various approaches described above in beef heifers under dry-lot conditions.³² Angus-cross heifers (n=503) were placed in two synchronization groups and three treatment groups on Day 0: heifers received intravaginal progesterone-impregnated devices (n=257) or were started on the oral progestogen melengestrol acetate at 0.5 mg/head/day (n=246) and then given either 2 mg estradiol benzoate (EB) and 50 mg progesterone in oil, or 100 mg GnRH or 12.5 mg LH. The last feeding of melangestrol acetate was given on Day 6, intravaginal devices were removed on Day 7, and all heifers received PGF, 500 µg cloprostenol, concurrently. Consistent with their treatment on Day 0, heifers were given either 1 mg EB 24h after PGF and inseminated 28h later or 100 mg GnRH or 12.5 mg LH 48h after PGF and concurrently inseminated. Ultrasonic pregnancy diagnosis was done approximately 30 days after AI.

Estrus rate was higher ($P < 0.01$) in EB-treated groups (92%) than in either the GnRH (51%) or LH (47%) groups, but there was no significant difference in pregnancy rates to a single fixed-time AI among groups (65%, 56%, and 62% in heifers treated with intravaginal progesterone plus GnRH, LH or EB, respectively, and

52%, 56% or 60% in melangestrol acetate treated heifers plus GnRH, LH or EB, respectively). In all previous experiments, the expression of estrus has been higher in estradiol-treated groups and inseminators reported that heifers were much easier to breed, with open cervixes, and copious amounts of mucous. Overall, results suggest that the oral progestogen and the intravaginal device are equally efficacious and that in combination with GnRH, LH or EB, either can be effectively used to synchronize estrus and ovulation for fixed-time AI.

Management

Many synchronization programs have failed due to inadequate attention to detail. Estrus synchronization and AI typically compliment good management, but rarely replace it. At the time of breeding, heifers should be approximately 65% to 70% of expected mature weight and cows should be at least 50 days postpartum. Body condition scoring and feeding will accordingly pay dividends. Good planning and communication are essential and written protocols are recommended. Close consultation with the producer is important and it is important to keep in close contact throughout the treatment program.

Conclusions

It is clear that in order for AI to make an impact in the beef industry, the necessity of estrus detection must be eliminated, or at the least, minimized without

FIGURE 4: Diagram of an Ovsynch program. A first GnRH injection is given to induce ovulation, a new CL and synchronize follicular wave emergence, PGF is given to induce luteolysis, and a second GnRH is given to induce LH release and synchronize the ovulation of the recruited dominant follicle.

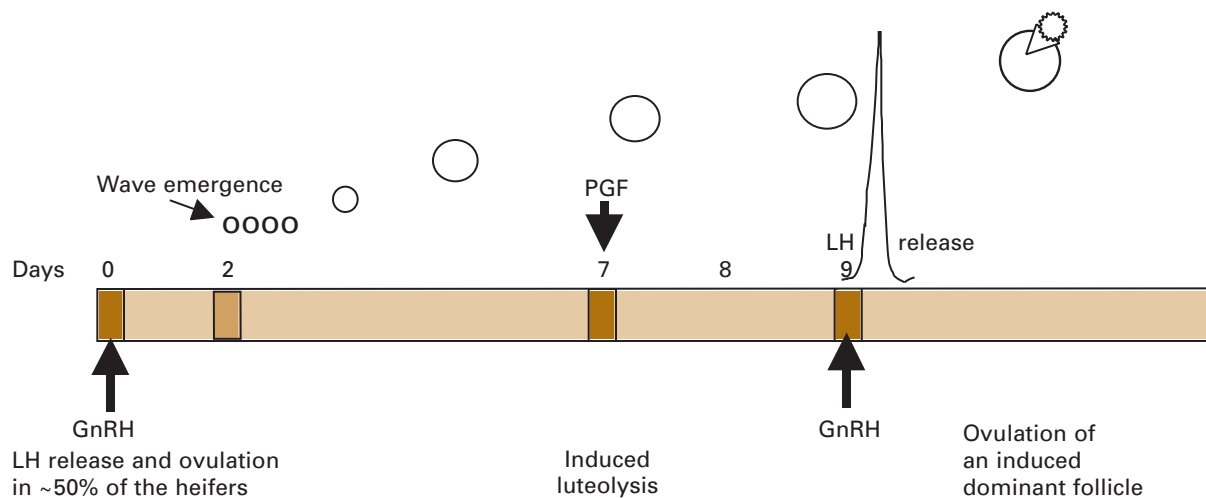
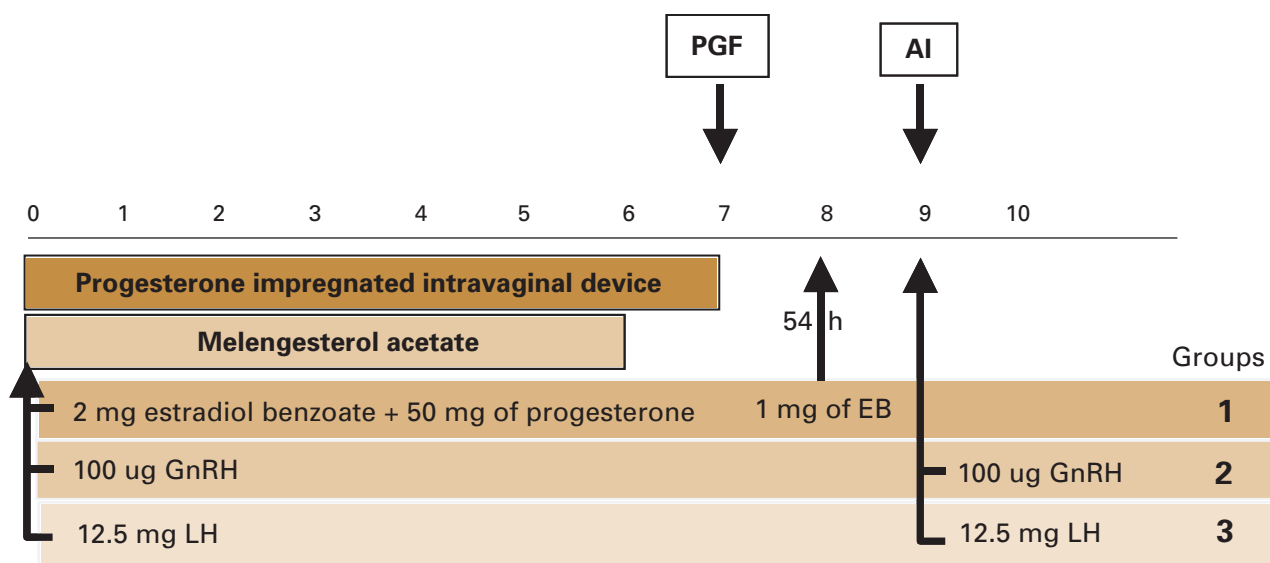


FIGURE 5: Design of an experiment for ovulation synchronization using progestogens, plus estradiol benzoate (EB), GnRH or LH.



compromising pregnancy rates. Experiments described in this issue demonstrate several different methods of eliminating estrus detection, permitting fixed-time AI in heifers. With the producer herd referred to at the beginning of this report, we chose to use the synchronization protocol with the estradiol benzoate/progesterone-impregnated device and have continued with this protocol over the last 3 years. Each year at the beginning of the program, heifers are scanned ultrasonically to eliminate pregnant animals and those with obvious abnormalities. No effort has been made to ensure heifers were cycling; however, heifers were in good body condition and at least two-thirds mature body weight. On Day 0, all heifers received a progesterone impregnated intravaginal device and were injected with 2 mg of estradiol benzoate and 50 mg progesterone. On Day 7, the progesterone-impregnated devices were removed and all heifers received PGF (500 µg cloprostenol); 24 hours later heifers received an injection of 1 mg estradiol benzoate and were inseminated approximately 28 hours after that. Over the 3-year period, 100 to 125 heifers per year had pregnancy rates to a single fixed-time artificial

insemination ranging from 63 to 77%. This program was very successful in this producer's eyes and helped him achieve his breeding objectives.

It must be recognized that estradiol benzoate is not a licensed product and must be used on prescription. Pharmacies indicated in the following list will prepare estradiol benzoate and progesterone for veterinarians on prescription:

TLC Pharmacy (Edmonton)	1-800-449-2115
Strathcona Prescription Centre (Edmonton)	
	1-888-433-2334
Script Pharmacy (Calgary)	
	403-253-6773
Denis Giroux (Saint-Pie, Quebec)	
	1-800-223-0666 or 1-888-888-7979
Veterinary Pharmacy (Guelph)	
	519-824-7887 or 1-800-446-8689

References

1. Ginther OJ, Kastelic JP, Knopf L. Composition and characteristics of follicular waves during the bovine estrous cycle. *Anim Reprod Sci* 1989;20:187-200.
2. Murphy MG, Enright WJ, Crowe MA, et al. Effect of dietary intake on pattern of growth of dominant follicles during the estrous cycle in beef heifers. *J Reprod Fertil* 1991;92: 333-338.
3. Evans ACO, Adams GP, Rawlings NC. Endocrine and ovarian follicular changes leading up to the first ovulation in prepubertal heifers. *J Reprod Fertil* 1994;100:187-194.
4. Savio JD, Boland MP, Hynes N, Roche JF. Resumption of follicular activity in the early postpartum period of dairy cows. *J Reprod Fertil* 1990;88:569-579.
5. Ginther OJ, Wiltbank MC, Fricke PM, Gibbons JR, Kot K. Selection of the dominant follicle in cattle. *Biol Reprod* 1996;55:1187-1194.
6. Adams GP, Matteri RL, Kastelic JP, Ko JCH, Ginther OJ. Association between surges of follicle stimulating hormone and the emergence of follicular waves in heifers. *J Reprod Fertil* 1992;94:177.
7. Adams GP. Control of ovarian follicular wave dynamics in mature and prepubertal cattle for synchronization and superstimulation. Proceedings of the XX Congress of the World Association of Buiatrics, Sydney, Australia. 1998;595-605.
8. Larson LL, Ball PJH. Regulation of estrous cycles in dairy cattle: a review. *Theriogenology* 1992;38:255-267.
9. Odde KG. A review of synchronization of estrus in postpartum cattle. *J Anim Sci* 1990;68: 817-830.
10. Seguin B. Control of the reproductive cycle in dairy cattle. *Proceedings of the Annual Meeting of the Society for Theriogenology* 1987; 300-308.
11. Kastelic JP, Knopf L, Ginther, OJ. Effect of day of prostaglandin F2a treatment on selection and development of the ovulatory follicle in heifers. *Anim Reprod Sci* 1990; 23:169-180.
12. Folman Y, Kaim M, Herz Z, Rosenberg M. Comparison of methods for the synchronization of estrous cycles in dairy cows. 2. Effects of progesterone and parity on conception. *J Dairy Sci* 1990;73:2817.
13. Adams GP, Kot K, Smith CA, Ginther OJ. Selection of a dominant follicle and suppression of follicular growth in heifers. *Anim Reprod Sci* 1993;30:259-271.
14. Bergfelt DR, Lightfoot KC, Adams GP. Ovarian dynamics following ultrasound-guided transvaginal follicle ablation in heifers. *Theriogenology* 1994;42:895-907.
15. Christian RE, Casida LE. The effects of progesterone in altering the oestrous cycle of the cow. *J Anim Sci* 1948;7:540.
16. Savio JD, Thatcher WW, Morris GR, Entwistle K, Drost M, Mattiacci MR. Effects of induction of low plasma progesterone concentrations with a progesterone-releasing intravaginal device on follicular turnover and fertility in cattle. *J Reprod Fertil* 1993;98: 77-84.
17. Adams GP, Matteri RL, Ginther OJ. The effect of progesterone on growth of ovarian follicles, emergence of follicular waves and circulating FSH in heifers. *J Reprod Fertil* 1992;95:627-640.
18. Hansel W, Malven PV, Black DL. Estrous cycle regulation in the bovine. *J Anim Sci* 1961;20:621.
19. Revah I, Butler WR. Prolonged dominance of follicles and reduced viability of bovine oocytes. *J Reprod Fertil* 1996;106:39-47.
20. Bo GA, Adams GP, Pierson RA, Mapletoft RJ. Exogenous control of follicular wave emergence in cattle. *Theriogenology* 1995;43:31-40.
21. Caccia M, Bo GA. Follicle wave emergence following treatment of CIDR-B implanted beef heifers with estradiol benzoate and progesterone. *Theriogenology* 1998;49:341.
22. Martinez, MF, Adams GP, Kastelic JP, Bergfelt DR, Mapletoft RJ. Induction of follicular wave emergence for estrus synchronization and artificial insemination in heifers. *Theriogenology* 2000;54:757-769.
23. Drost M and Thatcher WW. Application of gonadotrophin releasing hormone as a therapeutic agent in animal reproduction. *Anim. Reprod. Sci* 1992;28:11-19.
24. Macmillan KL, Thatcher WW. Effects of an agonist of gonadotropin-releasing hormone on ovarian follicles in cattle. *Biol Reprod* 1991;45:883-889.
25. Twagiramungu H, Guilbault LA, Dufour JJ. Synchronization of ovarian follicular waves with a gonadotropin-releasing hormone agonist to increase the precision of estrus in cattle: A review. *J Anim Sci* 1995;73:3141-3151.
26. Thatcher WW, Drost M, Savio JD, et al. New clinical uses of GnRH and its analogues in cattle. *Anim Reprod Sci* 1993;33:27-49.
27. Wiltbank MC. How information of hormonal regulation of the ovary has improved understanding of timed breeding programs. *Proceedings of the Annual Meeting of the Society for Theriogenology* 1997;83-97.
28. Pursley JR, Mee MO, Wiltbank MC. Synchronization of ovulation in dairy cows using PGF2a and GnRH. *Theriogenology* 1995;44:915-923.
29. Martinez MF, Adams GP, Bergfelt D, Kastelic JP and Mapletoft RJ. Effect of LH or GnRH on the dominant follicle of the first follicular wave in heifers *Anim Reprod Sci* 1999b;57:23-33.
30. Seguin B. Strategies for estrus control to improve dairy reproductive performance. *Proceedings of the Annual Meeting of the Society for Theriogenology* 1997a; 320-331
31. Martinez, MF, Kastelic JP, Adams GP, Mapletoft RJ. The use of CIDR-B devices in GnRH/LH-based artificial insemination programs. *Theriogenology* 2000;53:202.
32. Martinez MF, Kastelic JP, Adams GP, Cook RB, Mapletoft RJ. Synchronization of ovulation for fixed-time insemination in heifers. *Theriogenology* 1999;51:412.

Abstracts of Interest

Time interval between GnRH and prostaglandin injections influences the precision of estrus in synchronized cattle

ROY GL, TWAGIRAMUNGU H; KAPUSKASING, ONTARIO, SAINT-HYACINTHE, QUEBEC.

Variation in results of timed insemination programs using synchronization of ovulation with GnRH-Prostaglandin-GnRH protocol should be mostly due to individual or to a combination of factors involved in the process of ovulatory follicle selection, of prostaglandin-induced luteolysis and of artificial insemination. The objective of this study was to determine effects of a 6-day vs. 7-day time interval between GnRH and prostaglandin injections and of female physiological status on the synchronization rate and precision of estrus in beef cattle kept under similar housing conditions. Crossbred beef nonnursing (n = 24) and nursing (n = 85) cows > 60 d postpartum and heifers (n = 46) 14 mo old were injected im with GnRH (2 ml of Cystorelin, Rhone-Merieux Canada) on D 0 (day of start of experiment) and then were assigned randomly to 1 of 2 treatments: prostaglandin F2a (PGF, 2 ml of Estrumate, Mallinckrodt Veterinary Inc. Canada) on D 6 (D 6 treatment; n = 79) or on D 7 (D 7 treatment; n = 76). Estrus behaviour was detected and recorded twice daily (0600 to 0900 and 1800 to 21h00) between D 0 and D12 and thereafter less intensively until D 50 using vasectomized teaser bulls. AI was performed around 12 hours after onset of estrus (pregnancy data not available). Interval from PGF injection to onset of estrus and synchronization rate were analyzed by ANOVA and Proc Catmod of SAS, respectively. Precision of estrus was examined by analysis of the percentage of females showing estrus within fixed time intervals and by ratios of variance (F-test) of mean time interval to onset of estrus. Overall results show that estrous synchronization rate did not differ between treatments D 6 and D 7 (94.9 vs 90.8 %) and between animal status during a 50-day breeding season. Proportion of females detected in estrus from GnRH to PGF (8.9 vs 11.8 %), from PGF to 5 days later (53.2 vs 51.3 %), from Day 12 to D28 (24.1 vs 14.5 %), from D 28 to D 50 (8.9 vs 13.2 %) was similar (P > 0.10) in D 6 and D 7 groups. During the time period from PGF-induced luteolysis to 5 days later, estrus behaviour was different between treatments and between animal status. Within females that received PGF, synchronization rate was higher in heifers (66.7 %) and nonnursing cows (90.9 %) than in nursing cows (45 %) in D 6 and was higher in heifers (80 %) than in nonnursing (50.0 %) and nursing cows (48.7 %) in D 7 (treatment x status interaction P<0.003). This interaction effect was also observed (P<0.02) in the proportion of females detected in estrus between 24 and 72 h after PGF: 61.9, 81.8, 37.5 % and 65.0, 50.0, 33.8% for heifers, nonnursing and nursing cows in treatments D 6 and D 7, respectively. Time interval from PGF injection to onset of estrus was affected by animal status (P<0.005) but not by treatment. Estrus occurred 7.2 h earlier in heifers (52.3 ± 3.4 h) than in nonnursing cows (59.5 ± 2.8 h) and 7.6 h earlier in nonnursing cows than in nursing cows (67.1 ± 3.0 h). As indicated by the lower variance of mean interval to estrus, precision of estrus tended to be greater in D 6 than in D 7 (274.9, df = 41, vs 418.9,

df = 38; P<0.1) and was much better in D 6 heifers and D 7 cows than in other groups. In conclusion, timed insemination programs should consider the time interval between GnRH and PGF injection and the female physiological status in order to increase precision of PGF-induced estrus and subsequent pregnancy rate. *Theriogenology* 1999;51:413.

Follicular growth, estrus and pregnancy after fixed-time insemination in beef cows treated with intravaginal progesterone inserts and estradiol benzoate.

BRIDGES PJ, LEWIS PE, WAGNER WR, INSKEEP EK. MORGANTOWN, WEST VIRGINIA

An experiment was performed to compare the effects of 3 short-term treatments with progesterone and estradiol benzoate (EB) on follicular growth, synchrony of estrus and pregnancy rate after fixed-time insemination in lactating postpartum beef cows. In Treatment 1 (n = 46), each cow received a progesterone-containing intravaginal insert for 7 d with injection of EB (2 mg, im) at the time of device insertion. In Treatment 2 (n = 46), the insert was used for only 5 d with injection of EB (2 mg, im) at the time of insertion. Cows in Treatment 3 (n = 47) received an insert for 5 d with no EB at the time of insertion. Each cow in the 3 groups received PGF2[α] (25 mg, im) at the time of insert removal, followed by EB (1 mg, im) 30 h later. The cows were then inseminated 28 to 30 h after treatment with EB (58 to 60 h after insert removal). Treatment with 2 mg EB terminated the growth of the largest ovarian follicle (>5 mm in diameter) at device insertion in 16/16 and 14/15 cows in Treatments 1 and 2, respectively. Estrus was detected within an 8-h target period (48 to 56 h after insert removal) in 93, 87 and 81% of cows in Treatments 1, 2 and 3, respectively (P>0.05). Pregnancy rates at 39 d post insemination were 60, 50 and 51% for Treatments 1, 2 and 3, respectively (P>0.05). The pregnancy rates did not differ between cows that were anovulatory or those that had ovulated before the initiation of treatments (54%), or among cows that were 28 to 40, 41 to 60 or >60 days post partum at insemination (43, 59 and 54%, respectively). Treatment with progesterone inserts for 5 or 7 d, PGF2[α] at the time of insert removal and 1 mg EB 30 h later induced the high degree of synchrony of estrus and ovulation necessary for fixed-time insemination.

Theriogenology 1999;52(4): 573-583

Upcoming Meeting

23-27 May, 2001

American College of Veterinary Internal Medicine

Denver, Colorado

Contact: Tel.: (800) 245-9081

(303) 231-9933

Fax: (303) 231-0880

Email: acvim@acvim.org

Website: www.acvim.org

This publication is made possible by an educational grant from

Schering-Plough Animal Health