Effect of injecting sows with prostaglandin $F_{2\alpha}$ immediately postpartum on subsequent reproductive performance

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Summary: *At a North Carolina farm, 750 females received either none (control), one, or two injections (each 2 mL, 10 mg $PGF_{2\alpha}$) of Lutalyse® after farrowing. Sows were injected at 7 am or 5 pm on the day of farrowing and 24 hours later if they received two doses. Injections of Lutalyse® tended to increase the piglet average weight at weaning, 0.29 lb (0.13 kg) for one injection (P=.10), and 0.3 lb (0.14 kg) for two injections (P=.09) compared to piglet average weight for control sows. Neonatal mortality decreased 19% (P=.04) for two injections. Lutalyse® had no effect on the incidence of disease in sows during lactation, in the sows' wean-to-service intervals, or their survival.*

The benefit of using $PGF_{2\alpha}$ (Lutalyse® Sterile Solution, dinoprost tromethamine) for farowing induction has been recognized by swine producers worldwide for many years.[1] Research on the effect of injecting $PGF_{2\alpha}$ postpartum is underway and indicates that sows may return to estrus more quickly postweaning, be more prolific in subsequent farrowings, and that injections may prevent vaginal discharges, premature culling, or death of sows. Abad, et al.,[2] injected 10 mg $PGF_{2\alpha}$ (2 mL Lutalyse®) into sows at weaning (24.8 days) on a farm with no significant reproductive problems and reported conception rate increases of 12.25 percentage points for primiparous sows and 6.14 percentage points for multiparous sows. They also reported fewer (13.5% versus 25.8%) primiparous and fewer (10.4% versus 16.9%) multiparous sows culled for reproductive problems. Gil, et al.,[3] injected 10 mg of Lutalyse® 24–48 hours after farrowing into sows in a herd with a history of vaginal discharges and delayed returns to estrus. Compared to untreated controls, the Lutalyse®-treated sows showed a reduction in returns-to-service, i.e., failure to conceive, (13.9% versus 24.2%), reduction in the incidence of vaginal discharge (0% versus 2.7%), and increased pigs born alive per sow (11.32 versus 10.77).

Subsequently, Gil, et al.,[4] reported that when sows were injected with 10 mg of Lutalyse® on a farm with a history of reproductive problems, fewer sows were culled (1.14% versus 8.19%) and farrowing rate improved (90% versus 74%). Lorenzo, et al.,[5] in a study of 207 sows, showed a subsequent increase of 0.44 pigs born alive and improvement in returns-to-estrus (16.8% versus 20.8%), although the results were not significant statistically. Another study by Sanmartin, et al.,[6] suggests improved fertility but these results are difficult to interpret because differences between treatments were small and statistical comparisons were not reported.

In addition to the potential benefits reported above, Lutalyse® injected postpartum may increase sows' milk production and piglet weight and consequently decrease neonatal mortality. Work from Canada[7] indicates that piglets suckling sows with high progesterone postfarrowing tended to grow more slowly in the first 3 days postfarrowing. Therefore, Lutalyse® treatment early postfarrowing may improve litter weight gains in the current litter, and thereby possibly decrease preweaning mortality by more rapidly removing the corpora lutea (CL) of pregnancy and thus removing the negative effect of progesterone on milk production.

Objective

Our objectives were to evaluate the effects of a single 2-mL injection of Lutalyse® within 12 hours of the first pig born or two injections (2 mL each), one within 12 hours of the first pig born and a second 24–36 hours after the completion of farrowing, on litter weight gain and survivability in the current litter and prolificacy in the next farrowing. A secondary objective was to determine the effect of Lutalyse® administration on the incidence of vaginal discharges postfarrowing and sows' survival.

Materials and methods

Treatments

On a commercial farm in North Carolina, sows received either none (control), one, or two injections (each 2 mL, 10 mg $PGF_{2\alpha}$) of Lutalyse®. Sows were injected at about either 7:00 am or 5:00 pm. On Friday and weekend nights the evening injection may have been given as late as 7:00 pm. All sows receiving either one or two doses were injected if they had at least one pig by either 7:00 am or 5:00 pm. Sows receiving two doses were injected am/am or pm/pm. The first (or only) injection was always given on the sows' left side. The second injection was given in the right side of the neck.

Cross-fostering

Pigs were freely cross-fostered among similarly treated sows. Most cross-fostering occurred in the first 4 days.

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Nurse sows

Standard practice on this farm was to use nurse sows. Nurse sows are weaned twice; i.e., her first litter is weaned and a second litter of assorted piglets is given to her to raise. We weighed each litter that was raised by a nurse sow. Similarly, when sows were prematurely weaned, i.e., between our visits, farm staff weighed the litter and the data were recorded.

Animals

The trial animals included both sows and gilts. Sows of parity five or greater were excluded. All sows and gilts were identified with two colored ear tags for identification. Sows were handled according to normal farm procedures, which included the use of oxytocin, antibiotics, corticosteroids, and other medications as needed.

Allocation and randomization of animals

According to standard operating procedures on the farm, managers assigned females to groups at mating and females in these groups usually farrowed at about the same time and in the crates of usually no more than one, but sometimes two, farrowing rooms. The sows on trial were in 10 groups.

Three females (parities one through four), farrowing sequentially and meeting the inclusion criteria, constituted a block. Females within a block were in the same farrowing house and treated similarly. There were a total of 250 blocks. A unique, computer-generated, randomization schedule was used to assign animals to treatments within the blocks.

Analysis

Weaning weight

We analyzed the data using the Mixed, Means, and Univariate procedures of SAS.[8] The effects of treatment, block, and age at weighing (single and quadratic) were included in the mixed model.

Neonatal mortality

We calculated neonatal mortality for each litter by subtracting the number of piglets present when litters were weighed, just before they were weaned, from the number of pigs born alive and adjusted for fosterings.

Data were analyzed by analysis of variance using the mixed procedure of SAS.[8] Independent variables in the model initially included treatment, pigs born alive adjusted for fosterings, and the age at which they were weighed. We also included all two-way interactions. We included group and block, nested within group, as random effects. We then did repeated runs of the model, each time deleting a single nonsignificant (P>.10) variable, but never treatment. The final model included treatment and age when weighed, with group and block as random effects.

Sows' disease

The farm staff responsible for diagnosing and treating sick sows administered medication according to an established protocol and recorded these medications on the sows' records. From these sow records we noted the pattern of medication and recorded the corresponding disease. Thus, diseases were producer-diagnosed and we identified those diseases based on the assumption that farm staff had followed the medication protocol for the diseases.

The diseases treated included:

- off feed with fever;
- off feed no fever;
- hard underline;
- retained pig(s);
- lameness or skin cuts;
- "bleach-out" sow (i.e., anemia caused by gastric ulcers);
- manual intervention in farrowing, manually entering the sow's vagina;
- postfarrowing discharge; and
- savaging piglets, "crazy" sows.

All 635 sows whose litters were analyzed for weaning weight were included in the analysis. Data were analyzed using the frequency procedure of SAS[8] with the Chi-square option.

Weaning-to-service interval

The weaning-to-service interval (WSI) for a treated sow was calculated by subtracting the weaning date from the service date contained in the farm's computerized production records. Of the 635 sows whose litters were analyzed for weaning weight, only 527 sows were included in the analysis for WSI; 107 were deleted from the analyses either because they were culled or because they had a WSI of less than 1 or more than 100 days. One sow with a lactation length greater than 50 days was deleted because it was an outlier.

Data were analyzed by analysis of variance using the mixed procedure of SAS.[8] Independent variables in the model initially included treatment, parity, lactation length, and all two-way interactions. The effect of lactation length linear, quadratic or cubic, was also included. We included group and block, nested within group, as random effects.

We then did repeated runs of the model, each time deleting a single nonsignificant (P>.10) variable, but never treatment. The final model included treatment, lactation length—both singly and quadratic—with group and block as random effects.

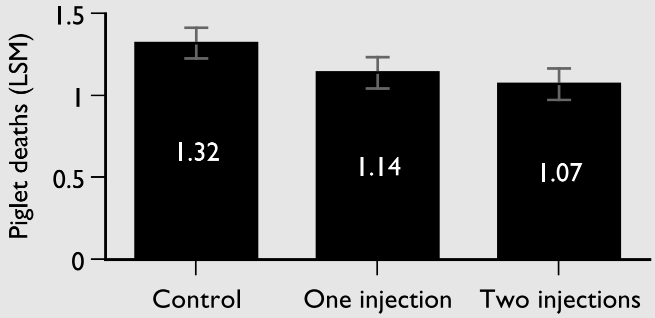
Also, data were analyzed using the Chi-square option in the frequency procedure of SAS[8] to determine whether differences existed in the proportion of sows that returned to estrus later than 6 days postweaning.

Pigs-born-alive

Pigs-born-alive (PBA) for treated sows at their subsequent farrowing was extracted from data in the farm's computerized production records. The same 526 sows included in the analyses for WSI were included in the analysis for PBA.

Data were analyzed by analysis of variance using the mixed procedure of SAS.[8] Independent variables in the model initially included treatment, parity, lactation length, and all two-way interactions. The effects of quadratic and cubic lactation length were also included. We included group and block, nested within group, as random effects. We

Figure 1



Least-squares means (LSM) ±SE of piglet deaths in a letter by treatment. Least-squares means are the expected value of class means for a balanced design involving the class variables with all covariates at their mean value. Model (P=.10).

then did repeated runs of the model, each time deleting a single nonsignificant (P>.10) variable, but never treatment. The final model included treatment, lactation length, the interaction of treatment and lactation, and group and block as random effects.

Sow survival

We determined the effect of treatment on sow survival using the frequency procedure of SAS[8] with the Chi-square option. A sow survived treatment if she neither was culled nor died at least until weaning her second litter post treatment and before her third farrowing posttreatment. Of the 635 sows whose litters were analyzed for weaning weight, only 631 sows were included in the analysis for sow survival; we excluded four sows from the analyses because we were unsure of their fate.

Results and discussion

Neonatal mortality and weaning weight

Of the 750 animals assigned, data for 115 were excluded prior to analysis, leaving 635 sows. Some animals were withdrawn from the experiment because we were not certain that they had received the treatment as it was designed.

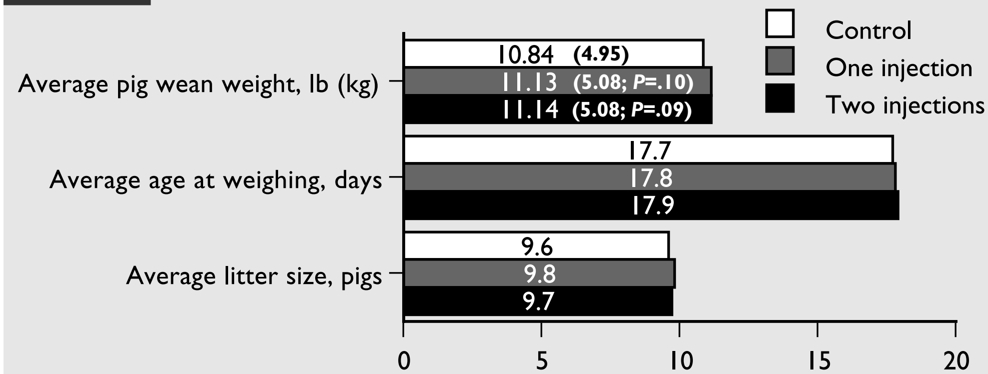
Lutalyse® injections tended (P= .10) to decrease neonatal mortality (Figure 1). Injections of Lutalyse® tended to increase the piglet average weight at weaning, 0.29 lb (0.13 kg) for one injection (P=.10), and 0.3 lb (0.14 kg) for two injections (P=.09) compared to piglet average weight for control sows (Figure 2). There was no difference in piglet average weight between one and two injections. During 6 of the 9 weeks the piglets were weighed, the average weight of Lutalyse®-treated piglets, adjusted for the age at weighing, was numerically greater than the weight of control piglets (Figure 3). Only in the week of October 19, 1993 were these differences significant (P=.06), but this lack of statistical significance may have been due to the low sample sizes of the weekly groups.

If the sows increased their milk production it may explain this tendency for increased piglet weaning weight and survivability. The evidence for this intuitively reasonable response is poor. Le Dividich[9] demonstrated that piglets' body fat deposition increased as the fat content of intragastrically fed sows' colostrum increased. Efforts to capitalize on this information and improve piglet survivability to weaning by increasing their caloric intake has been disappointing. Overall, the response to adding fat to the sows' diet in late gestation and/or lactation increases piglets' survival rate only 2.3 percentage points.[10] In addition, only poorly managed farms seem to benefit because when a herds' piglet survival rate is already above 80%, the response to adding fat is small.[10] Attempts to bypass the sow and provide the piglet with the energy directly have been disappointing. Orally dosing neonatal piglets with corn oil only delays the death of low-birthweight pigs and does not affect piglet weight gain.[11] Similarly, piglets dosed with medium-chain triglycerides did not improve growth or survival from birth to weaning[12] and in one case[13] decreased the survivability of low-birthweight pigs. However, Moody et al.,[14] markedly increased the proportion surviving by providing supplemental milk replacer by stomach tube to nursing pigs of low birth weight. Thus, $PGF_{2\alpha}$-injected dams may have increased piglet weaning weight and survivability if they had increased milk production.

Lysis of the corpora lutea of pregnancy decreases blood levels of progesterone, which in concert with increased prolactin, estradiol-17ß, and corticosteroids promotes milk production. After farrowing, some sows have abnormally high (>1 ng per mL) progesterone concentrations[7] which may come from corpora lutea,[15] placenta,[16] or body fat[17] and delay[18] and/or reduce[19] milk production. Thus, postpartum injections of $PGF_{2\alpha}$ may lyse residual corpora lutea and so decrease progesterone concentrations leading to increased milk production.

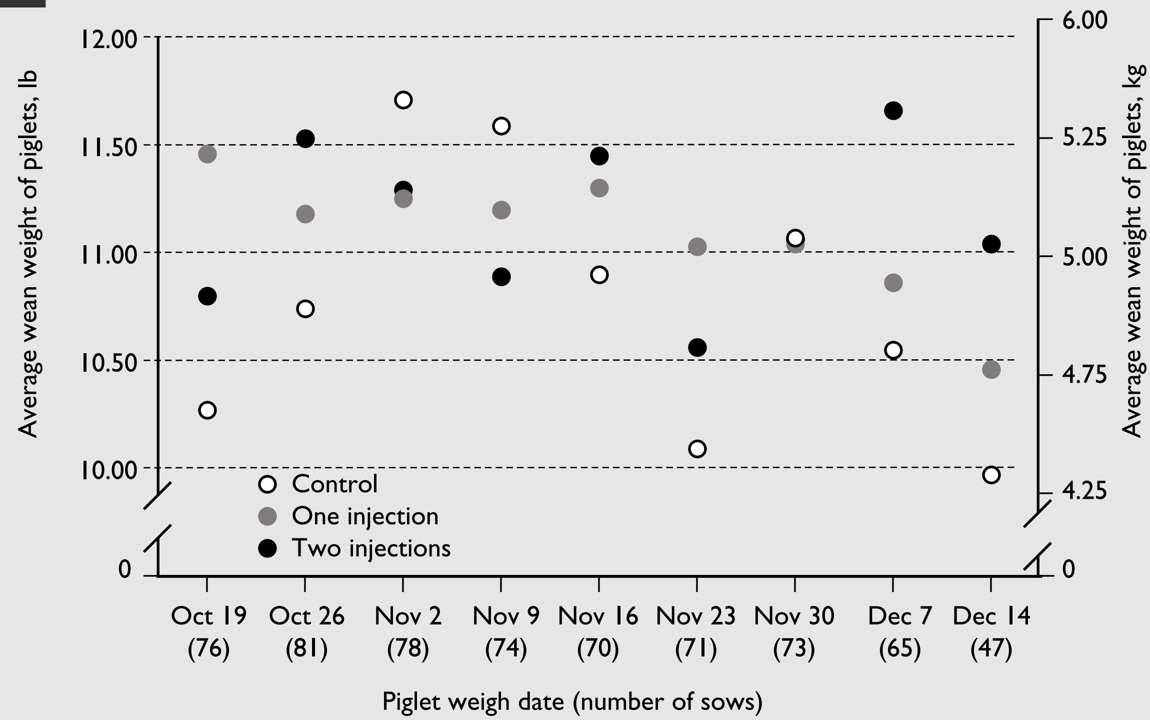
Generally, about half the piglet mortality occurs in the first 3 days of life,[20,21] with susceptibility to cold and hypoglycemia cited as major contributing causes.[22] Thus, our reported decrease in neonatal mor-

Figure 2



Effect of no, one, or two injections of Lutalyse® on the average weight of piglets.

Figure 3



Effect of no, one, or two injections of Lutalyse® on the average weight of piglets (lb on left scale; kg on right) by the date they were weighed.

tality is possibly associated with the proposed increases in sows' milk production and subsequent increases in weaning weight. An alternative explanation could be related to the known immunosuppressive nature of progesterone. If some sows have excessive blood progesterone resulting from incompletely lysed corpora lutea, then the blood level of suckling piglets could be abnormally high and immune function compromised, leading possibly to an increased probability of death.

Sows' disease

No sows were treated for savaging their piglets or because the farrowing attendant had to manually intervene in the farrowing process. Most sows received no medication and only five sows were treated for "off-feed no-fever," three sows for having retained pigs, three for lameness or skin cuts, one for bleach-out, and one for postfarrowing discharge (Table 1). Too few sows experienced obstetrical problems in this trial to determine if Lutalyse® injections decreased postfarrowing discharge. Forty-three sows were medicated for two disease events and nine for three disease events at their first farrowing. However, these never included treatments for postfarrowing discharge. There was no difference between treatments in the prevalence of sows' first (P=.78), second (P=.37), or third (P=.35) disease at first farrowing.

These results, showing no effect on sow morbidity to injecting sows postpartum, are consistent for a farm with no history of reproductive problems. Previous reports showing benefit have all been done in herds with a history of vaginal discharges or metritis,[3,23] or a more general history of "reproductive problems."[4]

Table 1

Frequency of diseases at sows' first farrowing by treatment

Treatment	Off-feed with fever	Hard underline	Other	No treatment	Total
Control	33	36	2	139	210
One injection	30	42	6	132	210
Two injections	28	41	5	141	215
Total	91	119	13	412	635

Model (P=.78). Other includes: off feed, no fever; retained pig(s); lameness or skin cuts; and bleach-out.

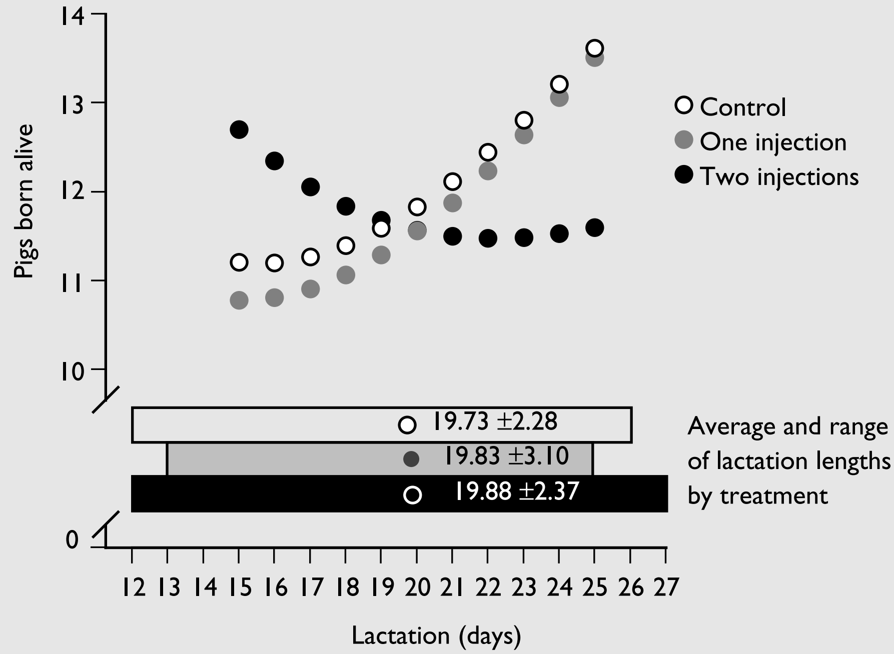
Weaning-to-service interval

Injection of Lutalyse® had no effect on WSI analyzed by either multivariate analysis (P=.25) or the proportion of sows returning to estrus within 7 days (P=.37). These results contrast with those of Gil Pascual, et al.,[4] who reported WSI was reduced on average 0.87 days on two farms, one with a history of "reproductive disorders," the other without. Also, Lorenzo, et al.,[5] reported an advantage of 3.34 days in weaning-to-fertile-service interval.

Pigs born alive at the subsequent farrowing

The effect of Lutalyse® on subsequent PBA de-

Figure 4



Effect of Lutalyse® on pigs born alive by lactation length. Significant interaction of lactation length with the threatment, P=.03. Quadratic effect of lactation length, P=.08. Cubic effect of lactation length, P=.07.

pended on lactation length (P=.03) (Figure 4). Compared to controls, administering one injection had no effect (P=.84) but administering two was significant (P=.02). We cannot explain why two injections would result in more pigs born alive to those sows who had shorter lactations and fewer pigs born alive to those sows who had longer lactations; it may be an unrepeatable random effect in this herd that had no previous reproductive problems. Herds with reproductive problems, where sows were injected with 2 mL of Lutalyse® within 48 hours after farrowing, have reported an increase in pigs born alive per sow (11.32 versus 10.77, statistical significance not reported[3] and 9.94 versus 8.7 [P<.05]).[23] Lorenzo, et al.,[5] in a study of 207 sows in a herd without a history of reproductive problems showed a subsequent increase of 0.44 pigs born alive although the results were not significant statistically.

Sow survival

Treatment had no effect (P=.20) on sow survival. The overall rate of not-surviving-to-produce-the-next-litter, 17%, is consistent with industry standards.[24] These results contrast with Abad, et al.,[1] who injected 10 mg $PGF_{2\alpha}$ (2 mL Lutalyse®) into sows at weaning on a farm with no significant reproductive problems, and reported fewer (13.5% versus 25.8%) primiparous and fewer (10.4% versus 16.9%) multiparous sows culled for reproductive problems (statistical significance not reported). Also, Gil Pascual, et al.,[4] reported that when sows were injected on a farm with a history of reproductive problems, fewer sows were culled (statistical significance not reported).

In conclusion, these data indicate that the average litter weaning weight on the experimental farm could be increased 2.8 lb (1.28 kg, 2.7%) by injecting sows with one or two doses of Lutalyse® soon after farrowing. There was a tendency for fewer piglets to die when they were suckling injected sows. In this trial, too few sows had postfarrowing discharge to determine the efficacy of Lutalyse®, but overall it had no effect on the incidence of diseases in that lactation. Lutalyse® injections had no effect on WSI; however, on the trial farm sows returned to estrus very quickly so it had limited opportunity to improve that parameter. On farms where sows return less quickly, Lutalyse® injections may decrease WSI.

Implications

- A single injection of Lutalyse® given to sows immediately postpartum may increase piglets weaning weight
- Two injections of Lutalyse® given postpartum may decrease neonatal mortality
- The ability of Lutalyse® given postpartum to improve the health status and survival of the sow, subsequent WSI, and prolificacy seems to vary by farm and to be more effective on farms with reproductive problems.

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