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Risk factors for prolonged postparturient vaginal discharge in sows

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Original Article

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Abstract

Previous study has shown that excessive postparturient vaginal discharge in sows causes impaired reproductive performance in the subsequent litter. This observational study aimed to investigate the effects of categorical predictors (farm (1-7), assisted farrowing, parity number (1, 2-5, >5) and stillbirth) and continuous predictors (farrowing duration, litter size and postparturient body temperature) on the incidence of prolonged postparturient vaginal discharge (duration of postparturient vaginal discharge >5 days) in sows. Data was collected from 620 postparturient sows raised on 7 farms in 4 provinces in Vietnam. Univariate logistic regression analysis was used to identify the potential risk factors for prolonged postparturient vaginal discharge. All risk factors that had a P-value <0.15 in the univariate analysis were selected for multivariate logistic regression analysis. The average farrowing duration, litter size, incidence of stillbirth at litter level and incidence of assisted farrowing were 4.0±1.7 h, 12.1±2.9, 39.4% and 32.9%, respectively. The duration of postparturient vaginal discharge was 4.3±0.9 days. The incidence of prolonged postparturient vaginal discharge was 12.6% (78/620). Multivariate logistic regression analysis revealed that the risk factors for prolonged postparturient vaginal discharge were assisted farrowing (RR=2.40, P<0.001), increased farrowing duration (RR=1.17, P=0.038), parity >5 (RR=2.57, P=0.001) and stillbirth (RR=1.93, P=0.009). In conclusion, prolonged postparturient vaginal discharge was common in sows. Assisted farrowing, increased farrowing duration, parity >5 and stillbirth were risk factors for prolonged postparturient vaginal discharge.

Keywords: Postparturient disorders, Prolonged postparturient vaginal discharge, Assisted farrowing, Farrowing duration, Parity, Stillbirth

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Introduction

In recent decades, due to genetic selection, improvements in nutrition and health management, the reproductive performance of sows has considerably improved (Koketsu *et al.*, 2017). The number of pigs weaned per sow per year has risen from 20 to 30 and may reach 40 in the future (Koketsu *et al.*, 2017). However, a large litter size causes increased piglet mortality (Rutherford *et al.*, 2013), deteriorated maternal ability (Lund *et al.*, 2016) and the decreased health status of the sows (Rutherford *et al.*, 2013). Common postparturient disorders include postparturient dysgalactia (Papadopoulos *et al.*, 2010), fever, low appetite and vaginal discharge (Tummaruk and Sang-Gassanee, 2013). In its turn, excessive postparturient vaginal discharge is responsible for the declining number of total piglets born and piglets born alive in subsequent farrowings (Waller *et al.*, 2002).

After parturition, the immune system recognizes fetal placentae as foreign tissues and attact them causing placental expulsion (Kimura *et al.*, 2002). Expulsion of the placentae depends on feto-maternal union and uterine contraction (Laven and Peters, 1996). Also, a decline in the number and function of leukocytes in the cotyledon results in retained placentae (Gunnink, 1984; Kimura *et al.*, 2002). As a consequence, remnants of placentae nourish commonly found facultative bacteria such as *Escherichia coli*, *Staphylococcus spp*. and *Streptococcus spp* (de Winter *et al.*, 1995) in the genital tract and these may invade the uterus before, at, or after parturition. The excessive growth of these pathogenic bacteria induces metritis in the sows, which may result in prolonged postparturient vaginal discharge.

Farrowing duration in sows varies between 133 and 411 minutes (Bjorkman *et al.*, 2017; van Rens and van der Lende, 2004). A long farrowing duration relates to an increased incidence of postparturient fever and reduced feed intake (Tummaruk and Sang-Gassanee, 2013) and is proportional to the length of placental expulsion (van Rens and van der Lende, 2004). A protracted farrowing duration also decreases conception rate at the first insemination after weaning (Oliviero *et al.*, 2013) and is associated with higher numbers of stillbirths (Oliviero *et al.*, 2010). Also, stillbirth correlates with parity number (Borges *et al.*, 2005). High parity sows are more likely to have an accumulated risk of having disorders in their genital tract (Boma and Bilkei, 2006).

The present study tested the hypothesis that postparturient vaginal discharge in sows is associated with environmental factors (farm, assisted farrowing) and maternal factors (farrowing duration, postparturient body temperature, litter size and parity) and piglet factors (stillbirth).

Materials and Methods

Animals: The present observational study was conducted from August to November 2016. This study enrolled 620 postparturient Yorshire x Landrace sows on 7 commercial farms in 4 provinces (Hai Duong, Bac Ninh, Thai Nguyen and Hung Yen) in Viet Nam. Farm capacity varied between 200 and 700 sows. Parity numbers varied between 1 and 13 and the numbers of sows at parity 1-13 were 78, 179, 138, 65, 57, 32, 25, 15, 8, 13, 5, 3, 2, respectively. All sows were vaccinated against classical swine fever, Aujeszky's disease, foot and mouth disease and porcine reproductive and respiratory syndrome. Sows were housed in individual gestation crates sized 57 cm x 220 cm. About 7 days before the predicted farrowing date, the sows were moved to individual farrowing crates sized 180 cm x 220 cm. The sow area, which measured 60 x 220cm, had a slatted floor and was situated in the middle of the farrowing crates. The piglet area, which was at the two sides of the sow area, measured 40 x 220 cm and 80 x 220 cm. The creep area, which measured about 45 x 110 cm, was located at one corner of the piglet area. During the gestation stage, sows were fed 1.8-3.5kg of industrial feed. The feed for sows during the first 84 days of gestation contained 13% crude protein and had metabolizable energy of 2900 Kcal/kg (Hi-Gro 566, Charoen Pokphand, Vietnam). After farrowing, the amount of feed for each sow was gradually increased from 1.5kg per day at day 1 to about 6kg per day at day 6. After day 6, sows were fed on demand. The feed for the last trimester sows and for lactating sows contained 17% crude protein and had metabolizable energy of 3100 Kcal/kg (Hi-Gro 567S, Charoen Pokphan, Vietnam). Water was provided *ad libitum* through a bite nipple drinker system. During the stage of piglet expulsion, all the sows were injected with at least one dose of oxytocin (Oxytocin, 20IU, Mekovet, Vietnam or Bio-Oxytocin, 20IU, BiO®, Vietnam or Oxytocin, 20IU, Hanvet, Vietnam). After farrowing, oxytocin was administered daily to all sows for at least 2 days with the same dose that was used during the parturition. Amoxicillin Trihydrate was intramuscularly injected into all sows at least 3 times in a 48 hour-interval starting as soon parturition had finished (Amoxoil retard, 15mg/kg, Syva, Spain or Hitamox LA, 15mg/kg, Thainaoka, Thailand or Amoxisol® L.A, 15mg/kg, Bayer, Vietnam or Vetrimoxin® L.A, 15mg/kg, CEVA, France or Invemox 15% LA, Invesa, Spain).

Clinical examination: Sows were examined by veterinarians who were trained in how to follow, collect and record the targeted data. Sows at different parities were categorized into 3 groups: 1) sows at parity 1, 2) sows at parity 2-5, and 3) sows at parity >5. The farrowing process was visually monitored and farrowing duration was recorded as the interval between the expulsion of the first and the last piglet. Litter size was calculated as the total number of piglets born. Stillborn piglets were defined as those dying before birth with no sign of decay (Vanderhaeghe *et al.*, 2010). Litter-level incidence of stillbirth was the proportion of the litters that had stillborn piglet(s) to all litters. Assisted farrowing was recorded when manual palpation occurred. Usually, workers used their lubricated bare hands to assist the sows. Within the first 6h postpartum, rectal temperature was measured using a thermometer inserted in the sows' rectum for 30s (AURORA, GMBH Joint-Venture, Germany). Postparturient vaginal discharge was followed twice every day until no discharge was observed in two consecutive observations. Then, the duration of postparturient vaginal discharge was calculated as the interval between the end of farrowing and the time of the first observation without discharge. Previous studies have variously defined postparturient vaginal discharge. According to Tummaruk and Sang-Gassanee, (2013) postparturient vaginal discharge is defined as the presence of abnormal vaginal discharge (≥1ml). Also, postparturient vaginal discharge has been described as purulent or mucopurulent (Stiehler *et al.*, 2015). In another study, postparturient vaginal discharge was defined as "excessive" if its duration exceeded 6 days

(Waller *et al.*, 2002). In the present study, postparturient vaginal discharge is categorized into normal (shorter than or equal to 5 days) or prolonged postparturient vaginal discharge (longer than 5 days). The categorization is based on the fact that the normal postparturient vaginal discharge can last for 5 days (Maes *et al.*, 1999).

Statistical analysis: Descriptive statistics (Table 1) were derived from data available from 620 sows. Incidence of prolonged postparturient vaginal discharge among farms was compared by means of the *Chi*-square test of association. Due to missing information on 107 sows, full records of 513 sows were used for risk analyses. Odds ratio (OR) for individual potential risk factor was calculated by univariate logistical regression. Since the incidence of prolonged postparturient vaginal discharge (Po, 59/513) was common in the studied sows, the adjusted OR was corrected following the formula: Risk ratio (RR) = OR/[(1 - Po) + (Po x OR)] (Zhang and Yu, 1998).

Risk factors that were significant at P<0.15 via univariate analysis were used for calculation of variance inflation factor (VIF) and Pearson's correlations in order to quantify the severity of multicollinearity. Only risk factors that resulted in a low VIF (VIF<5) and low Pearson's correlations (r<0.3) were included in the multivariate logistical regression analysis. Based on the biological plausibility and correlations, 5 risk factors including assisted farrowing, farrowing duration, parity, postparturient body temperature and stillbirth were enrolled into the multivariate analysis. Multivariate models were achieved using the backward stepwise elimination of non-significant factors (P>0.1). The Hosmer-Lemeshow goodness of-fit tests were used to measure the predictability of the multivariate models. All statistical analyses were conducted in SPSS program (IBM SPSS Statistics for Windows, Version 22.0, Armonk, NY: IBM Corp).

Table 1 Descriptive data

Parameters	Number	Mean±SD
Parity	620	3.6 ± 2.3
Farrowing duration (h)	562	4.0 ± 1.7
Litter size	608	12.1 ± 2.9
Assisted farrowing rate (%)	611	32.9
Litter-level incidence of stillbirth (%)	618	39.4
Postparturient body temperature (^{o}C)	541	39.3 ± 0.5
Incidence of prolonged postparturient vaginal discharge (%)	620	12.6
Duration of postparturient vaginal discharge (day)	620	4.3 ± 0.9
Duration of prolonged postparturient vaginal discharge (day)	78	5.9±0.4

Results

Descriptive data: The descriptive statistics of 620 sows in various parity are presented in the Table 1. Incidences of assisted farrowing, stillbirth and prolonged postparturient vaginal discharge were 32.9%, 39.4% and 12.6%, respectively. The respective postparturient body temperature, farrowing duration, duration of postparturient vaginal discharge and duration of prolonged postparturient vaginal discharge were 39.3 ± 0.5^{o}C, 4.0 ± 1.7 hours, 4.3 ± 0.9 days and 5.9 ± 0.4 days.

The incidence of prolonged postparturient vaginal discharge was similar among the 7 farms with 15.0% (12/80), 10.5% (9/86), 8.6% (8/93), 14.3% (10/70), 14.8% (21/142), 14.4% (13/90) and 13.6% (8/59), respectively (P>0.05).

Risk factors for prolonged postparturient vaginal discharge: The ORs for the association between single potential risk factors and prolonged postparturient vaginal discharge derived from the univariate analysis are demonstrated in Table 2. Farm and litter size had no significant effect on prolonged postparturient vaginal discharge. Five factors including assisted farrowing (RR=3.11), postparturient body temperature (RR=2.05), farrowing duration (RR=1.23), parity 1 (RR=1.93) and >5 (RR=2.52) and stillbirth (RR=2.26) significantly affected the risk of prolonged postparturient vaginal discharge (P<0.05).

Bivariate correlation revealed that correlations among these 5 potential risk factors were low (r ≤ 0.231). In addition, respective VIF for assisted farrowing, body temperature, farrowing duration, parity and stillbirth were 1.104, 1.065, 1.060, 1.031 and 1.037, which showed that there was no multicollinearity in the multivariate models when these risk factors were included in the multivariate analysis.

Multivariate logistic regression analysis demonstrated that assisted farrowing (RR=2.40, P<0.001), farrowing duration (RR=1.17, P=0.038), parity >5 (RR=2.57, P=0.001) and stillbirth (RR=1.93, P=0.009) significantly increased the risk of prolonged postparturient vaginal discharge, and postparturient body temperature tended to affect the rate of prolonged postparturient vaginal discharge (RR=1.60, P=0.084) (Table 3). The final multivariate model provided 87.7% "percentage correct" with a -2 loglikelihood of 314.858 and a Nagelkerke R square of 0.186. The Hosmer-Lemeshow test showed that the

multivariate logistic regression model was a good fit between the observed and expected prolonged postparturient vaginal discharge rate (P>0.05).

Table 2 Univariate logistic regression for association between potential risk factors and prolonged postparturient vaginal discharge.

Variables	Category	Incidence of prolonged postparturient vaginal discharge (%)	OR (95%CI)	RR (95%CI)	p-value
Assisted farrowing	No	6.3 (22/348)	1.00	1.00	-
	Yes	22.4 (37/165)	4.28 (2.43, 7.54)	3.11 (2.01, 4.30)	<0.001
Parity	2-5	8.3 (31/372)	1.00	1.00	-
	1	16.7 (10/60)	2.20 (1.02, 4.76)	1.93 (1.02, 3.32)	0.045
	>5	22.2 (18/81)	3.14 (1.66, 5.96)	2.52 (1.54, 3.80)	<0.001
Stillbirth	No	7.5 (24/319)	1.00	1.00	-
	Yes	18.0 (35/194)	2.71 (1.56, 4.71)	2.26 (1.47, 3.30)	<0.001
Farms	1	8.2 (6/73)	1.00	1.00	-
	2	9.5 (7/74)	1.17 (0.37, 3.65)	1.15 (0.40, 2,79)	0.791
	3	8.6 (8/93)	1.05 (0.35, 3.18)	1.04 (0.38, 2.54)	0.930
	4	10.8 (7/65)	1.35 (0.43, 4.24)	1.30 (0.46, 3.09)	0.610
	5	15.2 (16/105)	2.01 (0.75, 5.41)	1.80 (0.77, 3.59)	0.168
	6	12.2 (6/49)	1.56 (0.47, 5.15)	1.47 (0.50, 3.49)	0.467
	7	16.7 (9/54)	2.23 (0.74, 6.71)	1.95 (0.76, 4.05)	0.152
Postparturient body temperature			2.38 (1.32, 4.31)	2.05 (1.27, 3.12)	0.004
Farrowing duration			1.27 (1.08, 1.49)	1.23 (1.07, 1.41)	0.003
Litter size			1.05 (0.96, 1.16)	1.04 (0.96, 1.14)	0.283

Table 3 Multivariate logistic regression for the association of potential risk factors and prolonged postparturient vaginal discharge

Variables	Category	OR (95%CI)	RR (95%CI)	p-value
Assisted farrowing	No	1.00	1.00	-
	Yes	2.94 (1.62, 5,34)	2.40 (1.51, 3.56)	<0.001
Parity	2-5	1.00	1.00	-
	1	1.85 (0.80, 4.24)	1.69 (0.82, 3.09)	0.15
	>5	3.23 (1.61, 6.46)	2.57 (1.50, 3.97)	0.001
Stillbirth	No	1.00	1.00	-
	Yes	2.20 (1.22, 3.96)	1.93 (1.19, 2.95)	0.009
Postparturient body temperature		1.73 (0.93, 3.21)	1.60 (0.94, 2.56)	0.084
Farrowing duration		1.20 (1.01, 1.42)	1.17 (1.01, 1.35)	0.038

Discussion

To the author's knowledge, this is the first study to investigate the effects of assisted farrowing, farrowing duration, litter size, parity, postparturient body temperature and stillbirth on the incidence of prolonged postparturient vaginal discharge in sows.

In cases of dystocia, assisted farrowing helped to save offspring from suffocation and eased the mother in the parturition process. A previous study showed that assisted farrowing positively correlated with feverish puerperal illness (Bjorkman *et al.*, 2018). In cows, assisted calving reduces conception rate (OR=0.32) (McDougall 2001). It may be that assisted farrowing causes trauma to the endometrium, subendometrial tissues and increases the risk of contamination by bacteria from hands and tools to the uterus (Bjorkman *et al.*, 2018). Thus, the higher rate of prolonged postparturient vaginal discharge in assisted farrowing sows, in comparison to non-assisted farrowing sows, might be attributable to the traumatic and contaminating side effects of such intervention.

The reason why long farrowing duration increased the incidence of prolonged postparturient vaginal discharge might be because the long farrowing duration affected the health of sows by increasing the incidence of reduced appetite and fever (Tummaruk

and Sang-Gassanee, 2013). Furthermore, long farrowing duration is a risk factor for delayed postpartum uterine involution (OR=7.6) and metritis (OR=5.7) (Bjorkman *et al.*, 2018). In addition, during the farrowing process, series of uterine contractions cause huge energy loss in the sows. Thus, long farrowing duration results in increased energy loss that might harm the uterine involution (Van Knegsel *et al.*, 2007). Another explanation for the link between farrowing duration and incidences of prolonged postparturient vaginal discharge may be related to oxytocin**.** Low oxytocin concentration may be the cause of both long farrowing duration and impaired placental expulsion (Castrén *et al.*, 1993; Bjorkman *et al.*, 2017). Retained placentae in the uterus may become a nourishing medium for the growth of pathogenic bacteria and, as a result, subsequent infection causes prolonged postparturient vaginal discharge.

Previous studies have shown that parity correlates with incidences of postparturient disorders in sows. Postparturient vaginal discharge was more common in sows at parity 5-7 than in sows at parity 2-4 (Tummaruk and Sang-Gassanee, 2013). Pathological changes in the uterus, cervix and vagina were also more frequently observed in sows at parity >5 than in sows at parity 2-5 (Boma and Bilkei, 2006). These results suggest that the genital tracts of sows at parity >5 might have poorer health status in comparison with those of sows at parity 2-5. Therefore, during the postparturient period these "unhealthy" organs more often became infected by facultative bacteria from the vagina and cervix that resulted in prolonged postparturient vaginal discharge.

In this study, the postparturient body temperature of sows corresponded with the results in the study by King *et al.*, (1972) who reported that the mean postparturient body temperature of 217 sows was 39.25 ± 0.72^0C. The fact that 67.5% (365/541) of the sows in this study had a postparturient body temperature above 39^0C was, to some degree, in agreement with the figure of 77.49% reported by Tummaruk and Pearodwong, (2015). During and after farrowing, sow body temperature increases and remains high for some days postpartum (King *et al.*, 1972). The increment of body temperature may be due to nest-building activity, to elevated metabolism of mammary glands and to uterine and vaginal contractions. Furthermore, parturition is considered to be an inflammatory process (Thomson *et al.*, 1999). In the third trimester and after labor, there is an elevation of levels of interleukin -1 β (IL-1 β) and IL-8 in the amnion and choriodecidua (Elliott *et al.*, 2001). Moreover, with the existence of infection, concentrations of IL-6 and tumor necrosis factor alpha also become elevated in the amniotic fluid, myometrium, decidua, fetal membranes and maternal serum (Goldenberg *et al.*, 2000). These pyrexic cytokines may be absorbed into the blood flow and cross the blood-brain barrier to cause a rise in body temperature (Evans *et al.*, 2015). In human infants, fever magnitude positively correlates with the rate of serious bacterial infection (Bonadio *et al.*, 1991). It can be hypothesized that, at least in part, the higher body temperature is the result of more serious uterine infection. The increment of body temperature upregulates the immune system to help the body clear infection. However, high body temperature might cause discomfort, reduction in nutrient intake and increased nutrient loss (Scrimshaw, 1992) which results in negative energy balance. Negative energy balance may decrease the immune response of the uterus and reduce the intensity of uterine contraction (Van Knegsel *et al.*, 2007), and as a result, the clearance of uterine infection might take longer.

In sows, stillbirth was present in 31.3% to 54% of all litters (Le Cozler *et al.*, 2002; Borges *et al.*, 2005). Stillbirth may be the result of dystocia which is, at least in part, due to insufficient uterine contraction, i.e. low magnitude and/or low frequency. An explanation for the association between stillbirth and increased risk of prolonged postparturient vaginal discharge might be that stillbirth increases the odds for metritis (Correa *et al.*, 1993; Emanuelson *et al.*, 1993; Bjorkman *et al.*, 2018), and the odds for delayed uterine involution (Bjorkman *et al.*, 2018).

The interpretation of the results of this study should be treated with caution due to some limitations. This observational study did not analyze the effects of drugs used on the studied outcome. Oxytocin administration during farrowing supports uterine involution (Bjorkman *et al.*, 2018). Oxytocin can shorten the farrowing duration and expulsion interval but it may cause stillborn piglets with ruptured and hemorrhagic umbilical cords (Mota-Rojas *et al.*, 2006, 2002). Also, the use of non-steroidal inflammatory drugs such as flunixin méglumine after farrowing decreases the incidence of sows with fever and vaginal discharge (Tummaruk and Sang-Gassanee, 2013). In addition, the fact that the use of antibiotics (Cefquinome, Cefapirini and Amoxicillin trihydrate) immediately after farrowing alters the bacterial composition of cervical samples at 4-5 days after treatment (Laureckiene *et al.*, 2006) suggests that antibiotic use may affect the rate of prolonged postparturient vaginal discharge. Despite such limitations, the present study provides valuable results for a first insight into the effects of assisted farrowing, farrowing duration, parity, postparturient body temperature and stillbirth on the incidence of prolonged postparturient vaginal discharge in sows.

In conclusion, this study demonstrates that the incidence of prolonged postparturient vaginal discharge was common in commercial pig farms in Vietnam. Assisted farrowing, long farrowing duration, parity >5 and stillbirth increased the rate of prolonged postparturient vaginal discharge. The results of this study suggest that decreased use of old sows, restricting the application of assisted farrowing to necessary cases, shortening of farrowing duration by using oxytocin at appropriate times may have a positive effect on the postparturient vaginal discharge. Future research should explore the effects of other factors such as peripartum used drugs and sows' health status on the incidence of prolonged postparturient vaginal discharge, and the effects of prolonged postparturient vaginal discharge on the reproductive performance of the sows.

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