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Accuracy of prepartum vaginal temperature to predict the onset of calving in a Holstein-Friesian dairy herd: A comparison of anterior presentation, posterior presentation and twin calvings

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Abstract

Calving management is an important fundamental aspect of successful dairy operation. With the development of precision livestock farming, namely dairy monitoring technology, there is surprisingly very little research undertaken. Therefore, it is worth researching the accuracy of intravaginal thermometers to predict calving. This study was completed on 257 Hungarian Holstein-Friesian dairy cows to evaluate the accuracy of intravaginal thermometers (Vel'Phone Sensor - Medria Solutions) to predict the onset of calving, comparing differences between anterior presentation to posterior presentation and twin calving. It can be concluded that the intravaginal thermometer can accurately alert the producer of impending parturition within 48 hours of notification but there is no definitive differentiation between vaginal temperature changes and presentation of the foetus(es).

Contents

1. Introduction

Calving in dairy farms is the critical trigger point of farm operations, initiating lactation and producing viable replacement animals [1]. The goal of calving management is to optimise and ensure the overall health of the animals, and to decrease the occurrence of dystocia. Furthermore, to reduce the incidence of stillbirth and/or postpartum complications. Despite the lack of research, accurately identifying the onset of calving is pinnacle due to its ability to reduce complications. The transition from small, family run herds to large commercial farms, has demonstrated the importance and evolution of productivity practices. Real-time sensors and cameras are beginning to be used in conjunction with a skilled labour force and human monitoring. Calving difficulty and postpartum complications in fact cause problems for the animal itself and increase the need for interventional management and labour.

Despite the increased prevalence of dairy monitoring technology over the years, there is a limited collection of scientific research published [2]. The term Precision livestock farming (PLF) was established in 2004 [3], although techniques falling under this umbrella term were used years prior. Precision livestock farming is the use of automatic and/or electronic real time monitoring of production, reproduction, health and welfare of livestock and environmental impact. There is an increased need for precision in organisation, logistics and administration in high producing farms in order to adapt and provide for the continuously growing consumer demand. Frequently used devices to detect calving. The most frequently used devices to assist in calving detection are the inclinometer and accelerometers, abdominal belt, and vaginal sensors [3]. These devices have been developed due to the evidence indicating when the physiological process of calving begins, dairy cows change their feeding habits, rumination time, increase activity levels and decrease vaginal temperature approximately 48 hours before calving [4]. Research differentiating vaginal temperature changes between anterior presentation versus posterior presentation and twin calving in dairy cows is scarce, likely related to calving research that is already limited and the incidence of twin pregnancies is an unwanted phenomenon [5]. Twin pregnancies cause increased economic cost, pregnancy loss and calving intervention, as well as risking the return of a cow.

Prediction of calving, especially in the cases of twin pregnancies, would be of great significance due to the opportunity to monitor from a distance and could intervene as early as reasonably possible to reduce the risk of dystocia and increase the occurrence of viable calves and dams [6].

2. Objectives

The aim of this thesis is to analyse the calving data of a Hungarian Holstein-Friesian dairy herd in order to determine whether the change of vaginal temperature before parturition is able to accurately predict the onset of calving. Notably comparing the differences, if any, between anterior presentation versus posterior presentation and twin calving.

3. Literature Review

3.1 History of Holstein Friesian dairy cattle

Originating in the Netherlands, Batavian and Friesian cattle were crossed to produce the traditional 'black and white' and less prominent 'red and white' Holstein-Friesian dairy breed [7]. Holstein Friesian cattle are considered the most predominant dairy breed throughout Western Europe due to genetic progression improving milk feed conversion efficiency into high levels of milk production [8]. "They have an unequalled genetically anchored achievement ability which has no biological ceiling" [9]. Moreover, genetic improvements are thought to increase at a rate of one to two percent per year. Holstein cows are the product commitment to long-term breeding improvement, with their excellent lactation performance and good adaptability, they are a highly sought after breed [10].

3.2 Physiology of calving

Calving is a fundamental process to both cattle and producers, initiating the start of lactation and introducing replacement heifers [1]. To understand and accurately identify the onset of parturition the importance of the physiological process and changes cannot be understated. A study completed on the gestation periods of Holstein Friesian cows indicated that the average length of gestation for Holstein Friesian cattle varies from 262 to 296 days, with male calves extending the length by one day compared to female calves [11]. The rapid calf growth during the final days of gestation has been noted to increase risk of dystocia. Producers are required to calculate predicted time of calving within one week from service dates for each pregnant animal to facilitate appropriate timing of movement to the maternity unit, to avoid calving in inappropriate areas [12]. It is recommended that cows are placed into the maternity unit within 24 hours of calving at latest [12]. Despite the initial recommendation of moving cows within the first stage of calving, there has been research into the predictors of stillbirth suggesting that cows moved to the maternity pen early during the first stage of parturition, with mucus only present, were 2.5x more likely of a stillbirth versus movement with the presence of a full "water bag" or presence of hooves [12–15].

There are numerous physiological, behavioural, and environmental factors that play a role in the detection of the onset parturition. The traditional clinical signs of impending parturition are relaxation of the broad pelvic ligaments, vaginal secretion, udder hyperplasia and oedema, teat filling, tail relaxation and vulva oedema [16]. Stages of labour activity are divided into three stages: first stage: onset of parturition is most often undetectable, and timing varies largely between 6 to 12 hours (cows vs heifers) [12]. This includes restlessness, onset of myometrial contractions and cervical softening, isolation and calf shifting from ventral to dorsal position in the birthing canal [12,15]. The amniotic sac is present.

Expulsion of the calf, the second stage ranges from 30-60 minutes for multiparous cows to 2-4 hours for primiparous animals, uterine contractions begin at 3-5-minute intervals and abdominal muscles contract to aid in calf expulsion.

The third stage holds a duration of approximately 0.5-8 hours, when foetal membranes are expelled. Most studies define retained foetal membranes in cattle at 12 to 24 hours [17]. Being able to recognize the three stages is critical.

3.3 Presentations: anterior, posterior and twin calving

Anterior presentation, head tucked between extended front feet is considered normal calving presentation. Typically, this is the most seen presentation and does not cause calving difficulty. Posterior presentation, when the extended hind legs are coming first through the birthing canal, is not considered normal and often results in a high incidence of dystocia. In the instance of twin calving, most often there is one calf presenting anteriorly and the second posteriorly.

3.4 Dystocia

Dystocia is defined as calving difficulty at any stage of labour. Resulting in prolonged expulsion of the calf, often requiring interventional assistance, and causing adverse effects to both calf and dam. Typically, there is a failure in one or more of the three main components of calving: expulsive forces, birth canal adequacy and foetal size and position [18]. Small dam is often the cause of foetal size related dystocia, meaning the heifer is bred too early in relation to body size rather than large foetus due to sire selection. If there is evidence of lack of soft birth dilation, a manual or surgical approach such as episiotomy can be used before the use of strong force such as a calving jack [19]. If the dystocia is caused by the inability of the calf to pass through the bony birth canal, caesarean section or fetotomy, depending on foetal viability, should be performed. Choice and means of intervention/assistance is dependent on the severity and cause of dystocia. Monitoring is an important element of pregnancy and lack thereof can lead to delays in necessity of calving assistance and subsequently increasing rates of perinatal death [20]. Studies on Holstein cows show that calving complications cause negative effects on future reproductive performance, subsequently lengthening the calving to conception period [20].

A review of international research was completed by John F Mee in 2008, on the prevalence of dystocia between primiparous and multiparous cows. The review determined a range of 3% to 22.6% and 1.5% to 13.7%, primiparous and multiparous cows respectively; the United States' values were considerably higher [21]. Research reported by Sakatani et al. [22], determined that the rates of dystocia and calving assistance required is higher in that of a dairy breed versus beef breed (Holstein vs. Japanese Black). And that management of first parity heifers is especially important [22].

3.5 Automatic temperature monitoring devices

Crociati et al. [23] provided a thorough review of the available automatic devices and technologies for remote monitoring and calving prediction. Devices for automatic temperature monitoring include rumen temperature and pH, vaginal temperature, and tail base temperature. Medria solutions product, Vel'Phone, was reported to have a sensitivity and specificity of 86% and 91% for the 38.2°C temperature cut off and 66% sensitivity and 76% specificity for the -0.21°C cut off [23].

3.6 Vaginal temperature changes during parturition

Circadian Rhythm is well studied in humans but lacking in domesticated farm animals, particularly cows. Evidence exists that by the age of 2 months cattle temperature rhythmicity follows a diurnal body temperature pattern, lowest in the morning and highest in mid to late afternoon [24]. There are variables that affect the body temperature, such as wind and rain, heat stress and milking frequency [21,25,26]. Along with the rhythmicity of body temperature changes, it is a long-standing fact that vaginal temperature decreases 48 hours before calving.

Research performed by Burfeind et al. [21] investigated the validity of prepartum vaginal and rectal changes to predict calving in dairy cows. The three experiments used a microprocessor-controlled temperature sensor inserted into the vagina and measured the temperature changes until expulsion. Vaginal temperatures were found to be 0.2 to 0.7°C lower on the calving day [21]. This study was able to determine there was a consistent decrease in vaginal temperature 48 and 36 hours before parturition, with respect to the diurnal changes [21]. Aoki et al. [27] studied the changes of vaginal temperatures with the use of temperature loggers in beef cattle with twin foetuses. The research reflected that with a temperature decrease greater or equal to 0.3°C, parturition was imminent within the following 24 hours [15,21,22].

3.7 Conclusion

The ability to effectively produce viable calves and maintain the continuity of the lactation stage of cows within a dairy operation is highly important, if not the most important. Calving not only requires healthy animals and proper environment, but educated and skilled farm personnel. The use of automated devices to detect the onset of calving is beneficial, but not necessarily able to eliminate the use of the labour force. Intravaginal thermometers being the focus of this analysis, as highlighted in former studies, consistently remain informative regarding the process of calving.

Whilst the physiology of calving is more complex than solely a decrease in body temperature within 48 hours of parturition, the use of temperature sensors has been able to provide adequate data to assist and decrease the incidence of prolonged calving and associated difficulties. Along with the evolution and increased prevalence of precision livestock systems, there is concern. "As producer focus changes from clinical to sub-clinical disease to sub-optimal performance records, the pain, distress and injuries associated with dystocia in individual animals will receive less attention" [18].

As to the best of the author's knowledge, there is no current research into the significance of the calf presentation to the dam's physiology during the onset of calving and effects on the calving process (pre- and postpartum). Continued research into the use of calving sensors, specifically intravaginal devices, would be beneficial to determine the long-term financial benefit and production value for both large and smaller scale operations.

4. Materials and Methods

4.1 Farm Information

The data was collected from the Prograg Agrárcentum Ltd. in Ráckeresztúr, Lászlópuszta, Hungary, which has a herd of 900 Holstein-Friesian cattle [6]. The study was part of a larger research project into the metabolic, behavioural, and physiologic aspects of bovine parturition.

This data collection took place over 18 months using 257 randomly selected Hungarian Holstein Friesian cattle, including both nulliparous heifers (n=59) and multiparous cows (n=198). The control group was composed of a total of 116 healthy animals, including nulliparous heifers (n=38) and multiparous cows (n=78).

4.2 Equipment

The intra-vaginal thermometer used in the study was the product of Medria Solutions - Vel'Phone Sensor (Figure 1). The function of the intra-vaginal sensors is to send alert messages to

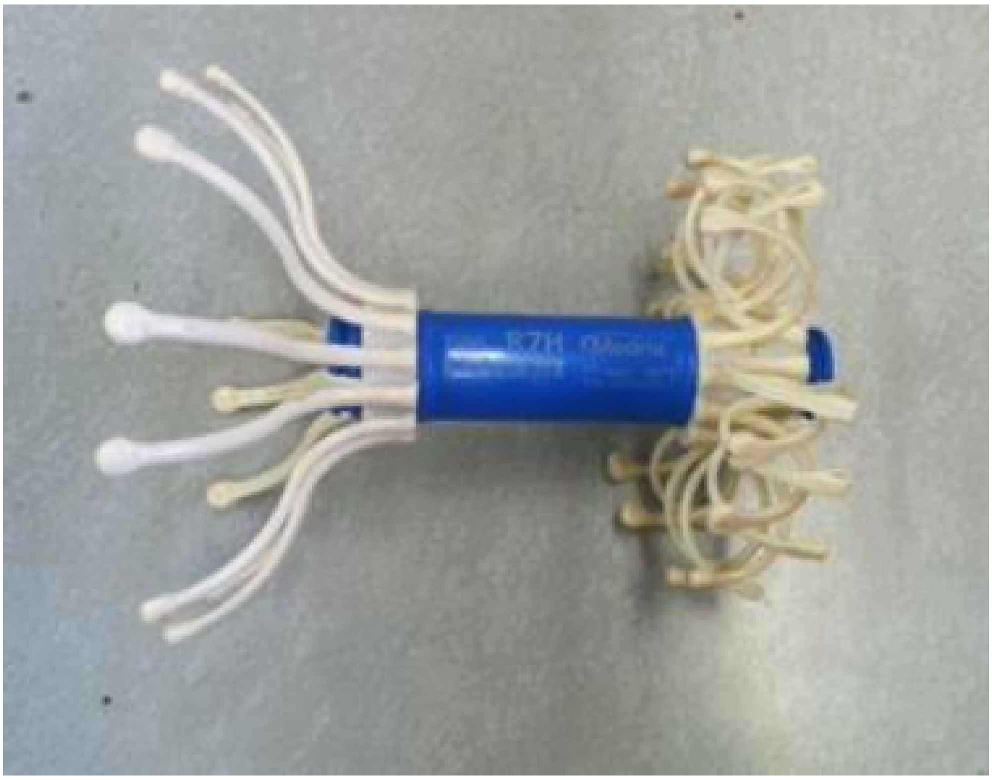

Figure 1. **"**Intra-vaginal thermometer (11.5 cm x 2.2 cm) used for multiparous cows" [6]

the respective connected mobile device. From the point of initial insertion and temperature detection, the sensor provided and recorded vaginal temperatures twice daily, at 12-hour intervals of 8am and 8pm. Based on two key algorithms, the sensor alerted one of two notifications via SMS, "Possible Calving in 48 hours" or "Expected Calving in 48hrs". "According to the producers' user manual the first algorithm calculates the absolute variation of the temperature that has dropped below 39°C after having previously risen above 39°C while the second algorithm calculates the relative variation of the temperature that has dropped close to 2°C after having risen close to 41°C" [6]. The 'expulsion' SMS was created when the sensor was dislodged by the allantoic sac, causing a temperature drop below 36°C.

Thermometers were placed in each respective animal approximately 5-7 days prior to the determined calving date. The implantation process included a betadine soak of the thermometer and disinfection of the perineal area prior to insertion [6]. Two variable appendages were attached to the thermometers, 'turquoise' for heifers and 'white' for multiparous cows [6].

4.3 Data categorization

Two hundred-fifty-seven animals were used as the experimental group including 59 nulliparous heifers and 198 multiparous cows. The control group included 116 animals, of which 38 were nulliparous heifers and 78 multiparous cows.

Information regarding parity, ear tag number, body condition score (conducted on a five-point scale) at calving, dystocia score (conducted on a one-to-four-point scale as follows: Score 1= no dystocia, Score 2= mild dystocia: assistance by one person, no mechanical traction required, Score 3= severe dystocia, assistance required with mechanical traction and/or more than one person and Score 4=surgical intervention), calf sex, calf weight, and calf presentation for both the experimental and control group animals was recorded. The incidence of twinning, stillbirth, retained foetal membranes, and uterine infection was also collected and recorded for both groups. "Stillbirth was recorded in case of death of a calf after an at least 260-day gestation, during calving or in the first 24 h of postnatal life," [15].

In addition, the following data was recorded for the experimental group: body condition score before calving, time of calving (six-hour time frame range), 'duration of calving within 48-hour SMS to expulsion *in hours*', 'duration of expulsion SMS to presence of hooves *in minutes*', 'duration of calving *in minutes*' and 'insertion of device until expulsion SMS *in days*' [6].

4.4 Statistical analysis

For this thesis, the raw data from the original study was provided by Dr. Szenci, to compare the differences between calf presentations (anterior to posterior and twin calving). With the use of Microsoft Excel, the data was organised into the respective groups, 'anterior presentation', 'posterior presentation' and 'twin calving' for both the experimental and control groups. Statistical technique, Analysis of Variances (ANOVA), was performed on the data. A P value less than 0.05 ($P<0.05$) was considered statistically significant.

5. Results

All thermometers used on the experimental animals were expelled at the start of the second stage of calving. The mean body condition score at the time of calving was 2.73 ± 0.04, 2.75 ± 1.33, 2.67 ± 0.44 and 2.59 ± 0.03, 2.7 ± 0.08, 2.49 ± 0.08, for control and experimental (anterior, posterior, and twin calving) groups respectively. The average calf weight in kilograms was 44 ± 0.85 and 43 ± 0.43, for the control and experimental groups. The prevalence of anterior, posterior, and twin calving presentations as reported across the experimental and control groups are depicted in Table 1.

Table 1. Prevalence of presentations (anterior, posterior, and twin calving) across experimental and control groups

Presentation	**Experimental group**		**Control group**		**Experimental group**	**Control Group**
	Nulliparous Heifers (n=59)	Multiparous cows (n=198)	Nulliparous Heifers (n=38)	Multiparous cows (n=78)	(n=257)	(n=116)
Anterior	53 (89.8%)	174 (87.9%)	37 (97.4%)	69 (88.5%)	227 (88.3%)	106 (91.4%)
Posterior	5 (8.5%)	10 (5.1%)	0 (0%)	7 (8.9%)	15 (5.8%)	7 (6.0%)
Twin calving	1 (1.7%)	14 (7.0%)	1 (2.6%)	2 (2.6%)	15 (5.8%)	3 (2.6%)

5.1 Variation of device intervals as per presentation

5.1.1 Duration insertion of device to expulsion SMS *in days*

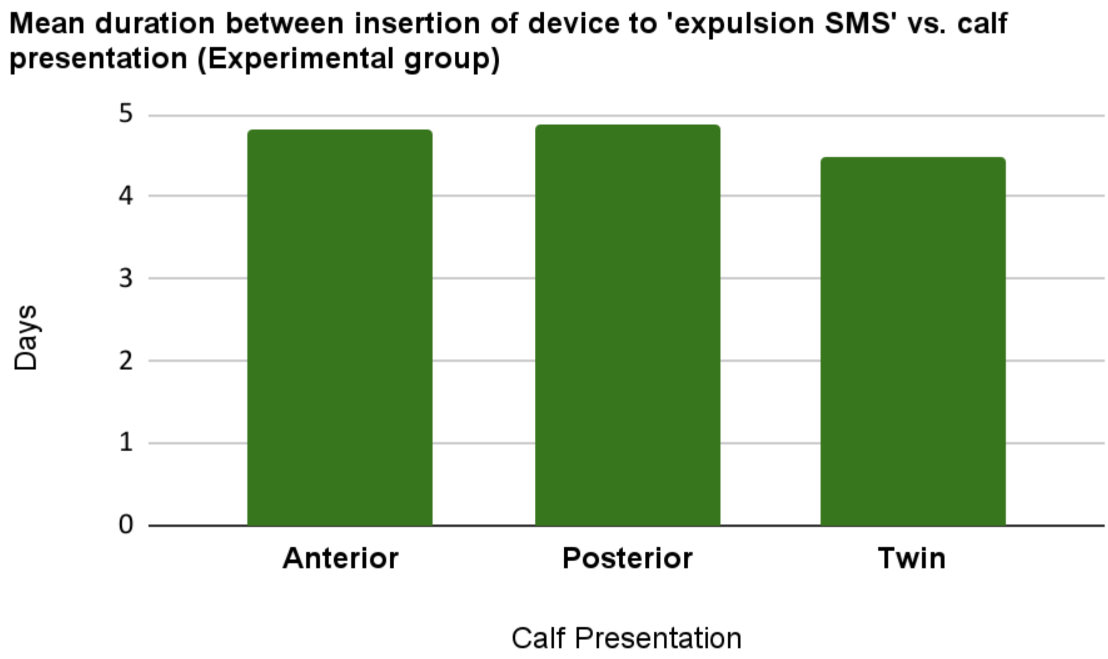

Figure 2. Variance in length of intravaginal thermometer placement, from day of insertion to expulsion alert in relation to presentation of calf. Average duration in days for anterior presentation 4.81 ± 2.39, posterior presentation 4.86 ± 2.77 and twin calving 4.5 ± 2.5. The P-value was calculated to be 0.878, determining no significant difference among groups (P>0.05).

5.1.2 Duration between ‘Calving within 48 hours’ SMS to ‘expulsion’ SMS *in hours*

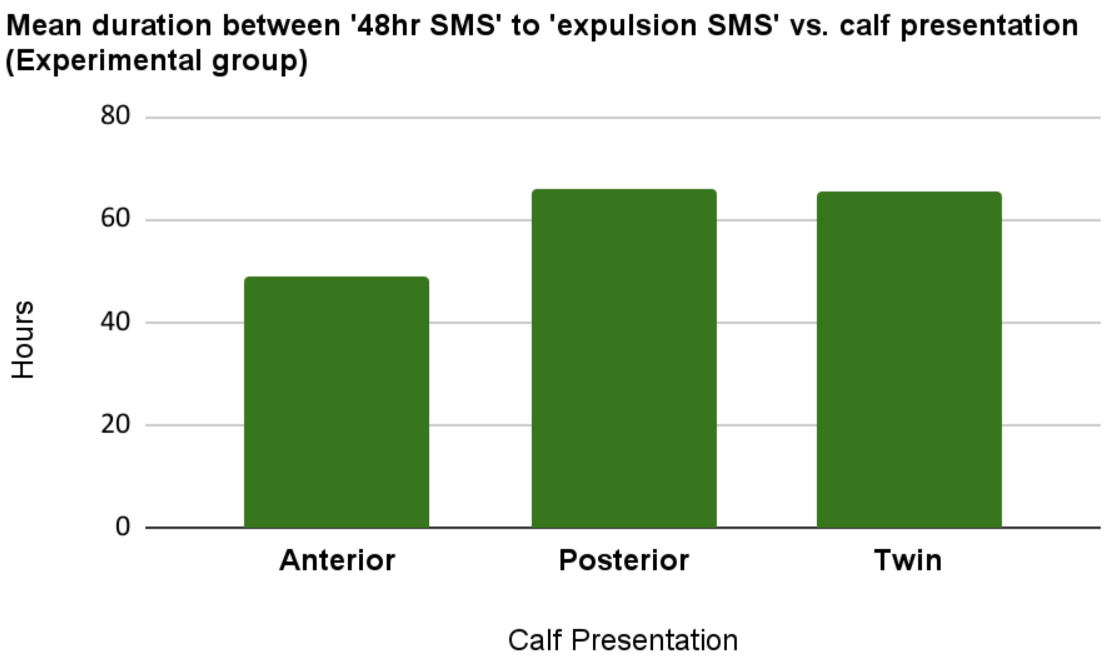

Figure 3. Variance in time between ‘predicted’ or ‘expected’ calving alert (after triggering the Vel’Phone sensor algorithm(s) and expulsion of the sensor as per different presentations. The purpose of the sensor is to provide a 48-hour window to producers to increase subjective monitoring, to assist in narrowing calving times and reduce risk of dystocia and or provide prompt assistance.

These results (mean ± SEM) indicate that the sensor provided more accurate results in the case of anterior presenting calves, with an average duration of 49.03 ± 2.76 hours. Posterior presentation average was 66.07 ± 10.77 hours and twin calving 65.27 ± 14.87 hours. Due to occurrence of no recorded data, there was a reduced number of animals for each presentation group; anterior (n=210), posterior (n=14) and twin (n=15). The P value 0.149 (P>0.05) determines this statistically insignificant despite the recorded variance of raw data.

5.1.3 Duration between ‘expulsion’ SMS to hoof appearance *in minutes*

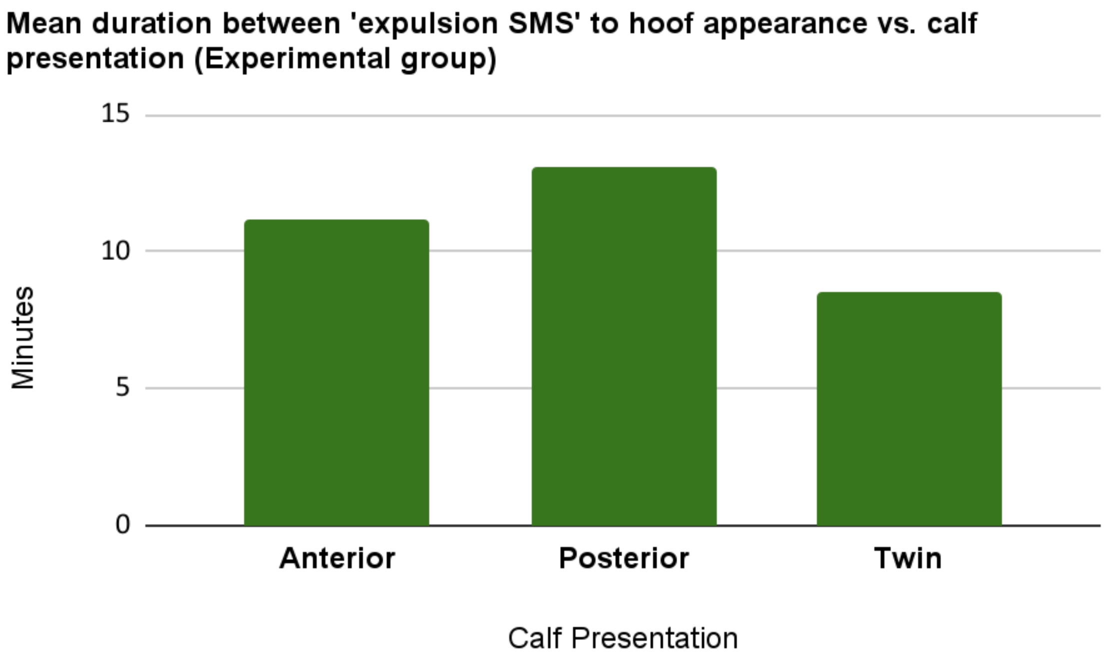

Figure 4. Variance in the timing between expulsion and the presence of hooves between anterior, posterior, and twin calving. Anterior presentation (n=226) had average duration of 11.15 ± 0.63 minutes, posterior presentation (n=15) 13.07 ± 3.25 and twin calving 8.56 ± 2.55. The average times reflect that the presence of hooves after sensor expulsion, in the case of twin calvings, was approximately 3 minutes quicker than that of posterior and anterior presentations. ANOVA one-way analysis determined no statistical significance to this data.

5.1.4 Duration of calving *in minutes*

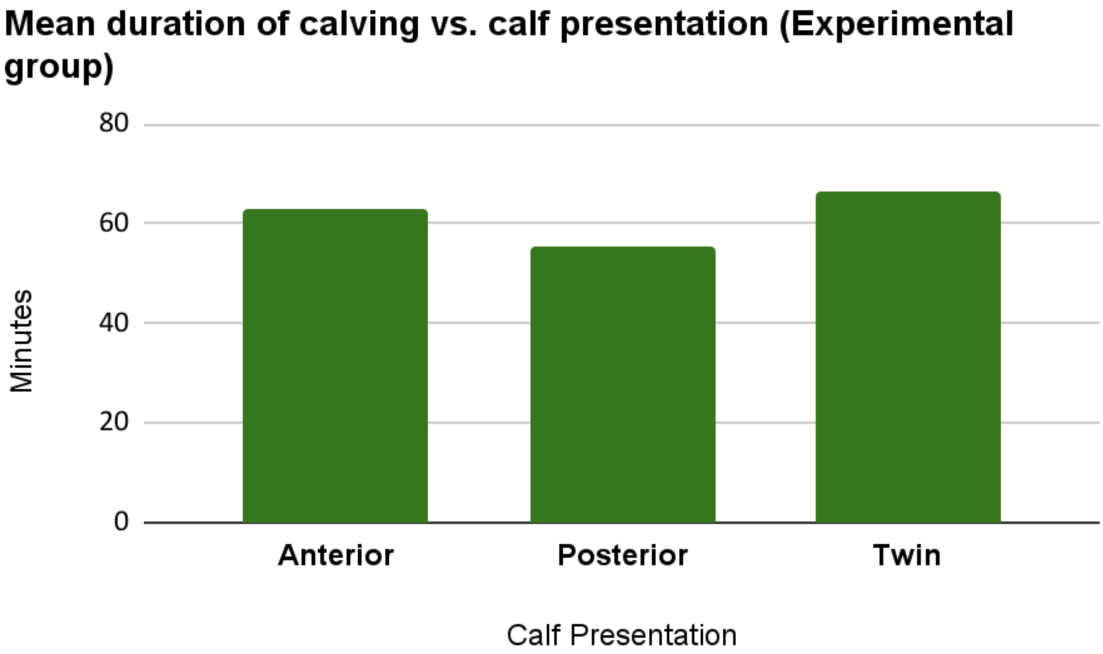

Figure 5. Variance in length of calving in minutes as per the calf presentation. The graph depicts the mean time in minutes ± SEM of each presentation. Anterior presentation was determined to be 63.11 ± 2.72, posterior presentation 55.33 ± 12.69 and twin calving 66.5 ± 10.86. The P value was deemed statistically insignificant (P=0.732) as per ANOVA.

5.2 Correlation between presentation and gender of calf

5.2.1 Experimental group

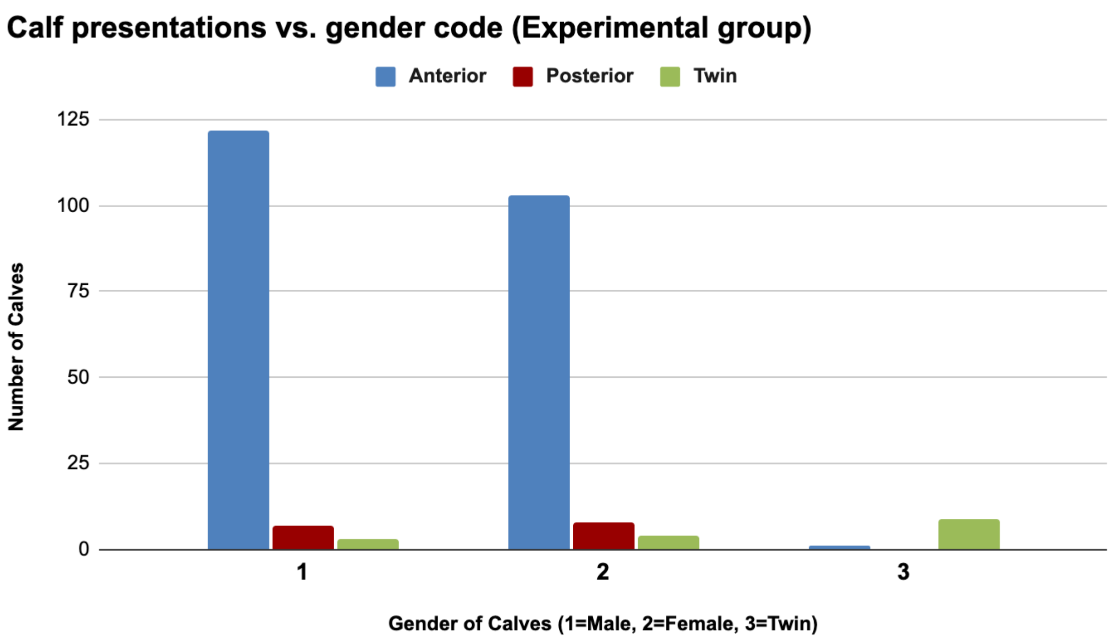

Figure 6. Correlation between calf presentation and gender of the experimental group (n=257).

5.2.2 Control Group

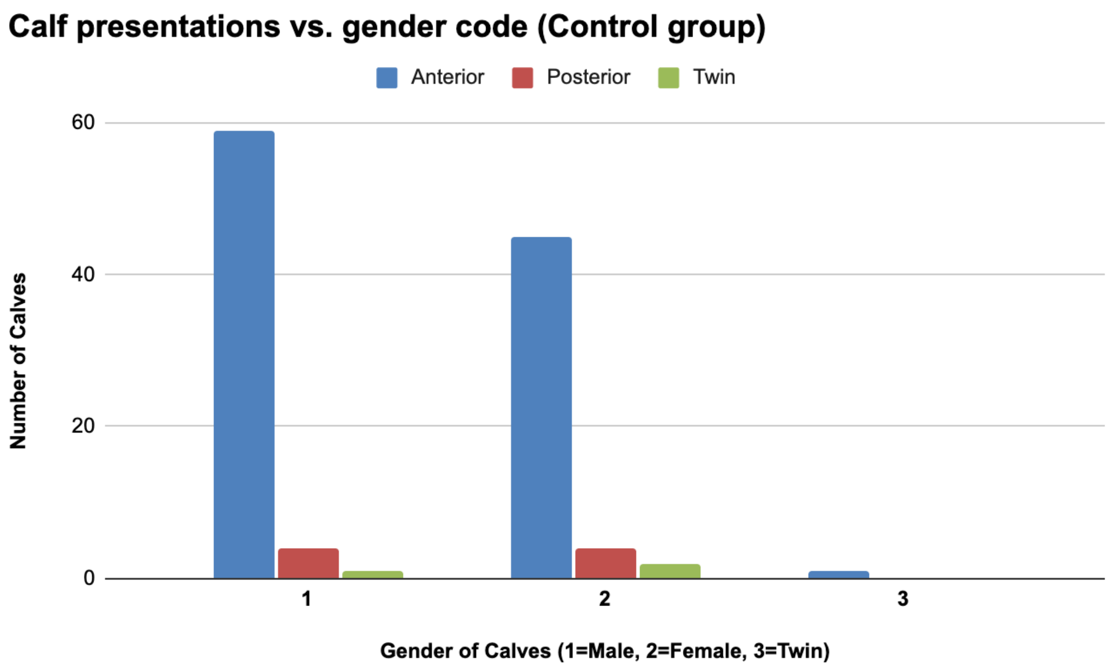

Figure 7. Correlation between calf presentation and gender in the control group (n=116).

5.3 Calf Weight in relation to presentation across control and experimental groups

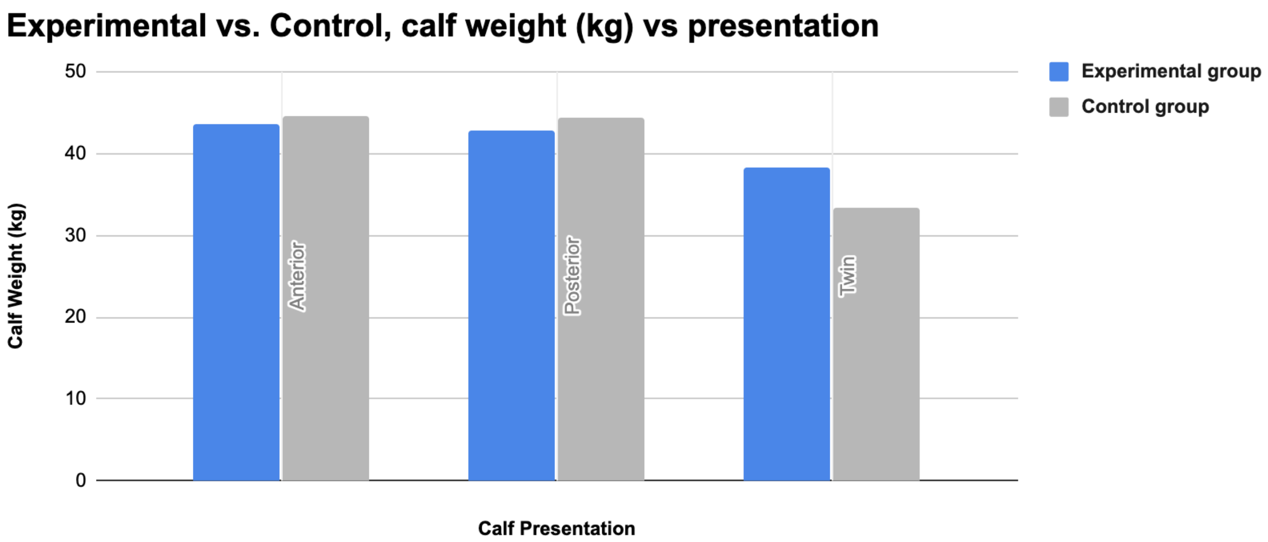

Figure 8. A comparison of control and experimental groups recorded calf weights in relation to presentation (anterior, posterior, twin). Data expressed as mean ± SEM values. The calf weight, expressed as mean ± SEM for the experimental group (n=257) was 43 ± 0.43 kg and the control group (n=116) was 44 ± 0.85 kg (P>0.05).

5.4 Prevalence of dystocia and complications associated

5.4.1 Connection between nulliparous heifers and multiparous cows and prevalence of dystocia

Table 2. Experimental and control groups assessed by dystocia score

Dystocia Score	**Experimental group**		**Control group**		**Experimental group**	**Control Group**
	Nulliparous heifers (n=59)	Multiparous cows (n=198)	Nulliparous heifers (n=38)	Multiparous cows (n=78)	(n=257)	(n=116)
Score 1	34	120	13	38	154	51
Score 2	23	69	22	36	92	58
Score 3	2	8	3	4	10	7
Score 4	0	1	0	0	1	0
Dystocia % (Score >1)	42.3%	39.4%	65.8%	51.3%	40.1%	56.0%

Score 1 = No dystocia

Score 2 = Mild dystocia: assistance by one person, no mechanical traction required

Score 3 = Severe dystocia, assistance required with mechanical traction and/or more than one person

Score 4 = Surgical intervention (C-Section)

5.4.2 Prevalence of stillbirth

5.4.2.1 Comparison of stillbirth between the experimental and control group

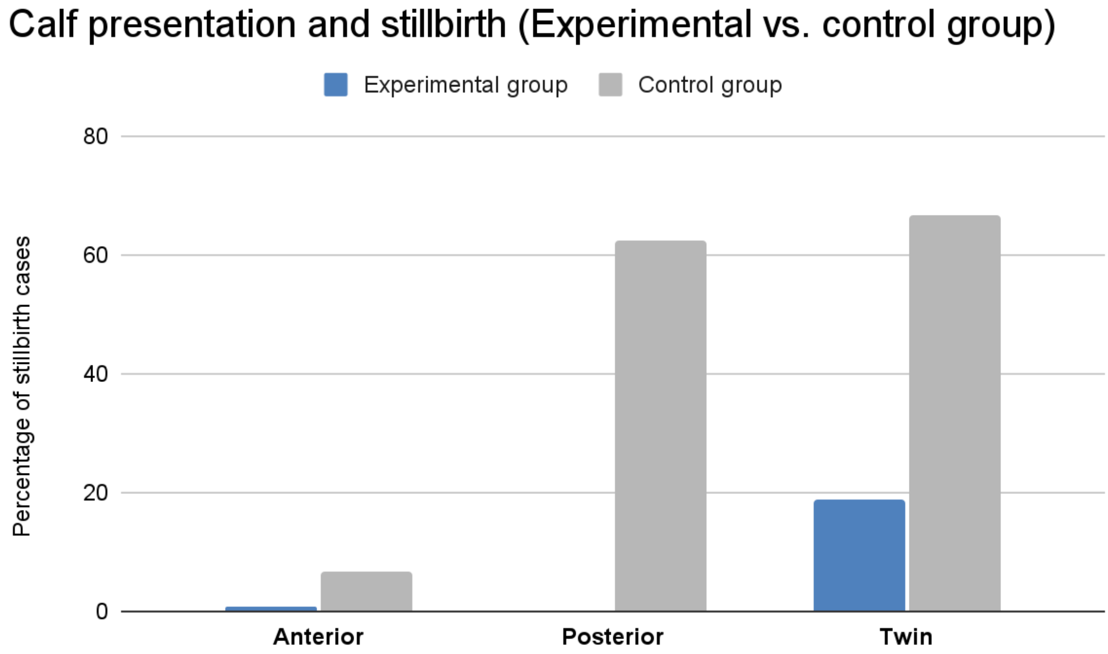

Figure 9. Incidence of stillbirth among anterior presentation, posterior presentation and twin calving as compared between the experimental and control group. Recorded data indicates cases of stillbirth were higher within the control group: anterior presentation: 6.7%, posterior presentation: 62.5% and twin calving 66.7%. Whereas, there was no recorded incidence of stillbirth within posterior presentation in the experimental group, but a prevalence of 0.9% in anterior presentation and 18.8% in twin calving.
Using ANOVA two-way analysis, there was found to be no statistical significance ($P>0.05$) between the experimental and control groups ($P=0.15$), as well as between the respective presentations ($P=0.35$).

5.4.3 Prevalence of uterine infection

5.4.3.1 Comparison of uterine infection between the experimental and control group

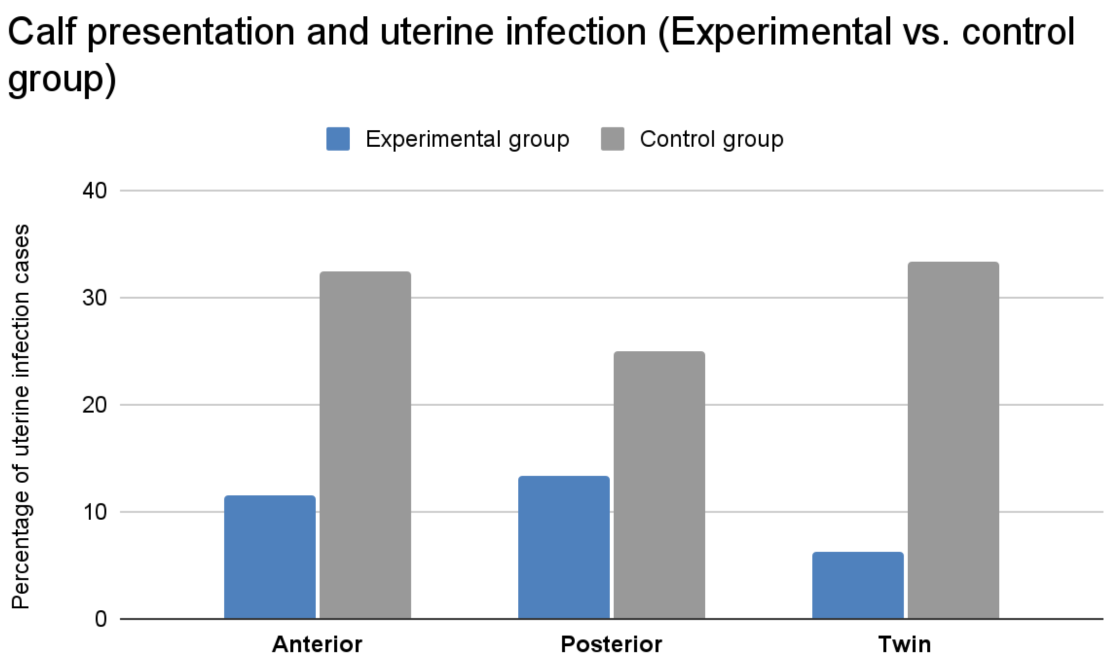

Figure 10. Incidence of uterine infection among anterior presentation, posterior presentation and twin calving as compared between the experimental and control group. The incidence of uterine infection within the experimental group was: anterior presentation: 11.5%, posterior presentation: 13.3% and twin calving: 6.3%. Whereas, within the control group, the incidence of uterine infection was higher: anterior presentation: 32.4%, posterior presentation: 25% and twin calving: 33.3%.
ANOVA two-way analysis determined statistical significance ($P<0.05$) between the experimental and control groups ($P=0.047$). No significant variance was found between the respective presentations ($P=0.88$).

5.4.4. Prevalence of retained foetal membranes (RFM)

5.4.4.1 Comparison of retained foetal membranes between the experimental and control group

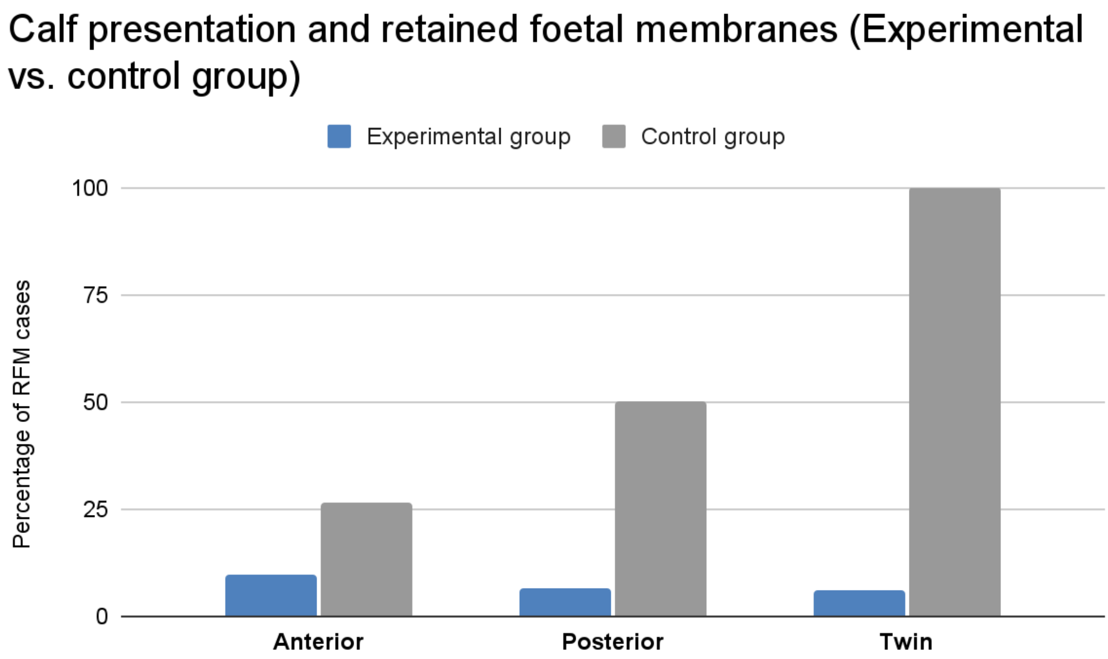

Figure 11. Incidence of retained foetal membranes across anterior presentation, posterior presentation and twin calving, experimental versus control group. Recorded data indicates that cases of retained foetal membranes were higher across all presentations (anterior presentation: 26.7%, posterior presentation: 50% and twin calving: 100%) in the control group. The experimental group had a prevalence of RFM in 9.7% of anterior presentations, 6.7% of posterior presentations and 6.3% of twin calvings.

Using ANOVA two-way analysis, there was found to be no statistical significance ($P>0.05$) between the experimental and control groups ($P=0.54$), as well as between the respective presentations ($P=0.15$).

5.5 Effect of parity on calf presentation

5.5.1 Experimental group

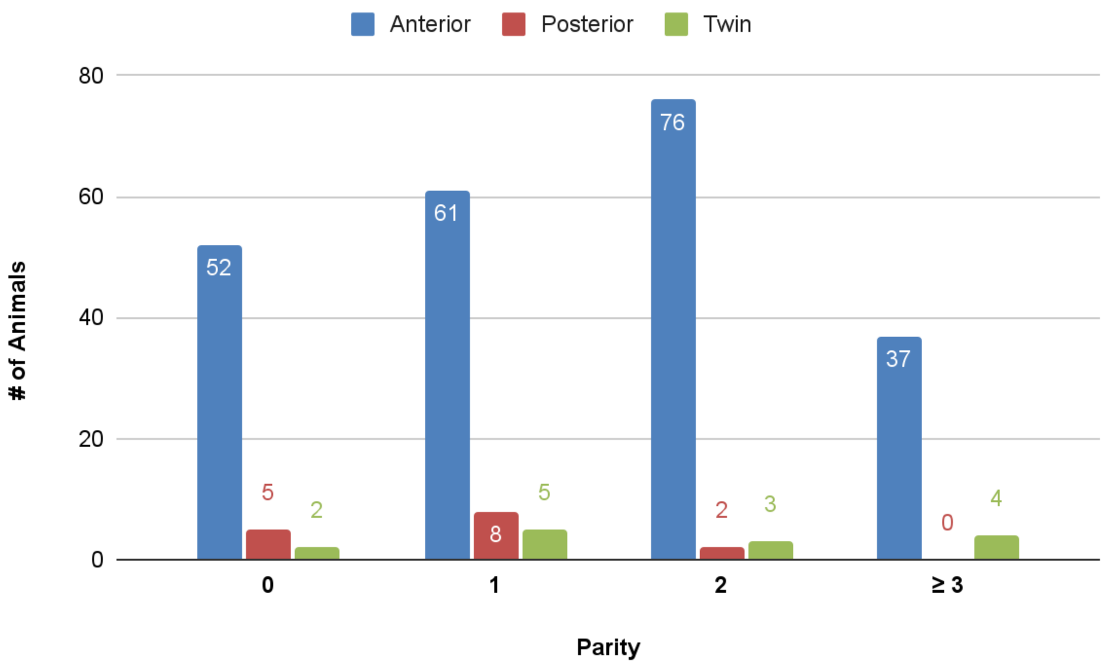

Figure 12. Differences in parity and its effect on presentation of the calf (anterior, posterior, twin). Parity varied from nulliparous heifers (no previous calving) to multiparous cows, having multiple calvings, up to ≥3 previous services. Data is expressed as mean ± SEM. Anterior presentation: nulliparous (n=52), one previous calving (n=61), two previous calvings (n=76), three or more previous calvings (n=37). Posterior presentation: nulliparous (n=5), one previous calving (n=8), two previous calvings (n=2) and three or more previous calvings (n=0). Twin presentation: nulliparous (n=2), one previous calving (n=5), two previous calvings (n=5), three previous or more calvings (n=4).

ANOVA one-way analysis with a post hoc Tukey's HSD test was used to evaluate the data and determined a significant result (P=0.045).

5.5.2 Control group

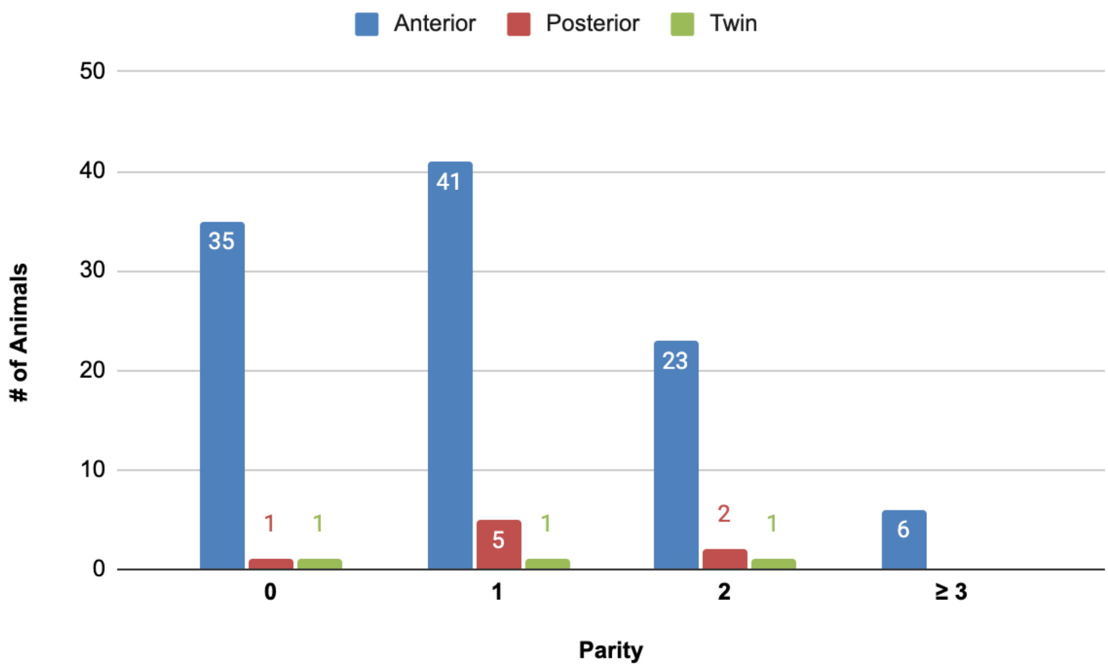

Figure 13. Differences in parity and its effect on presentation of the calf (anterior, posterior, twin). Parity varied from nulliparous heifers (no previous calving) to multiparous cows, having multiple calvings, up to ≥3 previous services. Data is expressed as mean ± SEM. Anterior presentation: nulliparous (n=35), one previous calving (n=41), two previous calvings (n=23), three or more previous calvings (n=6). Posterior presentation: nulliparous (n=1), one previous calving (n=5), two previous calvings (n=2), three or more previous calvings (n=0). Twin presentation: nulliparous (n=1), one previous calving (n=1), two previous calvings (n=1) and three or more previous calvings (n=0). ANOVA one-way analysis was used to evaluate the data, no significant difference was found (P>0.05).

6. Discussion

The use of automated calving sensors has been used in previous studies, in both beef and dairy cattle but the differentiation between anterior presentation, posterior presentation and twin calving as respective data groups has not been focused on [15, 21-23]. The purpose of this thesis was to determine variances within the recorded data when comparing between the three respective presentations.

The prevalence of anterior presentation was significantly higher (88.3% and 91.4%) across both the experimental and control groups, which being the 'normal' calving presentation is beneficial to ease of operation. Posterior presentation (5.8% and 6.0%), and twin calving (5.8% and 2.6%) had a lower occurrence in both groups.

The variance between anterior, posterior, and twin calving presentations measured duration between the sensor's SMS alert and calving, as recorded by presence of hooves, was not statistically significant. Despite some variance in timing found within the raw data.

The results indicated that the control group experienced a higher incidence of dystocia (score >1), stillbirth, uterine infections and retained foetal membranes as compared to the experimental group. The prevalence of uterine infection when compared between the experimental and control groups was found to be of statistical significance (P=0.047). This is likely due to the lack of automated monitoring and therefore perhaps a reduction in assistance response time.

Parity of all animals were recorded, when categorised into the appropriate presentation for both control and experimental groups, it was compared to the number of calves respectively. Significant (P <0.05) variation was found when examining the relationship between parity of the dam and calf presentation.

According to the results of this study, the only statistically significant finding affecting the vaginal temperatures within these Holstein-Friesian cows according to foetal presentation was the parity of the dam. Uterine infection in comparison between the experimental and control groups was found to be statistically significant (P <0.05). With review of calf gender, dystocia and stillbirth these values were found insignificant.

7. Summary

Transitioning from smaller herds to large scale commercial operations, there is an increased need for highly specific and sensitive technology to enhance that of the traditional observational monitoring. The purpose of this thesis was to compare the similarities and differences of the functionality of an intravaginal thermometer (Vel'Phone by Medria Solutions) as per the calving presentation. As categorised by anterior presentation, posterior presentation, and twin calving.

The findings of this study suggest that the intravaginal thermometer is not able to accurately detect 'stage one', the onset of calving based solely on changes in vaginal temperature. However, the sensor can accurately assess the initiation of 'stage two' and provide a calving window, within 66.07 ± 10.77 hours, based upon the highest average duration seen in posterior presentation.

Despite the inability to pinpoint the onset of calving, the efforts of this study have determined that with the use of a calving sensor, the incidence of dystocia, stillbirth, uterine infection and retained foetal membranes can be reduced. This is likely due to the ability to monitor calving processes and provide interventional assistance and therapy as necessary more accurately. Incidentally, analysing the variances between anterior presentation, posterior presentation, and twin calving, within the experimental group, parity of the animal was found to have a statistically significant role in calf presentation.

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10. Thesis progress report

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Thesis progress report for veterinary students

Name of student: Olivia Carolan

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Name and title of the supervisor: Dr. Szenci Ottó

Department: Department of Obstetrics and Food Animal Medicine Clinic

Thesis title: *Accuracy of prepartum vaginal temperature to predict the onset of calving in a Holstein-Friesian dairy herd: A comparison of anterior presentation, posterior presentation and twin calvings*

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Consultation – 1st semester

Timing				Topic / Remarks of the supervisor	Signature of the supervisor
	year	month	day		
1.	2022	05	02	Discussing the progress of the thesis	
2.	2023	05	03	Discussing the progress of the thesis	
3.					
4.					

Grade achieved at the end of the first semester: five (5)

Consultation – 2nd semester

Timing				Topic / Remarks of the supervisor	Signature of the supervisor
	year	month	day		
1.	2023	08.	16.	Discussing the progress of the thesis	
2.	2023	10.	17-31.	Discussing the progress of the thesis	

3.	2023	11.	01.	Discussing the final version of the thesis	
4.					
5.					

Grade achieved at the end of the second semester: five (5)

The thesis meets the requirements of the Study and Examination Rules of the University and the Guide to Thesis Writing.

I accept the thesis and found suitable to defence,

Dr. Ottó Szenci

…………………………………………………...
signature of the supervisor

Signature of the student: ……………………………………

Signature of the secretary of the department: …………………….…………

Date of handing the thesis in………… ………………..…...