Prevalence and risk factors of Udder Cleft Dermatitis in 20 Dutch dairy herds

Research Project at the GD Animal Health Service

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Abstract

Udder cleft dermatitis is mostly located between the forequarters and the abdomen (Beattie and Taylor, 2000; Warnick *et al.*, 2002). Characteristic features of UCD are a moist appearance, necrosis of skin and a foul odour. Udder cleft dermatitis is well known in the field however, relatively little is described in the veterinary literature. Thus far, the aetiology and treatment of UCD are unknown or disappointing, therefore we decided to set up a treatment trial in which three different treatments were compared. Udder cleft dermatitis is seen in all stages of lactation, also in non-lactating cows, but it is more common in older cows. The objectives of this study were to estimate the prevalence of UCD on both farm and cow level and to investigate potential risk factors of UCD on both farm and cow level. The objectives of the treatment trial were to investigate if one of three treatments is a good effective therapy for UCD and if there is a treatment which creates improvement regarding the wound healing.

Data were collected from 20 randomly selected dairy farms in The Netherlands. Each lactating and dry cow was photographed from a posterior, lateral and ventral aspect. In total of 1,143 cows were examined and complete data sets were available for 1,035 animals. The posterior and lateral photographs were used to determine various variables such as angle between udder and abdominal wall, fore udder attachment, udder width, udder depth and hygiene scores of udder and legs. The ventral photographs were used to score the degree of UCD using different categories and the hair length (long/short). To identify potential risk factors on farm level, a survey was conducted on farm to gather information about certain farm aspects such as herd size, milk production registration data, ventilation, cubicles information, and cleaning habits.

Udder cleft dermatitis (score 3 to 5) was recorded in 6.0% (95% binomial confidence interval [CI], 4.6 to 7.6) of the 1,120 examined cows. Farm level prevalences ranged between 0% and 13% and UCD was seen on 85% of the participating farms. Results of this study show that there are several risk factors of UCD on cow level. For instance, cows with a deep udder or relative deep udder are more likely to develop UCD. Also, a weak fore udder attachment increases the odds of UCD. And UCD is seen more frequently in cows with a smaller angle between udder and abdominal wall. All these risk factors on cow level are related to the shape of the udder. In the present study only 20 dairy herds were participating and therefore it is difficult to make solid statements concerning risk factors on farm level. There is presumptive evidence for a relation between UCD and the following: herd size, production level, type of bedding, cleaning frequency of the cubicles per day and use of footbath. There seems to be a relation between UCD and the length of the cubicles with an open front, where more UCD is seen on farms with longer cubicles. And when using the current dataset, there is a strong indication that UCD and cleaning frequency of the floor per day are related. Further research is needed to investigate if all the above mentioned variables on farm level are truly risk factors for UCD. The three used treatments showed no overall improvement meaning an improvement in the degree of UCD, size of the wound and visual assessment. There were mixed results concerning the different treatments. Therefore we can conclude, for now, that none of the used treatments is a good effective therapy for UCD.

1. Introduction

Udder health is an important aspect in dairy farming. There are numerous udder problems and one of them is udder cleft dermatitis (UCD; also bovine ulcerative mammary dermatitis, foul udder). Udder cleft dermatitis is mostly located between the forequarters and at the transition of the forequarters and the abdominal wall. Another udder dermatitis is necrotic dermatitis which is mostly seen in heifers (Blowey and Weaver 1990). This condition is not the same as UCD and as it affects the udder skin of the hindquarters and the skin of the thighs, it probably has a different aetiology.

Characteristic features of UCD are a moist appearance, necrosis of skin and a foul odour, which is caused by opportunistic anaerobic bacteria which colonize beneath the scabs and necrotizing skin. In untreated cases, deep lesions can be found (Boyer and Singleton, 1998), if those wounds burst open, serious bleedings may occur. The deep lesions could also impair animal welfare and milk production.

Udder cleft dermatitis is well known in the field however, relatively little is reported in the veterinary literature. The origin of UCD and a good effective therapy are thus far unknown. The therapies that are used have disappointing results. Since there is no good effective therapy for UCD, we decided to set up a treatment trial for UCD. In this treatment trial three different treatments are compared. In the field, a range of medications are used for therapy of UCD e.g. oxytetracycline spray, aluminium spray, zinc spray or ointment, antibiotics or homeopathic remedies. Out of frustrating, farmers experiment with different means because almost nothing the veterinarian prescribes really helps. They will even use brown tar or waste oil as a treatment. In this treatment trial the following medications are used: oxytetracycline spray (CTC spray), Naxcel cattle (Naxcel) and Tylan200 (Tylan).

A possible similar skin disease is known in dogs namely skin fold dermatitis (also intertrigo, skin fold pyoderma). This skin disease occurs in dogs with excessive skin folds. There are several types of skin fold dermatitis e.g. dermatitis of the facial, lip, tail, or vulvar folds and body fold dermatitis. Skin fold dermatitis is a surface pyoderma which is mostly caused by a common bacterial infection and the friction between the excessive skin folds (Ihrke, 1987; Medleau and Hnilica, 2006). There are a number of possible treatments depending on the underlying cause. For instance weight reduction is needed if the skin fold dermatitis is caused by obesity and any concurrent disease should be treated. Another option which may be useful is topical use of antibiotics e.g. ointment, solution or spray, every 24 hours for the first 5 to 7 days of therapy (Medleau and Hnilica, 2006). The most often used curative treatment is surgical excision of the excessive skin folds. If surgical ablation is not done, topical maintenance therapy may be needed e.g. cleaning the wounds every 12 to 72 hours with cleansing wipes, cleaning the affected area every 1 to 3 days with an antibacterial shampoo or usage of benzoyl peroxide shampoo as palliative therapy (Ihrke, 1987; Medleau and Hnilica 2006). Possibly the origin of UCD and skin fold dermatitis are alike and if so the treatments used for skin fold dermatitis may be useful for UCD.

The aetiology is poorly described and requires further research. There may be an association between bovine digital dermatitis (BDD) and UCD. There are several studies in which BDD-associated *Treponema* were identified in UCD lesions (Beattie and Tayler, 2000; Evans *et al*.,

2010; Keil *et al.*, 2002; Stamm *et al.* 2009), therefore *Treponema* may be a cause of UCD. Stamm *et al.* (2009) demonstrated that several *Treponema* phylotypes were present in UCD lesions. However, Evans *et al.* (2010) have proven that BDD treponemes are more associated with BDD lesions as there are with UCD lesions. On the other hand, results of research by Warnick *et al.* (2002) show that UCD and BDD are negatively associated. It is likely that UCD is caused by multiple microorganisms; further research is needed to determine if there are other microorganisms that are more highly associated with UCD lesions.

Hence the fact that little has been written about UCD, some researchers suspect mites in having a role in causing UCD. Warnick *et al.* (2002) studied the prevalence of UCD in a dairy herd that was experiencing an outbreak of sarcoptic mange. Unfortunately, their results do not prove or disprove the hypothesis that mites have a role and therefore their role is still unknown.

Research has shown that UCD is seen internationally; outbreaks of UCD were seen in Scotland (Beattie and Taylor, 2000), England (Boyer and Singleton, 1998) and The United States (Keil *et al.*, 2002; Stamm *et al.* 2009; Warnick *et al.*, 2002). On a single 1,800-cow dairy farm a prevalence of 18% was found (Warnick *et al*. 2002) and in a study done by Beattie and Taylor (2000) on four farms prevalences of 2% and 22% were seen. Udder cleft dermatitis is seen in all stages of lactation, also in non-lactating cows, but it is more common in older cows (Warnick *et al*., 2002). Farmers seem to see the condition more often during the winter period.

The reason that research on UCD is needed is among others the animal welfare aspect. As mentioned above, deep lesions can occur which in some cases can present itself as a opening in the udder the size of a fist. Because of the serious bleedings, which are often recurrent, a farmer can decide to cull the animal. The interests of the farmers is also a reason why research is needed. Farmers are irritated by the fact that they do not know what the origin of UCD is and that there is no effective treatment. The foul odour is very wearisome and the wounds are not a pleasant sight. A possible deterioration in milk quality should not be excluded relating to the purulent wounds which can contaminate the milk during milking.

The objectives of this study were to estimate the prevalence of UCD on both farm and cow level and to investigate potential risk factors of UCD on both farm and cow level. The objectives of the treatment trial were to investigate if one of the treatments is a good effective therapy for UCD and if there is a treatment which creates improvement regarding the wound healing.

2. Materials and Methods

2.1 Herd selection

Farms were selected from a list, containing all milk supplying farms in The Netherlands, using the following inclusion criteria:

- Predominant breed should be Holstein Friesian;
- Animals should be older than two years;
- Herd size should be at least 40 and no more than 120 lactating and non lactating cows;
- Farms should have cubicles and sufficient head lock facilities;

In total of 13,992 dairy herds were selected. A random selection of these herds was made and the first farms on the list were approached until 20 farms were participating. In the end 57 farms were approached whereof 8 farms were not meeting the inclusion criteria. Twenty-eight of the remaining farms were not willing to participate due to different reasons e.g. no interest, not enough time or they are not familiar with the condition. The participating farms were randomly distributed over The Netherlands (Fig 1) and were visited between June and November 2010.

Figure 1. Farm locations in The Netherlands

2.2 Data collection

Data collection was carried out on 20 randomly selected farms. To identify prevalence on farm and cow level, each individual cow was photographed. Due to herd management an unknown amount of eligible animals was missed. These animals were mostly dry cows because they were in the pastures during the time of examination. Therefore, only 1,143 cows were examined. Animals were hold in head locks at the feed barriers and were identified by

writing the plastic ear tag number on paper cards. These cards were clipped on a folding ruler (see: chapter 2.3) which was photographed with every cow. Animals were photographed from a posterior, lateral (Fig 2) and ventral aspect. Posterior and lateral photographs were taken from approximately 1.45 meters upward of the ground. Ventral photographs were taken using a mirror and camera attached to a stick (Fig 3). While collecting the data some important matters must be taken into consideration. First of all, blurry photographs are difficult to analyse therefore one must ensure that all photographs are sharp. Posterior and lateral photographs must be taken perpendicular to the cow or as close at a 90 degree angle as possible. To get the best assessable ventral photographs, the mirror should be clean at all times. Manure, dust, milk or other things can cause the camera to focus on those things instead of the udder. Therefore paper towels and denatured alcohol come in handy. In addition, the best ventral photographs are gained when the camera flashes.

Figure 2. Posterior and lateral aspect

Figure 3. Mirror and camera attached to a stick

To identify potential risk factors on farm level, a survey was conducted on farm containing:

1. Number of dairy cows in 2009
2. Milk Production Registration (MPR) data of the farm
    a. Production level in 2009
    b. Mean somatic cell count (SCC) in 2009
3. Ventilation (flaps, open ridge, open sidewall, space boarding, circulator fans or else)
4. Number of feeding sites at the feed barrier
5. Cubicles
    a. Number of cubicles
    b. Length, width, diagonal distance (from neck rail to trailing edge)
    c. Front of cubicle (open or closed)
    d. Type of bedding (concrete, rubber mat, littered, mattress or else)
    e. Bedding material (none, straw, red sawdust, white sawdust, wood shavings, or else)
    f. Use of calcium (… times a week)
    g. Cleaning frequency (… times a day)
    h. Frequency of bedding (… times a day)
6. Flooring
    a. Type of floor (grids, slotted floor, smooth solid floor or else)
    b. Cleaning frequency (… times a day)
7. Presence of sarcoptic mange (yes/no)
8. Presence of digital dermatitis? (yes/no) This occurs in … % of the animals
9. Do you make use of a footbath for the cattle? (yes/no) This happens … times a year for periods of … days

2.3 Data processing & analyses

As mentioned above, each cow was photographed from three different aspects. Posterior photographs were used to determine strength of the median suspensory ligament, udder width and distance between *tuber ischiae* (attachment 1). Lateral photographs were used to determine angles between udder and abdominal wall, distance between *calcaneus* and dew claws, udder depth and fore udder attachment (attachment 2). After measuring the above mentioned variables, two more variables were added, namely relative udder width and relative udder depth. Relative udder width is the udder width divided by distance between *tuber ischiae* whereas relative udder depth is the udder depth divided by distance between *calcaneus* and dew claws. To calculate distances and angular degrees, the program Adobe Photoshop CS5 extended version 12.0 was used. Before measuring, it is necessary to determine for each separate photograph how many centimetres in real life correspond with the number of pixels in the photograph. To do so, one zooms in on the folding ruler and uses the function 'analysis', 'set measurement scale' and 'adjust…' to match the distance in real life with the number of pixels of that same distance in the photograph. When in the 'adjust…'-function one selects 10 centimetres with the ruler-function, adjust the 'logical length' from 1 to 10. After doing this, one is able to measure distances and the program automatically converts the selected number of pixels to centimetres. In addition, hygiene scores of udders, thighs and legs were recorded (range 1 to 4, clean to very dirty, respectively) using the hygiene scorecard published by the UGCN (attachment 3). All the above mentioned measured variables are potential risk factors.

To estimate prevalence of UCD on farm and cow level, the ventral photographs were used. They were used to score the degree of UCD and hair length (short/long). The following categories were established (attachment 4):

- Category 0; includes udders without lesions, open wounds, change or shift in colour and crusts. In addition, udders which are covered with manure or dirt also belong to this category, given that it was clear that there is nothing wrong with the udder regarding the aspects mentioned above.
- Category 1; includes udders with a change or shift in colour. Between the forequarters and at the transition of the forequarters and the abdominal wall, is an explicit colour shift perceived. The change of colour usually has a reddish appearance and seems to be darker than the rest of the udder.
- Category 2; includes udders with bald spots, scales, scrapes, petechia or scars. There is obviously more to it than just a colour shift as seen in category 1.
- Category 3; includes udders with crusts. The degree of crusting can differ within this category.
- Category 4; includes udders with open wounds. The degree of wound formation can differ within this category.
- Category 5; includes udders with exsudate such as pus or blood.
- Category 9; includes udders which are barely, poorly or non-assessable. This can be due poor lighting, too many dirt or manure, blurry photographs or a combination of these.

Statistical analyses were done using SPSS Statistics 17.0 and Stata 11. The dependent variable was presence of UCD (score 3 to 5) and the independent variables were the above mentioned potential risk factors. Logistic regression analyses were used to determine the association of the potential risk factors, on both farm and cow level, and UCD. Two sample t test with equal variances was also used for some of the potential risk factors on farm level.

2.4 Treatment Trial

In the treatment trial in total of five farms participated. These farms were selected because they experienced serious problems with UCD and the prevalences on these farms were relatively high. The data collection, data processing and analysis were the same as mentioned in Ch. 2.2 and Ch. 2.3.

On each farm four cows participated in the trial, whereas one cow served as a control group. In total of 20 cows were examined. Each farm was visited four times during this trial with a 7 days interval. While visiting the farms, posterior, lateral and ventral photographs were taken of each participating cow. Prior of taking the ventral photographs, the udders were cleaned with soft tissues and lukewarm water. This so the wounds were clearly observable for analysis. Analysis of the ventral photographs was extended with the determination of the size of the wound using the program Adobe Photoshop CS5 extended version 12.0. The size of the wound was determined by measuring the outline of the wound using the 'quick selection'-function in the panel on the left in Adobe Photoshop (Figure 4).

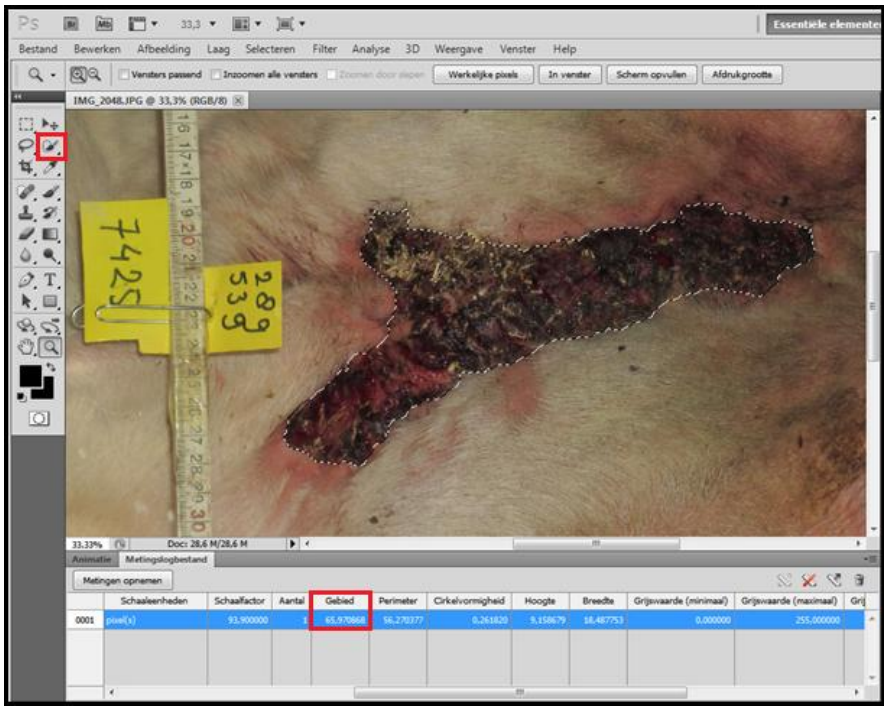

Figure 4. Illustration of measuring the size of the wound. The red square on the left is the 'quick selection'-function and the red square on the bottom of the image is the measured outline of the wound.

As mentioned above, CTC spray, Naxcel and Tylan were used as treatments (Figure 5). Normally CTC spray is used for treating superficial skin and claw infections, in particular digital dermatitis. Generally CTC spray is effective in cattle for treatment of digital dermatitis, for that reason and the possible association with UCD we chose this remedy as a treatment in this trial. Naxcel is a broad spectrum cephalosporin antibiotic which is used for treatment of acute bovine interdigital necrobacillosis also known as foot rot or pododermatitis. We chose this drug because of the non withholding period for

the milk. Indications for usage of Tylan are treatment of e.g. pneumonia, metritis, foot rot, acute mastitis or secondary bacterial infections associated with virus diseases. In general, this drug is effective for treatment of tylosin suspectible bacterial and mycoplasmal infections in cattle and pigs. Tylan is recommended by a dermatologist at the Faculty of Veterinary Medicine.

During the first visit, the veterinarian administered the medications. The treatments were as following:

- CTC spray: the affected area should be covered with the spray 2 times per day after milking for 7 days successively.
- Naxcel: the veterinarian administered the correct dose subcutaneous during the first visit. Naxcel only need to be administered once because the antibiotic is active for 9 days.
- Tylan: this antibiotic should be administered intramuscularly once a day for 4 days successively.

Figure 5. Tylan200, CTC spray and Naxcel cattle.

In order to determine if the treatment is effective, the photographs of the four visits were placed next to each other (Figure 6). Then the photographs were assessed on three points. First, the degree of UCD was determined and it was examined if the severity of the wounds i.e. degree of UCD, changed during the four weeks. The treatment is effective if there is progress in the wound healing process. Since a wound with scabs is better than a open wound with exudates, the given category must reduce in number i.e. the wound was first scored category 5 then later on in the trial, the wound must be scored as a category 4 or less. Second, the size of the wound was determined as explained above. As with the degree of UCD, the size of the wound over time was compared and there was an improvement if the size reduced. Thirdly, a conclusion was made about the progress of wound healing by simply looking at the wounds and compare them.

Figure 6. Ventral photographs of the four visits next to each other. 'Bezoek' = visit. These are images of the udder of the cow on farm 3 treated with Naxcel.

3. Results

3.1 Prevalence of UCD

An animal was considered positive if UCD (score 3 to 5) was recorded. A farm was considered positive if at least one animal was positive. Of the 1,120 cows that were examined, 62 (6.0%; 95% binominal confidence interval [CI], 4.6 to 7.6) were positive for UCD (Table 1). Cows with score 9 were omitted because these images were difficult to assess. Lesions were most often located between the forequarters and at the transition of the forequarters and the abdominal wall (Figure 7).

Category of UCD	Frequency	Percent	Percent (score 9 excluded)
0	717	64.00	69.28
1	234	20.90	22.61
2	22	2.00	2.13
3	45	4.00	**4.35**
4	13	1.20	**1.26**
5	4	0.40	**0.39**
9	85	7.60	-
Total	1,120	100.0	100.0

Table 1. Frequencies of UCD

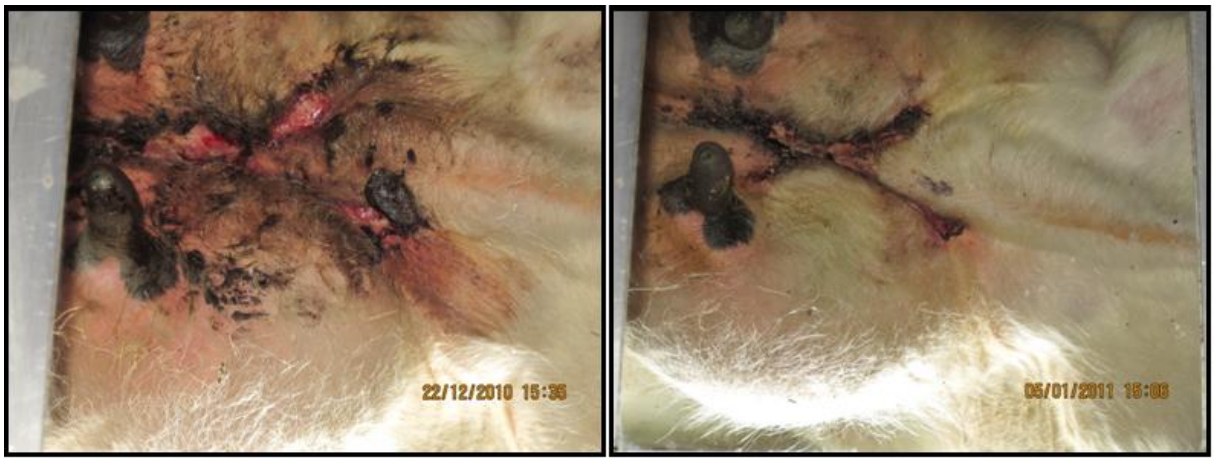

Figure 7. Typical UCD lesion between the forequarters and at the transition of the udder and abdominal wall.

Farm prevalences ranged from 0% to 13% (Table 2 and 3). Udder cleft dermatitis did occur on 85% of the farms. Most lesions were seen on Farm L where 8 of 57 cows were affected. Seven of the affected cows were scored category 3 and one cow had an open lesion (score 4). The lesions had variable amounts of crusting.

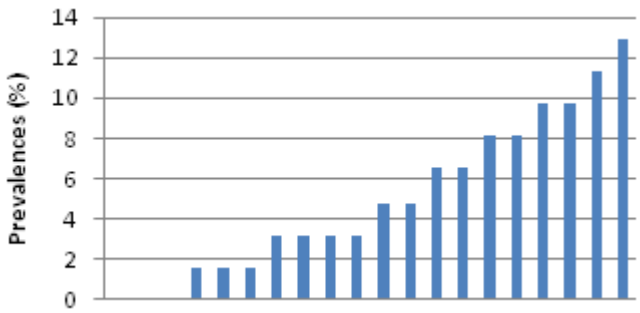

Table 2. Farm prevalences

Farm	Frequency	Percent
A	1	1.6
B	6	9.7
C	5	8.1
D	2	3.2
E	3	4.8
F	4	6.5
G	2	3.2
H	4	6.5
I	1	1.6

Farm	Frequency	Percent
J	3	4.8
K	2	3.2
L	8	12.9
M	5	8.1
N	6	9.7
O	1	1.6
P	7	11.3
Q	2	3.2
Total	62	100.0

Table 3. Cases of UCD per farm and farm prevelances

3.2 Risk factors on cow level

Both lactating and dry cows were included in analyses of potential risk factors for UCD. Complete data were available for 1,035 of the 1,143 examined cows and were included in the logistic regression analysis. There were various reasons for not including an animal e.g. missing ventral photographs or non-accessible photographs. All of the measured variables and available information per cow were included in the logistic regression analysis. This study indicates that UCD is related to dry period ($p<0.01$), the angle between udder and abdominal wall ($p=0.04$), udder depth ($p<0.01$), relative udder depth ($p<0.01$) and fore udder attachment ($p=0.02$). Udder cleft dermatitis is seen more in cows with a smaller angle between udder and abdominal wall. For udder depth applies the deeper the udder, the higher the UCD score. Fore udder attachment is also a risk factor for UCD. Cows with a weak fore udder attachment are more likely to develop UCD and the stronger the fore udder attachment, the lower the UCD score. Strength of the median suspensory ligament ($p=0.90$), udder width ($p=0.58$), distance between *tuber ischiae* ($p=0.11$), relative udder width ($p=0.55$), distance between *calcaneus* and dew claws ($p=0.55$), hygiene scores of udders (lateral view $p=0.77$; posterior view $p=0.92$), thighs and lower legs (respectively $p=0.48$ and $p=0.63$), and hair length ($p=0.94$) were not significant in the logistic regression analysis.

3. 3 Risk factors on farm level

The results of the surveys were used to determine if there are potential risk factors on farm level. There was no association between UCD and the following variables: mean SSC, type of ventilation, number of feeding sites at feed barrier, number of cubicles, length of cubicle with a closed front, diagonal distance of the cubicles, cubicle width, type of bedding material, use of calcium, frequency of bedding, presence of sarcoptic mange and presence of digital dermatitis.

There may be presumptive evidence for a correlation between UCD and the herd size (logistic regression analysis; p=0.10). As can be seen in Table 4 and 5, if the herd size exceeds 60 cows a prevalence of 6.0% is seen, compared to 3.8% prevalence in a herd with less than 60 cows.

Variable	Obs	Mean	Std. Dev.	Min	Max
UCD (%)	9	3.766667	3.341033	0	8.1

Table 4. Summary of UCD (%) if herd size < 61

Variable	Obs	Mean	Std. Dev.	Min	Max
UCD (%)	11	6.009091	4.22527	1.6	12.9

Table 5. Summary of UCD (%) if herd size > 60

There is an indication that UCD is correlated with the production level (logistic regression analysis; p=0.08)(Table 6). The production level is the mean milk production per cow per year (kg). If the production level exceeds 8,900 kg milk, higher prevalences of UCD are seen, for the most part 5% or more.

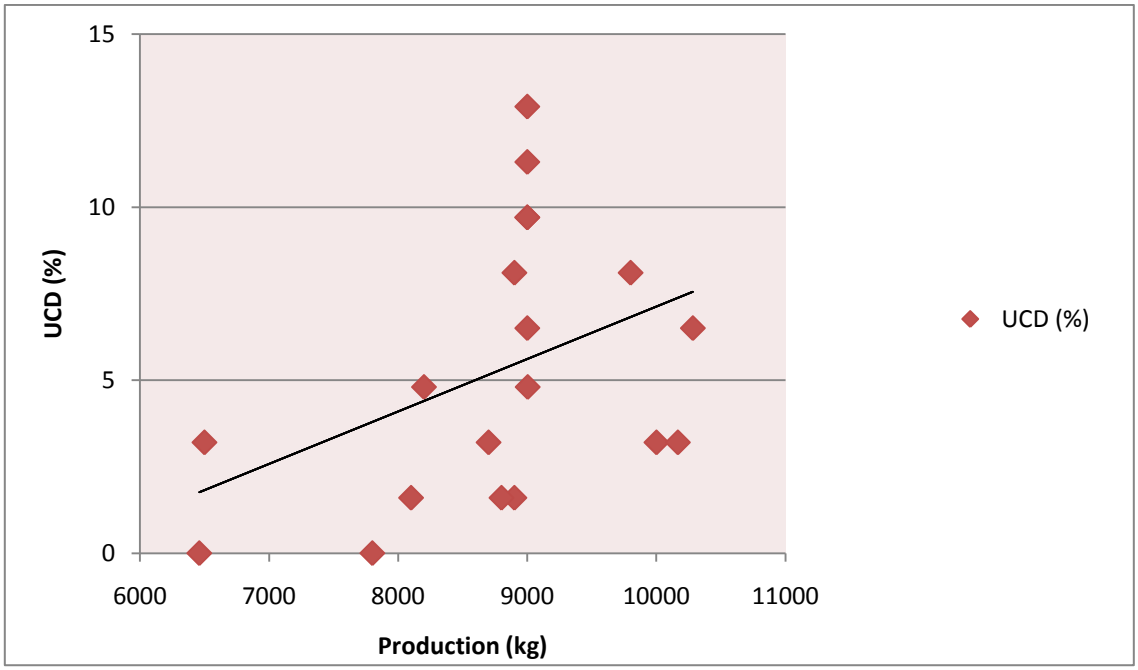

Table 6. Scatterplot of mean production level per dairy cow and percentages of UCD

There is a correlation between UCD and the length of the cubicles with an open front (logistic regression analysis; p=0.04). The farm with the length of the cubicle of 290 centimetres was omitted because this length is unlikely and probably incorrect.

There may also be presumptive evidence that the type of bedding may be a risk factor for the development of UCD (two sample t test with equal variances; p=0.10). The same applies to the cleaning frequency of the cubicles per day (logistic regression analysis; p=0.07). In addition to the above mentioned variables use of footbath (two sample t test with equal variances; p=0.09) may also be a potential risk factor for UCD. In Table 7 a prevalence of 6.1% is seen if the farm uses a footbath for the dairy cows. In contrary to use of footbath, a prevalence of 3.0% is seen when a farm do not uses a footbath for the dairy cows.

Lastly, logistic regression analysis of available data on the cleaning frequency of the floor per day show that there is a relationship with the percentage of UCD per farm (logistic regression analysis; p=0.02).

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Yes	13	6.084615	0.8654957	3.120589	4.198862	7.970369
No	7	2.985714	1.773942	4.69341	-1.354966	7.326394

Table 7. Part of results of a two-sample t test with equal variances; percentages of UCD and use of footbath. T = 1.7772 and degrees of freedom = 18.

3.4 Treatment Trial

Results from the different farms are described in Table 8, 9, 10, 11 and 12. We compared the results of visit 1 with those of visit 4 and made a conclusion if there was an improvement, worsening or no improvement at all.

Assessment points	Control group	CTC spray	Naxcel	Tylan
Degree of UCD	No improvement	No improvement	No improvement	Worsening
Size of the wound	Improvement	Unclassifiable	Improvement	Improvement
Visual assessment	No improvement	No improvement	Improvement	No improvement

Table 8. Results farm 1

Assessment points	Control group	CTC spray	Naxcel	Tylan
Degree of UCD	No improvement	Improvement	Worsening	No improvement
Size of the wound	Improvement	Improvement	No improvement	Improvement
Visual assessment	Improvement	Improvement	No improvement	No improvement

Table 9. Results farm 2

Assessment points	Control group	CTC spray	Naxcel	Tylan
Degree of UCD	No improvement	Worsening	Improvement	No improvement
Size of the wound	Improvement	Unclassifiable	Improvement	Improvement
Visual assessment	Improvement	No improvement	Improvement	Improvement

Table 10. Results farm 3

Assessment points	Control group	CTC spray	Naxcel	Tylan
Degree of UCD	No improvement	Improvement	No improvement	Worsening
Size of the wound	Unclassifiable	Improvement	Improvement	Improvement
Visual assessment	No improvement	No improvement	Worsening	Improvement

Table 11. Results farm 4

Assessment points	Control group	CTC spray	Naxcel	Tylan
Degree of UCD	No improvement	No improvement	Improvement	Improvement
Size of the wound	Improvement	Improvement	Unclassifiable	Improvement
Visual assessment	Improvement	Improvement	Improvement	Improvement

Table 12. Results farm 5

In the present study, three cows showed an overall improvement which means an improvement in all three assessment points. On farm 2 the cow that was treated with CTC spray (Figure 8), on farm 3 the cow that was treated with Naxcel (Figure 6) and on farm 5 the cow that was treated with Tylan. Seven cows showed an improvement in both size of the wound and visual assessment. One of those cows is the control group cow on farm 3 (Figure 9).

Figure 8. Ventral photographs of the udder of the cow on farm 2 treated with CTC spray.

Each treatment is assessed 15 times, the optimal situation would be 15 improvements. Both the control group and CTC spray group were given 7 improvements out of 15, where the CTC spray group received one worsening. The Naxcel group was given 8 improvements and the Tylan group received 9 improvements. Both the Naxcel group and Tylan group were given two deteriorations.

Figure 9. Ventral photographs of the udder of the control group cow on farm 3.

4. Discussion

2.2 Data collection

Despite our effort, there are still a reasonable number of photographs that do not meet certain criteria to get the best assessable data. Examples of things that hamper assessing the photographs are very dirty udders, blurry photographs and lighting in the barns which was often too dark. Another issue is the stance of the cow, for instance if the hind leg is in front of the udder it is not possible to assess the udder. The hind legs can also be too far caudally which causes a different distance between *calcaneus* and dew claws. Also important is the height and angle from which the photographs are taken. Taking photographs from a higher point results in distorted distances and angles. These are all things which can be corrected in future studies.

2.3 Data processing and analyses

While analysing the photographs numerous problems occurred. For instance, the distance between *tuber ischiae* should be determined from the most rear point; it was often difficult to determine which point should be taken as the most rear point. In addition, the *tuber ischiae* were often hardly visible due to too much lighting or too much fat.

A difficulty in measuring the udder depth was the position of the skin fold. As illustrated in Figure 10, the udder depth is determined using a straight line from the skin fold to where the udder ends. The blue line in Figure 10 represents the skin fold and the red line represents the udder depth. When the position of the skin fold is as seen in the left image one measures a small udder depth while in fact the udder depth is larger. The right image is the most correct udder depth comparing to the actual udder depth.

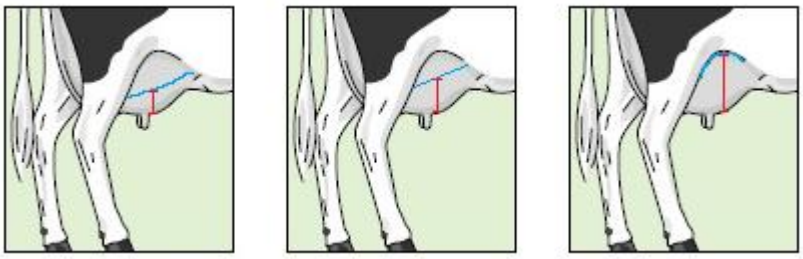

Figure 10. Illustration of measuring udder depth and possible difficulties.

Another problem occurred while determining how many centimetres in real life correspond with the number of pixels in the photographs. A fair amount of photographs were blurry and therefore the centimetres on the folding ruler were unreadable and the distance was non-assessable. When the distance was non-assessable, a mean of the number of pixels of 10 or more photographs was calculated and that amount was used for the blurry photographs where the centimetres were unreadable. There were also photographs that were blurred however, the centimetres were readable. In those cases the number of pixels was very different than the number of pixels in sharp photographs. This might be giving a distorted reflection of the actual distance.

As mentioned in Ch. 4.2.2. the stance of the cow is important for analysing the photographs. For example, in determining the udder width the stance of the hind legs are important. It was fairly common that while analysing the posterior photographs, the hind legs

were close together which causes it to be difficult to assess the udder. Another variable that was difficult to analyse was the angle between udder and abdominal wall. Also for this variable, the stance of the cow is very important. The height and angle from which the photograph is taken is also important. As one can see in Figure 11, the photograph is taken from a high point of view and therefore the measured angle between udder and abdominal wall is different from the actual angle. This also applies for the distance between *calcaneus* and dew claws, as mentioned above. The lower legs seem to be short, while in reality they are not. Another difficulty was the lacteal vein. In a majority of the lateral photographs, the angle was hard to assess because of the lacteal vein which overflows into the udder.

Figure 11. Example of a lateral photograph in which some problems occur while analysing various variables.

3.*1 Prevalence of UCD*

Having collected the data at only one point of time, it is possible that there were cows in an early stage of developing UCD lesions and were non-detectable in this study. It is not entirely known what the early stage of UCD lesions looks like. For that reason it is likely that in the present study no accurate prevalence is obtained. It may well be that the beginning of UCD starts as a red irritated area or the change in colour as seen in category 1 cows and later on develops as the typical UCD wounds and lesions which are seen in category 3, 4 and 5. If that is the case, a higher prevalence would be seen. Also, as mentioned in Ch. 2.3 category 2 includes udders with bald spots, scales, scrapes, petechia or scars. There is more to it than just a colour shift as seen in category 1. Therefore it is possible that, especially, the cows with scars or bald spots on their udders have had typical UCD lesions in the past which have healed. If so, the extend of the condition is even bigger than it now occurs.

The variation in farm prevalences might be due farm management or business-related factors such as stable climate, cubicles etc. It would be interesting to investigate if there are differences in farm management and farm conditions between farms where UCD does not occur and farms in which high percentages of UCD are seen.

3.2 Risk factors on cow level

In contrary to our expectations, there was no association between the strength of the median suspensory ligament and the prevalence of UCD. It is conceivable that cows with a strong median suspensory ligament have more risk of developing UCD as a deep groove is formed which can create a microclimate for the causative microorganisms. Also, while walking the udder halves chafe against each other causing irritation of the skin and possibly creating a port of entry for bacteria due to mechanical damage of the skin.

There seems to be a correlation between UCD and dry period ($p<0.01$) however, among the included cows, there were over 900 lactating cows and roughly 30 dry cows. In the present study, dry period as a risk factor is not really assessable because of the distorted representation. It would be very interesting to examine if dry period is really a risk factor in a study with an equal amount of lactating and dry cows.

Results of this study show that UCD is seen more frequently in cows with a smaller angle between udder and abdominal wall. Possibly a smaller angle creates an optimal environment for certain microorganisms to colonize, resulting in UCD. In addition, cows with a weak fore udder attachment are more likely to develop UCD. The precise reason is not known yet, although a quite similar skin disease is known in dogs (skin fold dermatitis) which is caused by friction between skin folds. Therefore it may be likely that UCD is seen more in cows with large udders in which the udder halves rub against each other while walking or lying.

3.3 Risk factors on farm level

There may be presumptive evidence for a correlation between UCD and several potential risk factors namely herd size, production level, type of bedding, cleaning frequency of the cubicles per day and use of footbath. Nothing has been proven yet, but perhaps there may be some sort of correlation. If the herd size increases more cases of UCD are seen. In the present study 1.5 times more UCD is seen in farms with more than 60 dairy cows. A higher risk of infection can be found if the population density increases, therefore herd size can be an indication for the occurrence of UCD.

As illustrated in Table 6, higher prevalences of UCD are seen (>5%) if the production level exceeds 8,900 kg milk. Due to high milk production the udders are often large, swollen and warm which can be a factor in the development of UCD. A study done by Beattie and Taylor (2000), showed that UCD was most common in high yielding cows. Percentages of cows with lesions ranged from 26% to 32% and the average milk yield per lactation (kg) ranged from 8,204 to 8,546 kg milk (Beattie and Taylor, 2000). Therefore it may well be that highly productive cows are more likely to develop UCD.

Despite of the correlation between UCD and length of the cubicles with an open front ($p=0.04$), it may be a coincidence that in the present study more UCD was seen on farms with longer cubicles.

In Table 13 a prevalence of 5.9% is seen for group 1 opposite to a prevalence of 3.6% for group 0. Bedding types in group 1 are rubber mats and mattresses and bedding types in group 0 are concrete, littered and other types. It may well be that a division in type of bedding is seen because of the fact that soft beddings such as mattresses become warmer and moister than hard beddings such as concrete beddings. This way a favourable microclimate is formed for the causative agent.

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
0	8	3.625	0.9578156	2.709112	1.360126	5.889874
1	12	5.916667	1.279609	4.432695	3.100266	8.733067

Table 13. Part of results of a two-sample t test with equal variances; percentages of UCD and type of bedding. T = -1.3024 and degrees of freedom = 18. Group 0 = concrete, littered and others. Group 1 = rubber mats and mattresses.

Another potential risk factor is the cleaning frequency of the cubicles per day. The more frequently the cubicle are cleaned, the more UCD is seen. Though, there is not specifically asked what one means with cleaning the cubicles. It may be that the fouled area is removed after which the bedding material which lies below is brought to the top. This bedding material is often moister, warmer and can contain many bacteria. The cow lies in this bedding material which is not favourable for the cow. This is just a suggestion, the real reason why more UCD is seen when the cubicles are cleaned more often is not known. However it is plausible that cubicles and especially cubicle hygiene play an important role in occurrence of UCD.

In the survey question 6.a. was about type of flooring in the farms e.g. grids, slotted floor, smooth solid floor or else. In the present study 19 farms had grid floors and only one farm had a slotted floor. Lacking of variation, the variable floor type is not suitable for analysis and therefore was omitted from analysis.

Looking at the current dataset, there is a strong indication that UCD and cleaning frequency of the floor per day are related (p=0.02). A solid explanation is not known yet however, farms which cleaned the floor more frequently use robots or scrapers for cleaning. On those farms higher prevalences of UCD were seen; a possibility is that UCD is contagious and therefore the robots or scrapers increase the problem because they go through the whole barn. As said before, nothing has been proven yet but there may be something to it.

Digital dermatitis may be a potential risk factor for UCD. In the survey the farmers were asked if they experienced problems with digital dermatitis. By asking about the percentage of cows in which digital dermatitis occurred, one is receiving subjective data. All the farmers made an estimation about this percentage and therefore the data concerning percentages of digital dermatitis on the farms is not really eligible.

A two times higher prevalence of UCD was seen when a farm uses a footbath for the dairy cows. The fact that more UCD cows were seen on these farms does not mean that use of footbath is the cause of UCD. This might be a cause-effect conversion e.g. one uses a footbath due to high infection pressure of digital dermatitis, which in turn may lead to more cases of UCD.

3.4 Treatment Trial

While assessing the cow on farm 1 treated with CTC spray, it seemed that the wound was healing because the wound was well vascularised (Figure 12) however, an overall view showed no evident change. The determination of the size of the wound was in some cases inconvenient because not in all photographs the whole wound was visible or assessable, those cases are unclassifiable, as seen in Table 8 and 10. In other cases, as seen in Table 11 and 12, the size of the wound was also not classifiable due to blurry photographs. In addition, while determining the size of the wound the angle from which the photograph was taken is important. The sizes differ too much if the photograph is taken from different angles, therefore it is difficult to make a conclusion whether the treatment has any effect only based on the determination of the size of the wounds.

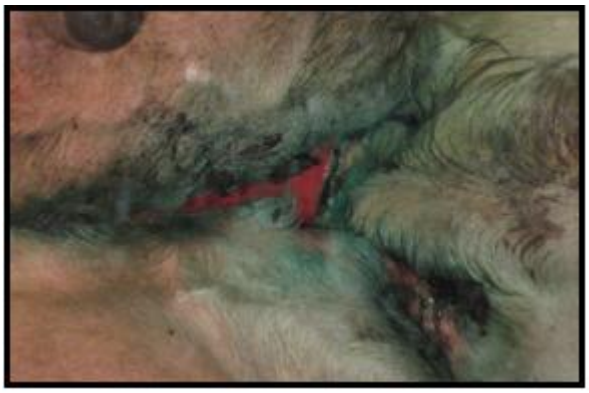

Figure 12. Ventral photograph of the udder of the cow on farm 1 treated with CTC spray. This image was taken during the third visit.

It is difficult to make a conclusion about the effect of the different treatments based on the three points of assessment. The wound may look better, but the degree of UCD is scored worse than in the beginning of the trial. Some of the farmers cleaned the wounds, therefore it may well be that the newly formed granulation tissue is removed, which may be expressed in a worsening of the degree of UCD. As seen in Ch. 3.4 in some cases the degree of UCD had become worse, but both the size of the wound and visual assessment were improved, is the treatment effective in those cases? Perhaps a different kind of assessment is of better quality.

5. Conclusion

One of the objectives of this study was to estimate the prevalence of UCD on both farm and cow level. The prevalence of UCD was determined among 1,120 cows in 20 dairy herds. Farm prevalences ranged from 0% to 13% and UCD was seen on 85% of the participating farms. Of the 1,120 examined cows, 62 (6.0%; 95% binomial confidence interval [CI], 4.6 to 7.6) cows were found positive for UCD.

Another objective of this study was to investigate potential risk factors of UCD on both farm and cow level. Results of this study show that there are several risk factors of UCD on cow level. An association existed between both UCD and udder depth and relative udder depth (both $p<0.01$). For instance, cows with a deep udder or relative deep udder are more likely to develop UCD. Also, a weak fore udder attachment increases the odds of UCD ($p=0.02$). And UCD is seen more frequently in cows with a smaller angle between udder and abdominal wall ($p=0.04$). All these risk factors on cow level are related to the shape of the udder.

In the present study only 20 dairy herds were participating and therefore it is difficult to make solid statements concerning risk factors on farm level. There is presumptive evidence for a relation between UCD and the following: herd size ($p=0.10$), production level ($p=0.08$), type of bedding ($p=0.10$), cleaning frequency of the cubicles per day ($p=0.07$) and use of footbath ($p=0.09$). There seems to be a relation between UCD and the length of the cubicles with an open front ($p=0.04$), where more UCD is seen on farms with longer cubicles. And when using the current dataset, there is a strong indication that UCD and cleaning frequency of the floor per day are related ($p=0.02$). Further research is needed to investigate if all the above mentioned variables on farm level are truly risk factors for UCD.

The objectives of the treatment trial were to investigate if one of used treatments is a good effective therapy for UCD and if there is a treatment which creates improvement regarding the wound healing. The three different treatments in the treatment trial showed no overall improvement in wound healing, as seen in Ch. 3.4. An overall improvement is an improvement in the degree of UCD, size of the wound and visual assessment. There were mixed results concerning the different treatments. In some cases the wound healing has improved however, the same treatment on a different farm did not have the same effect. All three treatments showed an one time overall improvement on three different farms; CTC spray on farm 2, Naxcel on farm 3 and Tylan on farm 5. Both Naxcel and Tylan score better in the given number of improvements, 8 out of 15 and 9 out of 15 respectively.
Lacking a consistent improvement for all treatments, we can conclude for now, that none of the used treatments is a good effective therapy for UCD.

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Attachments

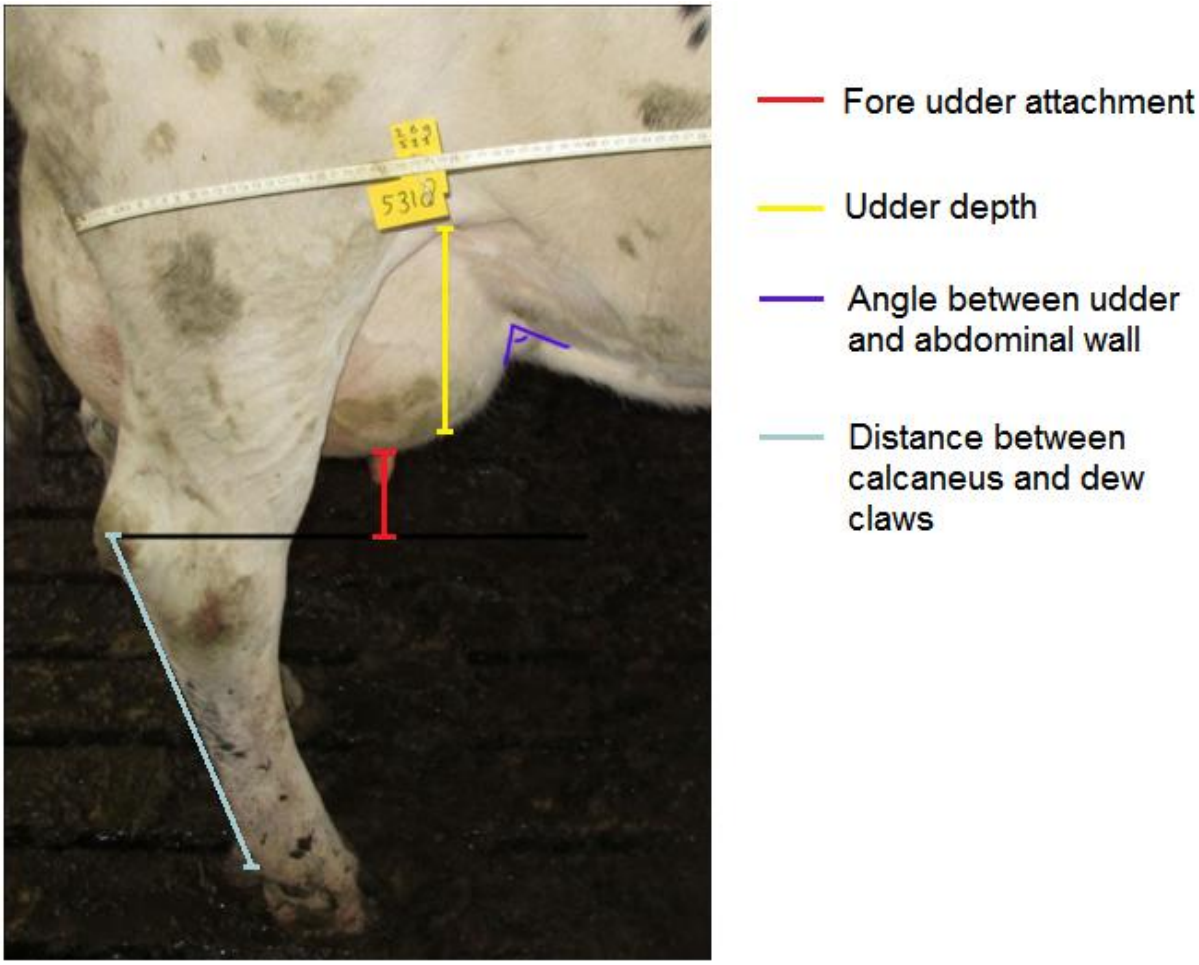
1. Analysis posterior photographs
2. Analysis lateral photographs
3. Hygiene scorecard of the UGCN.
4. Categories of the degree of UCD.

Udder width

Strength of the median suspensory ligament

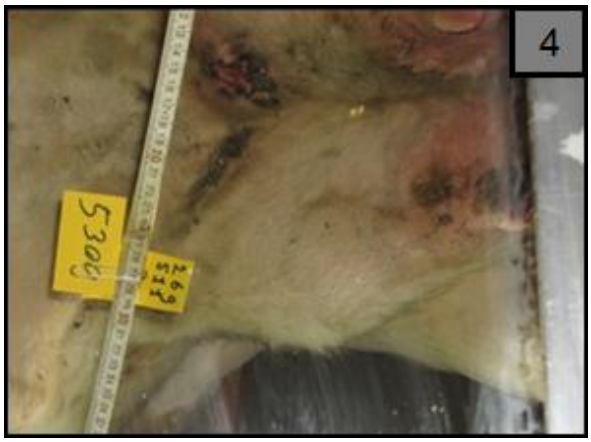
Distance between tuber ischiae

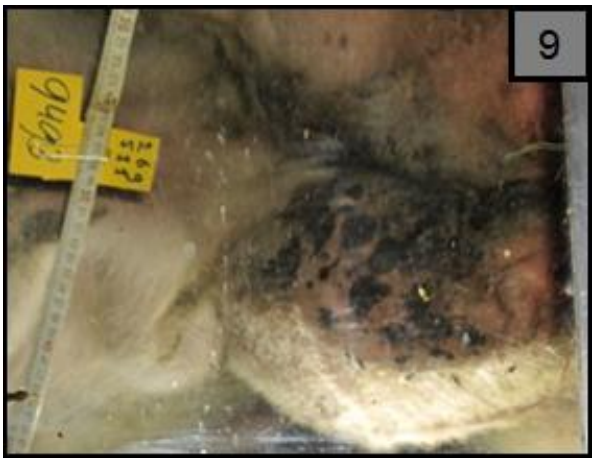
Attachment 1. Analysis of the posterior photographs



Attachment 2. Analysis of the lateral photographs

Attachment 3. Hygiene scorecard of the UGCN





Attachment 4. Categories of the degree of UCD

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