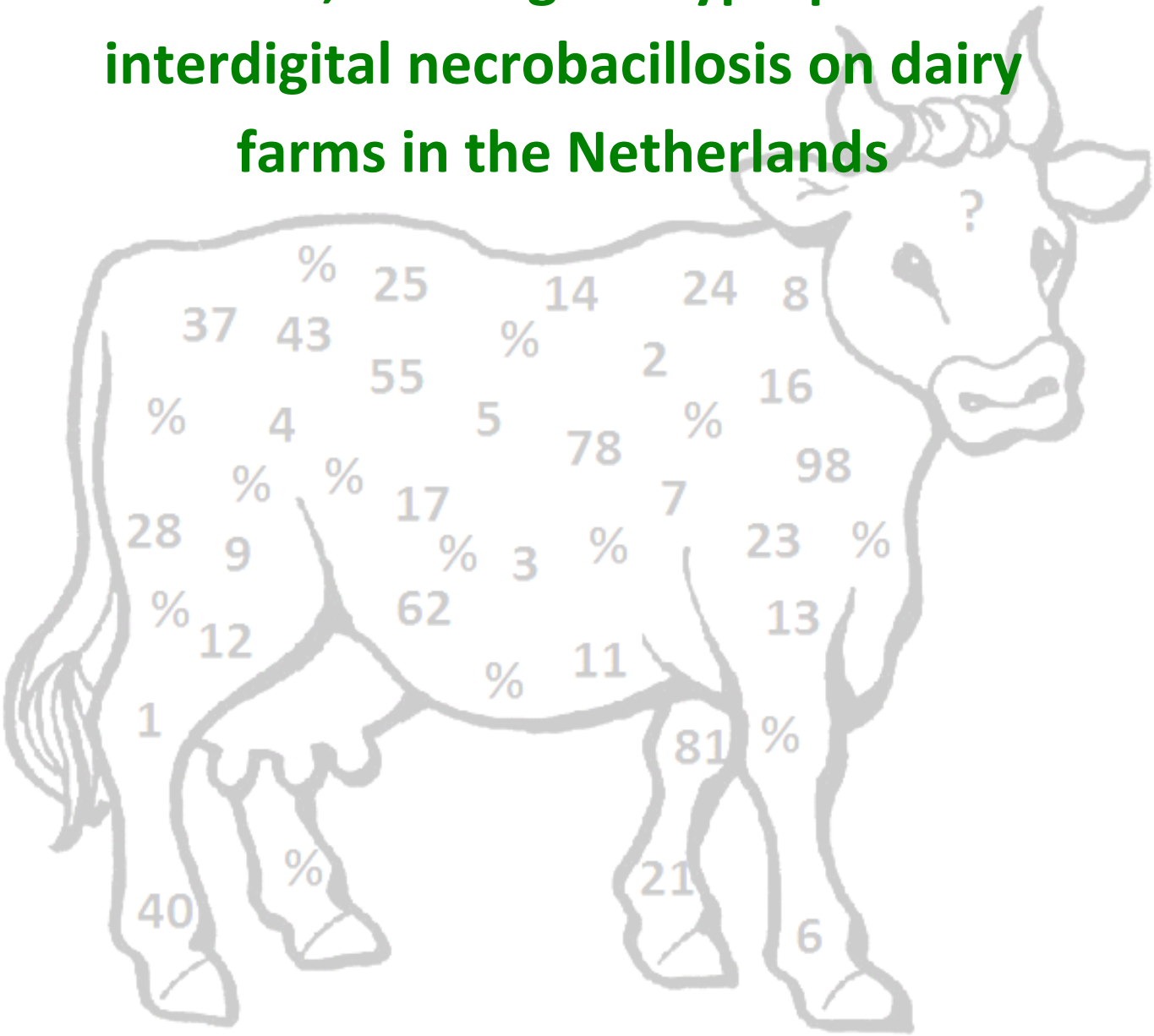
Prevalence of bovine digital dermatitis, interdigital hyperplasia and interdigital necrobacillosis on dairy farms in the Netherlands



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Abstract

The goal of this prevalence study was to determine the prevalence of digital dermatitis, interdigital hyperplasia and interdigital necrobacillosis on farms in the Netherlands. This is relevant due to the effects of lameness, a common symptom of these three diseases, on animal welfare and economic results. The data were collected within a clinical trial, required for the authorisation of a new topical treatment for digital dermatitis, set in October to December of 2013. Trained veterinary students collected data for this paper. The front and hind claws of each cow participating in the trial were inspected whilst the cow was in a trimming chute. Herds preferably contained over 100 cows, had a herd digital dermatitis prevalence level of 20% or more, were housed in cubicle systems, were of the Holstein Friesian breed and no preventive claw treatment on herd-level was executed in the three weeks prior to the trial. After visiting four farms, the goal of inspecting at least 300 cows was met, with a total of 373 animals. Prevalence was calculated per farm and an overall prevalence was calculated after visiting all four farms for each disease. A 95% confidence interval was calculated for each disease to establish whether the results differed significantly from values found in literature. Herd prevalence for digital dermatitis varied from 23.0% to 59.3%. For interdigital necrobacillosis, values varied from 0.0% to 1.6%. Interdigital hyperplasia varied in herd prevalence from 5.7% to 12.9%. The overall prevalence of digital dermatitis, interdigital necrobacillosis and interdigital hyperplasia was 40.8%, 1.1% and 8.3%, respectively. The results of interdigital hyperplasia did not differ significantly from those found in literature, the results of digital dermatitis and interdigital necrobacillosis did.

1. Introduction

This paper focuses on the prevalence of interdigital necrobacillosis, interdigital hyperplasia and digital dermatitis in (at least) 300 dairy cows on farms in the Netherlands.

The research question is: what is the prevalence of interdigital necrobacillosis, interdigital hyperplasia and digital dermatitis in dairy cows on farms in the Netherlands, participating in a clinical trial concerning the effectiveness of a treatment for digital dermatitis?
The hypothesis states that the prevalence of interdigital necrobacillosis, interdigital hyperplasia and digital dermatitis found in this research are concurrent with known prevalence data of these diseases in Dutch dairy farms. Prevalence (in this research) is stated as the percentage of diseased animals in a population at a certain point in time.
The aim of this paper is to find out what the prevalence of interdigital necrobacillosis, interdigital hyperplasia and digital dermatitis is, amongst cows that participate in a clinical trial, comparing two topical treatments for digital dermatitis. The compared drugs were a new topical drug called Repiderma ® (containing copper and zinc chelates, produced by Intracare BV in the Netherlands) and CTC spray ® (containing chlortetracycline, produced by Eurovet Animal Health BV in the Netherlands (1)).

Interdigital necrobacillosis is an acute or subacute necrotizing dermatitis. The disease affects the interdigital space up to the coronary band (2). Some researchers say it is caused by trauma of the skin in the interdigital area, followed by infiltration of *Fusobacterium necrophorum* and *Bacteroides melaninogenicus* (3). Others state that *Fusobacterium necrophorum* ssp. *necrophorum* and *Porphyromonas levii* are the responsible agents (4). The disease is mainly seen on the digits of the hind quarters. Especially mature cows are affected. Unsanitary and wet conditions with sharp objects on the floor predispose to the disease (5). The disease can be found all over the world (6) in housed cattle.

Figure 1: An example of a case of interdigital necrobacillosis, showing swelling between the digits (7)

A swollen foot, lameness and affected skin are signs of interdigital necrobacillosis. The typical odor (caused by necrosis) smelled at inspection can also help to diagnose the disease (4). A fissure in the interdigital space is another clear sign (5). Figure 1 shows an example of interdigital necrobacillosis.

Interdigital hyperplasia is a proliferative reaction of the digital skin (8). Interdigital hyperplasia is characterized by a fold of fibrous tissue hanging down into the interdigital space (7). Figure 2 clearly shows the mass in the interdigital space, a typical sign of interdigital hyperplasia.

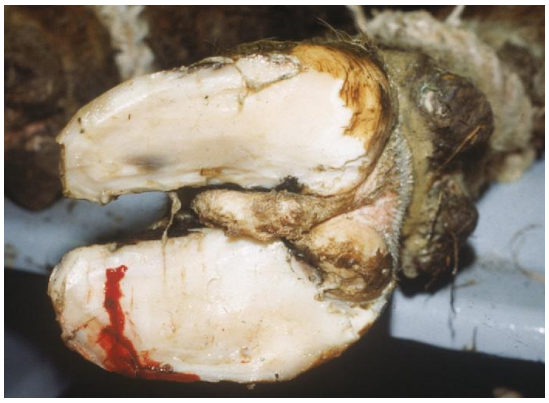

Figure 2: An example of interdigital hyperplasia (9), the typical mass can be seen between the digits

Hind claws are affected more often than front claws (10). Predisposing factors are spreading of the claws and poor ligament development (8), stretching of the interdigital skin and fibrosis of the subcutis (7). Genetic predisposition can induce interdigital hyperplasia. Chronic interdigital dermatitis (9) and chronic trauma such as poor hoof trimming or bad housing conditions can increase the chances of the occurrence of interdigital hyperplasia as well (11). Interdigital hyperplasia doesn't necessarily cause lameness, only when the hyperplastic tissue is large enough to be oppressed between toes and floor (9). Interdigital hyperplasia can be removed surgically.

Digital dermatitis is an acute inflammation of the hairy skin of the bovine foot. The disease is thought to be caused by spirochetes, as these microorganisms are commonly isolated from the lesions (7). More specifically, *Treponema* spirochetes are thought to be causative agents. The disease is present all over the world in housed cattle (3). Hind legs are more often affected than front legs (9). The lesions are commonly seen at the plantar side of the claw, near or in the interdigital space. Heifers seem to be the most affected age group (3) and it is especially seen in early lactation (4). Risk factors for digital dermatitis are large herds, acquisition of new animals and wet housing conditions (4). Figure 3 shows the most typical appearance of the disease: the ulcerative M2 stage (12).

Figure 3: Typical digital dermatitis lesion, showing a strawberry-like lesion surrounded by a white circle (7)

Digital dermatitis causes lameness (7), in one or more legs. Affected animals often walk on their toes, due to the frequent location of the lesion near the coronary band (6).

Researching the prevalence values of digital dermatitis, interdigital necrobacillosis and interdigital hyperplasia is relevant, because foot disorders in dairy cows can have economic consequences for dairy farmers. Bruijnis *et al*. (2010) recently estimated the annual costs of foot disorders at $75 per cow on an average Dutch farm (13). Enting *et al*. (1997) stated that foot disorders are economically speaking third in line in importance, following mastitis and reduced fertility (14). Another relevant matter is the impact of lameness, a common symptom of these three diseases, on animal welfare. Lameness in general and digital dermatitis more specifically, have substantial impact on animal welfare (15).

It is known that claw disorders are more frequently present in housing systems with concrete floors (slatted or solid) than in straw yards (16). As this study was done at Dutch dairy farms with concrete floors, studies with similar conditions were searched for in literature to compare results with.

Somers *et al*. (2003) studied the prevalence of several claw disorders in different housing systems in the Netherlands in 1999 and 2000. Housed cows (at least 50 days spent indoors and no more than 15 days spent at pasture at the time of observation) showed a digital dermatitis prevalence of 36.0%, hyperplasia prevalence of 14.2% and interdigital necrobacillosis prevalence of 0.4% (16).
Somers *et al*. (2005) found a digital dermatitis prevalence of 28.5% (17) in housed cows.
Smits *et al*. (1992) suggested a prevalence of 17.6% for digital dermatitis in zero-grazing cows in a less recent paper on the prevalence of claw diseases in Dutch dairy cows. The same study found a prevalence of 0.4% for interdigital necrobacillosis and one of 8.8% for interdigital hyperplasia (18).
Van der Linde *et al*. (2010) found prevalence values of 22.0% for digital dermatitis and 5.0% for interdigital hyperplasia (19) in the Netherlands.
Van der Waaij *et al*. (2005) found the following prevalence results in Dutch dairy cows in 2005: 21.7% for digital dermatitis, 5.9% for interdigital hyperplasia and 0.6% for interdigital necrobacillosis (20).
Table 1 summarizes all of the mentioned results.

	Digital dermatitis	**Interdigital necrobacillosis**	**Interdigital hyperplasia**
Somers *et al*., 2003	36.0%	0.4%	14.2%
Somers *et al*., 2005	28.5%	-	-
Smits *et al*., 1992	17.6%	0.4%	8.8%
van der Linde *et al*., 2010	22.0%	5.0%	-
Van der Waaij *et al*., 2005	21.7%	0.6%	5.9%

Table 1: Summarized prevalence values from several relevant literature sources (- = no observations about this disease in this study)

First, the context of this research is described. Then, the selection criteria for herds and cows will be discussed. Subsequently, the research design is explained and the definitions used in this paper are described. Next, the type of statistical analysis used in this paper is explained. The following chapter consists of results. Last, there is a discussion with a conclusion to this research.

This paper is written in the context of a research project that is part of the Master's degree program at the Faculty of Veterinary Medicine at Utrecht University from September until December 2013.

2. Materials and methods

3.1 Clinical trial

The data used in this paper were collected in the context of a clinical trial, necessary for the authorisation of a new topical treatment for digital dermatitis in the Netherlands. Four trained veterinary students collected data for the trial. The data for this paper were collected on the starting day of the trial on each farm, when all of the cows on that farm were inspected in a trimming chute. Data collection for both the trial and this paper took place from October until December of 2013.

3.2 Participating herds and cows

The criteria for participating farms in the clinical trial, and therefore also for the participating populations used in this paper, were:

- Prevalence of digital dermatitis over 20%
- 100 cows or more present per dairy farm
- Housing in cubicle systems
- Cows of the Holstein Friesian breed
- No preventive claw treatment on herd-level in the three weeks preceding 'day 0'

The goal was to examine at least 300 cows for collecting data for this paper. Data collection was stopped after visiting the farm on which the 300th dairy cows was seen. After visiting four farms which participated in the trial, the number of 300 dairy cows was exceeded, with a total of 373 lactating dairy cows participating in this research.

All of the cows were housed in barns with concrete floors and without pasture access. Only the hind legs of cows were taken into account for the clinical trial that compared digital dermatitis treatments. However, both hind and front legs were inspected for the paper considering digital dermatitis, interdigital hyperplasia and interdigital necrobacillosis.

3.3 Research design

The prevalence of interdigital necrobacillosis, interdigital hyperplasia and digital dermatitis was assessed in the first 373 cows seen in the clinical trial. Prevalence was calculated per farm.

Every cow on each farm was assessed in order to find digital dermatitis for the clinical trial on the first day of the trial on each farm. The hoofs of every cow were cleaned and trimmed, allowing the students to have a clear sight on the claws and therefore enabling them to diagnose disorders. Four trained veterinary students were responsible for diagnosing digital dermatitis and naming the stage of it for the clinical trial. These students also registered interdigital necrobacillosis and interdigital hyperplasia for this paper.

The first 373 lactating dairy cows that were seen in the clinical trial were registered in a schedule. They were scored to have interdigital necrobacillosis, interdigital hyperplasia, digital dermatitis, a combination of two or three of the diseases, or to have none of the mentioned diseases by encircling the appropriate situation in a schedule. Afterwards, the number of occasions of each disease and the total number of cows could be read from the schedule, allowing the author to calculate the prevalence of the three diseases on each farm.

3.4 Definitions

Prevalence is stated as the proportion of a population that is affected by a disease. More specifically, Petrie and Watson state the definition of prevalence as follows: 'the prevalence of a disease relates

to the number of cases of the disease that exist at a specific instant in time (point prevalence) or in a defined interval of time (period prevalence)' (21). By this definition, it does not matter if the cow is affected by a disease on one or more claws. Therefore, it was it was only recorded if a cow was affected by a disease at all, and no specification about the amount of affected claws per cow was registered. The farm prevalence was calculated after the results of each farm came in. After visiting all of the farms, an overall prevalence was calculated.

3.5 Statistical analysis

To determine whether the difference between the overall prevalence data of the three diseases differed significantly from the values found in literature, a 95% confidence interval was calculated for each prevalence value. The prevalence values from this paper as well as those from literature were were based on 30 or more events. Thus, confidence intervals can be calculated as follows.

RD = higher prevalence – lower prevalence (in %)
x_1 = number of cases used to calculate the first prevalence
x_2 = number of cases used to calculate the second prevalence
n_1 = number of total observations made to find first prevalence
n_2 = number of total observations made to find second prevalence

Lower confidence limit = $RD - \left(1.96\sqrt{\frac{x_1}{n_1^2}+\frac{x_2}{n_2^2}} \times 100\right)$

Upper confidence limit = $RD + \left(1.96\sqrt{\frac{x_1}{n_1^2}+\frac{x_2}{n_2^2}} \times 100\right)$

When an interval includes 0.00, the prevalence values do not differ significantly.

3. Results

4.1 Prevalence of digital dermatitis, interdigital necrobacillosis and interdigital hyperplasia

A total amount of 461 animals were seen in this research, but 88 of those were heifers, bulls and dry cows. As stated before, this paper focuses on dairy cows, so the results of 373 lactating dairy cows were processed. Figure 4 depicts the prevalence results in a bar chart. Based on these data, the overall prevalence of digital dermatitis, interdigital necrobacillosis and interdigital hyperplasia amongst lactating dairy cows is 40.8%, 1.1% and 8.3%, respectively.

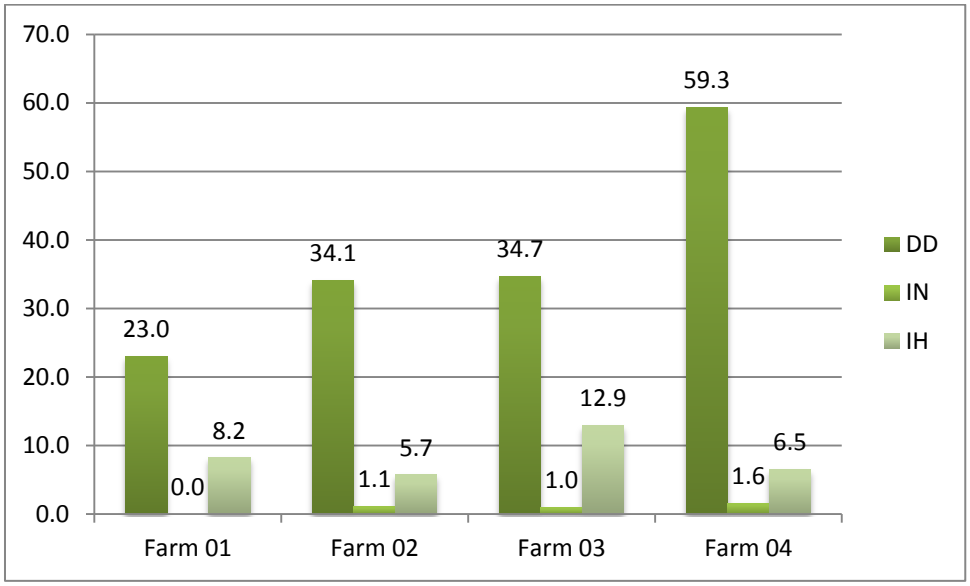

Figure 4: Bar chart representing the prevalence of digital dermatitis (DD), interdigital necrobacillosis (IN) and interdigital hyperplasia (IH) amongst lactating dairy cows on the farms (in %)

4.2 Comparing current results with previous results

As stated in the introduction, there has been previous research on this subject in the Netherlands. These papers found an weighted mean prevalence of 22.7% for digital dermatitis, with a total of 70,350 participating cows. An weighted mean prevalence of 3.23% was found for interdigital necrobacillosis, with a total of 67,458 cows in those trials. For interdigital hyperplasia, 26,922 cows were seen with an weighted mean prevalence of 7.11%.

When comparing the results found in literature to those of this research with the method described before, it is seen that there is a significant difference when it comes to the prevalence values of digital dermatitis and interdigital necrobacillosis. The results of interdigital hyperplasia do not differ significantly from those found in literature.

4. Discussion and conclusion

The answer to the research question that was proposed in the introduction is: the prevalence of interdigital necrobacillosis, interdigital hyperplasia and digital dermatitis on farms in the Netherlands, participating in a clinical trial concerning the effectiveness of a treatment for digital dermatitis, is 1.1%, 8.3% and 40.8%, respectively.

The hypothesis stating that the prevalence values would be concurrent with known data seems to be partially true. The results for interdigital hyperplasia do not differ significantly from those found in previous Dutch trials, but the values for the prevalence of digital dermatitis and interdigital necrobacillosis do.

There are some advantages to the setting of this research. For example, the housing systems on the farms in this trial (concrete floors, cubicle housing) are representative for the Netherlands, as Dutch cows are traditionally housed in circumstances like these (22).

There are also some disadvantages. For example, a population of only 373 lactating dairy cows to perform a prevalence analysis on is a rather small population.
Also, the digital dermatitis prevalence values found in this research cannot be seen as representative for the entire country (the Netherlands), as the farms were selected for a clinical trial that tested medication for digital dermatitis. Therefore, dairy farms with high prevalence rates (preferably over 20-25%) of digital dermatitis were selected. Thus, high prevalence levels of digital dermatitis were to be expected.
Other than that, on several occasions, combinations of diseases were seen. Out of 373 lactating dairy cows, 161 (43.2%) cows had at least one disease. Some of those suffered from more than one disease. Figure 5 shows some cases of interdigital hyperplasia combined with digital dermatitis. This combination was seen quite often in this study. Table 2 shows how often each combination was seen in this research. These combined diseases might affect each other and lead to delayed healing. Therefore, maybe it has an effect on the prevalence of either of the diseases as well. The fact that combined diseases occurred quite often can be seen as no surprise, as in a previous Dutch study, it was reported that all of the participating cows with interdigital hyperplasia, also had digital dermatitis (23). Other present claw diseases that were not recorded for this research might also have influenced the healing and therefore the prevalence of the three recorded diseases.
Another disadvantage is that the prevalence values were calculated from 373 cows on four different farms. Farm-bound factors differ between the herds, making it hard to call all of the cows one ‘population’, as stated in the definition of prevalence.

Figure 5: Combined interdigital hyperplasia and digital dermatitis as seen in this research, showing digital dermatitis lesions (stage M2) on interdigital hyperplasia

Combination	Number of occasions
Digital dermatitis and interdigital hyperplasia	19
Digital dermatitis and interdigital necrobacillosis	1
Interdigital hyperplasia and interdigital necrobacillosis	0
Digital dermatitis, interdigital hyperplasia and interdigital necrobacillosis	3

Table 2: The frequency at which each combination of diseases was seen in 373 lactating dairy cows in this research

These newly found data might indicate likely prevalence values of interdigital hyperplasia and interdigital necrobacillosis on dairy farms with high prevalence rates of digital dermatitis.

Due to the limited time for this research project, only three diseases were chosen beforehand to be recorded. However, the researchers noticed some other diseases on the participating farms of the clinical trial, as well. Frequently seen diseases were interdigital dermatitis, sole ulcers, white line disease and hock lesions. Future research could focus on more than just three claw disorders, to create a more clear picture of the gravity of claw disorder problems on modern Dutch dairy farms, by showing what diseases occur and the rate at which they occur.

Future research on the prevalence of digital dermatitis, interdigital necrobacillosis and interdigital hyperplasia could be performed on randomly selected farms (instead of farms selected for digital dermatitis) to find more realistic values for the prevalence of the three diseases. Also, future research could include more animals, to find more reliable results.

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