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**BVD eradication in Switzerland – A new approach**

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## Abstract

Diverse concepts for BVD eradication or control have been applied in several countries with varying success. Results of previous studies conducted in Switzerland have shown that the prevalence of antibody-positive animals is high and that BVDV is wide spread in the country causing serious economic losses. A new approach to eradicate BVD in the cattle population in Switzerland was chosen. It consists in testing the whole Swiss cattle population for virus detection in a short period of time, without initial antibody screening. Identified persistently infected (PI) animals have to be slaughtered, and new herd infections should be avoided by movement restrictions. Ear-notches are collected using special tags for labeling the animals, and are analyzed using ELISA or rtRT-PCR. Methods. Confirmatory tests if needed are performed on blood samples using rtRT-PCR. The eradication program is divided in four phases: 1) Pre-pasturing phase: all young bovines going to transhumance in summer have to be negative tested before. 2) Initial phase: all non-tested bovines have to be tested. Movement restrictions are effective at the same time. 3) Calves phase: all new-borne calves have to be tested 4) Surveillance phase: several strategies will be compared using a modeling approach.

After the pre-pasture phase already 595'230 animals (37% of the livestock) have been tested within four months. A prevalence of 1.1% of PI's was observed. The average age of infected animals is 403 days compared to 794 days for non-infected animals, with the oldest PI animal being over 11 years old. On average PI animals are slaughtered within 18 days after the last positive result.

The pre-pasture phase has shown that sampling and testing a high number of animals in a short time is challenging but possible. The next phase will deal with a double amount of animals in a similar time frame. The coordination between all partners as well as the collaboration of farmers is the key factor for ensuring the success of the program.

**Keywords**

Bovine viral diarrhea; eradication; Switzerland; PI animals

Accepted Manuscript

## Introduction

Surveys have shown that in European countries the prevalence of bovine viral diarrhoea (BVD) antibodies at the herd level before starting any eradication or control program ranged from 95% in England and Wales down to less than 1% in Finland (Greiser-Wilke et al., 2003). In Switzerland, based on a cross-sectional study, 57.6% of animals had antibodies to BVD virus (BVDV) and a within-herd prevalence of 55%; none of the farms investigated was free of antibody-positive animals (Rüfenacht et al., 2000). With different production structures and diverse initial situations, many European countries have initiated national and regional control-and-eradication campaigns for BVDV (Greiser-Wilke et al., 2003; Moennig et al., 2005).

The first systematic eradication schemes were launched in 1993-1994 in the Shetland Islands, Denmark, Finland, Norway and Sweden (Bitsch et al., 2000; Bitsch and Ronsholt, 1995; Lindberg et al., 2006; Synge et al., 1999). Regional approaches to control the BVD have been undertaken in various countries such as Germany (Gaede et al., 2003; Greiser-Wilke et al., 2003), Italy (Ferrari et al., 1999) and France (Joly et al., 2005; Viet et al., 2005). In Austria, a programme was first implemented at a regional level and in 2004 extended to the whole country (Obritzhauser et al., 2005; Rossmann et al., 2005).

The Scandinavian BVD-eradication models build mainly upon the initial classification of the population in non-infected and infected herds, the surveillance and certification of non-infected herds and the virus elimination from infected herds (Lindberg and Alenius, 1999). Herd-level tests for the determination of probable BVDV status are performed either on bulk milk or on serum or milk from a small number of animals of a certain age group. Enzyme-linked immunosorbent assays (ELISAs) is used for the detection of antibodies.

Regardless of the prerequisites like legal support and varying initial prevalences of herds with PI animals, it has taken the Scandinavian countries approximately ten years to reach their final phases (Hult and Lindberg, 2005; Nyberg et al., 2004; Rikula et al., 2005; Voss, 2004).

An alternative, when the prevalence of antibodies is high, is to focus the program on the direct identification and removal of PI animals. This option was adopted in Lower Saxony in Germany (Greiser-Wilke et al., 2003).

Due to the high density of farms and high level of contact between farms, as well as the prevalence situation of antibody positives, Switzerland opted for an intensive compulsory eradication program without initial antibody screening. The improvement of diagnostic tests for the detection of PI-animals in recent years in terms of early detection of young infected animals and the possibility to use ear-notch samples made the Swiss approach feasible (Hilbe et al., 2007; Houe et al., 2006). In 2008, all cattle will be tested.

Movement restrictions will take place in order to speed up the eradication program and minimize the apparition of new or re-infection of herds during the process.

The present paper describes the eradication program implemented in Switzerland and provides preliminary results as well as discusses some critical points imperative for its success.

## **Material and Methods**

### ***Structure of the livestock in Switzerland***

The bovine livestock in Switzerland consists of 1.572 million animals distributed in 43'722 farms with 55% of farms present in the plain and 45% in the mountains. The average herd size is of 36 cattle. Every type of stock-farming is present in Switzerland from purely fattening farms to dairy farms with the majority of farms being a mix of both.

The animal movement is very intense and is characterized mostly by the pasture that takes place every summer in various mountainous regions of the country. Around 25% of cattle are going to transhumance in the mountain with a mix between animals from many places of origin. The animals stay during summer in the mountains and return in autumn to their farm of origin. In addition, due to the specificity of the market, it is frequent that animals travel all over the country to be sold. Animal movements are therefore dense and consist of a complex network.

### ***Eradication program***

The key points of the eradication program in Switzerland are the followings:

- Compulsory for every farmer
- Individual identification and elimination of PI animals in the whole Swiss cattle population
- Action conducted in a short period (a year for the testing of the population)
- Movement restrictions
- Continuous information and education of farmers

The program is divided in four phases (Table 1):

#### 1. Phase before pasturing (January to July 2008)

In Switzerland, pasturing has an important role in maintaining and transmitting the virus, inducing new persistently infected calves. Therefore, all cattle younger than 2 years had to be tested antigen negative before going to summer pasturing. In some regions this was extended to older cattle as well. The number of animals to be tested was estimated at 350'000 based on data of previous years.

#### 2. Initial phase (October to December 2008)

All not tested cattle will be tested. An exception is made for cattle from pure fattening farms, where all cattle on the farm go directly to slaughter. The animal movements in the



herds are restricted from the time of sample taking until the results are available (15 days on average). Farms with all animals tested negative have no further restrictions. In farms with positive tested animals, all pregnant females have movement restrictions until calving. Calves are tested immediately after they were born and are blocked until the negative result is released.

### 3.Secondary or calve phase (October 2008 to October 2009)

After the initial phase all cattle alive should have been tested and all positive animals culled. However, there might still be newborn calves that are persistently infected.

Therefore, all newborn calves have to be sampled and tested. The farmer, while marking the calves, will take ear tissues and send them for analysis. In case of positive testing, the calf is slaughtered and the movement of every pregnant female on the farm is blocked till calves were born.

### 4.Monitoring phase (from October 2009 to 2011)

In October 2009 the major part of the Swiss cattle population will be free from BVD infected animals. In this period it is essential to monitor and to verify the entire population of Swiss cattle.

It is planned to keep on testing the new born calves for a period of at least a year and then target the monitoring on antibodies in milk from first lactating cows (starting in 2011). Modeling will be used to compare the different monitoring strategies and to better allocate resources to ensure a cost-efficient surveillance program.

[Insert Table I about here]

### ***Type of analyses***

For this eradication program, official sample takers use special ear-tags, to collect tissue sample while simultaneously identifying the animals. The sample is sent to one of the nine certified laboratories involved in the program the same day. In the laboratories

either real time reverse transcriptase PCR (rtRT-PCR) or Enzyme-Linked-Immunosorbent-Assay (ELISA) is used to detect virus-positive animals. The initial analyses are performed using one of the four tests: 1) HerdCheck Ag/Serum Plus from IDEXX Laboratories based on the identification of the E<sup>ns</sup>-antigen; 2) PrioCheck BVDV Ag PI focus ELISA from Prionics AG, based on the identification of the p80- or other expressions of the NS2/3-antigen (only for animals older than 60 days) ; 3) cadov BVDV RT-PCR Kit from Qiagen GmbH; 4) BoVir-SL® BVDV TaqMan RT-PCR from AnDiaTec GmbH & Co. KG. All initially positive as well as not interpretable results can be verified through a confirmation test. It can be decided by the farmer to cull the animal without confirmatory test or a blood sample is taken and tested using rtRT-PCR. If this result is negative, the sample is considered as negative; if positive, the sample is considered as positive; if not interpretable, the sample is sent to the reference laboratory for retesting. The reference laboratory partly confirms positive results as well as clarifies problems. The specificity and sensitivity of the tests are between 98% and 99.8% respectively 97.1% and 100% based on literature (Wolf et al., 2007; Fux, 2007; Fux et al., 2008; Hilbe et al., 2007).

### **Data flow**

The success of a national program of such a magnitude highly depends on the coordination and communication between every party involved. The Federal Veterinary Office is coordinating this program and has developed a database (ISVET) to connect the different partners (Figure 1). At the regional level, cantonal veterinarians are organizing the sampling process and are controlling the implementation of the measures. The BVD-Web is a website showing information from ISVET that lists all individual animals per farm, including their eartag-number, birthdate and test-result if existing. BVD-Web is accessible for the sample takers; lists of animals can be printed

and allow an overview of the situation. The laboratories communicate the test-results through the central laboratory database to the ISVET. During the phase before pasturing all negative results for individual animals were announced on the movement animal database, which is accessible for all farmers. In the following phase the movement restrictions for the individual farms and animals will be displayed on this database.

[Insert Figure 1 about here]

The analyses were performed using the statistical computing environment R (R Development Core Team, 2008).

## Results

Before the initial phase, a total of 595'230 animals (37% of the livestock) from 33'617 farms (77% of the farms) have been tested for BVDV (as of 25<sup>th</sup> September 2008). 81% of these animals were under three years old. The proportion of infected animals distributed in age categories compared to the proportion of animals sampled and the age distribution in livestock is shown in Figure 2.

[Insert Figure 2 about here]

Of the 6988 positive tested in the initial test, 3883 underwent a confirmation test of which 3427 were confirmed positive, corresponding to a confirmatory rate of 88%.

The total of 6532 PI animals gave a prevalence of 1.1% [95% confidence interval: 1.07, 1.14]. Under the assumption that the 3092 animals that were tested once would undergo a confirmation test and also 12% would be negative, results in a corrected PI-share of 1.03% [95% confidence interval: 1.00; 1.07]. Regional fluctuation in the proportion of PI-animals ranged between zero and 1.54%.

The average age of infected animals is 403 days compared to 794 days for non-infected animals (Figure 3). The oldest PI animal was over 11 years old.

On average PI animals had been slaughtered within 18 days after the last laboratory result. The maximal number of days elapsed before slaughtering was 242 days (Figure 4).

[Insert Figure 3 and 4 about here]

## **Discussion**

The high number of animals tested for BVD in a few months was demanding for all partners. The challenge for the sample takers was to handle a new electronic tool (BVD-Web) and to take ear-notch-samples with a new technique in a limited time. After a short adaption phase all sample takers appreciated the use of the BVD-Web, which let them have an overview of the program as well as simplifying the labeling process. The sampling resulted in a high number of empty samples arriving to the laboratories, which decreased from 4% at the beginning of the phase up to 1.2%. Laboratories also gained expertise and efficacy in analyzing large amounts of samples in a short period.

The pre-pasture phase allowed the detection and elimination of 6532 PI animals. Although the impact on the reduction of inducing new PI-animals cannot be assessed before having analyzed the results of the newborn calves in the following nine months, past studies clearly indicated the impact of BVD-negative transhumant on the reduction of new infections (Bodmer et al., 2008; Siegwart et al., 2006). Pilot studies conducted in Switzerland (Rüfenacht et al., 2000) combined with coming results of the calve phase will allow quantifying the impact of the reduction of new PI-animals.

Targeting the first phase of the eradication program on young animals and animal populations at risk in terms of intensity of contact of animals from different herds, the probability of detecting PI animals was higher than in the average cattle population. In consequence, the overall prevalence of PI animals should decrease once all animals in the cattle population have been tested.

Although on average PI's are younger than non-PI animals, about 20% of PI's are over two years old, with a maximum of 11 years old. This is consistent with results obtained from a monitoring program conducted in Germany (Gaede et al., 2008). Targeting a control program only on young animals can result in missing PI's. Those animals will then have a strong effect on maintaining the infection in the population. This effect will grow, as the prevalence of antibodies against BVDV decreases.

The time elapsed between PI's detection and slaughter can slow down the progress of the eradication program (Lindberg and Houe, 2005). By restricting animal movements we minimize this effect. Animals without negative test results, are not allowed to go to summer pasture. In addition, in the initial phase, all herds are blocked from the beginning of sample-taking until all results are negative and the PI-animals are slaughtered respectively. Moreover, movements are not allowed from a not-tested herd to a tested one. In herds with PI-animals, all pregnant animals are blocked until the calf born is tested negative.

Considering logistical problems occurring around the sampling process and results of analysis combined with the sensitivity of the tests and the detection of acutely infected animals, the confirmation rate of PI animals is still 88%. This is indicating a high specificity of the tests. The 12% false positives caused the slaughter of about 400 animals although they were negative. However, animals slaughtered after the first test had often some clinical signs, were weak or had not a high value for the farmer. Therefore, the number of misclassified animals is probably reduced. The level of false negatives cannot be assessed, because only a few cases based on clinical signs or other suspicions (negative offspring of a PI-cow) were retested.

The database provides a better coordination, overview, control and automation at all levels. Veterinarians for instance can control whether all animals on a farm are sampled

or not. The laboratories transmit the test-results to the central laboratory database and thus avoid sending papers with test-results to farmers and veterinarians. Herds and individual animals have automatically movement restrictions based on the test results. The automatic availability of the BVD-status of all farms and cattle on the animal movement database supports the farmers to make correct decisions, which is a central point in biosecurity (Lindberg et al., 2006).

## Conclusion

The BVD-eradication program was initiated by the farmers' associations. These stakeholders were also involved in the development of the eradication-program. Before and during the program a lot of emphasis was put on the information and education of farmers by sending leaflets, videos, creating a website ([www.stopbvd.ch](http://www.stopbvd.ch)) and presentations for farmers. Although time consuming and cost-intensive, the awareness of the farmers is one of the key factors for the success of this program.

The results and observations of the pre-pasture phase have shown that sampling and testing a high number of animals in a short time is challenging but feasible. The next phase will deal with the double amount of tests in a similar time frame. In that context, the collaboration of farmers is very important, not only for ensuring the success of the program but also for avoiding costs increase. Another crucial point is the blocking of farms and animals, which will reduce the risk of BVD-free herds from being reinfected. Currently it is planned to begin in 2011 with antibody screening in milk of first calving cattle. Alternatives in consideration are: 1) to conduct antigen screening in blood of calves over 6 months old, 2) to combine the two surveillance approaches, 3) to define risk population on which to target the sampling. An epidemiological model will help to assess the best surveillance strategy to be undertaken at the end of the eradication programme.

The Swiss BVD-eradication program will cost approximately 40 millions €; a third is paid by the farmers. Although the costs are initially high, with the short and intensive approach economically drastic re-infections can be probably reduced, having for the next years still a cattle population with a high sero-prevalence. Therefore, we assume that the long term costs will not differ substantially from other BVD-eradication programs. The costs will be quantified in the years following the active eradication.

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#### Conflict of Interest

None

Table 1 Overview of the BVD eradication program as conducted in Switzerland. The different phases as well as their key points are summarized.

Phase	Animals sampled	Samples/test	Comments
<b>Before pasture</b> (January – June 2008)	At least all young cows that go to summer pasture.	Ear-sample antigen test. Blood sample for confirmation if positive.	No movement restriction. Positive animals are culled.
<b>Initial phase</b> (October - December 2008)	Every not tested animals. Exception for fattening farms.	Ear-sample antigen test. Blood sample for confirmation if positive.	Movement restriction while testing. When PI's => movement restriction for pregnant cows.
<b>Calve phase</b> (from October 2008 after farms have completed initial phase)	Calves within 5 days after birth.	Ear-sample antigen test. Blood sample for confirmation if positive.	When PI's => movement restriction for pregnant cows.
<b>Monitoring phase</b> (October 2009)	Approach analogous to the calve phase during 2 years, then the status might be monitored via antibody detection in milk from first lactating cows (from 2011). Different strategies are to be tested through modeling.		

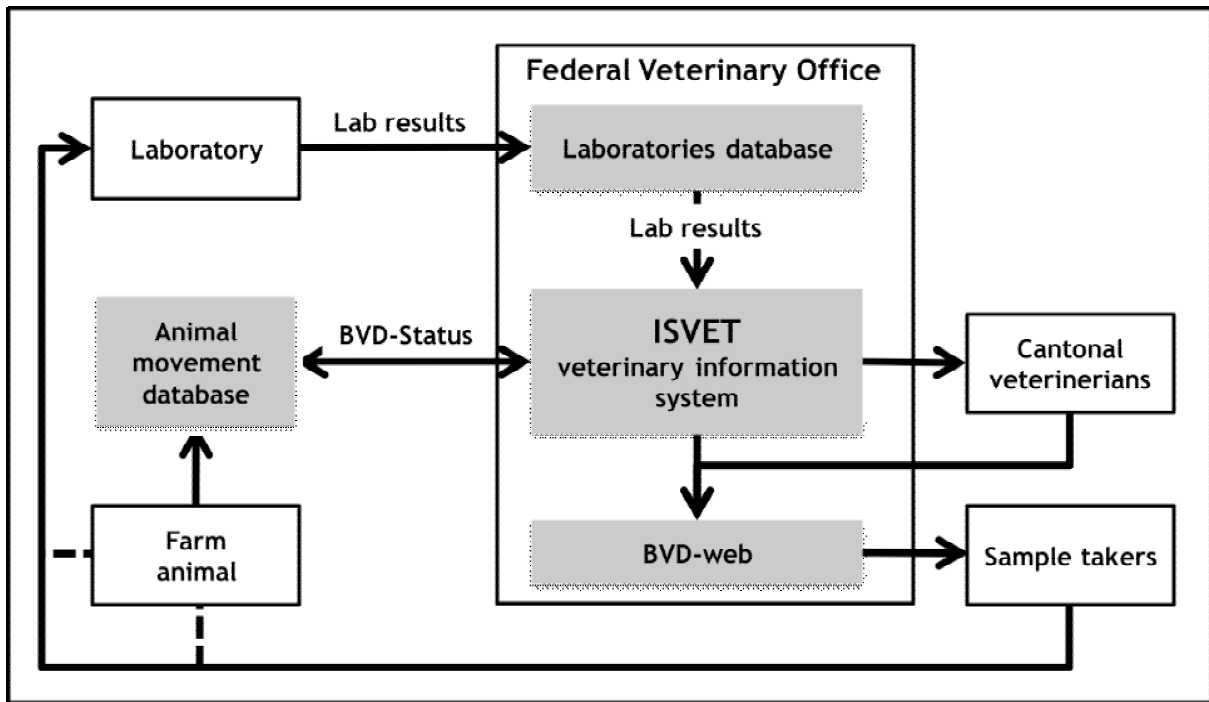


Figure 1 Structure of the data flow in the frame of the BVD-eradication program.

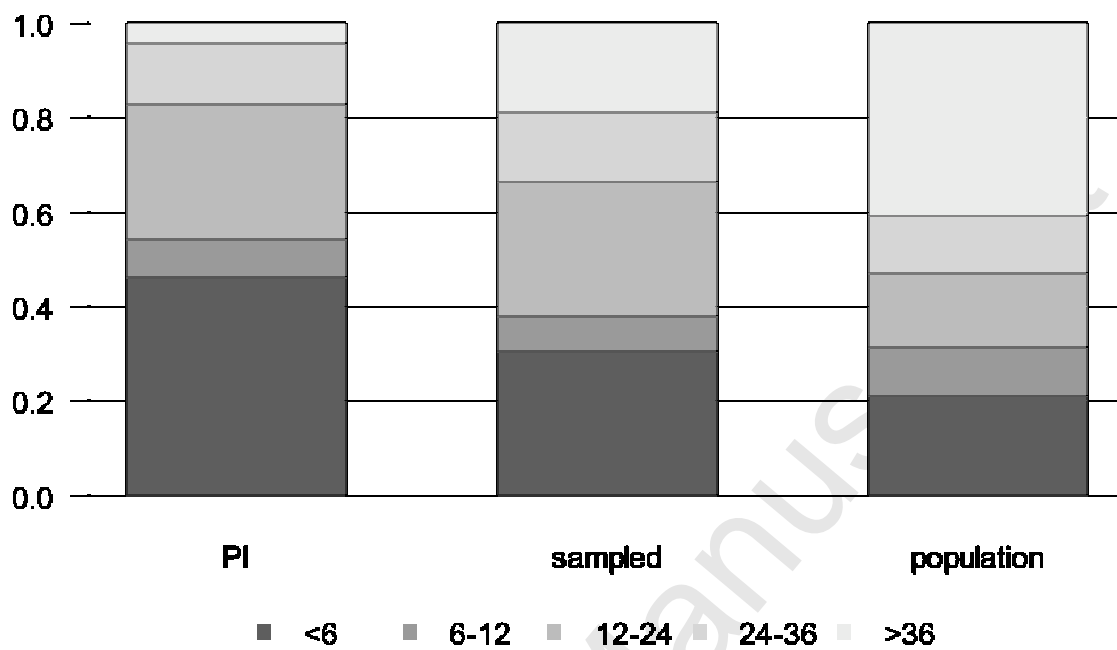


Figure 2 Relative distribution in percentage [0;1] of PI animals, sampled animals and the whole livestock population in the different age categories expressed in months.

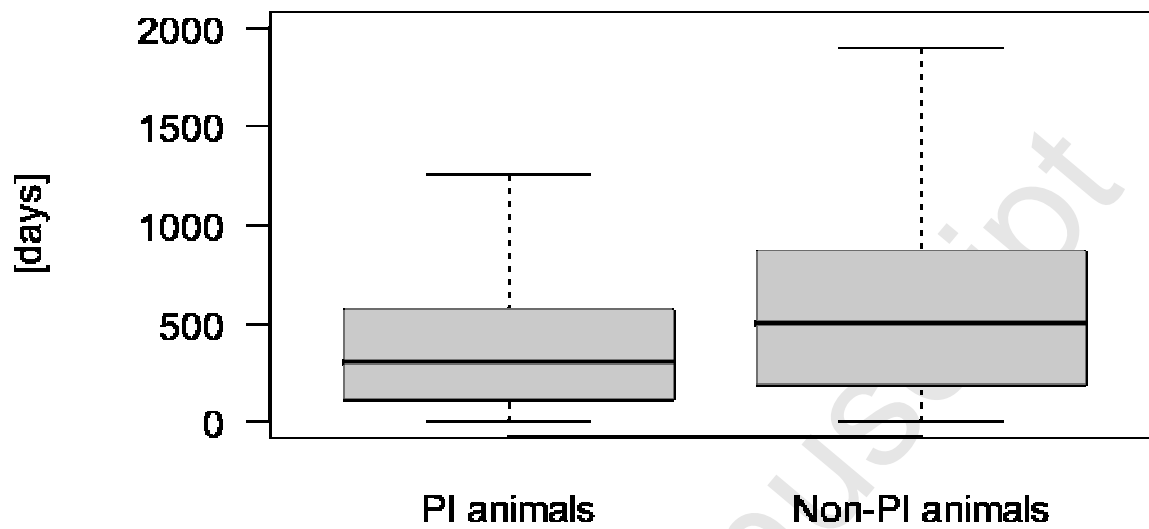
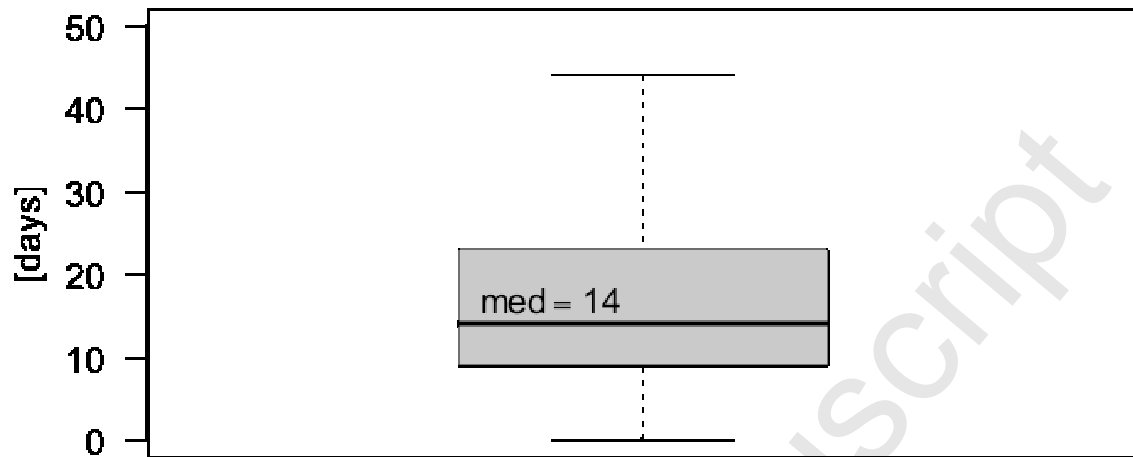


Figure 3  
animals.

Comparison of age distribution in days between infected and non-infected



#### PI animals slaughtered

Figure 4 Time elapsed between last result and slaughter of PI animals.