

**Epidemiological analysis of the 2006 bluetongue virus serotype 8 epidemic
in north-western Europe**

Nature and severity of disease in sheep and cattle

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Introduction and Objectives

The performance of the clinical diagnostic procedure to detect BTV-8 infected livestock herds is crucial for early detection. The diagnosis of BTV includes early recognition of a suspect clinical situation by the farmer and the veterinary practitioner, clinical inspection by veterinary specialists and laboratory tests on blood to detect the virus or specific antibodies against it. Clinical signs associated with BTV can vary considerably between animal species and are mostly non-specific. Furthermore, farmers and veterinary practitioners in Northern Europe are unfamiliar with the disease. Nevertheless, it is beyond any doubt that an accurate interpretation of clinical signs by the livestock owner or the veterinary practitioner, and subsequent notification to the veterinary authorities of a clinically suspect situation are crucial elements in an early detection system (EDS) because they are at the frontline of the diagnostic process. The quality of this clinical diagnosis, therefore, determines whether an infection with BTV will be recognized shortly after infection of the flock.

There have been earlier reports on BTV-8 outbreaks in India (Prasad et al. 1992), Africa (Gerdes 2004), and the Dominican Republic in the Caribbean (Mo et al. 1994), but there have not been detailed accounts on the nature and severity of disease associated with BTV-8.

The objective of this study was to describe the nature and severity of clinical disease in BT-infected cattle and sheep herds during the BTV-8 epidemic. This will help farmers and veterinary practitioners within Northern Europe and other countries to be better prepared for clinical recognition of the disease, and have better insight into the disease impact in terms of morbidity and mortality.

Materials and Methods

Clinical signs

Data on herd type (sheep or cattle) and clinical signs observed in the affected animals by the farmer and during the veterinary inspection were collected. Data were included from herds and flocks where BTV in one or more animals had been laboratory confirmed by 31 December 2006. Herds and flocks without clinical signs were excluded from the analysis. The following countries submitted data:

Belgium:	77 Sheep flocks	72 Cattle herds
France :		2 Cattle herds
The Netherlands:	266 Sheep flocks	156 Cattle herds

Morbidity, Mortality and Case Fatality

Data on herd type (sheep or cattle), herd- or flocksize, number of BT-associated sick animals at the time of clinical investigation and number of dead animals (BT-associated) were collected. Data were included from outbreaks where BTV had been laboratory confirmed by 31 December 2006. The following countries submitted data:

Belgium:	353 Sheep flocks	285 Cattle herds
France :		6 Cattle herds
Germany:	310 Sheep flocks	563 Cattle herds
The Netherlands:	270 Sheep flocks	185 Cattle herds

It should be noted that no follow-up investigations were performed after the first clinical investigation to confirm infection. It is therefore possible that the true number of sick and dead animals associated with BTV is higher than reported here.

Morbidity at the herd level was expressed as the number of clinically (BT associated) affected animals in a herd at the time of clinical investigation in relation to the number of animals in the herd at risk of becoming BT-affected at the time of clinical investigation.

Mortality at the herd level was expressed as the number of BT-associated dead animals at the time of clinical investigation in relation to the number of animals in the herd at risk of dying at the time of clinical investigation.

Case fatality at the herd level was expressed as the proportion of diseased animals that had died at the time of clinical investigation.

Results

Clinical detection

Since BT virus was previously absent in this part of Europe, farmers' and veterinarians' awareness of the clinical symptoms was likely to be low in the initial stage of the epidemic. Investigations in Belgium suggest that the first clinical signs of BT appeared mid July in a cattle herd (Czaplicki, 2006). In the first five BT outbreaks in the Netherlands (all in sheep), the owners indicated that the first clinical signs started 13 – 15 days before a suspicion was finally reported to the veterinary authorities via a veterinary practitioner (VWA, 2006). After a veterinary practitioner was called to the sheep flocks because of the problems - and with the help of veterinary specialists of the Animal Health Service in Deventer - BT was suggested as a possible cause of the clinical problems and reported promptly to the veterinary authorities in the Netherlands (Van Wuijckhuise et al. 2006). Subsequently, BT was confirmed within a day by the National Reference Laboratory CIDC-Lelystad. Once a BT suspicion was raised, a quick diagnosis was made, but there was a relatively long period between observation of the first clinical signs by the farmer and official notification. One reason for this was a lack of familiarity with BT in farmers and veterinary practitioners in this part of Europe during the early phase of the epidemic. In addition, there is often a reluctance to report suspect clinical situations by farmers and veterinary practitioners to the veterinary authorities due to fear of anticipated social and economic consequences.

Clinical signs

The most prominent clinical signs in affected sheep from BTV-8 infected sheep flocks were (**Table 1**) fever, salivation, erosions of the oral cavity, facial oedema, dysphagia, apathy and tiredness, congestion, erythema, redness of oral mucous membrane, and lameness.

The most prominent clinical signs in affected cattle from BTV-8 infected cattle herds were (**Table 1**): crusts/lesions of nasal mucous membrane, salivation, fever, conjunctivitis, dysphagia, serous nasal discharge, apathy and/or tiredness, hyperaemic/purple coloration, lesions of teats, lameness and coronitis.

Morbidity, Mortality and Case Fatality

Sheep

Morbidity: Flock size in the 933 BTV-8 outbreaks analysed ranged between 1 and 1248. The majority of the sheep flocks had a fairly small number of animals: almost 50% of the flocks had a flock size between 1 and 10 animals (**Figure 1**). In greater than 90% of the sheep flocks one or two sick sheep were observed at the time of clinical investigation (**Figure 2**). Seven percent of the sheep flocks did not have clinically sick sheep within the flock at the time of clinical inspection. Morbidity ranged from 0-100%. In 80% of the sheep flocks morbidity was 25% or less. Mean morbidity in affected sheep flocks was 20%.

Mortality: In 66% of the sheep flocks there were no dead animals reported. Approximately 30% of the sheep flocks had one or two dead sheep at the time of clinical investigation (**Figure 5**). Mortality ranged from 0 to 100%. In 93% of the sheep flocks mortality was 20% or less. Mean mortality in sheep was 5%.

Case Fatality: Case fatality ranged between 0 and 100% in sheep flocks; 23% of the sheep flocks showed case fatality of 50% (**Figure 7**).

Cattle

Morbidity: Herd size in the 1039 BTV-8 outbreaks analysed ranged between 1 and 675. Sixty-six percent of the cattle herds had a herd size of 100 heads of cattle or less (**Figure 3**). In ninety percent of the cattle herds one or two sick cattle were observed at the time of clinical investigation (**Figure 4**). About 10% of the cattle herds did not have clinically sick cattle at the time of clinical investigation. Morbidity ranged from 0-100%. In 87% of the cattle herds morbidity was 10% or less. Mean morbidity in cattle herds was 6.8%.

Mortality: In 91 % of the cattle herds there were no dead animals reported, where death had been reported for a herd it was predominantly only one animal (**Figure 6**). Mortality ranged from 0-30%. In 99% of the cattle herds mortality was 5% or less. Mean mortality in cattle was 0.3%.

Case Fatality: Case fatality ranged between 0 and 100% in cattle herds; 6% of the cattle herds showed a case fatality of 50% (**Figure 8**).

Goats

No BT-associated clinical signs were reported from goat herds, and no BT-associated clinical signs were reported in goats located in mixed herds in which BT was reported in cattle or sheep.

Discussion

A long time period between occurrence of clinical signs and reporting of a suspicion can in the case of infectious diseases like Classical Swine Fever (**CSF**), Foot and Mouth Disease (**FMD**) and Avian Influenza lead to a dramatic spread of the disease before control measures can be implemented (Elbers et al. 1999; 2004). In the case of clinical expression of bluetongue, FMD is a possible differential diagnosis. Again, experience with late reporting of an animal disease indicates the need to facilitate the process of excluding the possibility of a notifiable disease as a cause of clinical problems (Elbers et al. 2006). Diagnosis of notifiable animal diseases based solely on clinical signs is often difficult, because:

- they are exotic diseases, unfamiliar both to farmers and most veterinarians
- clinical signs may vary considerably, depending on the age and/or breed of the affected animals and pathogenicity of the disease agent.

Therefore, laboratory confirmation is necessary. Laboratory confirmation however is only initiated after notification of the competent authorities, which also leads to provisional control measures on the farm at the time of notification. Therefore, farmers and veterinarians may often be reluctant to report early clinical signs of notifiable diseases. As a consequence, the time required for a new infection to be detected is likely to give the disease agent significant opportunity for further spread. For instance, many case reports indicated CSF was suspected only after prolonged medication had failed to produce desired results (Young 1970; Elbers et al. 1999).

A key element for solving this dilemma would be to create the possibility for the veterinary practitioner to submit samples to a reference laboratory, without involvement of the Competent Authority in the submission of these samples. In the case of a positive test result, the Competent Authorities would be notified directly. For optimal performance of such a programme, it would be beneficial if it were to include the following elements:

- be free of charge to the individual farmer from whose farm the samples originate;
- provide the veterinary practitioner with clinical decision support systems (**CDSS**). These systems still need to be developed;
- make use of quick, sensitive, and specific diagnostic tests such as the PCR.

If there are disease-specific clinical signs or other not-to-miss signs like significant mortality, immediate notification of the veterinary authorities is indicated. However, in practice these black-and-white situations where there is or there is not a clinical indication for a suspicion of a notifiable animal disease, do not often occur. In-between the black-and-white possibilities there is a large grey area where a farmer and veterinary practitioner can not totally rule out a notifiable disease solely on the basis of a clinical inspection. This situation is likely to arise at the beginning of the disease outbreak, when non-specific signs will gradually emerge in a few animals. The ability to rule out a possible notifiable animal disease through laboratory diagnosis in this time period will considerably shorten the High Risk Period (**HRP**), in which the disease agent can circulate freely between herds. The alternative is that farmers wait several days before taking any action, then use medication for a period of days to attempt to solve the problem. This process can continue until the farmers realize that they have been affected by a problem that has run 'out of control' and the disease may well have spread to a number of other herds.

Although BTV may infect many different species of ruminants, clinical disease signs are generally associated with sheep and consequently most descriptions of the disease apply to sheep (Erasmus 1990). BTV affected sheep may develop a variety of clinical signs, including: fever; depression; nasal discharge which may be serous, mucopurulent or bloody; drooling of saliva; facial oedema; hyperaemia of the oral mucosa which is sometimes accompanied by erosion and ulceration; hyperaemia of the coronary bands; muscle weakness (Erasmus 1975; Hardy and Price 1952). The clinical signs observed in sheep during the BTV-8 epidemic in Northern Europe in 2006 confirm those reported in literature.

While clinical cases in cattle have been observed in major outbreaks outside Africa, the occurrence and severity of the clinical disease has always been much lower in cattle than in sheep (Lopez and Botija 1958). Although experienced farmers in BTV endemic areas of South Africa believed that from time to time they had observed clinical BT in their cattle, researchers believed that BT did not produce more than transient and mild, if any, clinical signs in cattle (Hourrigan and Klingsporn 1975). With respect to the level of occurrence of clinical disease, our observations of clinical disease in cattle during the BTV-8 epidemic in Northern Europe confirm the reports in literature. However, unlike the historical belief that

BTV produces either transient mild clinical signs or no signs in cattle, our BTV-8 study indicate that a few cattle within a herd can show distinct clinical signs.

Bluetongue in sheep has its most significant economic impact in temperate areas of the world. While infection of animals in the tropics and sub-tropics is common, clinical disease in indigenous species is unusual. The presence of endemic BTV activity is usually noticeable in the tropics and sub-tropics only when susceptible sheep are imported from temperate countries into the area (Gibbs and Greiner 1994). One of the first reported incursions of BTV in Europe, between 1956 and 1960 in Portugal and Spain, killed a large number of sheep (Manso-Ribeiro et al. 1957). During the first BTV-2 epidemic in Italy in 2000-2001 (Calistri et al. 2004), approximately 263000 diseased sheep and goats were reported (18% Morbidity) and 48000 sheep and goats died (3% Mortality). During their second epidemic in 2001-2002, approximately 251000 diseased sheep and goats were reported (18% Morbidity) and 73000 sheep and goats died (5% Mortality).

In sheep, this study found a mean morbidity of 20% and a mean mortality of 5% during the 2006 epidemic in Northern Europe. This is comparable with those reported from Italy in 2002-2002. However the values should be viewed with caution as the level of morbidity and mortality reported here could be artificially elevated due to the large number of sheep flocks with very low flock sizes.

Although BTV infection of cattle is generally subclinical, sporadic cases of disease in cattle do occur (Barrat-Boyes and MacLachlan 1995). A mean morbidity in cattle of 7% and a mean mortality of 3% during the 2006 epidemic in Northern Europe might fit into this pattern of occurrence for BTV in cattle.

Conclusion

In contrast to previous reports that BTV produced either transient mild clinical signs or no signs in cattle, this BTV-8 study indicates that a small number of cattle within a herd can show distinct clinical signs.

BTV-8 associated clinical signs were much more prominent in sheep than in cattle.

The most prominent BTV-8 associated clinical signs in cattle were: Crusts/lesions of nasal mucous membrane, salivation, fever, conjunctivitis, dysphagia, serous nasal discharge, apathy and/or tiredness, hyperaemic/purple coloration, lesions of teats, lameness and coronitis.

The most prominent BTV-8 associated clinical signs in sheep were: fever, salivation, erosions of the oral cavity, facial oedema, dysphagia, apathy and tiredness, Congestion, erythema, redness of oral mucous membrane, and lameness.

In the 2006 epidemic in Northern Europe there was a long interval between first clinical signs observed by the animal owners and reporting of a clinically suspect situation to the competent authorities (≥ 2 weeks). This is partly due to a lack of familiarity with BT in farmers and veterinary practitioners in this part of Europe during the early phase of the epidemic.

Approximately 10% of the BTV-8 infected cattle herds did not show any clinical signs at clinical inspection.

Approximately 7% of the BTV-8 infected sheep flocks did not show any clinical signs at clinical inspection.

Predominantly only one or two animals with clinical signs within a cattle herd or sheep flock were observed at clinical inspection.

In 66% of the sheep flocks and 91% of the cattle herds no BTV-associated mortality was observed.

At present there have been no follow-up investigations for the herds in this study. It is very well possible that after the clinical inspection there were additional animal deaths and a further development of clinical signs. Consequently the data presented here may underestimate the true extent of the 2006 epidemic in Northern Europe. The final morbidity and mortality may be higher than reported in this study.

Morbidity, Mortality and Case Fatality were much higher in sheep flocks compared to cattle herds.

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– common symptoms just a little bit different and in too many herds. Tijdschr. Diergeneeskd. 131: 649-654.

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Table 1. Distribution of clinical signs in BTV-8 affected sheep flocks and cattle herds in Belgium, France and The Netherlands.

Clinical signs in one or more animals within BTV-8 affected cattle herds and sheep flocks	% cattle herds in Belgium, France and Netherlands (N=230)	% sheep flocks in Belgium and the Netherlands (N=343)
Crusts/lesions of nasal mucous membrane	49.6	17.6
Salivation	37.8	43.4
Fever	31.0	50.6
Conjunctivitis	31.0	4.2
Dysphagia	25.2	37.0
Serous nasal discharge	25.0	17.0
Apathy, tiredness	24.2	37.6
Coronitis	22.2	17.7
Hyperaemic/purple coloration, lesions of teats	21.4	1.2
Lameness	21.4	30.3
Muscle necrosis, stiffness in limbs	20.9	14.0
Purulent nasal discharge	18.0	14.7
Ulcerations of oral mucous membrane	13.9	11.7
Facial oedema	13.5	41.7
Congestion, erythema, redness of oral mucous membrane	13.3	29.7
Weakness, paresis	12.6	23.1
No clinical signs at all at clinical inspection	11.7	0.6
Loathing or refusal to move, prostration	10.1	12.8
Erythema, inflammations, redness, hypersensitivity of skin	10.0	1.2
Anorexia, emaciation, weight loss	9.6	11.1
Dyspnea	6.1	15.5
Hyperaemic/purple coloration of tongue – tongue protrusion	5.7	19.5
Diarrhoea	5.7	5.2
Regurgitation, vomiting	2.6	1.5
Abortion	1.9	0
Torticollis	1.3	0.9
Born dead	1.3	0
Erosions/ulceration of tongue mucous membrane	0.6	12.0
Oedema of ears	0.4	6.1
Alopecia/broken wool	-	0

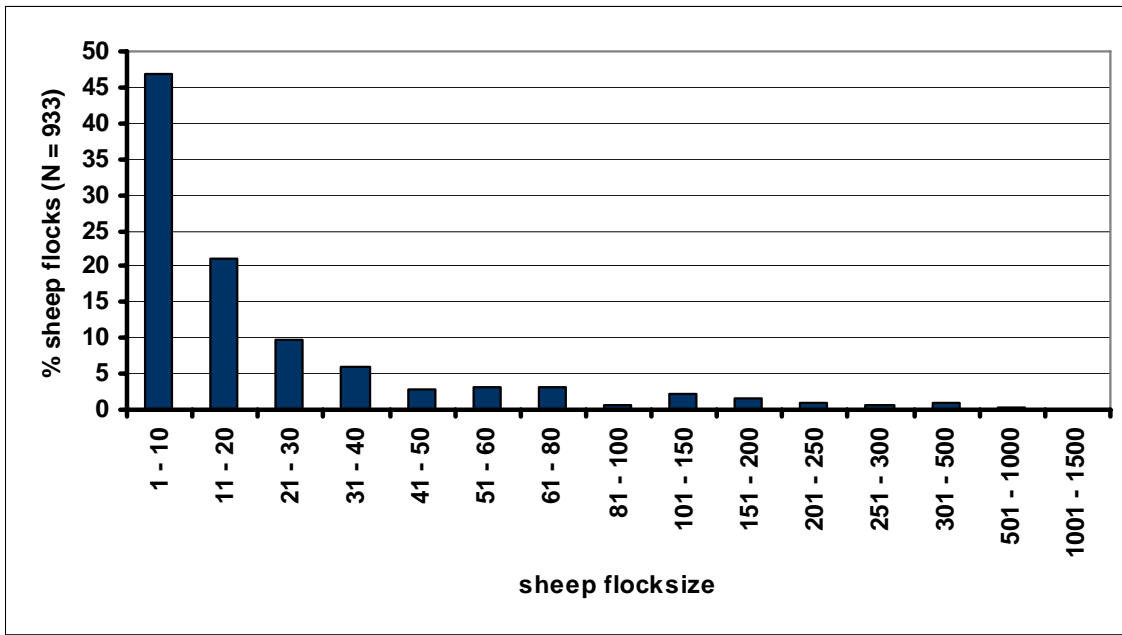


Figure 1 Distribution of sheep flock size of BTV-8 infected sheep flocks from Belgium, Germany, and The Netherlands.

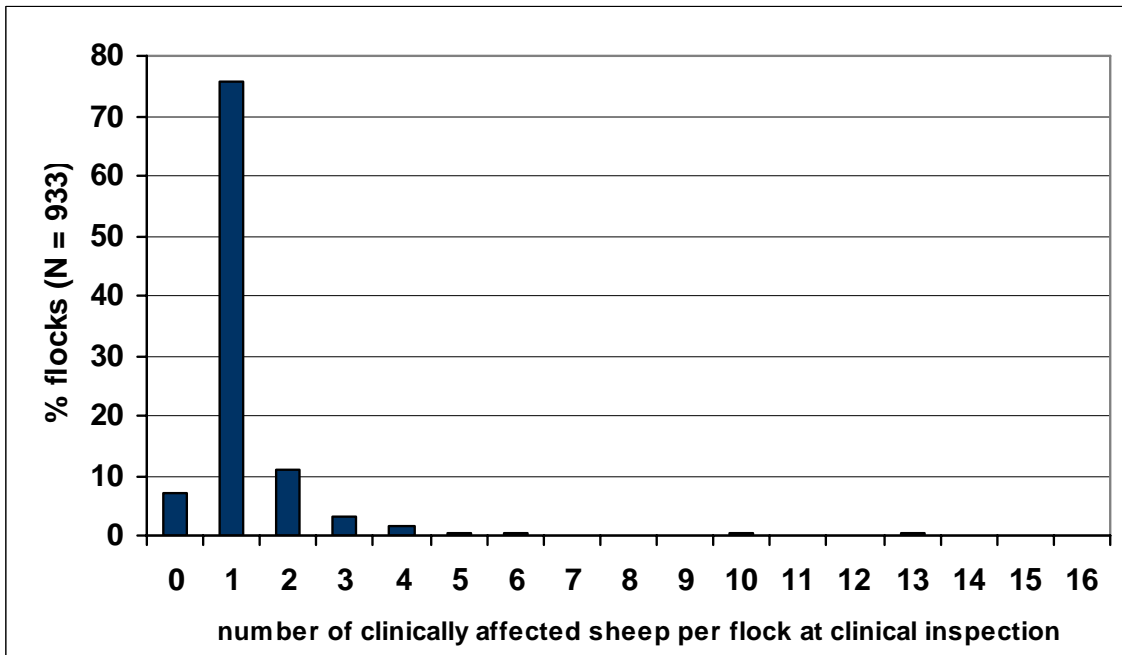


Figure 2 Distribution of number of clinically affected sheep per flock in BTV-8 infected sheep flocks from Belgium, Germany, and The Netherlands.

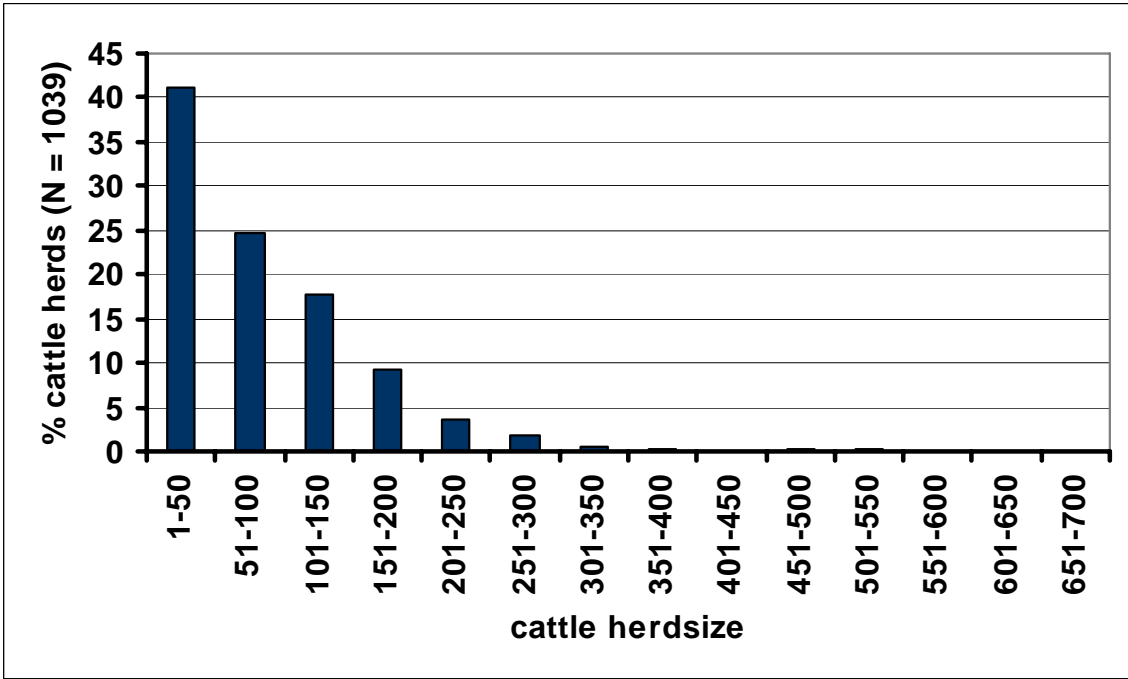


Figure 3. Distribution of herd size of BTV-8 infected cattle herds from Belgium, Germany, France and The Netherlands.

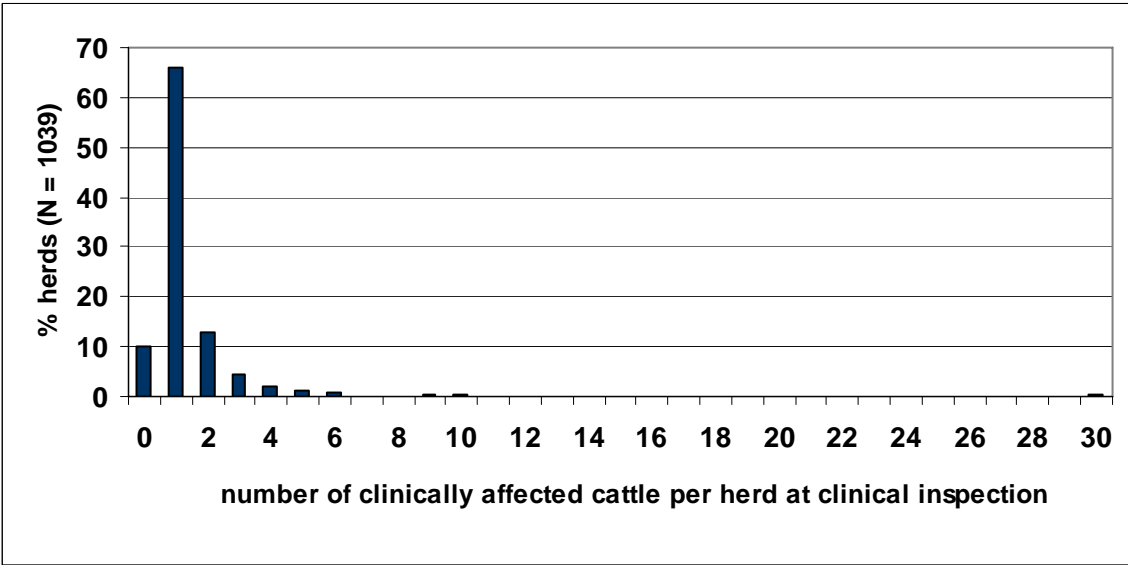


Figure 4 Distribution of number of clinically affected cattle per herd in BTV-8 infected cattle herds from Belgium, Germany, France and The Netherlands.

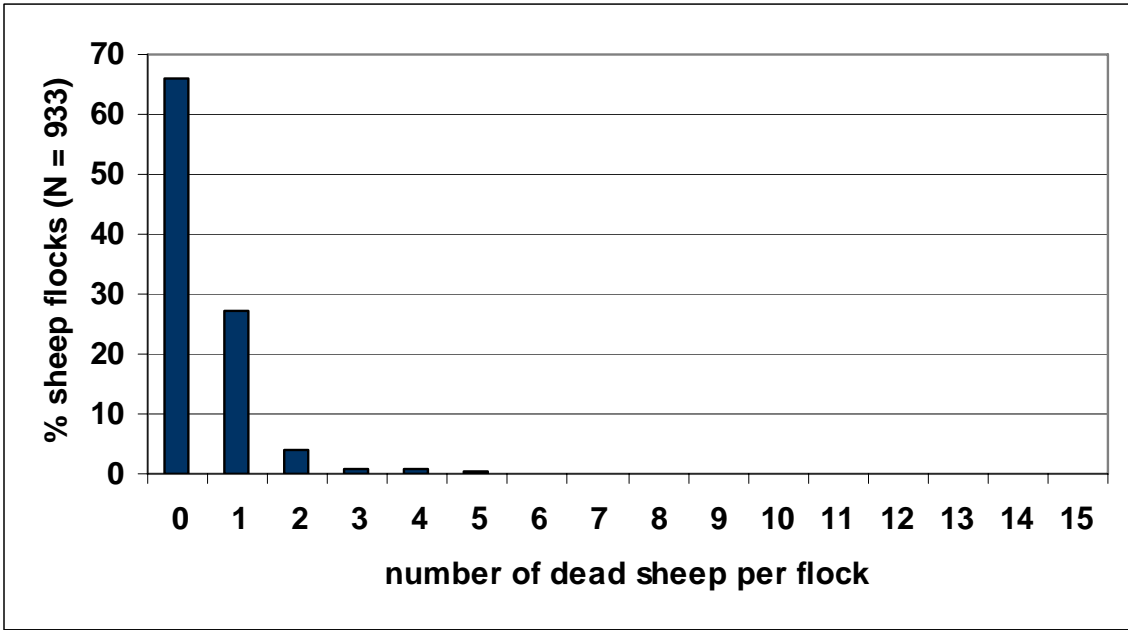


Figure 5 Distribution of number of dead sheep per flock in BTV-8 infected sheep flocks from Belgium, Germany, and The Netherlands.

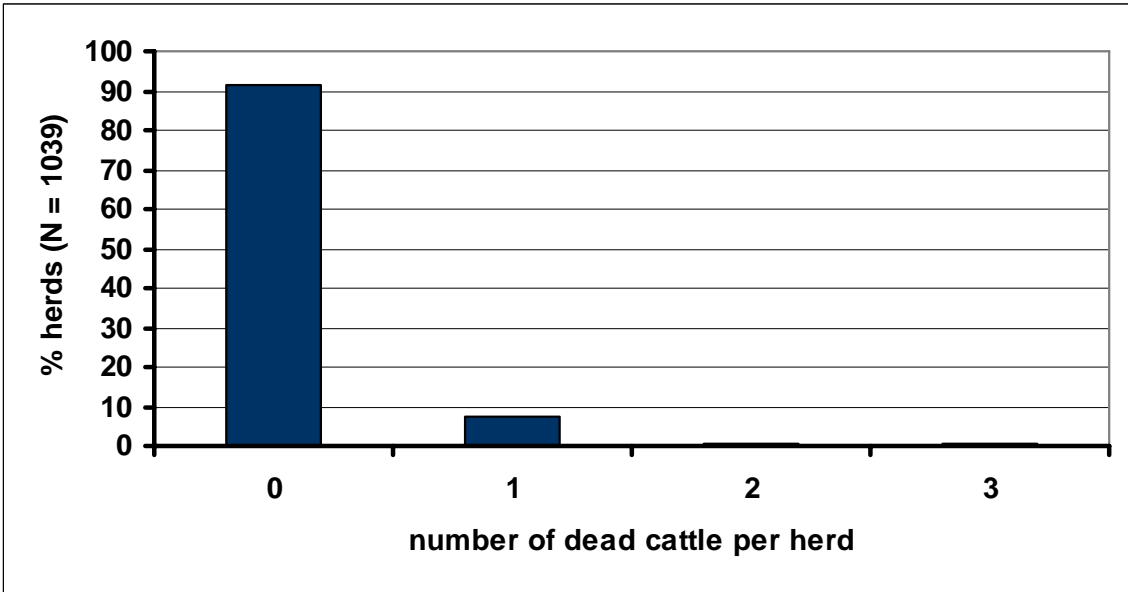


Figure 6 Distribution of number of dead cattle per herd in BTV-8 infected cattle herds from Belgium, Germany, France and The Netherlands.

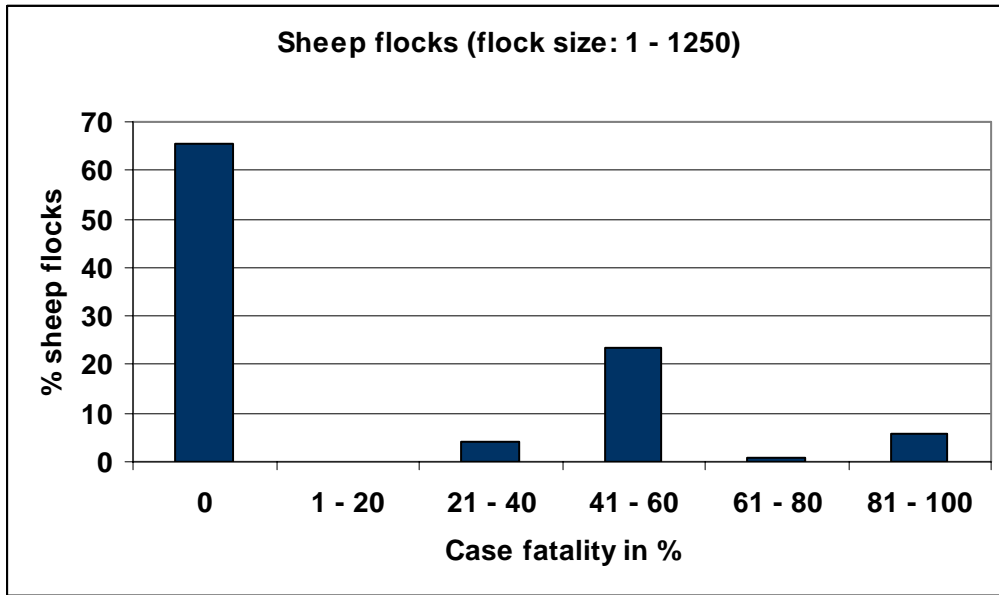


Figure 7 Distribution of case fatality % in BTV-8 infected sheep flocks from Belgium, Germany, and The Netherlands.

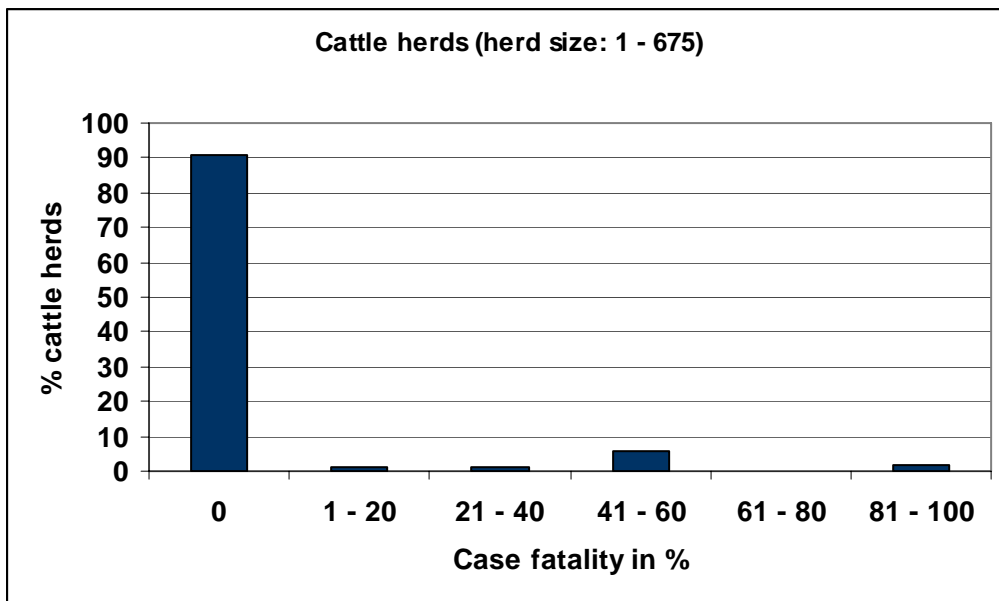


Figure 8 Distribution of case fatality % in BTV-8 infected cattle herds from Belgium, Germany, France and The Netherlands –