Bluetongue control strategy, including recourse to vaccine: a critical review

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Summary
The bluetongue (BT) epidemic that has prevailed in Europe since 2000 is the first example of continental spread of the BT virus (BTV) in large naive populations of susceptible animals. Based on the results of intensive surveillance and research in countries of the southern Mediterranean that were affected by the infection early on in the epidemic, a new strategy for prevention and control of the disease was developed to limit direct losses and to reduce the consequences due to movement restrictions. The basic innovations that were introduced were the use of mass vaccination of all domestic ruminant species to limit the spread of BTV and the use of intensive active surveillance to limit, as far as possible, the zone where movement restrictions must be applied. The novel strategy that was adopted dramatically reduced the number of clinical outbreaks in southern Europe and the Mediterranean Basin and ensured safer animal trade. In 2006, the first BTV-8 epidemic occurred, this time in north-western Europe. During this epidemic, affected countries adopted a ‘wait and see’ approach. No vaccination was implemented until 2008 and, in many instances, the movement of animals was authorised within restricted areas, thereby facilitating the spread of infection. The delay in administering vaccination was due to the decision to avoid the use of modified live virus vaccines, although this type of vaccine performed satisfactorily in the previous BT epidemics in southern Europe. Bluetongue has demonstrated that the infectious agents present in southern Africa can easily spread to the Mediterranean Basin, which should be considered a single entity as far as the epidemiology of animal diseases is concerned. Therefore, any effective strategy for the prevention and control of animal disease in Europe must take into account this reality and recognise the need for regional surveillance networks that include all the countries that border the Mediterranean.

Keywords

Introduction
Bluetongue (BT) was first reported over 125 years ago with the introduction of Merino sheep to southern Africa. Since then, BT virus (BTV) strains have been identified in many tropical and temperate areas of the world, but the disease is restricted to ruminants in the temperate zones. Little, if any, clinical disease is observed in the tropical and subtropical areas of the world, except when non-native ruminants are introduced into a virus-endemic area (70).

Several different episystems have been recognised around the globe, each consisting of relatively stable relationships between several distinct strains of BTV (virus topotypes), different species of Culicoides and susceptible vertebrate species, despite extensive and ongoing trade and movement of ruminants between individual episystems (10).
In the countries historically affected by BT, the control strategy was based on the vaccination of exposed sheep and on clinical and serological surveillance. All international movements of animals of susceptible species and their potentially infectious products from infected countries and zones were strictly forbidden unless they were demonstrated to be non-infected after a specified period of protection from vector attacks in an insect-proof environment, as required by the standards of the World Organisation for Animal Health (OIE), which included bluetongue among former List A diseases. Animal movements from infected countries or zones were possible, however, towards countries/zones where the absence of Culicoides spp. likely to be competent BTV vectors was proven (72).

The international situation changed as of 1998 when the Mediterranean epistem changed dramatically, leading to the largest BT epidemic ever recorded. This epidemic brought about a significant change of attitude towards BT in several countries and approaches to BT control have changed worldwide accordingly. The OIE standards on BT contained in the Terrestrial Animal Health Code (the Terrestrial Code) also underwent considerable changes and a new chapter on BT surveillance was introduced (75).

The aim of this paper is to describe the history of BT in Europe and to examine how control strategies adopted since the beginning of 2000 until now have been modified in parallel with the evolution of knowledge on vectors and virus distribution, as well as in connection with the implementation of vaccination. Changes made to the OIE standards and to European Union (EU) legislation are also briefly described.

The strategy of bluetongue control in Europe

The evolution of bluetongue epidemiology in the Mediterranean

In the eastern Mediterranean, a BT epistem has been recognised since the first half of the 20th Century. The disease became endemic in the eastern Mediterranean Basin (69), with sporadic spillovers into Cyprus, Greece, Spain and Portugal (41, 46, 56).

Between the autumn of 1998 and winter of 2002, successive waves of BT epidemics due to BTV-9 and BTV-4 were recorded in the Balkans, giving rise to a number of clinical outbreaks that caused severe direct losses in several countries, namely: Albania, Bosnia-Herzegovina, Bulgaria, Croatia, Greece, Kosovo, the Former Yugoslav Republic of Macedonia, Turkey and the Federal Republic of Yugoslavia (54). These epidemics could be considered to be part of the evolution of the historic Middle East epistem. The spread of the virus has been linked partly to animal movements and partly to the spread of vectors (7, 54).

In December 1999, a completely new epistem developed in the Mediterranean Basin. In the central and western Mediterranean Basin BTV-2 was recorded in the north and east of Tunisia, from where it spread to Algeria during the summer of 2000 (40). At the same time, BTV-2 appeared for the first time in Italy (Sardinia) (7) and France (Corsica) (73). Spain was also affected (Balearic Islands) (39). In November 2000, BTV-9 was isolated in the region of Calabria in Italy (7). The infection of these Mediterranean countries rapidly became the largest BT epidemic ever recorded both in Europe and North Africa (7).

The introduction of BT to Sardinia and the Balearic Islands from the movement of animals or animal products (semen, embryos) has never been proved and appears unlikely. Introduction of BT from one area into another by inanimate means (aeroplanes, ships) also appears unlikely considering the pathogenesis of BT infection and the nature of the vector. Therefore, it has been hypothesised that BTV-2 most probably entered Sardinia and the Balearic Islands through passive windborne transport of infected vectors from BTV-2-infected regions of North Africa. Several dust storms from North Africa reached southern Italy and the Italian islands between June and July 2000; one of these reached Sardinia 25 days before the first reported case of BT (7).

Subsequent waves of different BTV types (BTV-1 and BTV-4) occurred in southern Europe and spread on fairly regular and similar pathways. As an example, the spread of BTV-4 in an unvaccinated ruminant population in 2003 in Sardinia closely resembled the pattern and rapidity of spread of BTV-2 in the same population in 2000 (33). The sole exception was BTV-16, the spread of which changed after entering Italy after the use of a modified live virus (MLV) vaccine that was eventually demonstrated to be inadequately attenuated.

At the end of 2006, a totally new Mediterranean epistem was created, in which the western epistem of African origin and the eastern epistem of Asian origin had merged into one. In 2007, BTV-8 eventually entered this epistem to form what might now be defined as the ‘Euromediterranean BT epistem’.

Bluetongue control strategy in Europe in 2000

Europe was not fully prepared to face a vector-borne epidemic of the magnitude of the BT epidemic that started in 1998 in the Balkans and in the central and western Mediterranean (33). The disease arrived in Lesbos in
1998 with BTV-9, but Greece refused to vaccinate with live attenuated virus vaccines. The disease disappeared within four to five years, but not before starting an epidemic that involved most of the Balkan region, in a forerunner of the BTV-8 epidemic.

In 2000, in the EU, the strategy of BT control was still essentially based on stamping-out (as had been the case for most other OIE List A diseases, such as rinderpest and lumpy skin disease). Vaccination was considered a complementary measure to stamping-out, to control direct losses and to limit the spread of infection. Veterinary legislation at the time reflected this strategy and Directive 92/119/EEC (23) only prescribed direct control measures, which included the demarcation of a 3-km radius protection zone and a 10-km radius surveillance zone around each infected farm and the slaughter of all susceptible animals on the farm and possibly on neighbouring farms.

The situation was modified rapidly in the autumn of 2000 with Directive 2000/75/EC, as it became obvious that stamping-out was absolutely inadequate to deal with a vector-borne disease such as BT, and the slaughter of all susceptible animals in the entire infected and at-risk areas was not considered an alternative. The new control strategy was based on strict movement controls of the susceptible animals from zones considered infected and vaccination of exposed sheep in the protection zones. Vaccination was not considered either for susceptible ruminant species other than sheep or as a preventive measure outside the protection zone. Intensive clinical, serological and entomological surveillance was used to define the areas that were subject to movement restrictions (34). This strategy and legislation were both coherent with the OIE standards applicable at the time (72).

**Restriction zones**

European Union Council Directive 2000/75/EC (24) considered three levels of zones in which movement restrictions should be applied, namely:

- a 20-km radius zone
- a protection zone that included the infected zone, with a radius of at least 100-km around the infected holding, in accordance with the OIE Terrestrial Code standard
- a surveillance zone with a radius of at least 50-km that extended beyond the limits of the protection zone.

In the 20-km radius zone, all holdings had to be subjected to regular visits and, on each occasion, animals had to be examined clinically and pathology and laboratory tests were conducted to confirm the disease. A complete standstill of susceptible animals was to be applied, with no animal entering or leaving the holdings.

In the protection zone, an epidemiological surveillance programme had to be implemented, based on the serological and entomological monitoring of sentinel ruminants and vector populations, respectively. Animals in the protection zone were banned from leaving the zone unless it could be proved that the virus was circulating. Vaccination could be applied depending on different scientifically justifiable strategies.

In the surveillance zone, measures similar to those in the protection zone had to be implemented, with the exception of the administration of vaccines, which was prohibited.

The limitation of the movements of susceptible animal populations over a long period of time is very hard to impose. Stakeholders and local veterinary services had great difficulty in understanding why individual animals whose infection-free status had been confirmed by the most sophisticated laboratory testing could not be moved freely to and from restricted areas.

In some cases (for instance, in the south of Italy), livestock production was severely affected by these movement restrictions, which affected centuries-old customs such as the seasonal grazing patterns. The measures were imposed to protect susceptible ruminant populations in free areas of the north of Italy and the rest of Europe.

Farmers were further frustrated because nobody was able to tell them when the situation might change and they had no possibility of doing anything to solve the problem. The situation soon became unsustainable from the economic, social and political points of view.

**Development of a new strategy**

**The quest for new tools**

New tools had to be found to implement a strategy that would limit both direct losses and indirect losses due to movement restrictions. International standards had to be taken into account, as did the need to protect susceptible animal populations in the free zones. It was also necessary to produce sufficient scientific data to justify the choices made.

An intensive surveillance and research effort had been launched in 2000 in the individual affected EU member states to identify vector presence, abundance and dynamics as well as to establish BTV epidemiology in the European context (3, 29, 33, 38, 54, 60). While these studies were able to describe the epidemiological evolution of BT in Europe, they also demonstrated the existence of other competent Culicoides spp. vectors besides C. imicola. In particular, the Obsoletus Complex (62, 68) was shown to
play a significant role in BTV transmission in some areas. At the time, the northerly distribution limit, as indicated in the OIE standard, was 40° N, but the discovery of other competent vectors provided a clear warning of the possibility of the further expansion of BT well above this, into northern Europe, which did indeed happen later. Surveillance and research also demonstrated that BT could readily infect new areas through the movement of animals from infected zones when inappropriate risk-mitigating measures were applied (34). This might seem to contradict reports by some authors (43, 71), but the difference is likely to be due to the fact that, while the latter reported on rather stable episystems, a new and dynamic system was developing in Europe.

In addition, further studies were conducted on how effectively different chemical compounds could protect livestock from Culicoides attacks (7, 12) or reduce vector populations, by treating larval breeding sites and adult resting areas (61). Although a certain level of efficacy was recorded experimentally after the application of some pyrethroid-based products, they were not effective enough to consider basing any control strategy on direct control measures against Culicoides (5). The use of these compounds, therefore, was restricted to animal transportation, as an ancillary measure to reduce the probability of infection. The same results have recently been confirmed in a comprehensive review (27).

In 2000, only MLV vaccines were available. The efficacy of these vaccines in protecting sheep from the disease had been proved extensively on other continents, although reservations existed about their safety (71). Bluetongue vaccines had never been used in cattle and data on their efficacy in blocking viraemia in sheep were scarce. Several studies on vaccination were performed to assess the level of protection against disease and infection in susceptible species. Both controlled and field studies on vaccination, particularly of cattle, were conducted to assess whether vaccination would block viraemia and whether MLV vaccines affected either reproduction or milk production or had any adverse effects on the foetus (36, 42, 50, 51, 52, 62, 63, 64, 67). Several studies were also performed to assess the effect of MLV vaccine on milk production in sheep during lactation as well as other possible adverse effects (8).

The results of these studies encouraged the development of a new BT control strategy.

The effort of the researchers in performing these studies should be highlighted. Much time was devoted to this work, which was significantly constrained by meagre financial resources; apart from a few enlightened government agencies, traditional research bodies, including the EU, did not consider BT to be a research priority at that time.

The new strategy design

A new strategy had to fulfil two mandatory objectives, as follows:

- limit virus circulation in the environment to reduce the extent of the protection and surveillance zones and thus facilitate the movement of animals
- immunise animals to ensure that they were resistant to wild virus infection and did not contract disease or introduce infection to susceptible free populations.

The strategy did not consider the possibility of eradicating BT, although the results of mass vaccination, when correctly applied, demonstrated the disappearance of circulating BT, as was the case in the Balearic Islands, which were declared free from BTV-2 and BTV-4 in 2006 (21), or in Tuscany, where Massa Carrara, Pisa, Livorno and Grosseto Provinces were declared free from BTV-2 infection in 2005 (Massa Carrara [18]), 2006 (Pisa and Livorno [20]), and 2008 (Grosseto).

While a strategy that was solely based on direct control measures (movement restrictions) did not appear capable of limiting the spread of infection effectively when ruminant and midge population densities and dynamics were able to sustain BTV circulation, a control policy based solely on vaccination of sheep did not seem appropriate to meet the objectives of the new strategy either.

Voluntary vaccination of sheep only, as practised in most areas of the world, including Australia, South Africa and the United States, reduces losses incurred from disease and, in cases of low densities of other susceptible species, might also lead to a marked reduction in virus circulation. When a large bovine population exists, however, a cycle between cattle and vectors develops, irrespective of whether sheep and goats are present, and BT may establish itself in the area. Therefore, neither a strategy based on direct control measures alone, nor a strategy based solely on the vaccination of sheep and goats, appeared effective enough to reduce virus circulation and, consequently, to enable movement restrictions to be lifted while ensuring the safe trade of susceptible animals (9). Only a control strategy based on the vaccination of the entire susceptible domestic ruminant population could have induced sufficient population immunity levels to meet the objectives considered above (9).

Webster et al. (71) described the range of potential vaccination strategies for BT control, as follows:

- vaccination of cattle only
- vaccination of both sheep and cattle
- vaccination of sheep only
- no vaccination.
In Europe the strategies adopted until 2003 were as follows:

- direct control measures (movement restrictions) without vaccination, such as those adopted in Greece
- vaccination of sheep only, adopted in the Balearic Islands and in Corsica (55), together with movement restrictions outside the affected area.

Italy proposed an innovative strategy to the EU based on the analysis of both data generated by controlled experiments and factual field data collected by intensive serological and entomological surveillance. The choice of the new strategy was made after assessing (in the spring of 2001) the range and magnitude of consequences of three different strategies: not vaccinating, vaccinating all susceptible domestic livestock (cattle, sheep and goats), or just vaccinating sheep and goats in affected areas (34).

In the absence of a vaccination strategy, a quantitative assessment estimated that the infection would spread to the free regions of Italy within four to six months of the beginning of the new epidemic season. Vaccination, on the other hand, could reduce both direct economic losses and virus circulation significantly. To achieve a significant reduction in virus circulation, however, at least 80% of the BTV-susceptible populations had to be immunised to reach the goal of reducing the number of secondary cases to less than 1% of those expected to occur in the absence of vaccination (34).

Directive 2000/75/EC only considers the possibility of vaccination in the protection zone and does not provide specific criteria on the design of vaccination campaigns. Therefore, each EU member state had to decide whether to vaccinate or not and to design and implement its own vaccination strategy. The Veterinary Services of Italy decided to mass vaccinate all domestic BTV-susceptible species (sheep, goats and cattle) with the MLV vaccine types against the wild BTV strains circulating in the various zones of the country, as revealed by the intensive surveillance programme that was launched in 2000.

The strategy proposed by Italy, and finally approved by the EU, was to associate vaccination, considered insufficient per se to ensure effective control of BTV, with intensive surveillance. This surveillance must include serology, virology and entomology capable of recognising the presence and type of circulating viruses as well as the vector species. This enables the spread of virus circulation to be determined with the highest possible level of precision (9).

Strict movement controls of susceptible animals were maintained, but one of the consequences of the combination of mass vaccination and intensive surveillance was the reduction of the number of restriction zones from three to one. Systematic intensive clinical and serological surveys of all susceptible animals, first in a 20-km radius and then in a 4-km radius around any observed cases that revealed positive serology, were performed in 2002 and 2003. These surveys demonstrated that, in vaccinated populations, the circulation of BTV could only be very limited within the infected herd. As a consequence, when clinical and serological monitoring of all susceptible ruminants in an area of 4 km around the first evidence of virus presence gave negative results, the infected zone of 20 km was maintained as the sole area of restriction for 60 days.

Results of the new strategy

Reduction of bluetongue virus circulation

The validity of the model proposed by risk analysts can be easily inferred by observing the data of vaccination relative to Italy, Corsica and Spain, as well as the development of BTV spread in some European countries and regions.

The structure of the ruminant populations and certain local situations in Italy made it very difficult to reach the target of 80% population coverage unless cattle were also vaccinated. Therefore, Italian legislation required the vaccination of all domestic ruminants (cattle, sheep and goats). Only two regions of Italy met the objective of vaccinating at least 80% of their populations against BTV-2 (namely Sardinia and Tuscany). In these two regions, very low levels of BT infection were recorded in 2002 compared to 2001 (Table I). A total of 24 cases were reported in Sardinia and no cases in Tuscany. Clinical surveillance data were confirmed by serology on sentinel animals, as follows: in Sardinia 25 out of 4,393 sentinel animals revealed positive serological reactions in 2002, and in Tuscany 5 out of 691 animals had positive reactions (34). Conversely, BTV spread widely in the southern regions that did not even get close to the established target of vaccinated population.

In the Balearic Islands, two of the four islands, Majorca and Minorca, were affected in the epidemic that occurred in the summer of 2000. Sheep and goats represented 88% of the BTV-susceptible population of the islands. Mass vaccination of sheep and goats was performed; 78.3% of the total susceptible animal population were vaccinated. In 2001, no case of bluetongue was reported (Table I). In 2003, a new incursion of BT due to BTV-4 affected the islands and a further vaccination campaign of all sheep with MLV vaccine was implemented.

Mainland Spain and Portugal were affected by an epidemic of BTV-4 in 2004. The vaccination of all sheep and cattle that had to be moved was performed with MLV during the
first year and with inactivated vaccines thereafter. Levels of BTV-4 virus circulation were very low in 2006 and by 2007 there was none.

In 2000, BTV was reported for the first time in Corsica and vaccination was performed, but covering only 65.1% of the total sheep and goat populations (Rencontre des services vétérinaires bilatérale France-Italie, Ajaccio, 25 September 2001; unpublished report). As expected, the spread of infection was uninterrupted and, in 2001, 13,141 new cases were reported in sheep (Table I).

Restoration of animal trade

The novel strategy adopted in the Mediterranean EU member states led to both a dramatic decrease in the number of clinical outbreaks and to a significant reduction in BTV circulation. Therefore, it has led to safer animal trade, as shown by the data on animal trade in Sardinia. Before the epidemic of BT, Sardinia was involved in intensive cattle trade to continental Italy, particularly to the northern regions. Due to the BT epidemic and the enforcement of the legislation that had been in place since August 2000, trade came to a complete standstill. Trade was resumed in 2002 after mass vaccination and a total of 1,019 animals were shipped to continental Italy. 92% of them were during the last two months of the year. During the first six months of 2003, a total of 3,097 animals were sent from Sardinia to continental Italy, compared to a total of eight animals in the same period of 2002 (9). No BTV-2 has ever been recorded in the regions from where most of the Sardinian cattle were shipped. Subsequently, all exports were again interrupted due to the presence of BTV-4.

As soon as the surveillance data collected after the mass vaccination became available, a new risk assessment was conducted, taking into account these new results (35). The analysis led the European Commission to:

- authorise domestic movements of vaccinated animals directly for slaughter when at least 80% of the susceptible populations had been vaccinated in the area of origin (13)
- develop a new approach to the definition of areas subjected to movement restrictions, with a significant reduction in the restricted areas when at least 80% of the susceptible population had been vaccinated
- allow countries to despatch vaccinated slaughter animals from ‘lower risk areas’, even with active infection, and from ‘higher risk areas’ where viral circulation had not been detected, to free areas within their national territory (14)
- modify the demarcation of the 20-km protection and surveillance zones by merging these into a single restricted zone (15, 17).

All of this legislation was based on scientifically documented information that had been examined by the EU Standing Committee on the Food Chain and Animal Health, in accordance with the specific procedures stipulated in Directive 2000/75/EC. In all of these amendments, any derogation from the Directive’s provisions banning movement from restricted zones was subject to specific conditions, namely: the animals to be moved and their population of origin had to be vaccinated and a risk assessment had to be carried out.
Adverse events observed in the use of live attenuated virus vaccines

A possible drawback of the use of MLV vaccines for the control of BT is the possibility that the vaccine virus could cross the placental barrier causing infection of the foetus and consequent abortion, stillbirth or neonatal mortality (28).

To evaluate possible adverse effects of vaccination with MLV vaccines, a number of preliminary studies were conducted prior to and during the initial phases of the BT mass vaccination campaign. No adverse effects on reproduction (abortion or teratogenic defects) were observed in cattle immunised with the monovalent BTV-2 vaccine, or bivalent BTV-2 and BTV-9 vaccine, either in controlled or in field conditions (42, 50).

The only effect on milk production was a transient 30% decrease in production that lasted for about a week after vaccination with bivalent BTV-2 and BTV-9 vaccine in sheep (65, 66). In Sardinia, a study involving more than 18,000 dairy cows in 220 herds vaccinated with BTV-2 MLV did not demonstrate any negative effects either on the quality or quantity of milk produced (36).

Adverse vaccination effects (deaths, abortions, stillbirths) were monitored in the field by observing the type of damage incurred and the dates of vaccination and collecting samples from the animals to detect and identify both vaccine and field strains of BT. During the first vaccination campaign in Italy, 312 of 87,245 holdings on which vaccination was performed notified adverse effects (0.16% of vaccinated cattle herds and 0.50% of vaccinated small ruminant flocks). In 47 of these holdings (0.01% of vaccinated cattle herds and 0.09% of vaccinated sheep and goat flocks), the presence of vaccine virus was confirmed by the laboratory. As an indicator of how rarely BT vaccination caused negative effects, one can compare data on BT to those collected between 1991 and 2001 in the United States by the Vaccine Adverse Event Reporting System. During the study, 1.9 billion doses of 27 different types of human vaccine were administered and the prevalence of adverse events was 11.4 per 100,000 (equivalent to 0.01%) (76), which is a figure very similar to the 0.01% of vaccinated cattle herds and 0.09% of vaccinated sheep and goat flocks which experienced adverse effects.

A possible further drawback of the use of MLV vaccine is the possibility of reversion to virulence of the vaccine viruses and reassortment between vaccine and field strains of the virus (26).

The spread of BTV-16 in Italy has been used as an example of reversion to virulence of an MLV vaccine (4, 59); however, while it is true that the BTV-16 strain used in the vaccine and the virus isolated in the field appear to be the same virus (4, 57), the phenomenon does not appear to be due to reversion to virulence of the vaccine strain, but rather to an insufficient attenuation process of the virus used in manufacturing the vaccine (1, 26).

The reassortment of BTV strains has been monitored constantly in Italy over the last eight years. No reassortment between vaccine and field strains has been observed, although it has been witnessed between vaccine virus strains present in the same vaccine (53). In addition, the reassortment suggested in a BTV-16 strain isolated in Italy has been attributed by the authors to the reassortment of two vaccine strains that occurred in Israel (4). This latter evidence is in contrast to the Italian experience, where several million doses of polyvalent attenuated vaccines were used and no reassorted circulating strains were observed. It also appears odd that reassortment did not give rise to a constantly changing pattern of the pathogenicity of virus strains. The segments of the genome that code for the virus structures determining its antigenic and pathogenic characteristic might be influenced by reassortment on very rare occasions, if at all.

Claims of the dangers of the use of MLV vaccine against BT due to either reversion to virulence of the vaccine viruses or reassortment between vaccine and field strains of the virus (58) remain hypothetical for the time being and are not supported by factual scientific data.

Effects of the 1999 to 2002 epidemic on international bluetongue standards

The evolution of BT in the Mediterranean had a considerable effect on the international BT control policy. The epidemiology of BT worldwide had been considered fairly stable and, apart from extending the infective period, the international OIE standards had remained almost unchanged since the previous modification in 1993, following the second International Symposium on Bluetongue organised in Paris by the OIE in 1992 (74).

The changes in the BT situation in the Mediterranean prompted the OIE to organise the third International Symposium on Bluetongue in 2003 (44, 45). The recommendations of the symposium led to significant changes in OIE standards. In addition to recognising that the northern limit of the disease had extended to 50° N, the possibility of freely moving seropositive and vaccinated animals was also envisaged. The infective period was reduced and standards for BT surveillance were introduced, together with a case definition of BT.

These standards remain unchanged, despite the thorough review of the situation at a special meeting of the OIE Ad hoc Group on Bluetongue held in Paris in October
In 2006, after the BTV-8 incursion. No significant amendment to the BT chapter of the Terrestrial Code has been proposed recently.

**Incursion of bluetongue virus serotype 8 into northern Europe**

In August 2006, a new BTV serotype (BTV-8) was detected in the Netherlands. The infected area was close to the borders with France, Belgium and Germany, where cattle population densities are between two to five times the EU average (2) (Table II).

<table>
<thead>
<tr>
<th>Countries first affected in 2006</th>
<th>Cattle population (head)</th>
<th>Surface area (km²)</th>
<th>Cattle density (animals/km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>2,573,400</td>
<td>30,300</td>
<td>84.9</td>
</tr>
<tr>
<td>Netherlands</td>
<td>3,820,000</td>
<td>33,800</td>
<td>113.0</td>
</tr>
<tr>
<td>Germany</td>
<td>12,608,500</td>
<td>357,000</td>
<td>35.3</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>193,100</td>
<td>2,600</td>
<td>74.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Countries first affected in 2007</th>
<th>Cattle population (head)</th>
<th>Surface area (km²)</th>
<th>Cattle density (animals/km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>19,123,800</td>
<td>544,000</td>
<td>35.2</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>10,078,000</td>
<td>243,800</td>
<td>41.3</td>
</tr>
<tr>
<td>European Union</td>
<td>88,750,800</td>
<td>4,215,100</td>
<td>21.1</td>
</tr>
</tbody>
</table>

It is uncertain how BTV-8 reached north-western Europe, but the absence of BTV-8 circulation in the Mediterranean Basin suggests that it was not a simple linear extension of earlier outbreaks but was probably introduced by a distinct route and mechanism (25). Sequence analyses of Seg-2 from the Dutch isolate demonstrated that the virus originated in a western lineage from sub-Saharan Africa but was distinct from the BTV-8 vaccine strain (47, 48).

In 2006, the disease was observed in Belgium, Germany, Luxembourg, the Netherlands and France and a total of 2,047 outbreaks (clinical outbreaks) were reported. In 2007, the infection spread rapidly and extensively across France (15,379 outbreaks) and Germany (11,485 outbreaks) and reached Denmark, the Czech Republic, Switzerland and the United Kingdom (UK). A total of 40,919 clinical outbreaks due to BTV-8 were notified in the affected countries. In the first six months of 2008, a total of 6,082 BTV-8 outbreaks were reported: 5,995 in France, 68 in the UK, 11 in Spain, 5 in Italy, 2 in Switzerland and 1 in the Czech Republic.

The cessation of BTV circulation in some areas and the high number of outbreaks in others (i.e. France) during the winter of 2007/2008 may be linked to the different interpretations by EU member states of the definition of ‘BT outbreak’ in EU legislation. Until October 2007, EU provisions had not taken into account the case definition of the OIE Terrestrial Code and notification was consequently focused on clinical evidence. Although EU Regulation 1266/2007/EC (22) has a definition of ‘outbreak’ that differs slightly from the OIE standard, it has adopted the OIE standard definition of a ‘case’ of BT. Some difficulties, however, in the notification of cases still exist because some member states notify cases only if virus circulation is considered active either upon clinical observation or laboratory testing, whereas others notify cases on the basis of positive serology without any further consideration of virus circulation.

**Bluetongue control strategy in northern Europe**

In 2006 a ‘wait and see’ approach (71) was adopted during the first BTV-8 epidemic by the countries affected, apart from France, which imposed movement restrictions. It is possible that some northern European experts who lacked recent practical experience with BT were not convinced at the end of 2006 of the possible re-emergence of BTV-8 after the 2007 winter season, despite the experience of southern Europe.

When the second BTV-8 epidemic commenced in 2007, no effective structured surveillance network was in place in northern Europe to detect BTV infection. The restricted zones (protection and surveillance zones), therefore, were demarcated following the notification of clinical cases and this made the preparation of an up-to-date picture of the spread of BTV very difficult.

No vaccination was implemented and, in certain instances, the movement of animals at risk was permitted within the restricted areas, thus facilitating the spread of infection (49). Derogations from Directive 2000/75/EC, similar to those allowed in southern Europe, were applied in northern Europe, but the conditions that made such derogations applicable in the Mediterranean (the existence of mass vaccination programmes and the establishment of a widespread serological and entomological surveillance network) were not always present. These animal movements and the absence of vaccination might well explain the rapidity and the extent of BTV-8 spread, which resembled what happened in Sardinia in the absence of vaccination in the first four weeks of the 2000 epidemic. Furthermore, it must be noted that in northern Europe the spread in one year affected a geographic area that was larger than that affected over eight years in the Mediterranean, where vaccination, surveillance and animal movement controls had been applied (30).
Restricted zones

At the beginning of the BTV-8 epidemic (when disease was detected), a single restricted zone was created in most affected member states; others maintained the three areas (20-km, protection and surveillance zones) during the first epidemic ‘wave’, thereafter moving to the approach of the ‘single restricted zone’. This complied with the provisions of Decisions 2003/828/EC and 2005/393/EC that had authorised such an approach in the countries of southern Europe.

The adoption of single restriction zones in many member states in northern Europe affected by BTV-8 was automatic; whereas in southern Europe the 20-km, protection and surveillance zones were merged and standstill measures limited only after the implementation of surveillance systems and the mass vaccination of susceptible species. Changes to the restriction levels between territories in southern Europe were based on a risk analysis that evaluated the effects of vaccination (37), sensitivity of sentinel systems (6) and probability of BTV spread by animal movements (35).

The adoption of a single restriction zone within which animals could move freely in the absence of effective risk-mitigating measures, in some cases meant that potentially viraemic animals moved to the borders of the restricted zone and could have considerably altered the effectiveness of the preventive value of the restrictions applied.

In October 2007, the approval of Commission Regulation 1266/2007/EC (22) introduced important criteria to harmonise surveillance and reporting of BTV. The Regulation also introduced two important changes to the animal movement restrictions that had previously been stipulated in Decision 2005/393/EC, namely:

– removing the requirement for member states to give their approval before animals are moved into their territory from the restricted zones of other member states
– eliminating the standstill order on the movement of animals within restricted zones, except for animals with clinical signs of BT.

In addition, in compliance with the OIE standard, Regulation 1266/2007/EC introduced the possibility of moving animals from restricted zones after keeping them, for a given period, protected from attacks by Culicoides likely to be competent BTV vectors. This further increased the risk of BTV spread by animal movements because some countries affected by BTV-8 mistakenly considered the use of insecticides/repellents to be an effective stand-alone method for long-term protection of animals against Culicoides attacks. The option of moving animals after a period of protection had existed since 2001, but ‘protection’ had previously been interpreted as keeping the animals in insect-proof premises, such as quarantine stations. Insecticides/repellents were used only to protect the animals for short periods of time during transport.

Furthermore, the idea that simply the use of insecticides/repellents associated with individual animal testing for virus could be sufficient to certify animals from restricted areas as safe for trade, complicated matters further. The lack of effectiveness of these measures (already anticipated by a number of experts [5]) was demonstrated by the events that occurred in Italy from August 2007 to February 2008. During this period, 624,741 cattle were introduced into Italy from the infected countries. They were introduced in accordance with the provisions of Regulation 1266/2007/EC and included animals that gave negative results to the polymerase chain reaction (PCR) and that were protected from Culicoides attack by the use of insecticides for 60 days prior to the date of shipment. The Italian Veterinary Services traced and tested 64,295 of these animals and 280 of them, located on 86 farms, were found to be positive by the PCR test. BTV-8 was isolated in 32 animals on 20 farms located in four regions of Italy (32). At the end of March 2008, the first outbreak of BTV-8 was detected in northern Italy (Verona Province), providing a further field demonstration of the risk posed by unsafe animal movements.

According to the OIE standards for BT, animals from infected zones can be traded freely in the so-called ‘seasonally free’ periods of the year in which ‘surveillance demonstrates no evidence either of BTV transmission or of adult Culicoides likely to be competent BTV vectors’ either in the country of origin or in the country of destination or in both. In southern Europe, this had been used extensively with considerable success since 2001. It was applied as part of the strategy of BT management and control, following intensive investigations on potential BT vectors, areas of distribution and seasonal population dynamics. In northern Europe, the same strategy was applied without a full understanding of Culicoides population dynamics, although it was demonstrated that some of the Culicoides species involved in BTV transmission were different from those recorded in southern Europe and might, therefore, have different seasonal patterns (1, 19). Therefore, common sense, expertise and experience were required to successfully implement the solid principles underlying EU legislation and OIE standards.

Vaccination policy

Another important difference between the BTV management strategies of southern and northern Europe has been the timing of vaccination of susceptible populations. The BTV-8 epidemic commenced in 2006 and no vaccination was performed during the first two
epidemics up until the end of 2007, despite the availability of an MLV vaccine against BTV-8.

In January 2008, the EU organised a conference on BT vaccination strategies in Brussels and the very valuable expertise acquired by the southern member states affected by BT, especially in regard to the successful use of vaccination using both MLV and inactivated vaccines, was acknowledged. It also recognised that the use of any vaccine, of either type, was better than experiencing the disease and it would be hard to justify adopting the 2007 approach when controlling the disease in 2008, given the availability of vaccines.

While the local epidemiological situation largely influences the choice of the most adequate type of vaccine and vaccination strategy, it is clear that there is no scientific, economic or management justification to exclude the use of any of the existing vaccines for the emergency vaccination that should be performed within the existing EU legal framework for BT control and eradication, as is the case for any other former OIE List A diseases.

In conclusion, given the current EU situation, emergency mass vaccination has been recognised as the most efficient strategy and the European Commission has clearly stated that its strategy with regard to BT is mass vaccination with any available vaccine. The EU Commission has also made available substantial funding for vaccination campaigns in member states.

At present, all EU member states infected by BTV use vaccination as a tool to control the disease. In most countries only inactivated vaccines are used, but Italy also uses MLV vaccine against BTV-1 in addition to inactivated vaccines against the other serotypes present. Several different vaccination schemes are implemented in the various member states. Voluntary vaccination of cattle and sheep is implemented in the UK and the Netherlands, while mandatory vaccination is performed in Belgium, Denmark, France, Germany, Italy, Luxembourg, Portugal and Spain. No country in Europe outside the EU is vaccinating against BT at present, except for Switzerland, where vaccination of cattle, sheep and goats against BTV-8 is compulsory.

The EU vaccination strategy, in line with the legislation in force, does not envisage the protection of zones free from the disease that are at particularly high risk of BT introduction. Vaccination can be implemented in restricted zones only. It would appear, therefore, that it is used more as a tool to reduce direct losses in the animal populations of infected zones and to facilitate trade of the animals in the same zones, than to limit the spread of infection to free susceptible animal populations in contiguous non-restricted zones.

Surveillance and the development of a bluetongue information system

When BT was limited to the Mediterranean countries of Europe, the origin of the incursions into EU member states was generally beyond the EU. The intra-European transboundary spread of BT, until 2006, had only been documented from Sardinia to Corsica (57) and suspected from Greece to Italy (33, 34), probably because the effort made by affected individual countries had limited the spread of infection within each country. Neither the EU nor its individual member states thought it necessary to harmonise national information systems to create an integrated BT information system until BTV-8 appeared in northern Europe. In 2007, the European Commission decided to establish a mandatory Web-based surveillance network to collect, store and analyse BT surveillance data (22). This network (BTNET: bluetongue network) is a geographic information system that is able to collect, store, and analyse BT surveillance data. It has been developed from a similar network that was coordinated by the OIE in several countries of the Balkans and consists of two components, namely: one supranational and one national that can be used as a stand-alone element or can be integrated.

The EU-BTNET offers a visualisation system for the retrieval of technical, scientific, legislative and epidemiological information on BT. Information is presented in map, tabular, graph and text formats.

Data from the official Animal Disease Notification System (ADNS) of the EU are used to illustrate BTV occurrence in EU member states. In addition, information collected from the OIE World Animal Health Information System (WAHIS) completes the picture for the rest of the European continent and Mediterranean Basin. The geographic distribution of BT infection is presented according to the localisation of outbreaks, when the information for each single outbreak and its geographic coordinates are available (i.e. for ADNS-derived data and WAHIS immediate notifications). Therefore, the outbreak database is structured to collect and store data from both ADNS and WAHIS.

Data on the serological and entomological surveillance as well as on vaccination in EU member states are entered by each competent authority of the member states.

Lessons learned

The following lessons can be learned from recent experiences.

a) The fact that the infection usually did not cause any symptoms in cattle and that some serotypes did not cause
severe disease in sheep complicated matters. Apart from in some zones where it caused significant disease in sheep, bluetongue eventually began to be seen as a ‘minor’ disease. Therefore, most animal owners and veterinarians had great difficulty in accepting the burden of the control strategy. They considered that it was unjustified because it imposed measures that were considered disproportionate to the relative gravity of the disease and they considered there was no reason to limit movements of animals that were healthy and uninfected, in a context in which animal movement was both essential for the livelihood of farmers and an historical animal husbandry practice.

Increasing numbers of animal owners and veterinarians convinced themselves that a ‘wait and see’ policy that allowed the spread of infection would be the strategy of choice. They reasoned that if infection became endemic, movement controls would have no value and free animal movements could be resumed. Therefore, they regarded the use of vaccines as an obstacle to the spread of infection and to what they perceived as the solution to their problem. Before vaccination could be demonstrated as being capable of preventing both the direct losses incurred by sheep farmers and the indirect losses incurred by both sheep and cattle owners due to movement prohibition, the attitude of avoiding vaccination prevailed in many areas. Vaccination was recognised as necessary only in the zones where BT had caused severe losses in sheep.

b) The difficulty of having good quality vaccines in the quantities required and in sufficient time to perform vaccination during the seasons in which wild virus did not circulate represented the most negative factor in a very difficult situation. Furthermore, farmers, who did not receive compensation for indirect losses incurred by movement restrictions, began to attribute all kinds of adverse effects to the vaccine that were largely exaggerated in relation to those that did actually occur. The fact that MLV vaccines were used and that this was the first time ever that cattle had been vaccinated against BT complicated matters further. Several experts opposed both the vaccination of cattle on the grounds of this being unheard of and the use of MLV vaccines on the grounds that these vaccines were dangerous.

c) The need for an effective communication campaign on the strategy chosen was underrated and no effort was made to activate coherent risk communication directly involving farmers, other stakeholders and politicians. Furthermore, there was not sufficient time to inform and train veterinarians adequately, in particular those working as official field veterinarians. They were the people who had the greatest difficulties as they had to implement measures that they did not fully understand. It was incredibly difficult to grasp the scientific reasoning behind the fact that BTV was an infection that affected ‘territories’ rather than individual animals or farms. Even today, after eight years, much difficulty still remains in some areas in understanding why official veterinary measures must be based on monitoring a territory rather than individual animals or on herd testing results.

d) The spread of BTV-8 in northern Europe indirectly confirms the validity of the strategy applied in southern Europe. After 15 months, the virus introduced in a yet unexplained manner has spread across 11 countries and over 750,000 km². It has infected an area larger than the sum of all the areas infected in eight years by all the other five BTV types affecting four countries of southern Europe.

e) The possibility of a new incursion of BTV from other epistems is an ever-present threat. The most likely introduction pathways would be the same as those taken by the viruses currently circulating, namely: the Middle East and North Africa, although other routes cannot be excluded, as demonstrated by the BTV-8 event. Preparedness for such a situation appears necessary both in terms of early warning and vaccine availability. A surveillance system involving all countries of the Mediterranean Basin and countries of Eastern Europe should be organised as soon as possible, coordinated by the OIE, and surveillance in northern Europe should also be maintained. In particular, susceptible population immunity levels relative to virus circulation should be monitored closely to avoid a more serious epidemic.

Differences in the control strategies of northern and southern Europe

It is clear, then, that there are fundamental differences in the control strategies applied for the BTV-8 epidemic in northern Europe and those applied for other BTV serotypes in southern Europe.

Demarcation of restricted zones

The first difference is that movement controls in northern Europe were less effective than in southern Europe due to a lack of experience and expertise. Indeed, the 20-km, protection and surveillance zones were combined without implementing the risk-mitigating measures (vaccination in primis) that had been applied in Italy, Spain and Portugal. How the merging of the three zones facilitates the spread of BTV can be demonstrated by observing the rapidity of BTV-4 spread in southern Spain from September to November 2004, when legislation did not authorise the merging of restricted areas, and the spread of BTV-1 in the same zone from August 2007 to October 2007, after the zones had been merged. The latter closely resembles the spread of BTV-8 in northern Europe in 2006.

Use of insecticides/repellents

The second difference is that in northern Europe it has been improperly assumed that the use of insecticides and repellents alone can be sufficient to confer protection
against a *Culicoides* attack and that, if it is associated with individual animal testing before movements, it could ensure the safety of the animals moving from infected to free zones.

**Vaccination strategy**

The third difference is that, in the case of the BTV-8 epidemic, no vaccination was applied during two entire epidemic seasons. The reasons for the delay in implementing vaccination are twofold. The first was that experts in northern Europe suggested that the 2006 epidemic would wane during the winter months of 2006 to 2007 and, therefore, no action should be taken as a new epidemic appeared unlikely. The second was the unjustified fear of MLV vaccines.

Scientific facts, as well as field data derived from the application of millions of vaccine doses in different animal species, have been considered less significant than inferences based on hypothetical events. It is interesting to consider that while vaccination of humans has been and is performed widely with MLV vaccines (such as those for polio, smallpox, measles and mumps) and vaccination with MLV vaccines against animal diseases such as rinderpest, swine fever, rabies, brucellosis, infectious bovine rhinotracheitis, to mention just a few, has led to eradication, in Europe MLV vaccines are still considered dangerous by some experts and their use is feared.

It is worth mentioning that according to some authors (26) if inactivated BT vaccines are available, they should be used in preference to others, while MLV vaccines should be considered only after a specific risk/benefit analysis. Bluetongue vaccines are intended for use only in animals against a disease that does not have any human health implications. One would consider it logical that in such cases any risk/benefit analysis would have economic implications. It is, therefore, difficult to understand why such an analysis should not also be conducted for inactivated vaccines. Using some simple arithmetic it is possible to compare the cost of vaccinating with an inactivated vaccine with the cost of using an MLV vaccine (Table III): using the latter to vaccinate one million sheep in Europe would be €1.34 million cheaper than using an inactivated vaccine. The savings for vaccinating one million cattle would be even higher (€4.23 million).

The cost of potentially adverse effects after MLV vaccination can also be calculated. Notifications of such events are made frequently in Europe (26): 0.1% of vaccinated cattle are reported to suffer adverse effects after MLV vaccinations, as are 0.5% of vaccinated sheep (laboratory confirmation suggests that the actual proportion of animals that suffer negative effects as a result of these vaccinations is 0.02% of vaccinated cattle and 0.15% of vaccinated sheep). A worst-case scenario can be envisaged, in which all notified events were actually due to vaccination and all led to the death of the animals. If the average value of one sheep is estimated to be €200 and that of one bovine animal to be €1,000, the total loss incurred per $1 \times 10^6$ vaccinated animals would, in both cases, be €1 million. Even if there was no adverse effect from the use of inactivated vaccines, the use of the latter would still be negative from a cost/benefit point of view.

The European Medicines Agency (11) has stated that BT vaccines which would enable a differentiation between infected and vaccinated animals are desirable, but this position is difficult to justify in the current specific context. The OIE standards and EU legislation (22) consider seropositive animals safe for trade irrespective of the fact that antibody is generated by contact with either vaccine or wild virus antigen.

The fact that MLV vaccines performed satisfactorily in the early phases of the BT epidemic in southern Europe was eventually recognised in the 2008 vaccine conference organised by the European Commission that endorsed the use of both inactivated and MLV vaccines.

**Conclusions**

The BT epidemic that has prevailed in Europe since the beginning of the 21st Century is the first example of continental spread of BTV in large naive populations of susceptible animals. The traditional control strategies used in countries in which the relationship

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**Table III**

Cost of bluetongue vaccination in a single European country

<table>
<thead>
<tr>
<th>Type of animal</th>
<th>Cost of vaccine/dose</th>
<th>Cost of inoculation</th>
<th>Cost of immunising $10^6$ animals</th>
<th>Cost differences between using MLV and inactivated vaccines to vaccinate $10^6$ animals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inactivated</td>
<td>MLV</td>
<td>Inactivated</td>
<td>MLV</td>
</tr>
<tr>
<td>Sheep</td>
<td>€0.37</td>
<td>€0.15</td>
<td>€0.50</td>
<td>€0.25</td>
</tr>
<tr>
<td>Cattle</td>
<td>€0.69</td>
<td>€0.15</td>
<td>€2.00</td>
<td>€1.00</td>
</tr>
</tbody>
</table>

MLV: modified live virus
circulation reduce the probability of further spread of immunisation of susceptible ruminants due to wild virus. Although the present use of vaccines and the vast transmitted by vectors. serotypes entered countries that had never previously
The implementation of the strategy had limitations due to the virus–vector–vertebrate host had reached equilibrium over a relatively long period of time, were inadequate to control the situation. Furthermore, there was no experience in the control of insect-borne viral animal diseases when the first European member state faced an incursion of BT in 2000.

The density of the populations of susceptible species encountered in Europe is certainly another element that explains the speed and the extent of spread of the infection. The principal epidemiological features of the infection were the same as those observed elsewhere. As expected, BTV has been very efficient in finding the Culicoides species with the best competence and capacity to sustain its survival. Therefore, it has been a relative surprise to recognise how Culicoides spp. which had never previously been considered competent vectors of BTV have been able to sustain BTV infection cycles together with C. imicola, which until recently was considered the only important vector of BTV in the Mediterranean.

The transport of infected vectors by the wind was also demonstrated, first in the Mediterranean then in northern Europe, to be a significant determining factor in the spread of BTV over long distances. Animal movements, which were always considered of no importance for BTV spread, have also been demonstrated to contribute to the spread of the infection over long distances (31).

Therefore, the BT epidemic has demonstrated that there was a need to design a new strategy for prevention and control of the disease; the consolidated control methods used were inadequate, particularly given the need to move animals from infected to free zones.

The basic innovations that were introduced were the use of mass vaccination in all domestic ruminant species to limit the spread of BTV and the use of active surveillance to limit, as far as possible, the zone in which movement restrictions should be applied.

The strategy was successful in limiting the spread of BTV even within countries affected by multiple BTV types. The virus was eradicated from some limited areas of affected territories, namely those in which vaccination and movement controls were applied in accordance with the strategy design.

The implementation of the strategy had limitations due mainly to factors linked to the speed with which multiple serotypes entered countries that had never previously experienced either BT or any other animal disease transmitted by vectors.

Although the present use of vaccines and the vast immunisation of susceptible ruminants due to wild virus circulation reduce the probability of further spread of BTV infection due to the virus that is already present, the preventive measures in force should be maintained, in particular surveillance and vaccination.

It should also be recognised that BT has provided yet another example of how a disease historically present only in one hemisphere can enter and spread with ease in the other hemisphere. Today, when faced with events such as the BT epidemic, there is a temptation to attribute the occurrence to concurrent climatic changes. The similarity of the ecology of the two hemispheres is often underrated, as is the fact that there are a number of disease agents outside Europe, for instance in southern Africa, that could spread rapidly in Europe by finding naive susceptible animal populations. Should this happen, the consequences would be far worse than those incurred as a result of BT.

The epidemiology of BT has demonstrated that the infectious agents present in southern Africa can easily access the Mediterranean countries of North Africa. It has also been shown that the Mediterranean Basin represents a single entity in regard to the epidemiology of animal diseases. Any effective strategy for the prevention and control of animal disease in Europe, therefore, must take into account this reality and recognise the need for regional surveillance networks that include all countries that border the Mediterranean Sea.

Relevant components of disease management, such as risk assessment, early warning, contingency planning, the organisation and management of vaccine banks, would be much more efficient and effective for most of the European countries if surveillance networks were organised on a trans-Mediterranean basis. A small-scale example of this type of regional surveillance network already exists (BTNET) and the OIE has been instrumental in the development and implementation of this network. This experience could be expanded in both scope and geographic range, in particular within the framework of the new European Neighbourhood Policy in the Mediterranean Basin, according to which the European Commission considers that, for agricultural products, convergence with EU standards for sanitary and phytosanitary controls will greatly enhance reciprocal trade between the partner countries and the EU. Exchanging information and close cooperation with international organisations responsible for the control of animal and plant diseases and improved sanitary conditions to protect consumers are top priorities (16).

Finally, three additional elements should be taken into account in BT prevention and control. The first is the problem of unlawful animal movements, which are a very serious threat in regard to the introduction of foreign animal disease and might also have been the cause of the introduction of some BTV serotypes into certain countries of Europe. The second is the need to organise vaccine
antigen banks for the various BTV serotypes that are not yet reported in Europe. It is obvious that a serious analysis should be conducted before a decision is made on what types of vaccines should be used. It is particularly important to demonstrate the efficacy and safety of both multivalent inactivated and MLV vaccine in case there is a need for vaccines that include more than two BTV-type antigens. The third is the monitoring of the frequency of BTV-8 transplacental transmission to verify its relevance in relation to BTV spread.

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Les stratégies de lutte contre la fièvre catarrhale ovine avec vaccination : tour d’horizon critique

V. Caporale & A. Giovannini

Résumé
L’épizootie de fièvre catarrhale ovine (FCO) qui sévit en Europe depuis 2000 offre le premier exemple de propagation à l’échelle continentale du virus dans des populations naïves d’animaux susceptibles. Une nouvelle stratégie de prévention et de lutte contre la maladie a été mise au point, basée sur les résultats de la surveillance intensive et des recherches menées dans ce domaine dans les pays du sud de la Méditerranée (qui ont été les premiers touchés par l’épidémie), afin de limiter les pertes directes et de réduire les effets des restrictions imposées aux déplacements d’animaux. Les principales innovations introduites ont été la vaccination systématique de toutes les espèces de ruminants domestiques afin d’empêcher la propagation du virus de la FCO, et le recours à une surveillance active intensive destinée à circonscrire autant que possible la zone d’application des mesures de restriction des déplacements. Cette stratégie innovante a considérablement réduit le nombre de foyers cliniques en Europe du Sud ainsi que dans le Bassin méditerranéen, et a contribué à sécuriser les échanges internationaux d’animaux. La première vague épidémique de FCO due au sérotype BTV-8 a été enregistrée en 2006, affectant les pays du nord-ouest de l’Europe. Les pays atteints ont décidé d’attendre avant d’élaborer une riposte. Aucune campagne de vaccination n’a été entreprise avant 2008 et, dans bien des cas, les déplacements d’animaux ont été autorisés au sein des zones de restriction, ce qui a favorisé la propagation de l’infection. Le retard pris dans l’application de la vaccination s’explique par la décision d’éviter de recourir aux vaccins à virus vivant modifié, malgré le fait que ce type de vaccin avait donné des résultats satisfaisants en Europe du Sud lors des précédentes épizooties de FCO.

L’exemple de la FCO a montré que les agents pathogènes présents en Afrique méridionale se propagent facilement dans tout le Bassin méditerranéen ; cette région devrait donc être considérée comme une entité unique au regard de l’épidémiologie des maladies animales. Par conséquent, pour être efficaces, les stratégies de prévention et de contrôle des maladies animales en Europe devraient prendre en compte cette dimension et envisager la mise en place de réseaux régionaux de surveillance afin de couvrir tous les pays bordant la Méditerranée.

Mots-clés
Análisis crítico de la estrategia de lucha contra la lengua azul, en particular del uso de vacunas

V. Caporale & A. Giovannini

Resumen
La epidemia de lengua azul que afecta a Europa desde el año 2000 es el primer ejemplo de propagación a escala continental del virus de la lengua azul (VLA) en grandes poblaciones de animales sensibles sin ningún antecedente de exposición al patógeno. A partir de los resultados de una intensa labor de investigación y vigilancia en países del sur del Mediterráneo que se vieron afectados por la infección en las primeras fases de la epidemia, se elaboró una nueva estrategia de prevención y control de la enfermedad encaminada a limitar el número de pérdidas directas y atenuar las consecuencias de la restricción de movimientos. Las principales innovaciones introducidas fueron el recurso a vacunaciones masivas de todas las especies de rumiantes domésticos, a fin de contener la propagación del virus, y la instauración de una vigilancia intensiva para reducir al mínimo posible la zona en la que debían imponerse restricciones a los desplazamientos. Esa novedosa estrategia trajo consigo una espectacular disminución del número de brotes clínicos en el sur de Europa y la cuenca mediterránea y ofreció un mayor grado de seguridad al comercio de animales. En 2006 se produjo la primera epidemia causada por el VLA-8, esa vez en el noroeste de Europa, ante la cual los países afectados optaron por esperar antes de tomar cualquier decisión. No se practicaron vacunaciones hasta 2008 y en muchos casos se autorizó el movimiento de animales dentro de áreas restringidas, hecho que facilitó la propagación de la infección. Si hubo retraso en la administración de vacunas fue porque se decidió evitar el uso de vacunas con virus vivos modificados, pese a que esas vacunas habían funcionado correctamente durante la anterior epidemia de lengua azul en el sur de Europa. El caso de la lengua azul ha demostrado que los agentes infecciosos presentes en el África meridional pueden extenderse con facilidad a la cuenca mediterránea, espacio éste que, a efectos de epidemiología de enfermedades animales, habría que considerar una entidad única. Así pues, para resultar eficaz en Europa, toda estrategia de prevención y control de enfermedades animales debe tener en cuenta esta realidad y aceptar que las redes regionales de vigilancia deben abarcar necesariamente todos los países de la ribera mediterránea.

Palabras clave

References


