Manifestation and epidemiology of contagious bovine pleuropneumonia in Europe


Summary: The authors describe the clinical profile and epidemiology of contagious bovine pleuropneumonia in Europe. This disease, once considered to have been eradicated several years ago, has now become endemic in southern countries of Europe. The status of contagious bovine pleuropneumonia in Portugal and Italy, and the evolution of the disease during the last ten years, are analysed in detail, in addition to the measures undertaken for control and eradication. The authors also refer to hosts and possible reservoirs of the infection.


INTRODUCTION

Contagious bovine pleuropneumonia (CBPP) is one of the most important diseases of the bovine respiratory tract with great socio-economic impact. CBPP causes a large loss of animal life, especially on the African continent. In Europe, CBPP was reported at the beginning of the 18th century, if not earlier, and had been eradicated by the end of the 19th century. Hudson believed that CBPP originated in Europe and was disseminated to other continents by trade in animals (15).

After some sporadic outbreaks in Portugal between 1953 and 1954, and near the French-Spanish border in 1967, the disease reappeared in 1980 and became endemic in some southern European countries. Great efforts to control the spread of the disease have since been undertaken.

CBPP in typical form is characterised by anorexia and pleuro-pulmonary symptomatology. In the acute stage, polypnoea and abdominal respiration are normal symptoms. Fever and a short, weak cough are also common. At a more severe stage,
the animal is reluctant to move and shows the typical posture of extended neck and arched back. Mucus discharges and foam around the mouth may also be seen.

The aim of this paper is to review current knowledge on the epidemiology and clinical aspects of the disease as it occurs in Europe.

**CLINICAL SYMPTOMS**

The incubation period of CBPP is difficult to define. This period varies from 5 to 207 days, with the mean period ranging from 20 to 40 days (26). In experimental infections, animals showed a slight cough and nasal discharge at the 47th day after contact with animals infected through bronchial intubation (9).

In Europe, CBPP does not show significant mortality rates compared with Africa, where it is common to see affected animals dropping from exhaustion and dying. The typical posture of arched back and extended neck and head, which is seen in severe cases, has never been observed in European countries. Respiratory signs of the typical acute disease, such as polypnoea and abdominal respiration due to pain, the short and weak cough, fever and a fall in milk production, are also rare. In outbreaks registered in European countries, it is common that animals without typical symptomatology, and showing good feed conversion, reveal acute and chronic lesions characteristic of CBPP at post-mortem examination.

In Portugal, at Vila do Conde, there was one exception to this clinical profile, in which affected animals did display the typical symptomatology. This was probably caused by slackening of surveillance measures, due to the apparent absence of the disease in that particular area.

The subacute and chronic forms of the disease have been prevalent. This might be related to antibiotherapy, or to earlier control measures in which only serologically positive animals were slaughtered. The sensitivity of the complement fixation test (CFT) in detecting early and chronic infections has already been reported (22).

It is generally known that in infected calves under six months of age, the lesions are essentially limited to the synovial membranes and joints and, therefore, clinical signs of respiratory disease are absent. The most frequent sign is of arthritis at the carpatic and tarsic joints. However, it should be pointed out that, in the region of Entre-Douro e Minho, calves under six months of age have shown typical pulmonary lesions of the disease (16).

In Italy, the classic signs were also often absent or very slight, confirming the unreliability of clinical diagnosis in detecting CBPP outbreaks. Even in confirmed outbreaks, on a herd basis, the identification of individual affected animals was difficult. This may be due to such factors as the practice of administering antibiotics at the first signs of any respiratory disease, good management of bovine livestock, which generally deters the appearance of typical clinical signs, and the immediate slaughtering of all animals in a CBPP-infected herd. Only one outbreak has been reported in Italy solely on the basis of clinical diagnosis (25).

In contrast to CBPP epidemics which occur in other latitudes, the lower virulence of the European field strains of *Mycoplasma mycoides* subsp. *mycoides* SC (small colony) may also be responsible for the minor manifestations of the clinical disease on this continent.
EPIDEMIOLOGY

As Portugal and, more recently, Italy are the countries with the highest CBPP manifestation in Europe, this paper focuses special attention on the disease situation in these two countries, tracing the evolution of CBPP over the last ten years. However, before tackling this subject, a brief reference will be made to the French and Spanish situation.

In France, an outbreak was detected in October 1980 on a dairy farm in Palau de Cerdagne, a French district close to the Spanish border (Département des Pyrénées Orientales).

Each month, from March 1980, one or two new cows presented pulmonary disorders. CBPP was suspected, taking into account the slow evolution of the infection and the characteristic lung and pleural lesions. Of 30 serum samples taken for CBPP serological examination, 18 were positive. All animals in this outbreak were slaughtered. Eleven cows presented chronic pathological changes and only three showed typical acute lesions from which *M. mycoides* subsp. *mycoides SC* (*MmmSC*) was identified.

An observation area was established and two other outbreaks were detected near the first outbreak by the end of 1980. A wide serological survey was undertaken for the entire cattle population of the French Cerdagne (the cattle-breeding region of the Pyrénées Orientales). This enabled the detection on two other farms of a small number of animals, apparently healthy, which gave positive serological results for CBPP in the CFT.

Complete eradication was achieved at the beginning of 1981 by ‘stamping out’ all animals on these five farms: a total of 125 cattle.

As some herds are led every summer to mountain pastures, favouring contacts with other herds, it was decided to control all moving herds, submitting them to a double serological test before and after their return.

These measures, taken in accordance with the Spanish authorities, are followed every year. In 1982, two outbreaks were detected in Caldegas (Département des Pyrénées Orientales) and Montredon la Bessonnie (Département du Tarn), in cattle herds returning from mountain pastures of Mont du Cayrol and Mont Puch-Carcanière. A total of 840 animals were slaughtered.

In 1983, no positive animals were detected in approximately 20,000 serological investigations. In 1984, four outbreaks were notified in the department of Pyrénées Orientales, all related to mountain pastures in Massif du Carlit. A total of 189 cattle were slaughtered (11).

These observations led to the conclusion that the CBPP outbreaks appeared in France between 1980 and 1984, among cattle which were grazing in Pyrenean mountain pastures (17). The onset of the outbreaks occurs two or three months after the return of the cattle from the mountains. A few infected animals, generally young adults, are sufficient to carry the infection from the mountain pastures to resident cattle, since only one or two animals are affected every month over a long period.

Epidemiological surveillance is routinely carried out in these areas, including laboratory examination in the case of suspected infection, in particular bacteriological post-mortem examination of suspected lesions, and systematic serological control...
before and after cattle movements, using the CFT reference test (8, 10). No outbreaks have been detected since 1984. Thus, CBPP infection may be regarded as having been eradicated in this area. However, few positive reactions with CFT occur in a low percentage, less than 0.1%, and may be interpreted as false positive reactions, probably due to cross-reacting antigens. New serological tests, such as the blocking enzyme-linked immunosorbent assay (ELISA), which uses specific monoclonal antibodies (MAbs) (5), may be useful in placing these false positive results in the French epidemiological context.

Based on the reports of the Office International des Epizooties and the European Commission, the first notified outbreak in Spain occurred in 1967 in Llivia, a small territory within Cerdagna, after the disease had been eradicated from many European countries early in the 20th century. In this area of the eastern Pyrenees, the Franco-Spanish border is difficult to define, due to lack of geographical barriers. Communal pastures are also common, resulting in frequent contacts between French and Spanish cattle. The above outbreak was diagnosed by serology and confirmed by the isolation of \textit{MimmSC}. Drastic measures were then taken to eradicate the disease.

In October 1989, Spain again notified the existence of the disease on four farms in the provinces of Madrid and Segovia. Thirteen other outbreaks occurred in 1990 and two in 1991. The majority of these outbreaks were located in the northern territory near the coastal region of the Bay of Biscay. Later, between 1992 and 1994, eight new outbreaks were notified, of which three were again in the northern territory, while the remaining outbreaks occurred in the provinces of Madrid, Saragossa and La Rioja. With very few exceptions, the origins of the outbreaks were not known.

**Situation in Portugal**

After some thirty years of epidemiological silence (i.e. from 1954 to 1983), CBPP appeared again in Portugal. The disease was first recognised in January 1983, in a dairy cow which had tested positive for tuberculosis, slaughtered at the abattoir of Monção. The animal showed lesions of parietal and visceral fibrinous pleurisy, hypertrophy of the thoracic lymph nodes, pneumonia with interlobular gelatinous oedema and haemorrhagic foci in the pulmonary parenchyma. Histological examination showed a picture of interlobular inflammatory oedema, lymphatic thrombosis and organised perivascular foci. This cow belonged to a herd located near the Spanish border (18).

**Climatic conditions**

The climate of the entire coastal region of Portugal is greatly affected by the Atlantic Ocean. The regions of Entre-Douro e Minho, Beira Litoral and Ribatejo e Oeste are very humid, even in summer. The inland regions, such as Trás-os-Montes, Beira Interior and Alentejo, have a humid winter but are very dry and hot in summer. The agricultural region of the Algarve has a Mediterranean-type climate.

**Animal husbandry**

The cattle population in Portugal is estimated at approximately 1,200,000 animals, according to the 1989 census. Almost all the cattle are concentrated in the agricultural regions of Entre-Douro e Minho (370,400), Beira Litoral (220,100), Ribatejo e Oeste (168,600) and Alentejo (258,900). Of this estimated total, 324,405 animals are dairy
cattle, distributed among some 102,000 farms. These farms, which have an average of three cows per farm, are situated principally along the coastline.

Portugal has several national breeds of dairy and beef cattle, distributed mainly through the centre and to the north of the country. Other indigenous breeds, such as the 'Alentejana' and 'Mertolenga' originated in the south of the country. In addition to the national breeds mentioned, the Friesian was introduced into Portugal in the 17th century. Owing to its adaptability, there was a progressive increase in numbers and now the Friesian is the predominant breed throughout the country. Friesians predominate in the districts located in the centre and on the coastline of the regions of Entre-Douro e Minho and Beira Litoral. According to the general census of 1989, there are approximately 208,000 animals.

The type of husbandry in Portugal differs from one region to another. It differs from north to south, particularly in the agricultural regions of Entre-Douro e Minho, Beira Litoral and the Alentejo.

In the north and mid-west, the regions of Entre-Douro e Minho and Beira Litoral are areas of minifundio. These are densely populated areas, in which many villages cluster around the main roads. The majority of the inhabitants are farmers. As a consequence, these herds, with an average of two to three animals per owner, are kept in small, poorly ventilated, neighbouring sheds.

In addition to producing milk, the animals are also used for field work, and as a means of transport to take owners to fairs and markets.

Although this situation is still the norm, changes are occurring and bigger herds also exist. The areas of the coastal strip have low, wet land with a gentle slope, allowing intensive farming practices. It is in this area that the most significant quantity of milk is produced. The milk, which is sold to local co-operative societies, is collected in common milking parlours, where the animals are milked twice a day. In 1989, there were 1,904 of these units distributed throughout the country, the majority located in the regions of Beira Litoral (1,061) and Entre-Douro e Minho (609).

The inland farms of these two regions are either hilly or mountainous. As a result of mountain conditions and climatic factors, the agricultural system is different. Mechanisation is difficult or quite impossible in the majority of these areas, and the cattle are used to do the field work.

In the Trás-os-Montes region, small farms again predominate, with either dairy or beef cattle.

In the Ribatejo e Oeste region, where the land ownership system is different, the farmers, like those of the big dairy farms of Entre-Douro e Minho and Beira Litoral, have their own milking parlours and the farmholdings are well spaced.

In the Alentejo, where farms are large and well-fenced, there is extensive breeding of beef cattle. There are also dairy farms in this region.

**Evolution of the disease**

In 1983, the first year of a nation-wide serological survey, a total of 334,940 serum samples were analysed in the Laboratório Nacional de Investigação Veterinária (LNIV), by the CFT of Campbell and Turner (micromethod) (8, 10). The results obtained in this survey provided a better assessment of the incidence and prevalence of the disease, thus allowing the implementation of a national disease
The survey demonstrated an increasing prevalence of the disease from the south to the north, with a higher prevalence of outbreaks occurring in the centre to the north of the country, in the regions of Entre-Douro e Minho and Beira Litoral (22).

The disease, which had been detected in January 1983 at Monção, Entre-Douro e Minho, seems, by retrospective enquiries, to have begun in August 1982 (18). CBPP appeared in the region of Beira Litoral in March 1983, in Moimenta da Beira (Viseu). In about two months, the disease had crossed the natural control barrier of the river Douro, and was established. This situation can only be explained by considering the existence of traditional livestock markets where animals of various origins, including those from different agricultural regions, were concentrated. One month after detection of the initial outbreak in herds being milked at a common milking parlour in Tocha-Aveiro, the disease had spread all over the region of Beira Litoral.

At the end of 1983, in addition to the Entre-Douro e Minho region where 450 infected farms had already been detected, the region of Beira Litoral had notified a total of 1,131 outbreaks. Infection in the regions of Trás-os-Montes, Beira Interior, Ribatejo e Oeste and Alentejo were episodic in nature. These secondary outbreaks, according to epidemiological enquiries, were associated with the introduction of cattle from areas of Beira Litoral where the disease was endemic. However, the illegal transit of cattle, in spite of the restrictions implemented, may also have been involved. The spread of CBPP was mainly a consequence of the high number of common milking parlours.

In 1985, for better control and eradication of the disease, the Veterinary Services (Direcção Geral da Pecuária: DGP) developed a comprehensive, five-year plan. Portugal was divided into the following zones:

a) endemic zone: the regions of Entre-Douro e Minho and Beira Litoral were included in this zone, due to the high infection rate. The principal measures applied in this zone were, briefly, as follows:
- serological tests on all farms once a year
- a ban on bovine movement out of the area

b) risk zone: this zone included the agricultural regions of Trás-os-Montes, Beira Interior and Ribatejo e Oeste, where sporadic outbreaks were detected. The measures adopted were as follows:
- random serological tests on approximately 50% of farms
- control of bovine movement out of and within the zone by the official services

c) disease-free zone: this zone included the agricultural regions of Alentejo, where no further outbreaks were detected, and the region of Algarve, which remained free from the disease. The principal measures applied were as follows:
- random serological tests on 15% of farms
- control of bovine movement by the official services within this zone. Movement was only allowed from farms in the risk zone on which no cases of CBPP or even positive serological results had ever been reported.

This national eradication plan achieved control of the disease until 1989 and avoided disease spread to other regions, except for a few sporadic outbreaks, especially in the Trás-os-Montes region.
A new reinforced eradication plan was established in 1989, financially supported by the European Community (EC). According to this plan, Portugal was divided into three regions, as follows:

   a) infected region (Viana do Castelo, Braga and Porto in Entre-Douro e Minho and Aveiro, Coimbra and Viseu in Beira Litoral)

   b) buffer region (Trás-os-Montes, Beira Interior and Ribatejo e Oeste)

   c) disease-free region (the rest of the country).

This plan led to the intensification of serological testing, especially in the borderline areas. However, the massive increase observed in the total number of outbreaks in 1989, i.e. 1,317 (Table I), is unrelated to the efficiency of the plan, since most of these outbreaks occurred in the already infected areas. This can be seen in Figure 1a, which demonstrates the endemic nature of the disease in the regions of Entre-Douro e Minho and Beira Litoral, and the high prevalence of CBPP in some districts in these areas.

### Table I

<table>
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<tbody>
<tr>
<td>Entre-Douro e Minho</td>
<td>162</td>
<td>239</td>
<td>225</td>
<td>187</td>
<td>527</td>
<td>736</td>
<td>880</td>
<td>617</td>
<td>110</td>
<td>46</td>
<td>10</td>
<td>3,739</td>
</tr>
<tr>
<td>Beira Litoral</td>
<td>720</td>
<td>227</td>
<td>498</td>
<td>607</td>
<td>776</td>
<td>360</td>
<td>240</td>
<td>180</td>
<td>28</td>
<td>17</td>
<td>1</td>
<td>3,654</td>
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<tr>
<td>Trás-os-Montes</td>
<td>2</td>
<td>15</td>
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<td>0</td>
<td>14</td>
<td>27</td>
<td>113</td>
<td>32</td>
<td>27</td>
<td>0</td>
<td>0</td>
<td>230</td>
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<tr>
<td>Disease-free regions</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>884</td>
<td>484</td>
<td>723</td>
<td>794</td>
<td>1,317</td>
<td>1,123</td>
<td>1,233</td>
<td>829</td>
<td>165</td>
<td>63</td>
<td>11</td>
<td>7,626</td>
</tr>
</tbody>
</table>

In national terms, since 1985, the annual serological incidence of CBPP has varied from 0.59% to 0.23% in 1995, with a peak in 1987 (1.09%) and a lower peak in 1992 (0.67%). The same trend applies in the infected region of Entre-Douro e Minho, with peaks in the same years of 1.26% and 0.86%, respectively (Fig. 2).

At the national level, a higher incidence of seroconversions was observed in the period from June to October, caused by cross-reactions which are predominant during this period. This seasonal pattern is a common feature, whether in infected regions (Entre-Douro e Minho and Beira Litoral), buffer zones or disease-free regions (22).

Since July 1995, a new eradication plan, financially supported by the EC, has been conducted.

### The disease in the infected region

Considering the number and location of outbreaks observed between 1988 and 1991, areas of higher prevalence of the disease are clearly defined (Fig. 1d). In these areas, the ratio of the total number of outbreaks to cattle density is 30:6 in the remaining area of Entre-Douro e Minho and 45:5.6 in the remaining area of Beira Litoral. The most important factors which could be responsible for this situation in the Entre-Douro e Minho and Beira Litoral regions are as follows.
Distribution of contagious bovine pleuropneumonia in the endemic areas of Entre-Douro e Minho, Beira Litoral and Trás-os-Montes, during 1989 (a), 1991 (b) and 1995 (c). Areas of higher and lower prevalence of the disease in Entre-Douro e Minho and Beira Litoral are shown in (d)

Source: Instituto da Protecção e Produção Agro-Alimentar

FIG. 1
The most infected area (3,052 km$^2$), comprising 17 districts, includes the areas of Viana do Castelo, Braga and Porto, which correspond to 34% of the whole region (8,879 km$^2$). The most important risk factors are:

- a higher bovine population density, of 72 bovines per km$^2$, which includes 30 dairy cows (Friesian) per km$^2$. The remaining area has 26 animals per km$^2$, of which 7 are cows
- a higher density of common milking parlours, 0.17 per km$^2$, compared with the remaining area, which has 0.01 per km$^2$
- a higher number of farms, 16 per km$^2$, compared with 11 per km$^2$.

This area has 44% of the total number of farms, 60% of the total bovine population and 70% of the Friesian cows in the entire region.

Beira Litoral region

In this region (11,725 km$^2$), the endemic area, comprising 3,202 km$^2$ or 27% of the region, contains 18 districts and includes the areas of Aveiro and Coimbra. The main risk factors are as follows:

- a higher density of cattle than in the remaining area, 42 bovines per km$^2$, of which 30 are Friesian cows, compared with 10 bovines per km$^2$ in the remaining region, of which 4 are cows
- a higher density of common milking parlours, 0.2 per km$^2$, compared with 0.05 per km$^2$ in the non-endemic area
- a higher number of farms, 14 per km$^2$, compared with 4 per km$^2$.

In Trás-os-Montes, the animal trade and also the existence of common pastures and milking parlours, especially in the area of Miranda do Douro, have allowed the occurrence of sporadic outbreaks. In 1991, the number of outbreaks was the highest ever notified in this region, 113 (Table I) (Fig. 1b).
In addition to these factors, other elements, such as orographical, climatic and social conditions, profoundly influence the prevailing patterns of agriculture and cattle breeding.

In regard to Figure 3, which shows the evolution of the incidence of outbreaks between 1988 and 1995, it is evident that, between 1988 and 1991, there was an increasing occurrence in the region of Entre-Douro e Minho, 0.25% to 0.67%, whereas the disease status remained the same in the region of Beira Litoral in 1988 and 1989, at 1.14% and 1.11%, respectively. After this period and until 1995, there was a dramatic regression in both regions, especially in Beira Litoral.

**FIG. 3**

Incidence of confirmed outbreaks of contagious bovine pleuropneumonia in Portugal between 1988 and 1995

All the eradication plans enforced epidemiological surveillance all over the country, based on serological analyses of farmholdings, using randomised sampling and control of animal movements. Although the majority of outbreaks have been detected serologically, from 1990 onwards, detection through abattoir inspection was also implemented, which proved to be one of the methods of choice for assessing the disease situation, especially in disease-free areas.

**Types of herds and inter-herd mode of transmission**

Owing to the fact that dairy herds predominate in the littoral centre to the north of the country, with a high density per km² of farms and common milking parlours, where the concentration of Flugge-type droplets or droplets of either saliva or urine origin is high, it is evident that direct contact is the prime mode of transmission.

On the other hand, the disease has also appeared in a few of the bigger well-fenced dairy farms, with their own milking parlours, where the herds are well-isolated from
outside contacts. One hypothesis is of occasional wind-borne infection on foggy and misty days; in one case, for more than 200 m through a zone of dense vegetation.

**Situation in Italy**

CBPP was endemic in Italy until the 16th century in the area of the Eastern Alps. In the 18th century, CBPP spread throughout Europe and was eradicated in Italy in 1899.

**Cattle population**

During 1988 to 1989, the Italian bovine population (including buffalo), numbering approximately 8,858,000 head, were distributed in 444,000 herds, in which the average number of animals per herd was about 20 (1, 2). The northern region contained 50.6% of the herds (69.5% of animals), 16% of the herds (10.3% of animals) were located in the central region, 24.9% (12% of animals) in the southern region, and 8.5% (8.12% of animals) on the islands.

In 1992, the total number of buffalo was 147,336 (28). These were located mainly in southern (Campania, Puglia) and central (Lazio) regions.

The production of beef in Italy is unable to meet national demand so, during 1990 to 1991, an average of 1,309,878 beef cattle per year were imported from other European Union (EU) countries, mainly France (80% to 85%) (source: Ministry of Health).

**Evolution of the disease**

In October 1990, an outbreak of the disease was reported in the Lombardy region, in a dairy herd of 594 animals, and the presence of CBPP was confirmed following isolation and identification of *MmmSC* by the Centre National d'Etudes Vétérinaires et Alimentaires (CNEVA)/Laboratoire de Pathologie Bovine (LPB) (Lyons, France). Investigations into this outbreak failed to trace the origin of the infection. An analysis tracing back the disease showed that this outbreak did not result from a source within Italy, confirming the hypothesis that the disease was imported.

A total of 94 outbreaks occurred between October 1990 and September 1993, of which 62 were in the Lombardy region. Of these, 38 were in Bergamo and 18 in Brescia province (Fig. 4).

Forty-seven of the 94 outbreaks confirmed in Italy were detected in three well-defined areas of Lombardy.

Area 1 was in the Bergamo province, where 25 outbreaks occurred in a 20 km$^2$ area, which is equivalent to 1.25 outbreaks per km$^2$. Area 2 was also in the Bergamo province, comprising 21 km$^2$ in which there were 8 outbreaks, equivalent to 0.38 outbreaks per km$^2$. An internal area of 8.75 km$^2$ within area 2 experienced 6 outbreaks (0.69 outbreaks per km$^2$). Area 3 was in the Brescia province of Lombardy, where 14 outbreaks occurred within an 18 km$^2$ area, a mean of 0.78 outbreaks per km$^2$. An internal area of 9 km$^2$ within area 3 experienced 12 of the 14 outbreaks (1.33 outbreaks per km$^2$) (Table II).

To summarise, outbreaks detected in these three endemic areas totalled 50% of all the Italian outbreaks, amounting to 55.5% of slaughtered animals under the CBPP
eradication plan. Areas 1 and 2 are less than 10 km apart and come within the jurisdiction of the same Local Health Unit (USL). In 1993, this USL contained 56,640 animals on 616 farms.

The average yearly herd incidence was 5.29/100,000 on a national basis. The cases, however, were concentrated in these three endemic areas. In areas 1 and 2, the average yearly herd incidence was 1,339.29/100,000, while in the rest of Italy, excluding the Lombardy region, the incidence was 1.99/100,000.

A total of 24,053 animals (1,200 of which were buffalo) were involved in these outbreaks.
TABLE II
Number of outbreaks of contagious bovine pleuropneumonia in Italy, in geographical areas of different risk levels, in relation to the type of herd involved

<table>
<thead>
<tr>
<th>Geographical area</th>
<th>No. of outbreaks by type of herd</th>
<th>Outbreaks at abattoir</th>
<th>Total no. of animals in outbreaks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dairy</td>
<td>Beef</td>
<td>Mixed</td>
</tr>
<tr>
<td>Area 1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>18</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Area 2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area 3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>11</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Rest of Lombardy&lt;sup&gt;c&lt;/sup&gt;</td>
<td>9</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Subtotal, Lombardy</td>
<td>45</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Rest of Italy&lt;sup&gt;d&lt;/sup&gt;</td>
<td>11</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>56</td>
<td>19</td>
<td>5</td>
</tr>
</tbody>
</table>

<sup>a</sup> Herd in the stable of an animal trader
<sup>b</sup> Endemic area
<sup>c</sup> High-risk area
<sup>d</sup> Low-risk area

Types of herds and inter-herd mode of transmission

The types of herds involved are summarised in Table II: 60% of outbreaks occurred in dairy herds, 20% in beef herds, 5% in mixed herds and 10% in the stables of animal traders. The remaining 5% were detected in the abattoir.

Results of investigations into the outbreaks are described in Table III, in which only those cases which were able to be documented and traced back to source were considered. Undocumented cases are listed under ‘unknown’, as are those where the origin was suspected but not documented.

The frequent involvement of dairy farms is incongruous when considered against the high number of cases in which the origin of infection remained unknown. Because dairy cattle are individually identified, a reconstruction of all the movements of each animal should be possible. Animals present in the cow sheds of a dealer are the second most controlled part of the population. Each dairy animal or group of meat animals is recorded in a ledger which is constantly submitted to veterinary controls.

The ability to trace back the origin of outbreaks was clearly related to the efficacy of the animal identification method outside the endemic area (a 64% success rate in tracing back in outbreaks involving dairy herds, 50% in outbreaks involving trade animals, and 18% in outbreaks involving fattening herds). In regard to endemic areas, even after careful analysis of animal movements, the ability to trace back the origin of the infection was very limited and was unrelated to the efficacy of the animal identification method.

Two hypotheses may be considered to explain the different success rate in tracing back the outbreaks in endemic areas compared with non-endemic areas.

Supposing, on the basis of data collected, that CBPP entered Italy at least two years before the disease was recorded (i.e. at the end of 1988). Three outbreaks in area 1, one outbreak in area 2 and a further outbreak in Bergamo province can be ascribed...
### Results of investigations into outbreaks of contagious bovine pleuropneumonia: number of outbreaks with identified sources in relation to geographical areas of different risk levels

<table>
<thead>
<tr>
<th>Geographical area</th>
<th>No. of outbreaks by source of infection</th>
<th>Proportion of cases with origins traced back</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trade&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Indirect&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Area 1&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Area 2&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area 3&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Rest of Lombardy&lt;sup&gt;e&lt;/sup&gt;</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Subtotal, Lombardy</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Rest of Italy&lt;sup&gt;f&lt;/sup&gt;</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>17</td>
<td>2</td>
</tr>
</tbody>
</table>

<sup>a</sup> Purchase of animals from an outbreak  
<sup>b</sup> Exchange of agricultural devices is documented with outbreaks  
<sup>c</sup> Direct importation from abroad without mixing with indigenous animals, although infection is not reported in exporting countries  
<sup>d</sup> Endemic area  
<sup>e</sup> High-risk area  
<sup>f</sup> Low-risk area

To the trade in animals that took place in 1989 and 1990 among farms under USL 33 jurisdiction. These cases were later classified as CBPP outbreaks. Only in a few cases did retrospective studies on animal movement from/to the herd go back more than one year from the date of detection of the outbreak. Therefore, at least some of the outbreaks in the endemic areas could be due to trade which occurred in 1989 to 1990. This hypothesis could also explain why secondary outbreaks detected in the remaining part of Italy did not give rise to other areas becoming endemic. This was probably due to the immediate slaughter measures adopted in the case of secondary outbreaks.

This hypothesis of the entry of CBPP into Italy in 1988 cannot explain all of the outbreaks which occurred in endemic areas. In fact, Italian law states that serological tests have to be performed on all herds within the protection area (a 3 km radius) and, of course, on farms epidemiologically linked with the outbreak. In endemic areas, a number of herds gave negative results in serological tests, some even several times, before the detection of the disease. In such cases, the infection could not have been introduced before October 1990. To explain these outbreaks, in the absence of documented animal movements, the possibility of a spatial factor was investigated using the Pielou's index of segregation (19, 23) for herds in area 1. The existence of a clear spatial segregation between infected and non-infected herds in the endemic area was demonstrated. Based on this spatial segregation, the possibility of alternative methods of transmission (wind-borne disease or indirect transmission) cannot be completely excluded. The minimum spatial segregation necessary for the isolation of infection is unknown. The possibility of this type of transmission for CBPP has already been documented in Africa by Windsor and Masiga (27).
The origin of most outbreaks which occurred outside the endemic areas is ascribed to the introduction of animals from endemic areas or, in some cases, importation from abroad is suspected. In regard to the latter, five outbreaks occurred following direct importation without any contact with local animals: these cases involved two animals from France, two from Poland and one from Germany. Therefore, it is possible that some infected areas, still undetected, remain in these countries which have been reported as free from CBPP, or that some transit of animals through these ‘infected’ areas could have occurred before their importation to Italy.

**Outbreak detection and epidemiological surveillance**

**Outbreak detection**

The methods of detecting the outbreaks in relation to the type of herd are summarised in Table IV. The main analytical tools for outbreak detection were serology (36 out of 76 reported cases) and necrotic findings at the abattoir (30 out of 76 reported cases) in routinely slaughtered and culled animals. The former was the main method of detecting outbreaks among dairy animals, the latter was important in such detection among fattening animals. Few outbreaks were detected following clinical suspicion. In regard to serological analysis, only in 19 cases out of 36 were the reasons for sampling reported. These reasons were as follows:

- examinations in protection areas
- examinations before animal movement
- examinations on restocked farms after the extinction of the outbreak.

**TABLE IV**

Methods of detection of outbreaks of contagious bovine pleuropneumonia in Italy, by type of herd involved

<table>
<thead>
<tr>
<th>Type of herd</th>
<th>Serological</th>
<th>Necroptic</th>
<th>Clinical</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy</td>
<td>31</td>
<td>9</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Fattening</td>
<td>1</td>
<td>18</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Mixed</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Trade</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
<td>30</td>
<td>10</td>
<td>18</td>
</tr>
</tbody>
</table>

Most of the outbreaks detected through serology in the Lombardy region were in protection areas (nine in the endemic areas and three in the remaining part of Lombardy in comparison with only two in the remaining part of Italy), while the outbreaks detected through examinations before animal movement were mainly outside the endemic areas (one in Lombardy and three in the remaining territory). The single outbreak detected through serological analysis on restocked farms after the extinction of the outbreak was in the endemic area of Lombardy.
Epidemiological surveillance

Before the implementation of an eradication plan, a surveillance programme was conducted to determine the distribution of the infection in Italy. For this reason, the Minister of Health issued an ordinance (O.M. 4.10.1991), which made the surveillance programme compulsory throughout Italy.

The programme covered three different activities, as follows:
- random sampling in bovine herds
- controls on animal movements based on serology
- control in abattoirs.

Random sampling was based on the hypothesis (12) that CBPP was endemic in large geographic areas of Italy.

The programme differentiated between regions of high risk (Lombardy, including other regions in which outbreaks occurred) and regions where infection was considered absent. Therefore, the national territory was divided into six geographic areas with specific epidemiological profiles.

Controls on animal movement based on serology had a double aim:

a) a prophylactic objective, because animal movement is the only known method of spreading the infection out of endemic areas

b) a detection objective, to confirm the results of random sampling on a larger sampling base.

These serological controls had been planned:
- at the level of individual movements of breeding cattle (mainly dairy cattle)
- for sampling, at the level of the movements of all groups of fattening cattle.

Control in abattoirs was the third surveillance measure. This measure was intended to confirm the entire surveillance system through the examination of both fattening animals and culled cows.

Serological control on animal movements and control in abattoirs continued until 31 December 1995.

The results of the above surveillance activities were as follows:

a) Random sampling. The random sampling did not reveal any infected herd, although positive serological results were revealed in 0.168% of examined animals (confidence limits [c.l.] 95% = 0.134%-0.202%). The incidence of positive serological results (Italian average incidence estimated on regional cattle populations [7]) was 0.1938% (c.l. = 0.1936%-0.1940%) with a range of 0 to 1.26%. On the basis of the available data on disease prevalence, it seems evident that this kind of survey – even though it was adequate for the proposed aims – would not, by itself, have been able to reveal the spread of CBPP proposed in Italy, outside the primary endemic area

b) Serological controls on animal movement. Serological controls on animal movement were conducted on 2,461,684 animals during the period of January 1992 to September 1995. The percentage of positivity revealed was 0.17% (4,064 animals)

c) Control in abattoirs. The number of animals slaughtered in the 12 Italian regions for which data are available, during the first six months of 1992, was 1,245,596. In
1993, 982,327 animals were slaughtered in regions for which data are available (9/19), Lombardy excepted. From January to April 1994, 153,301 animals were slaughtered in regions for which data are available (7/19), Lombardy excepted. In Lombardy, from January to May 1992, 243,025 animals were slaughtered, while in 1993, 583,289 animals were slaughtered. All of these animals were submitted to veterinary inspection and a total of 30 outbreaks were detected.

HOSTS AND POSSIBLE RESERVOIRS

The isolation and identification of MmmSC in Europe from a buffalo herd (24), from bull semen and sheath washings (13), and from sheep and goats (4) is of great importance.

It is known that the genus Bos is the natural host of the CBPP aetiological agent. However, other species can be affected, such as bison and yaks, although without the same susceptibility (21). The isolation of MmmSC from sheep and goats in Portugal is interesting, since experiments with small ruminants in contact with infected cattle suggested the lack of sensitivity of those species (3), and natural transmission has also never been reported. It is important to note that the experimental infections mentioned were conducted with the African strain Afade, and not with European strains, which showed clear genetic differences from the African strains (6). Antigenic differences are also found in Italian isolates at the 98 to 100 kDa level, as compared with other European isolates, suggesting a variant clone with the same origin (14, 20). It is therefore proposed that the epidemiological significance and pathogenicity of these isolates should be further investigated.

CONCLUSIONS

In Europe, the typical acute form of CBPP is rare and cases of severe disease have never been observed. This could be due to the administration of antibiotics, good livestock management and the immediate slaughtering of animals. It could also be due to the low virulence of European strains in comparison with African strains. The subacute and chronic forms of the disease have been prevalent in Europe.

In Portugal, CBPP has been endemic in some areas of the agricultural regions of Entre-Douro e Minho and Beira Litoral, where the frequency of outbreaks has been higher and has been maintained for the last 10 years. These outbreaks occurred in 17 municipalities belonging to the areas of Viana do Castelo, Braga and Porto of the region of Entre-Douro e Minho, as well as in 18 districts of the areas of Aveiro and Coimbra, which are part of the region of Beira Litoral.

The most important common factors responsible for disease maintenance are as follows:
- a high bovine population density per km$^2$, in which Friesian cows predominate
- a high number of common milking parlours per km$^2$ where the animals gather twice a day
- a high number of farms per km$^2$.

In addition to the factors outlined above, other factors, such as orographical, climatic and social elements, are also important, exerting their influence on the prevailing agricultural systems and therefore on cattle rearing practices.
In regard to the evolution of the incidence of outbreaks, a dramatic decrease has been registered during the last three years in the regions of Entre-Douro e Minho and Beira Litoral. CBPP persisted in some endemic areas of the region of Trás-os-Montes, especially near the Spanish border, until 1993. In the remaining national territory no outbreaks have been reported since 1986. No infection was ever recorded in the Algarve.

In Italy, CBPP remained in three endemic areas of Lombardy; until April 1992 in one area, and until September 1993 in the other two.

Most outbreaks which occurred in other regions are ascribed to importation of animals from abroad or to the introduction of animals from endemic areas. As mentioned above, it is very likely that these endemic areas originated as a result of the importation of the disease from abroad.

Secondary outbreaks did not give rise to new endemic areas.

The adoption of measures of veterinary policy, embodied in the control and surveillance programmes of 1991, led to the eradication of CBPP from the entire country. In fact, no outbreaks have been recorded in Italy since September 1993.

The Italian Ministry of Health recently informed the EU Commission and the Office International des Epizooties that the disease has been eradicated, and that Italy should be considered free from CBPP from 1996.

The intriguing question of the re-emergence of CBPP in Europe and particularly in Italy could be answered by the presence of *MmmSC* in certain geographical areas where the disease could remain hidden. If this is the case, the presence of the aetiological agent could, in principle, be traced to possible reservoirs of infection, such as in small ruminants.

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des dix dernières années, sont analysées en détail ; sont également exposées les mesures adoptées pour lutter contre la maladie et l’éradiquer. Les auteurs s’intéressent enfin aux hôtes et aux réservoirs possibles de l’agent pathogène.


* * *


Resumen: Los autores describen el perfil clínico y la epidemiología de la perineumonía contagiosa bovina en Europa. Esta enfermedad, cuya erradicación se dio por hecha hace varios años, se ha convertido hoy en endémica en algunos países del sur del continente europeo. Se analiza detalladamente la situación de la perineumonía contagiosa bovina en Portugal e Italia, así como la evolución de la enfermedad en el curso de los últimos diez años y las medidas adoptadas para su control y erradicación. Los autores abordan también el tema de los huéspedes y posibles reservorios de la infección.


REFERENCES


