AUSTRALIAN VETERINARY EMERGENCY PLAN

# AUSVETPLAN

## Disease Strategy

## Anthrax

### Version 3.2, 2005

AUSVETPLAN is a series of technical response plans that describe the proposed Australian approach to an emergency animal disease incident. The documents provide guidance based on sound analysis, linking policy, strategies, implementation, coordination and emergency-management plans.

**Primary Industries Ministerial Council**

**This disease strategy forms part of:**

**AUSVETPLAN Edition 3**

**This strategy will be reviewed regularly. Suggestions and recommendations for amendments should be forwarded to:**

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**Approved citation:** Animal Health Australia (2005). Disease strategy: Anthrax (Version 3.2). Australian Veterinary Emergency Plan (AUSVETPLAN), Edition 3, Primary Industries Ministerial Council, Canberra, ACT.

**Publication record:**
Edition 1: Anthrax was not included in this edition
Edition 2: Anthrax was not included in this edition
Edition 3:
Version 3.0, January 2003 (new manual: interim draft while awaiting final endorsement)
Version 3.1, January 2005 (minor update for final endorsement)
Version 3.2, April 2005 (minor update, Section 1.5.3)

**AUSVETPLAN is available on the internet at:**
**http://www.animalhealthaustralia.com.au**



ISBN 0 642 24506 1 (printed version)
ISBN 1 876 714387 (electronic version)



**IMPORTANT NOTE: Important regulatory information is contained in the OIE Terrestrial Animal Health Code for anthrax, which is updated annually and is available on the internet at the OIE website: http://www.oie.int/eng/normes/en_mcode.htm. Further details are given in Appendix 3 of this manual).**

**DISEASE WATCH HOTLINE**

# 1800 675 888

The Disease Watch Hotline is a toll-free telephone number that connects callers to the relevant state or territory officer to report concerns about any potential emergency disease situation. Anyone suspecting an emergency disease outbreak should use this number to get immediate advice and assistance.

# Preface

This disease strategy for the control and eradication of anthrax is an integral part of the **Australian Veterinary Emergency Plan**, or **AUSVETPLAN (Edition 3)**. AUSVETPLAN structures and functions are described in the **AUSVETPLAN Summary Document**.

This strategy sets out the disease control principles that have been approved by the Primary Industries Ministerial Council (PIMC) out-of-session at meeting 7 on 17 January 2005 for use in an animal health emergency caused by the occurrence of anthrax in Australia. Relevant livestock industries have also been involved in the consultation and approval process (see below).

Anthrax is included on the OIE (World Organisation for Animal Health, formerly Office International des Epizooties) list of notifiable diseases as a multiple species disease. This obliges OIE member countries to notify the OIE within 24 hours of confirming the presence of anthrax. OIE-listed diseases are diseases with the potential for international spread, significant mortality or morbidity within the susceptible species and/or potential for zoonotic spread to humans.[1] The principles contained in this document for the diagnosis and management of an outbreak of anthrax conform with the *OIE Terrestrial Animal Health Code* (see Appendix 3).

In Australia, a major outbreak of anthrax is included as a Category 3 emergency animal disease in the *Government and Livestock Industry Cost Sharing Deed In Respect of Emergency Animal Disease Responses* (EAD Response Agreement).[2] Category 3 diseases are emergency animal diseases that have the potential to cause significant (but generally moderate) national socioeconomic consequences through international trade losses, market disruptions involving two or more states and severe production losses to affected industries, but have minimal or no effect on human health or the environment. For this category, the costs will be shared 50% by governments and 50% by the relevant industries (refer to the EAD Response Agreement for details).

This is the first AUSVETPLAN disease strategy that has been prepared for a disease that is already present in Australia. The basis of the Australian response has been developed from experience over the past 50 years in handling effectively sporadic and unusual outbreaks of anthrax. The unusual outbreak in central northern Victoria in early 1997 enabled a reappraisal of the Australian response to anthrax.

These disease control procedures set out in this strategy are fully consistent with the international standards for anthrax control discussed at the Inter-Regional Workshop on Anthrax[3] in Nepal, March 1997, sponsored by the World Health Organization (WHO) and the Food and Agriculture Organization of the United Nations (FAO). The measures undertaken to control the unusual outbreak of anthrax in Victoria in 1997

[1] These criteria are described in more detail in Chapter 2.1.1 of the *OIE Terrestrial Animal Health Code* (http://www.oie.int/eng/normes/mcode/en_chapitre_2.1.1.htm).
[2] Information about the EAD Response Agreement can be found at: http://www.animalhealthaustralia.com.au/programs/eadp/eadra.cfm
[3] http://www.who.int/emc-documents/zoonoses/whoemczdi986c.html

were recognised as a model by their incorporation into the 1998 WHO *Guidelines for the Surveillance and Control of Anthrax in Humans and Animals* (VPHAWG 1998).

Detailed instructions for the field implementation of AUSVETPLAN are contained in the disease strategies, operational procedures manuals, management manuals and wild animal manual. Industry-specific information is given in the relevant enterprise manuals. The full list of AUSVETPLAN manuals that may need to be accessed in an emergency is:

**Disease strategies**
- Individual strategy for each disease

**Operational procedures manuals**
- Decontamination
- Destruction of animals
- Disposal
- Public relations
- Valuation and compensation

**Management manuals**
- Control centres management (Volumes 1 and 2)
- Animal Health Emergency Information System
- Laboratory preparedness

**Enterprise manuals**
- Animal quarantine stations
- Artificial breeding centres
- Aviaries and pet shops
- Feedlots
- Meat processing
- Poultry industry
- Saleyards and transport
- Veterinary practices
- Zoos

**Wild animal manual**
- Wild animal response strategy

**Summary document**

Standard veterinary texts should be consulted for further information about the aetiology, diagnosis and epidemiology of the disease and should be read in conjunction with this strategy.

This strategy was developed from an earlier report — *The Control of Anthrax in Australia* — which was published by the Australian Government Department of Primary Industries and Energy (DPIE), now Department of Agriculture, Fisheries and Forestry, (DAFF) in March 1997. This original report was prepared by an ad hoc working group from DPIE, Department of Natural Resources and Environment, Vic (DNRE) and NSW Agriculture, and was revised by a working party headed by Andrew Turner (Andrew Turner Consulting Pty Ltd). Scientific editing was by Dr Janet Salisbury of Biotext, Canberra.

The revised manual has been reviewed and approved by:

**Government**
- Commonwealth of Australia
- State of New South Wales
- State of Queensland
- State of South Australia
- State of Tasmania
- State of Victoria
- State of Western Australia
- Northern Territory
- Australian Capital Territory

**Industry**
- Cattle Council of Australia
- Australian Lot Feeders Association
- WoolProducers Australia
- Sheep Meat Council of Australia
- Australian Dairy Farmers' Federation
- Australian Pork Ltd

The complete series of AUSVETPLAN documents is available on the internet at: http://www.animalhealthaustralia.com.au

# Contents

# 1 Nature of the disease

Anthrax is an acute infectious bacterial disease that can affect humans and a wide range of domestic and wild animals. It is caused by the bacterium *Bacillus anthracis*. The clinical forms of anthrax in animals are traditionally described as:

- peracute (very acute) — in which death occurs suddenly (within a few hours at most) of the onset of clinical signs;
- acute — in which death occurs from 24 hours to a few days after onset; and
- subacute or localised — which lasts for several days and may end in recovery.

Anthrax can affect humans and classically causes three types of infection affecting the lungs (pulmonary form), the digestive tract (intestinal form), or the skin (cutaneous form).

## 1.1 Aetiology

Anthrax is caused by the bacterium *Bacillus anthracis* – a large, gram-positive, rod-shaped bacterium. *B. anthracis* produces a toxic complex of three components: factor I (oedema factor); factor II (protective antigen); and factor III (lethal factor). These factors together kill phagocytes, damage capillary walls and interfere with blood clotting, leading to oedema, shock and death (Beveridge 1983). Protective antigen provides the mechanism for lethal factor to enter cells, and production of an antibody against protective antigen protects animals against infection.

## 1.2 Susceptible species

Anthrax affects many domestic and wild animals and humans.

**Cattle, sheep and goats**

In cattle, sheep and goats disease is usually peracute and infected animals are often found dead before any signs of illness are observed (except perhaps in dairy cattle that are under continuous and careful observation).

**Pigs**

In anthrax areas pigs may be infected by feeding on carcases or meat of cattle or sheep that have died of anthrax. Pigs manifest the subacute or the chronic forms. Pigs have some degree of natural resistance and may recover. Pigs that recover from the disease may remain carriers of *B. anthracis.*

**Dogs, cats and horses**

Dogs, cats and horses may also be infected, although cases are rare in Australia. Dogs have been infected in anthrax areas after being fed meat from infected carcases. Horses suffer the acute form but carnivores have some natural resistance and suffer the subacute or the chronic forms, and may recover.

## 1.3 World distribution and occurrence in Australia

Anthrax probably originated in the Middle East and spread by trade in animals and animal products. It occurs nearly worldwide, with only a few countries never having reported the disease (*World Animal Health in 2000,* OIE 2000*)*. Anthrax is acknowledged as under-reported in many countries, and is still common in tropical Africa, the Middle East and neighbouring countries of the former Soviet Union, parts of Central and Southern America and parts of Asia.

In countries in which the disease is not well-controlled, regular outbreaks of anthrax can become serious epidemics of both animals and humans. For example, when civil war interrupted normal vaccination and regulatory controls in Zimbabwe in the late 1970s, a massive outbreak resulted in more than 10 000 human cases and untold numbers of deaths in cattle (de Vos 1994).

In countries with well-established veterinary services and public health monitoring (eg Europe, North America, North Asia and Australia) anthrax outbreaks are rapidly contained by the imposition of standard control measures. Such outbreaks can affect both domestic animals (Fox et al 1973) and wildlife (de Vos 1994, Dragon and Rennie 1995). Human cases do not occur in significant numbers in areas where there is effective carcase control.

An increasing number of countries have been free from anthrax for a considerable time — Cyprus (1969), New Zealand (1954), Sweden (1981), Ireland (1970) and Malta (1974).

Anthrax occurred in New Zealand in the late 1800s and early 1900s and was associated with the importation of meat and bonemeal fertiliser. Between 1903 and 1932, a series of measures were put in place to prevent the introduction of anthrax, including a ban on the importation of meat and bonemeal. New Zealand has been considered to be free of anthrax since 1954, when a suspected outbreak occurred but there is some uncertainty as to whether this case was ever confirmed.

In Cyprus, anthrax was formerly one of the most serious diseases of sheep and goats. Human infection was not uncommon in the early 1900s. Fortunately, the disease has declined steadily since 1950. This has been attributed to the systematic, compulsory vaccination of sheep and goats on the island. After 1968 vaccination ceased in some areas and completely stopped in 1975 (Economides 2000).

### 1.3.1 Historical occurrence in Australia (1847–1996)

**Animals**

Anthrax was first introduced into Australia in 1847 near Sydney, and spread along stock routes throughout New South Wales and southern Queensland. It was later introduced into Victoria in 1876 and occasional outbreaks were also seen in South Australia and Tasmania (Seddon 1965). Routine quarantine with vaccination on and around infected premises was adopted in the 1890s and, with regulatory controls, has been very successful in controlling the disease.

There has been no evidence of anthrax in South Australia or Tasmania since the last reported cases in 1914 and 1933, respectively, and these states are now considered free of the disease. No cases have ever been reported in the Northern territory which is also considered free of the disease.

Western Australia was free of the disease until 1994, when cases occurred on three premises in a localised area. No further cases have occurred in Western Australia.

There had been no cases in Queensland for over 70 years until one infected animal was detected on a single farm in 1993. This occurred in an area geographically distant from the areas of historical outbreaks and was apparently due to contaminated feed.

**Humans**

Only the cutaneous form of anthrax has ever been reported in humans in Australia: pulmonary and intestinal forms have never been reported here. In the 1920s and 1930s, cutaneous cases were associated with infected shaving brush bristles. A number of people died from this source of infection, since there were no antibiotics available at that time. In the early 1960s a farm worker in New South Wales contracted cutaneous anthrax after conducting postmortems on dead sheep. The worker refused early medical treatment and died from the disease. Human cases have become less common over time, reflecting the reductions in animal cases: only six human cases were reported from 1977 to 1987, and only two cases from 1988 to 1999 (Victoria 1997; Queensland 1998).

Anthrax in humans has been nationally notifiable only since 1 January 2001.

### 1.3.2 Recent history in Australia (1997–2002)

For over 30 years until 1997 anthrax occurred only as sporadic incidents. From 26 January to 26 March 1997, however, there was an unusual outbreak in the Tatura–Stanhope area of the Goulburn Valley in central northern Victoria, which led to the deaths of 202 cattle and 4 sheep on 83 farms. There had been no cases of the disease in Victoria since 1988 and there had been no recorded instances of the disease in the outbreak area since 1914. The control program during the outbreak involved the vaccination of 78 649 cattle from 539 herds. The epidemic curve returned to its baseline on 26 February 1997. Concurrent with this unusual outbreak, a single sporadic incident occurred in a single cow in central northern Victoria, outside the outbreak area; the infected herd and 49 surrounding herds were vaccinated without cases occurring on further properties in this area.

In the summer of 1997–98 six anthrax cases occurred on previously infected properties in central northern Victoria. All six cases were in young stock vaccinated only once. In the summers of 1998–99, 1999–2000 and 2000–01, there were no cases of anthrax in Victoria despite extensive monitoring for the disease. Subsequently, in autumn 2002, there was a single case of anthrax on each of two separate properties that had had cases in 1997.

There were only sporadic incidents in New South Wales from 1997 to 2002, with the highest incidence being six in 1997–98.

In 2002, anthrax occurred on a property in southern Queensland near the New South Wales border and further cases occurred in cattle moved from the index property to another property some 400 km north.

### 1.3.3 Current situation in Australia

Anthrax is uncommon in Australia and clinical cases of the disease are seen only sporadically. Most cases occur in sheep, with some in cattle and a few in pigs. Goats and horses are rarely affected. The areas where cases occur tend to have neutral to alkaline subsoil and to be on floodplains along waterways, although cases may occur away from waterways on acidic soils. On average each year, in the whole of Australia, cases occur on only about 6 to 12 premises. Usually only a small number of cases occur on each affected farm (eg 1–3 cattle or 5–20 sheep on average).

Sporadic cases are reported through the centre of New South Wales and into northern and north-eastern Victoria. These areas of New South Wales are largely sheep-raising areas with an annual rainfall of 250–500 millimetres and cases occur predominantly between October and March. In Victoria, virtually all incidents and outbreaks occur in cattle, with cases occurring relatively evenly throughout the year.

Western Australia has only ever recorded cases in a localised, isolated area in the southwest of the state, north of Albany. The remainder of Western Australia is considered to be free of anthrax.

Two properties in southern Queensland linked by cattle movements suffered cases in 2002. The remainder of Queensland is still considered to be free of anthrax.

The Northern Territory, South Australia and Tasmania are considered to be free of anthrax.

## 1.4 Diagnostic criteria

### 1.4.1 Clinical signs

During the incubation period, the bacterium multiplies at the site of infection and is concentrated by the spleen and other lymphoid tissue until the immune system is overwhelmed. The subsequent sudden release of organisms and toxins into the bloodstream leads to a rapid death in ruminants. For dogs, pigs and horses that become infected, bacterial toxins tend to kill the animals before the levels of bacteria reach those associated with death in ruminants (see Section 1.5.1).

**Grazing animals**

Usually, the first indication that grazing animals may have anthrax is when they are found dead in the paddock. Blood-stained discharges at external orifices are characteristic of the disease but not all anthrax cases show these signs. A reliable sign is the failure of blood to clot. This is seen when samples are collected from carcases for diagnostic examination, or if the carcase has been attacked by predators. Dairy cattle may show a change in temperament and a drop in milk production. Horses usually suffer a sudden death with oedema of chest, abdomen and limbs; some horses may survive for days with colic and oedema.

**Pigs**

Pigs are usually visibly ill, with fevers of up to 42°C (commonly over 41°C), dullness, anorexia, swelling of the neck and face and sometimes blood-stained

froth at the mouth. In this localised pharyngeal form, swelling around the pharynx restricts respiration, causing laboured breathing and cyanosis of mucous membranes (due to lack of oxygen). Death can occur as soon as 12–18 hours after clinical signs develop, probably due to asphyxiation, but infected pigs commonly die after 2–7 days. Sudden death due to infection of the blood (septicaemia) may occur in young pigs. Anthrax bacilli localise in the lungs causing respiratory signs and blood-stained froth from the mouth. In the intestinal form of anthrax there may be either dysentery or constipation, or one followed by the other, and blood-stained froth from the mouth.

**Dogs and cats**

Dogs and cats, as carnivores, are generally highly resistant to anthrax. The ingestion of large numbers of anthrax bacilli in infected meat is necessary to establish infection. Dogs and cats often recover without treatment. Anthrax has not been recorded in cats in Australia. In dogs, high temperature and sudden death with swollen throat lymph nodes are usually seen.

**Humans**

In humans, anthrax classically causes one of three types of infection: lung (pulmonary form), digestive tract (intestinal form) or skin (cutaneous form). Only the cutaneous form has ever been recorded in Australia. Cases in Australia have often been associated with an occupational activity.

### 1.4.2 Pathology

Natural infection in animals usually occurs by ingestion of spores that can germinate in tissues such as the pharynx, mouth or intestines, or by absorption through the skin to cause cutaneous infection.

Animals vary in their susceptibility to anthrax according to the route of infection. For most animals, the oral route is the least successful and infection is most easily established by intramuscular injection. However, cattle are easily infected orally and more difficult to infect subcutaneously (de Vos 1994).

**Development of the disease**

Following infection the bacterium first multiplies at the site of infection. It then enters the bloodstream, where it is concentrated by the spleen and other lymphoid tissue until a point is reached when there is a sudden release of organisms and toxins back into the bloodstream, which leads to rapid death in ruminants. Valli (1985) stated that 'septicaemia in anthrax is a terminal event'. With dogs, pigs and horses, the toxins tend to kill the animals before the bacteraemia reaches the level seen in ruminants.

*B. anthracis* produces a toxic complex of three components: factor I (oedema factor), factor II (protective antigen) and factor III (lethal factor). These factors operate in combination and their total effect is to kill phagocytes, damage capillary walls and interfere with the clotting mechanism. The net effect is oedema, shock and death (Beveridge 1983). Protective antigen provides the mechanism for lethal factor to enter cells and it is an antibody against this protective antigen that protects animals against infection.

**Postmortem findings**

In the unopened carcase anthrax bacilli do not sporulate and are destroyed by the putrefactive process of postmortem change. Thus, to prevent spore formation and unnecessary contamination of the environment the postmortem examination of suspected cases of anthrax is actively discouraged.

If a carcase of an animal that has died from anthrax is opened, dark unclotted blood and an enlarged, haemorrhagic spleen are immediate indicators of anthrax (de Vos 1994). However, an enlarged spleen (splenomegaly), cited as a characteristic feature of anthrax and regularly seen in cattle, is uncommon in sheep, pigs and horses. The mesentery may be thickened and oedematous, with excess peritoneal, pleural and pericardial fluid. Petechial haemorrhages may be visible in many organs, and the intestinal mucosa may be dark red and oedematous, with some areas of necrosis. In many cases, rigor mortis does not occur. However, not all the signs are uniformly present in all cases of anthrax. If a postmortem examination is conducted and anthrax confirmed, the carcase and all disposable equipment should be destroyed as quickly as possible and the immediate area disinfected. Staff handling such cases should seek medical advice (see Sections 2.2.13 and 3.2.9).

### 1.4.3 Laboratory tests

Demonstration of encapsulated *B. anthracis* from infected blood or tissues and growth of the organism on blood agar plates is relatively uncomplicated and within the capability of most bacteriology laboratories.

**Specimens required**

If a veterinarian suspects that an animal has died from anthrax, they should make air-dried smears from blood collected using a vacuum tube from the peripheral blood vessels of the ear or leg, the mammary vein or the jugular. These smears and a blood sample should then be submitted to a recognised veterinary laboratory for microscopic examination. Although blood samples and smears are preferable, an ear (preferably the dependant ear) could be cut off, placed in a plastic bag (with or without smears), double bagged and labelled appropriately and transported to the laboratory for examination

Unlike ruminants, infected horses, dogs and pigs usually do not have large numbers of *B. anthracis* in their blood. In these animals the organism can be cultured from oedematous fluid or demonstrated in smears made from oedematous fluid.

**Transport of specimens**

Specimens must be transported in containers able to contain any fluids and materials from breakage of slides, syringes or blood tubes. Ice should be used if there is to be any likely delay in transportation. As anthrax is also a human pathogen, particular care should be taken to ensure that all statutory requirements are met for the transport of specimens. Specimens should be packed and labelled for transport in compliance with the carrier's conditions, government and postal regulations and International Air Transport Association (IATA) regulations, as appropriate. The laboratory should be advised that suspect anthrax samples are

being sent to them. The specimen advice form should be marked in large, clear letters that it is for suspect anthrax specimens.

Sharps (needles or blades) must NOT under any circumstances be forwarded with the samples but must be disposed of in an appropriate container.

**Laboratory diagnosis**

*B. anthracis* is a large, gram-positive, rod-shaped bacterium of about 1–1.5 by 3–8 μm. In smears of the blood of animals dying from anthrax, there are well-marked capsules that stain pink with 1% aqueous polychrome methylene blue. This distinguishes them from *Clostridia*. As the time after death increases, the bacilli stain less intensely until they appear only in ghost form with the capsular material being the last to disappear. When vaccinated animals die from anthrax before protective levels of antibodies have developed, few *B. anthracis* organisms may be present, making culture the preferred means of diagnosis.

*B. anthracis* can be readily grown on blood agar plates for non-contaminated specimens or on selective medium if isolation from contaminated materials, such as soil and meatmeals, is necessary. If spores are present in the material, contamination can be reduced by heating at 60°C before culture. Alternatively, *B. anthracis* can be recovered from suspect material that has undergone degeneration by the inoculation of guinea pigs or mice.

The Ascoli test, which is used on dried specimens, is unreliable because of cross-reactions with antigens of other *Bacillus* spp, and it is not an approved test for use in Australia.

Serological tests, including enzyme-linked immunosorbent assay (ELISA), have been developed for the detection of antibody to *B. anthracis*, particularly the protective antigen. But such tests are only carried out in specialist research laboratories and their results have to be interpreted with a knowledge of an animal's anthrax history. Developing such tests further could help us understand anthrax and vaccine-mediated immunity to it.

Recently, tests have been developed to demonstrate genetic relationships within *B. anthracis* (Keim et al 2000).

### 1.4.4 Differential diagnosis

Anthrax should be considered in the differential diagnosis of all cases of sudden death in grazing animals, especially when blood-stained exudate is present at the nose, mouth or anus. Anthrax cases are most often misdiagnosed as clostridial diseases, such as:

- blackleg (*Clostridium chauvoei*);
- black disease (*Clostridium novyi)*;
- malignant oedema (*Clostridium septicum*); and
- enterotoxaemia (*Clostridium perfringens* type D).

Less likely misdiagnoses include metabolic diseases such as grass tetany or milk fever.

Important factors in diagnosis include the anthrax history of the area, the vaccination status of the stock (for anthrax and clostridial diseases in particular), whether a full vaccination course was administered, whether antibiotics were given near the time of vaccination, and the risk that infected animals or anthrax spores may have been introduced from other areas or spread from other cases.

## 1.5 Resistance and immunity

### 1.5.1 Innate and passive immunity

The susceptibility of animals to natural infection does not correlate to experimental infection and varies with the route of exposure. When tested experimentally, cattle, horses and donkeys appear to have a greater degree of natural resistance to anthrax than sheep and goats but, under natural conditions, the former species appear to be more commonly infected than the smaller stock (de Vos 1994).

Innate resistance to anthrax appears to depend on the inhibition of the initial germination of spores and/or multiplication of the bacteria. Carnivores, rats and chickens appear to have a high resistance to infection but, once infected, are highly susceptible to the effects of the toxins— as infection progresses, they develop a low-level bacteraemia in the terminal septicaemia. On the other hand, animals such as herbivores, guinea-pigs and rabbits have a much lower resistance to infection and a relatively high resistance to the toxins, so they develop a high-level bacteraemia in the terminal septicaemia (de Vos 1994).

### 1.5.2 Active immunity

Although the mortality rate is high, animals surviving naturally acquired anthrax are immune to reinfection. Second attacks are extremely rare.

### 1.5.3 Vaccination

In the early 1890s, a double-dose Pasteur vaccine was used. From the late 1890s until 1960, this was replaced by a single-dose attenuated spore vaccine developed by Gunn and McGarvie Smith. Since 1960 all vaccines used in Australia have contained living spores of the non-capsulated naturally avirulent (live) Sterne 34F2 strain of *B. anthracis*. The currently registered vaccine delivers the following minimum doses:

- cattle — 4 million viable spores; and
- sheep and goats — 2 million viable spores.

(Note: the spore count specified for vaccine manufacturers in the United States is 2 million viable spores per dose.)

A single vaccination is usually effective for 6–12 months, provided that animals receive the full dose and are not under antibiotic therapy within 10–14 days before or after vaccination. The Sterne strain 34F2 vaccine causes few adverse reactions in cattle and sheep. There may be an elevated temperature 12–36 hours after vaccination causing reduced milk yield and possibly abortion in dairy cows. However, severe reactions can occur in goats, alpacas and horses. Hence, enforcement of vaccination in these species needs careful consideration. Care always needs to be taken when vaccinating animals in hot weather.

Animals that have been vaccinated twice, at least 6 months apart, are probably immune for life. Vaccine manufacturers' advice on immunity is that it will peak at 15 days after first vaccination. In the Victorian outbreak in 1997, 0.15% of vaccinated animals died after 15 days with anthrax. These deaths were attributed to an inadequate dose of vaccine, an inadequate immune response to a correct dose of vaccine, or a high challenge dose overwhelming an established but otherwise adequate immunity. There was also the possibility of interference from antibiotic treatment for conditions such as footrot and mastitis.

Human vaccines have been developed from cell-free filtrates of Sterne strain cultures that have been alum-precipitated or absorbed onto aluminium hydroxide. There is no vaccine registered for human use in Australia.

**Vaccination and withholding periods**

The spore vaccines in Australia from 1890 to 1960 were more virulent than the Sterne vaccine, and caused cattle to develop high temperatures. If these vaccines are used in other countries, it is recommended that milk from animals with high temperatures should not be incorporated into the bulk milk vat, because it cannot be determined whether an animal with a high temperature is reacting to the vaccine or to the field disease.

Cows vaccinated with the Sterne vaccine strain 34F2 do not shed *B. anthracis* in their milk (Tanner et al 1978). Neither the United States Department of Agriculture nor the Australian Pesticides and Veterinary Medicines Authority, which administers agricultural and veterinary chemical registration, imposes a withholding period for milk from vaccinated cattle. Australian milk and dairy products have never been shown to cause anthrax in humans or calves.

Australia requires a 42-day withholding period for meat after anthrax vaccination. This is consistent with the requirements of the United States Department of Agriculture and the guidelines of the World Health Organization (WHO) Veterinary Public Health Anthrax Working Group (VPHAWG 1998).

Due to its low annual usage in Australia during the 1990s, the Sterne strain vaccine was produced by only one Australian manufacturer. Vaccine production ceased in Australia in late 1996. With low ongoing annual usage, Australia is importing anthrax vaccine under permit from an overseas manufacturer.

## 1.6 Epidemiology

### 1.6.1 Source of infection

The source of infection for many incidents is often contentious. One clear source is the deep ploughing of pastures previously contaminated with effluent from knackeries or tanneries, or the unearthing of old graves. Once an animal has been infected and dies, its carcase remains a source of infection.

On the other hand, many outbreaks originate when there is no clearly definable source. When the events leading to the occurrence of anthrax are unclear, the sources can vary between countries and areas within a country. The guidelines for the surveillance and control of anthrax in humans and animals, compiled by the

World Health Organization's Veterinary Public Health Anthrax Working Group (VPHAWG 1998) state:

> Much has been written and hypothesised about the effects of season, rainfall, temperature, soil, vegetation, host condition and population density on the epidemiology of anthrax but little agreement exists on the roles played by these factors in the incidence of the disease. Most of the theories are based on concepts of conditions under which *B. anthracis* may germinate and multiply in the environment, but hard scientific supportive data are not readily available and the conditions under which multiplication in the environment could take place probably only occur in exceptional circumstances.
>
> No one model satisfactorily satisfies the varying observations on the factors listed above and the incidence and persistence of anthrax in a locality.

### 1.6.2 Incubation period

Herbivores exposed to infection develop clinical signs within 4–10 days. For international trade purposes, the OIE Terrestrial Animal Health Code (OIE Terrestrial Code) has fixed an incubation period of 20 days from last exposure to infection (see Appendix 3).

Animals incubating anthrax have the organism continuously filtered out of the bloodstream by the spleen and lymph nodes until the last few hours of life when the bacteria rapidly build up in the bloodstream causing a terminal septicaemia only hours before death (Valli 1985) (see Sections 1.4.1 and 1.4.2).

### 1.6.3 Persistence of agent

**General properties**

In its vegetative form *B. anthracis* is fragile and easily inactivated by disinfectants or exposure to moderate temperatures. It is also destroyed by normal post-mortem changes. However, on exposure to air, it forms highly resistant spores that can remain viable for many years in some soils. The spores are much more temperature resistant than the vegetative form, but not as resistant as the spores of most *Clostridia* and other *Bacillus* spp.

Vegetative *B. anthracis* cannot survive long in the environment and, when released from a carcase, has to sporulate or die. The conditions necessary for sporulation are:

- the release of vegetative bacteria from the carcase at death;
- a minimum temperature of 22°C; and
- a medium that is nutrient and oxygen-rich, such as blood.

In environments such as water or milk, the vegetative organism dies spontaneously and is not able to sporulate in these media (Minett 1950, Turnbull et al 1991, Bowen and Turnbull 1992, Lindeque and Turnbull 1994). The vegetative organism is readily destroyed by ordinary antiseptics or heat (see below) and can be prevented from sporulating by diluting with water and reducing temperatures to below 22°C.

Although the anthrax spore is much more resistant to the environment than the vegetative organism, it is not virtually indestructible as was once thought. However, spores deposited below the upper soil levels (below 15 cm) can remain viable for long periods, even centuries, in a favourable environment (de Vos 1998). In two cases, spores washed below the soil surface from spillage at old knackery and tannery sites were brought to the surface decades later by deep ploughing and started new outbreaks. Subsoils that are pH 9 and calcareous in nature are the most favourable for the survival of spores. Very high pH soil is unfavourable to spore survival.

Spores on and just below the soil surface are subject to wind, rain, sunlight, acidity, ultraviolet light, dryness and the activities of other micro-organisms and these factors all have a significant impact on spore viability. It is becoming accepted that spore numbers on the surface at infected sites diminish with time so that infective capacity can be lost over about 3 years, if there is no replenishment. This scenario fits with the containment of anthrax on the infected properties during the unusual outbreak in the Tatura/Stanhope area in 1997 (VPHAWG 1998) (see Section 1.3.2).

There is debate as to whether *B. anthracis* spores can germinate and multiply in the environment; clear, scientific evidence is not readily available. However, the conditions under which multiplication could take place in the environment probably only occur in exceptional circumstances (VPHAWG 1998).

Heat treatment of the organism varies with the type of heat and whether the organism is in its vegetative or spore form. The vegetative form is killed by heating to 58°C for 15 minutes. The spore form is quite resistant to dry heat, requiring a temperature of 140°C for 3 hours to achieve destruction. Under moist conditions, the spore is destroyed by a temperature of 100–115°C for 15 minutes (de Vos 1994) or of 100–105°C for 20 minutes (Gracey and Collins 1992).

**Live animals**

Animals incubating the disease are not infectious for other animals until they die and bloody discharges from the orifices spill infection into the environment (see Section 1.6.2). The high concentration of organisms in the blood of ruminants at death ensures high spore concentrations at death sites, particularly if carcases are broken open. The curiosity of cohort animals, which causes sniffing, licking and grazing infected sites, leads to other animals becoming infected.

Anthrax does not form a carrier state in susceptible animals, and live animals can only spread the infection by being moved when they are in the incubation phase of the disease, dying and releasing bacteria at the new site. As a precaution, animals can be moved to a holding site that is not contaminated for 20 days, with or without vaccination. If no disease occurs infection will not be transferred with the animals.

**Animal products and byproducts**

***Carcases***

Ruminants that die of anthrax have high levels of *B. anthracis* in the carcase and offal. The vegetative organism in carcases that are left intact die out over a period of 3 days at temperatures of 25°C or higher. The death site remains infected with organisms spilling from the carcase and sporulating unless decontaminated.

Non-ruminant carcases do not play a significant part in the spread of anthrax and few infections occur in these species. They all have low septicaemias compared with ruminants and so have little potential to contaminate the environment (see Section 1.4.2).

*Milk and milk products*

Anthrax bacilli can be detected in the milk of cows only at the point of, and after, death (M'Fadyean 1909). Bowen and Turnbull (1992) found that vegetative bacilli die out in milk over a period of 24 hours at 5–9°C, and faster at higher temperatures. Pasteurisation destroys vegetative bacteria. Thus, anthrax vegetative bacilli cannot survive in milk. Vegetative bacteria also cannot sporulate in unpasteurised milk (see Section 1.6.3 General properties/environment).

**Important: There are no records in the scientific literature of anthrax being transmitted to humans through the consumption of milk or dairy products (M'Fadyean 1909, Steele and Helvig 1953, VPHAWG 1998). Chin (2000) states that there is no evidence that milk from infected animals transmits anthrax.**

Further information is given in Appendix 6.

*Meat and meat products*

Meat and meat products from animals that have died of anthrax can spread the disease to animals and humans that eat these products untreated or without adequate treatment to destroy infection. Humans handling such products can contract cutaneous anthrax.

Meat and meat products from healthy animals pose no threat for human infection. Further details are given in Appendix 6).

*Wool and hair*

Historically, the collection of wool and hair from animals that have died from anthrax has been recorded as leading to human infection both in the cutaneous and in the pulmonary form. The introduction of hair into woollen mills led to the occurrence of pulmonary anthrax ('woolsorters disease') in the mills. Hair allows the spores to more easily become aerosolised and provide infectious doses to mill workers (Laforce 1978). Wool and hair products can be disinfected by using chemical or irradiation treatments (VPHAWG 1998).

Effluent from scouring plants is able to transmit infection to pastures and to susceptible ruminants. Australian wool and hair have not been recorded as causing anthrax infection in humans in woollen mills and other wool handling centres. Woolsorters' disease has not been recorded in Australian woollen mills. Imported hair and unscoured wool for manufacture are irradiated to control any infection.

*Hides and skins*

Historically, hides and skins collected from animals that have died from anthrax have led to human infections associated with tanneries. Effluent from tanneries and handling infected skins and hides can be a source of infection for grazing animals when discharged to pasture (VPHAWG 1998). Any hides or skins found on infected premises need to be destroyed.

*Meatmeals*

Traditionally, meatmeal and bonemeal prepared from animals that have died of anthrax was a significant means of spreading anthrax, but adequate control of processing standards has eliminated infection transfer. Vegetative bacilli are destroyed by heating at 58°C for 15 minutes, while both spores and vegetative bacilli are destroyed by the application of moist heat at 100–115°C for 15 minutes (de Vos 1994) or 100–105°C for 20 minutes (Gracey and Collins 1992). These controls, and the prohibition on the feeding of meatmeal and bonemeal to ruminants, ensure that these products are not involved in the spread of anthrax in Australia.

All carcases of animals that have died of anthrax in Australia are burnt (or deep buried where this is not possible), so meat or meatmeal and bonemeal are not knowingly produced from infected carcases. Adequate temperature treatment ensures infected carcases are decontaminated. *B. anthracis* spores cannot germinate and grow in meatmeal (unlike *Salmonella* spp).

**Equipment and personnel**

The role of equipment, protective clothing and personnel that are not directly contaminated with fluids from infected animals in the spread of infection is unclear. It is recommended that people and items are cleaned and decontaminated after they have been in areas where infected animals have died.

### 1.6.4 Modes of transmission

Anthrax is unusual among animal diseases in that it is not contagious (ie it is not spread from animal to animal). It is spread by release of bacterial spores from the carcase of an animal that has died of the disease and the subsequent ingestion of these spores by other animals. The period during which infection is systemic is short and the risk of spread of infection by preclinical infected animals limited.

However, in an unusual outbreak, common factors may exist on other properties (potentially infected premises) in an area other than the confirmed infected premises that exposes animals to infection with anthrax spores. These factors include previous cases of infection (possibly decades earlier), soil type, climatic conditions, topography, drainage systems and stocking density. An unusual outbreak could also arise if a contaminated product, such as blood and bone fertiliser, is applied to several properties in a short period.

**Live animals**

Natural infection in animals usually occurs by ingestion of spores, not by animal-to-animal transmission.

It is only on death that an animal becomes infectious for other animals, with the discharge of blood and other fluids from the carcase. Susceptible animals contract infection from the dead animal exudates or from the site on which it died. In Australia herbivores acquire infection only from pasture sources. Pigs and carnivores have acquired infection from eating inadequately treated carcases and offal.

In the past, travelling stock were a significant means for spreading anthrax across Australia and for maintaining contamination of stock routes. Anthrax is now rarely recorded as being spread by moving infected incubating animals between premises. Vaccination and movement restrictions now control such contamination.

**Animal products and byproducts**

Products from animals that have died of anthrax can transmit infection if there has been inadequate heat treatment to destroy spores or vegetative organisms. Meatmeal has not been recorded as transmitting anthrax infection for many years. Hair, wool, skins and hides could spread infection to new areas if treatment and scouring effluent is allowed to drain onto pasture, or deep ploughing brings spores back to the surface.

**Equipment and personnel**

It is not clear what role equipment, protective clothing and other fomites play in transmitting infection if they are not directly exposed to infected animals or infected sites. Equipment used in handling infected stock could spread infection to susceptible stock, either through broken skin or by injection, if the equipment is not sterilised before reuse.

**Vectors**

Tabanid flies have been recorded as able to spread anthrax mechanically from incubating animals to susceptible animals. In the 1997 Australian outbreak domestic and bush flies were shown to carry *B. anthracis* after feeding on carcases of animals that had died from anthrax, but their role in the spread of disease is unclear.

In South Africa bush flies have been recorded as regurgitating carcase feedings in trees on which browsing wildlife feed and contract anthrax. Although other insects, such as mosquitoes, can transmit infection, it would probably take numerous bites and uninterrupted feedings by many insects to transmit the disease (de Vos 1994).

The role of crows or foxes in the dissemination of anthrax is unclear. Scavenging animals, including hyenas and vultures in Kruger National Park, South Africa, are credited with spreading infection, particularly through congregating at watering holes, dragging pieces of infected carcase around death sites and defaecating infection (de Vos 1994).

In summary, the important traditional means for spreading anthrax to herbivores was through:

- eating contaminated, improperly treated meatmeal; and
- contact with dead animals or the contamination left at their death site or burial site.

Feeding meatmeal to ruminants is now prohibited in Australia, so the most important means by which anthrax is spread to herbivores is by eating pasture on or around a former death site or sniffing and licking around a recently dead anthrax carcase. The transport of incubating infected animals can transfer infection across paddocks, properties and districts.

### 1.6.5 Factors influencing transmission

Herbivores provide the predominant source of environmental contamination. Environmental conditions favouring outbreaks vary widely between locations.

There is little doubt that anthrax incidence is related to temperature and rainfall. Anecdotal evidence indicates that anthrax cases are sometimes observed after moderate rainfall following prolonged dry periods. Climate can influence the way in which an animal comes into contact with the spores (eg animals graze closer to the soil in dry periods when grass is short or sparse or herds may be moved to contaminated sites when water becomes scarce). Climate can also affect the general health of the host and their resistance to infection (VPHAWG 1998). Alkaline soils favour the survival of spores and anthrax tends to persist in areas where these soils occur in Australia.

## 1.7 Manner and risk of introduction to Australia

The disease was introduced into Australia at Leppington, New South Wales, in 1847 and at Warrnambool, Victoria, in 1876 in contaminated bone flour used to fertilise crops (Seddon 1965). Current quarantine restrictions on the entry of animals and animal products and byproducts provide little chance of further introductions of anthrax spores in sufficient numbers to establish infection in Australia.

One route by which infection could be introduced is through animal remedies containing animal extracts not declared as ingredients, if the remedy was not processed to eliminate anthrax infection. This has been a suspicious source for one case of anthrax in an otherwise anthrax-free area. Another possible source of infection would be the import of inadequately treated products such as wool, skins, hides or hair.

# 2 Principles of control and eradication

## 2.1 Introduction

The World Health Organization Veterinary Public Health Anthrax Working Group compiled the *Guidelines for the Surveillance and Control of Anthrax in Humans and Animals* in 1998 (VPHAWG 1998). Appendix VI of these guidelines outlines a 'Contingency Plan for the Prevention and Control of Anthrax', which recommends the response made to the anthrax outbreak in 1997 in central northern Victoria as a model response. In this response, the following steps were taken on infected and neighbouring premises:

- apparently healthy animals were identified, isolated and removed from sources of contamination;
- infected premises were quarantined for at least 20 days after the last case or 6 weeks after vaccination, whichever was later;
- soil that may have been exposed to infective material was decontaminated;
- infected carcases and their parts were destroyed by burning, rendering, or deep burial with quicklime after disinfection;
- all susceptible livestock in the infected flock or herd were vaccinated as well as neighbouring flocks and herds (in cases of high exposure, more rapid protection was provided by the use of antibiotics or specific immune sera if available);
- scavengers and possible vectors, such as flies, rats and birds, were controlled by rapid disposal of carcases;
- an epidemiological investigation was carried out to detect the source of infection (eg animal, feed, environment) to apply appropriate control procedures to limit further spread; and
- measures were taken to prevent the contamination of water and soil and to prevent the spread of infection to other premises and environments.

Anthrax is notifiable to animal health authorities in most countries but control measures vary. The principal control measure used is vaccination of susceptible animals in areas known to be at high risk. There may also be strict quarantine and movement controls combined with safe disposal of infected carcases and effective disinfection of contaminated sites. Regulatory controls on the production and use of meatmeal and bonemeal are also essential to prevent outbreaks caused by the ingestion of contaminated meals used in livestock feeds. However, many countries do not apply control measures to all parts of the country or to all types of production. This may be because they lack the necessary resources (eg to vaccinate large numbers of domestic animals or wildlife, or to adequately regulate the production of meatmeal and bonemeal) or because the low prevalence of the disease does not warrant routine controls such as annual vaccination of animals in low-risk areas.

## 2.2 Methods to prevent spread and eliminate pathogens

In Australia anthrax is generally a sporadic disease occurring on up to three premises during an incident. It has occasionally extended over many more premises, giving rise to an unusual outbreak. In Australia, it is usually spread by susceptible animals contacting infected dead animals, or their death sites, and ingesting infected soil and/or pasture. Wider spread of infection may occur with the movement of incubating-infected animals that later die at the new site.

In unusual outbreaks, infection spreads in all these ways and in other poorly defined ones. These unusual outbreaks remain largely undefined because of their irregular occurrence , but the spread can be expected to occur in a defined area unless incubating animals and/or gross contamination are moved across districts. Overseas experience adds little to the explanation of Australia's unusual outbreaks.

### 2.2.1 Quarantine and movement controls

**Infected premises**

In Australia, all premises experiencing infection are subject to immediate quarantine, with a total embargo on livestock movements. Animals on infected premises (IPs) are vaccinated. In serious cases, such as where infection has been suspected of having been in place for some time, animals on neighbouring premises are also vaccinated and quarantined.

For IPs, animals are held under quarantine for at least 6 weeks following vaccination and until there have been no further cases for at least 20 days, whichever is the longer. For non-infected premises, animals are quarantined for at least 42 days after vaccination. A summary of conditions for quarantine and movement controls of animals, animal products and byproducts is given in Appendix 2.

**Zoning**

Zoning may be required if an unusual outbreak is not quickly brought under control.

The OIE Terrestrial Code (see Appendix 3) provides principles for the application of zoning and regionalisation in the control of infectious diseases based on sound risk assessments rather than risk avoidance. These principles recognise that factors such as physical and geographical barriers and epidemiological considerations relevant to the particular disease are more appropriate mechanisms for defining areas from which trade in animals and animal products should be restricted or controlled. The OIE Terrestrial Code does not provide prescriptive zoning/regionalisation requirements for each disease.

The general requirements for zoning and regionalisation are that:

- the disease must be notifiable;
- size, location and delineation requirements for zones/regions will vary, according to disease, depending on the method of spread and national disease status;

- the extent of a zone and its limits should be established by the veterinary administration, be enforced by national legislation and be clearly delineated by effective natural, artificial or legal boundaries;

- constant supervision of the zone boundaries is essential, with control over the movement of animals and animal products; and

- the veterinary service must have adequate resources at its disposal and be able to supervise the boundaries, maintain clinical and epidemiological surveillance and monitoring and undertake confirmatory diagnostic testing.

### 2.2.2 Tracing

All animals that have been moved off a property during the 20 days before the index case of anthrax should be rapidly traced. If healthy, the animals can be immediately slaughtered or vaccinated and quarantined for 42 days after vaccination. If anthrax occurs, the premises is treated as a new outbreak site. When anthrax is suspected of being transported as an incubating case, trace-back is applied to imported animals.

Anthrax has never been spread through animals exported from Australia. The controls placed on affected or suspect livestock and their movement are more than adequate for preventing the spread of anthrax.

### 2.2.3 Surveillance

In sporadic incidents, active surveillance needs to be initiated and maintained on IPs and neighbouring premises. Unusual outbreaks require active surveillance over a wider area to ensure that the boundaries of infection can be established for zoning purposes.

The infectious status of herbivores that die suddenly must be investigated. This could require specimens being submitted to a local veterinary laboratory able to test for anthrax. Any doubtful specimens can then be sent to an approved laboratory for further testing. Such an arrangement enables carcases to be handled with knowledge of their infection status. Any reports of suspicious multiple deaths need to be investigated by an authorised officer.

### 2.2.4 Treatment of infected animals

Antibiotic treatment of valuable infected animals (with temperatures higher than 40°C) may allow complete recovery if given early in the course of the disease. However, antibiotics interfere with the development of immunity after vaccination and should, therefore, not be given in the 10 days immediately before or immediately after vaccination. If treatment cannot be avoided, then the treated animal should be identified and revaccinated as soon as possible after the 10-day period has expired. The appropriate withholding period for the antibiotic must be observed.

### 2.2.5 Destruction of animals

Mass killing of animals is not required for anthrax control.

### 2.2.6 Treatment of animal products and byproducts

**Milk**

Milk obtained from animals that are healthy at the time of milking does not contain anthrax bacilli (see Section 1.6.3). In addition, milk on dairy premises is now cooled rapidly and held at 4°C or below, so that multiplication or sporulation of any bacilli is prevented before pasteurisation, which kills all vegetative bacteria. Although, theoretically, milk may become contaminated with spores from the environment, experience demonstrates that this risk is negligible as anthrax has not occurred in humans as a result of consuming milk or milk products. There is no withholding period for milk from vaccinated animals. Further details are given in Appendix 6.

**Meat, wool and hides**

***Animals processed at an abattoir***

Meat obtained from animals that are normal and healthy at antemortem and postmortem inspection poses no risk of anthrax infection. The wool and hides from such animals are also free of infection. Further details are given in Appendix 6

***Animals that die on-farm or at a knackery***

The treatment of animal products such as wool, hides and meat possibly infected with anthrax should not be attempted in Australia. All likely infected materials should be disposed of by burning or burial. Treatment of hides, skins, hair and wool can be carried out for occupational health purposes using methods such as those outlined by VPHAWG (1998) and irradiation.

### 2.2.7 Disposal of animal products and byproducts

Disposal of animals that have died of anthrax, and associated materials, should take account of the epidemiology of anthrax (see Section 1.6). Anthrax is, to all intents, an obligate parasite. The spore phase of the disease is the mechanism for the survival of the organism and infection of another animal. Originally believed to be indestructible, spores on the soil surface are now recognised to be far more destructible than spores located 15 cm and more below the soil surface in an environment of pH 9.

Vegetative bacteria have been grown from spores that have been in a favourable subsoil environment for around 200 years (de Vos 1998). Therefore, spores associated with an infected carcase buried in a favourable subsoil environment (pH 9 calcareous environment) provide a source of sufficient concentration to initiate infection in future seasons and years. Spores at the soil surface, however, are inactivated and dispersed by the action of wind, rain, temperature, acidity, sunlight and ultraviolet irradiation (Lindeque and Turnbull 1994, Dragon and Rennie 1995).

Burning is the preferred way to dispose of infected carcases in Australia, unless it is precluded by other factors. If burning is not possible, carcases may be buried with a soil coverage depth of at least 1 metre, preferably 2 metres. When burying carcases, they should be liberally treated with quicklime (pH 11–13) or covered with a mixture of 1 part chloride of lime (25% activated chlorine) and 3 parts of soil before the grave is filled (de Vos 1994).

Dead animals should be disposed of under the control of government officers using methods designed to eliminate contamination.

In the 1997 unusual outbreak in Victoria, carcases were either burnt at the site and the ashes buried deeply, or removed in double thickness, heavy-duty plastic (to prevent the spilling of body fluids) to a burning site.

In some areas of Australia it is impractical to burn carcases for fire safety reasons and other ways to prevent carcases from becoming future long or medium-term infection sources need to be considered. Deep burial is also not practical in some areas in mid-summer, and in areas where subsoils are pH 9 it must be recognised that shallow burial of carcases will lead to long-term survival of anthrax spores. An alternative strategy for carcase disposal is leaving dead animals intact to putrefy, after first liberally treating the carcase and surrounds with 5% formaldehyde. Carcases are protected from predator attack. This strategy relies on the fact that formaldehyde destroys spores, and that spores in the environment are more fragile when exposed to full environmental conditions. It follows principles established in Cyprus, where an aggressive program to bypass carcase burial led to anthrax freedom (M Hugh-Jones, pers comm 1998).

### 2.2.8 Decontamination

Anthrax infection is maintained through infectious bacteria spilled from carcases at the time of death, and by any activities that will spread this infection from carcases and sites of infection.

The risk of contamination of buildings, yards, trucks and equipment must be carefully assessed. The following guidelines can be used where decontamination is needed. All treatment methods are taken from de Vos (1994).

**Personnel, clothing and equipment**

People handling diseased animals, carcases or tissues must wear gloves and protective clothing and follow appropriate personal disinfection procedures at the conclusion of such work to protect themselves and to prevent further spread of contamination. Disinfectants such as 1% activated chloramine, 5% formaldehyde or 4% glutaraldehyde, used for 4 hours, are effective against bacterial spores on clothing and small equipment. Boiling materials in 2% calcined ash for at least 90 minutes will also destroy spores.

**Contaminated sites**

Contaminated soil, bedding, manure, unused feed and so on should be decontaminated for at least 12 hours with 5% formaldehyde at a rate of 5 L/m$^2$, or deep buried with a liberal treatment of quick lime or chloride of lime to raise the pH (see Section 2.2.7). Alternative treatments for contaminated sites and soil are: 10% caustic soda solution, 5% clarified lime, 10% neutral calcium hypochlorite or 15% basic calcium hypochlorite or sodium dichlorisocyanurate; these solutions need to be applied at 10 L/m$^2$.

**Heavy equipment**

Machinery and equipment used to dispose of carcases, manure and other contaminated items should be disinfected with an appropriate disinfectant such as 1% activated chloramine. Exposure time needs to be at least 24 hours.

**Livestock transport**

When a death occurs during livestock transport, there is a high probability of contamination of the vehicle and exposure of other livestock in the vehicle. The vehicle can be dry-cleaned, then treated with a hot solution of 3% cresylic disinfectant or 1% orthophenylphenate and left for 2 hours followed by cleaning with detergents to remove organic matter.

**Premises**

Preliminary disinfection must be undertaken before cleaning. Disinfectant solutions that can be used are 10% hot caustic soda solution, 4% formaldehyde, chlorine disinfectants such as calcium hypochlorite (5% active chlorine), 7% hydrogen peroxide or 2% glutaraldehyde. These solutions are applied twice, 2 hours apart, at a rate of 1 L/m$^2$, and left for 3 hours followed by cleaning with detergents.

### 2.2.9 Vaccination

Singly vaccinated animals are usually protected for 6–12 months, provided that the animals receive the full vaccine dose and are not under antibiotic therapy before or after vaccination (see Section 1.5.3). Animals vaccinated twice at a 6–12 month interval are normally immune for life.

Vaccinating exposed animals for three years on infected premises following an incident provides time for the dispersal and inactivation of spores on the soil surface to levels unlikely to support initiation of infection. Compulsory vaccination on IPs was ceased three years after the unusual outbreak in central northern Victoria in 1997. Only six cases of anthrax were recorded in the summer of 1997–98, and no cases of anthrax were recorded in the summers of 1998–99, 1999–2000 or 2000–01, which supports the effectiveness of this decision.

The Sterne strain 34F2 vaccine causes few adverse reactions in cattle and sheep, although there may be a transient temperature rise and fall in milk production and sometimes abortions. However, as severe reactions can occur in goats, alpacas and horses, enforcement of vaccination in these species needs careful consideration. Alternative means for protecting these animals from infection need to be considered— for example, removal from pasture to a clean area and hand feeding; such animals would need close monitoring to enable antibiotic treatment of any animal developing a fever.

In an outbreak setting, vaccination does not seem to halt deaths as efficiently as with sporadic incidents, in which deaths normally cease 5–7 days after vaccination. Deaths will continue on heavily contaminated premises for more than 10 days after vaccination (up to 60 days has been recorded) and there is pressure to carry out revaccination. Whether revaccination is beneficial is unclear, although there is probably little benefit in revaccinating in under 6 months from first vaccination (see Section 1.5.3).

### 2.2.10 Wild animal control

Where possible, feral pigs should be prevented from scavenging on carcases and shallow-buried infective material. The impact of pigs and other vermin on the spread of contamination will be minimised by the rapid identification and safe treatment of infected carcases.

### 2.2.11 Vector control

A decision on control of biting insects in an infected area would only be likely when there were plague proportions of such insects and it was believed that they were important vectors of anthrax infection. Vaccination and herd immunity will limit the spread of anthrax by vectors. Rapid identification, removal and safe disposal of infected carcases will assist in reducing background contamination by carrion insects. Insecticide spraying of carcases to reduce carrion insects may be warranted if carcase disposal is delayed.

### 2.2.12 Sentinel and restocking

Complete destocking of a premises is not usually necessary for anthrax control. Where vaccination is being carried out, new stock introduced onto premises and calves that reach two months of age should be vaccinated promptly. Introduced stock vaccinated on arrival should not be put into known infected paddocks until immunity has had the opportunity to develop (about 10–15 days). IPs should revaccinate annually, before the season of greatest risk, for at least three years.

### 2.2.13 Human infection

As anthrax is a significant zoonosis, all people handling dead animals or other infective material, including live vaccines, should wear protective glasses, gloves and clothing and protect skin breaks from infection. People exposed to infection either through wounds or self inoculation while vaccinating animals with live vaccine should seek medical advice (see Section 3.2.9).

Anthrax is not highly transmissible from carcases because the organism occurs in long filaments or chains and hence is not readily aerolised. The disease has not occurred in people on affected farms unless there is contact between broken skin and associated butchering or other close contact with an infected carcase.

Pulmonary anthrax has not been recorded in Australia. Eighteen cases of pulmonary anthrax were reported in the USA from 1900 to 1976. Most of these cases occurred in special risk groups, including goat hair mill or wool or tannery workers, and two were laboratory associated. After 1976, no cases of pulmonary anthrax were reported in the USA until 2001, when several people contracted the disease through exposure to anthrax spores sent through the mail. There is no epidemiological evidence for the need for additional protection, such as body suits or respiratory masks or hoods, when people are handling infected carcases, and currently worldwide there are no recommendations for their use (Inglesby et al 2002).

### 2.2.14 Public awareness

Sporadic outbreaks rarely generate a significant amount of media attention, and then this is usually only at a local level. Unusual outbreaks may involve extensive media scrutiny and reporting, particularly from burning activities. A media

campaign must emphasise to cattle producers the importance of inspecting susceptible animals regularly and reporting illness or sudden deaths. Details of any imposed movement controls need to be readily available and clearly explained to industrial representatives.

Given the important zoonotic implications of anthrax, people at risk must be advised of appropriate occupational health and safety requirements and health authorities should be alerted to the potential for human infection. There will be a need to allay public concerns about the safety for human consumption of meat, dairy products and other animal products derived from healthy animals that are subjected to the routine inspection and processing regimes used in Australia.

## 2.3 Feasibility of control in Australia

Eradication of anthrax is difficult in Australia, although the disease has been eliminated from areas of Australia where it was previously endemic. Experience in Cyprus has demonstrated that eradication is possible with the appropriate disposal of carcases, particularly by avoiding the burial of carcases. Anthrax can be affectively controlled with vaccination and the safe disposal, preferably by burning, of carcases of animals that die of anthrax. In the long term, it may be feasible to eradicate anthrax from Australia.

# 3 Policy and rationale

## 3.1 Overall policy

**Anthrax is an OIE-listed animal disease that has the potential to affect many animals within a herd. It is important in the trade of livestock and is a significant public health issue. Anthrax is a notifiable disease in all states/territories of Australia.**

**The policy is to control anthrax in Australia using a combination of strategies including:**

- ***regular vaccination of susceptible livestock*** **located on sites with a known history of anthrax to prevent cases occurring;**
- ***epidemiological investigation*** **to promptly identify the source of infection and record where anthrax has occurred in livestock;**
- ***quarantine of*** **affected premises to prevent spread;**
- ***decontamination*** **of the environment at death sites, and facilities, products and equipment that may have been contaminated;**
- ***safe disposal*** **of carcases to control spread of infection;**
- ***prompt vaccination*** **and/or treatment of exposed livestock;**
- ***tracing*** **livestock movement in and out of infected premises (IPs);**
- **in unusual outbreaks, *establishment of a vaccination zone* around IPs encompassing premises with common circumstances to the infected premises within which livestock are vaccinated and premises quarantined;**
- ***ensuring the safety of livestock products*** **by preventing potentially infected livestock and livestock products from being processed for human or animal consumption or industrial use;**
- ***using recording systems*** **to facilitate trade in livestock and livestock products, by providing accurate data from investigations to assure area and farm freedom from anthrax, enabling accurate certification of livestock and livestock products and communicating anthrax surveillance information to the livestock industries; and**
- ***a public awareness campaign*** **to ensure reporting of sudden unexplained deaths of livestock, reduce the risk of human infection by providing advice to people handling livestock and by liaising with public health authorities in the event of an anthrax case in a human.**

**An uncontrolled outbreak of anthrax would cause severe production losses to the affected producers with potential dislocation and financial losses to the livestock industries from effects on exports. There is serious potential for fatal human disease.**

**A major outbreak of anthrax is an Animal Health Australia Category 3 disease under the government–industry EAD Response Agreement for cost-sharing arrangements. Category 3 diseases are those for which costs will be shared 50% by government and 50% by industry.**

For sporadic incidents of anthrax, states/territories report events on a weekly basis to the Australian Government Office of the Chief Veterinary Officer, who incorporates this information into annual reports to the World Organisation for Animal Health (OIE).

For unusual outbreaks, states/territories report immediately to the Australian Government Office of the Chief Veterinary Officer, who incorporates this information into an emergency report to OIE.

The chief veterinary officer (CVO) in the state or territory in which the outbreak occurs will be responsible for developing an Emergency Animal Disease (EAD) Response Plan. This plan will be approved for technical soundness and consistency with AUSVETPLAN by governments and affected livestock industry technical representatives on the Consultative Committee on Emergency Animal Diseases (CCEAD). The plan will ultimately be approved and cost-shared by government chief executive officers and industry leaders through the national management group (NMG) of government and industry representatives established for the incident.

CVOs will implement disease control measures as agreed in the EAD Response Plan and in accordance with relevant legislation. They will make ongoing decisions on follow-up disease control measures in consultation with the CCEAD and the NMG. The detailed control measures adopted will be determined using the principles of control and eradication (Section 2) and epidemiological information about the outbreak.

For further information on the responsibilities of the state or territory disease control headquarters and local disease control centres, see the **Control Centres Management Manual, Part 1.**

## 3.2 Strategy for control and eradication

The objective is to control anthrax in Australia. Since anthrax is an exceptional occurrence in Australia, but is not an exotic disease, the control of anthrax is already well established. Incidents of anthrax trigger rapid, rigorous and thoroughly comprehensive field response programs by national, state and territory government authorities to ensure that livestock products remain safe for both domestic and export markets. All of the principles recommended in the WHO *Guidelines for the Surveillance and Control of Anthrax in Humans and Animals* (VPHAWG 1998) are applied. State/territory legislation requires the notification of a suspicion of anthrax, quarantine of premises when anthrax is confirmed or suspected, vaccination of all livestock at risk, disposal of carcases and disinfection procedures.

Control measures are applied according to the two patterns of occurrence:

- sporadic incidents; and
- unusual outbreaks (on the decision of the relevant state/territory CVO when there are a number of cases on more than five premises within a defined geographical area in a short period of time).

Food for human consumption must be produced to rigorous standards to ensure that consumers are protected from foodborne pathogens, including anthrax. Inspection procedures relevant to the production of animal-derived food for humans are outlined in Appendix 6. These procedures are of international standing.

### 3.2.1 Stamping out

Stamping out or slaughter of all in-contact animals on infected premises (IPs) is not an appropriate control measure for anthrax.

### 3.2.2 Epidemiological investigation

Epidemiological investigation is undertaken to identify the index case, establish the source and trace livestock movement on and off affected premises.

Animals and risk items that have left IPs in the 20 days before the presumptive index case of an anthrax infection on a farm are traced. Assisting this, Australia has a national identification system that enables cattle to be traced back to their farm of origin. This involves the compulsory attachment to the animal of a numbered farm-specific tail-tag or ear-tag before it leaves the farm. In the abattoir this identification stays correlated with the carcase so that any pathological conditions and residue problems found at or after slaughter can be traced to the farm of origin.

Records of each suspected anthrax case should be collected, including the details of:

- the herd history (particularly recent unexplained sudden deaths, vaccination status for anthrax and clostridial diseases, treatments, supplementary feeding, location of stock, and recent stock movements);
- property details (including information on topography, use of fertilisers including organic fertilisers, vegetation, pastures, soils, stock water supplies, history of recent earthworks, rainfall, irrigation, drainage, and average daily temperatures in the period immediately before the occurrence of anthrax); and
- contaminated areas, such as death or burial sites

### 3.2.3 Quarantine and movement controls

In the event of anthrax occurrences, quarantine and movement controls are immediately placed on IPs (see Appendix 1) and any other premises on which stock are vaccinated.

When sporadic or unusual incidents of anthrax occur, the stock on the affected premises are vaccinated and placed under legal quarantine restrictions that describe and define the limits of the quarantine area. Contiguous premises on which there are susceptible stock may also be vaccinated, in which case the premises are quarantined. In sporadic cases vaccination of contiguous premises will be determined according to an assessment of risk of infection, but all contiguous premises to an infected premise should be vaccinated in unusual outbreaks. Movement controls are enforced on infected and vaccinated quarantined premises. A defined, localised vaccinated zone can be established using this legal mechanism or a 'vaccination zone' may be declared in unusual outbreaks.

In an unusual outbreak, a vaccination zone may be declared surrounding IPs.

See Appendix 2 for further details on quarantine and movement controls

**Zoning**

In an unusual outbreak, a decision will be made by CCEAD as to whether to implement zoning. This decision will be based on potential advantages to trade within and beyond Australia. In implementing zoning, a vaccination zone is imposed around IPs within which all susceptible animals are vaccinated. All premises in the vaccination zone are subject to quarantine with a mandatory movement embargo. The extent of the vaccination zone will be determined by the state/territory CVO. The zone is determined on the basis of a range of factors, including progression of infection, climatic conditions, topography and stocking density, the distribution of affected premises, the epidemiology and pattern of the disease occurrence in the outbreak and legal, natural or built barriers, such as rivers or roads, that can provide readily identifiable boundaries, consistent with the OIE Terrestrial Code (see Appendix 3). The zone may follow the boundaries of a legally defined entity, such as a local government area or parish. When declared, zone boundaries and movement controls on individual premises within the zone are enforced by government officers authorised under the affected state's animal disease control legislation.

In unusual outbreaks, intensive surveillance would be undertaken within the declared vaccination zone and surrounding areas, with suspect dead stock being subjected to laboratory testing.

Australia has the following infrastructure in place to facilitate implementation of zoning.

- Anthrax is a notifiable disease in all states/territories of Australia.
- The veterinary services in all states/territories have networks of government veterinarians, including specialists in epidemiology, diagnosis and disease control. These are supported by highly competent laboratory services and stock inspectors (animal health technicians) with the necessary regulatory powers to undertake confirmatory diagnostic testing and disease control activities, including movement controls on animals and animal products from affected and vaccinated premises.
- The Australian Quarantine and Inspection Service (AQIS) has veterinary officers and inspectors at export-registered premises to control the movement of animal products and ensure food safety. State meat hygiene legislation provides similar controls at meat establishments that supply domestic markets.
- There are private veterinary practitioners who are approved as necessary to undertake specific disease control activities in support of government programs.
- Appropriate vaccination zones can be enforced under legislation, being clearly delineated by effective natural, artificial and/or legal boundaries.
- The zone boundaries can be continuously supervised and the movement of animals and animal products controlled.

Adequate resources are available to supervise quarantined premises, monitor the boundaries of declared zones, maintain clinical and epidemiological surveillance and undertake confirmatory diagnostic testing and control the movements of animals and animal products.

Further information on quarantine and movement controls is given in Appendix 2.

**Criteria for lifting restrictions**

See Appendix 4 for further details.

***Sporadic incidents***

For sporadic incidents individual premises are released from quarantine restrictions when they meet the following criteria:

- IPs — a minimum of 42 days after completion of vaccination of susceptible animals on the farm or 20 days after their last confirmed case, whichever is the later.
- Vaccinated premises that have not had a case of anthrax — a minimum of 42 days after completion of vaccination of susceptible animals on the farm.
- IPs without animals, such as a knackery that had received an infected carcase — on completion of thorough decontamination and inspection by a government inspector.

***Unusual outbreaks***

Unusual outbreaks are considered to be over once the epidemic curve returns to the baseline for at least 20 days. This period is the same as the incubation period of the disease as defined in the OIE Terrestrial Code (Appendix 3).

Notwithstanding this criterion, individual premises must still satisfy the criteria for release from quarantine restrictions as specified for sporadic incidents.

Individual premises may be held in quarantine for longer periods at the discretion of the relevant state/territory CVO, to satisfy zone requirements.

### 3.2.4 Tracing and surveillance

If it is suspected that herd infection was established by introduction of an incubating animal, trace-back and trace-forward need to commence immediately anthrax is confirmed and must include the waste of live and dead animals, equipment associated with stock and people who had contact with dead animals.

All animals leaving a farm in the 20 days before the index case of anthrax should be rapidly traced, quarantined, assessed for infection and vaccinated against the disease. Any movements to abattoirs in this period must be notified to the relevant meat inspection service and product traced. Surveillance to rapidly detect cases of anthrax must begin as soon as anthrax is suspected, in order to establish the extent of infection in and around IPs.

See Appendix 4 for further details on surveillance.

### 3.2.5 Vaccination

Vaccination is the key control measure in IPs and outbreak zones. Livestock judged to be at risk, including other susceptible species grazing on or near the land on which the death(s) occurred, should be vaccinated immediately.

Vaccine use in all states/territories requires CVO approval. Such approval would normally be given to vaccinate livestock on all IPs and declared vaccination zones in an unusual outbreak, as well as on premises neighbouring IPs in sporadic incidents.

Vaccinated stock must not move out of quarantine until anthrax infection has been controlled.

Vaccination is compulsory on all IPs and on all premises in a declared vaccination zone. It may or may not be compulsory on neighbouring premises in sporadic incidents. If compulsory vaccination is not required on neighbouring properties, the owners may be permitted to vaccinate voluntarily, at the CVO's discretion.

When vaccination is being carried out, introductions of new stock onto premises and calves reaching 2 months of age require prompt vaccination. Affected properties should revaccinate annually for three years after the outbreak before the season of greatest risk and at least 6 months after the first vaccination to boost immunity should there be high challenge. Annual vaccination is in accordance with manufacturers' recommendations, and is precautionary to minimise the risk of further cases, although possibly unnecessary for many animals. In sporadic incidents neighbouring properties would not normally be required to revaccinate except under special circumstances. Neighbouring properties and other premises in the vaccination zone of an unusual outbreak might be required to revaccinate for up to two years after the last case.

In the areas of Australia where anthrax occurs sporadically, preventive vaccination is undertaken annually on a small proportion of previously affected properties.

Feedlots, as enterprises with large aggregates of animals, need to have a policy on whether to routinely require prior vaccination of all entering animals, to vaccinate all animals on arrival, to vaccinate those from certain areas or not to vaccinate at all. Anthrax vaccination is not warranted at all feedlots. Feedlot managers should make their own risk assessment for their situation and decide whether vaccine will be applied to all, some or no animals entering the feedlot. There is the opportunity for feedlot managers to require vaccination of animals from certain regions weeks in advance of arrival. The Australian Lot Feeders Association have developed a code of practice for feedlots to control anthrax (see Appendix 5).

Where vaccination is performed, vaccinated animals should be effectively identified and must not be slaughtered for human consumption until after the withholding period has expired. Vaccinated animals have a minimum withholding period of 42 days before slaughter for human consumption. Penalties apply for unauthorised disposal or slaughter of stock within the withholding period under both disease control legislation and legislation controlling the use of veterinary chemicals. Careful consideration should be given to the withholding period before vaccinating livestock, particularly in feedlots.

See Sections 1.5.3 and 2.2.9 for further details on vaccination, including vaccines available and methods of vaccination.

### 3.2.6 Treatment of infected animals

It is unusual for herbivores to be seen to be sick with anthrax so there is no opportunity for treatment. However, dairy cattle, which are under close observation, may be able to be treated with antibiotics.

Mass herd treatment with antibiotics has been carried out with variable results; the Australian experience does not support the wholesale treatment of animals exposed to anthrax infection with antibiotics because:

- a single treatment without a suspicion of infection (such as clinical signs or elevated temperature) will not necessarily protect against infection;
- treatment with antibiotics prevents effective vaccination of animals for a variable period of more than 10 days; and
- it is critical to raise herd immunity to prevent further dissemination of the disease following exposure to further cases in the herd.

### 3.2.7 Treatment of animal products and byproducts

**Knackery products**

Products from animals that have died of anthrax are not normally allowed to move off IPs. These products, products that have been removed to a knackery before diagnosis on the IP and any other products in contact, should be traced and disposed of by burning or burial.

**Other products from IPs**

Other animal products sourced from IPs are subject to inspection, assessment and treatment to destroy any possible infection. The treatment to be applied to products from infected zones would depend on the type of product, the nature of any declared area and the status of the premises.

**Milk and meat**

Milk products with pasteurisation treatment and meat products with antemortem and postmortem inspections are safe for human consumption (see Sections 1.6.3 and 2.2.6). Quarantine restrictions on IPs prevent the movement of infected animals to abattoirs. Any movements of animals from infected premises within the twenty days prior to the index case must be notified to the relevant meat inspection authority. Any meat from such animals must be traced, recalled and destroyed in accordance with the OIE Terrestrial Code. It is essential that all premises operate with a high level of hygiene, and that proper sanitation procedures are followed.

The rationale for the safety of Australian animal products is outlined in Appendix 6 and should be used when there is a question of Australia's capacity to keep *B. anthracis* out of the human food chain.

### 3.2.8 Decontamination

Vegetative *B. anthracis* is susceptible to a wide range of disinfectants and low-temperature heat treatment. The spores are much more resistant to destruction but

chemicals are available to clean and disinfect premises, other things and people (see Section 2.2.8). Decontamination is an essential part of the control program and must be rigorously applied.

The rapid removal of infected and suspect cases of anthrax and their rapid, safe disposal and treatment of death sites significantly reduces the load of infection at the IPs.

### 3.2.9 Public health implications

Anthrax is a serious human disease and may be fatal if exposure to the organism is not treated promptly. Therefore, people handling carcases, tissues or body fluids of animals known to be, or suspected of being, infected with anthrax should seek medical advice immediately, as preventive treatment may be necessary. Animal health authorities should advise the public health authorities when anthrax is diagnosed and ensure that appropriate referral procedures are established.

### 3.2.10 Communication and public awareness strategy and media

Anthrax is a sensitive issue, both in respect of public health perceptions and in relation to trade, particularly with some trading partners. When anthrax is suspected, the state or territory chief veterinary officer or delegate must be advised. If confirmed, the CVO must advise the Australian CVO, CCEAD and the relevant state industry organisation. The Office of the Australian CVO will advise the national peak industry organisations.

If necessary, particularly for 'unusual outbreaks', the state and Australian CVOs and peak industry representatives will develop a public communications strategy, including appointment of spokespersons and, if necessary, notification of Australian posts for overseas and trading partners

See Section 2.2.14 for further details on what to include in a public awareness campaign.

## 3.3 Social and economic effects

Incidents and outbreaks of anthrax are unlikely to seriously affect Australia's export of livestock and animal products.

The main losses would be from mortalities, which can be high, and losses due to an inability to trade while quarantine restrictions remain in place. There would be an increased cost from vaccinating animals, particularly if the program does not provide for this contingency. As it is unlikely that outbreaks would continue for more than two months from the start to the lifting of restrictions, the likelihood of there being long-term economic effects would be low.

Public concern about an anthrax outbreak may result in unnecessary boycotts of livestock markets and even sporting and social events in the area, producing unwarranted economic, social and/or emotional impacts on individuals and the community.

## 3.4 Criteria for proof of freedom

See Appendix 4 for details on proof of freedom.

## 3.5 Funding and compensation

The costs of controlling anthrax, particularly in sporadic incidents, have traditionally rested with the livestock owner. Some states/territories have carried out vaccination and disease control activities, such as disposal of carcases on IPs, with neighbouring properties having to finance vaccination. In the unusual outbreak in Victoria in 1997, the Victorian Government bore the costs of vaccination associated with establishing the vaccination zone. When the outbreak was declared over, owners, industry and the government shared the cost of vaccination.

A major outbreak of anthrax is now classified as a Category 3 emergency animal disease under the EAD Response Agreement between the governments of Australia and the livestock industries.

Category 3 diseases are emergency animal diseases that have the potential to cause significant (but generally moderate) national socioeconomic consequences through international trade losses, market disruptions involving two or more states and severe production losses to affected industries, but have minimal or no effect on human health or the environment. For this category, the costs will be shared 50% by governments and 50% by the relevant industries (refer to the EAD Response Agreement for details).[4]

Since infected and/or exposed animals are not destroyed for control of anthrax, compensation is not normally payable.

Information on the cost-sharing arrangements can be found in the AUSVETPLAN **Summary Document** and in the **Valuation and Compensation Manual**.

## 3.6 Strategy if the disease becomes established

The application of rigorous control procedures and vaccination will bring unusual outbreaks of anthrax under control. Following such outbreaks, it can be expected that there will be some sporadic incidents in the following 18 months. Widespread vaccination alone will bring outbreaks under control, but ongoing incidents are likely to be more frequent if proper attention is not given to the other measures due to there being more residual infection in the district. A comprehensive control program must be rigorously applied to all cases of anthrax to avoid contamination and further cases possibly over very long timeframes.

Eradication of anthrax from Australia is not possible in the foreseeable future but may be possible in the long term, as has been achieved in Cyprus.

[4] Information about the EAD Response Agreement can be found at: http://www.animalhealthaustralia.com.au/programs/eadp/eadra.cfm

# Appendix 1 Guidelines for classifying declared areas

## Premises

### Infected premises (IP)

A premises classified as an IP will be a defined area (which may be all or part of a property) in which anthrax is confirmed. An IP is subject to quarantine served by notice and to control procedures.

### Dangerous contact premises and suspect premises

Not applicable.

## Areas

### Restricted area and control area

Not applicable.

### Vaccination zone

With an unusual outbreak, a decision will be taken on whether to implement zoning. With sporadic incidents, implementation of zoning is not required.

A vaccination zone (VZ) will be a relatively small buffer zone around IPs, declared under legislation, which is subject to vaccination, intense surveillance and movement controls. Movement into and out of the area will, in general, be prohibited, with any movement being only by permit (see Appendix 2). All vaccinated premises in the VZ would be subject to quarantine with a mandatory movement embargo, and all animals at risk on these premises would be vaccinated.

The VZ will be clearly delineated by recognisable natural, artificial and/or legal boundaries. The zone boundaries will be continuously supervised and the movement of animals and animal products controlled. The extent of the VZ will be determined by the state/territory CVO on the basis of a range of factors, including progression of infection, climatic conditions, topography and stocking density.

In such unusual outbreaks, intensive surveillance would be undertaken within the declared zone and within the area surrounding the vaccination zone, with dead stock being subjected to laboratory testing for anthrax.

The VZ would be rescinded when most, if not all, premises within the VZ have been released from quarantine (see Appendix 2).

# Appendix 2 Recommended quarantine and movement controls

### Introduction

The management strategy used for the control of anthrax in Australia is comprehensive; it includes all of the recommendations of the World Health Organization (WHO), and is consistent with the standards of the OIE Terrestrial Code. Anthrax occurs in Australia most commonly as sporadic incidents. The measures used to control anthrax in Australia are summarised as follows.

### Imposition of quarantine

- Anthrax is a notifiable disease in animals in all states/territories of Australia under legislation that provides all the necessary powers for effective disease control.
- Diagnosis of a suspect case is confirmed by laboratory testing, and quarantine measures are imposed on the infected or potentially infected premises (farm, knackery, etc).
- Susceptible livestock are vaccinated using the Sterne strain, a living spore vaccine, which is the internationally preferred vaccine.
- Infected carcases, animal products from infected carcases, such as hides or meat, and any contaminated material (packaging, etc) are disposed of, preferably by burning and in exceptional circumstances by burying.
- Sites of infected carcases, animal products from infected carcases and any contaminated material that have been removed for destruction are thoroughly decontaminated.

### Movement controls

- Movement of animals and animal products to and from an IP in the 20-day period before the likely index case are traced and appropriate action implemented for these animals/products.
- For unusual outbreaks, a vaccination zone is established by quarantine of premises and vaccination of stock on affected and surrounding properties, an approach consistent with the OIE Terrestrial Code standards for the application of zoning and regionalisation in disease control (see Appendix 3).

### Surveillance and monitoring

- Surveillance and monitoring are carried out in an area around IPs to ensure that cases of anthrax are rapidly recognised.
- Dead stock within the vaccination zone and within the area surrounding the vaccination zone are subjected to laboratory testing for anthrax.

**Lifting of quarantine restrictions**

- A quarantine restriction on premises with animals is removed:
  - when 42 days have elapsed since vaccination, and
  - if no case of anthrax has occurred for 20 days (which ever is the later), and
  - thorough decontamination and inspection by a government inspector has been completed.

- In an unusual outbreak, with many contiguous premises affected, the outbreak would be declared to be over when 20 days had elapsed from when the epidemic curve had returned to the baseline. Individual premises would then be released from quarantine when the conditions outlined above had been satisfied.

**Assurance of product safety (see also Appendix 6)**

- Meat safety is assured by imposition of quarantine measures and tracing of livestock in the 20-day period preceding the index case on each infected premises. Additionally, antemortem and postmortem meat inspection procedures at slaughter establishments ensure product safety.

- Milk and dairy product safety is assured by milking only healthy cows, strict refrigeration temperatures for milk and strict milking hygiene measures. Further assurance is provided by heat treatments applied at milk processing factories.

- Hide, skin and wool safety is assured by quarantine measures and tracing of product obtained from animals in the 20-day period before the outbreak.

- Field control measures are subject to performance audit on premises, at saleyards and at other locations under a security program.

**Ongoing procedures**

- Premises where outbreaks have occurred are revaccinated on an annual basis for a minimum of 3 years.

- Replacement animals introduced into herds where anthrax has occurred in the previous three years are vaccinated upon introduction.

The above measures provide effective control of anthrax in Australia, protect public health and assure the safety of animals and animal products for domestic and export markets. The measures ensure that the occurrence of anthrax in Australia remains exceptional and limited in nature. The trade in animals and animal products is enhanced by Australia's systems of recording and animal identification that provide accurate certification of livestock and livestock products on a basis of area and farm freedom from anthrax.

In line with current knowledge on anthrax survival between outbreaks and incidents, Australia is embarking on a changed control policy under which the burial of carcases will be minimised to reduce the opportunity for the future release of anthrax spores to initiate future outbreaks and incidents.

# Appendix 3 OIE animal health code and diagnostic manual for terrestrial animals

## OIE Terrestrial Code

The objective of the *OIE Terrestrial Animal Health Code* is to prevent the spread of animal diseases, while facilitating international trade in live animals, semen, embryos and animal products. This annually updated volume is a reference document for use by veterinary departments, import/export services, epidemiologists and all those involved in international trade.

The OIE Terrestrial Code is amended in May each year. The current edition is published on the OIE website at:

**http://www.oie.int/eng/normes/mcode/A_summry.htm**

The following chapters are relevant to this manual:

Chapter 2.2.1 Anthrax

Chapter 1.3.5. Zoning, regionalisation and compartmentalisation

Chapter 1.3.6. Surveillance and monitoring of animal health

## OIE Terrestrial Manual

The purpose of the *OIE Manual of Standards for Diagnostic Tests and Vaccines for Terrestrial Animals* is to contribute to the international harmonisation of methods for the surveillance and control of the most important animal diseases. Standards are described for laboratory diagnostic tests and the production and control of biological products (principally vaccines) for veterinary use across the globe.

The OIE Terrestrial Manual is updated approximately every four years. The current edition is available on the OIE website at:

**http://www.oie.int/eng/normes/mmanual/A_summry.htm**

The following chapter is relevant to this manual:

Chapter 2.2.1 Anthrax

The World Health Organization's *Guidelines for the Surveillance and Control of Anthrax in Humans and Animals* is accessible at:

**http://www.who.int/emc-documents/zoonoses/docs/whoemczdi986.html**

# Appendix 4 Procedures for surveillance and proof of freedom

### Proof of freedom

The Organisation International des Epizooties (OIE) has not defined freedom from anthrax. Proof of freedom is unrealistic for anthrax, since spores can survive in soil for many years. The issue is, rather, to be able to declare with confidence that an unusual outbreak is over. In the case of the unusual outbreak in Victoria in 1997, the declaration was made when:

- the epidemic curve had returned to the baseline — new IPs were no longer being recorded on a regular ongoing basis; and
- the numbers of new cases of anthrax on known IPs had fallen to a low level.

In 1997, it was considered that these criteria were met 28 days after the epidemic curve returned to the baseline with low numbers of confirmed cases, but the period could have easily been 20 days (ie the OIE Terrestrial Code incubation period). The 20-day period is now the Australian recommended one.

### Procedures for surveillance

In determining an effective and efficient program to demonstrate control of the disease, the following elements should be considered.

- Early notification of sudden death of livestock to veterinarians and/or animal health authorities is critical for an effective program.
- A rapid diagnosis can assist with making decisions about appropriate carcase disposal and decontamination.
- Diagnosis can be speeded up by submitting specimens to a temporary local laboratory such as in a caravan.
- As the resources available for surveillance are likely to be limited, practitioners (and possibly farmers) should be encouraged to submit specimens of blood and ears from dead animals (such as at knackeries, boiling down works etc) to provide additional information on anthrax occurrence.
- Estimating the time when outbreaks could have commenced from death patterns on premises provides the point from which trace-forward needs to commence to secure meat, skin and hide supplies.
- Effective surveillance is needed to protect markets by ensuring the safety of animal products of animal origin intended for human consumption.

Surveillance needs to continue until it is clear that the unusual outbreak has been brought under control and further cases of anthrax are unlikely.

# Appendix 5 Code of practice for cattle feedlots to control anthrax

The Australian Lot Feeders Association (ALFA) has prepared a code of practice for cattle feedlots to control anthrax. The latest edition of the code is available on the AFLA website:

http://www.infarmation.com.au/ALFA/default.asp [and follow links to anthrax best practice guidelines]

The code can also be obtained by contacting the association by telephone on 02 9241 6988 or by email at alfabeef@magna.com.au.

# Appendix 6 Safety of Australian animal products and byproducts

Extract from *The Control of Anthrax in Australia*, which was published by the Australian Government Department of Primary Industries and Energy (DPIE — now Department of Agriculture, Fisheries and Forestry) in March 1997.

## Meat and meat products

### Action at abattoirs

The pathogenesis of anthrax under Australian field conditions is that the organism is continuously filtered out of the bloodstream until the last few hours of life when the bacteria rapidly build up in the blood stream. Valli (1985) stated that 'septicaemia in anthrax is a terminal event'.

Thus, animals infected with anthrax are visibly ill and the carcases of such animals have septicaemic characteristics that make them unsuitable for meat. Routine antemortem and postmortem inspections ensure such animals do not enter the food chain. Under the *Export Control Act 1982* and the *Export Meat Orders*, Australia applies rigorous controls to animals sent for slaughter. This legislation controls the inspection of livestock and meat at export slaughter plants and requires veterinary antemortem and postmortem inspections. Only meat from animals and carcases that has passed these inspections enters the human food chain. Livestock slaughtered for domestic consumption is also subject to antemortem and postmortem inspection.

Australian meat and meat products for human consumption can be assured of being anthrax-free because:

- infected premises are immediately quarantined and animals on the farm vaccinated; in unusual outbreaks, animals on surrounding premises are compulsorily vaccinated;
- diagnostic tests are applied to all animals dying suddenly within and outside the vaccination zone in an unusual outbreak;
- all vaccinated stock are withheld from slaughter for at least 42 days;
- all animals for slaughter are examined for health both antemortem and postmortem;
- only healthy animals are slaughtered;
- Australia has an animal identification system using ear and tail tags and a vendor declaration system to enable trace-back of animals to farm of origin and to identify the chemical and treatment status of animals at slaughter; and
- Australia has never spread anthrax to humans or animals through meat or meat products passed as fit for human consumption either domestically or in export produce.

### Action at feedlots

Australia has a national accreditation program for feedlots. The code of practice for feedlots covering the prevention program for anthrax is in Appendix 5.

In brief, the program is best practice guidelines for the operation of feedlots and includes prevention and responses to the occurrence of anthrax in a feedlot. Cattle in feedlots are examined daily for health and welfare. Cattle that are not well are removed and put into hospital pens for veterinary examination and treatment.

Where suspected, an early diagnosis of anthrax will decide the action to be taken to control the situation. When suspected, the carcase and surrounds need to be sprayed liberally with 5% formaldehyde and the carcase removed from the pen to an area where it can be safely disposed of. Where anthrax is confirmed, animals from the same source need to be segregated and temperatures of these animals taken twice daily. Animals with a high temperature would be treated immediately with appropriate antibiotics.

Cattle ready for slaughter, in the pen where the anthrax case occurred, would have temperatures taken twice daily for 10 days and those with normal temperature allowed to go to slaughter 20 days after the last potential exposure to anthrax. Temperatures would again be taken immediately pre-slaughter. Animals with elevated temperatures would be treated with penicillin and withheld from slaughter for the appropriate drug withholding period.

Cattle within six weeks of slaughter, in the pen where the anthrax case occurred, should be examined twice daily and temperatures taken and any cattle with an elevated temperature segregated and treated with antibiotics. In the absence of vaccination and where no further cases occur in the incubation period of 20 days, the infection has been controlled and quarantine may be lifted.

Cattle more than six weeks from slaughter in the pen where the anthrax case occurred should be vaccinated and withheld for slaughter for 6 weeks. Any animals with an elevated temperature prior to vaccination needs to be treated with penicillin and segregated. Quarantine will be lifted in the case of unvaccinated cattle 20 days after the last case and, for vaccinated cattle, 20 days after the last case or 42 days after vaccination whichever is the longer.

All cattle in the feedlot need to be kept under close observation for illness and treated appropriately. The pen in which the animal died needs to be treated with 5% formaldehyde at 5 L/$m^2$ and the pen can be reused 24 hours later, or have the top 5–10 cm of the yard removed and securely disposed of away from contact with animals. The remaining top soil may be treated with 5% formaldehyde.

### Additional safeguards

Property identification numbers of any farms that have had a case of anthrax or that have had their herds vaccinated against anthrax are entered on an anthrax database. This database is available to government officers to ensure that no livestock are traded within the prescribed withholding period. Performance audits are undertaken on farm, at saleyards and other locations to verify compliance. Breaches of quarantine and/or withholding period requirements can result in substantial penalties. The farms remain on the database while they are either in quarantine or there are livestock on the property within the withholding period for anthrax vaccination.

This system is supported by vendor declarations, signed by the animal owner or farm manager, that provide details of the history of any veterinary chemical treatments of cattle in the previous 60 days.[5] Although the use of vendor declarations are not mandated by law, their use is almost universal and the commercial practice is that consignments not covered by a declaration are subject to significant discounts in the marketplace and are not bought by export abattoirs. False or misleading statements made in a declaration may lead to prosecution by the government and/or attract civil action from the purchaser.

## Milk and dairy products

Australian milk and dairy products can be assured of being anthrax-free because:

- only milk from healthy cows is incorporated into farm vats for factory pick-up (the milk from infected cows does not contain *B. anthracis* until close to death or after the cow dies, M'Fadyean 1909);
- milk from unwell animals is not added to the farm milk vat — unwell animals are milked separately and the equipment used in collection is disinfected following milking;
- vegetative anthrax organisms cannot survive in unpasteurised milk — they cannot sporulate and die out over a 24-hour period at 59°C; pasteurisation also kills all vegetative organisms (Bowen and Turnbull 1992);
- milk from the cows is rapidly cooled by a heat exchanger and stored in a refrigerated vat that chills and holds the milk at less than 4°C within 3.5 hours;
- milk from the farm vat is transported to the milk processing factory in insulated tankers and stored in refrigerated 'silos';
- all milk used in the manufacture of dairy products is treated to at least HTST (high temperature short time) pasteurisation standard to ensure any vegetative anthrax bacilli and other pathogenic bacteria are destroyed should they gain access to milk;
- herds are vaccinated with Sterne strain vaccine, an avirulent and non-encapsulated organism that is not excreted into milk, and that is registered by United States and Australian authorities with a nil withholding period for milk; and
- milk and dairy products have never been shown to be a vehicle in Australia for the spread of anthrax to humans or calves.

[5] The National Vendor Declaration forms for *Cattle* and for *Sheep and Lambs* are published by Meat and Livestock Australia Ltd. The vendor declarations may be updated from time to time. The latest editions may be obtained by contacting Meat and Livestock Australia Ltd at the website http://www.mla.com.au or by telephone on 1800 635 445.

Australian milk handling processes require milk collected from the cow to be carried through milk lines through a heat exchanger to a milk room refrigerated vat. The heat exchanger rapidly cools the milk from around 37°C (as it leaves the cow) to less than 4°C within 3.5 hours. It is then transported in insulated tankers to the milk factory where it is stored in refrigerated 'silos' until processed.

The evidence that there is no risk of spreading infection through milk under proper hygiene conditions is now overwhelming. There are no records in the scientific literature of anthrax being transmitted to humans through the consumption of milk or milk products (M'Fadyean 1909, Steele and Helvig 1953, Chin 2000). The WHO Guidelines of 1998 recognise that the destruction of large quantities of milk is wasteful and can be avoided by farmers/owners and public health authorities taking account of:

- milking only healthy animals — animals showing signs of illness should be set aside for appropriate treatment and the milk from those animals, and utensils used in its collection, should be sterilised;

- ensuring hygienic practices are in place which prevent the environment of the premises becoming contaminated with anthrax spores and further prevent milk becoming contaminated from the environment;

- ensuring all milk is rapidly cooled to 4°C within 4 hours of milking and is held at this temperature until processed at a licensed dairy plant; and

- all milk is pasteurised before processing whether for animal or human consumption.

If the veterinary authority is satisfied these requirements are being met, milk from healthy animals in herds/flocks in which cases of anthrax have occurred need not be excluded from processing and bulked milk containing such milk need not be condemned.

This situation has been accepted by the United Kingdom by requiring the milk of animals known or suspected of being infected with anthrax to be excluded from the farm vat but bulk milk, including that from an animal subsequently suspected of being infected with anthrax, should be directed to pasteurisation to make it safe for consumption (UK Department of Health 1996). This situation also applies in Australia.

The Export Control (Processed Foods) Orders and national food legislation requires that all milk used for the production of export dairy products, including cheeses, skim milk powder and butter, is subject to pasteurisation, sterilisation or ultra high temperature treatment. These processes are sufficient to destroy vegetative bacilli.

Cows vaccinated with the avirulent non-encapsulated Sterne vaccine strain 34F2, which is the only vaccine strain approved for use in Australia, do not shed *B. anthracis* in their milk (Tanner et al 1978). Neither the United States Department of Agriculture nor the Australian National Registration Authority imposes a withholding period for milk from vaccinated cattle. Australian milk and dairy products have never been shown to cause anthrax in humans or calves. The milk from herds undergoing vaccination is safe for human consumption and handling and processing standards assure this status is maintained.

## Other animal products

For hides, skins and wool, the quarantine controls routinely applied by Australian authorities in respect of any occurrence of anthrax, mean that material from infected herds or flocks is not available for inclusion in export consignments. Carcases of animals infected with anthrax are burnt, or deep-buried where burning cannot take place. To assist containment of infection and reduce sporulation, wool, hair or hides cannot be taken from such carcases.

The general quarantine measures at the farm level in relation to movement bans, burning or deep-burial of infected carcases, and the rigorous thermal processes employed in the rendering process, ensure the safety of meatmeals.

# Glossary

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| Animal byproducts | Products of animal origin that are not for consumption but are destined for industrial use (eg hides and skins, fur, wool, hair, feathers, hooves, bones, fertiliser). |
| Animal Health Committee | A committee comprising the CVOs of Australia and New Zealand, Australian state and territory CVOs, Animal Health Australia, and a CSIRO representative. The committee provides advice to PIMC on animal health matters, focusing on technical issues and regulatory policy (formerly called the Veterinary Committee).<br>*See also* Primary Industries Ministerial Council (PIMC) |
| Animal products | Meat, meat products and other products of animal origin (eg eggs, milk) for human consumption or for use in animal feedstuff. |
| Australian Chief Veterinary Officer | The nominated senior Australian veterinarian in the Australian Government Department of Agriculture, Fisheries and Forestry who manages international animal health commitments and the Australian Government's response to an animal disease outbreak.<br>*See also* Chief veterinary officer |
| AUSVETPLAN | *Aus*tralian *Vet*erinary Emergency *Plan*. A series of technical response plans that describe the proposed Australian approach to an emergency animal disease incident. The documents provide guidance based on sound analysis, linking policy, strategies, implementation, coordination and emergency-management plans. |
| Chief veterinary officer (CVO) | The senior veterinarian of the animal health authority in each jurisdiction (Australian, state or territory) who has responsibility for animal disease control in that jurisdiction.<br>*See also* Australian Chief Veterinary Officer |
| Compensation | The sum of money paid by government to an owner for stock that are destroyed and property that is compulsorily destroyed because of an emergency animal disease. |
| Consultative Committee on Emergency Animal Diseases (CCEAD) | A committee of state and territory CVOs, representatives of CSIRO Livestock Industries and the relevant industries, and chaired by the Australian CVO. CCEAD convenes and consults when there is an animal disease emergency due to the introduction of an emergency animal disease of livestock, or other serious epizootic of Australian origin. |

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| Control area | A declared area in which the conditions applying are of lesser intensity than those in a restricted area (the limits of a control area and the conditions applying to it can be varied during an outbreak according to need). Not applicable for anthrax (*see* Appendix 1). |
| Cyanosis (adj. cyanotic) | Blueness of the skin and/or mucous membranes due to insufficient oxygenation of the blood. |
| Dangerous contact animal | A susceptible animal that has been designated as being exposed to other infected animals or potentially infectious products following tracing and epidemiological investigation. Not applicable for anthrax (*see* Appendix 1). |
| Dangerous contact premises | Premises that contain dangerous contact animals or other serious contacts. Not applicable for anthrax (*see* Appendix 1). |
| Declared area | A defined tract of land that is subjected to disease control restrictions under emergency animal disease legislation. Types of declared areas include *restricted area, control area, infected premises, dangerous contact premises and suspect premises*. *See* Appendix 1 for further details |
| Decontamination | Includes all stages of cleaning and disinfection. |
| Depopulation | The removal of a host population from a particular area to control or prevent the spread of disease. |
| Destroy (animals) | To slaughter animals humanely. |
| Disease agent | A general term for a transmissible organism or other factor that causes an infectious disease. |
| Disease Watch Hotline | 24-hour freecall service for reporting suspected incidences of exotic diseases — **1800 675 888** |
| Disinfectant | A chemical used to destroy disease agents outside a living animal. |
| Disinfection | The application, after thorough cleansing, of procedures intended to destroy the infectious or parasitic agents of animal diseases, including zoonoses; applies to premises, vehicles and different objects that may have been directly or indirectly contaminated. |
| Disposal | Sanitary removal of animal carcases, animal products, materials and wastes by burial, burning or some other process so as to prevent the spread of disease. |
| Enzyme-linked immunosorbent assay | A serological test designed to detect and measure the presence of antibody or antigen in a sample. The test uses an enzyme reaction with a substrate to produce a colour change when antigen–antibody binding occurs. |

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| Emergency animal disease | A disease that is (a) exotic to Australia or (b) a variant of an endemic disease or (c) a serious infectious disease of unknown or uncertain cause or (d) a severe outbreak of a known endemic disease, and that is considered to be of national significance with serious social or trade implications.<br>*See also* Endemic animal disease, Exotic animal disease |
| Emergency Animal Disease Response Agreement | Agreement between the Australian and state/territory governments and livestock industries on the management of emergency animal disease responses. Provisions include funding mechanisms, the use of appropriately trained personnel and existing standards such as AUSVETPLAN. |
| Endemic animal disease | A disease affecting animals (which may include humans) that is known to occur in Australia.<br>*See also* Emergency animal disease, Exotic animal disease |
| Enterprise | *See* Risk enterprise |
| Epidemiological investigation | An investigation to identify and qualify the risk factors associated with the disease.<br>*See also* Veterinary investigation |
| Exotic animal disease | A disease affecting animals (which may include humans) that does not normally occur in Australia.<br>*See also* Emergency animal disease, Endemic animal disease |
| Exotic fauna/feral animals | *See* Wild animals |
| Fomites | Inanimate objects (eg boots, clothing, equipment, instruments, vehicles, crates, packaging) that can carry an infectious disease agent and may spread the disease through mechanical transmission. |
| In-contact animals | Animals that have had close contact with infected animals, such as non-infected in the same group as infected animals. |
| Incubation period | The period that elapses between the introduction of the pathogen into the animal and the first clinical signs of the disease. |
| Index case | The first or original case of the disease to be diagnosed in a disease outbreak on the index property. |
| Index property | The property on which the first or original case (index case) in a disease outbreak is identified to have occurred. |

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| Infected premises | A defined area (which may be all or part of a property) in which an emergency disease exists, is believed to exist, or in which the infective agent of that emergency disease exists or is believed to exist. An infected premises is subject to quarantine served by notice and to eradication or control procedures.<br>*See* Appendix 1 for further details |
| Knackery | A premises for slaughtering and/or processing animals for pet food, stockfeed or fertiliser, but not for human consumption, often with rendering facilities. |
| Local disease control centre (LDCC) | An emergency operations centre responsible for the command and control of field operations in a defined area. |
| Meatmeal/bonemeal | Meat or bones from rendered animal carcases ground for use as stock feed or fertiliser. |
| Monitoring | Routine collection of data for assessing the health status of a population.<br>*See also* Surveillance |
| Movement control | Restrictions placed on the movement of animals, people and other things to prevent the spread of disease. |
| National management group (NMG) | A group established to direct and coordinate an animal disease emergency. NMGs may include the chief executive officers of the Australian Government and state or territory governments where the emergency occurs, industry representatives, the Australian CVO (and chief medical officer, if applicable) and the chairman of Animal Health Australia. |
| Native wildlife | *See* Wild animals |
| OIE Terrestrial Code | *OIE Terrestrial Animal Health Code.* Reviewed annually at the OIE meeting in May and published on the internet at: **http://www.oie.int/eng/normes/mcode/a_summry.htm**<br>*See* Appendix 3 for further details |
| OIE Terrestrial Manual | *OIE Manual of Standards for Diagnostic Tests and Vaccines for Terrestrial Animals.* Describes standards for laboratory diagnostic tests and the production and control of biological products (principally vaccines). The current edition is published on the internet at: **http://www.oie.int/eng/normes/mmanual/a_summry.htm**<br>*See* Appendix 3 for further details |
| Operational procedures | Detailed instructions for carrying out specific disease control activities, such as disposal, destruction, decontamination and valuation. |
| Owner | Person responsible for a premises (includes an agent of the owner, such as a manager or other controlling officer). |

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| Peracute | Very acute form of a disease |
| Petechial haemorrhages | Tiny flat red or purple spots in the skin or mucous membrane caused by bleeding from small blood vessels. |
| Premises | A tract of land including its buildings, or a separate farm or facility that is maintained by a single set of services and personnel. |
| Prevalence | The proportion (or percentage) of animals in a particular population affected by a particular disease (or infection or positive antibody titre) at a given point in time. |
| Primary Industries Ministerial Council (PIMC) | The council of Australian national, state and territory, and New Zealand ministers of agriculture that sets Australian and New Zealand agricultural policy (formerly the Agriculture and Resource Management Council of Australia and New Zealand).<br>*See also* Animal Health Committee |
| Processing plant | An abattoir for slaughtering poultry for human consumption, with chilled and frozen storage facilities. |
| Quarantine | Legal restrictions imposed on a place or a tract of land by the serving of a notice limiting access or egress of specified animals, persons or things. |
| Restricted area | A relatively small declared area (compared to a control area) around an infected premises that is subject to intense surveillance and movement controls.<br>Not applicable for anthrax (*see* Appendix 1). |
| Risk enterprise | A defined livestock or related enterprise, which is potentially a major source of infection for many other premises. Includes intensive piggeries, feedlots, abattoirs, knackeries, saleyards, calf scales, milk factories, tanneries, skin sheds, game meat establishments, cold stores, AI centres, veterinary laboratories and hospitals, road and rail freight depots, showgrounds, field days, weighbridges, garbage depots. |
| Sensitivity | The proportion of truly positive units that are correctly identified as positive by a test.<br>*See also* Specificity |
| Sentinel animal | Animal of known health status that is monitored to detect the presence of a specific disease agent. |
| Septicaemia | Infection of the bloodstream with bacteria. |
| Serotype | A subgroup of microorganisms identified by the antigens carried (as determined by a serology test). |

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| Specificity | The proportion of truly negative units that are correctly identified as a negative by a test.<br>*See also* Sensitivity |
| Stamping out | Disease eradication strategy based on the quarantine and slaughter of all susceptible animals that are infected or exposed to the disease. |
| State or territory disease control headquarters | The emergency operations centre that directs the disease control operations to be undertaken in that state or territory. |
| Surveillance | A systematic program of investigation designed to establish the presence, extent of, or absence of a disease, or of infection or contamination with the causative organism. It includes the examination of animals for clinical signs, antibodies or the causative organism. |
| Susceptible animals | Animals that can be infected with a particular disease |
| Suspect animal | An animal that may have been exposed to an emergency disease such that its quarantine and intensive surveillance, but not pre-emptive slaughter, is warranted.<br>OR<br>An animal not known to have been exposed to a disease agent but showing clinical signs requiring differential diagnosis. |
| Suspect premises | Temporary classification of premises containing suspect animals. After rapid resolution of the status of the suspect animal(s) contained on it, a suspect premises is reclassified either as an infected premises (and appropriate disease-control measures taken) or as free from disease.<br>Not applicable for anthrax (*see* Appendix 1). |
| Tracing | The process of locating animals, persons or other items that may be implicated in the spread of disease, so that appropriate action can be taken. |
| Vaccination | Inoculation of healthy individuals with weakened or attenuated strains of disease-causing agents to provide protection from disease. |
| Vaccination zone | A declared area surrounding infected premises within which all susceptible animals are vaccinated (ring vaccination) and the premises are quarantined<br>*See* Appendix 1 for further details |
| Vaccine | Modified strains of disease-causing agents that, when inoculated, stimulate an immune response and provide protection from disease. |
| – attenuated | A vaccine prepared from infective or 'live' microbes that have lost their virulence but have retained their ability to induce protective immunity. |

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| – inactivated | A vaccine prepared from a virus that has been inactivated ('killed') by chemical or physical treatment. |
| Vector | A living organism (frequently an arthropod) that transmits an infectious agent from one host to another. A *biological* vector is one in which the infectious agent must develop or multiply before becoming infective to a recipient host. A *mechanical* vector is one that transmits an infectious agent from one host to another but is not essential to the life cycle of the agent. |
| Veterinary investigation | An investigation of the diagnosis, pathology and epidemiology of the disease.<br>*See also* Epidemiological investigation |
| Wild animals | |
| – native wildlife | Animals that are indigenous to Australia and may be susceptible to emergency animal diseases (eg bats, dingoes and marsupials). |
| – feral animals | Domestic animals that have become wild (eg cats, horses, pigs). |
| – exotic fauna | Nondomestic animal species that are not indigenous to Australia (eg foxes). |
| Zoning | The process of defining disease-free and infected areas in accord with OIE guidelines, based on geopolitical boundaries and surveillance, in order to facilitate trade. |
| Zoonosis | A disease of animals that can be transmitted to humans. |

# Abbreviations

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| AAHL | Australian Animal Health Laboratory |
| AQIS | Australian Quarantine and Inspection Service |
| AUSVETPLAN | Australian Veterinary Emergency Plan |
| CCEAD | Consultative Committee on Emergency Animal Diseases |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| CVO | chief veterinary officer |
| DAFF | Department of Agriculture Fisheries and Forestry (Australian Government) |
| ELISA | enzyme-linked immunosorbent assay |
| FAO | Food and Agriculture Organization of the United Nations |
| IP | infected premises |
| LDCC | local disease control centre |
| NMG | national management group |
| OIE | World Organisation for Animal Health (Office International des Epizooties) |
| PIMC | Primary Industries Ministerial Council |
| VPHAWG | Veterinary Public Health Anthrax Working Group of WHO, OIE and FAO |
| VZ | Vaccination zone |
| WHO | World Health Organization |

# References


UK Department of Health (1995). *Milk Supplies in Relation to Anthrax in Dairy Herds/Flocks (England and Wales)*, United Kingdom Department of Health. Circular PL/CO (95)3.

Chin J (ed) (2000). *Control of Communicable Diseases Manual*, 17th Edition, American Public Health Association, Washington DC.

Beveridge WIB (1983). Anthrax. In: *Animal Health in Australia*, Volume 4. Australian Government Publishing Service, Canberra, 14–19.

Bowen JE and Turnbull PCB (1992). The fate of Bacillus anthracis in unpasteurised and pasteurised milk. *Letters in Applied Microbiology* 15:224–227.

de Vos V (1994). Anthrax. In: *Infectious Diseases of Livestock with Special Reference to South Africa* (JAW Coetzer, GR Thomson and RC Tustin, eds), Volume 2, Oxford University Press, Oxford, 1262–1289.

de Vos V (1998). The isolation of viable and pathogenic Bacillus anthracis organisms from 200 + 50 year old bones from the Kruger National Park; a preliminary report. Proceedings of the Agricultural Research Council Onderstepoort OIE International Congress with the World Health Organization co-sponsorship on anthrax, brucellosis, CBPP (contagious bovine pleuro pneumonia) clostridial and mycobacterial diseases, 22–24.

Dragon DC and Rennie RP (1995). The ecology of anthrax spores: tough but not invincible. *Canadian Veterinary Journal* 36:295–300.

Economides P (2000). Control of zoonoses in Cyprus. *Scientific and Technical Review, Office International des Epizooties* 19(3):725734.

Fox MD, Kaufmann AF et al (1973). Anthrax in Louisianna, 1971: epizootiological study. *Journal of the American Veterinary Medical Association* 163:446–451.

Gracey JF and Collins DS (1992). *Meat Hygiene*, 9th Edition. Bailliere Tindall, London, 320–323.

Inglesby TV, O'Toole T, Henderson DA et al (2002). Anthrax as a Biological Weapon, 2002. Updated Recommendations for Management. *Journal of the American Medical Association* 287(17):22362252.

Keim P, Price LB, Klevytska AM et al (2000). Multiple-locus variable-number tandem repeat analysis reveals genetic relationships within *Bacillus anthracis*. *Journal of Bacteriology* 182:2928–2936.

Laforce FM (1978). Woolsorters' disease in England. *Bulletin of the New York Academy of Medicine* 54:956–963.

Lindeque PM and Turnbull PCB (1994). Ecology and epidemiology of anthrax in the Etosha National Park, Namibia. *Onderstepoort Journal of Veterinary Research* 61:71–83.

Minett FC (1950). Sporulation and viability of *B. anthracis* in relation to environmental temperature and humidity. *Journal of Comparative Pathology* 60:161–176.

M'Fadyean J (1909). Anthrax bacilli in milk. *Journal of Comparative Pathology* 22:148–149.

OIE (World Organisation for Animal Health) (2000). *World Animal Health in 2000,* Office International des Epizooties, Paris, France. *)*

Seddon HR (1965). *Diseases of Domestic Animals in Australia*. Part 5, Volume 1: Bacterial Diseases, Australian Department of Health.

Steele JH and Helvig FJ (1953). Anthrax in the United States. *Public Health Reports* 68:616–623.

Tanner WB et al (1978). Public health aspects of anthrax vaccination of dairy cattle. *Journal of the American Veterinary Medical Association* 173:1465–1466.

Turnbull PCB, Bell RHV et al (1991). Anthrax in wildlife in the Luangwa Valley, Zambia. *Veterinary Record* 128:399–403.

Valli VEO (1985). The hematopoietic system. In: *Pathology of Domestic Animals,* 3rd Edition (KVF Jubb, PC Kennedy and N Palmer, eds), Volume 3, Chapter 2. Academic Press, Orlando.

VPHAWG (Veterinary Public Health Anthrax Working Group ) (1998). Guidelines for the Surveillance and Control of Anthrax in Humans and Animals, World Health Organization, Geneva. http://www.who.int/emc-documents/zoonoses/docs/whoemczdi986.html

## Further reading

### World distribution of anthrax

Dragon DC, Rennie RP and Gates CC (1996). Bison and anthrax in northern Canada. In: *Anthrax*. Proceedings of an International Workshop, Winchester, 19–21 September 1995 (PCB Turnbull, ed). *Salisbury Medical Bulletin*, Special Supplement 87:1–2.

Hugh-Jones ME (1996). World situation 1993–94. In: *Anthrax*. Proceedings of an International Workshop, Winchester, 19–21 September 1995 (PCB Turnbull, ed). *Salisbury Medical Bulletin*, Special Supplement 87:1–2.

Hugh-Jones ME (1996). Quality of reports: OIE World Animal Health in 1993 and the FAO/OIE/WHO Animal Health Yearbook. In: *Anthrax*. Proceedings of an International Workshop, Winchester, 19–21 September 1995 (PCB Turnbull, ed). *Salisbury Medical Bulletin*, Special Supplement 87:3–4.

Whitford HW (1994). Anthrax. In: *Handbook of Zoonoses,* 2nd edition (GW Beran and JS Steele, eds), Section A: Bacterial, Chlamydial and Mycotic, CRC Press, Boca Raton, 61–82.

### Control measures for anthrax

Blood DC, Radostits OM and Gay CC (1994). *Veterinary Medicine: A Textbook of the Diseases of Cattle, Sheep, Pigs, Goats and Horses,* 8th Edition. Bailliere Tindall, London.

Whitford HW (1994). Anthrax. In: *Handbook of Zoonoses,* 2nd Edition (GW Beran and JS Steele, eds), Section A: Bacterial, Chlamydial and Mycotic, CRC Press, Boca Raton, 61–82.

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