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Anthrax

NOTIFIABLE

The disease

Anthrax is a bacterial disease which primarily affects herbivorous animals, although all mammals are susceptible to infection. In humans, anthrax can affect the skin and, rarely, the respiratory or gastro-intestinal tracts. It is caused by the aerobic bacillus, *Bacillus anthracis,* and is spread by spores. Spores can be found in animal products such as wool, hair, hides, skins, bones and bone meal, and in the carcasses of infected animals. The spores can also contaminate soil and may survive for many years (Bergman, 2011).

The incubation period is usually 48 hours but may be up to seven days. In cutaneous anthrax, a lesion appears on the skin and develops into a characteristic ulcer with a black centre. Inhalational anthrax begins with a flu-like illness and is followed by respiratory compromise and shock around two to six days later. Intestinal anthrax results in severe abdominal pain, fever and bloody diarrhoea.

Anthrax can be treated effectively with antibiotics if identified early. If untreated, the infection can cause septicaemia, toxaemia or meningitis, and is fatal in around 5% of cases. However, from 4 October to 20 November, 2001, 22 cases of anthrax (11 inhalational, 11 cutaneous) were identified in the US; 5 of the inhalational cases were fatal. Twenty (91%) case-patients were either mail handlers or were exposed to worksites where contaminated mail was processed or received (Jernigan *et al*, 2002).

In the UK, human anthrax is rare, and was historically almost entirely an occupational disease affecting those handling imported infected animal products or working with infected animals (see Table 13.1). Prevention depends on controlling anthrax in livestock and on disinfecting, washing and scouring imported animal products. Processing of hides, wool and bone by tanning, dyeing, carbonising or acid treatment also reduces the risk of infection. Bone meal used as horticultural fertiliser may rarely contain anthrax spores when not correctly treated in the country of origin; a certificate of sterilisation should accompany any consignment on entry to the UK. Those handling bone

meal in bulk should wear impervious gloves that should be destroyed after use. Imported animal products are now required to undergo rigorous sterilization procedures in the country of origin, so the probability of viable anthrax spores persisting in such material is very low. Appropriate containment procedures nevertheless continue to be used, further reducing the risk of exposure of workers in these industries to anthrax spores.

Overall there are now no industries in the UK in which there is a risk of continuous exposure to high levels of airborne anthrax spores. In occupations where there is an on-going possibility of spore exposure, the prevailing levels of spores under normal circumstances are judged to be sufficiently low as to pose only a minimal risk of infection by either cutaneous or inhaled routes. It is possible that any spore exposure at this level that does occur will generate immunity rather than clinically symptomatic infection, as is suggested by the results of the study of the seroprevalence of antibodies against *B. anthracis* toxins in Belgian wool-processing factory workers (Kissling *et al*, 2012)

Table 13.1 Anthrax: likely source of infection for notified cases 1981-2015 in England and Wales

Occupation (source of infection)	Number of cases
Slaughterman, butcher, fellmonger	5
Factory worker (imported wool)	1
Factory worker -/(bone meal fertilizer)	1
Factory worker (imported cotton, wool or leather	1
Labourer (leather bales)	1
Leather worker	1
Engineer (animal skins in Zambia)	1
Worked with horses	1
Builder	1
Farm worker	1
Animal hide drums	1
Injecting heroin use	11
Not identified	4

Source: PHE 2016

Sporadic outbreaks of severe anthrax infection have occurred amongst drug users following injection of heroin contaminated with spores (Scottish Drugs Forum, 2013), and isolated cases of inhalational anthrax have been reported in individuals making drums with imported animal skins (Anaraki *et al*, 2008; Pullan *et al*, 2015). Anthrax spores have been released deliberately as biological weapons, most recently reported in the USA (Plotkin, Orenstein and Offit, 2013).

History and epidemiology of the disease

Anthrax is well documented in ancient historical texts and has been a notifiable disease in the UK since 1895. Vaccination for UK workers at risk was first introduced in 1965 and limited studies suggest that vaccination provides good protection against occupationally acquired infection (Plotkin, Orenstein and Offit, 2013).

Human infections occur in countries where the disease is common in animals including those in the Southern and Central Americas, Southern and Eastern Europe, the Caucasus, Asia and Africa.

The anthrax vaccine

The UK vaccine (**https://www.gov.uk/biopharmaceutical-manufacturing-and-product-development**) is made from antigens found in the sterile filtrate from cultures of the Sterne strain of *B. anthracis*. These antigens are adsorbed onto an aluminium adjuvant to improve their immunogenicity and are preserved with thiomersal.

The vaccine is inactivated, does not contain live organisms and cannot cause the disease against which it protects.

There have been no formal efficacy trials with the UK vaccine. In 1958, the introduction of vaccine successfully controlled cutaneous anthrax at a government wool-disinfecting station in Liverpool (Hambleton *et al.*, 1984). A controlled clinical trial was carried out in the 1950s among workers in goat-hair mills in New Hampshire, USA, using a vaccine similar to those currently licensed in the USA and the UK (Brachman *et al.*, 1962). Although the study did not have sufficient power to measure accurately the protection against pulmonary anthrax, no cases occurred in the vaccinated group compared with five in the unvaccinated.

To date there has been only one report of a case of anthrax in an individual previously vaccinated with the UK vaccine: in 2012, a former soldier who

had received 5 doses of the vaccine in 2002-4, survived a severe illness with features typical of inhalational anthrax, although no potential source for the infection was ever identified (Sykes et al, 2013).

Storage

Vaccines should be stored in the original packaging at +2˚C to +8˚C and protected from light. All vaccines are sensitive to some extent to heat and cold. Heat speeds up the decline in potency of most vaccines, thus reducing their shelf life. Effectiveness cannot be guaranteed for vaccines unless they have been stored at the correct temperature. Freezing may cause increased reactogenicity and loss of potency for some vaccines. It can also cause hairline cracks in the container, leading to contamination of the contents

Presentation

Anthrax vaccine is presented as a suspension ready for injection, which should be shaken before administration

Dosage and schedule

- First dose of 0.5ml on day 0.
- Second dose of 0.5ml at least three weeks after the first dose.
- Third dose of 0.5ml at least three weeks after the second dose.
- Fourth dose of 0.5ml at least six months after the third dose.

Administration

The vaccine is given by intramuscular injection, preferably into the upper arm. However, individuals with a bleeding disorder should be given the vaccine by deep subcutaneous injection to reduce the risk of bleeding.

Anthrax vaccine can be given at the same time as other vaccines. The vaccines should be given at separate sites, preferably in a different limb. If given in the same limb, they should be given at least 2.5cm apart (American Academy of Pediatrics, 2003). The site at which each vaccine is given and the batch numbers of the vaccines should be recorded in the individual's records. It is recommended that the employer keeps a vaccination record.

Disposal

Equipment used for vaccination, including used vials or ampoules, should be disposed of at the end of a session by sealing in a proper, puncture-resistant 'sharps' box (UN-approved, BS 7320).

Recommendations for the use of the vaccine

The objective of the anthrax vaccination is to provide a minimum of four doses at appropriate intervals for individuals at risk of occupational exposure. These occupations fall into two broad groups:

Occupations with potential continuous low-level risk of exposure

Workers dealing with infected animals or the processing of infected animal products where there is a potential risk of occupational exposure to anthrax include:

- farm workers - e.g. livestock breeders/keepers, shepherds, dairy workers
- veterinary surgeons
- zoo keepers, game park personnel
- abattoir workers, butchers
- construction workers
- routine microbiology laboratory staff
- workers in industries handling imported animal products
- individuals involved in the storage and distribution of material derived from any of the above

Under normal circumstances in the UK the prevailing levels of anthrax spores in these occupations are judged to be sufficiently low as to pose only a minimal risk of infection by either cutaneous or inhaled routes. In addition, if very low level spore exposure does occur it may generate immunity rather than leading to clinically symptomatic infection. It is unlikely that any individuals in these occupations in the UK would be assessed as being at risk of exposure to sufficiently high levels of spores as to require vaccination. The risk to those working in the UK with imported products of animal origin is also likely to be extremely low because of existing import restrictions.

Guidance on the risk of occupational exposure to infected animals or animal products is available from the Health and Safety Executive (1997).

Occupations with a potential intermittent risk of exposure

A small number of occupations may present situations where workers are at risk of one-off high level exposures to anthrax spores. e.g. following a deliberate or accidental release of spores. These include:

- office workers handling mail following a specific threat of attack
- laboratory workers working with anthrax in high containment facilities
- first responders responding to a confirmed anthrax incident
- military personnel
- environmental decontamination teams

Primary immunisation

When indicated, individuals in these groups who are assessed to be at risk should be offered a primary course of anthrax vaccination.

The primary course of anthrax vaccination consists of four doses. Three doses of 0.5ml are given with an interval of at least three weeks between each dose. The fourth dose is given at least six months after the third dose.

Reinforcing immunisation

Potential continuous low level exposure

There are no industries In the UK in which there is a risk of continuous exposure to high levels of airborne anthrax spores. However, where the risk assessment indicates that an individual is at continuous low level risk, a single reinforcing dose of 0.5ml should be offered at 10 year intervals on up to 3 occasions to sustain protection. Further doses are not recommended as they may result in a reduced immune response.

Potential intermittent high level exposure

Recent evidence suggests that, following a full primary course, offering a booster dose after a prolonged interval results in antibody levels superior to those seen in patients who receive annual boosters (Dstl, 2014). Therefore, individuals should be offered a single reinforcing dose of 0.5ml just before entering situations with a specific high risk of exposure. If such opportunities do not arise, in order to sustain immune memory, a single reinforcing dose should also be offered at 10 year intervals on up to 3 occasions.

Immunisation following proven or high probability of exposure to spores

For those ‘at risk’ occupations (listed above), booster vaccination should be offered, in addition to a course of antibiotics, following a proven exposure or where there has been a high probability of exposure to anthrax spores, except when a dose has been given in the preceding 12 months.

Advice on the treatment of previously unvaccinated individuals with a proven or high probability of exposure to anthrax spores, can be found in the PHE CBRN incident guidance at:

https://www.gov.uk/government/publications/chemical-biological-radiological-and-nuclear-incidents-recognise-and-respond

Contraindications

There are very few individuals who cannot receive anthrax vaccine. Where there is doubt and there is clear risk of infection, further advice can be obtained from Public Health England, Porton Down. The vaccine should not be given to those who have had:

- a confirmed anaphylactic reaction to a previous dose of anthrax vaccine, or
- a confirmed anaphylactic reaction to any of the components of the vaccine.

With the exception of confirmed anaphylaxis, it may be possible to continue the immunisation course where there is a history of other allergic reactions (such as rashes). Non-allergic local or general reactions to a previous dose of vaccine do not contraindicate further doses. Specialist advice must be sought from Public Health England, Porton Down.

Precautions

Minor illnesses without fever or systemic upset are not valid reasons to postpone immunisation.

Unless protection is needed urgently, immunisation may be postponed in acutely unwell individuals until they have fully recovered. This is to avoid wrongly attributing any new symptom or the progression of symptoms to the vaccine.

Pregnancy and breast-feeding

Anthrax vaccine may be given to pregnant women when clinically indicated. There is no evidence of risk from vaccinating pregnant women or those who are breast-feeding with inactivated viral or bacterial vaccines or toxoids (Plotkin, Orenstein and Offit, 2013).

Immunosuppression and HIV infection

Individuals with immunosuppression and HIV infection (regardless of CD4 count) should be given anthrax vaccine if indicated. These individuals may not make a full antibody response. Specialist advice may be required.

Adverse reactions

Pain, swelling or redness at the injection site are common and may last for two or more days. Such reactions have been reported to occur at the site of a previous anthrax injection. Regional lymphadenopathy, mild febrile reactions, flu-like symptoms, urticaria or other allergic reactions occur less commonly. Local or general reactions to the first injection are not good predictors of reactions to second or subsequent doses.

All serious suspected adverse reactions to vaccines in adults should be reported to the Medicines and Healthcare products Regulatory Agency (MHRA) through the Yellow Card Scheme.

Management of suspected cases and exposure

All suspected cases of anthrax must be notified. Guidance on the diagnosis and management of cases of cutaneous and inhalation anthrax can be found on the PHE website. Where there is a community level outbreak (e.g. in injecting drug users) specialist advice should be sought from Public Health England (Tel: 020 8200 4400) or, in Scotland, Health Protection Scotland (Tel: 0141 300 1191).

https://www.gov.uk/government/collections/anthrax-guidance-data-and-analysis#diagnosis-and-management

Guidance on exposure to potentially infected material and the management of suspect and confirmed cases may be found in *CBRN Incidents: clinical management & health protection* (HPA, 2008)

https://www.gov.uk/government/publications/chemical-biological-radiological-and-nuclear-incidents-recognise-and-respond

Supplies

Anthrax vaccine is available from:
ImmForm Tel: 0844 376 0040.
Website: **www.immform.dh.gov.uk**

If not already registered on ImmForm you will need to register in good time before placing an order.

Scotland:

Hairmyres Hospital (Tel: 01355 585000).

Northern Ireland:

Public Health Laboratory, Belfast City Hospital (Tel: 028 9026 3765).

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