Anthrax – Update on Diagnosis and Management

TK Dutta*, S Sujatha**, RK Sahoo***

Abstract

Human anthrax is difficult to contain. This is primarily because it is a zoonotic disease and the disease has never been contained in the livestock of India due to lack of adequate vaccination facilities. Animal anthrax is very common in many parts of India. The problem of anthrax is further compounded by lack of awareness on the part of village folk who unwittingly handle the hide and share the dead animal meat and this causes cutaneous and gastrointestinal forms of anthrax respectively. Hemorrhagic meningitis and pulmonary anthrax, the other forms of anthrax, carry a risk of nearly cent percent mortality. Characteristic gram positive rods abundantly found in the smear of the cerebrospinal fluid, blood etc. make diagnosis certain in most of the cases. Resistance to penicillin, the drug of choice, now being occasionally reported, may become a confounding factor while attempting successful control of the disease. Other antibiotics which are found to be very effective are doxycycline and ciprofloxacin. Fear of use of anthrax spores as a biological weapon has also given a new dimension to the problem.

General Considerations and Epidemiology

Anthrax is one of the great infectious diseases of antiquity. The fifth and sixth plagues in the Bible’s book of Exodus may have been actually the outbreaks of anthrax. The disease has long been intertwined with human history, though the disease appeared to have had globally eclipsed for a while.

It is a disease caused by bacillus anthracis - a gram positive spore forming aerobic rod. The word ‘Anthrax’ literally means ‘coal’ in Greek, as there is a skin lesion of painless black eschar as dark as coal. The reappearance of anthrax from several parts of South India and other parts of the world including Zimbabwe and former Soviet Union (at Sverdlovsk) few years ago was an extremely disturbing development. It is a deadly disease with certain types like inhalational and meningitic forms having almost cent percent fatality (Table 1). It is a deadly disease with certain types like inhalational and meningitic forms having almost cent percent fatality (Table 1).2,3

Between 20,000 and 100,000 cases of anthrax have been estimated to occur worldwide annually. Importance of anthrax has gained a new dimension because of its application in biological warfare. Japan used the anthrax bug for the first time against Manchuria in 1940s. More recently it was death of a Florida photo editor from inhalational anthrax acquired from a letter deliberately contaminated with spores of Bacillus anthracis. This extremely rare infection in USA into public awareness. Between September 18, 2001 and November 21, 2001, there were 13 cases of cutaneous anthrax and 11 cases of inhalational anthrax in association with known or presumed exposure to anthrax spores in contaminated mail in USA.

World was forced to recognize the possibility that anthrax may be used as a biologic weapon in 1979, when at least 66 people in Sverdlovsk died in the largest known epidemic of inhalational anthrax. This epidemic followed the accidental release of anthrax spores into the atmosphere by a research facility involved in “weaponizing” anthrax by preparing finely milled, nonclumping (electrostatically neutral) spores that are optimal for dissemination and inhalation and that produce toxins when they germinate.

After the Gulf War, Iraq admitted producing and deploying such weaponized anthrax in missiles; thus a clear threat remains.

Global Situation and Cause of Resurgence

The disease has been almost totally eradicated from Western world, the disease - in real sense - has never been fully contained in Asian, African and Central American countries, as the livestock in these countries are only marginally subjected to veterinary control and the environmental conditions here favor animal-soil-animal transmission. India, also, is an endemic region for animal anthrax because of unprotected livestock population. It is this which gives rise to emergence of human anthrax from time to time in some parts of the country, especially in southern India.

Although it can be found globally, it is more often a risk in countries with less standardized and effective public health programs. Areas currently listed as high risk are South and Central America, Southern and Eastern Europe, Asia, Africa, the Caribbean, and the middle East.

In Zimbabwe 10,000 cases occurred between 1978 and 1980 when political instability disrupted animal anthrax control measures.

Pattern of Disease Occurrence

The agriculture related cases occur in a seasonal pattern, but the occupation-related cases occur any time.

In June and July 1998, three outbreaks of anthrax were reported from different regions of Russia Federation causing 15 cases and two deaths. All the cases occurred following

Table 1 : Anthrax

- Anthrax - literally means ‘coal’ in Greek
- Coal-black painless eschar on skin - characteristic of disease
- Was called - Egyptian plague in the past
- Certain forms have 100% fatality - e.g. Meningeal and Inhalational forms
- Resurgence in S. India - An alarming development

*Professor and Head, Department of Medicine, **Professor, Department of Microbiology, ***Associate Professor, Department of Medicine, Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER), Puducherry 605006
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A large Gram positive spore-forming capsulated aerobic bacillus

Two forms:
- Vegetative form (from body tissue) - on exposure to atmosphere
  → sporulates

Bacteria has 3 components:
- Lethal factor (LF)
- Edema factor (EF)
- Protective antigen (PA)

- Spores are very resistant to dry heat, survive for decades
- However, usually destroyed by 10 minutes of boiling

Consumption of meat from privately raised cattle, and all received treatment.

In India, in 1924 there was an outbreak of the disease in U.P., when about 300 people died of it. It was associated with death of nearly 1000 cattle. Anthrax in India is a notifiable disease.

**Anthrax Bacillus**

Bacteria have two forms: spore and vegetative forms (Tables 2 and 3). Spore form is infectious and dry resistant. Anthrax in mammals can be divided into two major types, one localized and the other disseminated. Cattle are among the group of animals, which are particularly susceptible to *B. anthracis*, they develop the systemic form of disease and clinically progress to death in one to two days. An overwhelming septicemia results from massive proliferation of organism. Hence the cattle provide permissive setting for multiplication of *B. anthracis* to a quantity sufficient to infect less susceptible mammals like human beings. Man is an accidental host. Herman Gold in 1955 reported 117 cases of cutaneous anthrax. In almost all cases, there was history of contact with animal or animal product. However, soil contaminated with spores alone can also transmit cutaneous anthrax; the spores can survive for decades in dry earth. Spores of bacteria survive in improperly cooked meat, though boiling for about 10 minutes destroys the spores.

**Pathogenesis and Types**

Cutaneous anthrax occurs within two weeks after exposure to spores (Table 4, Figure 1). The initial lesion is an erythematous papule often on an exposed area of skin that vesiculates and then ulcerates and undergoes necrosis progressing to a purple to black eschar.

Anthrax Infection is initiated with the introduction of the spore through a break in the skin (cutaneous anthrax) or entry through the mucosa (gastrointestinal anthrax). After ingestion by macrophages at the site of entry, germination to the vegetative form occurs, followed by extracellular multiplication and capsule and toxin production (Table 5).

Though lesion may be limited to cutaneous form, it is also complicated by systemic forms. Septicemic form occurs when bacteria enters the systemic circulation. Anthrax meningitis (hemorrhagic) is a complication following septicemia. Though the usual portal of entry is skin, it may also occur along with gastrointestinal or pulmonary anthrax.

Pulmonary anthrax is an example of inhalational form of anthrax, where anthrax spores present in the atmosphere are inhaled. It is a risk for the people in the profession of wool making and dealing with sheep, thus this form named as woolsorter’s disease. Newer dimension added to this disorder is the fear of biological warfare, when the bacteria may be introduced into atmosphere. The disease is slowly progressive to start with, but soon causes hemorrhagic lymphadenitis, mediastinitis and pleural effusion. In rhesus monkeys, the inhalation of spores (1 to 2 µm in diameter) results in their deposition in alveolar spaces whence surviving spores are transported by lymphatics to mediastinal lymph nodes, where germination occurs up to 60 days later. These observations were the basis for the recommendation that antibiotic prophylaxis for inhalational exposure should be given for 60 days. This is consistent with the data from human exposure after the accidental discharge of anthrax spores at a military biologic research facility in Sverdlovsk, Russia, in which all the cases occurred within six weeks of the release of spores.

**Table 2 : Anthrax bacillus**
- A large Gram positive spore-forming capsulated aerobic bacillus
- Two forms:
  - Vegetative (body tissue)
  - Spore forming (soil and atmosphere)
- Vegetative form (from body tissue) - on exposure to atmosphere
  → sporulates

**Table 3 : Cycles of B. anthracis**
- Soil Cycle : Spores in soil → infective for years
- Animal Cycle : Herbivorous animals the natural susceptible host → inoculation of spores from soil while grazing → massive multiplication of bacteria in blood → Bleeding from natural orifices → Death → vegetative form spilled into grazing land → sporulates.
- Human Cycle : Human being an accidental host following contact with animal and animal products
  - Hides, hair → Cutaneous form
  - Meat → Gastrointestinal (G.I.) anthrax
  - Inhalation → Pulmonary anthrax (wool-sorter’s disease, bioterrorism-related)

**Table 4 : Pathogenesis and types of anthrax**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutaneous Anthrax</td>
<td>- Good prognosis: 80-90% recovery, Commonest type (95% of human anthrax):</td>
</tr>
<tr>
<td></td>
<td>occurs on face, neck, arm, hand etc.</td>
</tr>
<tr>
<td></td>
<td>- Bacterial entry through skin → red macule → papule → vesicle → ulcer →</td>
</tr>
<tr>
<td></td>
<td>black eschar (painless with brawny edema) → heals in 3 weeks</td>
</tr>
<tr>
<td></td>
<td>- No pus, only serum - malignant pustule a ‘misnomer’</td>
</tr>
<tr>
<td>Inhalational Pulmonary</td>
<td>- A complication following septicemia and cutaneous anthrax (100% fatality)</td>
</tr>
<tr>
<td>Gastro-intestinal (after ingesting</td>
<td>- Bloody fulminating gastroenteritis (50% fatality)</td>
</tr>
<tr>
<td>contaminated meat)</td>
<td></td>
</tr>
</tbody>
</table>

**Fig. 1 : Cutaneous anthrax**

Table 3 : Cycles of B. anthracis

Table 4 : Pathogenesis and types of anthrax
Diagnosis

Bacteriologic Tests

*Bacillus anthracis* is a large, gram-positive, aerobic, spore-forming bacillus that measures 1.0 to 1.5 \( \mu \text{m} \) by 3.0 to 10.0 \( \mu \text{m} \) (Table 6, Figure 2). Methylene blue stained smear of CSF, blood, pleural fluid shows long and thick bacilli, surrounded by amorphous purplish area representing the capsular material (the McFadyean reaction).\(^3\) A part of the *B. cereus* group of bacilli, *B. anthracis* is easy to differentiate from other members of the *B. cereus* group by observing the morphologic features of the colony on a blood-agar plate. Colonies of most *B. anthracis* isolates are non-hemolytic and are white to gray, often looking like ground glass. It is nonmotile, is nonhemolytic on sheep's-blood agar, grows readily at a temperature of 37°C, and forms large colonies with irregularly tapered outgrowths (a "Medusa head" appearance generally seen with the low power objective of the microscope where the tangled bacilli appear like the serpents on the mythological Medusa head).\(^3\) In vitro it grows as long chains, but in the host it appears as single organisms or chains of two or three bacilli. It forms mucoid colonies and exhibits a prominent capsule when grown on nutrient agar (containing 0.7 percent sodium bicarbonate in the presence of 5 to 20 percent carbon dioxide). It is identified as *B. anthracis* by standard biochemical reactions.

The culture of tissue grows *B. anthracis*; however, all cutaneous samples may not be positive for the bacteria. Nevertheless, other samples like blood, pleural fluid, CSF grow large number of encapsulated bacilli. The bacteria may be dismissed as contaminant by laboratory staff unless physician specifically requests testing.\(^3\) Blood cultures in cases of systemic anthrax infection are almost always positive, because of the large numbers of bacterial cells in the circulation. Cultures of tissue from skin lesions, however, are not useful diagnostically, because the rate of positive cultures does not exceed 60 to 65 percent, probably owing to the microbicidal activity of local antagonistic skin flora. However, in a study in our hospital, in all the 23 cases of cutaneous anthrax, aspirated material showed the specific bacilli,\(^4\) though the organisms were fewer in number. There are reports of clinical isolates of *B. anthracis* that are resistant to penicillin.\(^5\) Because of the potential for drug-resistant strains, including deliberately modified strains, antibiotic-susceptibility testing should be performed on all isolates.

Serologic and Immunologic Tests

The major immunogenic proteins of *B. anthracis* appear to be capsular antigens and the exotoxin components. Specific enzyme-linked immunosorbent assays (ELISAs) that show a quadrupling of the titer of antibodies against these components are diagnostic of past infection or vaccination. The most reliable indicators are the titers of antibody to protective antigen and to capsular components. In studies of the measurement of antibody titers by ELISA, the sensitivity of possible indicators was as follows: 72 percent for protective antigen, 95 to 100 percent for capsule antigens, 42 percent for lethal factor, and 26 percent for edema factor. Indirect microhemagglutination gives results similar to those obtained with ELISA but has certain drawbacks, including the short shelf life of antigen-sensitized red-cell preparations, the limited reproducibility of the test, and longer preparation times.\(^3\)

New Molecular Diagnostic Methods

New diagnostic techniques have focused on the use of the polymerase chain reaction to amplify markers specific to *B. anthracis* or the *B. cereus* group. Two markers, *vrrA* and *Ba813*, have been the subject of extensive study.\(^3\)

Antimicrobial Therapy

The treatment of choice for *B. anthracis* infection is penicillin unless otherwise proved. Though the prognosis is very good (80-90% recovery in untreated cases) in cutaneous form, which constitutes 95% of total human anthrax, patients with anthrax meningitis invariably die within 24 hours of admission despite best treatment. All meningitis cases are treated with high ‘meningitic’ doses of intravenous crystalline penicillin i.e., 2 million units every two hours (24 million units every 24 hours). Patients with cutaneous anthrax are treated with intravenous crystalline penicillin 2 million units every 4 hours for 5 days followed by intramuscular procaine penicillin 8 lakh units twice a day for 8 days. All patients with cutaneous anthrax respond favorably. Antibiotic treatment should be continued for at least 14 days for systemic anthrax after the symptoms abate (Table 7).\(^10,11\)

Systemic infection resulting from inhalation of organism has also a mortality approaching 100 percent, with death usually occurring within a few days after onset of symptoms.\(^3\)

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**Table 5 : Incubation Period**

<table>
<thead>
<tr>
<th>In General - 2-5 days:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Cutaneous - 3-10 days (80-90% spontaneous healing)</td>
</tr>
<tr>
<td>• G.I. form (from inadequately cooked meat) - 12-18 hrs.</td>
</tr>
<tr>
<td>• Inhalational - Longer than G.I. form (Approximately 10 days)</td>
</tr>
</tbody>
</table>

**Table 6 : Laboratory Diagnosis**

| • A fascinating bacteria - large thick gram + ve bacillus with truncated ends, abundantly present in a smear |
| • Bacilli present in chains in a smear ® have box-car (bamboo stick) appearance |
| • CSF, blood - Easily isolated in large number |
| • Skin vesicle - 50 - 60% yield |
| • Culture - Grows easily on agar medium |
| • Specimens and cultures are to be handled with care, preferably in a safety cabinet (level III) |
| • Serologic and Immunologic Tests – ELISA, IHA tests |
| • New Molecular Diagnostic Methods – PCR technique |

Data from this outbreak indicate an average incubation period of approximately 10 days for inhalational anthrax;\(^3\) however germination of spore in the respiratory system may occur up to 60 days. Occasionally anthrax by aerosols may be limited to skin only.
Penicillin has been the drug of choice for anthrax for many decades, only very rarely has penicillin resistance been found in naturally occurring isolates. There have been recent reports of occasional resistance to penicillin from South India and other parts of the world.\textsuperscript{12, 13, 14} Doxycycline and ciprofloxacin can be used in such situations.

In vitro, \emph{B. anthracis} is also susceptible to most other commonly used antimicrobial drugs, such as ciprofloxacin, ofloxacin, levofloxacin, tetracyclines, chloramphenicol, macrolides, aminoglycosides, clindamycin, imipenem, rifampin, vancomycin, cefazolin, and other first-generation cephalosporins.\textsuperscript{5}

Figure 8 summarizes pharmacologic therapy for anthrax. Penicillin and doxycycline are mainly used for the treatment of anthrax. Intravenous administration is recommended in cases of inhalational, gastrointestinal, and meningeal anthrax. Cutaneous anthrax with signs of systemic involvement, extensive edema, or lesions on the head and neck also requires intravenous therapy. Despite early and vigorous treatment, the prognosis of patients with inhalational, gastrointestinal, or meningeal anthrax remains poor. In cutaneous anthrax, treatment with oral penicillin renders lesions sterile after 24 hours, although they still progress to eschar formation. Chloramphenicol, erythromycin, tetracycline, or ciprofloxacin can be administered to patients who are allergic to penicillin. If resistance to penicillin and doxycycline is suspected, ciprofloxacin may be administered empirically.

In cases of extensive edema, meningitis, or swelling in the head-and-neck region, corticosteroid therapy may be added.\textsuperscript{3}

### Bioterrorism and Inhalational Anthrax

Treatment should continue for 60 days in the context of bioterrorism, as opposed to 7 to 10 days for naturally acquired disease. Treatment must continue for 60 days due to the risk of delayed germination of spores, after which time the therapy should be withdrawn under medical surveillance in inhalational anthrax. Although there are limited human studies in treating inhalational anthrax, the evidence suggests penicillin G is effective. However, the treatment must begin before the onset of symptoms and as early as possible in the course of the disease because the second phase of the illness is catastrophic. Unfortunately, penicillin resistance is easily induced in the laboratory so it must be assumed that a determined terrorist organization would be able to render penicillin ineffective against this organism. The Working Group on Civilian Biodefense, a group of top physicians and scientists from all sectors, met in May 1998 to discuss anthrax and its use as a biological weapon. At that time, the group recommended the following 60-day intravenous antibiotic therapy for patients with clinically evident inhalational anthrax infection: ciprofloxacin 400 mg every 12 hours until the sensitivity of the organism is known—and then a change to 4 million units of penicillin G every 4 hours, or doxycycline 100 mg every 12 hours.\textsuperscript{15}

#### Potential New Treatments

The current understanding that anthrax is a toxigenic condition suggests the potential of antitoxin therapy. The central importance of lethal toxin is understood. Unfortunately, antitoxin preparations are not currently available. The recent discovery that lethal toxin acts as a zinc metalloprotease inside target cells and the identification of potential target substrates may provide new insights for use in designing drugs that directly inhibit the toxicity of lethal factor in vivo.\textsuperscript{3}

### Experience at Several Places in India

Animal anthrax is very common in many parts of India.\textsuperscript{16} Since 1953 till 2000, the number of human anthrax reported is 182 (Figure 9 shows major incidences). All the cases including those of three outbreaks of anthrax have been reported from South India. Thus, the disease is more or less endemic in South India. One of the major concerns has been a report of 23 cases including seven cases of anthrax meningoencephalitis (AME) from Pondicherry in a single year of 1999. The disease at present is endemic in trijunction of southern Indian states of Andhra Pradesh, Karnataka and Tamil Nadu, and in Union Territory of Pondicherry (Table 8).\textsuperscript{22}

The first documented case of human anthrax was noticed in this region in 1990. Three patients presented with anthrax meningoencephalitis (AME). From 1990 to February, 2000, 35 cases of human anthrax have been encountered; 23 of them presented with cutaneous anthrax (all recovered) and 12 with AME (all died). Three patients denied history of contact with animals; others gave history of handling animals, animal

<table>
<thead>
<tr>
<th>Author and Year</th>
<th>No. of cases</th>
<th>Type</th>
<th>Outcome</th>
<th>Probable source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Venkataramaiah\textsuperscript{17}</td>
<td>30</td>
<td>Cutaneous</td>
<td>5 expired</td>
<td>Anthrax infected meat</td>
</tr>
<tr>
<td>Lakshmi et al \textsuperscript{18}</td>
<td>25</td>
<td>Cutaneous-18</td>
<td>2 expired</td>
<td>Infected cow meat</td>
</tr>
<tr>
<td>Tirupati, A.P. \textsuperscript{19}</td>
<td></td>
<td>Intestinal-7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chandrasekhar et al \textsuperscript{19}</td>
<td>30</td>
<td>Cutaneous-10</td>
<td>5 expired</td>
<td>Anthrax infected meat</td>
</tr>
<tr>
<td>Chittoor, A.P. \textsuperscript{20}</td>
<td></td>
<td>Systemic-20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lalitha and Kumar \textsuperscript{20}</td>
<td>49</td>
<td>AME-29</td>
<td>27 expired</td>
<td>Contact with infected animal meat/hide</td>
</tr>
<tr>
<td>CMC, Vellore, T.N. \textsuperscript{21}</td>
<td></td>
<td>Cutaneous-17</td>
<td>All recovered</td>
<td></td>
</tr>
<tr>
<td>Kumar et al \textsuperscript{22}</td>
<td>35</td>
<td>AME-12</td>
<td>2 expired</td>
<td>Contact with animal meat/hide in 32 cases</td>
</tr>
<tr>
<td>Pondicherry\textsuperscript{22}</td>
<td></td>
<td>Cutaneous-23</td>
<td>All recovered</td>
<td></td>
</tr>
</tbody>
</table>
Table 9: Presentation of anthrax (n=35)

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutaneous</td>
<td>23</td>
<td>0</td>
</tr>
<tr>
<td>AME</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>12</td>
</tr>
</tbody>
</table>

Table 10: Prevention

- Prevention of animal anthrax → Key to prevention of human anthrax
- Mass immunisation of livestock - Very important
- High risk individuals (industrial and agricultural workers) - To be immunized
- AVA Sterne strain vaccine - Prepared from Protective Antigen → 6 doses of 0.5ml subcutaneously
- Disposal of dead animal - Deep burial (6 feet) with lime
- Other methods - Incineration, autoclaving of contaminants

Table 11: Schedule for AVA Sterne strain vaccine

<table>
<thead>
<tr>
<th>Number</th>
<th>Time Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 ml dose SC at 0 week</td>
<td></td>
</tr>
<tr>
<td>2 weeks</td>
<td></td>
</tr>
<tr>
<td>4 weeks</td>
<td></td>
</tr>
<tr>
<td>6 months</td>
<td></td>
</tr>
<tr>
<td>12 months</td>
<td></td>
</tr>
<tr>
<td>18 months</td>
<td></td>
</tr>
</tbody>
</table>

Booster 0.5 ml once a year

There is however a need for development of vaccines with better protection and simpler schedule

Table 12: Prophylaxis For Suspected Exposure In Asymptomatic Individuals

- Doxycycline - 100 mg bd orally x 6 weeks
- Ciprofloxacin - 500 mg bd orally x 6 weeks

Clinical Presentation

Anthrax meningoencephalitis (AME)

AME was observed in 12 cases. But for two cases where it was cutaneous, the portal of entry was not detectable. In all the cases, except two with cutaneous anthrax (in form of eschar), the diagnosis was clinically missed. The presentation was in form of cerebrovascular accident including subarachnoid hemorrhage, pyogenic meningitis and cerebral malaria. All the cases in common had headache, vomiting, high fever, change in mentation and signs of meningeal irritation. All the patients died despite heavy doses of penicillin. Most of the deaths occurred within 24 hours of admission.

Cutaneous Anthrax

Primary cutaneous anthrax was seen in 23 cases. Most of these had classical black ‘eschar’ (see Fig. 1). Five patients had presented with septicaemia.

JIPMER Experience From 2000-2004: There were 31 culture confirmed cases of anthrax, seven cutaneous, nine septicaemic, 12 meningitic types, two from lymphadenopathy and one from peritonitis. There was an overwhelming male preponderance (28/31 patients) with the ages ranging from the newborn to 75 years. In three of the seven cutaneous anthrax cases, the direct smear did not reveal the organism whereas all the meningitis, lymphadenopathy and peritonitis cases had positive direct smears as well as culture. All patients gave a history of contact with animals, particularly cattle. There were reports of cattle death in the area in some cases.

In the years 2005 - 2006, however, there have been no culture proven cases of anthrax, though there were some clinically suspected cases of cutaneous anthrax.

Prevention of Anthrax

High index of suspicion can only limit the spread of the disease. Thus, the physicians in endemic areas should be aware of its early presenting features. Cutaneous ‘eschar’ in humans, unexplained cattle death and gastroenteritis after sharing same animal meat are some of the clues to its diagnosis (Table 10).

All high risk individuals need to be protected by vaccination to arrest the recurrence of this disease. Being a zoonotic illness, one of foremost importance is prevention of infection in the livestock population of the endemic areas especially by mass immunization.

The standard anthrax vaccine, used both for humans and animals, is ‘Anthrax vaccine adsorbed’(AVA), which is an aluminium hydroxide-precipitated preparation of protective antigen (PA) from attenuated, non-encapsulated B. anthracis cultures of Sterne strain (Table 11).3

Routine immunisation of domestic animal with single inoculation of live Sterne vaccine is presumed to provide protective immunity for about a year, but ideally a booster dose every 6 months is essential.21

Inhalational Anthrax: Postexposure Prophylaxis

Unlike chemical agents, which typically lead to violent disease syndromes within minutes at the site of exposure, diseases resulting from biological agents including B. anthracis have incubation periods of days.24 A long period of prophylaxis is thus recommended because of the prolonged latency period that may elapse before the germination of spores acquired through inhalational exposure to B. anthracis. Because of the threat of a bioterrorist attack and because a strain of B. anthracis has been produced overseas that is resistant to multiple antibiotics (penicillin, doxycycline, chloramphenicol, macrolides, and rifampin), ciprofloxacin is the drug of choice for initial therapy now (Table 12).3

AVA vaccine supplies are extremely limited. In primates, optimal postexposure prophylaxis has been provided by the combination of antibiotic therapy and immunization. Should the vaccine become widely available, it has been proposed that its use at 0, 2, and 4 weeks might shorten the period of postexposure antimicrobial therapy to 30 to 45 days.

Autoclaving and incineration are acceptable procedures for the decontamination of laboratory materials. In southern India, continuous surveillance, mass education and animal vaccination efforts must be undertaken to control human and animal anthrax.

Hospital Infection Control and Decontamination

Since bacilli on exposure to atmosphere sporulate and there are no data indicating the occurrence of person-to-person transmission even in the case of patients with inhalational anthrax, patients with anthrax may be hospitalized in a standard hospital room with standard precautions. Contact precautions should be used with patients who have draining cutaneous lesions.
Dressings containing drainage should be considered to be hazardous waste and should be incinerated or autoclaved. Antibiotic prophylaxis need not be administered to health workers or to the members of the family unless they have come into contact with infected meat or animal. The state public health laboratory should be notified immediately of any suspected isolate of \textit{B. anthracis}. Consultation with the state public health laboratory is necessary regarding any suspected \textit{B. anthracis} isolate, and the communicable disease epidemiology service of the state department of health may have to be involved. For the decontamination of contaminated areas, sporicidal solutions approved for hospital use should be employed. Commercially available bleach or 0.5 percent hypochlorite solution (a 1:10 dilution of household bleach) may be used.\textsuperscript{5}

\section*{References}