Human cutaneous anthrax in Bangladesh: a case-control study

Principal Investigator: Mir Mobarak Hossain[1]
Co-authors: Mahmudur Rahman[2]; Md. Rizwanul Karim Shamim[3]

[1]Institute of Public Health Nutrition, Directorate General of Health Services, Ministry of Health and Family Welfare; [2] Institute of Epidemiology, Disease Control and Research; [3]National Institute of Preventive and Social Medicine;

Introduction

Anthrax is a zoonotic disease caused by *Bacillus anthracis*, an aerobic, gram-positive bacillus. Depending on route of exposure, cutaneous, gastrointestinal and inhalational forms of the disease occur in people. Sepsis or haemorrhagic meningitis may develop from any kind of anthrax infections. Most cases are cutaneous and the case fatality is <1% if treated properly. In developed countries, it is declining but in developing countries it is still a great public health burden, especially in low income group people.

In August 2009, a human cutaneous outbreak was detected that was closely related to an animal outbreak (1). From 2009, regular outbreaks have occurred in Bangladesh, with 607 human cases were reported in 2010 (IEDCR web site). Bangladesh produces only 3.8 million doses of animal vaccine each year, but we have 48.5 million herbivores (DLS, 2009). Sick animals are slaughtered to minimize their economic loss and some people purchase the relatively cheap meat from these animals. People are habituated to dispose of dead animals in flood water or open areas. During outbreak periods, the supplies of hides to the 60 tanneries fall sharply, affecting tannery owners and the 70,000 tannery workers in the country.

In this study we aimed to identify the aetiology, modes of transmission, social, behavioural, and cultural factors that contribute to these outbreaks. This study will be helpful for Bangladesh to take effective control and prevention measures against anthrax.

Objectives

- To obtain information about the socio-demographic characteristics of human cases of cutaneous anthrax.
- To undertake a case-control study to assess risk factors associated with the occurrence of human cutaneous anthrax.

Methods

A case-control study of human cutaneous anthrax was conducted in 8 upazilas (sub-districts) in north-west Bangladesh during May-September 2013. Suspect cases were identified by trained field-level health workers based on the WHO case definition: a skin lesion evolving over 2 to 6 days from a papular through a vesicular stage, to a depressed black eschar invariably accompanied by oedema that may be mild to extensive. Diagnosis of cutaneous anthrax was confirmed following referral of suspect cases to the medical officers at the upazila hospital. Trained data collectors went to patient's house and collected data from cases and controls on the same day by pretested questionnaire. Two control households were randomly selected for every case in the same village, followed by random selection of a family member in each household. Control definition was: a healthy person randomly chosen from the same community of the case having no skin lesion, respiratory illness or gastro-enteric illness. Children under five years of age were excluded from the study and we also collected the data by proxy from parents if a case or control was under 14 years of age.

Figure 1. A case of cutaneous anthrax.

We collected data about general information, socio-economic status, history of present illness, injury history and history of possible exposure within the last one month (animal sources, environmental sources, and occupational sources). Swabs from vesicles were also collected by trained laboratory technicians under close supervision of a microbiologist.

We entered the data and conducted initial analyses using Epi Info 7.1.2.0 version statistical software. Univariable and multivariable logistic regression modelling was conducted in Stata IC version 13.

Results

We enrolled 213 cases and 426 controls from same community for this case-control study. Details of the variables for cases and controls and p-values for the univariable analyses are shown in Table 1.

Table 1. Comparison of variables for cases and controls and p-value resulting from univariable analysis.

Variables	Categories	Case (%)	Control (%)	p
Age	≥ 34 years	114 (53.5)	214 (57.9)	0.29
	> 34 yrs	99 (46.5)	180 (42.1)	
Sex	Male	101 (47.2)	163 (38.3)	0.03
	Female	112 (52.6)	263 (61.7)	
Average monthly expenditure	< 5000tk	55 (25.8)	331 (77.7)	0.32
	=> 5000tk	158 (74.2)	95 (22.3)	
Education	Primary school & below	98 (46.0)	169 (39.7)	0.13
	Above primary school	115 (54.0)	257 (60.3)	
Wall materials	Mud	38 (17.8)	39 (9.1)	0.001
	Jute stick, straw, bamboo thatch tin, brick, cement	175(82.1)	387(90.9)	
Floor materials	Earth	183 (85.9)	315 (73.9)	0.001
	Cement, concrete	30 (14.1)	111 (26.1)	
Previous injury (within last one month)	Yes	38 (17.8)	39 (9.2)	0.001
	No	175 (82.2)	387 (90.9)	
Exposed to Anthrax-affected person	Yes	113 (53.1)	294 (69.0)	0.0001
	No	100 (47.0)	132 (31)	
Exposed to sick/dead animals	Yes	97 (45.5)	43 (10.1)	0
	No	116 (54.5)	383 (89.9)	
Exposed to animal products	Yes	200 (93.9)	170 (39.9)	0
	No	13 (6.1)	256 (60.1)	
Work related to animal contact	Yes	165 (77.5)	307 (72.1)	0.14
	No	48 (22.5)	119 (27.9)	
Cutting grass for animals	Yes	90 (42.3)	138 (32.4)	0.01
	No	123 (57.8)	288 (67.6)	
Wet land	Yes	51 (23.9)	67 (15.7)	0.01
	No	162 (76.1)	359 (84.3)	

In exposure history, 97 (45.5%) patients handled sick animals, including cattle (n=62, 29.1%) and goat (n= 35, 16.4%). The number of patients who handled sick cattle, dead cattle and participated in cattle slaughter were 38 (17.8%), 4 (1.9%) and 20 (9.4%), respectively. Dead cattle and carcases were most commonly disposed of in open places (n=47, 22.1%). Only one patient knew of cattle that had been diagnosed with anthrax. The number of patients who handled sick goats, dead goats, participated in goat slaughter were 20 (9.39%), 1 (0.47%) and 14 (6.57%), respectively. Dead goats and carcases were also commonly disposed of in open places (n=32, 15.02%), and one patient knew about goats that had been diagnosed with anthrax.

Two hundred (93%) patients handled animal products like hide (n=30, 6.10%), raw meat (n=198, 92.96%) and gut (n=26, 12.21).

Sixty (28.17%) patients reported that they had worked within in the paddy fields in the last month, and 67 patients (31.46%) told that they had worked in other crop fields like jute (n=49, 23%) and nuts (n=4, 1.88%), and 90 (42.25%) patient said that they cut grass from wet land (n=51, 23.94%) and dry land (n=40, 18.78%).

Table 2. Descriptive information about 213 human cutaneous anthrax cases in Bangladesh.

Variable of interest	Number (%)
Most affected site	
Hands	154 (72.3)
Face	14 (6.1)
Lower extremity	14 (6.6)
Arms	13 (6.1)
Chest	13 (6.1)
Oral cavity	5 (2.4)
Head	2 (0.9)
Penis	2 (0.9)
Major Features of Anthrax	
Ulcer	212 (99.5)
Oedema	199 (93.4)
Escher	191 (89.7)
General Symptoms of Anthrax	
Fever	173 (81.2)
Myalgia	169 (79.3)
Itching	168 (78.9)
Fatigue	143 (67.1)
Headache	138 (64.8)
Chill	76 (35.7)
Lymph node	10 (4.7)
Abdominal pain	5 (2.4)
Others	5 (2.4)
Patients received treatment	
Qualified doctors	98 (46.0)
Paramedics	88 (41.3)
Quack	18 (8.5)
Shop owners	7 (3.3)
Traditional healer	2 (0.9)

Descriptive information about anthrax is shown in Table 2. Ciprofloxacin (n=179, 87.75%) was used frequently for treatment and the patients received treatment mainly from qualified doctors (n=98, 46.01%) and paramedics (n=88, 41.31%). Only 5 (2.35%) patients were admitted in the local hospital.

We collected 46 swab samples and 15 (32.61%) were culture-positive. Variables found to have a significantly positive association with cutaneous anthrax in the multivariable analysis were: house with an earth floor, house with mud walls, cutting grass for animals. Exposure to a person with anthrax had a significant protective effect. Two significant interaction terms were found: both the effect of exposure to a sick animal and exposure to animal products was dependent on whether the person had an injury in the previous month (Table 3).

Table 3. The results of a multivariable logistic regression model showing the significant risk factors for human cutaneous anthrax in North West Bangladesh.

Variables	Odds Ratio	95% CI	p-value
Exposed to animal products	39.9	16.6–95.8	<0.001
Exposed to sick animal	4.1	2.4-7.0	<0.001
Exposed to a person with anthrax	0.4	0.3-0.7	0.0001
Earth floor (compared with cement floor)	2.0	1.2–3.5	0.017
Mud walls	2.2	1.2-4.2	0.001
Cut grass for animals	1.9	1.2–2.9	0.008
Injury within last month	12.8	3.8-43.0	<0.001
Exposed to sick animal * Injury	0.2	0.05-0.8	0.03
Exposure to animal products*Injury	0.2	0.05-1.0	0.05

Discussion

Anthrax is an endemic disease in Bangladesh among people as well as animals. From 2009, a higher number of human cutaneous anthrax cases have been reported from North West parts of Bangladesh. In the year 2013, the reported cases were 327 (up to 11/11/2013, IEDCR website) which are higher than last two years.

This study has identified the socio-demographic characteristics and statistically significant risk factors for human cutaneous anthrax. Cutaneous anthrax occurred in all ages with no significant association with sex once exposure factors had been controlled for. Most of the cases of this study had a contact history with sick or dead animals (cattle, goat) and animal products (raw meat, hide and gut), which were significant. This study finding is similar with case control study of Gombe et al in Zimbabwe (3) and Woods et al in Kazakhstan (4). Interestingly, in this study the effect of exposure to sick animals and to animal products was dependent on whether the person had an injury in the previous month. One possible explanation for this is that people who had an injury were more likely to have taken antibiotics which may have provided protection against developing anthrax. Exposure to a person who had anthrax in the previous month was protective, which may be due to an increased awareness of the risk of anthrax.

Three other significant risk factors are living in a house with an earth floor, living in a house with mud walls and cutting grass from wet land or dry land. People who live on earth floors and those with mud walls come from low income group and average monthly family expenditure of most cases were less then 10000tk. Most people who with sick cattle and goats disposed of dead animals in open fields. This suggests a lack of knowledge and awareness about the risk of the carcases of sick animals spreading disease. Another complicating factor is that during the monsoon season there is very little dry land available for burying dead animals.

An interesting finding of this study was the significant risk associated with cutting grass, which has not previously been reported. This may be due to direct exposure to anthrax spores in grass whilst cutting or it may be a proxy variable for some other factor(s) associated with exposure to animals.

The major site of anthrax infection was a hand, which is consistent with Mwenye et al finding of a study in Murehwa (5) and as well as Gombe et al in Zimbabwe (3). The hands were involved in infected animal product handling and cutting grass. One study showed that the chance of infection was high when someone with an injured hand handled infected meat.

In most cases, cutaneous anthrax presented with a single lesion which was characterised by ulcer, black eschar and oedema with associated fever, itching, myalgia, chill and headache. The incubation period of cutaneous anthrax is 0–7 days after exposure. No case fatality was recorded in this study.

Our case-control study may be limited by the case definition which was the WHO suspected clinical case definition rather than a laboratory-confirmed diagnosis. Data collection was conducted by local level, field health staff who were not trained to find out injury history properly. Furthermore, more information about sick cattle would have been useful to investigate epidemiological links between animals and people. In some occasions, data was collected 10-15 days late and recall bias may influence the study.

Lessons learned

The study suggested that animals are the main source of infection and some human behaviour may increase the chance of infection. Environmental sources may also cause cutaneous anthrax lesions. So anthrax is not just a disease of people, it is also a disease of animals and the environment too. But, in Bangladesh, we have only few collaborative works among animal health, human health and environmental health in some outbreak investigation.

We have no true collaboration regarding disease control at the field level. Not every department shares their information at the field level. We have no reliable data in either the animal or human health sector about anthrax cases. A collaborative disease surveillance program will help us to estimate the disease burden and focus the anthrax control program.

We have a control program in the animal health sector via the distribution of vaccine in anthrax affected areas, but this is not sufficient. The scarcity of trained person is another issue for administering vaccines to animals.

We have sanitary inspectors in every upazila to supervise the slaughter houses, but during outbreak people slaughter their animal at home and sell meat to minimise their economic loss. Most of the time people hide this information.

Before 2009, anthrax was not a common disease in Bangladesh especially in the human health sector, so doctors and field level health personal are not aware about this disease for appropriate treatment and also reporting. Proper training will be helpful for disease control. Anthrax in animal is not only an in-country issue of Bangladesh, it is also a cross-border issue. Every year we import lots of cattle from India, so it needs regional collaboration for sharing data and gaining knowledge about control programs.

Recommendations

A lack of awareness of the cattle owners and community people about transmission of disease is the major issue for controlling anthrax outbreak. Awareness creation about disposal of dead carcases, handling and slaughtering of infected animal, personal hygiene among the community people will be helpful.

Continuous supply of animal vaccines and ensuring they are administered appropriately by trained vaccinators will help anthrax control in animal populations as well as people.

A combined surveillance program will be needed for identifying the actual disease burden and the epidemiological links to control anthrax outbreak.

Further investigation will be needed to find out environmental risk factors that will help us to know about environmental characteristics of affected areas and take proper control measures.

Establishment of a One Health network in region will help us to solve cross border health issues and give information about recent outbreaks in other countries so that control measures can be taken against emerging disease.

Acknowledgments

We thank Dr. Md. Khalequzzaman, Dr. Mohammmad Anowar Uddin who helped us to develop questionnaire, Dr. Md Munir, Dr. Iftekar Ahmed Taslim, Dr. Abu Masud Nurul Karim, Dr. Mehbuba syeed, Dr. Irfan Nowroze noor, Dr. Murad Md. Shamsher Tabris khan, Dr. Gazi Ahmed Hasan, Dr. Md. Harun Ul Morshed who helped us for training and field investigation at upazila level, Dr. Md Ahasanul Hoque, Dr. Dilip Kumar Ghosh who supplied veterinary data, Dr. Ashraraf Alam and his team who participate for sample collection and testing, all study participants for their contributions, all upazila health and family planning offices from where we collected data and data collection team of every upazila. We especially thank to Professor Roger Morris, and Dr Joanna McKenzie for their mentorship, and to Massey University for creating us this type of opportunity.

References

Mahmudur Rahman, Director IEDCR,Bangladesh, M K Zaman Biswas, WHO Bangladesh, Gyanendra Gongal,DSE, SEARO, Unusual outbreak of human anthrax in Bangladesh.

Livestock Research Institute, 2010. Annual Report on Production, Distribution and Balance of Vaccines in the Financial Year, 2009–2010, Bangladesh. Dhaka: Livestock Research Institute

Gombe NT, Nkomo BMM, Chadambuka A1, Shambira G, Tshimanga M. Risk factors for contracting anthrax in Kuwirirana ward, Gokwe, North, Zimbabwe, African Health Science Vol 10 No. 2 June 2010

Christopher W. Woods, Kenes Ospanov, Akylbek Myrzabekov, Michael Favorov, Brain Plikaytis and David A. Ashford. Risk factors for Human Anthrax among contacts of anthrax- infected Livestock in Kazakhstan. Am J Trop Med Hyg., 71(1), 2004, pp 48-52

Mwenye KS, Siziya S, Peterson D: Factors associated with human anthrax outbreak in the Chikupo and Ngandu villages of Murewa District, Mashonaland East; Central African Medical Journal Nov 1996; 42(11): 312-5

Figure 2. A training workshop in the detection of anthrax cases for field level workers.