TÜBİTAK

Original Article

Turk J Med Sci
2012; 42 (1): 39-45
© TÜBİTAK
E-mail: medsci@tubitak.gov.tr
doi:10.3906/sag-1103-71

Cutaneous anthrax patients in Eastern Anatolia, Turkey: a review of 44 adults cases

Kemalettin ÖZDEN[1], Zülal ÖZKURT[1], Serpil EROL[1], Muhammet Hamidullah UYANIK[2], Mehmet PARLAK[1]

Aim: Anthrax is a zoonotic infectious disease caused by *B. anthracis*. It remains as an important issue in developing countries and it is a potential threat for the world because of its use as a biological weapon. In this study, we evaluated the epidemiological, clinical, and laboratory characteristics of 44 patients with cutaneous anthrax in our region.

Materials and methods: The study included 44 cutaneous anthrax patients admitted to our hospital from the Eastern Anatolia Region of Turkey between 2005 and 2008.

Results: Out of 44 cases, 24 (54.5%) were male and 20 (45.5%) female. The mean age was 41 ± 14.96 years. High risk occupations were farmers (n = 21, 48%) and housewives (n = 19, 43%). The sample consisted of 33 (75%) cutaneous anthrax with pustular lesion and 11 (25%) severe cutaneous anthrax with extensive edema. The most common exposures to sick animal or animal products were cutting of meat (n = 36, 81.8%), slaughtering of animal (n = 34, 77.3%), and direct contact with sick animal (n = 22, 50%). Cutaneous lesions were commonly located on hands (n = 24, 54.5%), arms (18, 40.9%), and fingers (n = 11, 25%). No death occurred and all of them were discharged from hospital.

Conclusion: Anthrax is still an important health issue in Turkey and usually presents as a cutaneous anthrax. Cutaneous anthrax should be considered in any patient with a painless ulcer with vesicles, edema, and a history of exposure to animals or animal products. The people under risk should be informed about risky exposures. Vaccination of animals may decrease the number of animal and human anthrax cases.

Key words: *Bacillus anthracis*, anthrax, cutaneous anthrax

Doğu Anadolu bölgesinde 44 deri şarbonu olgusunun değerlendirilmesi

Amaç: Şarbon *B. anthracis* tarafından oluşturulan zoonotik bir enfeksiyon hastalığıdır. Gelişmekte olan ülkelerde hala önemini korumaktadır. Biyolojik silah olarak kullanılmaya uygun olması, tüm dünya için potansiyel bir tehdit oluşturmaktadır. Biz bu çalışmamızda bölgemizde görülen deri şarbonu olan olgularının epidemiyolojik, klinik ve laboratuar özelliklerini irdelemek.

Yöntem ve gereç: Çalışmamız, 2005-2008 yılları arasında Doğu Anadolu bölgesinden hastanemize başvuran ve yatırılarak tedavileri yapılan 44 deri şarbonu olgusunu içermektedir.

Bulgular: Çalışmamız kapsamındaki 44 deri şarbonu olgusunun 24'ü (% 54,5) erkek, 20'si (% 45,5) kadındı. Hastaların yaş ortalaması 41 ± 14.96 olarak bulundu. Mesleki açıdan en yüksek risk grubu çiftçiler (n = 21, % 48) ve ev hanımlarıydı (n = 19, % 43). Olguların 33'ü (% 75) hafif püstüler şarbon lezyonu, 11'i (% 25) ise ağır deri şarbonu ve yaygın ödemi bulunan hastalardan meydana gelmişti. Riskli temasların sıklıkla hayvanın etinin doğranması (n = 36, % 81,8), hayvan

Received: 29.03.2011 – Accepted: 22.06.2011

[1] Department of Infectious Diseases and Clinical Microbiology, Faculty of Medicine, Atatürk University, Erzurum - TURKEY
[2] Department of Microbiology and Clinical Microbiology, Faculty of Medicine, Atatürk University, Erzurum – TURKEY
Correspondence: *Kemalettin ÖZDEN, Department of Infectious Diseases and Clinical Microbiology, Faculty of Medicine, Atatürk University, Erzurum - TURKEY*
E-mail: drkemalozden@gmail.com

kesimi (n = 34, % 77,3) ve hasta hayvanla direkt temas (n = 22, % 50) şeklinde oluştuğu tespit edildi. Cilt lezyonlarının en sık eller (n = 24, % 54,5), kollar (n = 18, % 40,9) ve parmaklarda (n = 11, % 25) lokalize olduğu belirlendi. Olgularımızın hiçbiri ölümle sonuçlanmadı, tamamı şifa ile taburcu edildi.

Sonuç: Şarbon ülkemiz için hala önemli bir sağlık sorunudur ve genellikle deri şarbonu şeklinde karşımıza çıkmaktadır. Hasta bir hayvan ya da hayvan ürünüyle temas öyküsü olan ve ödem, vezikül ile birlikte ağrısız ülseri bulunan bir kişide şarbon akla gelmelidir. Risk grubunda bulunan kişiler bulaş ve riskli davranışlar açısından eğitilmelidir. Hayvanların aşılanması, hem hayvan hem de insan şarbon olgularını azaltabilecektir.

Anahtar sözcükler: *Bacillus anthracis*, şarbon, deri şarbonu

Introduction

Bacillus anthracis, the etiological agent of anthrax, is a Gram-positive, aerobic or facultatively anaerobic, spore-forming, rod-shaped bacterium (1-3). Although anthrax has gradually reduced throughout the world, it has not been completely eradicated. Human is an incidental host and infected as a result of direct or indirect contact with contaminated animals or animal products (4). Anthrax has 3 major transmission channels to humans: inhalational, gastrointestinal, and cutaneous. Cutaneous anthrax is the most common form of naturally occurring anthrax and consists of approximately 95% of all cases of anthrax (4,5). In cutaneous anthrax, the organism's portal of entry is a cut or an abrasion on the skin. The areas at the greatest risk of exposure are hands, arms, face, and the neck.

Although anthrax is a rarely encountered disease in the United States of America, it is a relatively common infectious disease in the Middle East, Central Asia, and Africa. Anthrax cases are found in some parts of Europe, especially in Mediterranean countries, such as Spain, Greece, and Turkey (1,5,6). Anthrax has gradually reduced in Turkey over the years, but it is still an endemic infectious disease. In Turkey, from 1960 to 1969, 10,724 cases of human anthrax have been reported. The numbers of reported cases were 4423, 4220, and 2210 between 1980 and 1989, between 1990 and 1999, and between 2000 and 2005, respectively. According to the report of the Ministry of Health, 262 human cases were reported in 2007, 126 in 2008 and 132 in 2009 in Turkey (5,7,8).

In this study, we evaluated the clinical history and features, treatment, and outcome of 44 patients with cutaneous anthrax followed up in our clinic over a 4-year period between 2005 and 2008.

Materials and methods

The adult patients, who admitted to the Infectious Disease Clinic of Atatürk University Faculty of Medicine between January 2005 and December 2008, with the suspicion of cutaneous anthrax, were included in the study. The records of the patients were reviewed, and data on age, gender, occupation, clinical symptoms and findings, location and type of lesions, clinical history, laboratory findings including the white blood cell (WBC), peripheral blood smear, blood biochemistry and C-reactive protein, were recorded.

The clinical finding was a typical anthrax skin lesion (an ulcer covered by a characteristic black eschar) in a patient with appropriate history. The detailed medical history included the occupation of the patient, exposure to sick animals or animal products, and the time of onset of the first lesion. Microbiological diagnosis was based on demonstration of Gram-positive bacilli from a lesion, and/or isolation of *B. anthracis* after bacteriological culture. Clinical material was obtained with needle aspiration from vesicle in the vesicular stage and with sterile swab under an eschar during the eschar stage. Obtained clinical specimens were inoculated onto blood agar and incubated for 24 h at 37 °C under aerobic conditions. In the case of non-hemolytic, fairly flat, 2-7 mm diameter, white or gray-white colonies with irregular edges were observed, the grown bacteria were identified by conventional methods. To this end, Gram-stain, motility agar and catalase activity were used.

Results

The study included 44 patients with cutaneous anthrax, 24 (54.5%) were male and 20 (45.5%) female.

The mean age was 41 ± 14.96 years (min:16-max:67). High risk occupations for anthrax were farmers (48%) and housewives (43%). The distribution of the patients by their occupation is shown in Figure 1.

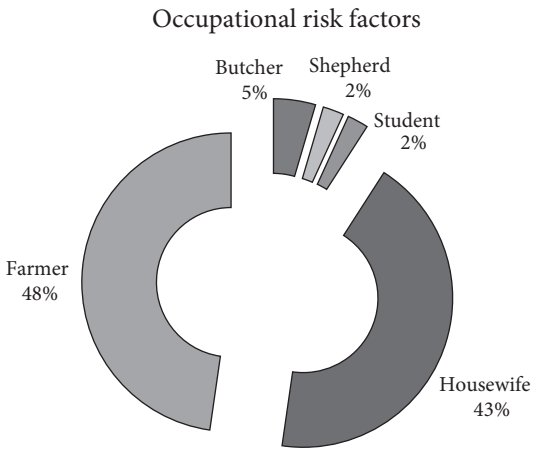

Figure 1. Occupational risk factors.

Almost all of the patients who admitted to our hospital were from the rural area of eastern Anatolia, mainly from Erzurum and Kars cities. Although there were cases of anthrax throughout the year, it peaked especially in August (22.7%) and September (38.6%). The incidence of the disease was similar between 2005 and 2007; however, its frequency increased in 2008 (Figures 2 and 3).

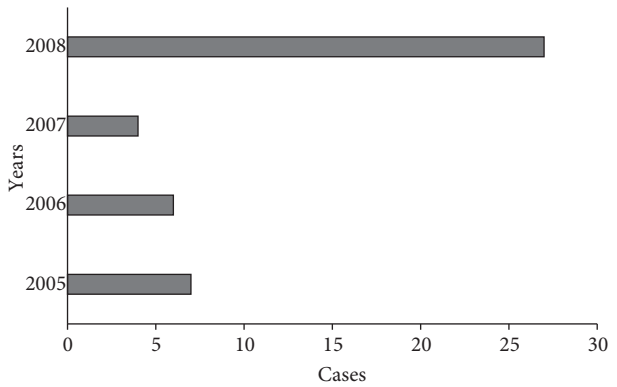

Figure 2. Annual distribution of the patients.

All of the patients who were admitted to our clinic were cutaneous anthrax. Of cutaneous lesions, 11 (25%) were severe cutaneous anthrax with extensive edema and 33 (75%) cutaneous anthrax with a typical pustular lesion (Figures 4 and 5).

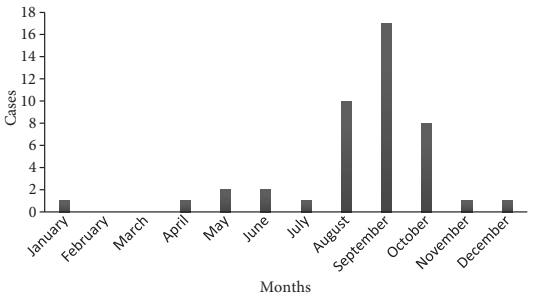

Figure 3. Monthly distribution of the cases.

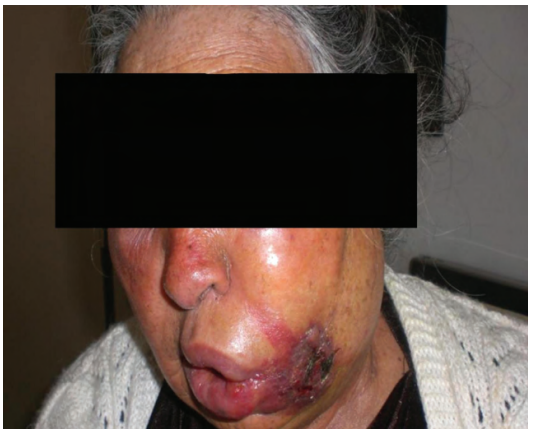

Figure 4. Cutaneous anthrax lesion with extensive edema on the face.

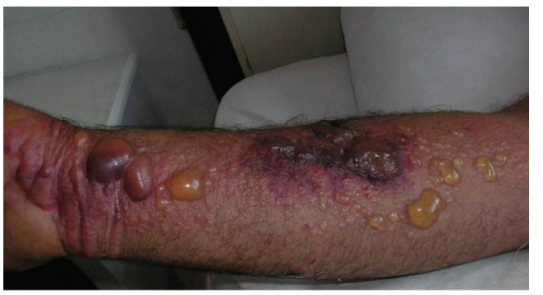

Figure 5. Edema and hemorrhagic bullae on the arm.

In all patients, there was a contact history either with a sick animal (cattle, sheep), or an animal product except for 2 cases (4.5%), both were farmers and living in a rural area. One of these patients, who had no known contact history, had told that when he went outside of his home to drink water in a fountain, a bird dropped a piece of meat into the water and he removed it with his hand. He also told us an acne-like lesion appeared on his face on the day after the

incident occurred and later his face got swollen. The other patient had no history of direct contact with sick animals and animal products; however, he was living in a rural area and busy with farming. Thus he was likely to contact with contaminated soil. Risky contacts in the patients were cutting of meat (81.8%), slaughtering (77.3%), contact with sick animals (50.0%), skinning (15.9%), and carrying contaminated animal products (11.4%) (Table 1). Some patients had a history of multiple contacts.

Table 1. Types of animal contact.

	n = 44	%*
Cutting of meat	36	81.8
Slaughtering	34	77.3
Skin peeling	7	15.9
Carrying contaminated packet	5	11.4
Contact with sick animals	22	50.0

* A case may have more than one contact history

Some patients had lesions in more than one region. Their lesions were located in hands (54.5%), arms (40.9%), fingers (25.0%), face (11.4%), neck (9.1%), lips and surrounding area (6.8%), and eyelids (6.8%). Out of the patients, 11 (25.0%) had lesions in 2 different areas and 5 (11.4%) in 3 different areas (Table 2). Diagnosis was mainly based on the typical skin lesion and the history of the patients cases. Only 5 patients had positive culture result for *Bacillus anthracis*.

Table 2. Sites of the lesions.

	n	%
Finger	11	25.0
Hand	24	54.5
Arm	18	40.9
Eyelids	3	6.8
Lips and surrounding area	3	6.8
Neck	4	9.1
Face	5	11.4

* A case may have more than one lesion.

Their treatments were tailored according to the clinical and laboratory results and also the location and extent of the lesions. In severe cases with extensive edema, crystallized penicillin G (20-24 million IU/day) IV, in mild cases procaine penicillin G (800,000 IU bid) intramuscularly, and in cases with small lesions oral amoxicillin (1000 mg tid) was the preferred treatment option. In addition to the antibiotic treatment, 1 mg/kg per day prednisolone was given in most of the cases with extensive edema and some cases of malignant pustule. Mean treatment duration was 9 and 9.3 days in cases with malignant pustule and with extensive edema, respectively.

The average incubation period of the disease was 4.2 ± 3.6 days (range, 1-11 days). None of the patients followed in our department developed any complications, such as sepsis or respiratory obstruction, and all were discharged from hospital with cure. The symptoms, and clinical and laboratory data of the patients are shown in Table 3. CRP was within normal limits only in 2 patients (4.5%). In the remaining 42 patients (95.5%), it was higher than normal ranges (>5 mg/L). The average CRP level was 63.2 ± 64.6. The number of WBC in 15 patients (34.1%) was within normal limits, and in 29 patients

Table 3. Clinical and laboratory findings.

	n	%
Age		
<18	3	6,8
≥18	41	93.2
Female	20	45.5
Male	24	54.5
Black eschar formation	44	100
Swelling	44	100
Erythema	44	100
Pain	13	29.5
Pruritis	21	47.7
Fever	8	18.2
Laboratory findings		
WBC > 10.000/mm^3 (normal range 4-109 cells/L)	29	65.9
CRP > 5 mg/L (normal range < 5 mg/L)	42	95.5

(65.9%) was higher than normal levels (>10.000/ mm^3). The mean WBC levels were found to be 14.142 ± 7.486.

Discussion

Anthrax has been eradicated in developed countries; however, it still remains a major public health problem in many developing countries. Its suitability for use as a biological weapon has increased its importance and popularity. In developed countries, there is also a risk of infection after contact with a commercial product prepared from inadequately treated wool or leather (5). Although anthrax has gradually decreased because of animal vaccination programs, farmer training, and economical changes, it is still an endemic zoonosis in Turkey, particularly in the eastern part (5,7,9-12).

Almost all the reported cases in Turkey are cutaneous anthrax. All of our cases were also cutaneous anthrax, and no death occurred. The disease is commonly seen in people engaged in animal husbandry and agriculture. While industrialized cases are associated with industrialized countries, agricultural cases are the dominant form of infection in developing countries, such as Turkey (5,7,12-14). People are exposed to infectious agent during operations, such as slaughtering of the animal, skinning, and cutting of meat. In all of our patients, except for 2 cases, there was a history of direct or indirect contact by infected animal or animal products.

In our study, most of the cases were male, but there was no significant difference between genders. In many studies, it has also been reported that there was no difference in terms of transmission of the disease between genders (12,15-17). This data is consistent with our results. However, male or female predominance has been reported in some studies (10,14). In our region, animal care, slaughtering, skinning, meat handling, and processing are performed by both men and women, which may be the reason why the disease is distributed equally among both genders. When we look at the high risk occupations, farmers and housewives were 91% of the patients. In the study of Karahocagil et al., farmer and housewives were 64.7% of the patients while in the study of Engin et al., they were 89.8% of the patients (14,15).

The highest risk contacts were cutting of meat (n = 36, 81.8%) and slaughtering animals (n = 34, 77.3%) in our study. There was the history of direct contact with sick animals in half of the cases (n = 22, 50%). Our results were similar to the results of other studies (11,12,15,18,19).

In terms of localization of the lesions, the most frequent localizations were hands, fingers, and arms that are in direct contact with sick animal and animal products. The most common areas of involvement in our study were hands (54.5%) and arms (50.9%), which have a high probability to contact with contaminated product and are relatively open areas. Eyelids involvement were observed only in 6.8% of the cases. In the literature, the involved parts of the body varies according to the region wherein the study was performed. In the study by Kaya et al., previously carried out in our region, hand and arm involvement were 36.4% and 25.5%, respectively (12). In a recent study by Engin et al., they found the rate of patients with hand, arm, and eyelid involvement as 48.7%, 23.1%, and 20.5%, respectively (14). The distribution of hands, arms, and eyelids in the study of Baykam et al. was reported as 39%, 20.6%, and 6.8 percent, respectively (18). The distribution of hand, arm and face involvement in the study of Demirdağ et al. was 48%, 28%, and 8%, respectively (19). Although there have been some areas where eyelids involvement occurred as the leading area, but hand and arm involvement are mostly reported in the cases reported from our country and their results are similar to our results (12,14,15,18,19).

The seasonal variation in the frequency of the disease is well known. The number of cases in our study was increased in August and September. Animals are infected when they graze on fields or grain contaminated with spores or through the bites of flies that have fed on infected carcasses. Heavy spring rains may serve to concentrate spores into low-lying area, and if this is followed by a hot, dry period, animals grazing on these areas with high spore burdens may become infected (20). Although animals graze on the field during late spring, whole summer season and early autumn months in our region, it is highly possible that contamination risk of

animals increased in August and September, which relatively have dry weather. The number of cases in the present study also peaked in 2008. The peak may be related to the increase of animal anthrax cases in the same years; however, we have no data supporting this thesis. In the present study, the WBC count was more than 10,000/mm^3 in 29 patients (65.9%) and the CRP level was more than 5 mg/L in 42 patients (95.5%). The elevation of CRP levels in patients with cutaneous anthrax has been reported previously in one study and they also found that CRP levels were higher than 3 mg/L in all patients (11). The data which were obtained from both studies, showed the elevation of CRP levels in cutaneous anthrax cases; but more studies are needed to draw this conclusion. For the diagnosis of cutaneous anthrax, first the disase should be suspected. Diagnosis may be difficult in non-endemic areas. If a patient has a typical malignant pustule or extensive edema and a contact history with animals, the diagnosis may be easy. The patients admitted to our clinic usually had a history of antibiotic use –especially amoxicillin- prior to their application. Following 24-48 h of the use of an active antibiotic against *B. anthracis* has decreased the chance of growth of the microorganism from the cutaneous lesion (5). It is clear that this results in diagnostic difficulties. History of contact with sick animals or animal products, and clinical appearance of the lesions are important data for the diagnosis. We believe that in addition to the history and typical clinical appearance, the diagnosis should be confirmed by detecting the agent in Gram-staining, the growth of the organism in the culture, or both. Today, in addition to the conventional diagnostic methods, serological and molecular methods, such as ELISA and PCR, have been used. An enzyme-linked immunosorbent assay (ELISA) for immunoglobulin G antibodies against *B. anthracis* protective antigen in human serum is useful for diagnostic purposes. The newest diagnostic modality is a polymerase chain reaction (PCR) (1,14).

Penicillin G is still the drug of choice, and doxycycline or ciprofloxacin are now accepted as the best alternatives in the treatment of naturally-occurring anthrax. World Health Organization (WHO) guidelines recommend IM procaine penicillin treatment for 3-7 days in mild uncomplicated cases of cutaneous anthrax. Intravenous therapy is not recommended in these patients (1,5). As an alternative, oral penicillin V or amoxicillin for 3-7 days is recommended for the patients who refuse IM treatment. In patients with life threatening anthrax, such as inhalational anthrax, gastrointestinal anthrax, meningoencephalitis, sepsis, or extensive edema with cutaneous anthrax, antibiotics should be given intravenously and penicillin G (20-24 million unit total daily dose) is recommended as the first choice (1). Both the US CDC and the European guidelines state that until sensitivities are established the first line treatment should be ciprofloxacin or doxycycline with additional 1 or 2 antibiotics from rifampicin, chloramphenicol, clindamycin, clarithromycin, erythromycin, gentamicin, streptomycin, or vancomycin (21-24).

From various regions of the world, albeit in a small number, in-vitro penicillin resistance in clinical isolates has been reported (14, 25). In studies in Turkey penicillin resistance has not been shown yet (14,26). We selected the treatment modality according to the patient's clinical and laboratory results, and the location and extent of the lesions. All of the patients in this study were treated with intravenous or intramuscular penicillin G or with oral penicillin derivatives. Regarding management, the lesions were topically covered with gauze embedded with the topical antiseptic, Rivanol, to prevent secondary infection. In our patients, none of the possible complications including secondary infection, toxemic shock or airway obstruction were detected and no mortality occurred. Because no penicillin resistance is shown in our clinical findings, the findings of other studies, and antibiotic susceptibility tests clearly indicate that Penicillin G still has an important place and should be the first choice in the treatment of cutaneous anthrax in Turkey.

As a result, although anthrax has decreased over the years, it is still an important public health problem in Turkey, especially in the Eastern Anatolia Region of Turkey. It is easily diagnosed from painless ulcers, edema and the typical vesicular skin lesions in endemic areas. In addition, presence of typical history of contact with animals or animal products provides important information for diagnosis. Nevertheless, the recognition of the disease in non-endemic areas

may be difficult. Early diagnosis and treatment of the disease is important for prognosis. All clinical forms may be seen but majority of the cases are cutaneous anthrax. Clinical presentation of cutaneous anthrax may be mild or severe, and sometimes leads to severe complications, such as sepsis, toxemic shock, and other organ involvement. These clinical forms are life-threatening complications of cutaneous anthrax. Early supportive treatment for these complications with appropriate antimicrobial treatment could be life-saving.

References

1. Turnbull PCB.WHO Anthrax Working Group. Anthrax in humans and animals. 4th ed. Geneva: World Health Organization; 2008.
2. Lew DP. Bacillus anthracis (anthrax). In: Mandell GL, Bennett JE, Dolin R, editors. Principles and practice of infectious diseases. 5th ed. New York: Churchill Livingstone, 2000.p.2215-20.
3. Doğanay M, Eşel D. Bacillus anthracis ve diğer bacillus türleri. In: Topçu AW, Söyletir G, Doğanay M, editors. Enfeksiyon Hastalıkları ve Mikrobiyolojisi 2nd ed. İstanbul: Nobel Tıp Kitabevi, 2002.p.1533-43.
4. Dixon TC, Meselson M, Guillemin J, Hanna PC. Anthrax. N Engl J Med 1999; 341: 815–826.
5. Doganay M, Metan G, Alp E. A review of cutaneous anthrax and its outcome. J Infect and Public Health 2010; 3: 98-105.
6. Jernigan JA, Stephens DS, Ashford DA, Omenaca C, Topiel MS, Galbraith M et al. Bioterrorism-related inhalation anthrax: the first 10 cases reported in the United States. Emerg Infect Dis 2001;7: 933-44.
7. Ozkurt Z, Parlak M, Tastan R, Dinler U, Saglam YS, Ozyurek SF. Anthrax in eastern Turkey, 1992—2004. Emerg Infect Dis 2005; 11: 1939-41.
8. T.C. Sağlık Bakanlığı İstatistik Yıllıkları (The Ministry of Health Annual Statistic). http://www.saglik.gov.tr/TR/belge/1-2952/istatistik-yilliklari.html. Date last accessed: June 11, 2011.
9. Doğanay M, Metan G. Human anthrax in Turkey from 1990 to 2007. Vector Borne Zoonotic Dis 2009; 9: 131-40.
10. Irmak H, Buzgan T, Karahocagil MK, Sakarya N, Akdeniz H, Caksen H et al. Cutaneous manifestations of anthrax in eastern Anatolia: a review of 39 cases. Acta Med Okayama 2003; 57: 235-40.
11. Ozcan H, Kayabas U, Bayindir Y, Bayraktar MR, Ay S. Evaluation of 23 cutaneous anthrax patients in eastern Anatolia, Turkey: diagnosis and risk factors. Int J Dermatol. 2008 Oct; 47: 1033-7.
12. Kaya A, Tasyaran MA, Erol S, Ozkurt Z, Ozkan B. Anthrax in adults and children: a review of 132 cases in Turkey. Eur J Clin Microbiol Infect Dis 2002; 21: 258-61.
13. Sternbach G. The history of anthrax. J Emerg Med 2003; 24: 463-7.
14. Engin A, Elaldi N, Dokmetas I, Bakici MZ, Kaya S, Bakir M. Cutaneous Anthrax in the Central Anatolia Region of Turkey: A Review of 39 Adults Cases. Turkiye Klinikleri J Med Sci 2010; 30: 1032-8.
15. Karahocagil MK, Akdeniz N, Akdeniz H, Calka O, Karsen H, Bilici A et al. Cutaneous anthrax in Eastern Turkey: a review of 85 cases. Clin Exp Dermatol. 2008l; 33: 406-11.
16. Doganay M, Kökkaya A, Hah MM. 35 şarbon olgusunun değerlendirimi. *Microbiol Bült* 1983; 17: 1-10.
17. Oncül O, Ozsoy MF, Gul HC, Koçak N, Cavuslu S, Pahsa A. Cutaneous anthrax in Turkey: a review of 32 cases. Scand J Infect Dis 2002;34(6):413-6.
18. Baykam N, Ergonul O, Ulu A, Eren S, Celikbas A, Eroglu M et al. Characteristics of cutaneous anthrax in Turkey. J Infect Dev Ctries. 2009; 3: 599-603.
19. Demirdag K, Ozden M, Saral Y, Kalkan A, Kilic SS, Ozdarendeli A. Cutaneous anthrax in adults: a review of 25 cases in the eastern Anatolian region of Turkey. Infection 2003; 31: 327-30.
20. Hugh-Jones ME, deVos V. Anthrax and wildlife. Rev Sci Tech 2002; 21: 359-383.
21. Inglesby TV, O'Toole T, Henderson DA, Bartlett JG, Ascher MS, Eitzen E et al. Anthrax as a biological weapon, 2002: updated recommendations for management. JAMA 2002; 287: 2236-52.
22. Bossi P, Tegnell A, Baka A, Van Loock F, Hendriks J, Werner A *et al.* Bichat guidelines for the clinical management of anthrax and bioterrorism-related anthrax. Euro Surveill 2004; 9: E3-4.
23. Stern EJ, Uhde KB, Shadomy SV, Messonnier N. Conference report on public health and clinical guidelines for anthrax. Emerg Infect Dis. 2008; 14. pii: 07-0969.
24. Waterer GW, Robertson H. Bioterrorism for the respiratory physician. Respirology 2009; 14: 5-11.
25. Lalitha MK, Thomas MK. Penicillin resistance in Bacillus anthracis. Lancet 1997; 349: 1522.
26. Metan G, Doğanay M. The antimicrobial susceptibility of Bacillus anthracis isolated from human cases: A review of the Turkish Literature. Turkiye Klinikleri J Med Sci 2009; 29: 229-35.