ORIGINAL RESEARCH

Clinical Predictive Values in Botulism: A 10-year Survey

Sara Saeidi[1], Bita Dadpour[2], Lida Jarahi[3], Anahita A Ghamsari[4], Mahdi J Nooghabi[5]

Abstract

Background: Botulism occurs periodically or in outbreaks in Iran. Botulism is lethal and accordingly a considerable issue in environmental health, although it is uncommon. This study was performed to evaluate the potential predictive factors in foodborne botulism in a 10-year span.

Materials and methods: All medical records from patients with foodborne botulism admitted to Imam Reza Hospital in 10 years (2005–2015) were analyzed retrospectively.

Results: 61 cases were included (38 men, mean age ± SD 28.93 ± 19.14 years). All cases were treated with antitoxin. 6.6% of cases died. Canned beans were correlated with the admission to intensive care unit (ICU), and also, it increased the length of ICU stay significantly ($P = 0.007$ and 0.023, respectively). The incidence of dizziness and diplopia significantly induced excess demands for higher doses of antitoxin ($P = 0.038$ and 0.023, respectively). Risk of dysphagia was remarkably higher in cases with ptosis ($P = 0.039$, odds ratio: 3). While in this study, time elapsed between the onset of clinical manifestations and antitoxin administration was correlated with the occurrence of dysphagia, constipation, and blurred vision, and early treatment did not improve the outcomes. Multiple analysis of potential variables by a logistic regression model disclosed that the independent significant factors affecting mortality were the need for mechanical ventilation ($P = 0.000$), dyspnea ($P = 0.044$), general weakness ($P = 0.044$), and lack of consciousness ($P = 0.008$) at the time of admission.

Conclusions: Taking clinical signs and symptoms into account upon patient arrival is important and, of course, is a key to further management in the emergency setting.

Keywords: Botulism, Clinical toxicology, Foodborne, Predictive, Prognostic factors.

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Introduction

Botulism is an acute neuroparalytic illness, mainly caused by *Clostridium botulinum* neurotoxins. *C. botulinum* (CB) is an anaerobic, gram-positive bacterium that produces neurotoxins, which are classified into seven serotypes (A–G). Humans are mostly affected by types A, B, and E and rarely by F.[1]

Foodborne botulism usually occurs when foods containing the botulinum toxins are ingested. Toxins are released only under suitable conditions for germination of the CB spores including a pH less than 4.5 and anaerobic milieu.[2,3]

During this condition, neurotoxins accumulate in the nervous system and thus affect the neuromuscular junctions by inhibiting neural transmission and acetylcholine release, which clinically leads to flaccid paralysis.[4]

Initial symptoms include abdominal cramps, nausea, vomiting, and diarrhea although constipation is more common. After a few hours (12–24 hours and rarely after several days), neurologic signs and symptoms present, including blurred vision, diplopia, dysphagia, dysarthria followed by respiratory failure and progressive muscle weakness.[5,6] If left untreated, botulism is fatal with a mortality rate of about 40–50%.[7]

The only antidotal treatment is infusion of equine antitoxin, which has been widely used for botulism; it exerts a neutralizing effect in the bloodstream against the toxin's molecules; hence, it is beneficial to be administered on time, ideally less than 24 hours within the onset of symptoms, for the maximum effect.[8–10] Intensive care unit (ICU) admission, especially mechanical ventilation, has proven to be effective in improving the disease outcomes.[7]

The incidence of foodborne botulism is low in Iran. In a study during 2004–2010, it was reported that the average number of botulism cases per year was 2.7.[11,12] The major cause of most botulism cases in Iran was found to be the consumption of contaminated fish and vegetables.[13]

In a study by Tavakoli et al.[14] between 2004 and 2008 in Iran, saline fish and prawn were identified as the most implicated foods in 31.08% of botulism outbreaks.

The aim of this study was to identify clinical risk factors and prognostic indicators in botulism cases over a 10-year period from May 2005 to May 2015.

Materials and Methods

Study Design

An observational retrospective study was carried out. All medical records of admitted patients in the medical toxicology department

[1,2,4]Medical Toxicology Research Center, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran

[3]Department of Community Medicine, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran

[5]Department of Statistics, Ferdowsi University of Mashhad, Mashhad, Iran

Corresponding Author: Bita Dadpour, Medical Toxicology Research Center, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran, Phone: +98 9155149842, e-mail: Dadpourb@mums.ac.ir

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of Imam Reza Hospital, Mashhad, Iran, with clinical diagnosis of foodborne botulism from May 2005 to May 2015 were reviewed. Patients who did not receive antitoxin due to hypersensitivity reactions were excluded from this study.

Study Endpoints

The primary endpoints of our study were to evaluate in-hospital survival and factors affecting prognosis of patients. Length of hospital stay and ICU stay, need for tracheal intubation, mechanical ventilation requirement and need for ICU admission and antitoxin dosages were considered as primary criteria for determining prognosis of botulism cases. All signs and symptoms of patients at the time of admission and during hospital stay in addition to number of infused antitoxin vials were extracted from medical records.

Time elapsed between the onsets of symptoms and receiving antitoxin was collected as well, in order to find out if it may be a factor affecting outcome and prognosis.

In this study, the contaminated foods are classified into five different groups including leftover and suspected foods, yogurt and kashk, meat and tuna, canned beans, Olivier and pasta salad. Foods are basically divided into homemade and commercially produced groups.

Statistical Analysis

For statistical analyses, we used IBM SPSS Statistics 21. In order to analyze the relationship between prognostic variables and mortality, we used cross tabulation test; univariate comparisons of all categorical variables were performed by Pearson's correlation, chi-square analysis, and Fisher's exact test, and also either independent sample t test or Mann–Whitney test was applied for continuous variables as appropriate.

All confounding variables were entered into a binary logistic regression model for multiple analysis to determine independent predictors of outcome. Significance was considered at the probability level of 0.05.

Results

Over the study period, 63 cases of botulism with clinical diagnosis were admitted. Two cases did not receive antitoxin due to hypersensitivity reactions and therefore were excluded from the study. The age of the patients ranged from 1 to 71 years with a mean of 28.93 years; 23 (45.9%) of them were male and 38 (54.1%) were female. It should be noted that mortality status was not affected by age or sex.

Table 1 shows the demographic characteristics of the patients.

All 61 cases were administered the antitoxin of which 17 (27.9%) required ICU admission, 7 (11.9%) needed tracheal intubation, and 3 (5%) underwent mechanical ventilation. The mean time elapsed between the onset of symptoms and antitoxin administration was 4.78 days (3.58, <24 hours to 14 days). Leftovers with 36.1% (22/61) were the most reported foods followed by meat and tuna group with 24.6% (15/61) and canned beans with 14.8% (9/61). Leftovers were referred to as foods patients usually kept in the refrigerator for more than 24 hours. In the present study, they were mostly commercial products.

In most (47.5%) of the reported cases, the suspicious contaminated foods were commercially produced, while 26.2% of cases presented a history of consuming home-canned foods.

Diplopia, dysphagia, ptosis, and weakness were the most reported common clinical manifestations in 68.9, 59, 55.7, and 47.5% of patients, respectively, of which general weakness significantly affected the mortality status (*P* value = 0.046). The trivalent botulism antitoxin was administered to 86.9% of cases while its monovalent equivalent was administered to 13.1%. Most of the cases in the monovalent administered group were admitted in the first half of the study period when the trivalent antitoxin was not available in our setting (Table 2).

Table 1: Clinical and demographic characteristics and associated mortality

Characteristics	*N (%)*	*P value*
Age (mean ± SD, Min–Max)	28.93 ± 19.14 (1–71)	0.232
Sex		
Male	28 (45.9%)	0.325
Female	33 (54.1%)	
Contaminated foods		
Leftovers	22 (36.1%)	0.316
Yogurt and kashk	7 (11.5%)	
Meat and tuna	15 (24.6%)	
Canned beans	9 (14.8%)	
Olivier and pasta salad	8 (13.1%)	
Homemade foods	16 (26.2%)	0.999
Length of hospital	6.65 ± 8.85 (1–51)	0.412
Stay (day) (mean ± SD, min–max)		
Need for ICU admission	17 (27.9%)	0.062
Need for mechanical ventilation	3 (5%)	0.010
Length of ICU	2.12 ± 6.66 (0–47)	0.058
Stay (day) (mean ± SD, min–max)		
Antitoxin dose	3.35 ± 3.36 (1–17)	0.275
Polyvalent		
Antitoxin (*n*) (mean ± SD, min–max)		
Time elapsed between onset of symptoms and antitoxin (day)	4.78 ± 3.58 (less than 24 to 14 h)	0.259
Mortality rate (%)	4(6.6%)	

Pearson's correlation and chi-square test were used

Of all the cases, 83.6% recovered, 9.8% self-discharged, and 6.6% died predominantly due to cardiopulmonary arrest secondary to respiratory failure. The time period between the manifestation of symptoms and receiving antitoxin was correlated with the incidence of dysphagia, constipation, and blurred vision (*P* = 0.007, 0.000, and 0.042, respectively).

The results showed that ptosis was common among patients who had consumed homemade foods than commercially produced ones [*P* = 0.048; odds ratio (OR) = 3.60; 95% confidence interval (CI) = (0.985–13.159)]. Risk of occurrence of dysphagia was significantly higher in cases who had ptosis (*P* = 0.039, odds ratio: 3). Survival rate was negatively correlated to the need for mechanical ventilation. Requiring intensive care showed a significant relationship with the type of consumed food, as ICU admission was also significantly higher in patients who consumed canned beans (*P* = 0.007). Furthermore, mean duration of ICU stay was more prolonged in these cases (36.25 days and *P* = 0.023).

Dizziness and diplopia showed a significant correlation with dosage of antitoxin as cases who suffered dizziness and diplopia required higher antitoxin doses (*P* = 0.038 and 0.023, respectively).

Table 2: Clinical manifestations and associated mortality

					Confidence interval (95%)	
Clinical manifestation	*N (%)*	*Mortality rate (%)*	*P value*	*Odds ratio*	*Lower*	*Upper*
Diplopia	42 (68.9%)	4.91	0.999	0.722	0.070	7.431
Dysphagia	36 (59%)	3.27	0.999	1.478	0.194	11.257
Ptosis	34 (55.7%)	4.91	0.623	0.397	0.039	4.054
General weakness	29 (47.5%)	6.55	0.046			
Blurred vision	23 (37.7%)	1.63	0.999	1.886	0.184	19.287
Dyspnea	16 (26.2%)	3.27	0.279	0.326	0.042	2.531
Decreased muscle tone	15 (24.6%)	3.27	0.251	0.295	0.038	2.307
Dizziness	15 (24.6%)	0	0.564			
Mydriasis	13 (21.3%)	3.27	0.196	0.239	0.030	1.890
Nasal speech	10 (16.4%)	3.27	0.122	0.163	0.020	1.330
Nausea vomiting	8 (13.1%)	0	0.999			
Lack of consciousness	7 (11.5%)	3.27	0.061	0.096	0.011	0.837
Drooling	6 (9.8%)	1.63	0.346	0.288	0.025	3.317
Constipation	5 (8.2%)	0	0.999			

Chi-square test was used

Table 3: Logistic binary regression model (enter mode) of all variables

Variables	*Sig.*	*Exp (B)*
Sex	0.227	0.00
Age	0.233	1.033
Hospital stay	0.783	0.223
Period time between manifestation of symptoms and receiving antitoxin	0.548	0.023
ICU admission	0.030	0.061
Need for ventilation	0.000	1.183
Dysphagia	0.704	0.00
Dyspnea	0.264	0.465
General weakness	0.030	1.542
Decreased muscle tone	0.222	0.520
Drooling	0.292	0.00
Diplopia	0.784	0.841
Blurred vision	0.588	0.130
Ptosis	0.422	0.011
Mydriasis	0.147	0.00
Dizziness	0.237	0.068
Nausea vomiting	0.421	0.00
Lack of consciousness	0.012	1.616
Overall statistics	0.008	0.070

The time elapsed between the onset of symptoms and antitoxin administration was not in correlation with patients' survival, length of hospital stay, and the need for ICU admission. The study also did not report any association between antitoxin dosage and length of hospital stay, the need for ICU admission, and mortality rate.

Multiple analysis of potential variables associated with mortality using a logistic binary regression model revealed that the statistically significant factors affecting mortality were the need for mechanical ventilation, need for ICU admission, general weakness, and lack of consciousness upon admission (Table 3).

Discussion

Unlike the infantile form that may occur abruptly, the onset of clinical presentations in foodborne botulism is less rapid. The sudden onset of clinical manifestations varies by hours to days and is correlated to the neurotoxin dosage. Airway obstruction due to paralysis of the pharyngeal muscles in addition to paralysis of the diaphragm and accessory muscles of respiration leads to respiratory failure, which is the most probable cause of death in such cases.[15]

Although botulism is rare and early diagnosis would be difficult in sporadic cases and outbreaks, early detection and intervention remain crucial.[16] ICU care, especially mechanical ventilation, has been reported to significantly affect the disease outcome.[7]

The exact clinical features that can predict the outcome of botulism cases have not been clearly identified. Therefore, in large outbreaks, identifying clinical predictive factors of respiratory failure would be helpful in the management of patients.

In the United States, an average of 145 cases of botulism is reported annually of which about 15% are foodborne. Outbreaks occur when two or more individuals become affected and they are mostly caused by home-canned foods.[17]

The European Union[18] reported an average incidence of 119 botulism cases per year between 2006 and 2008 (104–132 cases annually). The highest numbers of confirmed cases were reported in Romania, Italy, Poland, and France with the consumption of contaminated home-preserved foods as the major cause.[19]

In a cross-sectional 4-year study (2003–2007) and based on information from the Ministry of Health and Medical Education in Iran,[20] 341 cases were reported to be suspected botulism. Ninety of the cases were from Gilan province, while West Azerbaijan reported only four incidences. Home-processed foods were the most common cause of food poisoning.

In this study, 63 cases of botulism over a 10-year period were studied. This is similar to a previous study conducted over a 7-year period in this center in which 45 patients were included.[21]

Aminzadeh et al. in a 10-year study (1996–2006) of 80 cases of botulism with confirmed diagnosis of 58.8%, reported cheese and seafoods as the most common contaminated foods in foodborne botulism.[22]

In a study on some Iranian traditional foods (kashk, salted fish, and cheese) in 2009, C. botulinum was found in 4.58% of 131 samples with cheese and salted fish having the highest contamination rates, respectively, while kashk uncontaminated. Furthermore, toxin subgroups A and E were dominant in the contaminated food samples.[23]

In another retrospective study at Razi hospital in Rasht between 2001 and 2006, the major causes of botulism were reported to be preserved foods, caviar, and fish.[24]

In our study, the most common reported foods were leftovers, meat, tuna, and canned beans. The type of contaminated food was found to be a significant factor in predicting prognosis. The need for intensive care varied among cases who consumed different types of contaminated foods, such that it was significantly higher in cases who consumed canned beans. Mean duration of ICU stay was also significantly more prolonged in these cases (36.25 days).

The results of this study showed that patients mostly suffered from improper processing and preservation of foods rather than faulty canning. In fact, the most contaminated foods were the leftovers kept in the refrigerator for more than 24 hours.

However, in the present investigation, no significant correlation was found between homemade or commercially produced foods. In addition, mortality and ptosis were found to be correlated with the consumption of homemade products.

In another study by Afshari et al.,[25] the most frequent signs and symptoms reported during admission were diplopia, hoarseness, and headache.

The medical records of 706 patients admitted for foodborne botulism in Atlanta, Georgia, were studied from 1980 to 2002. Eighty-eight percent of the cases received trivalent antitoxin, while eight percent died. Mortality rate in patients whose gag reflex was impaired and cases with dyspnea were higher than cases without these symptoms.[26]

One hundred and thirty-seven cases of foodborne botulism were studied in Thailand. 31.4% of the patients developed symptoms and signs of respiratory failure. The major predictors of respiratory failure were nausea, vomiting, and cranial neuropathy.[27]

In this study, diplopia, dysphagia, ptosis, and weakness were the most common clinical presentations in 68.9, 59, 55.7, and 47.5% of patients, respectively. Among these symptoms, only general weakness had a significant correlation with mortality rate.

Among all clinical findings, there was a significant relationship between dizziness, diplopia, and antitoxin dosage in this study. Therefore, these conditions induced demand for higher antitoxin doses.

Antitoxin administration was identified as a favorable prognostic factor. In this study, antitoxin was administered to all cases except for two cases that were not administered due to hypersensitivity reactions. There was no correlation between administration of antitoxin doses and duration of admission, survival rate, and ICU admission.

In another investigation between 1973 and 1980 on 132 patients with foodborne botulism, it was reported that early administration of antitoxin decreased mortality rate by about 36 and 31% when given within and after 24 hours of symptom onset, respectively, in comparison with patients who were not administered the antitoxin. In survivors, mean hospital stay and number of days of mechanical ventilation were shortened with the administration of the antitoxin.[28]

A smaller cohort study on 18 patients registered in Nan Hospital in Thailand in 2006, after a large outbreak of foodborne botulism due to the consumption of contaminated bamboo shoots, reported that early administration of antitoxin was significantly effective in a reduction in length of mechanical ventilation, particularly when given in day 4 versus day 6 after exposure.[29]

Early administration of antitoxin was identified to be associated with a more favorable prognosis in the latter study. However, in the current study, there was no considerable correlation between early administration and mortality rate, length of hospital stay, and ICU admission. While there was a correlation between the onset of symptoms and antitoxin administration with the occurrence of dysphagia, constipation, and blurred vision, it did not influence the survival of patients, length of hospital stay, and the need for ICU admission.

As retrospective study, this investigation was carried out based on data from medical records. Hence, the limitation of the study included poorly recorded data. Prospective surveys with more precise data recording are therefore recommended.

Conclusion

Although botulism is rarely lethal, some clinical parameters might be associated with poor outcomes. While time elapsed between the onsets of symptoms and receiving antitoxin was correlated with the occurrence of dysphagia, constipation, and blurred vision, early treatment did not show any benefit in the prognosis. Dizziness and diplopia induced excess demand for higher doses of antitoxin. Also, some clinical parameters such as general weakness, dyspnea, and lack of consciousness at the time of admission were predictors for poor outcome; therefore, paying close attention to clinical signs and symptoms upon a patient's arrival is necessarily important and, of course, is a key to further management.

Highlights

- Type of contaminated food matters; canned beans may increase the duration of intensive care.
- Dizziness and diplopia induce excess demands for higher doses of antitoxin.
- Early treatment may not impact the outcomes.
- Factors predicting higher mortality: dyspnea, general weakness, and lack of consciousness on admission.

Orcid

Sara Saeidi https://orcid.org/0000-0001-9255-821X
Bita Dadpour https://orcid.org/0000-0001-6004-0344
Lida Jarahi https://orcid.org/0000-0001-7753-6610
Anahita A Ghamsari https://orcid.org/0000-0001-8441-1197
Mehdi J Nooghabi https://orcid.org/0000-0002-5636-2209

Author Statement

SSS contributed in main idea, study design, review articles, collecting data, analyzing and interpreting the results, and writing and submitting article. BD contributed in main idea, study design, review articles, collecting data, analyzing and interpreting the results, and writing article. LJ and MJN contributed in statistical analyzing and interpreting the results. AAG contributed in reviewing articles and collecting data.

References

1. Lonati D, Rossetto O, Fenicia L, Locatelli C. Botulism. General, applied and systems toxicology. Chichester: John Wiley; 2009.
2. Fenicia L, Anniballi F. Infant botulism. Ann Ist Super Sanita 2009;45(2):134–146.
3. Roberts T, Tompkin R. Microorganisms in foods 5: characteristics of microbial pathogens. New York: Springer Science & Business Media; 1996.
4. McLauchlin J, Grant K, Little C. Food-borne botulism in the United Kingdom. J Public Health 2006;28(4):337–342. DOI: 10.1093/pubmed/fdl053.
5. Terranova W, Palumbo JN, Breman JG. Ocular findings in botulism type B. JAMA 1979;241(5):475–477. DOI: 10.1001/jama.1979.03290310015004.
6. Vahdani P, Sharifian HA, Aminzadeh Z, Jahromi MK, Zamiri SA. An 18 year old boy presenting with nausea, vomiting and diplopia. Arch Clin Infect Dis 2008;18(3):191–192. DOI: 10.1177/000992287901800319.
7. Dembek ZF, Smith LA, Rusnak JM. Botulism: cause, effects, diagnosis, clinical and laboratory identification, and treatment modalities. Disaster Med Public Health Prep 2007;1(2):122–134. DOI: 10.1097/DMP.0b013e318158c5fd.
8. Arnon SS, Schechter R, Maslanka SE, Jewell NP, Hatheway CL. Human botulism immune globulin for the treatment of infant botulism. N Engl J Med 2006;354(5):462–471. DOI: 10.1056/NEJMoa051926.
9. Chalk C, Benstead TJ, Keezer M. Medical treatment for botulism. Cochrane Database Syst Rev 2011(3):CD008123. DOI: 10.1002/14651858.CD008123.pub2.
10. Hatheway CH, Snyder JD, Seals JE, Edell TA, Lewis Jr GE. Antitoxin levels in botulism patients treated with trivalent equine botulism antitoxin to toxin types A, B, and E. J Infect Dis 1984;150(3):407–412. DOI: 10.1093/infdis/150.3.407.
11. Afshari R, Shafiei S, Sayyahjezhad M, Dadras-Moghaddam D, Balali-Mood M. A botulism outbreak following a wedding in a rural area in North East Iran, 2006. Clin Toxicol 2007;45(4):388. DOI: 10.4172/2161-0495.1000115.
12. Asl HM. Identification of botulinum toxin type in clinical samples and foods in Iran. Arch Iranian Med 2013;16(11):642. PMID: 24206405.
13. Keramat F, editor Outbreak of food borne botulism in a family in Hamedan (Iran) due to consumption of soup prepared with traditional kashk. In: 8th congress of infective diseases, Tehran, Iran; 2000.
14. Tavakoli H, Zeynali M. Epidemiological survey of food-borne botulism in Iran during 2004–2008. Epidemiology 2009;20(6):S113. DOI: 10.1097/01.ede.0000362394.97915.47.
15. Sobel J. Botulism. Clin Infect Dis 2005;41(8):1167–1173. DOI: 10.1086/444507.
16. Louis MES, Peck SH, Bowering D, Morgan GB, Blatherwick J, Banerjee S, et al. Botulism from chopped garlic: delayed recognition of a major outbreak. Ann Intern Med 1988;108(3):363–368. DOI: 10.7326/0003-4819-108-3-363.
17. Control CfD, Prevention. National center for emerging and zoonotic infectious diseases. Available from: http://www.cdc.gov/nczved/divisions/dfbmd/diseases/campylobacter/technical html. Accessed January 2014.
18. Secretariat E. Eurobats: the agreement on the conservation of populations of European bats, 2004. Retrieved April 1, 2009.
19. Cowden J. Food-borne Clostridium botulinum intoxication from mass produced foodstuffs in Europe. Eurosurveillance 2011;16(49):20033. DOI: 10.2807/ese.16.49.20033.
20. Tavakoli H, Zeynali M, Mehrabi Tavana A. Scrutiny of food-borne botulism intoxication in Iran during 2003-2007 with the food hygiene view point. Hakim Res J 2009;11(4):38–46. DOI: 10.1097/01.ede.0000362394.97915.47.
21. Habibiyan Nejad Z, Afshari R. Foodborne botulism in Mashhad from 2003 to 2010. J Clin Toxicol 2011;1:115–119. DOI: 10.4172/2161-0495.1000115.
22. Aminzadeh Z, Vahdani P, Mirzaei J. A survey on 80 cases of botulism and its clinical presentations as a public health concern. Arch Clin Infect Dis 2007;2(2):77–81.
23. Tavakoli H, Meshgi MA, Jafari NJ, Izadi M, Ranjbar R, Fooladi AI. A survey of traditional Iranian food products for contamination with toxigenic Clostridium botulinum. J Infect Public Health 2009;2(2):91–95. DOI: 10.1016/j.jiph.2009.03.001.
24. RahbarTaromsar M, Badsar AR, Akhoundzade N, Oojaghi F, Karkan MF. A survey on the clinical presentations in food-borne botulism for patients refering to Razi Hospital during 2001-06. Iranian J Toxicol 2012;5:15.
25. Afshari R, Habibiyan Nejad Z, Shafiei S, Sayyahnejezhad M, Dadras-Moghaddam D, Balali-Mood M. A botulism outbreak following a wedding in a suburban area of Mashhad, 2006. J Birjand Univ Med Sci 2010;17(1):59–65.
26. Varma JK, Katsitadze G, Moiscrafishvili M, Zardiashvili T, Chokheli M, Tarkhashvili N, et al. Signs and symptoms predictive of death in patients with foodborne botulism—Republic of Georgia, 1980–2002. Clin Infect Dis 2004;39(3):357–362. DOI: 10.1086/422318.
27. Wongtanate M, Sucharitchan N, Tantisiriwit K, Oranrigsupak P, Chuesuwan A, Toykeaw S, et al. Signs and symptoms predictive of respiratory failure in patients with foodborne botulism in Thailand. Am J Trop Med Hyg 2007;77(2):386–389. DOI: 10.4269/ajtmh.2007.77.386.
28. Tacket CO, Shandera WX, Mann JM, Hargrett NT, Blake PA. Equine antitoxin use and other factors that predict outcome in type A foodborne botulism. Am J Med 1984;76(5):794–798. DOI: 10.1016/0002-9343(84)90988-4.
29. Kongsaengdao S, Samintarapanya K, Rusmeechan S, Wongsa A, Pothirat C, Permpikul C, et al. An outbreak of botulism in Thailand: clinical manifestations and management of severe respiratory failure. Clin Infect Dis 2006;43(10):1247–1256. DOI: 10.1086/508176.