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Original Article

Epidemiological characteristics and rabies post-exposure prophylaxis status of 5497 patients with bite injuries of Beijing, China

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Abstract: Objective: To analyze the epidemiological characteristics and rabies post-exposure prophylaxis status of 5497 animal bite patients attending Peking University People's hospital during 2013, to reveal the risk factors of animal bite and the defects of post-exposure prophylaxis, and to make rational proposals for the prophylaxis of rabies. Methods: A longitudinal survey was conducted in Peking University People's Hospital from January to December 2013, the data was analyzed by using descriptive statistics and correlation analysis. Results: The 5497 cases of animal bites did not show a typical seasonal characteristic. The male to female ratio was 0.82:1, women, children, retirees were risk population for animal bites. On the basis of WHO classification, 0.9% of animal bite patients were placed in Category I exposure, 78.1% in Category II and 21.0% in Category III. 64.0% of patients had wounds in hands. 75.9% of patients were injured by dogs. Different animal kinds were related to different injured parts and different exposure classifications. 89.1% of all animals were domestic animals, and only 19.7% of these domestic animals were vaccinated within the last 1 year. In the patients injured by the domestic dogs, 18.3% had wounds of Category III exposure, and in the patients injured by nondomestic dog, 30.3% had wounds of Category III exposure. Some patients did not seek for treatments timely after being bitten, only 74.3% of patients were vaccinated within 24 hours after injured. Some patients with wounds of Category III exposure did not use the passive immune agents, and only 8.0% patients used passive immune agents. Conclusion: The high urban population density of Beijing and the large amount of domestic animals were all reasons of the high incidence of animal bites in Beijing. Women, children and retirees were the main risk populations under this circumstance. Most cases were from dogs. The prevention awareness of Beijing population needs to be improved. Domestic animals should be vaccinated timely and nondomestic animals should be well managed. Patients should attend the hospital for post-exposure prophylaxis as soon as possible, and receive passive immune agents if necessary.

Keywords: Animal bite, epidemiology, rabies, prophylaxis

Introduction

Rabies is a well-known zoonosis with a case-fatality rate approaching 100%. The estimated annual 60,000 human deaths occur from rabies, and most cases are in Africa and Asia [1, 2]. Worldwide, rabies is spread by various warm-blooded mammalian species [3], mainly by bites. In the US, approximately 50% of the population will sustain an animal bite. Of these bites, 90% are from domestic animals. Dogs are responsible for 80% to 90% of bites. Cat bites are the second most common domestic animal bites, constituting 5% to 15% of all bites [4]. At the same time, the rabies vaccination coverage in animal host (mainly for dog) in China is low [5]. As a result, 92.1% of rabies are caused by dog bites in China [6]. Animal bite brings severe harm to patients both physically and mentally.

Meanwhile, although diagnosis is easy to make, the mortality is still high due to the lack of effective treatments. The median of incubation period of rabies was 70 days in China [6], in some cases around the world this period could last up to years [7, 8]. During this period, the patients had little knowledge on the potential danger caused by animal bites. Some patients did not seek for standard treatments after being bitten for economic reasons or for the complicated vaccination procedures. There were also some questions for patients who came to hospitals for treatments, such like nonstandard treat-

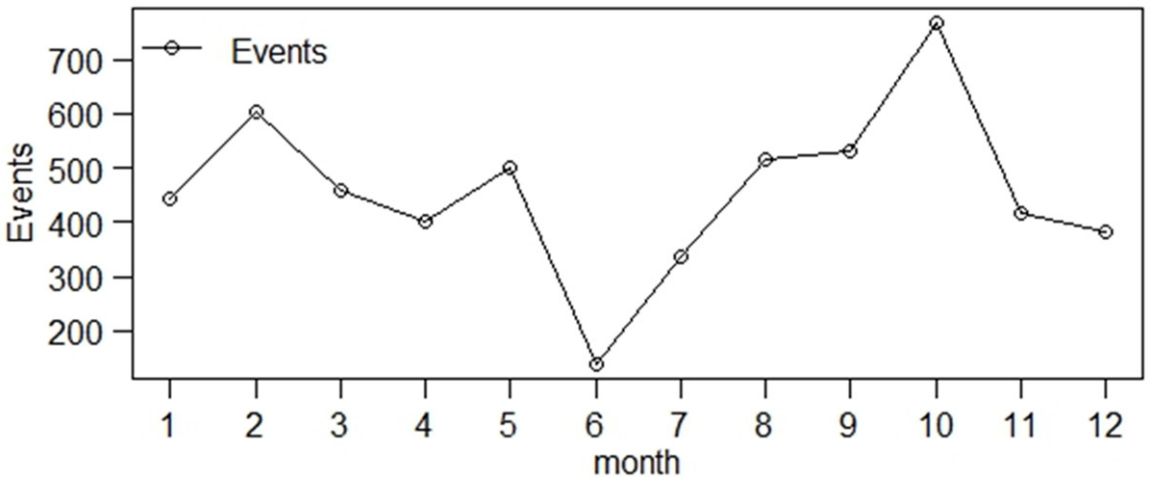

Figure 1. Seasonal distribution of bite events in 2013. The numbers of bite events happened in each month were 442 (Jan), 603 (Feb), 457 (Mar), 403 (Apr), 500 (May), 139 (Jun), 337 (Jul), 517 (Aug), 532 (Sep), 768 (Oct), 418 (Nov), 381 (Dec).

Table 1. Age and gender variation in 5497 cases in emergency department of the Peking University People's Hospital

Age	Male		Female		Total	
(years)	Events	Weight	Events	Weight	Events	Weight
0-9	525	21.2%	439	14.5%	964	17.5%
10-19	197	8.0%	216	7.1%	413	7.5%
20-29	543	21.9%	723	23.9%	1266	23.0%
30-39	328	13.3%	368	12.2%	696	12.7%
40-49	303	12.2%	363	12.0%	666	12.2%
50-59	350	14.1%	586	19.4%	936	17.0%
≥60	229	9.3%	327	10.8%	556	10.1%
Total	2475	100%	3022	100%	5497	100.0%

ments, delayed treatments and nonstandard vaccination [9]. The post-exposure prophylaxis was held up by all the reasons above, which left potential risks of rabies. Outcome of an animal bite can be fatal. The only preventive/curative measures available are anti-rabies vaccination and the use of human rabies immune globulin, hence to assure 100% compliance, propaganda and education are required [10].

Based on the situation, this research focused on the present status of post-exposure prophylaxis of animal bites, summarized the questions in the prophylaxis procedures by sending questionnaires to patients of animal bites, and proposed suggestions of preventing rabies by analyzing the epidemiological characteristics of animal bites.

Materials and methods

Materials

The emergency station of Peking University People's Hospital is an authenticated center for the treatments of animal bite authenticated by the Center for Disease Control and Prevention of Beijing, the doctors and nurses are trained to manage patients of animal bites according to Rabies post-exposure prophylaxis disposal norms (2009 version) issued by the Center for Disease Control and Prevention of China. This research investigated the 5497 patients with animal bites who attended to Peking University People's Hospital emergency station for post-exposure treatments during from 2013 January 1st to December 31st, and then analyzed the questionnaires.

Methods

The questionnaires were designed and were sent to patients who came to the hospital with animal bites.

Statistical analysis

The statistics were input with Epidata 3.1. Analysis was performed using the SPSS version 22.0 software. The chi-squared test was performed to examine the relationship between different factors. $P<0.05$ was defined as statistically significant.

Table 2. Age and sites of bites variation in 5497 cases in emergency department of the Peking University People's Hospital

Age (years)	Head-Face-Neck		Hand		Upper Limb		Lower Limb		Trunk		Multi sites		Total
	Events	Weight	Events	Weight	Events	Weight	Events	Weight	Events	Weight	Events	Weight	
1-9	218	44.1%	551	15.7%	29	13.4%	148	13.0%	12	17.1%	6	9.7%	964
10-19	42	8.5%	273	7.8%	15	6.9%	73	6.4%	7	10.0%	3	4.8%	413
20-29	89	18.0%	809	23.0%	49	22.7%	296	26.1%	9	12.9%	14	22.6%	1266
30-39	46	9.3%	449	12.8%	26	12.0%	158	13.9%	8	11.4%	9	14.5%	696
40-49	34	6.9%	429	12.2%	26	12.0%	163	14.3%	8	11.4%	6	9.7%	666
50-59	45	9.1%	624	17.7%	40	18.5%	202	17.8%	13	18.6%	12	19.4%	936
≥60	20	4.0%	384	10.9%	31	14.4%	96	8.5%	13	18.6%	12	19.4%	556
Total	496	100.0%	3519	100.0%	216	100.0%	1136	100.0%	70	100.0%	62	100.0%	5497

Table 3. Categories and sites of bites variation in 5497 cases in emergency department of the Peking University People's Hospital

Sites Bites	Category I		Category II		Category III		Total
	Events	Weight	Events	Weight	Events	Weight	
Head-Face-Neck	6	12.8%	351	8.2%	137	11.9%	496
Hands	22	46.8%	2760	64.3%	737	63.8%	3519
Upper Limbs	2	4.2%	169	3.9%	45	3.9%	216
Lower Limbs	15	31.9%	926	21.6%	195	16.9%	1136
Trunks	2	4.3%	53	1.2%	15	1.3%	70
Multi Sites	0	0.0%	35	0.8%	27	2.3%	62
Total	47	100.0%	4294	100.0%	1156	100.0%	5497

Results

Seasonal characteristics

Animal bites happened in every month in 2013. The most cases were reported in October (768), followed by February (603). The least cases were reported in June (139), followed by July (337), as shown in **Figure 1**.

Population distribution

A total of 5497 patients were reported in the emergency department of the Peking University People's Hospital in 2013. 2475 of them were male, 3022 of them were female, with male and female ratio 0.82:1. Female patients were more than male patients. They were aged from 1 to 95 year-old (mean, 33.23 year-old). Injury rates were the highest among 20-30 year-old age group (1266, 23.0%), followed by 1-10 year-old age group (964, 17.5%), and 50-60 year-old age group came in the third (936, 17.0%), as shown in **Table 1**.

Sites of bites

Hands were the most frequent sites of bites (64.0%), followed by lower limbs (20.7%), as shown in **Table 2**.

Correlation between age and sites of bites

Sites of bites varied in different age groups. The most frequent sites of bites among children aged 1-10 were hands, head-face-neck and lower limbs, nevertheless the most frequent sites of bites among other people were hands, lower limbs and head-face-neck. There was statistically significant difference in the correlation between sites of bites and age (χ^2=320.57, P<0.05, r=0.235), as shown in **Table 2**.

Wounds classification

Wounds classification was assessed according to *Rabies post-exposure prophylaxis disposal norms (2009 version)* issued by the Center for Disease Control and Prevention of China, the classification was also in accord with WHO classification. 47 (0.9%) patients had Category I wounds, 4294 (78.1%) patients had Category II wounds, 1156 (21.0%) patients had Category III wounds. Sites of bite varied in different categories. In Category III and Category II, the most frequent sites of bites were hands. In Category I, most frequent sites were hands and lower limbs. There was statistically significant difference in the correlation between site of bite and

Table 4. Types of animals and site of bite variation in 5497 cases in emergency department of the Peking University People's Hospital

Sites of Bites	Dogs		Cats		Other Animals		Total
	Events	Weight	Events	Weight	Events	Weight	
Head-Face-Neck	405	9.7%	78	7.5%	11	3.9%	494
Hands	2501	59.9%	762	73.3%	256	89.8%	3519
Upper Limbs	168	4.0%	46	4.4%	2	0.7%	216
Lower Limbs	996	23.9%	128	12.3%	12	4.2%	1136
Trunks	54	1.3%	13	1.3%	3	1.1%	70
Multi Sites	49	1.2%	12	1.2%	1	0.4%	62
Total	4173	100.0%	1039	100.0%	285	100.0%	5497

Table 5. Types of animals and wounds classification variation in 5497 cases in emergency department of the Peking University People's Hospital

Types of Animals	Category I		Category II		Category III		Total
	Events	Weight	Events	Weight	Events	Weight	
Dogs	32	68.1%	3352	78.1%	789	68.3%	4173
Cats	13	27.7%	759	17.6%	187	23.4%	1039
Other Animals	2	4.3%	271	4.3%	98	8.4%	285
Total	47	100.0%	4294	100.0%	1156	100.0%	5497

Table 6. Domestic/nondomestic animals and wounds classification variation in 5497 cases in emergency department of the Peking University People's Hospital

Wounds Classification	Nondomestic		Domestic		Total
	Events	Weight	Events	Weight	
Category I	3	1.5%	29	0.7%	32
Category II	137	68.2%	3215	80.9%	3352
Category III	61	30.3	728	18.3%	789
Total	201	100%	3972	100%	4173

category (χ^2=51.87, P<0.05, r=0.097), as shown in **Table 3**.

Types of animals

Most bites were from dogs (4173, 75.9%), followed by cats (1039, 18.9%). 285 (5.2%) bites were from other animals. Most bites were from domestic animals (4900, 89.1%). Among them 4863 (88.1%) were from the patients' families, comparing with 64 (0.9%) from their neighbors' families. 597 (10.9%) bites were from nondomestic animals. Among all 4173 animals, 964 (19.7%) were injected with anti-rabies vaccines. The rest 3936 were not or were unknown.

Correlation between types of animals and sites of bites

Sites of bites varied in different types of animals. The most frequent sites of bites from dogs were hands (59.9%) and lower limbs (23.9%). The most frequent sites of bites from cats and other animals were hands. There was statistically significant difference in the correlation between sites of bites and types of animals (χ^2=171.01, P<0.05, r=0.174), as shown in **Table 4**.

Correlation between types of animals and wounds classification

Types of animals varied in different categories of wounds. The most frequent bites in Category II were from dogs (78.1%). Bites in Category I and Category III were from both dogs (27.7%) and cats (23.4%). There was statistically significant difference in the correlation between types of animals and wounds classification (χ^2=58.82, P<0.05, r=0.103), as shown in **Table 5**.

Correlation between domestic/nondomestic animals and wounds classification

Given domestic/nondomestic could be a confounder, stratified analysis was performed. There was statistically significant difference in the correlation between domestic/nondomestic and wounds classification with dogs. Most frequent bites from domestic dogs were Category II bites, and most frequent bites from nondomestic dogs were Category II and Category III bites (r=0.069), as shown in **Table 6**.

Time of treatments

74.3% of the patients were injected with anti-rabies vaccines in 24 h. 24.9% of the patients received treatments in 1-7 days. 0.8% of the patients received treatments in 8-90 days, as shown in **Table 7**.

Types of treatments

All 5497 patients received post exposure treatments, debridements and vaccine injections

Table 7. Time of treatments variation in 5497 cases in emergency department of the Peking University People's Hospital

Days after Bites	Events	Weight
0	4085	74.3%
1~7	1366	24.9%
8~90	46	0.8%
Total	5497	100.0%

were performed to all the 5497 patients. 438 patients were given rabies immunoglobulins (Human Immunoglobulins). Among them 334 had Category III bites, 103 had Category II bites, and 1 had Category I bite. Among the 438 patients injected with rabies immunoglobulin, 2 were pregnant, and 436 were normal people.

Discussion

Epidemiological characteristics of animal bites

Of all the 5497 cases, the incidence of bites increased significantly in February and October. Although there were no significant seasonal characteristics, it would be influenced by holidays. In Canada, animal bites had strong correlation with seasons, spring and summer had higher incidences [11]. The male to female ratio was 0.82:1, this could be because of the different feeding habits between male and female, female tended to have closer contact with animals, and therefore easier to get injured. 20-29-year-old age group occupied the highest portion of 23%, followed by the 1-9-year-old age group 17.5%, and followed by 50-59-year-old age group 17.0%. These three age groups occupied much higher portions than any other age groups. Considering the age structure of population of Beijing presented by the nationwide census, 20-29-year-old age population had the largest population base contributed by nonresident students and migrant workers, and this resulted in their higher portion in animal bite patients. As the accelerating urbanization, domestic animals increased, making it easier for 1-9-year-old age group and 50-59-year-old age group to get injured by domestic animals. These two groups also had a longer time staying at home and getting in contact with animals, and their self-protection awareness and ability were weak.

Characteristics of wounds

The hands were the most common bite sites occupying 64%, followed by the lower limbs 20.7%, Stephen A. Kennedy also mentioned that the hand was the most common site for bite injuries, and because of specific characteristics of hand anatomy and bite mechanics, it could lead to serious outcome [4]. The age distribution was related to the bite sites, the main sites of injury in the 1-9-year-old age group were hands, head-face-neck and lower limbs, while the other age groups were mainly hands, lower limbs and head-face-neck, because this group had a lower height and their self-protection ability was low. Patients of Category II exposure took up the largest portion of 78.1%. There were different site distributions in different wounds, wounds of Category II and III exposure mainly distributed in hands, while wounds of Category I exposure mainly distributed in hands and lower limbs.

Characteristics of animals

Dogs caused 75.9% of bites, in which domestic dogs occupied 89.1%. Compared with Lebanese, the ratio of dogs was lower, while the domestic ratio was higher [3]. The immune status of domestic animals were unsatisfactory, only 19.7% of domestic animals were immunized during the last year, while this number in a statistical result of Canada 2014 was 54% [11], this difference showed the great defect of Chinese animal immune status compared to some developed countries. Different animals resulted in different sites of bites, dogs mainly caused wounds of hands and lower limbs, while cats and others mainly hands. It was probably because cats and other animals had smaller sizes and it was difficult for them to bite other sites. Different animals were related to different categories of exposure, dogs mainly caused wounds of Category II exposure, other animals mainly caused wounds of Category II and III. Considering whether the animals were domestic would have influence on the result, we stratified this factor and found that, cats and other animals did not show significant difference on this factor, while dogs showed difference, domestic dogs mainly caused wounds of Category II exposure, nondomestic dogs mainly caused wounds of Category II and III exposure. This reminds the population to pay attention to bites caused by nondomestic dogs.

Post-exposure prophylaxis

74.3% of patients with animal bites came to hospital and were injected vaccines during the 24 hours after injured. Patients should seek for standardized treatments as soon as possible after injured, this ratio showed the preventive awareness of rabies of the rest 25.7% patients was poor. Enhanced education and propaganda of rabies prophylaxis is in great need. According to *Rabies post-exposure prophylaxis disposal norms (2009 version)* published by the Center for Disease Control and Prevention of China, all the patients with Category III wounds or with immunodeficiency or with dangerous Category II wounds (head-face-neck wounds caused by suspicious infected animals) should use passive immune agents. The research found that all patients received debridements and vaccine injections. 438 patients received passive immune agents, among these 438 patients, 334 patients had Category III wounds, 103 patients had Category II wounds, 1 patient had Category I wounds. However, apart from these 438 patients, there were still 4 immuno-deficient patients with Category II wounds and 822 patients with Category III wounds who did not receive passive immune agents. The reasons were probably the poor cognition of rabies, the poor compliance of patients, economic reasons or the lack of communication between patients and doctors.

Suggestion

The growing urban population of Beijing and the large amount of domestic animals all resulted in the high incidence of animal bites in Beijing. The prevention awareness of rabies of Beijing population needs to be improved. The immune management of domestic animals of China was far behind those of some developed countries. Medical institutions should improve the preventive awareness and knowledge on rabies of all the Beijing population, and should strengthen the animal management. Based on this situation, we proposed several suggestions below: ① Animal bites had a high incidence rate during holidays, the population should pay additional attention to animals during holidays. ② Women, children aging from 1-9-years-old, and 50-59-years-old middle aged people were risk population for animal bites. These population or their guardians are in great need of preventive awareness. ③ The administration system of animals need to be improved. Relative departments should supervise the vaccine injections of domestic animals and manage nondomestic animals properly. Population should avoid getting in contact with nondomestic animals, and should make enough protection once in need. ④ Medical institutions should improve the preventive awareness and knowledge on rabies of all the Beijing population. Patients should seek for standard treatments and vaccine injections after injured as soon as possible, and should use passive agents if necessary. Doctors should explain the necessities of passive immune agents to the patients in need, in order to decrease the risk of rabies.

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Disclosure of conflict of interest

None.

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