

Vital Surveillances

Epidemiological Characteristics of Human Rabies — Shandong Province, China, 2010–2020

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ABSTRACT

Introduction: Rabies is a viral zoonotic disease that causes progressive and fatal inflammation in the brain. Rabies has caused more than 5,000 human deaths in Shandong Province since 1955. This study aimed to analyze the epidemiological characteristics of human rabies in Shandong Province from 2010 to 2020 and to provide a scientific basis for policy changes.

Methods: The data of reported human rabies cases from 2010 to 2020 were obtained from China's National Notifiable Disease Reporting System, and data related to exposure and post-exposure prophylaxis (PEP) of the cases were acquired through case investigation.

Results: A total of 414 human rabies cases were reported in Shandong Province from 2010 to 2020. Out of the 414 total cases, 87.20% were primarily farmers; 83.10% were over 40 years old. 70.29% (265/377) belonged to category III exposure; and 96.67% (377/390) were exposed to the virus through infected dogs. The vaccine inoculation rate of these cases after exposure was only 8.85%; 1.03% (4/390) had been vaccinated with rabies immunoglobulin, developing the disease 11 to 13 days after category III exposure.

Conclusions: Dogs were still the primary animal hosts. Most rabies patients died due to no or inadequate post-exposure prophylaxis. Vaccine inoculation rates for dogs should reach the target of 70% as soon as possible. Health departments should improve the accessibility and quality of PEP; and improve the health literacy of the elderly in rural areas.

Rabies is a viral zoonotic disease that causes progressive and fatal inflammation of the brain (1). China has been working on the control and elimination of human rabies. Since 1955, rabies became one of the notifiable infectious diseases in

China. A total of 5,632 human rabies cases were reported comprising 4 epidemic peaks in Shandong Province from 1956 to 2020. In 2007, a total of 133 cases were reported and the number of cases reached the fourth peak in recent years (2). This study analyzed epidemiological characteristics and risk factors of human rabies in Shandong Province from 2010 to 2020. The data provided essential information and suggestions for adjustments to the rabies control policy in Shandong Province.

METHODS

Historical data of human rabies cases from 2010 to 2020 in Shandong Province were collected through China's National Notifiable Disease Reporting System (NNDRS) from January 1, 2010 to December 31, 2020. The questionnaire about every case was filled out through a face-to-face interview with a family member of the patient by trained public health physicians at the county-level CDC and sent to the Shandong Provincial CDC. The questionnaire included patient information (gender, age, occupation), clinical manifestations, wounds caused by animals, and post-exposure prophylaxis (PEP) at the local clinics, etc. Reverse transcription-polymerase chain reaction (RT-PCR) and fluorescence quantitative PCR were carried out on patients' saliva, urine, blood specimens and so on. Epidata (version 3.1, Epidata Association, Denmark) was used for data entering and ArcGIS (version 10.0, Esri Inc, California, USA) was used for making regional distribution graphics.

RESULTS

A total of 414 human rabies cases were reported in Shandong Province from 2010 to 2020, and the incidence of human rabies decreased rapidly year over year, except for a small rebound in 2011 and 2015. The reported incidence rate decreased from 0.10/100,000 population in 2011 to 0/100,000 in

2020 with the mean incidence rate of 0.04/100,000 from 2010–2020. Overall, 74 and 91 cases were reported in 2010 and 2011, respectively, and the number of new cases reached 0 in 2020 (Figure 1). Only 15.22% (63/414) of specimens from cases were collected and confirmed in the lab. Among these 63 cases, 16 cases were laboratory-confirmed with a positivity rate of 25.40%. Also, 73.42% (304/414) of cases were recorded between March and October with a peak season in October. After 2015, rabies cases gradually reduced, and the peak season was not obvious.

These 414 human rabies cases were distributed widely in 16 municipal areas and 84 counties. Among the 414 human cases, 51 cases were reported from Heze, 48 cases from Linyi, 45 cases from Qingdao, 40 cases from Dezhou, 39 cases from Yantai, accounting for 53.86% of cases in 2010–2020 in Shandong Province. Pingdu City (16 cases), Cao County (14 cases), Laiyang City (12 cases), Junan County (12 cases), and Mudan District (12 cases) were the top five counties in the number of cases, accounting for 15.94% of the total cases in the whole province. All cases occurred in rural areas.

Overall, 71.01% (292/414) of cases were male, and 28.99% (122/414) cases were female. The gender ratio of cases was 2.39:1. The average age was 52.30±17.04 years old, with a range from 2 to 89 years old. In total, 83.10% (344/414) cases were more than 40 years old. Most human rabies cases from 2010 to 2012 were among the age group from 40 to 49 (62/232, 26.72%), while most human rabies cases from 2013 to 2015 and 2016 to 2020 were among the age group from 50 to 59 (35/124, 28.23%) and from 60 to 69 (24/58, 41.38%), respectively (Table 1). The higher-risk population was born between 1954 and 1972. By occupation, 87.20% (361/414) of cases occurred in

farmers, followed by 3.62% (15/414) in students, 3.14% (13/414) in homemakers and unemployed individuals, 2.17% (9/414) in preschool children, and 3.86% (16/414) others.

The fatality rate was 100.00%. Overall, 407 questionnaires of human rabies cases were obtained and the response rate was 98.31% (407/414). The median course of disease was 4 days, ranging from 0 to 28 days; 91.40% (372/407) of patients died within one week. Most cases showed typical rabies symptoms such as agitation, hydrophobia, fearing of wind, convulsion, and photophobia, etc.

In the study, categories of exposure were recorded in 377 cases (92.63%); 265 (70.29%) of reported fatalities were category III exposure. Location of exposure and exposure modes were recorded in 396 cases (97.30%). The wounds injured mostly occurred on the extremities, and the frequent exposure sites were hands (224 cases, 55.04%), followed by the lower limbs below the knee (78 cases, 19.16%). In 18 cases, there was more than one wound; 343 (86.62%) human cases that died from rabies were due to animal bites; 390 (95.82%) fatalities had reported wounding animal and animal origin; 139 cases (35.64%) were injured by stray animals; and 231 cases (59.23%) by domestic animals (belonging to the family of the case or a neighbor and raised in free range). Overall, 96.67% (377/390) of the cases were injured by dogs, and only 1.89% (4/212) of domestic dogs had been vaccinated against rabies (Table 2).

Of the 389 (95.58%) cases with available PEP treatment, 216 (55.53%) cases had no wound treatment post exposure at all. Another 137 (35.22%) cases treated the wound by themselves. In total, there were 353 (86.73%) fatalities without proper wound treatment. Only 36 (9.25%) cases had their wounds treated in medical institutions, mostly in village clinics

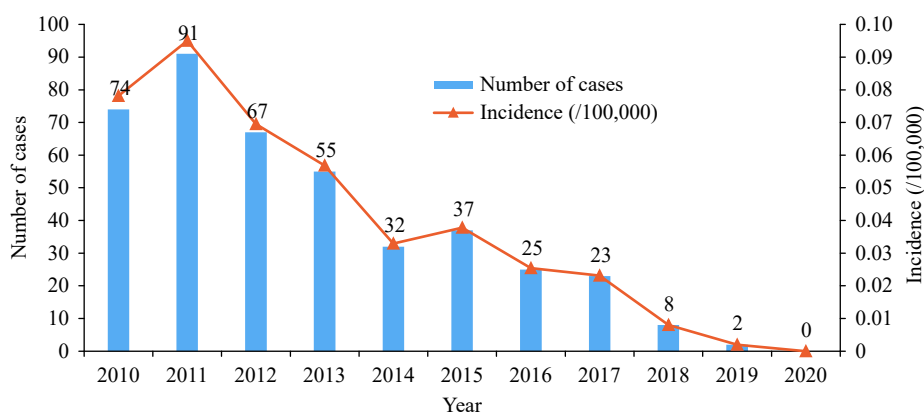


FIGURE 1. The number of cases and incidence rate of human rabies in Shandong Province, China, 2010–2020.

TABLE 1. Age distribution of human rabies cases in Shandong Province, 2010–2020.

Age group (years)	2010–2012		2013–2015		2016–2020	
	Number of cases	Proportion (%)	Number of cases	Proportion (%)	Number of cases	Proportion (%)
0–	4	1.72	2	1.61	0	0.00
5–	5	2.16	6	4.84	0	0.00
10–	6	2.59	0	0.00	2	3.45
20–	8	3.45	3	2.42	0	0.00
30–	26	11.21	5	4.03	3	5.17
40–	62	26.72	17	13.71	12	20.69
50–	53	22.84	35	28.23	10	17.24
60–	42	18.10	34	27.42	24	41.38
70–	22	9.48	18	14.52	6	10.34
80–	4	1.72	4	3.23	1	1.72

(21/36) (Table 2). Regarding the post-exposure vaccination, the rabies vaccine coverage rate was 8.85% (36/407), and 23 cases were vaccinated at village clinics or private clinics. Of the 11 cases who received the full vaccination, 10 cases classified as category III exposure did not receive rabies immunoglobulin as recommended by the WHO guidelines. Among the 25 cases who were not fully vaccinated, 17 died before vaccination was completed.

Among the reported cases, 4 patients who were bitten by stray dogs came to county-level medical institutions for wound treatment and were injected with rabies vaccine and anti-rabies immunoglobulin within 12 hours. Among them, 2 cases were over 60 years old, and another 2 cases were pre-school children, all of whom were exposed as category III and died before vaccination completed.

CONCLUSION

Rabies is a vaccine-preventable disease. By taking measures to strengthen disease surveillance, conduct technical training, and standardize the clinic treatment for PEP (1,3), the number of human rabies cases in Shandong declined significantly from 2011 to 2020, which was consistent with the epidemic trend of human rabies in China (4–5). First, every reported human rabies case was investigated and the specimens were collected as soon as possible. The case survey rate was almost always 100%. Second, a special training class on rabies was conducted for staff from all over the whole province every year by Shandong CDC. Third, Shandong Province has gradually standardized the construction of PEP clinics since 2001. A series of documents such as construction standards of PEP

TABLE 2. Characteristics of exposure history and post-exposure prophylaxis, according to data from case investigations, Shandong Province, 2010–2020.

Exposure characteristics	Number of human rabies cases	Proportion (%)
Age group (years)		
<20	24	5.90
20–39	42	10.32
40–59	189	46.44
≥60	152	37.35
Gender		
Male	289	71.01
Female	118	28.99
Occupation		
Farmers	359	88.21
Students/preschool children	23	5.65
Others	25	6.14

TABLE 2. (Continued)

Exposure characteristics	Number of human rabies cases	Proportion (%)
Exposure level*		
I	18	4.77
II	94	24.93
III	265	70.29
Exposure mode*		
Bite	343	86.62
Scratch	33	8.33
Others	20	5.05
Animal source*		
Domestic animal	231	59.23
Stray animal	139	35.64
Others	20	5.13
Animal vector*		
Dog	377	96.67
Cat	7	1.79
Others	6	1.54
Exposure reason*		
Active attack by the vector	211	56.42
Defensive attack by the vector	59	15.78
Playing with the vector	72	19.25
Other	32	8.56
Bite more than one person*		
Yes	59	15.69
No	317	84.31
Exposure site		
Head	33	8.11
Neck	4	0.98
Hand	224	55.04
Trunk	10	2.46
Arm	38	9.34
Lower limb above the knee	11	2.70
Below the knee	78	19.16
Wound treatment*		
Untreated	216	55.53
Self-treated	137	35.22
Treated in medical facilities	36	9.25
Rabies immunoglobulins administered		
Yes	4	0.98
No	403	99.02
Vaccination administered		
Yes	36	8.85
No	371	91.15

* Variables with missing values.

clinics, were first issued in 2007. And now, there are more than 2,000 qualified rabies PEP clinics in Shandong Province, and they can provide timely services for people. Fourth, health education is indispensable for people.

The study indicated that people over 40 years old and farmers were still the main high-risk groups in Shandong in the past decade (5–7). Before 2013, the number of human rabies cases was the highest in the 40–49 age group, but in the following years, it gradually changed to the group of 50–69 years old. 11.52% (47/408) were young students and preschool children from 2003 to 2007 (2), declining to only 5.80% from 2010 to 2020.

This change indicated the elder people in rural areas need additional protection. Therefore, health education should be focused on the rural elderly. The main reasons for human rabies fatalities were failure to carry out timely and standardized wound treatment and immunization prevention after exposure. In the study, 353 (90.75%) cases died without proper wound treatment and 371 (91.15%) fatalities did not receive vaccination. The vaccination rate (8.85%) of the cases was lower than that in other studies (8). Most cases were treated with PEP in village clinics. These findings suggested that it is important to ensure the quality of PEP at village clinics and establish a transfer system to higher-level hospitals in case of complications. Since 2016, only 2 cases failed to complete the immune program, indicating that the standardized management of rabies vaccination has played an important role in the prevention and control of human rabies (3,8). A total of 4 cases received PEP due to category III exposure on heads died before the vaccine procedure completion with an incubation period of 11 to 13 days. It is important for people to seek standardized PEP immediately after exposure, especially for wounds on the head. The physicians should also participate in training courses and pay more attention to serious wounds on the head and face (1).

The result showed that Shandong had a higher rate of dog-related injuries among the cases when compared with the national average level (96.67% vs. 91.46%) cases (5). The majority of attacking animals were domestic animals, with only 1.89% vaccinated for rabies, which was similar to a national study (5). These findings indicate that dog-related injuries are still a primary risk factor for human rabies in Shandong despite the sharp decline in the number of cases, and it is necessary to manage and vaccinate domestic dogs in rural areas as well as stray dogs.

This study was subject to some limitations. First, 7 of 414 human rabies cases have failed to carry out case

investigation for missing data rate of 1.69% (7/414). Second, the survey response rate was not 100%, but still above 92.5%. Third, most human rabies cases were clinically diagnosed because no specimens were collected immediately and no laboratory results.

In conclusion, to achieve zero human deaths from rabies, management and vaccination of dogs in rural areas should be prioritized to reach the 70% vaccination target (9), as well as by improving the accessibility and quality of PEP in rural areas from the health departments in Shandong.

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