Human Surveillance in Response to the 2013 Re-emergence of Animal Rabies in Taiwan

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Abstract

On July 16, 2013 Taiwan announced that the rabies virus had been found in wild ferret-badgers. Taiwan's Ministry of Health and welfare and Council of Agriculture strengthened the monitoring of human and animal rabies and launched various preventive interventions in accordance with their responsibility. In response to the ongoing rabies outbreak, in human rabies surveillance, besides the notifiable infectious disease surveillance system, use vaccine apply mechanism to collect human cases information of animal bite or scratch, and gather rabies vaccination information and Council of Agriculture animal laboratory data , to provide intact information for risk assessment and the intervention for prevention and control. This article analyzes 5,335 cases of animal bites or scratches that led to an application for a vaccine from July 21, 2013 to September 30, 2013. Male (55.0%), particularly those aged 25-49 years old (40.2%), were predominant. Overall, 78.6% had been exposed to dogs or cats the majority (56.1%) of which was stray dogs or cats. Eastern area had a higher number of cases than the other areas, with male accounting for 60%, and 65.4% having the category 3 wounds. Analysis of the Taiwan's Real-time Outbreak and Disease Surveillance System (RODS) found that the number of emergency room due to dog bite is consistent with the applications for rabies vaccines. 205 specimens from cases of encephalitis of undetermined etiologies from January 2010 to September of this year were all ruled out as being infected with rabies. There has been no confirmed case of human rabies as of September 30, 2013. Only central, southern and eastern districts have animals been found to have rabies and are classified as potential risk areas. In the future, the will be an improved surveillance mechanism for animal bites or scratches, the establishing of a platform for the collection of data to strengthen risk assessment and risk communication, and the reduction of exposure and probability of infection, are directions for future work.

Key word: Rabies, animal bite or scratch, Surveillance

Introduction

Rabies is a zoonotic infectious disease. The virus exists in the saliva of an infected animal, and is transmitted to humans through scratches, bites, or incidentally through wounds or mucous membranes. Human rabies is widely distributed around the world, with most cases occurring in Africa and Asia. WHO estimates that rabies causes about 60,000 human deaths a year, 95% of which take place in Asia and Africa; the major animal vector are dogs. In the cases of being bitten or scratched by a suspected rabid animal, 40% are children under the age of 15[1].

Rabies was introduced to Taiwan from China in 1947. There were epidemics occurred continually after the first human rabies case found at Taipei city in 1948, regard 238 cases in 1951and 102 cases in 1952 as most. Though dog vaccination countrywide, put out stray dogs and the quarantine of dog imported, controlled the epidemic effectively, no more e human case appeared since 1959 [2], the confirmed cases were imported in recent years; Animal's epidemic situation, Taiwan had not occurred animal's case since 1961, till July 16, 2013, Council of Agriculture's Animal Health Research Institute reported to World Organization for Animal Health (OIE) on July 17 that the wild ferret-badger was contagious with the rabies virus[3]. The reoccurrence of rabies after in Taiwan after 50 years led the Ministry of Health and Welfare and the Bureau of Animal and Plant Health Inspection and Quarantine to establish a rabies prevention inter-ministerial working group on July 24, which reported to the Executive Yuan on 1 August, leading to the setting up of a Central Epidemic Command Center (CECC) for Rabies, and launched follow-up monitoring, controlling and preventive interventions. This article analyzes data from the period of July 21 to September 30 during the setting-up of relevant monitoring systems by the surveillance team of the CECC.

The surveillance of human rabies

1. Collection and monitoring the information of animal bite and scratch

(1).Database of applications for human rabies vaccine for animal bites and scratches.

Taiwan was rabies free in the past and did not have a surveillance system for animal bites and scratches. The majority of those who applied for the human rabies vaccine had been bitten or scratched by animals abroad and had to finish the vaccination after returning country, while the minority were pre-exposure prophylaxis. The use of the human rabies vaccine was low, and the vaccine was allocated to travel medical clinics countrywide, and managed and dispatched through the National Immunization Information System(NIIS) of the Taiwan CDC (TCDC). It was unable to provide complete epidemiological information of the cases animal bites or scratches. In response to this rabies outbreak, the TCDC assessed the area and animals at risk, widened the criteria of those eligible for vaccination for those suspected of being exposed to rabies, and provided free post-exposure vaccination to

people at a high risk of infection. The six regional centers of Taiwan TCDC recorded information on the applicants for the vaccination according to the application forms submitted by the hospitals under their jurisdiction. The content of the database included gender, age, the county or city inhabited, exposure time, place, animal, wound grade, etc. Besides relevant analysis, the surveillance team of the Central Epidemic Command Center gathered laboratory data from the Bureau of Animal and Plant Health Inspection and Quarantine and vaccination data of NIIS in order to understand the laboratory results and follow the vaccination situation of the people bitten or scratched by animals.

(2).Recall Project for ferret-badgers bite or scratch

The incubation period of rabies is one to three months, but may be shorter than one week or over one year, depending on wound severity and volume of virus. Once onset, the fatality rate is nearly 100%. Treating the wound as soon as possible after exposure, with either a rabies vaccine or immunoglobulin, can effectively induce the onset of rabies and death [1].

According to the retrospective research of the Council of Agriculture, the earliest rabies infected ferret badger was found in July, 2010, people who had risk to be bitten or scratched by ferret -badgers during July, 2010 to September 30, 2013 could register voluntarily through the TCDC 1922 hotline to get further risk assessment and medical referral at the same time.

The project was conducted during August 1 to September 30, 2013. People who have bitten or scratched by ferret-badgers in previous years will get the rabies vaccine by the general application.

2. Surveillance of notifiable infectious disease

According to degrees of risks and hazards such as case fatality rate, incidence rate, and transmission speed, human rabies is categorized as a Category 1 communicable disease. The criteria for reporting are: a person who has been to a rabies affected area and been bitten or scratched by mammals such as dogs, cats, bats, raccoons, etc., or who has accepted an organ transplant from a suspected rabies case, or worked in a rabies virus laboratory during the incubation period, etc., and suffers from anxiety, headache, fever, and an unusual sensation in at the site of an animal bite. A diagnosis of a suspected rabies case should be reported by a doctor within 24 hours in order to strengthen the surveillance; if the case is not in accordance with the definition, but requires testing, the doctor can also report it as ' other '.

3. Real-time Outbreak and Disease Surveillance System (RODS)

RODS was launched formally in November 2006, to collect and convey information between the TCDC and over 150 emergency rooms in the hospitals every day and monitor epidemic trends of relevant infectious diseases every week [4]. People who have bitten or scratched by animals will usually seek emergency intervention at hospitals first,

and this system can detect the possible clustering or particular situation from frontline emergency medical units. It can also monitor the weekly trends of gender, age and areas of cases of animal bites or scratches. This report used ICD-9-CM Code: E906.0 (bitten by dogs) for analysis. By reviewing the RODS data, another relevant disease code E906.3 (bitten by cats, rodents, except mice, sharks or eels) was not adopted in this report for analyzing due to rare notification and various species.

4. Sentinel surveillance for encephalitis of undetermined etiologies

To detect emerging and re-emerging infectious diseases, the TCDC has cooperated with hospitals since 2010. Physicians should report cases on the infectious disease system as an 'encephalitis of undetermined etiologies ' under “others”, and submit serum, throat swab and CSF from patients with either encephalopathy or ataxia of unknown etiologies, plus any one of the following: fever, seizure, focal neurological signs, abnormal CSF profile, abnormal electroencephalography (EEG) and brain images.

Taiwan was rabies free for approximately half century, so that cases of ' encephalitis of undetermined etiologies' were not test for rabies regularly. In response to the outbreak which can be traced back to the detection of rabies animals in July 2010, the specimens from cases of unexplained encephalitis have been examined for rabies since January 2010 to ensure no human case infected by rabies.

The surveillance of animal rabies by the Bureau of Animal and Plant Health Inspection and Quarantine, Council of Agriculture

According to the data from World Organization for Animal Health (OIE), the types of rabid animals differ by country, including dogs, cats, other domestic animals, and wild animals such as skunks, raccoons, foxes, etc.. Bats also have become a rabies reservoir in Africa, Australia, Central Asia, Southeast Asia and Europe. In 2010, Europe notified more rabid animals than other areas, followed by Africa and America. In Asia animals infected by rabies were mostly dogs, cats and other domestic animals [3]. Thus, to control animal epidemic can be helpful to reduce the risk of human infection.

The Bureau of Animal and Plant Health Inspection and Quarantine started the disease mortality and morbidity surveillance of wild animals in 2012. Besides general monitoring, the monitoring of rabies in carnivorous animals began in 2013 [5], this bureau responds to public notices of dead animals or reports of unusual behavior. The TCDC and Bureau of Animal and Plant Health Inspection and Quarantine set up a single point of contact from July 26, daily exchange of laboratory information of animals by mobile phone text message , besides providing the Central Epidemic Command Center and local government with risk assessments, and also offering real time tests and results informing, so as to ensure that animal bites or scratches are treated.

Results

1. The collection and analysis of applications for human rabies vaccine for animal bites and scratches:

(1). Database of applications for human rabies vaccine for animal bites and scratches.

We obtained details of 5,335 applications for the human rabies vaccine (not including the cases of exposure abroad and those unidentified) for the whole country from July 21 to September 30. 3,923 (73.5%) met the criteria for vaccinations. The cases are exposed mostly in central area (23.5%) and followed by Taipei area (20.3%). The number of applications rose daily in the beginning of the outbreak, and peaked on August 1. Although the eligibility criteria for the vaccination were set wider in response to the outbreak of animal rabies, the number of vaccination applications was declined (Fig. 1).

Among the applications for human rabies vaccines 55.0% were male, mostly aged 25-49 years old (40.2%) and followed by 24.9% aged 50-64 years old. The animals responsible for exposure were mainly by cats and dogs (78.6%), followed by mice (9.5%) and house shrews (6.0%). The majority animals were stray dogs and cats (56.1%), followed by domestic animals (24.3%) and wild animals (19.2%). The legs (52.4%) were the most often site of the wound, followed by arms (42.7%) and 1.1% had multiple (two or more) wounds. More than half (52.6%) cases were belong category 3 contact type.

Males are higher than females. Analyzing the exposed area, male in the eastern area accounted for 60%, higher than other areas. Those bitten or scratched by animals were mostly aged 25-49, followed by those aged 50-64 years old in all areas. Those aged 13-24 year old were the third highest in Taipei and the Kaohsiung-Pingtung area, while males over 65 years old were the third highest in other areas. Those in 0-12 years old were accounted for 10.6% in eastern area, noticeably higher than other areas.

Dogs and cats were accounted for more than 75% of the cases in all areas and mice are the second. Those bitten by mice are accounted for 14.6% among all animals in Taipei area, higher than other areas. 47 cases were bitten by high risk ferret-badger and the case number in central area (15 cases), Kaohsiung-Pingtung area (13 cases) and eastern area (10 cases) are higher than other areas. However, cases bitten by ferret-badger were accounted for 3.2% among all animals in eastern area, higher than other areas. Stray cats and dogs were responsible for most of cases in all areas, followed by domestic animals and wild animals. 61.9% of cases were exposed by stray cats and dogs in Taipei area, which is higher than other areas. More than 22% of cases were exposed by wild animals in southern and eastern areas.

Analyzing the categories of wound, category 2 was predominant in northern and central areas while category 3 was predominant in other areas. 65.4% of cases were belonged category 3 in east area, higher than other areas.

The legs were most likely to be bitten or scratched, followed by the arm in all areas (table 1). There is significant difference after cross analysis with the gender, age and exposed area. Among the cases bitten by the ferret badger, most were 50-64 years old (15 cases) and 25-49 years old (14 cases). Males (31 cases) were twice than females (16 cases).

(2).Recall Project for ferret-badgers bite or scratch

As of September 30 2013, the project had finished and received 15 cases. Investigation found that one case was not a ferret-badger bite and another was of the consumption of ferret-badger blood without high risk exposure – these were excluded. 13 cases have completed all rabies vaccinations. Among these 13 cases, over 50 years old (61.5%) and males (76.9%) were predominant, while the most area with the highest number of cases is the southern area (30.8%) , and the arm was the common site of the wound (69.2%). All were category 3 wound, and exposure time was between October 2012 and June 2013.

Table 1. Characterization of applicants for the human rabies vaccine in Taiwan, July 21 to September 30, 2013

area exposed	case number (n=5335)	Taipei Area (n=1083)	Northern Area (n=811)	Central Area (n=1252)	Southern Area (n=941)	Kaoping Area (n=936)	Eastern Area (n=312)
gender							
female	2399(45.0%)	517(47.7%)	384(47.3%)	549(43.8%)	409(43.5%)	418(44.7%)	122(39.1%)
male	2936(55.0%)	566(52.3%)	427(52.7%)	703(56.2%)	532(56.5%)	518(55.3%)	190(60.9%)
age							
0-12	331(6.2%)	64(5.9%)	57(7.0%)	73(5.8%)	60(6.4%)	44(4.7%)	33(10.6%)
13-24	778(14.6%)	183(16.9%)	99(12.2%)	174(13.9%)	137(14.6%)	141(15.1%)	44(14.1%)
25-49	2147(40.2%)	482(44.5%)	349(43.0%)	515(41.1%)	323(34.3%)	372(39.7%)	106(34.0%)
50-64	1331(24.9%)	241(22.3%)	206(25.4%)	313(25.0%)	242(25.7%)	249(26.6%)	80(25.6%)
over 65	748(14.0%)	113(10.4%)	100(12.3%)	177(14.1%)	179(19.0%)	130(13.9%)	49(15.7%)
animal exposed							
dog and cat	4195(78.6%)	865(79.9%)	678(83.6%)	968(77.3%)	714(75.9%)	731(78.1%)	239(76.6%)
mouse	507(9.5%)	158(14.6%)	57(7.0%)	105(8.4%)	89(9.5%)	74(7.9%)	24(7.7%)
house shrew	320(6.0%)	6(0.6%)	33(4.1%)	97(7.7%)	87(9.2%)	79(8.4%)	18(5.8%)
squirrel	65(1.2%)	11(1.0%)	7(0.9%)	17(1.4%)	19(2.0%)	8(0.9%)	3(1.0%)
ferret-badger	47(0.9%)	5(0.5%)	1(0.1%)	15(1.2%)	3(0.3%)	13(1.4%)	10(3.2%)
bat	35(0.7%)	2(0.2%)	5(0.6%)	14(1.1%)	7(0.7%)	7(0.7%)	-
gem-faced civet	24(0.4%)	2(0.2%)	2(0.2%)	7(0.6%)	6(0.6%)	2(0.2%)	5(1.6%)
others	63(1.2%)	13(1.2%)	9(1.1%)	10(0.8%)	14(1.5%)	9(1.0%)	8(2.6%)
unknown	79(1.5%)	21(1.9%)	19(2.3%)	19(1.5%)	2(0.2%)	13(1.4%)	5(1.6%)
source of animal exposed							
stray dog and cat	2992(56.1%)	671(61.9%)	443(54.6%)	702(56.1%)	480(51.0%)	535(57.2%)	161(51.6%)
domestic animal	1298(24.3%)	220(20.3%)	254(31.3%)	289(23.1%)	247(26.2%)	209(22.3%)	79(25.3%)
wild animal	1025(19.2%)	187(17.3%)	112(13.8%)	258(20.6%)	211(22.4%)	188(20.1%)	69(22.1%)
others/unknown	20(0.4%)	5(0.5%)	2(0.2%)	3(0.2%)	3(0.3%)	4(0.4%)	3(1.0%)
exposure of wound[1]							
category 1	45(0.8%)	6(0.6%)	10(1.2%)	20(1.6%)	5(0.5%)	2(0.2%)	2(0.6%)
category 2	2273(42.6%)	459(42.4%)	441(54.4%)	542(43.3%)	384(40.8%)	342(36.5%)	105(33.7%)
category 3	2804(52.6%)	607(56.0%)	353(43.5%)	511(40.8%)	551(58.6%)	578(61.8%)	204(65.4%)
no exposure/unknown	210(4.0%)	11(1.0%)	7(0.9%)	179(14.3%)	1(0.1%)	14(1.5%)	1(0.3%)
exposure position[2]							
leg	2817(52.2%)	563(51.5%)	418(51.0%)	655(51.9%)	490(51.2%)	527(55.6%)	164(51.9%)
arm	2307(42.7%)	475(43.4%)	363(44.3%)	542(42.9%)	412(43.1%)	377(39.8%)	138(43.7%)
head and neck	84(1.6%)	17(1.6%)	15(1.8%)	18(1.4%)	15(1.6%)	13(1.4%)	6(1.9%)
hip	72(1.3%)	13(1.2%)	5(0.6%)	16(1.3%)	16(1.7%)	17(1.8%)	5(1.6%)
trunk	88(1.6%)	22(2.0%)	14(1.7%)	18(1.4%)	18(1.9%)	13(1.4%)	3(0.9%)
shoulders	12(0.2%)	3(0.3%)	2(0.2%)	2(0.2%)	4(0.4%)	1(0.1%)	-
unknown	17(0.3%)	1(0.1%)	2(0.2%)	12(1.0%)	2(0.2%)	-	-

1. Categories of wound: category 1: Touching or feeding animals; licks on intact skin; category 2: nibbles on uncovered skin; minor scratches or abrasion with no bleeding; category 3: Single or multiple bites or scratches that break the skin; licks by animals on broken skin; contamination of mucous membrane with saliva from licks; contact with bats.

2. Exposure position: Multiple bites are counted individually.

2. Analysis of notifiable infectious disease surveillance

There have been 6 suspected human rabies cases notified in the past ten years, 3 of which were confirmed cases, and all of which were contracted abroad (2 from China and 1 from the Philippines): all three patients died. Between July and September 2013, only one case was notified as ' other ' and ruled out after being tested for rabies. There has been no confirmed case of human rabies.

3. Analysis of Real-time Outbreak and Disease Surveillance System

Between January up until July 20, before there rabies outbreak, there were 263 weekly cases of dog bites or scratches (ICD9: E906.0). After July 21, 2013, the number of cases began to rise rapidly, gradually dropping after peaking at the end of that month. 3.65 per thousand saw a doctor: 2.77 per thousand females were slightly higher than the 2.67 per thousand males. The highest group was 50-64 years old, with 25-49 years old second; 13-24 years old, males over 65 years and children under 13, were all relatively low. 3.86 per thousand in the eastern area were higher than other areas, and the central area second highest. The rate of dog bite case among the emergency cases was consistent with the trend in applications for a rabies vaccine. (Fig. 1)

4. Analysis of sentinel surveillance of encephalitis of undetermined etiology

During January 2010 to September, 2013, the TCDC was notified 365 cases with encephalitis of undetermined etiologies. Of 205 available stored samples, none tested positive for rabies virus.

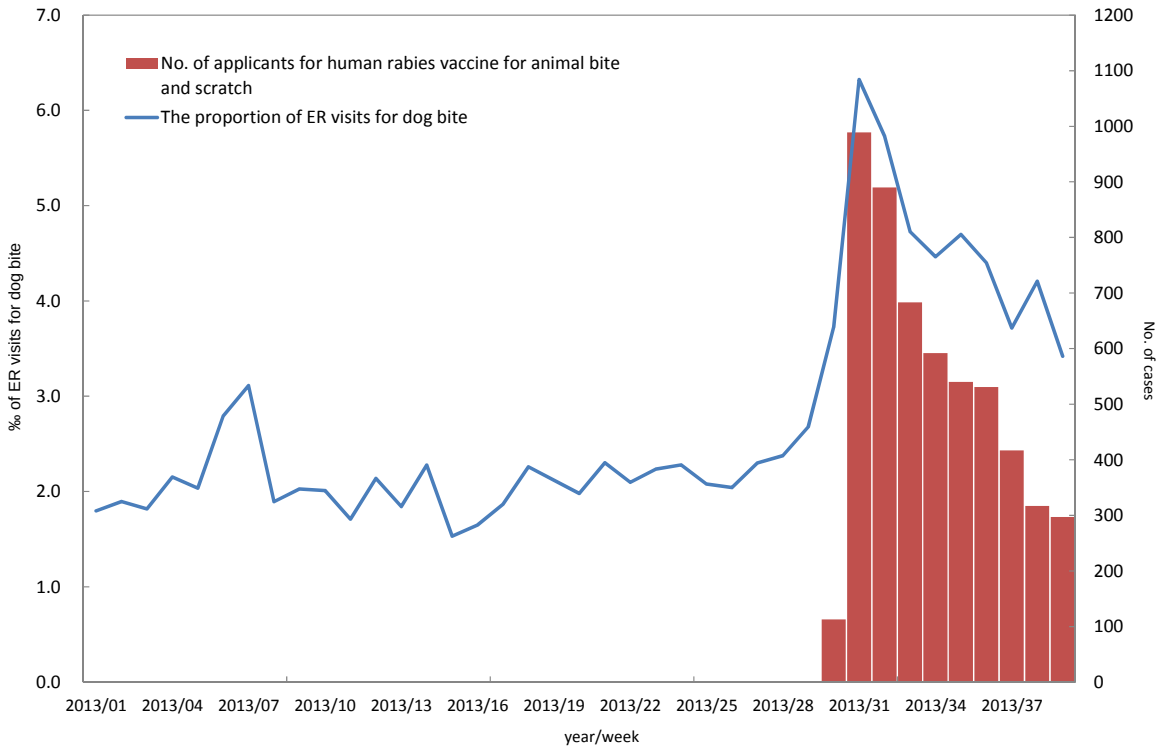

Figure 1. Number of applicants for human rabies vaccine and the proportion of emergency room visits for animal bites or scratches in Taiwan, 2013

Analysis of the surveillance of animal rabies by the Bureau of Animal and Plant Health Inspection and Quarantine

As of September 30, the Bureau of Animal and Plant Health Inspection and Quarantine had examined 627 wild carnivorous animals, 284 other wild animals, 862 dogs, 61 cats and 44 bats. Other than the 155 ferret-badgers(98.7%), 1 house shrew and 1 isolated dog bitten by a ferret-badger and confirmed as having the rabies infection, none of the other animals had rabies. The area covered 9 counties and cities, 53 townships/districts, including10 mountainous indigenous townships, in which the ferret-badger was predominantly the infected animal.

The central area detected 64 (40.7%) rabid animals, followed by the eastern area with 44 cases (28.0%). The area covered included the counties and cities from Heping District in Taichung City in the north, to Majia Township in Pingtung County in the south, and from Chenggong Township, Donghe Township, Yanping Township in Taitung County in the east, to Liouying District in Tainan City and Tianliao District of Kaohsiung City in the west. Taitung county and Nantou County with 41 cases are the highest (both account for 26.1% each), Taichung City with 23 cases (14.6%) is second (see table 2); the combined distribution of cases involving ferret-badgers and rabid animals is shown in Figure 2. As of September 30, there were 7 cases of people being bitten or scratched by a rabid animal, all of which were ferret-badgers. These were at Dongshih District of Taichung City; Renai Township, Yuchih Township and Shueili Township of Nantou County; and Chenggong Township, Donghe Township and Beinan Township of Taitung County. All cases have already inoculated with immunoglobulin and a rabies vaccine. A woman in Taitung City was bitten by a house shrew on July 27, which was confirmed as being infected with rabies. No wound was found by the doctor and there was no need for a rabies vaccine.

Table 2. Distribution of rabid animals in Taiwan, July 21 to September 30, 2013

area	county and city	Township and District	case no.	%	cases of Township and District
central area	Taichung City	7	23	14.6%	Sinshe District(6)、Taiping District(5)、Heping District(4)、Dongshih District(3)、Wufong District(3)、Dali District(1)、Beitun District (1)
	Nantou County	10	41	26.1%	Renai Township(3)、Yuchih Township (8)、Sinyi Township (2)、Shueili Township (3)、Lugu Township (7)、Guosing Township (6)、Jhushan Township(7)、Caotun Township (2)、Puli Township (2)、Jhongliao Township(1)
southern area	Yunlin County	1	6	3.8%	Gukeng Township (6)
	Chiayi County	4	10	6.4%	Fanlu Township (5)、Jhongpu Township (2)、Jhuci Township (2)、Alishan Township (1)
	Tainan City	9	17	10.8%	Nanhua District(4)、Longci District(3)、Zuojhen District(3)、Nansi District(2)、Lioujia District(1)、Danei District(1)、Dongshan District(1)、Guanmiao District(1)、Liouying District(1)
Kaoping area	Kaohsiung City	10	12	7.6%	Neimen District(1)、Tianliao District(2)、Cishan District(2)、Meinong District(1)、Yanchao District(1)、Liouguei District(1)、Alian District(1)、Jiasian District(1)、Shanlin District(1)、Maolin District(1)
	Pingtung County	2	4	2.5%	Majia Township (3)、Wutai Township (1)
eastern area	Hualien County	2	3	1.9%	Jhuosi Township (2)、Yuli Township (1)
	Taitung County	8	41	26.1%	Donghe Township (14)、Taitung City (2)、Chenggong Township (7)、Haiduan Township(3)、Chihshang Township (6)、Guanshan Township (2)、Yanping Township (1)、Beinan Township (6)
Total		53	157		

Note: Under line is the mountain indigenous township.

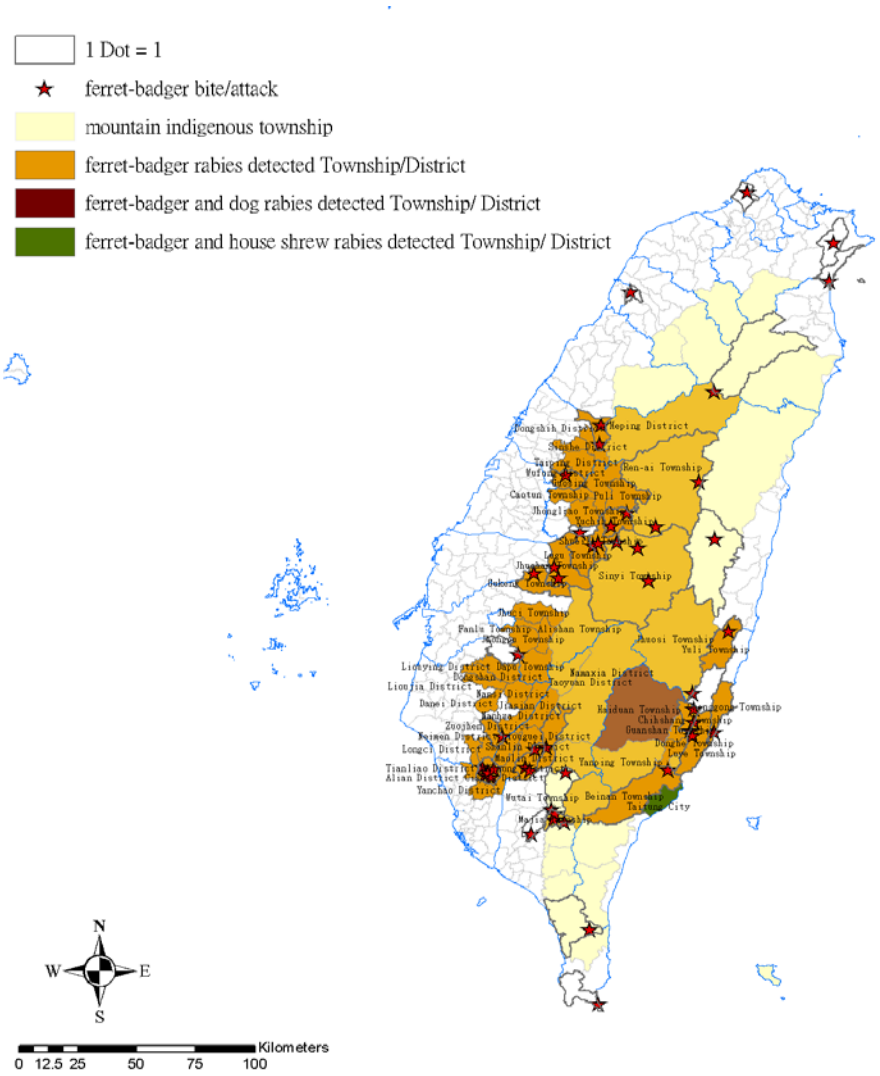

Figure 2. The geographic distribution of rabid animals and the occurrence of ferret-badger attack events in Taiwan, July 21 to September 30, 2013

Discussion

1. Risky population and area

Our data revealed that the male had higher risk to be bitten by animals than the female. Persons aged 25-64 years old were more likely to be bitten by animals this is different from other countries that the 5-14 years old children are the highest risk group of being bitten or scratched by animals [1]. This may reflect the different cultural and attitudes toward nature in other countries. Dogs and cats were the main source of animal bites or scratches, while the detection of rabid animal was mainly in wild animals: this is similar to the U.S.A.'s experience, only the rabid animals are often raccoons rather than ferret-badgers [6]. China has had many human rabies cases due to being bitten or scratched by ferret-badger since 1997[7, 8]. In addition, surveillance in Georgia, U.S.A., shows that females are more apt to be bitten by cats, but males are more likely to be bitten by wild animals (raccoon); most often was the hand was the site of the wound (40%), followed by the head and neck (19%) [9]. This result is different from Taiwan’s experience.

In Taiwan, the predominant rabid animal was ferret-badgers, rabid ferret badgers were mainly detected in central, southern and eastern parts of Taiwan especially in the mountainous areas in Nantou County, Taichung City and Taitung County. Researches revealed that in Taiwan the ferret-badger is one of the main species of small carnivorous animals widely spread in low mountainous area above sea level and in these areas there has been closer interaction between ferret-badgers and human [10-11]. The mountainous area of Nantou County, Taichung City and Taitung County had a high ferret-badger detection rate, including 8 remote mountain indigenous townships where it is difficult to transmit information. This suggests that to raise the awareness of the resident in these remote areas to avoid contact with ferret-badger is needed.

2. Potential risk areas

Rabid animals may appear sick, behave unusually even attack human initiatively [12]. These were similar to the main symptoms shown by the rabid ferret-badgers in 7 cases. The ferret-badger is a nocturnal animal [10-11], therefore ferret-badgers haunt during the day, as well as unprovoked attack human is unusual behavior.

In our database, there were also many reports of suspected rabid animals or ferret-badger attacks from the northern part of Taiwan such as New Taipei City, Yilan County and Hsinchu County, up to the end of September 2013. The Bureau of Animal and Plant Health Inspection and Quarantine examined about 160 specimens from these area but all the specimens were tested negative for rabies. Because of rivers, mountains and other natural barriers exist, which might be the reason why rabies has not spread to northern Taiwan. However, we suggest to conduct an active surveillance program in the townships neighboring to the epidemic area for monitoring the rabies epidemics in wild animals. The townships located in central, southern and eastern parts of Taiwan which nearby where the rabid ferret-badgers had been detected should be classified as a potential risk area.

3. Potential risk species

In other countries, dogs, cats, raccoons, foxes, and other animals are reported to be infected by rabies virus, and bats are also reservoirs for the virus. In 2002, a case of human rabies due to ferret-badger bite was reported from Chunan county in Zhejiang Province, China, and a case of rabies in a domestic dog in 2008, but has not reported any case of human rabies since 2005. It reveals that transmission of the virus from wild animals to domestic animals cannot be excluded [7]. It shows that rabies has the possibility of being transmitted across species: dogs and carnivorous animals are potentially the main species at risk. A study that interviewed people working in the lower mountainous areas of Miaoli and Hsinchu Country shows that there are still some wild animal hunting, in which the residents will take domesticated dogs which may be used to catch various wild animals. There is a risk of infection and spreading the disease [10].

4. Analysis of human behavior

The surveillance data for animal bites and scratches from Georgia in the US reveals that regardless of the age, the main cause of animal bites and scratches is provoking the animal, accounting for 61-80% in all age groups [9]. The present surveillance has not collected the relevant information of this human behavior, so we are unable to offer comparable statistics.

Suggestion

1. Set up the surveillance mechanism for being bitten or scratched by animal

In order to classify the high risk area and to detect clusters of incidences promptly, surveillance of rabies should include human and animal. In addition, the use of rabies vaccine should be included [12,14]. The U.S. has adopted an animal bite and scratch notification mechanism, and has human and animal laboratory information in hand at the same time[6, 9,13] to ensure comprehensive surveillance.

Taiwan was previously rabies free. Although human rabies was classified as a Category 1 communicable disease and was to be monitored, there were no other monitoring mechanisms. Advanced countries in rabies affected areas monitor animal bites and scratches and collect epidemiological information from these cases. The only information collected at present is through the rabies vaccine application and reviewing mechanism. The hospital fills out an application form for each case, and the staff of regional control center of TCDC will enter the data into the database. Rabies vaccination will be included in the National Health Insurance (NHI) coverage. Besides integrating the existing surveillance systems, one suggestion is to use the NHI database and RODS to analyze the trend of animal bites and scratches. If an unusual rise is detected, other than providing warning, it can alert relevant government institutes to strengthen monitoring and find the causes. Integrating long-term NHI surveillance data and RODS can help understand the demographic characteristics of the population bitten or scratched by animals, so as to help focus on the target population and provide the relevant information of risk, as well as help prevention and control if necessary. In addition to the reporting mechanism for infectious diseases, we suggest testing patients with unexplained encephalitis in intensive care units for rabies and collect epidemiological information from the NIIS, in order to have information on the risk of animal bites and scratches.

Relevant information from animal laboratory testing, vaccination and management, also are helpful for assessing the areas at risk of rabies and the data from surveillance systems will be stronger if these data are integrated.

2. Set up an information consolidating platform for animal surveillance and human bitten or scratched by animals.

The rapid and complete exchanging of information is an important point in the control and prevention of infectious disease. We suggest that information from human rabies surveillance, animal bites and scratches surveillance, application for rabies vaccinations, animal laboratory testing, active surveillance and vaccine inoculation and management, currently done separately by government departments and agencies is consolidated. In order to understand the outbreak the epidemic intelligence is considered longitudinally, can connect horizontally information such as human and animal surveillance, laboratory data and vaccine inoculation. Integrated information sees the overall epidemic situation, and is a basis for the evaluation of the risk of different areas and animals to the wider population for prevention, and provides a reference for physicians in the diagnosis and treatment of patients bitten or scratched by animals. It can also be regarded as a reference for decision-making for prevention and control policies.

3. Investigation and analysis for the model of human behavior

Chingtien county in Zhejiang Province in China has recorded a case of rabies from catching and eating a ferret-badger[8]. When the field investigation for this outbreak, found that the residents in southern and eastern mountain area have habits of catching and eating ferret-badgers, and drinking the blood of ferret-badgers. These risky behaviors can result in being bitten or scratched by ferret-badgers and subsequently being infected with rabies. In addition, the hunting of wild animals for eating, pest control, selling and breeding, is practiced in some mountainous areas. The higher proportion of small carnivorous animals hunted are gem-faced civets, followed by ferret-badgers[10]. This shows that human behavior is related to animal bites and scratches.

In depth interviews and field observations will have more value for reference, so a case study method in the future is recommended, along with active surveillance of animals in mountainous areas, going deeper into remote townships and indigenous districts, to study the risks to specific populations and behaviors.

Limitation

This article studies the surveillance of animal bites and scratches by analyzing the vaccine application database; it is not representative of the wider population.

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