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Estimating the Cost of Prevention and Control of Rabies: A Case Study in the Northwest of Iran

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ABSTRACT

Background: The significance of rabies is due to high mortality rate, economic damage caused by livestock loss, and high costs of treatment. Considering the economic problems in developing countries as well as the lack of resources and facilities, economic assessments will be very useful in obtaining the necessary financial information. Therefore, the present study aims to estimate the cost of prevention and control of rabies in Ahar, East Azarbaijan, during 2010-2011 and 2011-2012.

Methods: This is a descriptive, cross-sectional study conducted in Ahar, East Azarbaijan. This study was carried out using available documents (Vaccine registries, Human Resources Department records, Staff daily wages) and data collection (Ministry of Health and Medical Education, Taxi Administration, Municipality Office and the Veterinary Network) to estimate the cost of prevention and control of rabies during 2010-2011 and 2011-2012. The societal perspective was taken into account to estimate costs. Data was entered into SPSS version 20 and the total cost was calculated. Also, the Mann-Whitney U test was used for data analysis.

Results: The total financial burden of preventing and controlling rabies in Ahar during 2010-2011 and 2011-2012 was about 803 and 850 million rials respectively. The loss of the patient's income (240 and 260 million rials during 2010-2011 and 2011-2012), cost of rabies vaccine (approximately 231 and 237 million rials during 2010-2011 and 2011-2012), and staff costs (approximately 118 and 247 million rials during 2010-2011 and 2011-2012) had the largest share of the cost, while cost of tetanus vaccine (1.3 and 1.2 million rials during 2010-2011 and 2011-2012) had the smallest share.

Conclusion: The present study showed that the prevention and control of rabies put a significant financial burden on the government through direct medical expenses, rabies control program for dogs, and care of the disease. It put a burden on the people, as well, through the loss of productivity and income, and transportation costs.

Key words: Financial Burden, Rabies, Cost, Prevention, Control

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Introduction

Rabies is a viral and zoonotic disease that manifests as acute and fatal encephalitis in humans and other mammals (1). The major cause of this disease is through contaminated saliva of mammals such as dogs, cats, wolves, foxes, and bats, and requires immediate treatment (2). Post-exposure prophylaxis (PEP) is the most important means of preventing and controlling rabies infection. For those exposed to rabies, PEP including wound healing, rabies vaccination, and passive immunization with immune globulin rabies (RIG) is necessary (3).

International statistics have shown that around 50,000 to 100,000 people die every year from rabies around the world, with more cases occurring in developing countries (4, 5). About 10 million people each year, outside India, are receiving post-bite treatment to prevent rabies. Asia, alone, accounts for 96.5% of the burden of disease in developing countries, with an annual cost of 560 Million Dollars (mainly for treatment-prevention) (6, 7).

The importance of the disease is due to high mortality rate, economic damage caused by livestock losses, and high costs of treatment. Although mortality rate has been significantly reduced due to the use of effective PEP, the economic impact of rabies is significant in many developing countries (9-11). Around 29 million people worldwide receive PEP with an estimated cost of $2.1 billion to prevent rabies annually (8). Studies also show that about $583.5 million is spent annually on PEP in Asia and Africa (12). According to the United States Centers for Disease Control and Prevention, the estimated total annual cost of rabies prevention amounts to $300 million in the United States (13).

Rabies is highly endemic in Iran and is considered as the most important zoonotic diseases in the country (14). Reports indicate that animal biting is rising and, despite prevention efforts, there are several deaths from rabies every year in Iran. Rabies Research Center of Pasteur Institute of Iran reports that all provinces of the country are more or less infected with rabies (15, 16). According to the Iran Center for Disease Control, the incidence of animal biting in the country during 2011-2012 was 177 (per population of 100 000); in East Azarbaijan, it was 240 (per population of 100 000) and in Ahar was 468 (per population of 100 000). The incidence rate in Ahar is approximately 3 and 2 times higher in comparison to average national and provincial levels (16), this explains the necessity of research in various aspects of the disease.

Considering the economic problems in developing countries, as well as the lack of resources and facilities, economic assessments will be very useful in order to obtain the financial information required by decision makers. The present study aims to estimate the cost of prevention and control of rabies in Ahar, East Azarbaijan. The results of this study can provide useful information for planning and developing policies for rabies control, controlling costs, allocating resources effectively, and adopting appropriate policies to improve efficiency, effectiveness, and service quality improvement.

Materials and Methods

This is a descriptive and cross-sectional study carried out in Ahar, East Azarbaijan province. This study estimates the cost of prevention and control of rabies during 2010-2011 and 2011-2012, using existing documentation and collecting required data.

A societal perspective was taken into account to estimate costs regardless of the responsibility of paying the costs. Choosing an appropriate perspective is a fundamental decision for any analysis, and it has a decisive influence on the process of costing and results.

Cost variables include rabies care costs (rabies vaccine, anti-rabies serum, tetanus vaccine, and staffing cost), patient and family costs (patient's income loss and transportation costs) and other sector's costs (culling stray dogs and vaccination of livestock) (Table 1). It should be noted that the consumption costs for injection, washing, stitching, dressing, maintenance, distribution, and waste of vaccine; cost of quarantine activities for stray dogs

and livestock, capital costs, and other potential costs were not considered due to data access restrictions.

Cost of each vial of rabies vaccine, anti-rabies serum, and tetanus vaccine during 2010-2012 were identified by an inquiry from the Ministry of Health and Medical Education (MoHME). According to the MoHME, the cost of each vial of rabies vaccine and anti-rabies serum (each 5 cc vial equals 1500 units) were 10 and 6 dollars respectively (1 dollar was about 10,000 rials during 2010-2012). Also, the cost of each vial of tetanus vaccine was 2,200 rials. Then, the total vaccines and anti-rabies serum cost was estimated by multiplying the units cost on their consumption extracted from the Vaccine registries.

The staffing costs, including wages and benefits, were calculated annually using the Human Resources Department records and sharing the cost of providing care.

The transportation costs of referring to Rabies Treatment Centers from urban and rural areas were estimated by inquiries from related centers. The average transportation costs during 2010-2011 from urban and rural areas were 2000 and 12500 rials, respectively, and 2500 and 15000 rials during 2011-2012. Then, by multiplying the number of referrals to the average cost of each visit, the total transportation cost was calculated.

The minimum daily wage announced by the Ministry of Cooperatives, Labor, and Social Welfare during 2010-2012 was equal to 101,000 rials, this was what people lost every time they came to treat rabies.

Finally, the total cost of culling stray dogs and vaccination of livestock was taken from the Municipality and Veterinary Network of Ahar.

Data were entered into SPSS version 20 and the total cost was calculated. Since the data of two years was not normal distribution, the non-parametric Man-Whitney test was used to compare costs between two years.

Furthermore, all ethical issues are based on the Helsinki Declaration.

Results

Estimation of the costs of care for rabies is presented in Table 2. 747 and 745 rabies suspected cases were reported by Ahar Health Center during 2010-2011 and 2011-2012 respectively; 2311 and 2367 vaccine doses were consumed during 2010-2011 and 2011-2012, respectively. Thus, the total cost of rabies vaccination during 2010-2011 and 2011-2012 was approximately 231 and 237 million rials, respectively.

During 2010-2011 and 2011-2012, 71 and 105 anti-rabies vials were consumed, respectively, and cost about 4 and 6 million rials. The total cost of tetanus vaccine for animal bites during 2010-2011 and 2011-2012 was estimated 1.3 and 1.2 million rials, respectively. Staffing cost for rabies care was estimated at 118 and 247 million rials, respectively during 2010-2011 and 2011-2012. Thus, the total cost of rabies care in Ahar was estimated during 2010-2011 and 2011-2012 at 354 and 481 million rials.

The transportation cost of referring to Rabies Treatment Centers in urban and rural areas is presented in Table 3.

Due to the total number of 2311 and 2367 vaccinations for animal bite, patient's income loss was estimated at 240 and 260 million rials, respectively, during 2010-2011 and 2011-2012.

According to the Ahar Municipality report, the total cost of culling stray dogs (including equipment and staff) was respectively 65 and 35 million rials during 2010-2011 and 2011-2012. Also, according to the Ahar Veterinary Network report, the total vaccination cost of livestock was 101 and 19 million rials, respectively, during 2010-2011 and 2011-2012.

Total costs are presented in Table 4. Accordingly, the total financial burden of prevention and control of rabies in Ahar during 2010-2011 and 2011-2012 was about 803 and 850 million rials, respectively. Patient's income loss, rabies vaccine cost, and the staffing cost had the largest share of the total cost, while tetanus vaccine had the smallest share.

Based on the Mann-Whitney U test, there is no significant difference between the costs of

prevention and control of rabies during 2010-2011 and 2011-2012.

Table 1. Data collection source and cost estimation procedures

Cost variable type	Variable	Data collection source	Estimated value
Care services for rabies	Rabies vaccine	Inquiry from the MoHME	100,000 Rials per vial during both 2010-2011 and 2011-2012
	Anti-rabies Serum	Inquiry from the MoHME	60,000 Rials per vial during both 2010-2011 and 2011-2012
	Tetanus vaccine	Inquiry from the MoHME	2,200 Rials per vial during both 2010-2011 and 2011-2012
Patient and Family	Staff	Human Resources Department records	wage and benefit
	Transportation Costs	Inquiry from Taxi Administration	The average cost of transportation in urban and rural areas was respectively 2000 and 12500 Rials during 2010-2011, and 2500 and 15000 riyals respectively during 2011-2012
	Income Loss	Minimum wage according to the labor law	101,000 Rials daily during both 2010-2011 and 2011-2012
Other Sections	Culling stray dogs	Inquiry from the Municipality	65 and 35 million Rials respectively during 2010-2011 and 2011-2012
	Livestock vaccination	Inquiries from the Veterinary Network	101 and 19 million Rials respectively during 2010-2011 and 2011-2012

Table 2. Estimation of cost variables for rabies care service during 2010-2011 and 2011-2012 in Ahar (million Rials)

Year	Dosage of rabies vaccine	The total cost of rabies vaccine	Number of anti-rabies serum	Total cost of anti-rabies serum	Number of tetanus vaccine	Total cost of tetanus vaccine	Total staffing cost
2010-2011	2311	231.1	71	4.26	591	1.3	117.6
2011-2012	2367	236.7	105	6.3	509	1.2	247.2

Table 3. Estimation of transportation costs for patients referred to the Health Centers for rabies treatment in Ahar during 2010-2011 and 2011-2012

Year	Area	Number of visits	Total transportation costs (million Rials)	
2010-2011	Urban	1394	2.788	43.13
	Rural	3228	40.35	
2011-2012	Urban	126	3.165	55.03
	Rural	3458	51.870	

Table 4. Estimation the cost of prevention and control of rabies in Ahar during 2010-2011 and 2011-2012

Cost variable	2010-2011		2011-2012	
	Cost (million Rials)	Total cost (%)	Cost (million Rials)	Total cost (%)
Rabies Vaccine	231.1	28.8	236.7	27.9
Anti-Rabies Serum	4.26	0.5	6.3	0.7
Tetanus Vaccine	1.3	0.2	1.2	0.1
Staff Costs	117.6	14.6	247.2	27.9
Transportation Costs	43.13	5.4	55.03	6.5
Income Loss	240	29.9	260	30.6
Culling Stray Dogs	65	8.1	35	4.1
Livestock Vaccination	101	12.6	19	2.2
Total	803	100	850	100

Discussion

Rabies-related interventions such as PEP, livestock vaccinations, dogs control programs, care services, and livestock protection programs against rabies put financial charges on communities (17). Due to the fact that patients with rabies die quickly and there is no effective treatment, the cost of illness, especially in developing countries, is relatively low. In contrast, direct costs such as PEP and animal death are significant. Indirect costs include animal vaccinations and test of suspected dogs. Other economy sectors can also be affected by direct and indirect costs of the disease (18). The global cost of rabies is estimated at $695 million annually (12). The cost of rabies prevention in the United States is estimated at $230 million to $1 billion annually (19). Due to the significant economic burden of rabies, significant benefits are derived from the elimination of this disease.

A study by Hamidi Parsa et al. (20), aims at estimating the cost of health services provided to people suffering from animal bites in Qom province. The findings showed that more than 9.61 billion rials was spent on providing health services to 844 animal-bite cases during a year. Also, total average cost per patient was estimated about 11.7 million rials.

Pourmerzai et al. (21), reviewed the activities to prevent rabies and tetanus after animal biting in Rasht during a year. The study, by investigating 561 dog bite cases, concluded that for each case, 3.2 doses of anti-rabies vaccine, 499.5 units of anti-rabies serum, 0.7 doses of dual vaccine, and 0.1 anti-tetanus serum vials were consumed.

A study by Hampson et al. (22), states that around 59,000 deaths occur from rabies annually all over the world, resulting in an annual economic loss of $6.8 billion.

A study by Wera et al. (23), was aimed at estimating the cost of rabies control activities in Flores Island, Indonesia in 2000-2011. In this study, the costs associated with vaccination of dogs, culling roaming dogs, quarantining dogs, diagnostic costs, and PEP costs were considered. The results showed that the costs of culling roaming dogs were the highest portion, about 39 percent of the total costs, followed by PEP (35 percent), mass vaccination (24 percent), pre-exposure treatment (1.4 percent), and others (1.3 percent) (dog-bite investigation, diagnostic of suspected rabid dogs, trace-back investigation of human contact with rabid dogs, and quarantine of imported dogs).

A study by Sambo et al. (24), was aimed at estimating household costs, health behaviors, strategies, and the consequences of exposure to rabies in rural and urban communities in Tanzania. In this study, the disease costs were considered in two parts of the treatment-related costs and non-treatment-related costs. The average cost of each suspicious bite was estimated at $44 and the cost of receiving each dose of treatment was estimated at $22.

Another study by Knobel et al. (12), was conducted to estimate the economic burden of rabies in Asia and Africa, therefore, costs of dog control, lost livestock, and care systems' costs had been evaluated. According to the results of the study, annual costs in Africa and Asia for rabies were $20.55 and $536 million, respectively. The study also found that treatment costs after exposure to the illness were the major part of the cost, accounting for roughly half the costs.

Although, the economic burden of rabies in Iran may be significant, there is very little knowledge of the cost of interventions related to rabies and financial losses associated with it, because no studies have been done so far on the financial burden of this disease. The present study describes the results of the first attempt to estimate the cost of prevention and control of rabies from the societal perspective.

The findings of this study indicate that the highest share of the total financial burden of rabies is related to the patient's income loss. Rabies also causes psychological burden on the families of victims and those who are at risk of disease (25). This psychological damage has not been empirically described, but potentially leads to a reduction in productivity.

According to the results of this study, the cost of rabies vaccines is a significant contribution and the cost of anti-rabies serum and tetanus vaccine are a small fraction of the total cost of preventing and controlling rabies. The rabies care service in Iran is free and it could impose a significant financial burden on the health system on a national level. In contrast, for many countries in which most of the costs are paid by patients (12, 26-28), mortality rate from rabies increases, because appropriate prevention after exposure to the disease will not be available in countries with limited resources. Increasing the use of PEP can also increase the knowledge of other people of society about rabies (12, 26).

The present study indicated that the costs of prevention and control of rabies placed a significant financial burden on the government through direct medical costs for PEP in humans, rabies control programs for dogs, disease care, as well as huge financial burden on people, through patient's income losses and transportation costs. However, our estimates may be lower than actual costs, because the consumption costs for injection, washing, stitching, dressing, maintenance, distribution, and waste of vaccine; cost of quarantine activities for stray dogs and livestock; capital costs; and other potential costs were not considered due to data access restrictions, which was the most important limitation of the study. Improving the recording of all costs and documents, and the availability of this data, provide more detailed information on the impact of rabies and related costs.

This article can provide guidance on estimating the economic effects of rabies, designing disease control programs, planning and organizing a national vaccination program, and proposed approaches to reduce the cost of rabies. It also can help to eliminate rabies by 2030 which is a common program by the World Health Organization (WHO), Food and Agriculture Organization (FAO), World Organisation for Animal Health (OIE), Global Alliance for Rabies Control, and the international community (29).

Periodic estimates of costs of various interventions for rabies are necessary to assess the economic burden of the disease. Future studies can estimate the costs of prevention and control of rabies on a comprehensive and national level, the economic burden caused by rabies in the absence of prevention and control activities, and can estimate possible economic savings.

Conclusion

The potential benefits of limiting or eliminating rabies are significant. Since the relationship between humans and dogs is the most important epidemiological stimulus, the elimination of rabies caused by dog bite is known as the most important cost-effective approach for preventing human rabies (26, 30). A number of countries have managed to eliminate rabies, which leads to significant saving in long-term (31-33).

Elimination of rabies requires a coherent and collaborative approach where public health professionals and animal health professionals interact effectively.

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Conflicts of interest

There is no conflict of interest.

Authors' contributions

Abbasi M, Hazratian T, and Abbasi R designed research; Abbasi M Hazratian T and Abbasi R conducted research; Abbasi M and Barfar E analyzed data; and Abbasi M and Barfar E wrote the paper. Barfar E had primary responsibility for final content. All authors read and approved the final manuscript.

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