Short Communication

Retrospective Study of Extensive Vaccination Programs for Canine Rabies Control and Public Health in Korea

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SUMMARY: This retrospective study of the patterns and efforts of the extensive vaccination programs for canine rabies control (EVPCRC) compared the prevalence rate (PR) of rabies under two different vaccination programs for dogs in Korea between 1962 and 2007. A total of 753 cases of rabid dogs were reported between 1962 and 2007, and there were 350 human cases reported in the same period. There were 518 cases (PR, 4.11) of rabid dogs reported from 1962 to 1979, when the low-egg-passage Flury strain vaccine was used, and a total of 342 human cases were observed over the same period. However, there were 235 rabid dogs (PR, 0.83) identified from 1980 to 2007 when the Evelyn-Rokitnicki-Abelseth strain vaccine was used, and only 8 human cases of rabies were observed during the same period. The prevalence of rabies in dogs during the two periods was significantly different (P < 0.01). Moreover, the year with the largest outbreak, 1975, contained 91 cases, and the PR value was 6.3. In 1963, for humans, there were 103 cases, and the PR value was 0.4. However, in recent years, raccoon dogs have increased as a reservoir of rabies in the mountain areas linking North Korea with South Korea near the demilitarized zone, reflecting areas with poor EVPCRC.

Rabies is a zoonotic disease that is caused by an RNA virus, genus Lyssavirus, family Rhadoviridae. The disease infects both domestic and wild animals and is spread to humans by contact with infected saliva through bites or scratches. Rabies is present worldwide, except in Australia, Japan, Great Britain, most of Oceania, some Caribbean islands, etc., but more than 95% of human deaths occur in Asia and Africa. Once symptoms of the disease develop, rabies is nearly always fatal (1). In the Korean Peninsula, the first official report of rabies in animals was recorded in 1907 (2–4). From 1907 to 1945, the epidemiological aspects of rabies were first apparent with many outbreaks of rabies. However, there were few epidemiological studies and reports about the outbreaks of animal or human rabies in Korea, except for statistical reports by the official expression, until 1960. About 4% of the dog population was inoculated with a phenolglycerin-inactivated rabies vaccine, which was prepared from the brain tissue-derived vaccine of rabbits and produced by Umeno-Kondo’s methods in Japan (2,5). After the Korean War in 1959, the National Veterinary Research Institute developed an attenuated-live vaccine containing the low-egg-passage (LEP) Flury strain, and this vaccine was used in extensive vaccination programs for canine rabies control (EVPCRC) from 1960 to 1979. Thereafter, from 1980 to the present, a tissue culture-attenuated live vaccine containing the Evelyn-Rokitnicki-Abelseth (ERA) strain has been used for dogs and other domestic animals in Korea (4,6).

This study compares the rabies prevalence under the two vaccination programs for the EVPCRC in Korea from 1962 to 2007. During the period from 1962 to 2007, there were 753 cases of rabid dogs that were confirmed by the National Veterinary Research and Quarantine Service (NVROS) in the Ministry for Food, Agriculture, Forestry and Fisheries (MFAFF) (7,8). Data on rabies vaccinations in domestic dogs throughout the whole country were obtained from the Food, Agriculture, Forestry and Fisheries Statistical Yearbook of the MFAFF, 1962–2007 (9), and data on the human cases of rabies were obtained from the Ministry of Health and Welfare, Republic of Korea, 1962–2007 (10,11).

In this study, the prevalence rate (PR) of rabies cases per 100,000 was calculated. Significant differences between the PRs between the two vaccination programs were determined using the chi-square test; the levels of significance were set at P < 0.05 and P < 0.01, respectively. Data analyses were carried out using the statistical analysis system software, Microsoft Excel 2003.

Dogs in Korea were a principal vector for the transmission of rabies to other animals and humans. Table 1 compares the prevalence of rabies in dogs under the two different vaccination programs from 1962 to 2007; there were a total of 518 rabid dogs with a PR of 4.11 from 1962 to 1979 when the LEP Flury strain vaccine was used (Table 1); 342 human cases of rabies occurred during the same period (Table 1). However, there were 235 rabid dogs (PR, 0.83) identified between 1980 and 2007 when the ERA strain vaccine was used, and only 8 human cases of rabies occurred during the same period. The PRs of rabies in dogs during the two periods were

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significantly different ($P < 0.01$). Moreover, the use of the ERA vaccine with the EVPCRC (average vaccination rate, 47.1%) appeared to have reduced the prevalence of canine rabies much more than the LEP Flury strain vaccine did (37.1%). In 1975, the year with the largest outbreak, there were 91 cases, and the PR was 6.3 (Fig. 1). In 1963, there were 103 cases and a PR value of 0.4 for humans (Fig. 1). However, in recent years, there has been an increase in the number of rabid dogs and raccoon dogs (*Nyctereutes procyonoides*) in the mountain areas linking North Korea with South Korea near the demilitarized zone (DMZ) (8,12). Since 1945, South Korea has been isolated by this zone, which divides the Korean Peninsula into two, and, thus, it is not surprising that the rabies epidemics in Korea are similar to those of an island country (3,4). For example, over the 27-year period from 1980 to 2007, 8 human deaths from rabies were reported, with 1 death each in 1982, 1984, 1999, 2001, 2002, and 2005 and 2 deaths in 2003 (Fig. 1). Bites by raccoon rabid dogs caused 2 of the cases, and rabid dogs caused the other 6 (7,8). All rabies cases, including 6 human cases, occurred at the border of the DMZ (8). In Korea, rabies was geographically distributed along the mountain range during the 1960s, but, in the beginning of the 1970s, rabies began to appear in regions of the Gyeongsang and Gangwon provinces, near the DMZ (3,6–8).

As reported by the NVRQS for the period from 1993 to 2007, rabies most frequently occurred in winter with 36.0% of the total of 417 cases, while 28.8% were diagnosed in spring, 20.1% in autumn, and 15.1% in summer (8).

In most endemic countries, stray dogs are the main source of human rabies infection (11,13,14). Rabies, which is a preventable viral disease of mammals, is most often transmitted through the bite of a rabid animal (1,6–8,11–14). In Korea, the period from 1907 to the present can be divided into four separate phases on the basis of the epidemiological aspects of rabies. The first phase, named the endemic period of rabies, occurred between 1907 and 1945. At that time, there were many outbreaks of rabies in Korea; from 1926 to 1938, 241,806 stray dogs were killed in order to prevent rabies (15). During that period, the number of canine rabies cases varied from 491 to 881 per year (2,6). The second phase, called the decrease period of rabies, lasted from the end of the 1950s to 1984, when an average of 24 cases of rabies occurred annually. The third phase, named the elimination period of rabies, spanned from 1985 to 1992, when there were no outbreaks of rabies for 8 years. The fourth phase, named the recurrence period of rabies, began in 1993. The disease reemerged in 1993 after 8 years of no reported cases, and it showed a sylvatic form of rabies in different wildlife species with mainly raccoon dogs acting as carriers and/or transmitters near the DMZ in the Korean Peninsula (3,4,6,12,16). Therefore, annual oral vaccinations using the vaccinia-rabies glycoprotein (V-RG; Merial Ltd., Duluth, Ga., USA) bait vaccine, has been implemented.
for wild animals, including raccoon dogs, foxes, and wild cats, in the vicinity of the DMZ in South Korea since 2002 (8,12).

The results of this comparison of the prevalence patterns of rabies under the two vaccination programs for the EVPCRC in South Korea from 1962 to 2007 indicate that the prevention of rabies in human beings depends upon the management of animal rabies by the EVPCRC, as well as the control of stray dogs and wildlife.

Finally, the development of a public health education system for rabies prevention and improvement of the living environment will aid in reducing the number of cases of human rabies.

**Conflict of interest**  None to declare.

**REFERENCES**