

An Epizootic of Rabies in Maryland, 1982–84

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Abstract: The number of reported rabid raccoons increased by 617 per cent in Maryland from 1982 to 1984. The per cent of raccoons that tested positive for rabies increased from 7.9 per cent in 1982 to 57 per cent in 1984. During this period of time, more than 74 per cent of human exposures to rabid animals involved raccoons. Reports of

animal bites of humans, however, showed only a 2.6 per cent increase. The raccoon rabies epizootic has had significant public health impact in terms of human rabies postexposure prophylaxis and rabies control programs. (*Am J Public Health* 1986; 77:42–44.)

Introduction

There are descriptions of apparent human rabies dating back more than 2,000 years with the dog usually implicated as the primary reservoir host.¹ In the United States in the 1950s, the number of reports of rabies in wildlife species surpassed that in dogs, and eventually in all domestic species. By 1966, 70 per cent of rabies cases were reported in wildlife species.²

Prior to 1957, wildlife rabies in the United States was most often reported in foxes (45–70 per cent of wildlife cases), followed by skunks (20–40 per cent), with raccoons and bats comprising less than 10 per cent.^{3,4} In the early 1970s, reports of fox rabies declined, but skunk and bat rabies remained relatively stable, and by the late 1970s raccoon rabies dramatically increased in frequency. By 1982, raccoons accounted for 21 per cent of all rabid wildlife cases in the United States, in part due to an enzootic of raccoon rabies in the southeastern United States.^{2,5,6} In 1966, 86 per cent of all raccoon rabies cases in the United States were reported from Florida and Georgia.² From 1975 to the present, rabies in raccoons has progressed northward and westward from Florida and Georgia into South Carolina and Alabama. In the late 1970s, raccoon rabies was observed with increasing frequency in Virginia and West Virginia. By 1982, a new raccoon enzootic was firmly established in the Mid-Atlantic States (Table 1).

This study investigated the epizootic of raccoon rabies in Maryland from 1982 to 1984 and its potential public health significance.

Methods

Rabies and animal bite reports from the Veterinary Division of the Department of Health and Mental Hygiene of the State of Maryland were reviewed for the years 1982 through 1984 to determine the number of confirmed rabies cases and the per cent of all animals tested that were positive (the positivity rate). Comparisons of positivity rates were evaluated by chi-square tests, and the 95 per cent confidence intervals are presented. Reports of humans exposed to rabid animals were also examined to assess the extent of the rabies epizootic as a public health problem. Finally, the frequency of animal bites of humans was studied to determine if it was related to the number of reported rabies cases in animals.

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Results

Rabies Positivity

Rabies positivity rates in raccoons increased from 8.0 per cent in 1982, to 23.5 per cent in 1983, a difference of 15.5 per cent (95% confidence intervals 13.4, 17.5) and increased to 57 per cent by 1984, a difference of 33.6 per cent (95% CI 30.7, 36.3) (Table 2). During this period, rabid raccoons comprised greater than 75 per cent of all reported rabid animals in the State. The variety of terrestrial species reported as rabid, and the total number of reported cases also increased from 1982 to 1984. The bat rabies positivity rate increased from 2.3 per cent in 1982 to 4.4 per cent in 1983, an increase of 2.1 per cent (95% CI 0.5, 37.0), however there was a 4.5 per cent decrease in 1984 (95% CI -1.8, 15.0).

Geographic Spread

In 1982, 118 rabid raccoons were reported from four contiguous Maryland counties west of the Chesapeake Bay, with 66 from Montgomery County, immediately north of Washington, DC. Sixteen cases in other wildlife and a single rabid domestic cow were also reported in 1982. In 1983, 735 rabid raccoons were reported from the original four counties plus three additional adjacent counties on the western, southern, and eastern sides of the original cluster of counties. In addition, 41 cases of other terrestrial wildlife and 11 cases in domestic animals were observed. In 1984, 10 counties reported 964 rabid raccoons with the largest number still focused in Montgomery and Frederick Counties (97 and 219, respectively). Throughout the State, from 1982 to 1984, reports of rabies increased from 16 to 71 cases in terrestrial wildlife species other than raccoons and increased from 1 to 19 cases in domestic species.

From 1982–84, cases of terrestrial rabies were not reported in counties east of the Chesapeake Bay despite isolated cases in bats.

Human Rabies Exposure

In Maryland, from 1982 to 1984, greater than 74 per cent of the 261 human exposures to rabid animals involved contact with 164 raccoons (Table 3). This pattern was similar to that observed in Alabama and Georgia, where raccoon rabies was also enzootic.^{7,8} In contrast, in states reporting little or no raccoon rabies, more than 50 per cent of human exposures to rabid animals typically involves dogs and cats.⁸

Animal Bites

Although most human exposures to rabid animals involved raccoons, greater than 80 per cent of the reported animal bites of humans in Maryland were inflicted by owned cats and dogs (Table 4). While the number of people exposed to a rabid animal increased from 17 to 90 (429 per cent increase) from 1982 to 1983 and to 112 (24.4 per cent increase) from 1983 to 1984, the total number of animal bites of humans showed only a small increase in proportion to the increase in

TABLE 1—Number of Confirmed Rabid Raccoons in the mid-Atlantic States, 1977–85

States	1977	1978	1979	1980	1981	1982	1983	1984	1985
West Virginia	1	0	8	14	22	43	89	26	15
Virginia	0	3	4	7	102	645	545	158	102
Maryland	0	0	0	0	7	118	735	964	672
Pennsylvania	0	0	0	0	0	26	81	281	286
Washington, DC	0	0	0	0	0	5	158	10	4
TOTAL	1	3	12	21	131	837	1,608	1,439	1,079

SOURCE: S. Jenkins⁹ and S. Jenkins, personal communication, 1986.

TABLE 2—Number (% positive) of Animals Tested for Rabies by Species in Maryland, 1982–84

Animals Tested	1982	1983	1984
Wildlife			
Raccoon	1,484 (8.0)	3,134 (23.5)	1,691 (57.0)
Skunk	80 (16.3)	120 (23.3)	69 (46.4)
Fox	79 (0)	116 (4.3)	91 (20.9)
Bat	753 (2.3)	1,169 (4.4)	1,098 (4.2)
Groundhog	72 (0)	215 (2.3)	445 (2.9)
Deer	11 (0)	24 (4.2)	36 (2.8)
Rabbit	64 (0)	102 (0)	202 (1.0)
Mouse/Rat	100 (0)	86 (0)	144 (0.7)
Opossum	99 (0)	256 (0)	510 (0.4)
Chipmunk/Squirrel	197 (0)	260 (0)	597 (0.3)
Ferret/Mink	24 (0)	22 (0)	28 (0)
Beaver/Muskrat	6 (0)	26 (7.7)	12 (0)
Total	2,969 (5.1)	5,530 (15.0)	4,923 (22.0)
Domestic			
Horse	8 (0)	19 (0)	27 (3.7)
Cattle	27 (3.7)	72 (4.2)	103 (1.9)
Cat	609 (0)	1,069 (0.7)	1,503 (1.0)
Dog	603 (0)	750 (0)	801 (0.1)
Goat/Sheep/Pig	12 (0)	23 (0)	34 (0)
Total	1,259 (0.1)	1,933 (0.6)	2,468 (0.8)

TABLE 4—Number (% of annual total) of Animal Bites of Humans in Maryland

Animal Bites	1982	1983	1984
Dog			
owned	8,413 (72.4)	8,341 (70.3)	8,719 (76.6) ^a
stray	1,268 (10.9)	1,163 (9.8)	—
Cat			
owned	873 (7.5)	1,081 (9.1)	1,922 (16.9) ^a
stray	439 (3.8)	671 (5.7)	—
Other			
Domestic	11 (0.1)	16 (0.1)	23 (0.2)
Raccoon	123 (1.1)	69 (0.6)	189 (1.7)
Bat	54 (0.5)	117 (1.0)	100 (0.9)
Other Wildlife	439 (3.8)	406 (3.4)	429 (3.8)
TOTAL	11,620 (100)	11,864 (100)	11,382 (100)

^aDifferences between owned and strays unavailable.

the human population. For example, from 1982 to 1983, Maryland's human population increased by 2.4 per cent while reports of animal bites of humans increased by 2.6 per cent. From 1982 to 1984, each of the 164 confirmed rabid raccoons exposed an average of 1.6 people.

Discussion

One hypothesis for the unexpected appearance of raccoon rabies in the Mid-Atlantic region is that rabid raccoons were acquired in Florida by hunting clubs and released in Virginia and West Virginia to stock areas hunted by members.⁹ Among shipments of raccoons to the Mid-Atlantic states, rabies was confirmed in animals from cages in which other animals were released.^{9,10} Therefore, it is plausible that numerous raccoons had been exposed to rabid animals while in shipment and were incubating rabies when released into a susceptible, non-immune native population. This transloca-

TABLE 3—Number (% of annual total) of Rabid Animals Exposing Humans in Maryland

Rabid Animals	1982	1983	1984
Raccoons	3 (76.5)	68 (75.5)	83 (74.1)
Wildlife ^a	1 (5.9)	9 (10.0)	9 (8.0)
Bats	2 (11.7)	5 (5.6)	8 (7.2)
Domestic Animals	1 (5.9)	8 (8.9)	12 (10.7)
TOTAL	17 (100.0)	90 (100.0)	112 (100.0)

^aExclusive of raccoons and bats.

tion theory is supported by immunologic findings indicating that raccoons from the Southeast and Mid-Atlantic regions are infected with an antigenically similar strain of rabies virus.¹¹ Other factors that may have contributed to the establishment of the Mid-Atlantic raccoon enzootic include the relatively long period of communicability for rabies in raccoons and the possibility of non-lethal infections.^{12,13} In addition, communal denning, polygamous mating, and concentration at feeding sites among raccoons facilitates intra-species rabies transmission.

Although rabies virus typically circulates among a single primary reservoir species, it may also be transmitted to other domestic and wildlife species (spillover). However, spillover infrequently results in development of an enzootic in the secondary species. This may be related to differences in antigenicity and pathogenicity of rabies virus strains, differences in host susceptibilities, or to ecological factors.^{11,13,14} However, there have been reports of concurrent fox-skunk rabies cycles.^{4,11}

The small absolute, but significant increase (91.3 per cent) in reported bat rabies in Maryland from 1982 to 1983 may reflect increased public awareness of animal rabies since there was a simultaneous 55 per cent increase in the number of bats submitted throughout the State for testing. Increased submissions may have facilitated detection of a low level of bat rabies in areas that were free of raccoon rabies, e.g., Baltimore City, Baltimore County, and counties east of the Chesapeake Bay. The fact that the frequency of bat rabies did not increase further from 1983 to 1984, even in counties reporting an increased frequency of raccoon rabies, suggests that the bat and terrestrial rabies cycles are independent. Furthermore, it has been shown that enzootic bat rabies involves an antigenically distinct rabies virus from that in terrestrial reservoirs.^{11,15}

Rabies virus spillover from the raccoon reservoir to

other terrestrial species occurred in Maryland from 1983 to 1984 as indicated by an increase in fox rabies positivity from 4.3 per cent to 20.9 per cent, a difference of 16.6 per cent (95% CI 7.4, 25.7) and skunk positivity from 23.3 per cent to 46.4 per cent, an increase of 23.3 per cent (95% CI 9.1, 37.0). In addition, rabies was confirmed in species heretofore considered as rabies-free, e.g., the groundhog, opossum, and rabbit.

The ongoing raccoon epizootic in Maryland has important public health implications. Raccoons are one of the most adaptable wildlife species and thrive in urban or suburban settings where they are attracted to human refuse. Their cute appearance and clever antics encourage their acceptance by humans, and occasional adoption as pets.

Although raccoons generally have well-defined home ranges,¹⁶⁻¹⁸ their territory is not tenaciously defended.* As long as food and den sites are plentiful, raccoon populations may reach high densities which in turn increases raccoon-raccoon and raccoon-human contacts. The Maryland raccoon population has not been well studied, but a high density is suggested by the large percentage of human rabies exposures attributed to raccoons.

It has been suggested that infection with rabies virus may not always be lethal to raccoons, yet these animals can be infective to others particularly during the mating season when males become aggressive.^{12,13} Rabid raccoons are typically non-aggressive and approachable, thus increasing the likelihood for domestic animal and human exposures.^{5,6,12} More than 74 per cent of human exposures to rabies involved rabid raccoons, although the exact circumstances were not recorded.

In Maryland, human rabies postexposure prophylaxis was not necessarily associated with an animal bite, but was typically considered following contact with a confirmed or suspected rabid animal. There was only a small increase in the number of humans reported bitten by domestic and wild animals, and this was not correlated with the large increase in rabies in wildlife.

Although there have been no human deaths attributed to rabid raccoons in the United States, the large increase in the number of people being treated for rabies following raccoon exposure in Maryland has important financial implications. Each exposure incident involves costs for animal testing, human treatment, and administrative follow-up. A recent study estimated that in 1982, the costs for rabies control in three Maryland counties was \$1 million, and the annual costs

for the State could exceed \$7 million.¹⁹ Lastly, the raccoon rabies epizootic in Maryland may become a continuing enzootic as happened in the Southeast. Such an enzootic will require continued surveillance, increased public awareness, intensified vaccination of domestic animals, and serious consideration of wildlife immunization.

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