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# Rabies in Iowa and the Upper Midwest: What a Rural Practitioner Should Know

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## Rabies in the United States - an Overview

A thorough history of rabies in the United States has been written by Steele,<sup>1</sup> who begins by writing that the first reference to rabies in the United States occurred, in dogs, in Virginia and North Carolina, in 1753 and 1762, respectively. An outbreak that occurred in Boston and other North American towns in 1768 is considered the first major epizootic in north America. "Canine madness," as it was called, raged all over colonial North America throughout the late 1700's. Rabies reappeared in the eastern US in 1810 and in Ohio assumed an epizootic character affecting dogs, foxes, and wolves. Steele goes on to report that, following the Civil War, rabies was widespread across most of the USA. Mad dogs were reported in many urban as well as rural areas. Sylvatic rabies was recognized in the eastern US in the 18th century, and in the 19th century the disease was seen in foxes throughout the eastern part of the country.

With the movement west of the population, rabies appears to have gone with the pioneers, as is also discussed by Steele. Skunk rabies was reported by the mountain men on the Great Plains in the 1830's, and was reported in California as early as the 1850's. The U.S. Army reported that skunk rabies was so common that the early settlers on the Great Plains referred to skunks as hydrophobia cats, or phobey cats. At the turn of the 20th century,

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rabies was a dreaded disease throughout the USA. Control measures were not effective at that time as the public would not accept dog control and muzzling.

It was not until dog vaccination could be successfully performed by a single inoculation that the fear of dog rabies was to be alleviated. Cases of canine and human rabies in the USA dropped precipitously between 1940 and 1970 due to a stringent urban rabies control program, including mandatory vaccination, leash laws, and stray dog control, instituted in many urban centers throughout the country beginning in the late 1940's<sup>2</sup>. Virtually all canine cases that occur in the USA today are caused by exposure to rabid wild animals,<sup>2</sup> for none of the twenty-two canine strains of rabies are endemic in this country anymore.

The sylvatic rabies problem, unlike the canine rabies problem, remains in the USA. Although sporadic cases of skunk rabies were reported in the central part of the US in the 1930's and the early 1940's, the disease in skunks became less common in the second and third decade of this century.<sup>3</sup> Since 1958, the number of cases of rabid wildlife has surpassed cases of domestic animals, and today wildlife dominates the rabies picture, accounting for the vast majority of all cases.

Compartmentalization of the disease has occurred, resulting in the predominance of rabies in a single host species in each of several areas of the USA: a large region of skunk rabies that extends from Minnesota to Texas across the central USA and a separate skunk rabies area in northern California, two separate raccoon rabies areas in the southeastern and mid-Atlantic states, and a region of red fox rabies in Maine and New York.<sup>5</sup> Fox rabies (in arctic and red foxes) also occurs in Alaska and Canada, and there are two foci of rabies in grey foxes in Texas and Arizona, respectively.<sup>6</sup> Within each of these areas, single species

involvement is almost universal (excluding the grey fox areas within the skunk area) and cases that occur in other animals are generally regarded as spillover or accidental infection from the major reservoir animal.<sup>7</sup> This compartmentalization of rabies within one species may reflect the ecological isolation of species, virus strain differences, or a combination of these and other unidentified factors.<sup>7</sup>

Use of monoclonal antibodies to rabies virus nucleocapsid proteins has made possible the demonstration of antigenic variation among virus isolates.<sup>7</sup> Thus it is known that there are at least 2 strains of rabies virus associated with the large skunk rabies endemic area in the central USA. There is a single strain of rabies virus associated with raccoon rabies in the southeastern and mid-Atlantic states. There is also a single strain associated with red fox rabies in the northeastern USA and Canada and arctic foxes in Alaska and northern Canada. A separate strain occurs in grey foxes in Arizona, whereas the strain in the grey fox area of Texas seems to be the north central US skunk strain.

In addition to these five strains of virus that occur in wild terrestrial mammals, there are also five separate strains recognized in bats, in which rabies has been reported from all 48 contiguous states.<sup>6</sup> Although bats are suspected as a source of rabies infection in terrestrial mammals, particularly as a source of rabies that has suddenly appeared in areas and species that previously were unaffected, the role of bats as reservoirs for rabies maintenance in terrestrial mammals in nature has not been proven.<sup>7</sup> It is generally thought that bats do not play an important role in the epidemiology of the disease in terrestrial mammals.

### **Rabies in Iowa**

The sole terrestrial reservoir of rabies in Iowa is the Striped Skunk (*Mephitis mephitis*), which maintains the north central US skunk rabies virus strain within its population.<sup>14</sup> Bats are also reservoir hosts of rabies in Iowa, but reported cases in bats are few and their significance to terrestrial mammals is negligible, so further discussion will center around skunk rabies and its ramifications.

The epidemiologic picture of rabies in Iowa, then, centers around the skunk. All rabies cases in other species must result from

transmission from skunks to animals of these other species, and this occurs by biting.<sup>14</sup> During the 1980's, the number of reported cases varied from 150 to 881 cases/year; 64% of all reported cases occurred in wild animals. Skunks accounted for 60% of all cases and 93% of all wild animal cases. Thus, it can be seen that very few cases of rabies occur in wild animals other than skunks in Iowa. It should be mentioned here that it is probable that only a fraction (estimated at about 1/10) of the cases that occur in wild animals get diagnosed.

Thirty six percent of all reported cases occurred in domestic animals, with cattle, cats, and dogs accounting for 90% of domestic animal cases. Cattle accounted for the second highest number of case in Iowa (18% of all cases) and were the domestic species most commonly reported rabid (49% of domestic cases). Cats were third overall (9% of total) and second in domestics (26% of domestics). Dogs were fourth overall (5%) and third in domestics (14%).

This data provokes a number of interesting observations. First, the majority of reported cases of rabies in Iowa occur in wild animals, with the vast majority of these occurring in skunks. What is interesting, though, is that wild animal cases, while still a majority, make up a far less percentage of total cases in Iowa (64%) than they do in the nation as a whole (89%). Conversely, domestic animal cases make up a far greater percentage of total cases in Iowa (36%) than was true for the nation as a whole (11%).

More interesting than this, though, is the fact that the number of domestic animal rabies cases in Iowa comprises an amazingly large portion of the absolute number of domestic animal cases that occur in the entire United States. From 1980-1988, Iowa had by far the most reported cases of domestic animal rabies of all states, with over 17% of the nation's total. Iowa also ranked first in reported cattle cases with 22% of the nation's total, and cat cases, with >16% of the nation's total. Iowa ranked second in the number of reported cases in the other domestic species: horses (14% of nation's total), sheep and goats (21%), and dogs (11%). The high number of cases in domestic animals in Iowa relative to the rest of the USA is particularly interesting when one considers the extensive area of the USA in which rabies is endemic, the relatively small

size of the state of Iowa, and the fact that Iowa is as often not in the top ten states in number of cases in wildlife as it is in the top ten in this category. Whatever the reason, it seems that the problem of rabies in domestic animals is greater in Iowa than it is in any other state in the union and thus warrants a great deal of attention. This is true mainly because of the public health threat imposed by rabies, but also because of certain economic consideration. Before going on, it should be mentioned that in areas of the upper Midwest adjacent to Iowa, a similar rabies picture exists.

Since the epidemiology of rabies in the upper Midwest centers around the epidemiology of rabies in the Striped Skunk, it is important to understand certain facts about rabies and skunks. It has been said that clinical rabies in skunks in the central US occurs in cycles averaging seven years between peaks.<sup>4</sup> In Iowa, cycles seem to average about nine years. The last two cycle peaks, in 1982 and 1972, were nine years apart, as were the last two cycle bottoms, in 1984/1985 and 1975.<sup>15</sup> Presently, we are at a high point in a cycle; 1990 may be the peak year. We should see a decline in reported rabies cases after this year until the mid-1990's, and the next peak should occur sometime around 1998.

Not only does clinical rabies in skunks occur in yearly cycles in Iowa, it also seems to occur in seasonal cycles, according to data from the Iowa State University Veterinary Diagnostic Lab.<sup>16</sup> Cases occur in all months, but the number of reported cases typically begins to rise after January/February and peaks in the spring to early summer months, after which it declines until about March. The greatest number of cases are recorded from March to July, usually from April to June. April is commonly the peak month. The lowest number of cases usually occurs from September to February. Nationwide, a distinct peak of reported cases in skunks usually occurs in March and April.<sup>13</sup> Transmission of rabies within the skunk population is not yet fully understood; there are probably mechanisms other than bite transmission involved.

In general, reported skunk rabies is more prevalent in the northern 2/3 of Iowa and less prevalent in southern Iowa, especially in the southcentral and southwestern regions.<sup>15</sup> The highest prevalence areas generally are the central and east central regions, but high preva-

lence counties also exist in the northwestern and northeastern regions.<sup>15</sup>

These patterns of cyclicity and geography are important to remember because all domestic animal cases are associated with skunk rabies. Thus, patterns of rabies in domestic animals tend to follow those observed in skunks. This is especially true concerning cattle. Cattle are the second most commonly affected species in Iowa and account for 1/2 of all domestic animal cases. Also, as stated previously, 22% of all rabid cattle reported in the US, 1980-1988, were from Iowa. This is partly due to the fact that cattle have extensive opportunity for contact with skunks and are, for the most part, unimmunized<sup>15</sup>. Also, the high number of rabid skunks that occur in Iowa and the relatively high number and density of cattle probably have an effect. Geography and cyclicity patterns follow that of skunk rabies. It is interesting to note that, nationwide, a distinct peak in rabies cases in cattle usually occurs in April/May, about one month following the skunk peak<sup>13</sup>.

Rabies in Iowa cats, while not as prevalent as rabies in Iowa cattle, is also a very important issue, which will be more thoroughly discussed when public health implications of rabies are discussed later. Cases of rabies in cats outnumbered cases in dogs for the first time in 1981, nationwide<sup>8</sup>. In Iowa, however cases in cats have been far more numerous than cases in dogs ever since the canine strains of rabies were eliminated<sup>15</sup>. As in other midwestern states, there is a high population of cats on or around Iowa farms that are not vaccinated for rabies. They are "farm cats" that may be tame, somewhat wild, or totally feral. It may be that the higher density of farms in Iowa manifests itself in a more dense cat population than exists in less populated agricultural states. This, combined with the high number of rabid skunks in Iowa, might explain the high prevalence of rabies in cats in Iowa.

Little is known about skunk-cat interactions and exactly how cats can be approached and bitten by rabid skunks. Clark<sup>17</sup> recently wrote, "Cats and skunks frequently share the same habitat (such as a barn), and do so in a state of peaceful coexistence, whereas any encounter between a dog and a skunk will invariably be antagonistic. After one such encounter (which usually does not include physical contact with the skunk's body) most

dogs will keep a safe distance from skunks, but most cats have not learned avoidance, and therefore are more vulnerable to attack by a rabid skunk.”.

A significant number of rabies cases in Iowa dogs also occurs. These cases, as for cats, are predominately in unvaccinated animals in a rural environment. Rabies is also reported in the other domestic species (horses, sheep & goats, swine) in Iowa more frequently than in other states, with the exception of Texas. Of these, horses probably hold the most significance (to be discussed later).

### **Clinical Signs**

Discussion will be limited mainly to food animals; only brief reference will be made to the other domestic species. In all species, rabies can manifest itself in three phases: The prodromal (altered behavior) phase, the furious (excitation) phase, and/or the paralytic phase<sup>14</sup>. The extent to which these three phases occur is highly variable. If the furious phase is prominent, it is said that the animal has the “furious form” of rabies; if not, the animal is said to have the paralytic or “dumb form” of rabies.<sup>14</sup>

Cattle:<sup>18,19</sup> The incubation period of rabies in cattle is usually 3-4 weeks (1 week to months). The clinical course of the disease can be up to 10 days, which is considerably longer than in most other species. Either the dumb or furious form of rabies may occur. Observed signs of rabies in cattle can be extremely variable; certain signs may be transient, and thus not notices, or absent. Temperature is usually normal, but a fever of up to 105 degrees may be present early in the course of the disease. Cattle are often afflicted with a paresis to flaccid paralysis that often begins in, or occurs only in, the hindquarters (often one leg), along with knuckling at the fetlock. Another sign is extension of the head along with a hoarse or voiceless bellowing. Tenesmus with repeated efforts to urinate or defecate is also commonly seen; this is often accompanied by paralysis of the anus and tail, manifested by tail deviation and flaccidity.

If the furious form of rabies occurs, one will witness what can be described as mania/hysteria/hyperexcitability. This includes a very tense, alert appearance with the ears thrown forward; the eyes are wide open and follow any moving object with a fixed stare.

These cattle may be very aggressive and violent, and may charge upon provocation. One commonly thought of sign, profuse salivation, is seen less than 50% of the time according to one source<sup>18</sup>, and is actually a drooling caused by paralysis of the muscles of deglutition. Other possible signs include bloat, abrupt cessation of lactation, a sexual precocity of bulls manifested by mounting of inanimate objects, and a variety of other neurologic signs.

All cases terminate in a progressive paralysis, with the animal going down and subsequently dying in a few hours up to two days.

When talking about clinical signs of rabies in cattle, it is important to consider signs that do not usually occur with rabies. Eyesight usually remains completely normal until death. Also, gross muscular tremors or convulsions are usually not seen.

There are many differential diagnoses to consider if signs are such that rabies is considered as a possibility. Some of the ones that resemble rabies the most include acute or subacute lead poisoning and pseudorabies. Other conditions that may be high on the ruleout list include hypomagnesemic tetany, nervous ketosis, and hepatic encephalopathy such as that caused by plant pyrrolizidine alkaloid toxicosis. Other common neurologic conditions such as listeriosis, polioencephalomalacia, tetanus, and thromboembolic meningoencephalitis may also have signs in common with rabies. One must use criteria such as age, number sick, and environment as well as clinical signs to narrow down the possibilities and proceed with diagnostic tests and response to therapy from there.

Sheep/Goats:<sup>14,19</sup> Rabid sheep are usually quiet and anorectic and go directly from behavior change to paralysis. Possible signs include pruritus and vigorous wool pulling, salivation, and pica. Less commonly, sheep will exhibit sexual excitement and/or aggressiveness. Goats exhibit aggressiveness and excessive, continuous bleating more frequently than do sheep. Pseudorabies, polioencephalomalacia, and listeriosis would be considered as differentials for these species as well.

Swine:<sup>14,19</sup> As with other species, swine may exhibit the dumb or furious form of rabies, meaning that they may act dull and uncoordinated, or less commonly, hyperexcitable with a tendency to attack. If this is the case, rabid hogs will bite! Possible signs

include twitching of the nose, rapid chewing movements, excessive salivation, avoidance of other hogs with movement to the darkest location in the unit, sexual excitement, and generalized clonic muscle spasms progressing to fine tremors. The disease usually results in terminal paralysis and death within 12 to 48 hours from the onset of clinical signs, but there have been documented cases of recovery from clinical disease in this species.

**Horses:**<sup>14</sup> A specific lameness, if bitten on the leg, or CNS symptoms, if bitten on the muzzle, are often the first signs noted, along with a change of behavior that is usually quite recognizable to the owner. This prodromal phase usually progresses directly to a paralytic phase. Occasionally, though, an excitement phase may occur in which the horse can be extremely destructive through kicking, striking with front legs, and biting.

**Dog/Cat:** Not much will be mentioned about the specific signs in dogs and cats except for one important fact: In Iowa, the furious phase of rabies is much more exaggerated in the cat than it is in the dog;<sup>14</sup> consequently, a greater percentage of rabid cats are described as having the furious form of rabies than are rabid dogs in Iowa. In Iowa, roughly 3/4 or more of rabid cats have the furious form, whereas only about 1/3 or less of the rabid dogs in Iowa have the furious form.<sup>15</sup>

### **Rabies Management**

A comprehensive discussion of animal rabies control is published each year by the National Association of State Public Health Veterinarians, Inc., in the form of the Compendium of Animal Rabies Control.<sup>20</sup> The 1990 Compendium states that "It is neither economically feasible nor justified from a public health standpoint to vaccinate all livestock against rabies. However, consideration should be given to the vaccination of livestock located in areas where wildlife rabies is epizootic, especially animals which are valuable and/or may have frequent contact with humans." This paper has demonstrated that rabies in livestock, particularly cattle, is a significant problem in Iowa. Thus, vaccination of valuable cattle, e.g. registered animals, embryo transfer animals, etc., should be considered in Iowa, especially during peak years of the skunk rabies cycle. Currently there are two vaccines licensed for

cattle (& sheep): Rabguard-TC from Norden, and IMRAB from Pitman-Moore.

These two vaccines are also licensed for horses. RABVAC 3 from Solvay Animal Health, Inc. is the third rabies vaccine licensed for horses. Because of the economic and/or personal value of most horses, along with the amount of human handling most horses receive, horses should definitely be vaccinated for rabies in areas where rabies occurs at all.

A state anti-rabies vaccination law for dogs was put into effect in Iowa; the law today requires dog owners to have their dogs vaccinated against rabies when the dogs reach six months of age.<sup>15</sup> Vaccination of other pets is not required, but vaccination of cats is highly recommended. Rabies occurs primarily in unvaccinated animals, suggesting the animal vaccines are efficacious if handled and administered properly.

The 1990 Compendium also states that livestock bitten by a rabid animal and currently vaccinated with a USDA approved vaccine for that species should be revaccinated immediately and observed for 90 days. Unvaccinated livestock should be slaughtered immediately or kept under very close observation for six months. If the animal is slaughtered within seven days of being bitten, its tissues may be eaten without risk of infection, provided that liberal portions of the exposed area are discarded. Federal meat inspectors will reject for slaughter any animal known to have been exposed within eight months. Neither tissues nor milk from a rabid animal should be used for human consumption, but since pasteurization temperatures will inactivate rabies virus, drinking pasteurized milk or eating cooked meat does not constitute a rabies exposure.

### **Public Health Issues**

Since a relatively large number of cases of rabies in cattle occur in Iowa, one must always handle cattle exhibiting signs compatible with rabies with care. This is especially true when examining the mouth and pharynx of animals suspected of having choke - these animals may in fact be rabid.

Horses should be vaccinated in rabies endemic areas since their husbandry and care often permits access to skunks and once ill, are cared for more intensively than livestock, thus

increasing opportunities for saliva contact and risk of transmission. Rabies is not that common in horses in Iowa, but it does occur with enough frequency here to warrant proper preventive care.

Some of the miscellaneous facts that all veterinarians should know involve bats and wildlife other than skunks. Care should be taken to avoid handling bats, especially those that appear disoriented or are acting strangely (e.g. flopping around on the ground), because bats can certainly transmit rabies to humans. A few cases of rabies occur each year in a host of other wildlife species in Iowa. These species include the red fox, coyote, raccoon, badger, and woodchuck.<sup>15</sup> Rabies in rodents is extremely rare, but it does occur in woodchucks with some frequency because they tend to frequent the same dens that are used by skunks.<sup>14</sup> Opossums are very resistant to rabies.<sup>14</sup>

The most serious rabies threat in Iowa today is the domestic cat. While skunks are the reservoir host of rabies, most serious human exposures result from domestic animal contact, and the majority of these involve the cat. In 1981, 42 of 57 bite exposures from known rabid animals were from rabid cats; figures for this category were 7 or 10 in 1982 and 17 of 27 in 1983.<sup>15</sup> Cats have also been responsible for far more non-bite exposures involving rabid animals, and bite and non-bite exposures involving animals of unknown status, than any other domestic or wild species in the last decade. This is because not as much of the cat population is vaccinated against rabies as is true for dogs, and there are usually quite a few more cases of rabies in cats than in dogs reported in Iowa in any given year. Excluding dogs, cats tend to have more contact with humans than do other animal species. Cats also tend to exhibit the furious form of rabies, which makes them more prone to bite, whereas dogs more commonly exhibit the dumb form of rabies.

The importance of dogs as a public health threat should not be underestimated as dogs do result in a significant number of human rabies exposures in Iowa. However, we already have a dog vaccination law; we just need better compliance. What we really need today is increased emphasis on the vaccination of cats, especially in rural areas. At this point in time, controlling rabies in skunks is technically not

feasible, so vaccination of dogs and especially cats is the weakest link in the chain of exposure to humans.<sup>15</sup> An effort should be made by veterinarians to get rural clients to have dogs and cats on their farms vaccinated against rabies, because virtually all rabid cats and dogs in Iowa are unvaccinated animals from a rural environment.<sup>15</sup>

Human exposure to rabies is not only dangerous, it is expensive. Post exposure prophylaxis today costs up to about \$1000.00. Expense can increase greatly when a rabid pet is handled by several family members before diagnosis.<sup>15</sup> In case of potential rabies exposure, a physician and the Iowa Department of Public Health should be consulted. The Iowa Dept. of Public Health will also lend technical guidance with pre-exposure immunization for high risk personnel, such as veterinarians.<sup>15</sup>

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