

VIRGINIA

EPIDEMIOLOGY BULLETIN

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June 2002

Volume 102, No. 6

Controlling Raccoon Rabies in Virginia with Oral Rabies Vaccine

In August 2002, oral rabies vaccine will be distributed in southwest Virginia in an attempt to stop the westward spread of raccoon rabies. The purpose of this article is to inform health care providers and veterinarians about the project, to describe the bait and how it will be distributed, and to provide information about the potential risk of human and domestic animal exposure.

Background

From colonial times to the mid-1950s, dogs were the most common animal rabies risk in the US. With the advent of effective canine vaccines and the enforcement of animal control laws, rabies in dogs was reduced and human rabies cases were significantly decreased. As domestic animal rabies was controlled, wildlife rabies became more evident (Figure 1). Although



skunks were the predominant species for a long time, raccoon rabies rose to prominence in the late 1970s.

Raccoon rabies was first noticed in Florida in the mid-1950s and spread very gradually into Georgia and Ala-

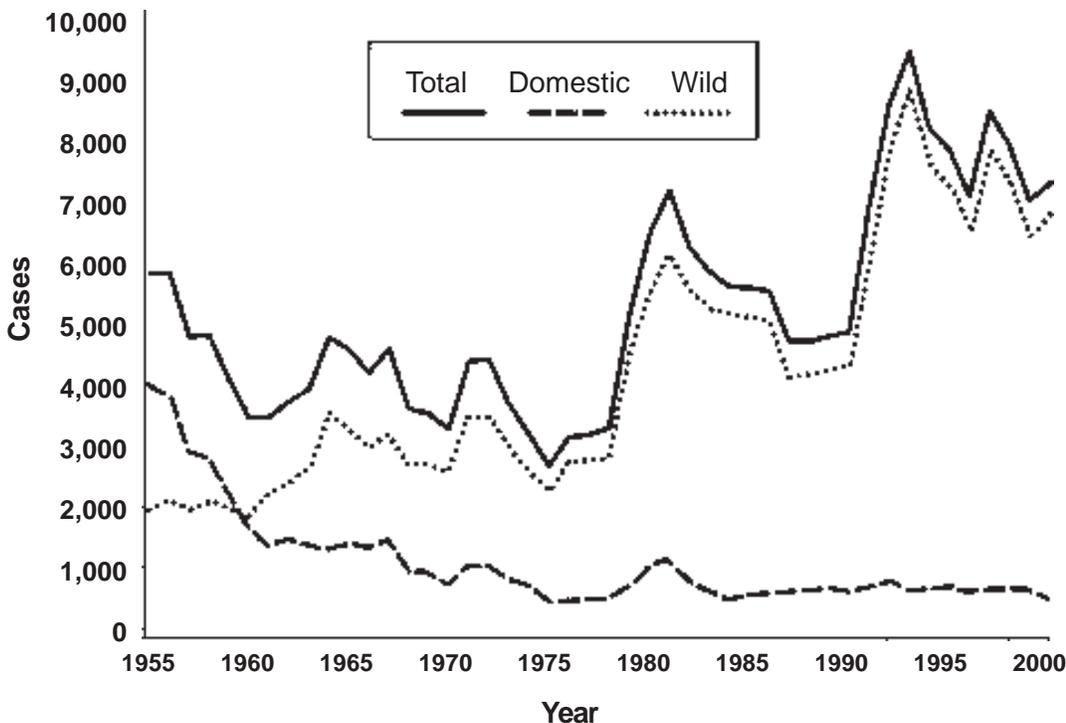
bama. In the late 1970s a separate focus of raccoon rabies was noted on the West Virginia/Virginia border, probably due to the translocation of raccoons from Florida. From that focus there was rapid spread, especially to the northeast, but also south and west until the southern and mid-Atlantic outbreaks merged in North Carolina in 1995. Today, the raccoon rabies area involves the full extent of the US east coast as far west as Alabama, and north into Ontario, Canada.

Virginia is in the unique position of having two endemic rabies virus variants present in terrestrial animals. The raccoon variant is established throughout most of the state (except the far southwest) and is responsible for the majority of animal rabies cases in Virginia. Although raccoons are the most commonly reported rabid animals, spillover to other species occurs, including a va-

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Figure 1. Cases of Animal Rabies, 1955-2000



riety of wild and domestic species. Endemic skunk rabies has been present at a low level in far southwest Virginia as an extension of the north-central skunk area since at least 1969, based on historical evidence and more recently verified by using monoclonal antibodies and genetic sequencing of the rabies viruses (Figure 2).

History of Oral Vaccine for Wildlife

Modified live rabies virus vaccine has been used in baits to orally vaccinate foxes in Europe and Ontario since the 1970s. Maintenance was required at the boundaries of vaccinated areas to stop recurrence. In 1983, a vaccinia virus rabies recombinant vaccine (V-RG) was developed by Wistar Institute, with the patent subsequently transferred to Merial for commercial production. This product has replaced modified live virus rabies vaccine in Western Europe and Ontario where fox rabies has been nearly eliminated.

The first field trial in the US to evaluate the safety of the V-RG vaccine was conducted on Parramore Island off the eastern shore of Virginia in 1990. Following the success of that trial and others in Pennsylvania, efficacy field trials were conducted in the following areas: Cape May, New Jer-

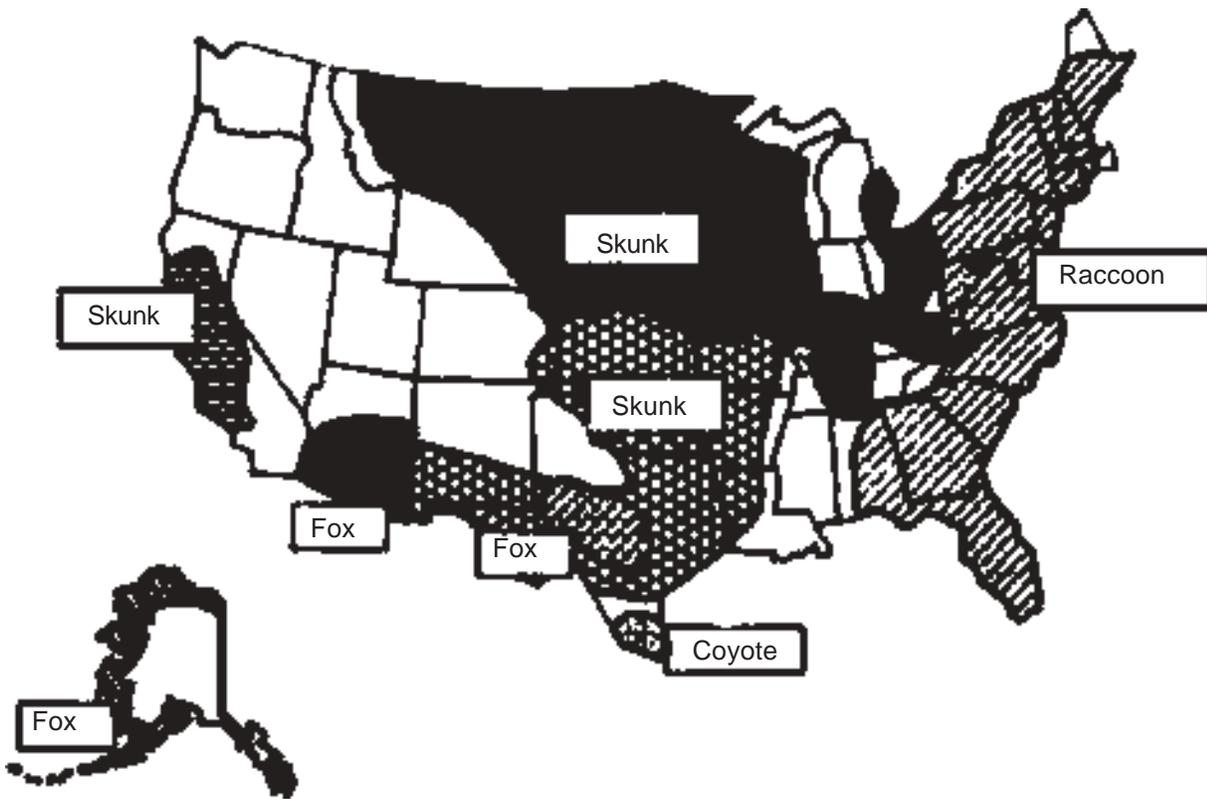
sey; Cape Cod, Massachusetts and the New York capitol region. In 1995, V-RG was conditionally licensed as Raboral V-RG®. That same year experimental programs were initiated in Texas (coyote rabies); Pinellas County, Florida (raccoon rabies); and additional New York counties (raccoon rabies). In 1996, Texas began a field trial for gray fox rabies control and the following year Ohio and Vermont began raccoon rabies control programs. In 1997, the vaccine was fully licensed for raccoons.

Most raccoon rabies control programs have been initiated to create barriers at the edges of endemic areas to prevent further spread, for example into Cape Cod, Massachusetts, or through Ohio. In addition, there have been some attempts to reduce or eliminate raccoon rabies in endemic areas such as around Albany, New York; Pinellas County, Florida; Anne Arundel County, Maryland; and Fairfax County, Virginia (canceled this year when not re-funded by the county). These programs appear to work best if there is some kind of natural barrier to help control the re-entry of rabies. By far, the barrier programs have been the most successful. For example, in 1997, Ohio reported 62 rabid raccoons; last year there was only one.

Vaccine and Bait

Raboral V-RG® vaccine is the only vaccine currently approved for raccoon rabies control by the United States Department of Agriculture (USDA), the agency that licenses biologics for animals. Use in other species is still done under a conditional license, although approval to expand the label for more species may be forthcoming. The vaccine is not effective in skunks and a much larger dose is needed to immunize dogs. Other oral vaccines for wildlife also may be in the production pipeline. Raboral V-RG® is restricted for use by federal or state rabies control programs and is limited to authorized recipients designated by the State Veterinarian. (In Virginia, Dr. William Sims of the Virginia Department of Agriculture and Consumer Services is the State Veterinarian.) The vaccine is not available to private veterinarians or other individuals. In addition, Virginia requires approval by the Interagency Oral Rabies Vaccine Task Force consisting of representatives from the Departments of Health, Agriculture and Consumer Services, and Game and Inland Fisheries, as well as District Health Directors from affected districts. The requirements of the Task Force assure that vaccine will be used in a scientific, safe and effective way and that provi-

Figure 2. Distribution of Major Terrestrial Reservoirs of Rabies in the United States



sions are made for post-baiting evaluations and appropriate public information.

The vaccine is made up of a live vaccinia (a self-replicating pox virus) vector with the rabies gene that is responsible for the production of rabies glycoprotein inserted into the vaccinia virus. The vaccine is contained in a heat-sealed plastic sachet that is then surrounded by a 1.25 square inch bait made of fishmeal, fish oil and a synthetic binder. One hundred milligrams of tetracycline hydrochloride is added as a biomarker. The bait has a toll free number imprinted on it for citizens to call should they or one of their domestic animals inadvertently be exposed to the vaccine.

When a raccoon eats the bait and punctures the sachet, the vaccine is spread around the mouth and enters the system through the pharyngeal tissue. Previous studies have been able to detect virus in only a very few animals. No virus has been detected beyond 24 to 48 hours and there is apparently no viral shedding. Baits usually disappear from the environment within a few days because animals readily consume them. Because only a portion of the rabies virus genetic material is present in the vaccine, there is no possibility of vaccine-induced rabies. Over 23 million doses

of Raboral V-RG® have been distributed in the US since 1990 and no adverse effects from it have been noted in any wild or domestic animals.

Appalachian Ridge Oral Rabies Vaccination Barrier Plans

As part of a nationwide, cooperative effort between the USDA, the Centers for Disease Control and Prevention, and state agencies, vaccine-laden baits will be distributed in Pennsylvania, Ohio, West Virginia, Virginia and Tennessee this year (Figure 3). The primary goals of this project are to prevent the further spread of raccoon rabies in the eastern US and to eventually eliminate this variant of the rabies virus from some or all of its existing range. In recent years, oral vaccine has been distributed along the eastern edge of Ohio, parts of western Pennsylvania, and into West Virginia. The “immune barrier” appears to have halted the westward spread of raccoon rabies in these areas. This year USDA is planning to extend the barrier eastward in Pennsylvania and southward through West Virginia, southwestern Virginia, and into eastern Tennessee (Figure 3). Immune barriers have

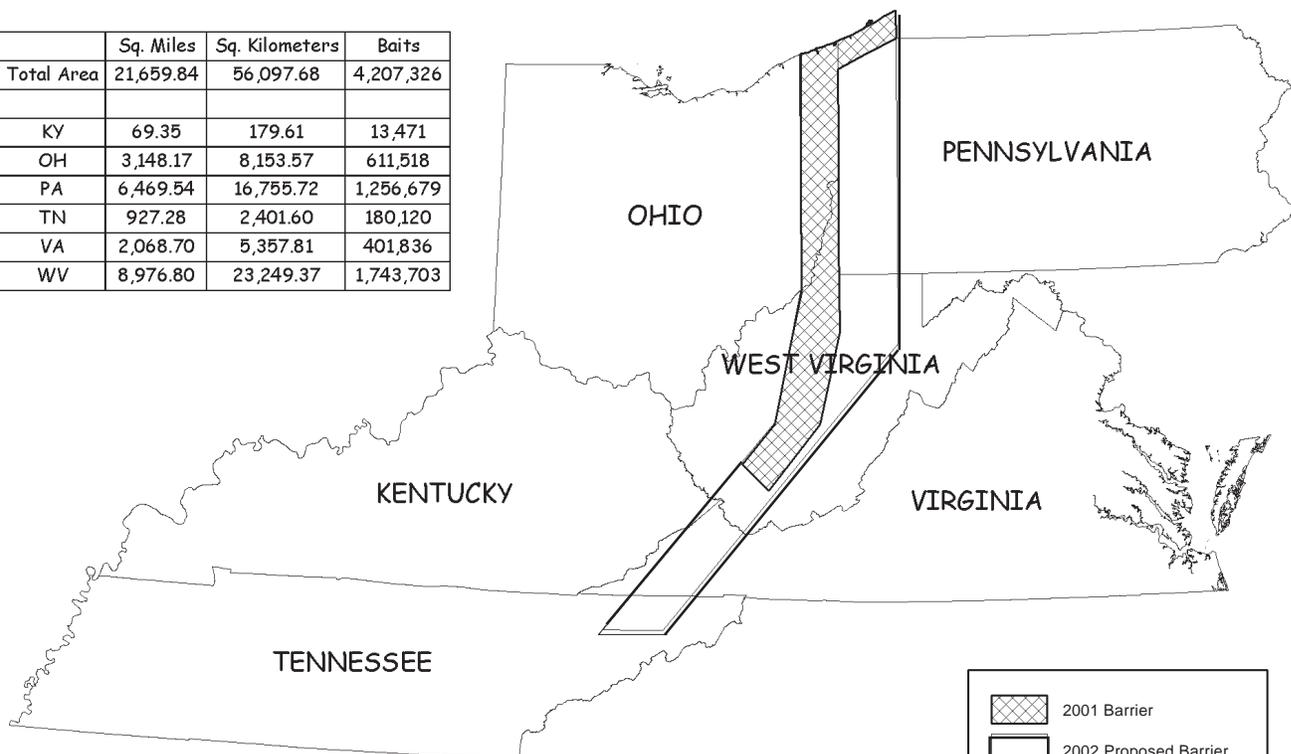
also been established in New York and Vermont.

The baits will be distributed by air, land vehicle, and hand. Baiting for the northern half of the Appalachian Ridge zone will be centered out of an Ohio airport and will start as close to August 5 as weather and logistics allow. The southern half of the zone, including all or part of eight counties and the city of Norton in Virginia (Figure 4), will be baited starting around August 12 out of a West Virginia airport. The entire bait drop operation will require approximately three weeks to complete. The timing of the drop has been planned to be late enough for young raccoons to be moving around and able to consume baits, but early enough to allow sufficient time to conduct eight to ten weeks of post-baiting trapping for surveillance of antibody titers and biomarker presence.

Vaccine-laden baits will be distributed by fixed-wing aircraft at 194 baits/square mile, along flight lines that are spaced about 500 yards apart. Planes will fly approximately 500 feet above ground. In urban or developed areas within the bait zone, baits may be distributed by hand or by vehicle. The estimated area to be covered within southwest Virginia is over 2,000 square

Figure 3. Appalachian Ridge Oral Rabies Vaccination Barrier

	Sq. Miles	Sq. Kilometers	Baits
Total Area	21,659.84	56,097.68	4,207,326
KY	69.35	179.61	13,471
OH	3,148.17	8,153.57	611,518
PA	6,469.54	16,755.72	1,256,679
TN	927.28	2,401.60	180,120
VA	2,068.70	5,357.81	401,836
WV	8,976.80	23,249.37	1,743,703



2001 Barrier
 2002 Proposed Barrier

miles; approximately 400,000 baits will be dropped. Subsequent bait drops are anticipated for the late summer or fall of each year, with the bait zone in Virginia slowly being moved eastward to attempt to eventually eliminate raccoon rabies from Virginia. All future plans are dependent on Congressional funding.

Special Information for Physicians

Although the vaccinia virus contained in Raboral V-RG® is highly attenuated, it does present a remote risk to humans, especially those who are immunocompromised. Contact of the liquid vaccine with skin or mucous membranes is considered an exposure and requires some type of follow up. Persons at highest risk for vaccinia infection are those with a skin disease, especially eczema; immunosuppression due to disease or drug therapy; pregnancy; or a central nervous system disorder.

Last year, a pregnant woman in Ohio with epidermolytic hyperkeratosis was exposed to V-RG vaccine while attempting to take a bait away from her dog.¹ She sustained mild abrasions on her forearm and a puncture wound on a finger. The latter wound bled and was washed thoroughly

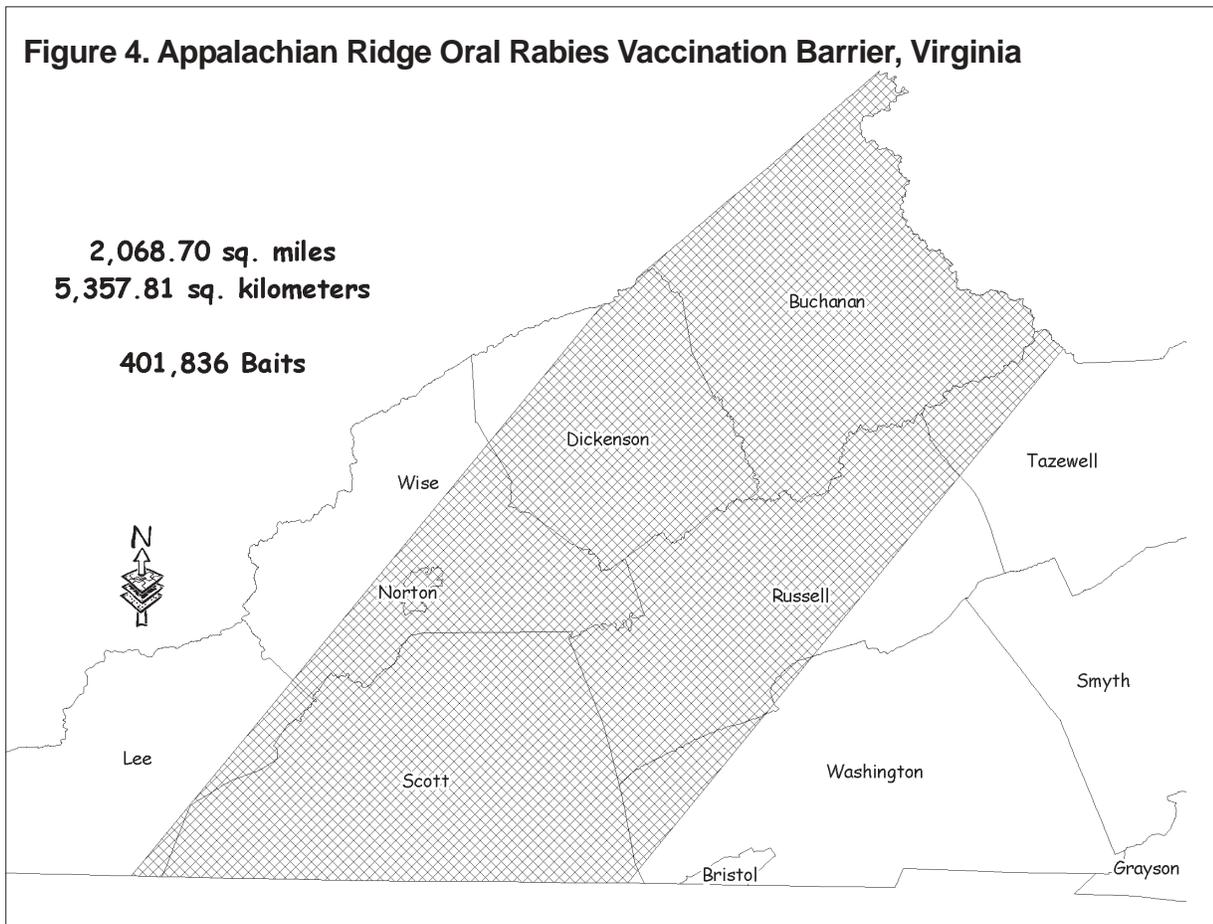
with soap and water. Three days following the encounter she observed two small blisters on her forearm which progressed to nontender, vesicular lesions approximately 1.5 cm in diameter. She was treated with amoxicillin-clavulanate at this time, but presented two days later with progressive pain, erythema, swelling of the forearm, and necrosis of the vesicular areas, which had expanded to 2 cm. She was hospitalized. Three days later the swelling and erythema had worsened. She had left axillary adenopathy and the necrotic lesions were larger. Ten days after the dog bite, incision and drainage of a presumed abscess in the forearm was performed. There was scant pus and no loculations. The following day the arm was improved and she was discharged a day later. She presented to the emergency room the next day with general erythroderma, mild burning sensations, a feeling of tightness in the face, and generalized exfoliation on her face and neck. Five days later, a thick layer of epidermis exfoliated from her palms and soles. Within two weeks the exfoliation had stopped and her wounds were healed. She remained free of symptoms and delivered a healthy child after a normal pregnancy.

Swabs from the affected area and a residual eschar from 30 days post-bite, as well

as samples from the placenta, were cultured and examined by electron microscopy, and polymerase chain reaction (PCR) products were sequenced. For all specimens except the placenta, typical morphologic features of orthopox viruses were observed by electron microscopy and PCR products were positive. Sequences exhibited 100 percent homology with those expected for V-RG virus. Routine virus-neutralization and indirect immunofluorescent assays were positive for antibodies against vaccinia and rabies viruses in serum from the patient and for rabies in serum from umbilical cord blood.

This case emphasizes the importance of educating the public to leave baits alone and, in particular, to avoid attempting to take baits away from animals. If exposure occurs, immediate washing of the site may prevent infection. Any person who has direct contact with a bait that might indicate an exposure to the vaccine should contact the local health department or the toll free number on the bait. Physicians who examine patients with a history of bait contact and compatible symptoms should contact the local health department for advice on appropriate testing and treatment. Vaccinia immune globulin may be useful if administered promptly for the treatment of ec-

Figure 4. Appalachian Ridge Oral Rabies Vaccination Barrier, Virginia



zema vaccinatum and some cases of progressive, ocular, or severe generalized vaccinia. Its effectiveness is questionable if administration is delayed until well after the onset of symptoms.

Special Information for Veterinarians

Although Raboral V-RG® has been extensively tested in over 50 species of animals in both the laboratory and under natural field conditions with no ill effects identified, there is a remote possibility that an immunocompromised animal could develop some illness from vaccinia virus infection. If an immunocompromised animal that is under your care consumes a bait, please contact the Office of Epidemiology at 804-786-6261. Under normal circum-

stances the vaccine is safe and USDA has determined that animals that have eaten baits can still receive their routine rabies vaccinations at any time. The oral vaccine does not contain a high enough dose to adequately immunize dogs. Apparently dogs can consume multiple baits with no ill effects from the fishmeal polymer.

Conclusion

Use of oral rabies vaccine for wildlife is an important adjunct to conventional rabies control programs. In August, over 400,000 V-RG® vaccine laden baits will be distributed by air or hand in all or part of eight southwest Virginia counties and the city of Norton. This program is a cooperative project involving USDA, the Centers for Disease Control and Prevention, the Vir-

ginia Department of Health and other agencies.

Despite the large number of V-RG® baits that have been widely distributed in multiple sites in the US (22 million doses distributed from 1990 to 2000), human contact with the vaccine appears to be rare and only one adverse outcome has been reported. Persons at greatest risk for an adverse reaction are those for whom smallpox vaccine would be contraindicated, such as pregnant women or patients with an exfoliative skin condition. There have been no ill effects reported in domestic or wild animals.

1. Rupprecht CE, Blass L, Smith K, et al. Human infection due to recombinant vaccinia-rabies glycoprotein virus. *NEJM* 2001; 345:582-6. Submitted by Suzanne R. Jenkins, VMD, MPH, Director of Zoonotic Disease Control, Office of Epidemiology.

West Nile Virus Update, Virginia

As this issue of the *Virginia Epidemiology Bulletin* goes to press (July 30), the number of birds and mosquito pools testing positive for West Nile virus (WNV) is increasing on a daily basis. The Virginia Department of Health requests that health care providers maintain a high level of suspicion for this disease in patients presenting with signs and symptoms compatible with viral encephalitis (fever $\geq 38^{\circ}\text{C}$ or 100°F ; altered mental status and/or other evidence of cortical involvement such as focal neurologic findings or seizures; and cerebral spinal fluid pleocytosis with predominant lymphocytes and/or elevated protein and a negative gram stain or culture). Patients hospitalized with clinical evidence of viral encephalitis should be reported immediately to the local health department. The health department will advise on specimen collection and submission. (Please go to the website www.vdh.state.va.us/epi_news/wnvtesting.pdf to obtain a summary of available tests and testing criteria.)

Since the beginning of this year, specimens from 21 persons have been tested for WNV by the state laboratory; none were positive. Thirty-eight other mammals (36 horses, 1 dog, and 1 cow) have been tested and no WNV was detected.

The following summarizes the current level of WNV activity in Virginia. The number of WNV positive birds totals 126 (119 crows, 6 blue jays, and 1 kestrel). Positive birds have been found in the following jurisdictions: Arlington County (10), Alexandria (17), Fairfax County (57), Hanover County (1), Henrico County (2), Norfolk (1), Portsmouth (2), Prince William County (8), and Richmond City (28).

Throughout the state, over 15,000 mosquito pools (approximately 45,000 mosquitoes) have been tested for WNV. The first positive pools were collected on July 10th (one from Richmond City and one from Arlington County). Since then, a total of 52 WNV-positive mosquito pools has been collected. All of the positive pools have been *Culex* species (24 from Arlington

County, 5 from Fairfax, 22 from Richmond City, and 1 from Henrico County). Some of these species are primarily bird-biting mosquitoes that breed in sewers and waste water; however, others bite birds and humans equally.

In addition to the WNV activity detected, mosquito surveillance in Chesapeake City has detected eastern equine encephalitis (EEE) activity in Virginia this year. Three pools of *Culiseta melanura* collected in Chesapeake on July 11th, tested positive for EEE. *C. melanura* is exclusively bird-biting and inhabits hardwood swamps. EEE infected mosquitoes are found fairly frequently in the tidewater area without repercussions in humans or horses.

In an effort to prevent these diseases, physicians should remind their patients, especially the elderly who may be at increased risk for severe illness, of the importance of protecting themselves against mosquito bites.

Submitted by David N. Gaines, PhD, Public Health Entomologist, Office of Epidemiology.

Cases of Selected Notifiable Diseases Reported in Virginia*

Total Cases Reported, May 2002

Regions

**Total Cases Reported Statewide,
January through May**

Disease	State	NW	N	SW	C	E	This Year	Last Year	5 Yr Avg
AIDS	98	3	33	12	8	42	328	407	376
Campylobacteriosis	47	15	9	7	4	12	152	129	159
<i>E. coli</i> O157:H7	3	1	0	2	0	0	9	12	12
Giardiasis	22	4	11	1	2	4	75	146	149
Gonorrhea	849	33	39	139	261	377	4,354	3,714	3,480
Hepatitis A	6	1	1	1	3	0	36	55	72
B, acute	21	2	5	1	9	4	88	54	50
C/NANB, acute	0	0	0	0	0	0	1	0	4
HIV Infection	82	4	30	7	20	21	368	366	342
Lead in Children†	74	3	8	24	26	13	243	222	188
Legionellosis	1	0	0	1	0	0	4	6	7
Lyme Disease	2	1	0	0	1	0	8	27	14
Measles	0	0	0	0	0	0	0	0	1
Meningococcal Infection	2	0	0	0	1	1	18	21	24
Mumps	1	0	1	0	0	0	3	2	4
Pertussis	7	7	0	0	0	0	69	10	13
Rabies in Animals	54	15	10	11	8	10	240	168	229
Rocky Mountain Spotted Fever	0	0	0	0	0	0	1	0	<1
Rubella	0	0	0	0	0	0	0	0	0
Salmonellosis	65	8	15	17	10	15	267	382	291
Shigellosis	40	4	4	1	9	22	361	54	84
Syphilis, Early§	26	0	5	0	5	16	57	118	174
Tuberculosis	41	1	28	3	4	5	105	99	119

Localities Reporting Animal Rabies This Month: Augusta 1 fox, 1 raccoon; Bath 1 bat; Bedford 1 cat, 1 raccoon; Brunswick 1 skunk; Buckingham 1 skunk; Campbell 1 cat; Chesapeake 1 raccoon; Clarke 1 raccoon; Dinwiddie 1 raccoon; Fairfax 2 foxes, 2 raccoons, 2 skunks; Franklin 2 raccoons; Frederick 3 foxes; Galax 1 raccoon; Grayson 1 raccoon; Greene 1 raccoon; Hampton 1 raccoon; Hanover 2 raccoons; Henrico 1 raccoon; Highland 1 raccoon; King George 2 foxes; Loudoun 4 raccoons; Louisa 2 raccoons; Lunenburg 1 raccoon; Mecklenburg 1 skunk; Middlesex 2 raccoons; Newport News 2 raccoons; Norfolk 1 raccoon; Orange 1 raccoon; Pittsylvania 2 raccoons; Russell 1 skunk; Scott 1 skunk; Southampton 1 raccoon; Spotsylvania 1 raccoon; Westmoreland 2 raccoons.

Toxic Substance-related Illnesses: Arsenic Exposure 1; Asbestosis 100; Lead Exposure 6; Pneumoconiosis 9.

*Data for 2001 are provisional. †Elevated blood lead levels $\geq 10\mu\text{g/dL}$.

§Includes primary, secondary, and early latent.

Published monthly by the
VIRGINIA DEPARTMENT OF HEALTH
 Office of Epidemiology
 P.O. Box 2448
 Richmond, Virginia 23218
<http://www.vdh.state.va.us>
 Telephone: (804) 786-6261



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