

Review of the 1997 outbreak of vesicular stomatitis in the western United States

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Vesicular stomatitis (VS) in the United States is caused by 2 serotypes of the virus, VS New Jersey (VS-NJ) or VS Indiana (VS-IN). These viruses are members of the family Rhabdoviridae, genus vesiculovirus. Reviews of the biological, pathogenic, and epidemiologic aspects, as well as clinical signs and outbreak procedures, have been published.^{1,3} Briefly, clinical VS is primarily seen in cattle, swine, and horses in the United States. Serologic evidence of viral exposure has been observed in numerous species including mule deer, elk, pronghorn antelope, coyotes, wood rats, deer mice, and white-tail deer.^{4,5} Clinical signs of VS in livestock include vesicles and ulcers on mucosal surfaces in the oral cavity, on teats, or at the coronary band. Ptyalism, anorexia, and weight loss are sequelae of the oral lesions. Lameness and, rarely, sloughing of the hoof are sequelae of coronary band lesions.

Outbreaks of VS in the southwestern United States historically have been sporadic. Four outbreaks have been documented in the United States since 1980, affecting approximately 1,200 premises.^{3,6} The 1982 outbreak started in Camp Verde, Ariz. That outbreak resulted in investigation of 1,324 premises, 627 (48%) of which were confirmed by the USDA-Animal and Plant Health Inspection Service (APHIS)-Veterinary Services as housing animals positive for VS-NJ. Those premises were located in 14 states, including Arizona, California, Colorado, Idaho, Kansas, Missouri, Montana, Nebraska, New Mexico, Oregon, South Dakota, Utah, Washington, and Wyoming.⁷ Another outbreak of VS-NJ was documented in 1985; it was confirmed that 256 premises housed VS-positive animals in Arizona, Colorado, and New Mexico.⁶ In 1995, there were 1,162 premises investigated for VS, and 367 (32%) premises were confirmed that housed animals positive for VS-NJ in Arizona, Colorado, New Mexico,

Texas, and Utah.³ In addition to those outbreaks, Ossabaw Island, Georgia has been established as an endemic area of VS-NJ in the United States.⁹

Before 1997, VS-IN had not been isolated from livestock since an outbreak in 1965-1966. The 1965 outbreak of VS included 25 positive premises that had animals with VS-IN in San Juan County, NM and 26 positive premises in Taos, NM.¹⁰ In addition, 48 premises in Colorado were identified that housed animals positive for VS-IN in Montezuma County and 25 in La Plata County. During the 1966 outbreak, VS-IN and VS-NJ again were isolated from animals in New Mexico and Colorado. The VS-IN serotype is endemic in areas of Mexico, Central America, and South America.

1997 Outbreak

The USDA-APHIS-Veterinary Services definition of the index case for the United States during the 1997 outbreak was detection of clinical signs in the affected animal consistent with VS accompanied by virus isolation or a fourfold increase in titer (complement fixation [CF] or serum neutralization [SN] test) in paired sera collected 7 days apart. The definition for subsequent cases was the detection of clinical signs and a positive result for a competitive ELISA (cELISA), clinical signs and a positive result for detection of antibodies by a CF test, or clinical signs and a fourfold increase in titers (CF or SN test) in paired sera obtained 7 days apart. Premises with livestock suspected to have VS and reported by private practitioners were visited by USDA-APHIS-Veterinary Services veterinarians. Examination of animals with clinical signs and collection of blood samples for serum harvest and swab specimens of lesions were conducted. In addition to examinations and sample collection, epidemiologic information was collected, using standardized questionnaires. All testing of biological samples was performed at USDA National Veterinary Services Laboratories (Ames, Iowa for nonruminant species; Plum Island, NY for ruminant species).

The index case for the 1997 outbreak in the United States was investigated on May 27 in Yavapai County, Ariz after suspicious vesicular lesions were reported by a private practitioner. One of 9 horses on this farm had clinical signs of VS and was confirmed to be infected with VS-NJ (fourfold increase in titer on the CF test).

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Epidemiologic investigation of this premises indicated that none of the animals had left the farm and returned in the 30 days prior to diagnosis, and new animals had not been introduced on the farm in the 30 days prior to diagnosis. The premises was located 2.5 miles from the closest source of running water and > 5 miles from a source of standing water. To the knowledge of the owner, VS had not been diagnosed on the premises before 1997.

During the 1997 outbreak, 689 investigations for VS were conducted in 40 states. There were 380 (55%) premises identified as housing animals positive for VS in 4 states (Arizona, Colorado, New Mexico, and Utah; Table 1). As has been observed during outbreaks of VS in the southwestern United States,⁷ there was a northward progression of the disease over time (Fig 1). Similar to the 1995 outbreak, there were clusters of

Table 1—Summary of vesicular stomatitis (VS) investigations and number of premises with VS-positive animals in states reporting cases during the 1997 outbreak

State	No. of investigations	No. of premises with positive animals	%
Arizona	27	2	7
Colorado	372	273	73
New Mexico	104	67	64
Utah	53	38	71
Total	556	380	68

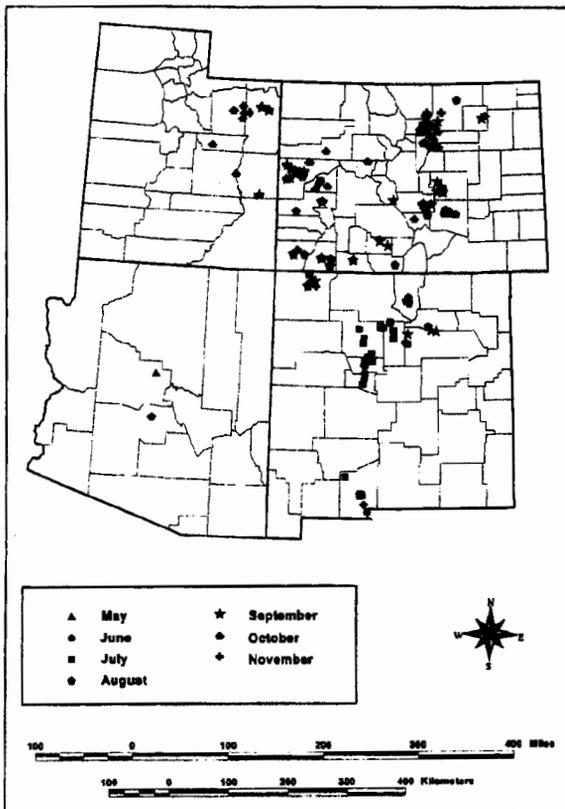


Figure 1—Geographic distribution and temporal spread of vesicular stomatitis (VS) in Arizona, New Mexico, Colorado, and Utah during the 1997 outbreak. Each symbol represents a specific premises containing animals positive for VS.

cases in the areas of Albuquerque, NM and Grand Junction, Colo. However, unlike the 1995 outbreak, a large number of cases were identified in counties in Colorado east of the Continental Divide, extending from Pueblo, Colo to as far east as Brush, Colo.

A curve of the 1997 outbreak was generated (Fig 2). The epidemic peaked between Sep 22 and Oct 19. A majority (57/88; 65%) of the cases during this time were in Mesa County, Colo.

Nationwide, horses comprised 704 of 802 (88%) examinations conducted for VS, and 362 of 374 (97%) positive premises on which species of infected animal were identified had horses positive for VS. Cattle comprised 78 of 802 (10%) examinations conducted, and 12 of 374 (3%) positive premises on which species were identified had cattle positive for VS. There were 6 positive premises that did not include identification of the primary species in which VS was confirmed. None of the premises had both positive cattle and horses. The remaining 20 of 802 (2%) examinations were conducted in sheep, goats, swine, llamas, elk, and a dog. None of these species were positive for VS. Although these viruses are zoonotic, there were not any confirmed reports of human infections.

There were 311 swab specimens or tissue samples submitted for virus isolation. Vero cell cultures were stained with fluorescent antibody conjugates for detection of VS-NJ or VS-IN. Virus was isolated from 55 (18%) samples. Virus was isolated from 55 of 241 (23%) samples submitted from the 4 states in which positive animals were identified. Overall, 13 of 55 (24%) virus isolates were VS-NJ and 42 (76%) were VS-IN.

In 1997, VS-IN was initially isolated from a horse in Dona Ana County, NM. All viruses isolated from New Mexico (n = 8), Utah (5), and Arizona (1) were VS-IN and were isolated from affected horses. In Colorado, 13 isolates were VS-NJ and 28 were VS-IN. There were 3 isolates from affected cattle in Colorado, and all were VS-NJ. Clinical signs of affected animals did not differ between the 2 serotypes. In many cases, serologic testing detected antibodies to VS-NJ and VS-

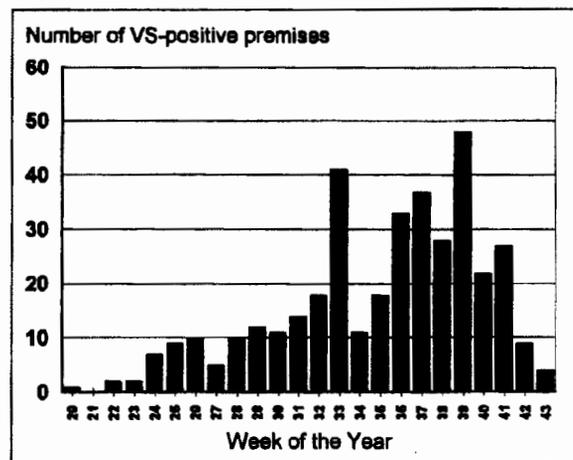


Figure 2—Number of VS-positive premises during the 1997 outbreak, analyzed by time of year (week). The index case for the outbreak was identified on week 20, and the outbreak peaked between weeks 39 and 40.

IN, using the cELISA and CF tests, in a single animal. Of the 42 VS-IN isolates, 14 came from animals that had positive titers (> 1:5 on CF test) for both serotypes. Of the 13 VS-NJ isolates, 1 came from an animal that had positive titers for VS-NJ and VS-IN. There were 290 animals tested on the 67 positive premises in New Mexico, and 150 (52%) were positive on the basis of the cELISA for VS-IN and VS-NJ. There were not distinct differences in the geographic distribution for the 2 serotypes. Cross-type serologic reactions were also reported for the 1965-1966 outbreak.¹⁰

Discussion

The curve of the 1997 VS outbreak suggests a propagating epidemic and looks similar to a curve generated for the 1995 outbreak.³ The number of positive premises peaked during week 39 and then rapidly declined. This may have been associated with the onset of cold weather, which inhibits potential transmission by biting insects, or to a decline in the number of susceptible animals in the areas of the outbreak.

Number of cattle at risk in outbreak areas was much greater than the number of horses. For example, in the 25 Colorado counties with VS-positive premises, the average cow-to-horse ratio in the county was 30.1:1 (range 2.4:1 to 242.1:1).¹¹ The observation that a majority of the investigations as well as the proportion of positive premises identified horses as the primary animals in 1997 suggests that the viruses causing VS in the southwestern United States have a predilection for this species. During the 1995 outbreak, 825 of 1,162 (71%) investigations and 286 of 367 (78%) positive premises had horses as the primary animal affected.³ Cattle comprised 279 of 1,162 (24%) investigations and 81 of 367 (22%) positive premises during the 1995 outbreak. Laboratory challenge-exposure of cattle and horses to investigate a potential viral predilection for horses has not been conducted for the viruses isolated in the southwestern United States during 1995 or 1997.

The fact that horses were overrepresented may also have been attributed to more frequent observation or reporting bias. During the month most commonly associated with a VS outbreak, cattle are typically pastured in areas that do not afford close daily observation. This may allow clinical signs in potentially infected cattle to remain undetected. Horses more typically are observed daily in confined housing, decreasing the potential for clinically affected horses to remain undetected. In addition, the economic impact for quarantine of premises containing cattle is perceived to be greater than that for premises containing horses. This may result in nonreporting of clinical cases of VS in cattle because of concerns about losing marketability of cattle during quarantines.

The rather distinct geographic distribution of VS-positive premises in the 1995 and 1997 outbreaks and in other documented outbreaks suggests that environmental or ecologic factors may be associated with development of VS on positive premises.^{3,6,7} A case-control study conducted during the 1997 outbreak assessed the association of some ecologic factors and whether a premises had VS-positive animals.¹² The idea

that ecologic factors may affect the likelihood of VS virus infection in livestock has been investigated in a VS-endemic region. The evolutionary pattern of VS-NJ has suggested that the virus adapts to ecologic factors exerting pressure on the virus.¹³ It was concluded that differences in VS virus genetics represented adaptation to vectors or reservoirs in specific ecologic zones, facilitating exposure of livestock to the virus. Although such specific studies have not been completed in the southwestern United States, the observation that VS has developed in livestock in the same areas during different outbreaks suggests the virus has adapted to these specific geographic locations. Although VS-positive animals were not detected in Colorado east of the Continental Divide during the 1995 outbreak, they were observed east of the Continental Divide in outbreaks during the 1980s, indicating that areas east of the Continental Divide provide adequate ecologic factors necessary for virus transmission and infection. Clustering of VS-positive premises was evident during the 1997 outbreak. However, similar to other outbreaks, a majority of positive premises identified during this outbreak were not contiguous with other positive premises.

Controlled laboratory experiments have indicated that animals with clinical signs of VS after infection with a single serotype of VS mount serotype-specific responses detectable with CF, SN, IgM-capture ELISA, and cELISA testing.¹⁴ Serologic monitoring of VS in 3 dairies in Costa Rica also did not reveal cross-reactivity between animals infected with VS-NJ and VS-IN.¹⁵ During the outbreak reported here, a number of sera results were positive for VS-NJ and VS-IN, using the cELISA and CF tests. The cELISA primarily measures antibodies in the IgG class. Similarly, the SN test primarily measures IgG. In other reports,^{16,17} serum antibody titers (SN test) were detectable 36 and 52 months after exposure to VS viruses. The CF test mainly measures antibodies in the IgM class and provides the best serologic indication of recent exposure to virus. In 1997, samples from some animals with confirmed VS-IN and VS-NJ virus isolation were serologically positive to both serotypes when tested by the CF test. This may be an indication of an overabundance of the IgM antibodies of one serotype overwhelming the heterologous serotype antibodies so that results of the CF test are considered positive. It would not be surprising to find animals serologically positive to VS-NJ and VS-IN by the cELISA, because the IgG class of antibody primarily measured in this assay is retained for long periods, and animals may have been exposed to 1 serotype during a previous outbreak and the heterologous serotype during a subsequent outbreak.

The potential for simultaneous infection with VS-NJ and VS-IN must not be overlooked. During the 1997 outbreak, VS-NJ and VS-IN were each isolated from specific animals in Delta, Fremont, Montezuma, and Weld counties in Colorado. In all other counties with positive animals, virus isolation yielded only 1 viral serotype. None of the individual premises had animals from which both serotypes were isolated. Circulation of VS-NJ and VS-IN potentially exposes animals to both viruses with a subsequent immune

response to each. Clinical disease may result from either serotype. Dual infection or circulation of both isolates in an area suggests that the necessary ecologic conditions, including potential vectors and reservoirs, required by each of the 2 serotypes are present or are shared in certain outbreak locations. This may be important if control points or strategies are found to vary between the 2 serotypes.

During the 1995 outbreak, VS-positive premises were quarantined and a quarantine circle (10 miles in diameter) was placed around the premises. Within a quarantine circle, prohibited activities included movement of animals, shipment of livestock to other states, and congregating livestock (eg, livestock markets, rodeos, fairs). Premises positive for VS were quarantined during the 1997 outbreak, but quarantine circles were not implemented. Epidemiologic investigation of positive premises in 1995 and 1997 rarely supported direct movement of animals to the positive premises as a source of infection. The potential exists for virus-shedding animals to be brought to adjacent premises, with subsequent spread of the disease to positive premises. This may explain the large number of positive premises identified east of the Continental Divide. However, as mentioned, outbreaks prior to 1995 also had positive premises identified east of the Continental Divide. It is unlikely that animal movements are solely responsible for the difference in geographic distribution between the 1995 and 1997 outbreaks. A 1995 survey of the interstate movement of livestock as a method of spread of VS did not find a correlation between the number of horses or dairy cattle imported from an infected state, or their proportion relative to other states, and the number of VS-positive premises in the importing state.¹⁸

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