

## Review of the 1995 vesicular stomatitis outbreak in the western United States

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In spring 1995, an outbreak of vesicular stomatitis (VS) in the western United States was reported. Vesicular stomatitis virus serotype New Jersey was identified as the causative agent. The most recent previous outbreak of VS in the United States was in 1985. Effects of this disease on specific animals were typically mild, but institution of control and prevention procedures as well as identification of this disease often had substantial effects on local livestock commerce and international trade. The purpose of this report was to provide a review of the 1995 outbreak.

### The Disease

The causative agent of VS is a virus in the family Rhabdoviridae. Two serotypes (New Jersey and Indiana) have been identified in the United States. Vesicular stomatitis primarily affects horses and cattle, but other susceptible animals include swine, sheep, goats, camelids, human beings, and wildlife.<sup>1-3</sup> From 1 to 100% of the animals on a premises may have clinical signs of VS,<sup>6-8</sup> but mortality attributable to VS is usually low.

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Clinically, VS initially causes a fever of short duration that is often inapparent.<sup>9,10</sup> The virus targets the germinative layer of the epithelium, resulting in formation of vesicles that rupture, developing into ulcers.<sup>11,12</sup> Typically, vesicles and ulcers are evident in the oral cavity, on teats, or at the coronary band. Salivation, anorexia, and weight loss are secondary to oral lesions. Lameness, secondary to lesions on the coronary band, is typically mild but can be quite severe in horses. Lesions on the coronary band in horses have

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even led to sloughing of the hoof.<sup>11</sup> In dairy cattle, decreases in milk production and mastitis can result, and lesions are seen on teats of approximately a fourth of infected dairy cattle.<sup>13</sup> Vesicular stomatitis in human beings usually causes an influenza-like illness with rare development of vesicular lesions.<sup>14</sup>

Other diseases or conditions in horses that look clinically similar to VS include oral lesions that result from trauma or photosensitization. For cattle and other cloven-hoofed animals, differential diagnoses include vesicular diseases such as foot-and-mouth disease and swine vesicular disease. Diagnosis of a specific vesicular disease requires laboratory confirmation, because these diseases cannot be differentiated on the basis of clinical signs. Laboratory tests for VS include virus isolation and various serologic tests. Serum neutralization and complement-fixation tests are considered standard serologic tests for detection of exposure to the VS virus. Titers can persist for years, especially those detected by use of the serum neutralization test.<sup>6,7,12</sup>

Treatment in livestock is palliative for secondary infections and lesions. Vesicular stomatitis is a self-limiting disease lasting 1 to 5 weeks; however, clinical signs may recur a few weeks after resolution of original lesions.<sup>15</sup>

The mode of transmission of VS virus is not completely understood. Direct contact and insect vectors appear to play important roles in transmission. However, it has been suggested that VS results from a set of complex host, agent, vector, and environmental interactions. The virus can spread directly via aerosols and vesicular fluids.<sup>3</sup> Although the virus cannot penetrate intact skin, it can enter the body via wounds and mucous membranes.<sup>3,12</sup> The virus is rapidly inactivated by common disinfectants and sunlight.

The epidemiology of VS, including pattern of spread, seasonal distribution, and clustering of cases along rivers and irrigated areas, supports the insect vector theory.<sup>4,16</sup> The VS virus has been isolated from various insect genera in previous outbreaks, which also supports the insect vector theory. Growth and replication of the VS virus in black flies (*Simulium vittatum*) indicates the possibility of biological transmission.<sup>17</sup> The virus has also been iso-

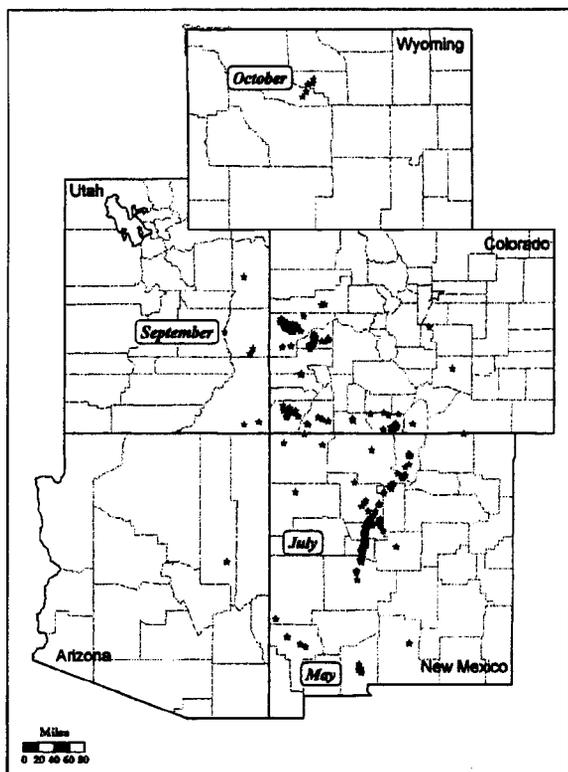


Figure 1—Geographic distribution and temporal spread of vesicular stomatitis (VS) during the 1995 outbreak. ★ = premises with VS-positive animals (1 in Texas is not shown).

lated from several other insects including *Culicoides* sp, house flies, and eye gnats. The low virus titers found in these insects indicate that they have a role as mechanical, but not biological, vectors.<sup>4,7,16,18</sup>

### History

Vesicular stomatitis is endemic in Mexico, Central America, and parts of South America. It is also endemic on Ossabaw Island, which is off the coast of Georgia. The VS New Jersey serotype was originally isolated in 1926. Since then, there have been reported outbreaks in the United States in 1916, 1926, 1944, 1949, 1957, 1959, 1963, 1982/1983, and 1985.<sup>14</sup> Sporadically, VS has been confirmed in a few isolated animals in other years. Outbreaks in the western United States typically develop in spring or summer and continue until early winter.

The 1982/1983 outbreak was 1 of the largest recorded VS outbreaks in the United States, involving 673 herds.<sup>19</sup> Overall, animals in 14 states were affected (Arizona, California, Colorado, Idaho, Kansas, Missouri, Montana, Nebraska, New Mexico, Oregon, South Dakota, Utah, Washington, and Wyoming). Six of these states were involved as a result of interstate movement of infected animals. The 1982/1983 outbreak was unusual in that it continued through winter into the subsequent spring. In the 1985 outbreak, 214 premises were reported as having VS-positive animals.

Table 1—Summary of vesicular stomatitis (VS) investigations and positive premises in states reporting cases during the 1995 outbreak

State	No. of investigations	No. of premises with positive animals	%
New Mexico	333	186	56
Colorado	327	165	50
Wyoming	26	8	31
Utah	55	6	11
Texas	119	1	1
Arizona	30	1	3
Total	890	367	41

### The 1995 Outbreak

The first case of VS reported in the United States in 1995 was confirmed on May 9, 1995 in Las Cruces, NM. A case during this outbreak was defined as an animal with positive results on virus isolation or positive results on a serologic test in combination with clinical signs consistent with VS. As in previous VS outbreaks, the disease progressed in a northerly direction (Fig 1). A large cluster of cases was detected near the Rio Grande river valley in and around Albuquerque. Overall, 140 investigations were conducted in the 2 counties surrounding this valley, with 103 (74%) premises having VS-positive animals. A similar cluster of cases was detected near Grand Junction, Colo. In the county containing Grand Junction, 103 premises were investigated, and 83 (81%) were determined to have VS-positive animals. The final northerly movement of VS was in October, with VS-positive animals detected in Worland and Thermopolis, Wyo on October 2 and 10, respectively. A final cluster of cases was detected in late October in the San Luis Valley of Colorado. Overall, 27 investigations were conducted in 2 counties in this valley, with 20 (74%) premises having VS-positive animals.

Overall, 1,162 investigations were conducted for vesicular diseases in 42 states during the 1995 outbreak. Vesicular stomatitis was confirmed in animals in only 6 states (Table 1).

Horses and other equidae comprised 825 of 1,162 (71%) investigations and 286 of 367 (78%) premises with VS-positive animals. Cattle comprised 279 of 1,162 (24%) investigations and 81 of 367 (22%) premises with VS-positive animals. The remaining 58 (5%) investigations were primarily of sheep and goats, but none were VS positive. One VS-positive llama was identified during this outbreak.

A curve of the 1995 outbreak was generated (Fig 2). The curve appears trimodal because of clusters of cases in Albuquerque (weeks 25 to 28), Grand Junction (weeks 36 to 38), and the San Luis Valley (weeks 42 to 44). Albuquerque and Grand Junction were similar in that both had a large number of premises that consisted of only a few acres that, typically, would support 1 or 2 horses or other species of livestock. These premises historically have been encompassed in green zones bordered by irrigation canals or other water sources. Taken as a whole, these premises constituted a concentrated area of livestock use and production. Such concentration sim-

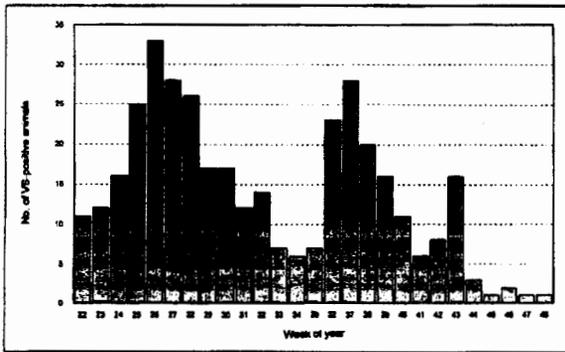


Figure 2—Number of VS-positive animals during the 1995 outbreak, analyzed by time of year (week).

plifies transmission of the VS virus via direct contact or vector transmission, resulting in clustering of the disease. The cluster of cases in the San Luis Valley was attributable to infection of animals whose owners were members of a grazing association. Twenty of 22 members of this association ultimately had VS-positive cattle.

### USDA Response

Veterinarians at the USDA-Animal and Plant Health Inspection Service (APHIS) play an active role in keeping VS from becoming established in the United States. Of primary importance is differentiating VS from foot-and-mouth disease, which was eradicated from the United States in 1929. Clinically, vesicular diseases look identical; thus, laboratory tests are required to differentiate them. In addition, the USDA has an obligation to report confirmed cases of VS to the international agricultural community.

In response to the initial cases in New Mexico, the USDA-APHIS established the livestock disease investigation unit. This unit was operational by June 1, 1995 and was responsible for coordinating, conducting, and reporting all investigations for VS in the western United States. All investigations were conducted by USDA-APHIS veterinarians specifically trained in the diagnosis of foreign animal diseases. These foreign animal disease diagnosticians were responsible for clinical observation, collection of diagnostic samples, collection of history for animals and premises, and entry of this information into a computerized database. In early July 1995, a livestock disease reporting unit was established in Denver, with the assignment of generating daily summary reports and maps, coordinating efforts of USDA-APHIS veterinarians, conducting media relations, analyzing data, and disseminating information. Information was distributed through weekly printed updates, the USDA-APHIS home page on the World Wide Web (<http://www.aphis.usda.gov>), and weekly conference calls with USDA-APHIS personnel, state veterinarians, and representatives from livestock industries.

### Laboratory Diagnosis

Blood, epithelial tissue, and swab specimens were collected and forwarded to the National Veterinary Ser-

vices Laboratory (NVSL) for testing for VS virus. Serum samples were tested by means of the microtiter virus neutralization or complement-fixation test, according to standard laboratory protocols. Epithelial tissue and swab specimens for virus isolation were transported in Tris-buffered tryptose broth, treated with 3% penicillin-streptomycin, and inoculated onto Vero cell cultures. After 18 to 24 hours, cell cultures were stained with anti-VS virus fluorescent antibody conjugate. If fluorescence was not observed, cultures were incubated for an additional 6 days and reexamined. Because of the potential that vesicular lesions were caused by other foreign animal diseases, specimens from swine and ruminants were tested for VS virus and other vesicular diseases at the NVSL Foreign Animal Disease Diagnostic Laboratory in Plum Island, NY. Specimens from other species were sent to the NVSL Diagnostic Virology Laboratory in Ames, Iowa and were tested for VS virus only.

### Vaccine

In response to the outbreak, an autogenous, killed VS vaccine was approved by the USDA for restricted use in cattle and equidae.<sup>a</sup> Use of vaccine was limited to states that had confirmed cases of VS and states considered to be at high risk of having cases of VS. The greatest demand for vaccine came from the dairy industry. During the 1982/1983 outbreak, some dairies had substantial economic losses. It is required that autogenous vaccines be tested for safety and purity but not for efficacy. Limited research conducted on vaccine use in dairy cattle during the 1995 outbreak indicated that it was immunogenic, but the amount of protection afforded by its use could not be determined. Adverse reactions were not reported for animals vaccinated during the 1995 outbreak.

### Restrictions on Animal Movement

Control measures to minimize the spread of VS during the 1995 outbreak involved restrictions on animal movement. If a premises had a VS-positive animal on it, the premises was quarantined, and animals could not be moved off the premises until the quarantine was lifted, which was 30 days after all VS-related lesions had healed. Unfortunately for many industries involving livestock, the time of year VS outbreaks typically occur is during fair and rodeo season, which is also the time of year that a large number of cattle are sold through livestock markets. Consequently, VS outbreaks tend to be during the time of year when the amount of animal movement and grouping is high, with prime opportunity for disease transmission, and when movement restrictions impact the greatest number of people.

Other means of movement restriction used in the 1995 outbreak were restricted circles and a restricted zone. A restricted circle was an area 10 miles in radius with a quarantined premises as the center. The restricted zone was an area in New Mexico that was established on June 27, 1995 because of the large number of infected premises in close proximity to each other. The restricted zone had a northern boundary at Bernalillo, NM, a south-

ern boundary at San Antonio, NM, and extended 10 miles on both sides of the Rio Grande. Within a restricted circle or restricted zone, prohibited activities included movement of animals, shipment of livestock to other states, and congregating animals (eg, livestock markets, rodeos, fairs). On July 26, 1995, the restricted zone was abolished because of the decreasing number of infected premises within it. At that same time, the state of New Mexico relaxed restrictions by allowing congregation of animals and movement of animals within restricted circles. In addition, animals were permitted to be moved out of a restricted circle but were required to stay within the state.

Most states implemented temporary restrictions regarding importation of livestock from states in which VS was diagnosed. The basic and most common requirement was a statement on the health certificate, signed by an accredited veterinarian, that was similar to the following:

Vesicular stomatitis has not been diagnosed within 10 miles of the premises of origin of these animals within the past 30 days. I have examined the animals indicated and have not found signs of vesicular stomatitis.

Other restrictions implemented by states included requiring permits for entry, establishing a quarantine period after entry, requiring negative results on VS tests, totally banning entry of livestock from states containing animals infected with VS, and prohibiting movement of animals vaccinated for VS.

### International Impacts

Vesicular stomatitis is an Office of International Epizootics list-A disease. List-A diseases are communicable diseases that have the potential to spread rapidly, be of serious socioeconomic or public health consequence, and are of major importance in the international trade of livestock or livestock products. List-A diseases include foot-and-mouth disease, African horse sickness, and hog cholera.

Because VS is a list-A disease, the USDA has certain obligations for reporting outbreaks to the international veterinary community. Another consequence of VS being a list-A disease was the institution of international trade restrictions on US products in response to the outbreak (Appendix).

Economic impacts of trade restrictions during the 1995 outbreak were attributable to meat embargoes and increased costs for testing. The greatest losses, an estimated \$480,000, were to the beef and pork industries. Through September 1995, additional testing costs to the horse industry were estimated at \$28,000; however, because of the seasonality of movements of equidae to the European Union and United Arab Emirates and because of additional testing requirements instituted by Japan in November 1995, this number was expected to more than double by the end of 1995.<sup>b</sup>

### Other Economic Impacts

Production losses are another source of economic impact during an outbreak of VS. After the 1995 out-

break, the economic impact of VS in New Mexico was assessed. Of the 2 dairies in New Mexico reported to have VS-positive cattle, only 1 had lactating cows that were affected. This dairy had 25 affected cows, resulting in an estimated loss of \$787/case. Increased culling was the major reported source of economic loss.<sup>c</sup> At \$53/case, beef cattle owners spent much less than horse or dairy cattle owners. Most of the cost to beef cattle owners was attributable to costs for increased labor.<sup>c</sup>

Mean cost reported by horse owners in New Mexico was \$382/case. Owners of  $\geq 5$  horses spent less (\$116/case) than owners of  $\leq 4$  horses (\$515/case). The high cost for owners with  $\leq 4$  horses was primarily attributable to the reported value (\$4,000) of 2 horses that were euthanatized. Owners of affected horses also reported spending substantial time and expense caring for their horses (labor, \$2,720; veterinary fees and medicine, \$1,992). Excluding the 2 horses that were euthanatized from analysis, the cost for owners with  $\leq 4$  horses was \$117/case.<sup>c</sup>

A third area of economic impact came from the cancellation of many animal events in response to the VS outbreak. Cancellation of fairs and rodeos resulted in loss of revenue for organizers and sponsors of events, participants in events (loss of prize money), and members of ancillary businesses associated with these events, such as lodging and restaurant owners and retailers of souvenir items. The value of these losses was unknown; however, estimates for New Mexico ranged from \$32,000 to  $> \$1,800,000$ /event, with a total estimated loss of \$14,366,000.<sup>d</sup>

### Research

Research efforts to provide information about the source and transmission of epizootic VS virus have been initiated by numerous agencies and institutions. These initiatives include epidemiologic and experimental studies. A field epidemiology evaluation team was established by the USDA to promote and coordinate research efforts. Epidemiologic studies will include case-control studies designed to identify factors associated with higher or lower prevalences of VS on specific premises and in various geographic locations. Active surveillance studies will use samples derived from the market cattle identification program and from equine infectious anemia testing of horses to obtain baseline data about the prevalence of VS in various geographic locations. Long-range surveillance in these species may allow for predictions of future VS outbreaks. Seroprevalence studies in wildlife species will attempt to determine their role as reservoirs or spillover hosts in epidemiologic and ecologic contexts of the disease. Spatial analysis will be used to examine geographic and environmental factors associated with VS outbreaks.

Researchers currently are investigating the role of arthropods in the transmission of VS virus to ruminants. These investigations will specifically attempt to establish whether insects can transmit VS virus to ruminants, resulting in clinical disease. Genetic mapping of viruses isolated from the 1995 outbreak will be com-

pleted, and these genetic codes will be compared with isolates from previous outbreaks. These molecular techniques will be useful in determining the natural and iatrogenic spread of the disease. In addition, molecular techniques will be used to develop a genetically engineered vaccine as well as molecular diagnostic tools.

Despite the moderate clinical effects VS has on most domestic livestock, quarantines and movement restrictions placed on infected animals are economically serious. During an outbreak of VS, establishing a balance between domestic issues and international trade issues is tenuous. Because it causes clinical signs similar to those of other foreign animal diseases, has a negative impact on livestock production and trade, and creates public health concerns, USDA veterinarians, state animal health officials, and private practitioners work hard to prevent VS from becoming established in the United States.

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<sup>b</sup>Hillberg-Seitzinger A, USDA-APHIS, Veterinary Services, Centers for Epidemiology and Animal Health, Fort Collins, Colo: Personal communication, 1996.

<sup>c</sup>Ott S. *Financial impact of vesicular stomatitis virus on New Mexico livestock owners*. Fort Collins, Colo: USDA-APHIS, Veterinary Services, Centers for Epidemiology and Animal Health, 1996.

<sup>d</sup>Domenici PV, US Senate, Washington, DC: Personal communication, 1995.

## Appendix

International trade restrictions enacted during the 1995 vesicular stomatitis outbreak

Country	Action
Russia	Ban on importation of US beef.
Romania	Ban on importation of US beef.
South Africa	Ban on importation of US beef and pork.
Latvia	Ban on importation of US poultry meat.
Canada	Certification that horses, ruminants, and swine have not been in a VS-affected state for the past 30 days. All horses entering must be inspected by a Canadian federal veterinarian. Livestock from a high-risk state must have negative results on a VS test and have resided on unaffected premises with protection from insect vectors for 30 days prior to export.
European Union	Horses must have negative results on a VS test and must be accompanied by certification indicating that for the past 30 days, horses have not been in any state or had contact with any livestock that has been in any state in which VS was diagnosed during the preceding 8 months.
Japan	All susceptible livestock, including horses, must have negative results on a VS test.
Chile	Live susceptible animals must be from a state free of VS.
United Arab Emirates	Same as European Union.

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