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Rotavirus Infections in Swine

Kent J. Schwartz, DVM*
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Introduction
Advances in meat animal production in the last twenty years are unprecedented in the history of agriculture. Despite the intensive research in medicine and animal health, disease continues to contribute tremendous economic loss in animal production by direct death loss, decreased feed efficiency, and longer production time. Enteritis of various etiologies, especially in the neonate, is probably the most visible in terms of death loss, and paradoxically, also one of the most insidious causes of economic loss in subclinical cases or cases of permanent intestinal dysfunction.

Relatively recent advances in diagnostic techniques have led to increasing awareness of virus induced enteritides. The isolation and identification of a corona virus as the etiologic agent of transmissible gastroenteritis (TGE) in swine was well documented in the early 1960's. Since that time, the use of refined tissue culture techniques, electron microscopy, and various serological techniques have led to the isolation and identification of many other viral agents in domestic animals, with or without associated pathogenic effects. In 1969, Mebus described a reovirus isolated from a calf with enteritis. A reovirus-like agent was identified in the feces of children with acute gastroenteritis in 1970. The association of reo-like virus infections with diarrhea in young calves and humans stimulated interest in the possibility of a similar agent in swine, either as a primary pathogen or as a potential experimental model for the human and bovine disease.

Etiology
The term reovirus is an acronym for Respiratory Enteric Orphan. Classification in the family Reoviridae is not based on morphology as with most viruses. It is recognized as the only family of viruses containing double-stranded RNA. Nomenclature of this group of viruses is extremely confusing since morphology and physical-chemical characteristics are variable. Rotaviruses are a distinct genus within the family Reoviridae and they are antigenically and serologically distinct from other members.

Swine rotaviruses, unlike bovine isolates, are generally difficult to propagate in conventional tissue culture cell lines. Swine rotavirus is best isolated on pig kidney cells, but until recently it could not be maintained on this culture medium more than 5-9 passages. There is a recent report of a tissue culture adapted swine rotavirus which may aid in the study of this virus.

Clinical Characteristics
Eighty percent of diagnosed rotavirus infections are found in unweaned pigs. Rotavirus infections usually involve a morbidity of 50-80% with a low mortality of 0-15%. These values vary with: 1) age of piglets; 2) challenge dose; 3) immune status of
dam and herd; and 4) other complicating infections. Rotavirus infection in piglets less than 14 days old is characterized by watery diarrhea and occasional vomiting. The diarrhea progresses to greyish-white, pasty feces by the third day. Piglets rapidly dehydrate and become depressed but may remain appetent.

Rotavirus infections have been associated with "white scours" or "milk scours" during the lactation period and with diarrhea in the postweaning period which is transient unless complicated by secondary bacterial processes. Infection in swine over 3 months of age is usually subclinical although diarrhea and some vomiting with low morbidity has been reported in growing swine and sows in naive herds.

The severity and epidemiology of rotavirus enteritis is also affected by the immune status of the swine herd. Circulating antibody (IgG) acquired from colostrum has little neutralizing effect on the prolonged challenge of rotaviruses. Piglets ingesting milk containing virus neutralizing antibody (IgA, IgM, and possibly IgG) may be passively protected from rotavirus infection. However, sows previously exposed to rotavirus may not develop high enough titers of secretory antibody for this passive immunity to be complete. Also, IgA titers decrease as lactation progresses and may fall below the critical level at which antibodies can neutralize ingested virus. Consequently, piglets suckling immune sows may develop a rotaviral diarrhea during the course of lactation. In this way the antibody titer attained in particular sows may influence severity of clinical signs and morbidity of affected litters within the same herd. This "immune modified" form of the disease, which has been described with TGE virus, may be confused with enzootic TGE or colibacillosis.

When piglets are weaned, passively acquired IgA is no longer available to neutralize ingested virus and an active infection with clinical diarrhea ensues.

The source of infective virus is primarily carrier sows. It was demonstrated that cows and, later, that sows may become carriers and may shed the virus intermittently. Factors which induce shedding are unknown, however, prevalence of the disease is greater during winter months and during situations associated with stress. Fecal shedding of virus is accompanied by a transient rise in serum antibody titer. This titer rapidly falls and the carrier again becomes inapparent. As a result, the disease may become enzootic within a herd, especially in continuous farrowing operations. These same phenomena have been described with transmissible gastroenteritis (TGE).

Concurrent infections with TGE and rotavirus may also occur either as a severe disease in acutely affected naive animals or as the "immune modified" disease syndromes described above.

There are reports that incriminate virus of the Reoviridae as a possible etiological factor in abortions and infertility in swine. This virus has been isolated from fetuses aborted late in gestation and has had adverse affects on swine fertility in experimental situations.

Gnotobiotic pigs may be infected with human, calf, foal, and swine rotavirus. It also appears there are different strains of rotavirus that may successfully infect a host so that herds with antibody titers to a particular strain of rotavirus may be superinfected with another strain.

**Pathogenesis**

The pathogenesis of rotavirus enteritis very closely resembles the pathogenesis of TGE virus. The host-specific outer shell antigen allows viral particles to attach and penetrate only mature apical villous epithelial cells of the small intestine, starting in the mid-duodenum and progressing caudally. Onset of clinical signs in field cases varies from 1-5 days. Immunofluorescent and histological studies have demonstrated the migration of infected columnar epithelial cells to the apical portions of the villi followed by desquamation into the lumen. These infected cells are replaced by non-fluorescing, noninfected cells which are less mature and have much less absorptive potential. This process proceeds caudally to affect the small intestine either in its entirety or segmentally. If migration of the immature, uninfected cuboidal cells is not rapid enough to replace those desquamated columnar cells, there is a potential for the exposed areas to become secondarily infected with other pathogens and opportunists. *E. coli*, in the presence of altered intestinal function and damaged epithelium, is most often involved in this
bacterial overgrowth and may delay restoration of normal function or cause further injury.12

The net effect of an uncomplicated rotavirus infection is the loss of absorptive function of the small intestine. This coupled with unimpaired secretion of fluids into the small intestine and the presence of ingesta with high osmotic pressure, will result in a malabsorption and osmotic diarrhea. The pathogenesis of TGE virus is similar except that this corona virus is less selective and infects a larger portion of the villous epithelium, consequently producing a more severe disease.4

Histologically, mild villous atrophy is the primary lesion in uncomplicated rotavirus infection. The apical villous epithelial cells have a cuboidal appearance or may be absent. Debris may be present on the epithelial surface. Shortened villi may be blunted or fused to adjacent villi. Mild leukocytic infiltrates may also be present in the submucosa. Lesions in the duodenum are more common than with TGE; rotavirus lesions tend not to be as diffuse as those found with TGE. Subsequent bacterial overgrowth may cause hyperemia and edema of the submucosa.4 Gross lesions are variable. The small intestine maybe seen as a flaccid, fluid and gas-filled structure with gross mild atrophy of villi or may appear nearly normal. Evidence of diarrhea should be apparent in the colon and on the perineum.

**Diagnosis**

Clinical signs, history, and response to therapy aid in the diagnosis of viral enteritis but cannot be definitive. The diagnosis is more difficult if an immune modified viral infection is present or the primary etiologic agent (viral) is obscured by the presence of a secondary invader (*E. coli*). Generally, the most difficulty lies in differentiating TGE, colibacillosis, and rotavirus infections in young pigs.

Several techniques are routinely used to definitively diagnose rotavirus infection in swine. An immunofluorescent technique, first applied in calf diarrheas, utilizes a monospecific, fluorescein labeled antiserum and a frozen section of the small intestine from an acutely affected, sacrificed animal. It is reported that fluorescein labeled antiserum prepared with either bovine or swine rotavirus will yield satisfactory results with this technique.1

Electron microscopic examination of feces, or preferably small intestinal contents for the presence of typical virions is also a satisfactory method of diagnosis. This relatively simple technique best utilizes watery intestinal contents. After differential centrifugation and impregnation with phospho-tungstic acid, specimens are nebulized onto a plastic-coated copper grid and observed with a transmission electron microscope for presence of typical virions. With this simple process, diagnosis of rotavirus infection can be easily rendered within 3-4 hours.

A particular benefit of the immunofluorescent technique and the electron microscopy technique is that both are relatively insensitive to low numbers of virus particles. During active infection, rotavirus is found in exceedingly high numbers whereas only occasional virus particles are present after the active process. Consequently, these techniques may distinguish active, primary disease states from transient or non-disease producing infections.

Virus isolation from trypsin-digested intestinal contents is also possible but requires 3-5 blind passages before a specimen can be proven negative. This is generally too laborious to be used as a routine diagnostic.

### Table 1: Comparison of TGE, Rotavirus & *Escherichia Coli*

<table>
<thead>
<tr>
<th></th>
<th>TGE</th>
<th>Rotavirus</th>
<th><em>E. Coli</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Incubation period:</td>
<td>48-72 hrs.</td>
<td>2-5 day</td>
<td>variable</td>
</tr>
<tr>
<td>Onset in herd:</td>
<td>explosive*</td>
<td>abrupt*</td>
<td>gradual buildup</td>
</tr>
<tr>
<td>Morbidity in neonates:</td>
<td>100%</td>
<td>50-80%</td>
<td>variable</td>
</tr>
<tr>
<td>Mortality in neonates:</td>
<td>high</td>
<td>low</td>
<td>variable</td>
</tr>
<tr>
<td>Clinical signs in weaned pigs:</td>
<td>diarrhea; vomiting</td>
<td>diarrhea</td>
<td>diarrhea?</td>
</tr>
<tr>
<td>Diarrhea and vomiting in sows:</td>
<td>frequent*</td>
<td>rare</td>
<td>none</td>
</tr>
<tr>
<td>Grossly visible villous atrophy:</td>
<td>frequently severe</td>
<td>mild</td>
<td>segmental or none</td>
</tr>
</tbody>
</table>

*Those herds with enzootic or immune modified forms of the disease may be variable in onset.*
method. The possibility of isolating rotavirus present in low numbers and not associated with a disease process also exists.

**Treatment and Control**

As with most virus diseases, the best control measures are based on the prevention of infection or establishment of an immune state. Treatment of rotavirus enteritis is, at best, palliative. If confronted with an acute outbreak in suckling pigs treatment may involve: 1) administering broad spectrum antibiotics to prevent bacterial overgrowth, 2) having fresh water available, 3) weaning if possible, and 4) practicing good sanitation. The presence of milk in the gut contributes significantly to the osmotic diarrhea which develops. Therefore, easily fermented food is contraindicated. Glucose is passively absorbed even in the compromised gut; a glucose and water solution may be given orally as an energy source to allow time for epithelial regeneration.

In weaned pigs, the ration should be carefully scrutinized. Lower carbohydrate and protein feed rations are indicated. The addition of bulky grains (oats) has been advantageous in many situations.

Environmental considerations are important in the prevention and control of viral enteritis. Adequate heat and ventilation are necessities for the high populations of swine found in intensive confinement units. Virus particle concentrations reach extremely high titers (10⁷-10⁸ virions per gram) in feces of acutely affected pigs, consequently reducing the infective dose through good sanitation is very important.

Many management considerations have been offered as aids in the prevention of the disease. In the farrowing house, recommendations include: 1) the use of multiparous sows which are more likely to secrete neutralizing antibody during lactation; 2) providing a break in continuous farrowing systems to allow adequate sanitation and prevent buildup of fecal material; 3) exposure of gestating gilts and sows to fecal material from the farrowing house or nursery. (This procedure involves the risk of inducing viral abortion and should be done at least 5-4 weeks prior to farrowing.); and 4) maintenance of a closed herd and elimination of animal (and human) traffic within units. The fact that strains of rotavirus may infect several species may have a great influence on transmission but more study is needed. Preventing the entrance of possible carrier animals into a herd applies to rotavirus as well as other infectious diseases.

There has been success in the vaccination of rotaviral calf diarrhea using a modified live virus vaccine derived from a tissue-adapted strain of bovine rotavirus and administered orally to neonates. Swine rotavirus had been difficult to adapt to tissue culture which has impeded study of the virus and production of a vaccine strain. All field strains reported thus far have been pathogenic. There also appear to be several pathogenic strains of rotavirus that differ antigenically and with which there is no cross neutralization serologically, implying possible sequential infection of a single animal by these different strains.

**Summary**

Current trends toward the confinement and isolation of swine are producing herds with a unique bacterial and viral flora. Exposure to the many varieties of organisms of disease potential is limited. Consequently, an ubiquitous organism not recognized as pathogenic several years ago, may be pathogenic when introduced into a naive herd today. It is important to note that mildly pathogenic organisms that were ignored or obscured in the past may cause insidious, but significant, economic loss in today's swine production units that rely on efficiency and maximum production potential for profit.

Rotavirus infections are capable of producing diarrhea in a variety of animals including swine. The paucity of information available will be supplemented in the future with continued research. Until that time, the importance of obtaining a correct diagnosis and the application of sound management practices cannot be overemphasized.

**Bibliography**


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Dogs have Better Diets

America's dogs have better balanced diets available to them than the diets consumed by the nation's children, said Dr. James E. Corbin, an animal scientist at the University of Illinois.

Overeating can be as much a problem of dogs as man, he pointed out, causing obesity, physical exhaustion, hip dysplasia, susceptibility to disease and decreased life span.

For dogs, a 22 percent protein diet on a dry basis is recommended for growth; high meat diets should be avoided unless supplemented. Five percent fat on a dry basis is recommended, but most commercial dog foods contain twice that amount for energy, palatability and texture. Dogs also require daily vitamins for maintenance and for growth in puppies. Vitamins recommended are A, D, E, menadione (Vitamin K equivalent), and B complex.

(from *Pfizer News* May 8, 1978)

Top AKC Breeds

A study, published in the May 15, 1978 *JAVMA*, reported that out of 122 recognized AKC breeds, 30 breeds accounted for nearly 90% of all births. Poodles were the most prolific, followed by German Shepherds, Beagles, Irish Setters, Dachshunds, and Miniature Schnauzers. The average litter size was 4.73 pups with 50.6% being males. Larger breeds generally had larger litters and more males. California ranked first in total number of births followed by Texas, Missouri, New York, and Kansas.

The study was based on 87,880 AKC litter registration records from 1971-73. It was compiled by Drs. John B. Tedor and John S. Reif of the University of Pennsylvania School of Veterinary Medicine.

(from *AVMA New Release*, May 15, 1978)

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