Swine Disease Diagnostic Manual

FOURTH EDITION

A COMPREHENSIVE GUIDE TO SWINE DISEASE DIAGNOSIS

Editor: David H. Zeman, DVM, PhD, DACVP

Assisting the pork industry in solving challenging herd health problems using cutting-edge technology and personalized customer support.

Custom Made Vaccines
As the nation’s largest manufacturer of Custom Made Vaccines, Newport Laboratories is a highly focused, technology–based company dedicated to providing timely, science–based solutions to food animal disease problems. We do this by providing customers with industry-leading science backed by PINPOINT® Technologies. Our products and services are delivered and supported by a dedicated and experienced sales staff and Veterinary Service team.

Copyright Newport Laboratories, Inc. All rights reserved.

Table of Contents

Helpful Tools
- Swine Diagnostic Submission Guide 4
- Tissue Submission Guidelines 6
- Dx-REPORTS - Diagnostic Reporting Software 8
- Major Pig Organs 9
- Nursery Pig Necropsy Instructions 10
- Grower/Finisher Pig Necropsy Instructions 12

Respiratory Diseases
- Glässer’s Disease - Haemophilus parasuis 14
- Mycoplasma Pneumonia – Mycoplasma hyopneumoniae 16
- Pneumonic Pasteurellosis - Pasteurella multocida 17
- PRRSV – Porcine Reproductive and Respiratory Syndrome 18
- SIV - Swine Influenza Virus 19
- Swine Pleuropneumonia - APP 20

Gastrointestinal Diseases
- Clostridial Enterocolitis - C. perfringens & C. difficile 21
- Coccidiosis 23
- E. coli - Intestinal Colibacillosis and Edema Disease 24
- Gastric Ulcers 25
- Hemorrhagic Bowel Syndrome – HBS 26
- Ileitis - Lawsonia intracellularis 27
- PEDv - Porcine Epidemic Diarrhea Virus 28
- TGE - Transmissible Gastroenteritis 29
- Rotavirus Enteritis 30
- Salmonellosis: Enteritis and Septicemia 31
- Swine Dysentery - Brachyspira hyodysenteriae 32

Multisystemic Diseases
- Erysipelas 33
- Hemagglutinating Encephalomyelitis Virus 34
- Polyserositis & Polyarthritis (Mycoplasma hyorhinis) 35
- Porcine Circovirus Associated Disease (PCVAD) - PCV2 36
- Strep - Streptococcus suis 38

Miscellaneous Diseases
- Mulberry Heart Disease 39
- Polyarthritis - Mycoplasma hyosynoviae 40

Reproductive Diseases
- Leptospirosis 41
- Parvo 41
- PRRSV 41

Acknowledgements 42
<table>
<thead>
<tr>
<th>Disease Suspected</th>
<th>Specimen</th>
<th>Sample Preparation</th>
<th>Laboratory Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Actinobacillus pleuropneumoniae</em></td>
<td>Lung</td>
<td>Refrigerate</td>
<td>Culture-sensitivity, Serotyping (via PCR)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10% Formalin</td>
<td>Histopathology</td>
</tr>
<tr>
<td></td>
<td>Serum</td>
<td>Refrigerate</td>
<td>Serology</td>
</tr>
<tr>
<td>Arthritis</td>
<td>Joint fluid, Joint swab, Synovium</td>
<td>Refrigerate</td>
<td>Culture-sensitivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10% Formalin</td>
<td>Histopathology</td>
</tr>
<tr>
<td><em>Clostridium perfringens</em></td>
<td>Duodenum, Jejunum, Ileum, Colon</td>
<td>Refrigerate</td>
<td>Anaerobic Culture-sensitivity, Toxin PCR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10% Formalin</td>
<td>Histopathology</td>
</tr>
<tr>
<td><em>Clostridium difficile</em></td>
<td>Duodenum, Jejunum, Ileum, Colon, Fecal swabs, Colon content</td>
<td>Refrigerate</td>
<td>Culture, A/B Toxin ELISA, A/B Toxin PCR</td>
</tr>
<tr>
<td><em>Escherichia coli (E. coli)</em></td>
<td>Duodenum, Jejunum, Ileum, Colon, Brain with brainstem, Fecal swabs, Colon content</td>
<td>Refrigerate</td>
<td>Culture-sensitivity, PCR, Toxin PCR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10% Formalin</td>
<td>Histopathology</td>
</tr>
<tr>
<td>Enteritis (non-specific)</td>
<td>Duodenum, Jejunum, Ileum, Colon, Fecal Swabs, Colon content</td>
<td>Refrigerate</td>
<td>Culture-sensitivity, smear, Anaerobic culture/typing, TGE Immunohistochemistry (IHC), Rotavirus qPCR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10% Formalin</td>
<td>Histopathology</td>
</tr>
<tr>
<td>Erysipelas</td>
<td>Heart, Lymph node, Liver, Spleen, Synovium, Joint fluid</td>
<td>Refrigerate</td>
<td>Culture-sensitivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10% Formalin</td>
<td>Histopathology</td>
</tr>
<tr>
<td><em>Haemophilus parasuis</em> (Glasser's disease-polyserositis)</td>
<td>Lung, Pleural Fluid, Heart, Pericardial fluid, Pericardium, Synovium, Joint fluid</td>
<td>Refrigerate</td>
<td>Culture-sensitivity, qPCR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10% Formalin</td>
<td>Histopathology</td>
</tr>
<tr>
<td>Hemagglutinating Encephalomyelitis Virus (HEV)</td>
<td>Brain with brainstem, Mid-cervical spinal cord, Thoracolumbar junction spinal cord, Lung, Tonsil</td>
<td>Refrigerate</td>
<td>Virus isolation, qPCR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10% Formalin</td>
<td>Histopathology</td>
</tr>
<tr>
<td></td>
<td>Serum</td>
<td>Refrigerate</td>
<td>Serology</td>
</tr>
<tr>
<td>Hemorrhagic Bowel Syndrome (HBS)</td>
<td>Duodenum, Jejunum, Ileum, Colon</td>
<td>Refrigerate</td>
<td>Gross lesions and culture to rule out mimic infections</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10% Formalin</td>
<td>Histopathology</td>
</tr>
<tr>
<td>Ileitis (Lawsonia intracellularis)</td>
<td>Ileum, Spiral colon, Cecum, Feces</td>
<td>Refrigerate</td>
<td>PCR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10% Formalin</td>
<td>Histopathology</td>
</tr>
<tr>
<td>Mulberry Heart Disease</td>
<td>Lung, Pericardial fluid, Heart, left and right ventricles</td>
<td>Refrigerate</td>
<td>Culture to rule out septicemia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10% Formalin</td>
<td>Histopathology</td>
</tr>
<tr>
<td><em>Mycoplasma hyorhinis</em> (Polyarthritis and Polyserositis)</td>
<td>Lung with pleura, Pericardium, Pericardial fluid, Synovium, Joint fluid</td>
<td>Refrigerate</td>
<td>Culture-sensitivity, Mycoplasma Multiplex PCR, Culture</td>
</tr>
<tr>
<td><em>Mycoplasma hyosynoviae</em> (Polyarthritis)</td>
<td>Synovium, Joint fluid</td>
<td>Refrigerate</td>
<td>Mycoplasma multiplex PCR, Culture</td>
</tr>
<tr>
<td>Mycoplasma Pneumonia (M. hyopneumoniae)</td>
<td>Lung</td>
<td>Refrigerate</td>
<td>Culture, Mycoplasma multiplex PCR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10% Formalin</td>
<td>Histopathology, PCR</td>
</tr>
<tr>
<td></td>
<td>Serum</td>
<td>Refrigerate</td>
<td>Serology</td>
</tr>
<tr>
<td>Disease Suspected</td>
<td>Specimen</td>
<td>Sample Preparation</td>
<td>Laboratory Procedure</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>-------------------</td>
<td>------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Pasteurella Pneumonia and Rhinitis</strong></td>
<td>Lung, Turbinates if investigating rhinitis</td>
<td>10% Formalin</td>
<td>Culture-sensitivity</td>
</tr>
<tr>
<td><strong>Porcine Circovirus Disease (PCV2, PMWS, PDNS)</strong></td>
<td>Lung, Spleen, Liver, Lymph nodes, Kidney, Ileum, Pancreas, Serum</td>
<td>Refrigerate</td>
<td>Virus isolation, qPCR</td>
</tr>
<tr>
<td><strong>Porcine Epidemic Diarrhea (PEDV)</strong></td>
<td>Duodenum, Jejunum, Ileum, Colon, Colon content or feces, Fecal swabs, Serum</td>
<td>Refrigerate</td>
<td>Histopathology, Fluorescent antibody, Serology, qPCR, VI</td>
</tr>
<tr>
<td><strong>Porcine Reproductive &amp; Respiratory Syndrome (PRRS)</strong></td>
<td>Lung</td>
<td>Refrigerate/frozen</td>
<td>Virus isolation, qPCR</td>
</tr>
<tr>
<td><strong>Reproductive Diseases/Abortions (Parvo, Lepto, PRRS, etc)</strong></td>
<td>Fetus, Mummies, Stillborns, Weakborns, Serum</td>
<td>Refrigerate</td>
<td>Culture-sensitivity, IgG, PCR, etc.</td>
</tr>
<tr>
<td><strong>Rotavirus Enteritis</strong></td>
<td>Duodenum, Jejunum, Ileum, Colon, Colon content or feces, Fecal swabs</td>
<td>Refrigerate</td>
<td>PCR, Virus isolation, Sequencing, RotaStat</td>
</tr>
<tr>
<td><strong>Salmonella</strong></td>
<td>Duodenum, Jejunum, Ileum, Colon, Liver, Lung, Spleen, Mesenteric lymph node, Colon content or feces, Fecal swabs</td>
<td>Refrigerate</td>
<td>Culture-sensitivity, Serotyping, Genotyping</td>
</tr>
<tr>
<td><strong>Streptococcus suis</strong></td>
<td>Brain including cerebellum and brain stem, Lung, Liver, Spleen, Synovium</td>
<td>Refrigerate</td>
<td>Culture-sensitivity, Serotyping</td>
</tr>
<tr>
<td><strong>Swine Dysentery (Brachyspira hyodysenteriae)</strong></td>
<td>Feces, Cecum, Spiral colon</td>
<td>10% Formalin</td>
<td>Histopathology</td>
</tr>
<tr>
<td><strong>Swine Influenza Virus (SIV)</strong></td>
<td>Trachea, Lung, Nasal swabs (in viral transport media)</td>
<td>Refrigerate</td>
<td>Virus isolation, qPCR, Subtyping, Sequencing, BinaxNOW™, HT-SN™, Influenza multiscreen</td>
</tr>
<tr>
<td><strong>Transmissible Gastroenteritis (TGE)</strong></td>
<td>Duodenum, Jejunum, Ileum, Colon, Colon content or feces, Fecal swabs, Serum</td>
<td>Refrigerate</td>
<td>Histopathology, Fluorescent antibody, Serology, qPCR, VI</td>
</tr>
<tr>
<td><strong>Gastric Ulcers</strong></td>
<td>Stomach</td>
<td>Refrigerate</td>
<td>Gross lesions</td>
</tr>
</tbody>
</table>

For bacterial culture, we recommend swabs with transport media to prevent desiccation. For virus isolation, swabs should be placed into viral transport media; see tissue submission guidelines on next page or call the lab for information.

FREE Diagnostic Submission Kits.
800-220-2522 • www.newportlabs.com
Whenever possible, animals selected for laboratory analysis should be free from antibiotic therapy and in an early or acute disease stage. Selected tissues should be collected as aseptically as possible. Ideally, two or three humanely euthanized pigs in the early stages of disease that are displaying typical clinical signs and immediately necropsied will yield the most reliable diagnostic data. A meaningful history of the disease outbreak and a tentative diagnosis, based upon clinical evaluation and necropsy findings, should be included. Laboratory test results are directly affected by animal selection, necropsy technique, specimen selection, specimen handling, adequate preservation, and speed of shipment to the laboratory. Contact Newport Laboratories if you have any questions regarding sample collection or the diagnostic process.

**Preparation & Collection of Tissues/Samples**

**Tissues-Fresh**
Aseptically collect approximately 2x4 inch samples and place in a plastic bag. Sample visible lesions with adjacent normal tissue. Double bag in Whirl-pak® bags. Do not mix swabs, intestines, or brains with other tissues in one single bag. Transport tissues with 2-3 cold packs in an insulated container. It is important that the tissue samples arrive at the laboratory before the cold packs expire.

Collect sections of small and large intestine. The selected, clearly identified samples should be double bagged and sealed in Whirl-pak bags to prevent spillage. Do not cut the loops of intestines open. The intestine, approximately 2 inches long, should be refrigerated and cooled thoroughly prior to shipping. Avoid shipping whole pigs or over weekends.

**Swabs**

**Aerobic Culture**
Commercial swabs with Stuart’s or Amies transport media is recommended to prevent desiccation.

**Anaerobic Culture**
Port-A Cult® (BBL) or other anaerobic transport system. (The Port-A Cult® tube can be used for anaerobic, facultative, and aerobic bacteria.) For abscesses or exudates use a capped syringe with needle removed or a tube with a snug cap.

**Nasal Swabs-Bacterial Suspect**
Clean the external nares and internal nostrils with a moist towel to remove common contaminants. (Use swabs with transport media such as Amies or Stuart’s). Insert swab into the pre-cleaned nasal cavity and rotate. Upon successful sample collection, the swab is inserted into the accompanying sterile plastic sheath. The ampule located at the end of the sheath is gently crushed, releasing transport medium.

**Nasal Swabs-Viral Suspect**
Prepare nostrils and sample as in bacterial suspect. For viral swabs use Viral Culturette® (Becton Dickinson #4361514) or equivalent.

Use of the incorrect swab and media may jeopardize the ability to detect or culture the offending pathogen. For bacterial isolation, avoid using Mycoplasma or viral media which contain antimicrobials and may inhibit growth of the desired pathogen. Avoid using bacterial culture media to isolate viruses or Mycoplasma organisms.

Identify all swabs with the following:
- Farm ID, including site and building where appropriate
- Animal identification number
- Source of the swabbed material such as oral fluid, joint exudate, pericardial fluid, peritoneal fluid, tracheal wash, urine, blood

**Histopathology**

**Preparation of Tissue for Fixation**
Multiple sites or types of lesions, to include both normal and diseased tissue and a sample at the line of demarcation, should be taken. The sections should be no more than 1 inch thick. The small size of the tissue results in rapid and complete penetration of the fixative.

Selected tissues should be cut with a sharp knife or scalpel since the squeezing action of scissors crushes and tears tissue. Autolysis or freezing will make samples unsuitable for histopathological evaluation. Place formalin and tissues in double Whirl-paks. Identify bags if multiple animals are submitted. Do not use narrow mouth bottles to submit fixed tissues.
Tissue Submission Guidelines

Volume of Fixative
The selected tissues should be fixed in 10% neutral buffered formalin. Use 10 times the volume of the tissues being fixed to assure good perfusion of the sample and to maintain the tissue architecture. After 24 hours fixation, excess formalin can be poured off, and a smaller formalin volume can then be used for shipping.

Formula to make 10% Neutral Buffered Formalin
- 37-40% formaldehyde: 100 mL
- Distilled water: 900 mL
- Sodium phosphate, monobasic monohydrate: 4.0 g
- Sodium phosphate, dibasic anhydrous: 6.5 g

Tissue Selection for Histopathology
Check the recommended samples in the guideline table on page 4 and 5. If the cause of death is unknown or the clinical syndrome is vague, then submit samples exhibiting gross lesions and sections from all of the following: lung, heart, liver, kidney, spleen, various levels of the gastrointestinal tract, mesenteric lymph nodes, and brain.

If hollow organs (gut or uterus) retain significant amounts of content, then they should be gently flushed with 10% formalin without disturbing the mucosal lining before placing in the formalin bag. Be sure to take proper precautions when handling formalin.

I.D. & Handling of Blood Samples:
Collection of Blood Samples
- Collect in sterile tubes. Serum separator tubes work well. Follow the manufacturer’s directions. Based on the number of tests requested, 1 mL – 3 mL of nonhemolyzed serum is required.
- Fill vacutainer tubes ¾ full and allow to stand at room temperature for an hour to permit a solid clot to form and retract.
- Pipette the serum into sterile tubes with snap caps (3 mL plastic tubes with snap caps, Falcon #2054, are recommended). Make sure caps are securely closed.
- Use permanent markers and underline the I.D. numbers (e.g. 16 vs. 91).
- Do not freeze whole blood or samples with the clot remaining.
- Contaminated or toxic samples cannot be used in virus isolation tests.

I.D. Samples on Submission Forms
- Using one form per client and site, identify the tubes on the submission request form by different barns, or age groups as logical for the diagnostic investigation.
- Clearly specify the test(s) requested on the submission form.
- When sending paired sera, identify the acute samples from the convalescent samples on the tube and on the request form.

Diagnostic submission forms can be downloaded from our website: www.newportlabs.com, or by calling Newport Customer Service at 800-220-2522.

Packing Specimens
To avoid leaking in transit, double bag ALL samples. Whirl-pak bags or equivalent are recommended. Wrap sample bags and 2-4 ice packs in absorbent paper (e.g. newspaper). Place the package into a styrofoam container. Completed submission forms should be inserted in a separate bag in case of leakage and clearly attached to the matching specimens. This is especially important if your container contains specimens from multiple clients or sites. Avoid mixing intestinal samples with other tissues. If you need more information about shipping specimens to Newport’s Diagnostic Laboratory, please call us at 800-220-2522.

Mailing
Newport Laboratories provides free diagnostic kits for sample submission. Call us at 800-220-2522 to request submission form(s) or shipper containers. Submission forms are also available online at www.newportlabs.com. Samples should be submitted by the fastest means possible to avoid deterioration of specimens. Next day or overnight delivery is preferred. The most reliable mailing services that we have found are listed below:

- United Parcel Service (UPS)
- Fed Ex
- Spee-Dee
- U.S. Parcel Post (only as a final option)

Laboratory Hours
The Newport Diagnostic Laboratory is open for service from 8:00 A.M. to 5:00 P.M. (CST) Monday through Friday, with the exception of holidays.

Diagnostic Shipping Address
Newport Laboratories
1524 Prairie Drive
Worthington, MN 56187
Dx-REPORTS is a secure site which allows veterinarians to view diagnostic testing results where they want and when they want. This system allows veterinarians to easily organize and distribute diagnostic results. Livestock producers receive pertinent information from their veterinarian in a precise and understandable format.

Dx-REPORTS provides numerous features and benefits:
- Password protected site maintains confidentiality of all diagnostics information
- Complies with producer’s and attending veterinarian’s privacy requirements
- Accessible from any computer location at any time
- Easy to navigate interface
- Applications for all food animals and cervidae
- Ease of collecting, distributing and banking individual pork production site data
- Data analysis to identify disease trends within groups and between groups
- Left margins icons and header action button provides data management menu options
- Real-time database allows you to see results and status of submissions

Call Newport Laboratories at 800-220-2522 for more information about Dx-REPORTS capabilities.

Online Web Portal
Major Pig Organs

- Liver
- Lung
- Heart
- Cecum
- Small Intestine
- Spiral Colon
- Stomach
- Head
- Spleen
- Kidney
- Urinary Bladder
Important: Start with a sharp knife.

Cut through the axilla to partially separate the front limb from the rib cage. Repeat for other side.

After cutting through the axillae, the pig will lie upright on its back.

Hook the knife under the cranial sternum. Cut through the cartilage of all the ribs on both sides.

Continue this cut to remove the skin with sternum, and the ventral abdominal wall (belly) of the pig.

Most organs are now visible.
Flex the nose toward the floor and the ears down to open the space between the top vertebra and the skull. This will allow room to cut between them.

Organs are easily examined.

Brain Swabs: Cut through the skin and muscle behind the ears at the base of the skull.

Place a swab on the exposed spinal cord toward the brain. This is an excellent way to test for strep.

Cut between the ribs below the collar bone.

Spread and crack the ribs open.
With the pig on its side, hold the lower front limb down with your foot while pulling up on the upper front limb.

Use the knife to cut through the axilla (armpit) to separate the leg from the rib cage.

The upper hind limb is cut and laid back likewise.

As you push the hind limb back, up and over the hip by cutting muscle in the area, the hip socket will become exposed, cut through socket and continue pushing the limb straight back over hip.

Cut between the skin and body wall, beginning at the pelvis, along the midline all the way to the neck.

Continue the cut along the ventral midline towards the neck.
Grower/Finisher - Necropsy Instructions

Following the cut just made, dissect the skin away from the body wall, reflecting it over the back.

Continuation of previous step. Note that abdominal wall and back muscles are being exposed, but abdomen is not open.

Carefully open the abdomen wall without cutting into intestines or urinary bladder; beginning near the pelvic floor working towards the head along midline. Reflect abdominal wall over the back.

Puncture the diaphragm near caudal sternum. Cut through cartilage of the sternum all the way to neck.

Cut muscles between ribs in pairs; break ribs by pushing one or two at once over the back.

Organs are now exposed for examination.
Glässer’s Disease
Haemophilus parasuis

Clinical Signs & History
- Sudden death.
- A temperature of 104°-107°F develops, and there is anorexia, depression, and occasionally mild rhinitis and dyspnea with coughing.
- Some pigs become lame with painful, warm, swollen, joints.
- Chronic arthritis and occasionally meningitis and convulsions may develop.

Stage of Production
- Nursery
- Grow-Finish

Diagnosis
- Based on history, clinical signs, and necropsy. Confirmed by culture of the organism from joint fluids, involved tissues, or CSF.
- Polyserositis, polyarthritis and meningitis.

Tissues to Submit
- Synovium
- Joint Fluid
- Meninges
- Lung with Pleura
- Exudate
- Heart with Pericardium

Diagnostic Tests
- Culture-sensitivity
- Quantitative PCR
- ELISA (OppA)
- Histopathology
Glässer’s Disease

Haemophilus parasuis

Vaccine

Single Dose - 1mL Dose

Avirulent Live Culture

We immediately saw a significant reduction in morbidity and mortality associated with H. parasuis. We are very pleased with this product’s performance.

- Dr. Brian Schantz, Laurel, NE

PARASAIL is available through your veterinarian.

1. PARASAIL [carton label]. Worthington, MN: Newport Laboratories, Inc.; 2013

FOR MORE INFO SCAN WITH SMART DEVICE

800-220-2522
info@newportlabs.com
www.parasailprotection.com
Mycoplasma hyopneumoniae
Mycoplasma Pneumonia

Tissues to Submit
- Lung
- Serum

Diagnostic Tests
- Mycoplasma
  Multiplex PCR
- Mycoplasma culture
- Quantitative PCR
- Histopathology
- Serology

Clinical Signs & History
- Coughing is the most common sign and is most obvious when pigs are roused.
- Sporadically, individual pigs or groups develop severe pneumonia.
- Often accompanied with secondary *Pasteurella multocida* or other bacterial infections.

Stage of Production
- Nursery
- Grow-Finish

Diagnosis
- Affected lung tissue is gray or purple, most commonly in the apical and cardiac lobes (cranioventral).
- Lesions are clearly demarcated from normal lung.
- The associated lymph nodes may be enlarged.
Pneumonic Pasteurellosis
*Pasteurella multocida*

**Clinical Signs & History**
- Respiratory: Cough, rapid breathing (thumping).

**Stage of Production**
- Nursery
- Grow-Finish

**Diagnosis**
- Diagnosis is based on necropsy findings and culture of *P. multocida* from the lesions.
- Exudative bronchopneumonia, sometimes with pericarditis and pleuritis.

**Tissues to Submit**
- Lung

**Diagnostic Tests**
- Culture
**PRRSV**
Porcine Reproductive & Respiratory Syndrome

**Tissues to Submit**
- Lung
- Serum
- Semen

**Diagnostic Tests**
- Virus Isolation
- Quantitative PCR
- Sequencing
- ELISA
- Histopathology
- IHC
- Serology

**Clinical Signs & History**
- Respiratory: cough, rapid breathing (thumping), unthrifty pigs.
- Reproductive: late term abortions after 90 days gestation with fresh and autolyzed piglets, stillborns, weak live piglets.

**Stage of Production**
- Gestation
- Farrowing
- Nursery
- Grow-Finish

**Diagnosis**
- Characteristic lesions and organism identification.
- Diagnosis is based on herd history and Virus Isolation (VI) or viral antigen testing (PCR or IHC).
Clinical Signs & History
- Respiratory: Rapid spread of severe cough throughout the barn, rapid breathing (thumping), depression, fever to 108°F, anorexia, dyspnea, weakness, prostration and a mucous discharge from the eyes and nose.
- Outbreak is characterized by sudden onset and rapid spread through the entire herd, often within 1-3 days.

Stage of Production
- Farrowing
- Nursery
- Grow-Finish

Diagnosis
- In uncomplicated infections, lesions are usually confined to the lungs.
- Necrotizing bronchiolitis becomes proliferative in chronic cases; SIV is confirmed by IHC or PCR or VI.
- The airways contain a copious mucopurulent exudate, and the bronchial and mediastinal lymph nodes are edematous and enlarged.

Tissues to Submit
- Lung
- Nasal Swabs
- Serum
- Trachea

Diagnostic Tests
- Virus Isolation
- Quantitative PCR
- Subtyping
- Sequencing
- BinaxNOW®
- Histopathology
- Serology (HI, ELISA)
- Influenza Multiscreen
- HT-SN™

SIV Pneumonia: diffuse interstitial pneumonia as described above with cranioventral consolidation related to secondary bacterial bronchopneumonia (arrow).
Swine Pleuropneumonia - APP
Actinobacillus pleuropneumoniae

Clinical Signs & History
- Respiratory distress is severe; there is thumping and occasionally open-mouth breathing with a blood-stained frothy nasal and oral discharge, fever, anorexia, and reluctance to move.

Stage of Production
- Grow-Finish

Diagnosis
- An explosive disease onset is suggestive.
- The pneumonia is usually bilateral, but often unevenly distributed with unique dorsal and caudal lung lobe involvement.
- The characteristic lesion is a severe fibrinonecrotic and hemorrhagic pneumonia with accompanying fibrinous pleuritis.
- In acute cases, the lesions are sharply delineated, dark consolidated regions that ooze bloody fluid from the cut surface. The involved pleura and interlobular septa are thick with exudate.
- The trachea may contain blood-stained froth. Bloody nasal/oral discharge is common.
- In chronic cases, the lesions are more organized and adhesions between the lung and rib cage become fibrous.

Tissues to Submit
- Lung
- Serum

Diagnostic Tests
- Culture-sensitivity
- Histopathology
- Serology
- PCR
- Culture
Clostridial GI Diseases
C. perfringens & C. difficile

Clinical Signs & History
- Diarrhea is the most common sign in enteric clostridial infections.
- Sudden onset of hemorrhagic diarrhea followed by collapse and death is characteristic in piglets 1-3 days old as a result of Clostridium perfringens Type C.
- Clostridium perfringens Type A and Clostridium difficile most frequently cause diarrhea without hemorrhage in pigs 3-15 days of age.

Stage of Production
- Farrowing
- Nursery

Diagnosis
- Necropsy is usually sufficient to establish the diagnosis of C. perfringens Type C in the peracute hemorrhagic form and in the acute form with jejunal emphysema. Histologic observation of villous necrosis with mucosal colonization by numerous large gram-positive rods is adequate for confirmation.
- Isolation and identification of the organism is necessary to diagnose C. perfringens Type A and C. difficile.
- C. perfringens Type C - In acute cases, gas bubbles (gut emphysema) will be visible through the serosa and within the mucosa. The disease is often segmental, normal areas can be adjacent to severely diseased areas. Important to find and submit specimens from diseased areas.
- C. perfringens Type A - Lesions are much milder than seen with C. perfringens Type C and are similar to those seen with E. coli.
- Mesocolonic edema can be seen in C. difficile and C. perfringens Type A cases.

Tissues to Submit
- Small Intestine
- Large Intestine
- Colon
- Colon Content
- Fecal Swabs

Diagnostic Tests
- Culture-sensitivity
- Toxin PCR
- Histopathology
- A/B Toxin ELISA
IF ONLY YOU DIDN'T HAVE TO WORRY ABOUT HERD HEALTH.

Commercial vaccines contain a generic selection of disease isolates from around the country and, in some cases, from around the world. With Custom Made Vaccine from Newport Laboratories, you can be confident that your herd is vaccinated against the specific isolates found in your area. Combine that with the ability to customize your vaccine to fit your animal health program and you’ve got one less thing to worry about.

Reduce Your Worries with Newport Laboratories.
800-220-2522 | www.newportlabs.com

Custom Made Vaccines are sold exclusively through your veterinarian.
Coccidiosis

Clinical Signs & History
• Diarrhea in farrowing house caused by *Isospora suis*, usually after 5 days of age. The disease is most intense from 7 to 14 days of age. Less common in nursery pigs where it can be associated with *I. suis* or other types of coccidia.
• Clinical signs of coccidiosis are due to destruction of the intestinal epithelium and, frequently, the underlying connective tissue of the mucosa.
• Infection is characterized by a watery or greasy diarrhea, usually yellowish to white and foul smelling. Piglets may appear weak, dehydrated and undersized; weight gains are depressed and sometimes piglets die.

Stage of Production
• Farrowing house disease after 5 days of age; intense between 7 to 14 days of age.
• Nursery (less common)

Diagnosis
• Diagnosis is by histopathological observation of sporozoites in the diseased mucosa; or by finding sporozoites in mucosal smears via direct microscopic examination.

Tissues to Submit
• Small Intestine
• Large Intestine
• Fecal Swab

Diagnostic Tests
• Smear
• Histopathology
Intestinal Colibacillosis/Edema Disease

E. coli

Tissues to Submit
- Small Intestine
- Large Intestine
- Fecal Swab
- Brain

Diagnostic Tests
- Culture
- Histopathology
- Toxin PCR
- Pilin PCR
- Adherence Factor PCR

Clinical Signs & History
- Diarrhea
- Sudden Death
- CNS (Edema Disease)

Stage of Production
- Farrowing
- Nursery

Diagnosis
- Confirmation is based on histologic observation of villous colonization and isolation of pathogenic E. coli.
- Dehydration and distension of the small intestine and colon with yellowish, watery to cream-like fluid. Mesenteric lacteals are still white with milk fat, indicating absorption is still normal, but hypersecretion is producing diarrhea.
Gastric Ulcers

Clinical Signs & History
- Sudden death related to gastric bleeding; hematoma (large blood clot) found in stomach.
- In the “chronic” form, hemorrhage results in anorexia, weakness, anemia, and black tarry feces.

Stage of Production
- Grow-Finish

Diagnosis
- Appearance in a pen of one or two listless, anorexic pigs that show weight loss, anemia, and dark feces.
- Sometimes dyspnea is suggestive of gastric ulceration, as is the sudden death of an apparently healthy pig.
- The typical terminal ulcer lesion is found in the gastric mucosa near the esophageal opening (cardia) in the rectangular area of white, glistening, non-glandular, squamous epithelium.
- In cases of sudden death, the stomach will contain a large hematoma (blood clot) that originates from a chronic bleeding ulcer.

Tissues to Submit
- Stomach

Diagnostic Tests
- Post-mortem Exam
Bright red gas distended loops of small intestine with bloody content.

### Hemorrhagic Bowel Syndrome - HBS

#### Mesenteric Torsion of the Small Intestine

---

**Clinical Signs & History**
- Sudden death of 4-6 month old grow-finish and young breeding pigs.
- Only involves a few animals; not a large outbreak.

**Stage of Production**
- Grow-Finish

**Diagnosis**
- Sudden death of previously healthy grow-finish pigs and characteristic post-mortem findings.
- Before manipulating the intestines, palpate the mesenteric root (tissue coming down from the lumbar back and supporting the gut mass) for a twist or torsion. When present this is diagnostic for mesenteric torsion. Smaller lesions may only involve a torsion within the mesentery of a portion of the small intestine.
- The involved gut loops are thin walled, gas filled, red due to congestion, and contain bloody fluid.

---

**Tissues to Submit**
- Small Intestine
- Colon

**Diagnostic Tests**
- Post-mortem Exam
- Tests to rule out Salmonellosis, Ileitis, and Swine Dysentery

---
Ileitis
Lawsonia intracellularis

Clinical Signs & History
- Diarrhea
- Ileitis can be either a chronic disease in growing pigs, or an acute hemorrhagic form in market weight and adult pigs.

Stage of Production
- Grow-Finish

Diagnosis
- Confirmation is based on histologic observation of characteristic proliferation and inflammation of mucosal crypts.
- Lesions may occur anywhere in the lower half of the small intestine, cecum, or colon, but are most frequent and obvious in the ileum.
- The wall of the intestine is thickened and the mesentery may be edematous.

Tissues to Submit
- Ileum
- Feces

Diagnostic Tests
- Histopathology
- PCR
**Porcine Epidemic Diarrhea**

**PEDv**

---

**Clinical Signs & History**
- The primary clinical sign in outbreaks that occur in previously naïve herds is severe diarrhea in all ages.
- Clinical signs will be essentially identical to those expected with acute TGEv infections.
- Virus is shed in the feces and transmission is via the fecal-oral route.
- The incubation period is 12-24 hours after exposure with clinically ill pigs shedding virus for 7-10 days.
- Mortality rate in suckling pigs in a naïve herd can be 30-100%.

**Stage of Production**
- Farrowing
- Nursery
- Grow-Finish

**Diagnosis**
- Clinical signs with severe diarrhea begin explosively in naïve herds leading to a presumptive diagnosis of TGEv or PEDv.
- PEDv in naïve herds affects animals of all ages.
- The most common sources of infected feces are pigs, trucks, boots, clothing or other fomites.
- Preferred samples for diagnostic testing are live pigs in acute stages of disease, fresh and formalin fixed small intestine and colon.
Transmissible Gastroenteritis
TGE Virus

Clinical Signs & History
- In susceptible herds, vomiting often is the initial sign, followed by profuse watery diarrhea, dehydration, and excessive thirst.
- Feces of nursing pigs often contain curds of undigested milk.
- Mortality is nearly 100% in piglets <1 week old, whereas pigs >1 month old seldom die.
- Gestating sows occasionally abort and lactating sows often exhibit vomiting, diarrhea and agalactia.
- Diarrhea in surviving nursing piglets continues for 5 days, but older pigs may be diarrheic for a shorter period.
- Clinically and pathologically mimics PEDV.

Stage of Production
- Farrowing
- Nursery
- Grow-Finish

Diagnosis
- Clinical signs in the epidemic form of TGE usually provide a presumptive diagnosis.
- In the mild endemic form, laboratory procedures are required. Histologic and immunofluorescent examination of the small intestine to demonstrate typical lesions and the presence of TGE viral antigen provide confirmatory evidence.
- Piglets are severely dehydrated and the skin is soiled with liquid feces.
- The stomach usually contains milk curd, but may be empty.
- The small intestine is thin walled, and the entire intestine contains greenish or yellow watery fluid and clumps of undigested milk.

Tissues to Submit
- Small Intestine
- Large Intestine
- Fecal Swab
- Serum

Diagnostic Tests
- Histopathology
- Fluorescent Antibody
- Serology
- IHC
Rotavirus
Rotavirus Enteritis

Clinical Signs & History
- Diarrhea
- Commonly, the infection is endemic in a herd. Sows have varying levels of antibody in the colostrum and milk which provides varying degrees of passive protection to nursery pigs.
- Diarrhea often begins in pigs 5 days to 3 weeks old, and is very common immediately after weaning.

Stage of Production
- Farrowing house and nursery piglets

Diagnosis
- Laboratory procedures are required for accurate diagnosis.
- The small intestine appears thin-walled and the cecum and colon contain abundant liquid and usually yellow feces.
Salmonellosis
Enteritis & Septicemia

Clinical Signs & History
• Septicemia is the usual syndrome in pigs up to 6 months of age. Illness is acute, depression is marked, fever (105°-107°F) is common and death occurs in 24-48 hours. Nervous signs may occur in pigs; these animals may also suffer from pneumonia. Mortality may reach 100%.
• Nursing pigs may develop diarrhea, but usually succumb to generalized septicemia.
• Weaning or grow-finish pigs are febrile and have liquid feces that may be yellow and contain shreds of necrotic debris.

Stage of Production
• Farrowing
• Nursery
• Grow-Finish

Diagnosis
• Depends on the clinical signs and on the laboratory examination (culture) of feces, tissues from affected animals, feed (including all mineral supplements used), water supplies, and feces from wild rodents and birds that may inhabit the premises.
• A dark red to purple discoloration of the skin is common, especially at the ears and ventral abdomen.
• Also, a swollen spleen, liver and lymph nodes can be seen as well as rubbery congested hemorrhagic lungs and roughened necrotic intestinal mucosa with ulceration and accumulation of debris.

Tissues to Submit
• Small Intestine
• Large Intestine
• Liver
• Lung
• Spleen
• Mesenteric Lymph Nodes

Diagnostic Tests
• Culture-sensitivity
• Histopathology
• Genotyping PCR
• Serotyping
**Swine Dysentery**  
*Brachyspira hyodysenteriae*

**Tissues to Submit**
- Feces
- Cecum
- Spiral Colon

**Diagnostic Tests**
- Histopathology

**Clinical Signs & History**
- Bloody diarrhea, affects large intestine, partial anorexia, soft feces, dehydration, profoundly weak, gaunt, and emaciated

**Stage of Production**
- Grow-Finish

**Diagnosis**
- Presumptive diagnosis can be based on necropsy and direct examination of smears prepared on slides from fresh colonic mucosa or feces.

**Lesions**
- Diffuse superficial lesions, confined to cecum, spiral colon and rectum.
Clinical Signs & History
- Acute septicemia, the skin (subacute) form, chronic arthritis and vegetative endocarditis may occur together or separately.
- Pigs with acute septicemia may die suddenly without previous signs. This occurs most frequently in finishing pigs weighing 100-200 lb.
- Acutely infected pigs are febrile (104°-108°F), walk stiffly, and lie on their sternums separately rather than piling in groups. They squeal when handled and may shift weight from foot to foot when standing.
- Skin discoloration may vary from widespread erythema and purplish discoloration of the ears, snout, and abdomen to diamond, square or rhomboid-shaped skin lesions (infarcts) almost anywhere on the body, particularly the lateral and dorsal areas.

Stage of Production
- Grow-Finish

Diagnosis
- Acute Erysipelas is difficult to diagnose in pigs showing only fever, poor appetite, and listlessness.
- The typical diamond-shaped skin lesions are highly characteristic when found, but not always present and can sometimes be seen with other bacterial septicemias.
- Arthritis and endocarditis are not diagnostic in the live animal because other agents can cause similar syndromes.
- In acute infection, in addition to skin lesions, lymph nodes are usually enlarged and congested, the spleen is noticeably enlarged and the lungs are edematous and congested.
- Petechiae may be found in the kidneys, heart, and occasionally elsewhere.
Lack of characteristic lesions. HEV almost exclusively affects piglets less than 4 weeks of age with vomiting, emaciation, or neurological signs such as tremors and dog-sitting posture.

**Clinical Signs & History**
- Occurs in pigs less than four weeks of age with 100% mortality
- Young pigs: sneezing, coughing, vomiting, constipation, anorexia, rapid death or chronic emaciation, huddling, nervous disorders, tremors, jerky gait, walking backwards, dog-sitting posture, down paddling, dehydration, teeth grinding

**Stage of Production**
- Nursery

**Diagnosis**
- Isolation of virus from brain stem.
- Histopathology of brain stem and pyloric portion of stomach has characteristic lesions.

**Tissues to Submit**
- Tonsils
- Brain
- Lung

**Diagnostic Tests**
- Virus Isolation
- Histopathology
- Quantitative PCR
- Hemagglutination Inhibition Assay
- Serology
**Mycoplasma Polyserositis & Polyarthritis**

*Mycoplasma hyorhinis*

---

**Clinical Signs & History**
- *M. hyorhinis, Strep suis, H. parasuis* signs are similar because these organisms all can cause polyarthritis and polyserositis.
- *M. hyorhinis* generally occurs in 3 to 10-week-old pigs becoming unthrifty, with roughened coat, slight fever, difficult movement, swollen joints, and lameness with duration up to 14 days.

**Stage of Production**
- Nursery

**Diagnosis**
- Isolation of organism from acute and subacute cases depends on freshly necropsied pigs.
- Polyserositis affected lungs, pleura, pericardium, epicardium, and peritoneum.

**Tissues to Submit**
- Consolidated lung
- Heart
- Polyserositis affected lungs, pleura, pericardium, epicardium, and peritoneum.

**Diagnostic Tests**
- Culture
- Myco Multiplex PCR

---

Fibrinous peritonitis and polyserositis over intestinal serosa, peritoneum, and liver capsule.
Porcine Circovirus  
PCV2 • PMWS • PDNS

Clinical Signs & History
- The most frequent clinical sign is wasting or failure to thrive. In decreasing order of frequency, other signs include dyspnea, enlarged lymph nodes, diarrhea, pallor, and jaundice.
- All of the fundamental clinical signs are often not observed in a single pig, but most affected farms will present the majority - if not all - of the signs over a period of time.
- Less common clinical signs include: coughing, fever, gastric ulceration, multifocal hemorrhagic dermatitis, and central nervous disorders.

Stage of Production
- Nursery
- Grow-Finish

Diagnosis
- Diagnosis of PCV2 requires that a pig or group of pigs have a specific set of clinical signs and microscopic lesions.

PCV2 Diagnostic Criteria
- Microscopic Lesions: depletion of lymphoid tissues and/or lymphohistiocytic to granulomatous inflammation in any organ (predominantly lung, lymphoid tissue, liver, kidney, intestine, pancreas), or interstitial pneumonia with bronchiolitis.
- PCV2 antigen or genetic material within characteristic lesions.
- Clinical signs alone are not diagnostic.
- Gross lesions alone are not diagnostic.
- Role of co-infections: Field observations and scientific literature suggest that PCV2, although essential for development of PCVAD, may require other factors or agents to induce the full spectrum of clinical signs and lesions associated with advanced PCVAD in conventional pigs:
  - PRRS + PCV2
  - Mycoplasma + Swine Influenza + PCV2

Tissues to Submit
- Lung
- Spleen
- Lymph nodes
- Kidney
- Intestine with Peyer's patches
- Pancreas

Diagnostic Tests
- Virus Isolation
- Quantitative PCR
- Sequencing
- Histopathology
Aid in the Prevention of Viremia, Lymphoid Depletion & Inflammation with IM administration also aids in the prevention of Lymphoid Tissue Virus Colonization with TD administration.¹

CIRCOVAC is available through your veterinarian.

Call the Experts for Whole PCV2 Virus Protection. 800-220-2522

Place Orders With

www.newportlabs.com/CIRCOVAC

Manufactured By

A SANOFI COMPANY
Strep
Streptococcus suis

Joint exudate
Fibrinous lesions on the epicardium (heart surface).

Prominent valvular endocarditis lesion; typical of pigs with bacterial septicemia.
Pus covering cerebellum and brain stem (arrow). Diffuse engorgement of meningeal blood vessels due to hyperemia of septicemia.
Pig down paddling, CNS signs with head tilted back.

Clinical Signs & History
- CNS/brain disease; lateral recumbency, paddling, ataxia, head tilt, convulsions, sudden death, arthritis with warm swollen joints, endocarditis (heart).

Stage of Production
- Farrowing
- Nursery

Diagnosis
- Definitive diagnosis depends on gross and microscopic lesions and isolation and identification of the organism. The disease can be confused with other streptococcal infections, other bacterial infections (such as Erysipelas, Salmonellosis, or acute Glasser’s disease), water deprivation, or pseudorabies.
  - The skin may be reddened in patches. Lymph nodes are often enlarged and congested, and fibrinopurulent polyserositis is common.
  - Joint capsules may be thickened and joints may contain excessive clear or cloudy fluid.
  - Affected lungs may show varying degrees of diffuse rubbbery interstitial change or patchy consolidation due to bronchopneumonia.

Tissues to Submit
- Brain
- Lung
- Joint
- Liver
- Spleen

Diagnostic Tests
- Culture-sensitivity
- Serotyping
- Histopathology
Mulberry Heart Disease
Nutritional Cardiomyopathy of Pigs

Clinical Signs & History
- Sudden death in healthy rapidly growing piglets and young pigs
- One or a few pigs in a barn.
- No premonitory signs, but collapse may be precipitated by exercise.

Stage of Production
- Farrowing House or Nursery
- 2 – 16 weeks old

Diagnosis
- Necropsy reveals pericardial effusion and marked epicardial hemorrhages.
- Cross sections of the ventricles show hemorrhages extend throughout the wall.
- Hemorrhages are not superficial on the epicardium, as seen with bacterial septicemias.
- Histopathological heart lesions are pathognomonic. Send formalin fixed cross section of ventricles for definitive diagnosis.
- A Vitamin E/Selenium responsive disease.
- Diets may be low in active form of Vitamin E or selenium (Se).
- Factors that may increase Se demand include low concentrations of dietary protein (especially sulfur-containing amino acids), diets with an excess of selenium antagonistic compounds, and possibly genetic influences on selenium metabolism.
- Vitamin E demand may increase with diets high in polyunsaturated fatty acids, Vitamin A, mycotoxins, or rancid fats.

Tissues to Submit
- Fresh lung and pericardial fluid
- Formalin fixed left and right ventricles

Diagnostic Tests
- Culture of lung and pericardial fluid to rule out septicemia
- Histopathology reveals diagnostic lesions

Fresh heart with multiple prominent hemorrhages on the epicardial surface.

Cross sections of formalin preserved pig heart. Heart on the left is normal. Heart on the right shows severe diffuse hemorrhage and necrosis of entire left ventricular wall.
**M. hyo Polyarthritis**  
*Mycoplasma hyosynoviae*

### Clinical Signs & History
- Lameness typically occurs at 3 to 5 months of age, appearing acutely and may occur in more than one leg.
- Slight reduction in appetite resulting in weight loss.

### Stage of Production
- Grow-Finish

### Diagnosis
- Infected joints are swollen with edema and hyperemia of synovial membranes.
- On necropsy, lesions are restricted to the joints; especially stifles.
- Joints contain excess of clear, yellow synovial fluid while surrounding tissues are unaffected.
- Definitive diagnosis is made based on isolation of organism.

### Tissues to Submit
- Joints
- Synovium

### Diagnostic Tests
- Myco Multiplex PCR

---

**Proliferative synovitis**

**Collecting joint fluid**

**Dog-sitting pig**
### Reproductive Diseases

#### Lepto/Parvo/PRRSV

**Tissues to Submit**
- Aborted Fetus - two of the freshest
- Mummies - two typical
- Stillborns
- Weakborns
- Sow serum

**Clinical Signs & History**
- Abortions, mummies, stillborns, weakborns.
- PPV is the most commonly identified cause of reproductive failure with associated mummification.
- Lepto can cause abortions occurring 2-4 weeks before farrowing and is the most common manifestation of leptospirosis in pigs.

**Stage of Production**
- Gestation
- Farrowing

**Diagnosis**
- Porcine Parvovirus (PPV) is usually asymptomatic in adults.
- Sows infected with PPV before 70 days of gestation may abort mummified or near term autolyzed fetuses.
- PRRS causes late term abortions including fresh and autolyzed pigs; or weak born piglets.

---

**Parvo**

Parvovirus infected sow litter following abortion. Note mummified fetuses, uneven sizes, and postmortem change indicative of *in utero* death.

**PRRS**

One litter from a PRRS virus associated abortion. Note litter has late term piglets, at varying stages of *in utero* decomposition, typical of the disease infecting one piglet at a time *in utero*.
Acknowledgements

**Editor**

David H. Zeman, DVM, PhD  
Diplomate, American College of Veterinary Pathologists  
Professor, Head & Director Emeritus  
Veterinary & Biomedical Sciences Department  
Animal Disease Research & Diagnostic Laboratory  
South Dakota State University

**Associate Editors**

Mark Titus, DVM, MS  
Newport Laboratories  
Technical Services Veterinarian

George Caraway  
Newport Laboratories

Newport Laboratories would like to extend appreciation to the following organizations and individuals that have contributed valuable content and/or input for the fourth edition of the Swine Disease Diagnostic Manual:

University of Minnesota - Veterinary Diagnostic Laboratory  
Iowa State University - Veterinary Diagnostic Laboratory  
South Dakota State University - Animal Disease Research & Diagnostic Laboratory  
Suidae Health & Production - Algona, IA  
Swine Veterinary Center - St. Peter, MN  
Veterinary Medical Center - Worthington, MN