

University of Minnesota

Veterinary Diagnostic Laboratory

2016 Annual Report





2016 Annual Report

The Veterinary Diagnostic Laboratory's mission is to protect and promote animal and human health through early detection and monitoring of animal diseases. The VDL fulfills its mission by identifying emerging diseases, developing new diagnostic methods, and training diagnosticians, veterinarians and graduate students. The laboratory is the official laboratory of the Minnesota Board of Animal Health and is Minnesota's only full service accredited animal health diagnostic facility.

2016 Highlights

New Director

The VDL welcomed Dr. Jerry Torrison as the new director of the lab in late March. Jerry is returning to the VDL, having served as an associate clinical professor and diagnostician from 2004 to 2011. From 2011 to March 2016, he was a swine veterinarian with the research and nutritional services team at Zinpro Corporation, a Minnesota-based manufacturer of organic trace minerals for beef and dairy cattle, swine, poultry, aquatic, equine, and companion animals. Prior to 2004, he was a swine consultant with Swine Vet Center, PA, in St. Peter, Minnesota, for six years and health assurance manager with PIC, a swine breeding stock company, from 1994-1998. Jerry earned his DVM and PhD degrees in veterinary medicine from the University of Minnesota.

MPTL expansion

The 2015 Minnesota Legislature provided an appropriation of \$8.5 million to expand the Minnesota Poultry Testing Laboratory (MPTL), a branch lab of the VDL and partnership with the Minnesota Board of Animal Health (BAH). Enhancements included new offices, conference room and break room space along with new laboratory space specifically sample delivery room, necropsy lab, media prep lab, bacteriology and serology lab, sample process & extraction lab, PCR testing lab, master mix lab, and autoclave room. The lab spaces also have new equipment such as: chemical fume hoods, biosafety cabinets, PCR machines, centrifuges, sample vortex machines, freezers, and other diagnostic equipment. The 20-year-old space was expanded from a 3,665 square-foot building to an 11,890 square-foot facility.

The lab, located in the heart of the Minnesota's poultry industry, will enhance the ability of the state to respond to disease outbreak situations such as the avian influenza outbreak of 2015 which affected over 110 poultry production facilities and had an economic impact in Minnesota estimated at over \$650 million. MPTL also serves as the Authorized Laboratory for the National Poultry Improvement Plan (NPIP) in Minnesota and is the center for management of BAH poultry programs.

NAHLN Level 1 status

The UMN VDL achieved Level 1 status in the National Animal Health Laboratory Network (NAHLN). The NAHLN is a network of federal, state and university laboratories that provide diagnostic testing services for disease surveillance and outbreak response in agricultural animals. Level 1 laboratories must meet a defined set of criterion, including quality standards, Biosafety Level 3 space, the ability to send test results electronically and the capability of performing tests on large numbers of samples.



To support its Level 1 status the VDL has obtained federal funding for support for the quality system, electronic messaging enhancement and support, equipment that increases testing capacity, and technical support for foreign animal disease and/or emerging disease diagnostic capabilities, including emerging disease case work up.

Legislative funding

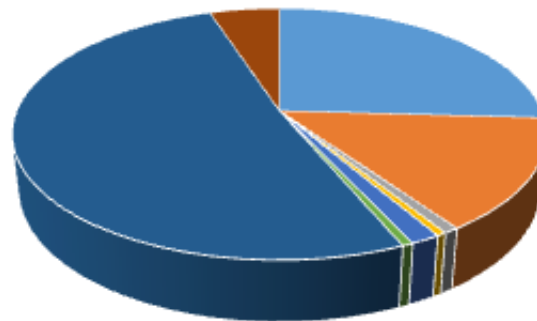
The Minnesota state legislature approved nearly \$2.1 million to expand and enhance the Veterinary Diagnostic Laboratory's services. The one-time funds will provide equipment for developing new diagnostic tests for emerging diseases, and increase the lab's genomic sequencing capacity to discover emerging viruses and characterize existing viruses. The funding also will allow for three years of computer programming and software development to securely deliver higher quality diagnostic reports to veterinarians and animal owners.

2016 Numbers

Cases: 52,129

Procedures: 1,283,364

Procedures by Species:



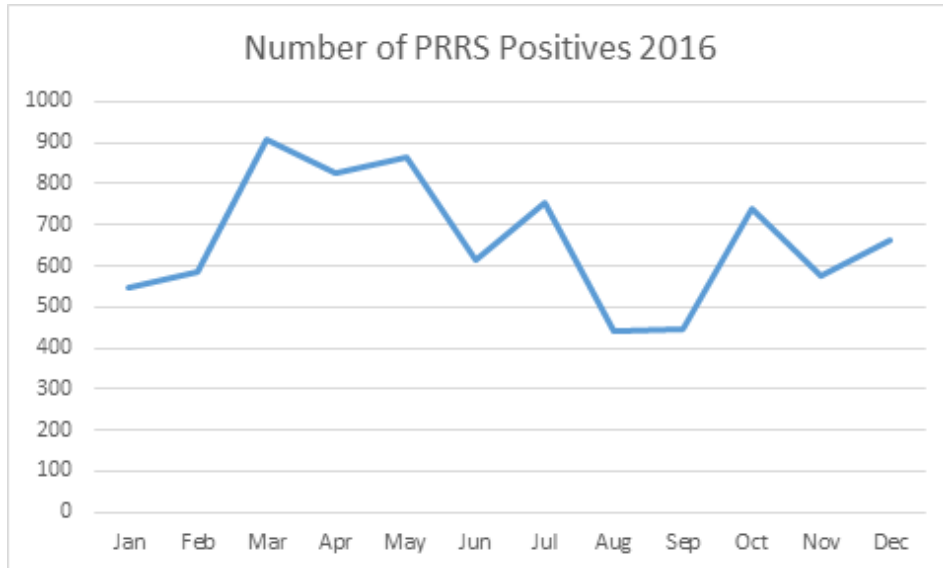
■ Avian 332,359	■ Bovine 184,826	■ Canine/Feline 9,935
■ Equine 6,283	■ Other Ruminant/Cervidae 19,319	■ Fish 7,292
■ Porcine 658,589	■ Other Miscellaneous 64,761	

TOTAL 1,283,364

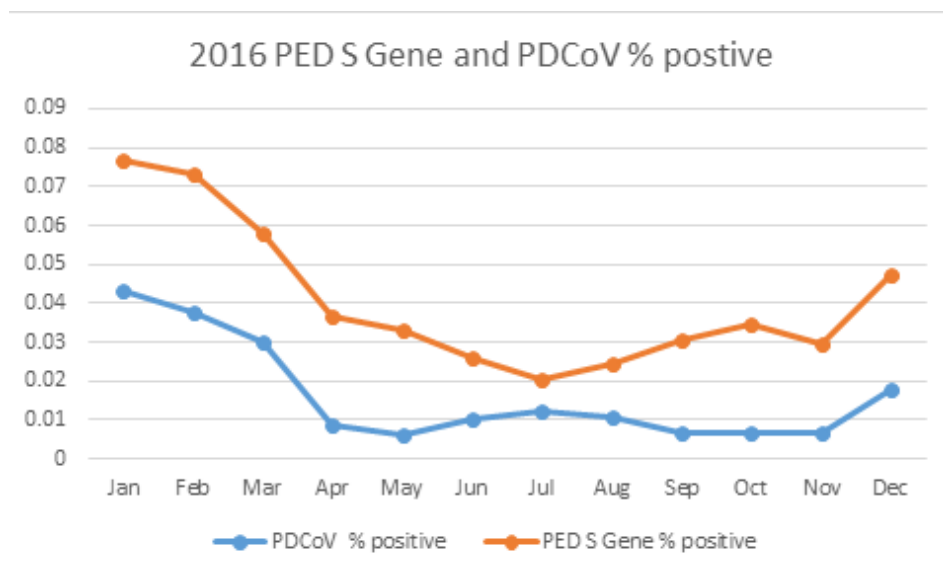


2016 Selected Animal Health and Disease Trends

Porcine Reproductive and Respiratory Syndrome (PRRS) causes decreased reproductive performance and respiratory disease in pigs and is the most economically significant disease affecting U.S. swine production. In 2016, the VDL ran 244,189 PRRS PCR tests.

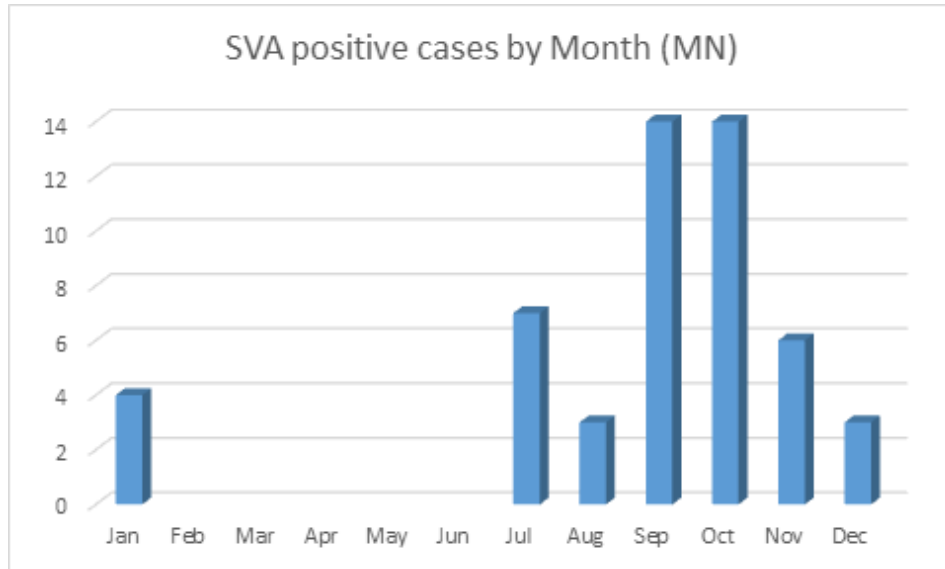


Swine Enteric Coronavirus Disease is a diarrheal disease of pigs that has recently emerged in the United States and caused by Porcine Epidemic Diarrhea virus (PEDv) and/or Porcine Delta Coronavirus (PDCoV) and can appear similar to another corona virus disease Transmissible Gastroenteritis (TGE). In 2016, the VDL ran 40,131 PEDv and PDCoV Multiplex Real Time PCR tests and 5,238 Triplex (PEDv/TGE/PDCoV) RT-PCR tests. The VDL began running the Triplex PCR in November 2016.





Senecavirus A - SVA (Seneca Valley Virus) can cause a vesicular disease in pigs that can appear like Foot and Mouth Disease or other vesicular diseases not present in the US that have the potential to devastate the US livestock industry. The UMN VDL ran 3,205 Senecavirus A EZ Real time RT-PCR tests in 2016.



Lab for Udder Health (LUH) Testing - the VDL LUH provides diagnostic services to the dairy industry in its bacteriology laboratory, culturing individual cow, bulk milk and environmental samples.

Mastitis Cow/Quarter Culture
Top 10 positive Organisms of 18,036 samples

Bacillus sp.	3,580
Staphylococcus chromogenes	2,031
Escherichia coli	1,464
Staphylococcus sp.	1,264
Aerococcus sp.	1,228
Streptococcus dysgalactiae	1,169
Streptococcus uberis	867
Staphylococcus aureus	832
Lactococcus garvieae	820
Streptococcus sp.	658

Screening Tests – Positive Results

Mycoplasma Culture Total	48,101
Mycoplasma positive	1,486
Prototheca Culture Total	6,566
Prototheca positive	242
Staph & Strep Culture Only Total	12,089
Non-ag Strep. sp.	6,052
Staphylococcus aureus	266
Staphylococcus sp.	3,660
Streptococcus agalactiae	11
Staphylococcus Culture Only Total	23,722
Staphylococcus aureus	1,473
Staphylococcus sp.	13,033



Tularemia is a zoonotic bacterial disease that can cause illness and death in rabbits and other rodents and can also affect domestic animals such as cats that may come into contact with infected mammals. The bacteria can also be spread by ticks or other vectors. People can also become infected with the bacteria that causes Tularemia (*Francisella tularensis*). The VDL has diagnosed an average of 0-1 cases of Tularemia per year over the last 10 years, but 2016 saw an increase in the number of cases.

2016 Tularemia Positives: Date, Animal and Location Information

Month	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Apr 2016	4	5	6	7	8	9	10
	11	12	13	14	15	16	17
	18	19	20	21	22	23	24
	25	26	27 Rabbit Hennepin County	28	29	30	1
May 2016	2	3	4	5 Cat Hennepin County	6	7	8
	9	10	11	12	13	14	15
	16	17	18 Cat Ramsey County	19	20	21	22
	23	24	25	26	27	28	29
	30	31	1	2	3	4	5
Jun 2016	6	7	8	9	10	11	12
	13 Cat Swift County	14	15	16	17	18	19
	20	21	22 Cat Washington County	23	24	25	26
	27 Cat Hennepin County	28 Cat Washington County	29	30	1	2	3
Jul 2016	4	5	6	7	8	9	10
	11	12	13	14	15	16	17
	18	19	20	21 Cat La Crosse WI	22	23	24
	25	26	27	28	29	30	31
Aug 2016	1	2	3	4	5	6	7
	8	9	10	11	12	13	14
	15	16	17	18	19	20	21
	22	23	24 Cat Hennepin County	25	26	27	28
	29	30	31	1	2	3	4
Sep 2016	5	6	7	8	9	10	11
	12	13	14	15	16	17	18
	19	20	21	22	23	24	25
	26	27	28	29	30	1	2
Oct 2016	3	4	5	6 Cat La Crosse WI	7 Cat La Crosse WI	8	9
	10	11	12	13	14 Cat La Crosse WI	15	16
	17	18	19	20	21	22	23
	24	25	26	27	28 Rabbit Hennepin County	29	30
	31 Cat Hennepin County	1	2	3	4	5	6



UMN VDL Regulatory Testing Numbers 2016

The VDL conducts surveillance testing for diseases foreign to the United States through various USDA and other programs. Other zoonotic or economically important diseases are reportable to the Minnesota Board of Animal Health.

FOREIGN ANIMAL DISEASES AND PROGRAM DISEASES	# PROCEDURES
FOOT AND MOUTH DISEASE	298
CLASSICAL SWINE FEVER – USDA SURVEILLANCE	725
PSEUDORABIES – USDA SURVEILLANCE	3318
AVIAN INFLUENZA	70,515
EXOTIC NEWCASTLE DISEASE	9532
VESICULAR STOMATITIS VIRUS	1548
SWINE INFLUENZA VIRUS- USDA SURVEILLANCE	3372 (FY2016)
RABIES	2248
SCRAPIE	161
CWD	2578
KOI HERPES VIRUS	8
VIRAL HEMORRHAGIC SEPTICEMIA	564
OTHER DISEASES - REPORTABLE TO THE MINNESOTA BAH	
BRUCELLOSIS (B CANIS AND SP.)	13,744
EQUINE INFECTIOUS ANEMIA	4099
JOHNE’S DISEASE	12,201
Q FEVER	413
TULAREMIA	32 positive
EQUINE HERPES MYELOENCEPHALOPATHY	2
AVIAN ENCEPHALOMYELITIS	10
AVIAN METAPNEUMOVIRUS	17,621
MYCOPLASMA GALLISEPTICUM	41,666
MYCOPLASMA MELEAGRIDIS	62,568
MYCOPLASMA SYNOVIAE	72,672
PULLORUM TYPHOID	592
SALMONELLA ENTERITIDIS	107 positive
OTHER ZONOTIC AND EMERGING DISEASES	
SENECAVIRUS A	4147
OPP	4707
TOXOPLASMOSIS	52
CANINE INFLUENZA	16
BORRELIA BURGDORFERI	205



Section Updates

Administration

- The new laboratory director, Dr. Jerry Torrison began work April 1, 2016. Interim director, Dr. Stephanie Rossow resumed her role as a veterinary diagnostic pathologist specializing in swine.
- Dr. Jim Collins completed his sabbatical where he spent a year exploring the use of telepathology and other technology in veterinary diagnostic medicine. He is back working as a food animal pathologist.

Bacteriology

- Bacteriology is participating in a project with Vet-LIRN, (an FDA laboratory network of veterinary diagnostic laboratories that can coordinate to respond to chemical and microbial food or drug contamination events) that is determining the antibiograms of selected veterinary clinical pathogens using Sensititer data.

Comparative Immunology and Endocrinology

- Testing services in the Comparative Immunology & Endocrinology (CIE) lab section were discontinued, effective September 2016. Routine testing will be outsourced and research testing will be done in a CVM research laboratory.

Electron Microscopy

- A new JEOL 1400 Plus transmission electron microscopy (TEM) microscope was purchased. The new TEM will replace the current TEM unit, which is 26 years old. The scope is equipped with newly developed digital imaging, to allow high-definition images. Features include automated focusing, stigmatism and alignment. The optics system will provide high-contrast, rotation-free imaging, and stability that minimizes astigmatism. The JEOL 1400 Plus has a newly designed graphical user interface, and tomography capabilities, which will allow 3-dimensional imaging of viral particles and tissue components.

Histology

- The Histology lab acquired two important pieces of equipment – an additional/backup tissue processor and tissue embedder. These pieces of equipment were necessary to provide continuous service to the VDL.

Immunohistochemistry

- The IHC Lab continues to perform lymphoma typing for a Hong Kong diagnostic center, as well as tumor and infectious agent identification for various VDLs from around the US and South America.
- The IHC Lab has acquired a digital oven to precisely control the heat steps present in the IHC and in situ hybridization procedures, as well as a new pressure cooker (for unmasking antigens) and a micro-centrifuge.
- The IHC lab participated in the 2016 AAVLD/NVSL Program for Inter-laboratory Comparison, and scored 100% in its detection of Porcine Circovirus type 2 in the test samples provided by NVSL.



Information Technology

- The state funding for the VDL will provide for computer programming and software development over the next three years, to securely deliver higher quality diagnostic reports to veterinarians and animal owners. The upgrades will allow the addition of historical trends to a herd's health status, the ability to trace disease pathogens through a business's supply chain, and ensure compatibility with regional and federal disease reporting standards. The new reporting tools also will be built for delivery via mobile technology—giving veterinarians and farmers more convenient access to their data.
- Work on the project began in 2016 and an RFP was developed and sent out to solicit bids for the project.

Lab Receiving

- New laboratory refrigerator and freezer were purchased to increase sample storage space and security.
- Lab staff have taken on various roles in sample processing for molecular diagnostics and bacteriology, with plans to grow this into a larger team of staff dedicated solely to sample processing for the entire VDL.
- A significant upgrade to the shipping and receiving logistics is in progress, which will improve inbound tracking capabilities and return shipping label systems for VDL clients across the state. The goal is to implement the new program within the next couple of months.

Molecular Development

- State funds will provide equipment to create a dedicated section for developing new diagnostic tests for emerging diseases, and increase the lab's genomic sequencing capacity to discover emerging viruses and characterize existing viruses. The extra equipment means the development of new tests won't disrupt routine lab testing. It also provides reserve testing capacity during large-scale disease outbreaks.
- Work has begun on the process to renovate VDL room 341 in preparation for the transition of that space to accommodate the Molecular Development group.
- A new wet-bench expert and a new section head were added to the Molecular Development Section in 2016. A new -80 freezer was also added to the lab.

Molecular Diagnostics

- The Molecular section underwent reorganization and as of October 31st, 2016 no longer consists of two separate labs (formerly Molecular Diagnostics and Molecular Bacteriology) and instead is designated as one section- Molecular Diagnostics.
- Seneca Valley Virus PCR was validated by the Molecular Development Lab and is part of routine testing in Molecular Diagnostics twice a week.
- A new multiplex Polymerase Chain Reaction (PCR) test that combines Porcine Epidemic Diarrhea Virus (PEDv), Porcine Deltacoronavirus (PDCoV) and Transmissible Gastroenteritis Virus (TGEV) into one assay was implemented into the Molecular Diagnostic clinical testing schedule effective October 31st, 2016. The new assay provides clients with timely, quality results for all three viruses at the same time.



- The Molecular Diagnostics lab has hired 7 new employees in the last year and plans to add 3 more in the coming months.
- The Molecular Diagnostics lab has improved the average PRRS sequencing turn-around time from 4 business days to 2 business days.

Necropsy

- Three new large pieces of equipment have been installed in the Necropsy section.
 - A digital Faxitron machine has replaced decades old film version to increase efficiency and productivity for cases requiring x-rays.
 - A Biosafety Cabinet has been installed in the BSL-2 area for the containment of high risk specimens such as tularemia and Brucella suspects.
 - A downdraft table was donated to the VDL by Laboratory Builders of Burr Ridge, IL. This provides much needed ventilated space for trimming of formalin fixed tissues.

Parasitology

- The parasitology section purchased an Olympus SZX16 transillumination and reflective stereoscope with a double objective (0.5x and 1.0x objective) that allows for magnification from 5x to 115x magnification with a 5MP Color Camera Head Compatible with CellSense 1.14 imaging software. The lab is now able to take videos and high resolution photos of gross specimens for teaching, collaboration, and telepathology.

Pathology

- Two residents began the residency training program in 2016. The VDL currently has 4 anatomic pathology residents.

Poultry Testing Lab

- The Grand Re-Opening of the MPTL occurred September 22, 2016. The renovated and expanded space and new equipment will greatly improve service for poultry clients.
- PCR testing officially began at MPTL on Monday September 26th; the lab is currently able to run AI, aMPV, END, and NDV PCRs in the new molecular lab. Mycoplasma and salmonella serotyping PCR will be added in the near future.
- A Luminex machine was also purchased as part of the project to run salmonella serotyping.
- The Sensititre System was also purchased with building project funds for the bacteriology lab. This has been installed and training is complete.
- The serology section purchased a second automated ELISA plate washer and stacker which will make it much easier for the technicians to coordinate testing runs, which provides more testing capabilities and decreases turnaround time.



Quality Assurance

- The VDL successfully completed 3 external audits last year.
- There were two major upgrades to QPulse (the quality management software system).
- The VDL is currently accredited by AAVLD (American Association of Veterinary Laboratory Diagnosticians).
- Dr. Becky Davies of Quality Central and some research GRP clients were published as part of a news feature in Nature. (<http://www.nature.com/news/how-quality-control-could-save-your-science-1.19223>)

Serology

- The Serology lab conducted intensive testing in collaboration with Zoetis for validation of porcine epidemic diarrhea (PED) antibody test kit which they are planning to release on the market soon. Also, the lab collaborated with a company “Indevr” to test samples for validation of an automated HI reader. The lab successfully completed required proficiency testing performed through the National Veterinary Services Laboratory. The lab also started offering the Parachek 2 ELISA test for detection of antibodies to Johne’s disease in small ruminants.
- The Serology lab started offering ELISA test for antibodies to Seneca Valley Virus in pigs.

Udder Health

- The Laboratory for Udder Health developed a new agar media that will be launched in the near future as part of the Minnesota Easy Culture™ System. This new media has undergone internal testing and was part of a validation study and pilot study on selective dry cow therapy.
- The LUH is currently exploring adding options for dairy bedding testing, making use of the UMN Soils Lab to offer dry matter and organic matter testing.
- The MN Easy Culture System was featured in the UK Farmer’s Guardian online and in print (2/5/2016).

Virology

- The Virology lab validated and started offering Seneca Valley Virus (SVV) isolation and indirect immunofluorescence assay (IFA) for detection of antibodies to SVV.
- The Virology lab also worked with the Molecular Diagnostic Lab to validate a tissue processing method using an instrument called “Genogrinder”. Validation for isolation of swine influenza virus on samples processed using genogrinder was completed.



VDL Faculty and Staff

The VDL currently employs 16 faculty members and 78 staff.

Outreach

- The St. Paul VDL conducted 19 formal tours in 2016 with a total of 190 people visiting the lab. After the remodel and expansion, the MPTL conducted 11 tours of the new facility in addition to the multiple tours given during the Grand Opening ceremony.
- In addition to the CVM senior veterinary students and veterinary technician students from nearby technical colleges, the VDL also trained several outside individuals or groups including the Joint Pathology Center residents, a swine certificate student from China and others.
- The Laboratory for Udder Health conducted 4 trainings for 69 people on their Easy culture system and also had two trainees for an extended training in the lab.
- The Molecular Diagnostics lab trained National Guard members from the Mobile Lab Unit on avian influenza testing.
- Other outreach activities included:
 - VDL/OFC booths at the MN Dairy Health Conference and the AABP Conference

Awards

- Jan Shivers, Anibal Armien, CVM researchers: Davis-Thompson Foundation (former CL Davis Foundation) Journal award for best article in the journal Veterinary Pathology for the year 2016
- Ileana Miranda- J1 scholar under Dr. Armien: ACVP Young Investigators Award Poster Competition in the category of Diagnostic Pathology.
- Matt Sturos: Charles Louis Davis DVM Foundation for the Advancement of Veterinary and Comparative Pathology 2016 Student Scholarship award
- Dr. Talita Resende, a PhD student advised by Dr. Fabio Vannucci; Best poster at the 24th International Pig Veterinary Society (IVPS) congress
- Dale Lauer: Exemplary Leadership Award
- Dr. Jim Collins: 2016 Minnesota Pork Board Distinguished Service Award

Publications

Aboubakr HA, Nauertz A, Luong NT, Agrawal S, El-Sohaimy SA, Youssef MM, **Goyal SM**. In Vitro Antiviral Activity of Clove and Ginger Aqueous Extracts against Feline Calicivirus, a Surrogate for Human Norovirus. J Food Prot. 2016 Jun;79(6):1001-12. doi: 10.4315/0362-028X.JFP-15-593.

Acierno MM, Ober CP, Goupil BA, **Olson EJ**. Ureteral obstruction secondary to disseminated penicilliosis in a German shepherd dog. Can Vet J. 2016 Dec;57(12):1242-1246.



Anjos BL, Peixoto PV, Caldas SA, Bhaltazar D, França TN, **Armién AG**. Poisoning by the swainsonine-containing plant *Sida carpinifolia* in captive sambar deer (*Cervus unicolor*). *J Zoo Wildl Med*. 2016 Sep;47(3):862-867.

Boniotti MB, Papetti A, Lavazza A, Alborali G, Sozzi E, Chiapponi C, Faccini S, Bonilauri P, Cordioli P, **Marthaler D**. Porcine Epidemic Diarrhea Virus and Discovery of a Recombinant Swine Enteric Coronavirus, Italy. *Emerg Infect Dis*. 2016 Jan;22(1):83-7. doi: 10.3201/eid2201.150544.

Clancy CS, Roug A, **Armién AG**, Van Wettère AJ. Intracerebral Malignant Plasmacytoma in a Mule Deer (*Odocoileus hemionus*). *J Comp Pathol*. 2016 Feb-Apr;154(2-3):268-71. doi: 10.1016/j.jcpa.2016.02.003

Davies B, Wang X, Dvorak CM, **Marthaler D**, Murtaugh MP. Diagnostic phylogenetics reveals a new Porcine circovirus 2 cluster. *Virus Res*. 2016 Jun 2;217:32-7. doi: 10.1016/j.virusres.2016.02.010.

de Francisco ON, Feeney D, **Armién AG**, **Wuenschmann A**, Redig PT. Correlation of brain Magnetic Resonance Imaging of spontaneously lead poisoned bald eagles (*Haliaeetus leucocephalus*) with histological lesions: A pilot study. *Res Vet Sci*. 2016 Apr;105:236-42. doi: 10.1016/j.rvsc.2016.02.010.

Detmer SE, Bouljihad M, **Hayden DW**, **Schefers JM**, **Armién A**, **Wünschmann A**. Fatal pyogranulomatous myocarditis in 10 Boxer puppies. *J Vet Diagn Invest*. 2016 Mar;28(2):144-9. doi: Brain, Craniofacial, and

Durward-Akhurst SA, Finno CJ, Barnes N, **Shivers J**, Guo LT, Shelton GD, Valberg SJ. Major Histocompatibility Complex I and II Expression and Lymphocytic Subtypes in Muscle of Horses with Immune-Mediated Myositis. *J Vet Intern Med*. 2016 Jul;30(4):1313-21. doi: 10.1111/jvim.14371.

Finno CJ, Valberg SJ, **Shivers J**, **D'Almeida E**, **Armién AG**. Evidence of the Primary Afferent Tracts Undergoing Neurodegeneration in Horses With Equine Degenerative Myeloencephalopathy Based on Calretinin Immunohistochemical Localization. *Vet Pathol*. 2016 Jan;53(1):77-86. doi: 10.1177/0300985815598787

Gazda LS, **Collins J**, Lovatt A, Holdcraft RW, Morin MJ, Galbraith D, Graham M, Laramore MA, Maclean C, Black J, Milne EW, **Marthaler DG**, Vinerean HV, Michalak MM, Hoffer D, Richter S, Hall RD, Smith BH A comprehensive microbiological safety approach for agarose encapsulated porcine islets intended for clinical trials. *Xenotransplantation*. 2016 Nov;23(6):444-463. doi: 10.1111/xen.12277

Glaser L, Carstensen M, Shaw S, Robbe-Austerman S, **Wunschmann A**, Grear D, Stuber T, Thomsen B. Descriptive Epidemiology and Whole Genome Sequencing Analysis for an Outbreak of Bovine Tuberculosis in Beef Cattle and White-Tailed Deer in Northwestern Minnesota. *PLoS One*. 2016 Jan 19;11(1):e0145735. doi: 10.1371/journal.pone.0145735.

Goodell CK, Zhang J, Strait E, Harmon K, **Patnayak D**, **Otterson T**, **Culhane M**, Christopher-Hennings J, Clement T, Leslie-Steen P, Hesse R, Anderson J, Skarbek K, Vincent A, Kitikoon P, Swenson S, Jenkins-Moore M, McGill J, Rauh R, Nelson W, O'Connell C, Shah R, Wang C, Main R, Zimmerman JJ. Ring test evaluation of the detection of influenza A virus in swine oral fluids by real-time reverse-transcription polymerase chain reaction and virus isolation. *Can J Vet Res*. 2016 Jan;80(1):12-20.

Heinrich D, **Sturos M**, Smith K, Vernau W, Overmann J. What is your diagnosis? Liver aspirate from a cat. *Vet Clin Pathol*. 2016 Sep;45(3):513-4. doi: 10.1111/vcp.12382. Epub 2016 Jul 5.



Homwong N, Diaz A, **Rossow S**, Ciarlet M, **Marthaler D**. Three-Level Mixed-Effects Logistic Regression Analysis Reveals Complex Epidemiology of Swine Rotaviruses in Diagnostic Samples from North America. *PLoS One*. 2016 May 4;11(5):e0154734. doi: 10.1371/journal.pone.0154734.

Homwong N, Jarvis MC, Lam HC, Diaz A, **Rovira A**, Nelson M, **Marthaler D**. Characterization and evolution of porcine deltacoronavirus in the United States. *Prev Vet Med*. 2016 Jan 1;123:168-74. doi: 10.1016/j.prevetmed.2015.11.001.

Hong S, **Rovira A**, Davies P, Ahlstrom C, Muellner P, Rendahl A, Olsen K, Bender JB, Wells S, Perez A, Alvarez J. Serotypes and Antimicrobial Resistance in *Salmonella enterica* Recovered from Clinical Samples from Cattle and Swine in Minnesota, 2006 to 2015. *PLoS One*. 2016 Dec 9;11(12):e0168016. doi: 10.1371/journal.pone.0168016

Hull JJ, **Marthaler D**, **Rossow S**, Ng TF, Montmayeur AM, Magana L, Moon SS, Jiang B. Genomic Sequence of the First Porcine Rotavirus Group H Strain in the United States. *Genome Announc*. 2016 Mar 10;4(2). pii: e01763-15. doi: 10.1128/genomeA.01763-15.

Jarvis MC, Lam HC, **Rovira A**, **Marthaler DG**. Complete Genome Sequence of Porcine Epidemic Diarrhea Virus Strain COL/Cundinamarca/2014 from Colombia. *Genome Announc*. 2016 Apr 21;4(2). pii: e00239-16. doi: 10.1128/genomeA.00239-16

Jarvis MC, Lam HC, Zhang Y, Wang L, Hesse RA, Hause BM, Vlasova A, Wang Q, Zhang J, Nelson MI, Murtaugh MP, **Marthaler D**. Genomic and evolutionary inferences between American and global strains of porcine epidemic diarrhea virus. *Prev Vet Med*. 2016 Jan 1;123:175-84. doi: 10.1016/j.prevetmed.2015.10.020.

Joshi LR, Fernandes MH, Clement T, Lawson S, Pillatzki A, Resende TP, **Vannucci FA**, Kutish GF, Nelson EA, Diel DG. Pathogenesis of Senecavirus A infection in finishing pigs. *J Gen Virol*. 2016 Dec;97(12):3267-3279. doi: 10.1099/jgv.0.000631.

Krüger MU, **Wünschmann A**, Ward C, Stauthammer CD. Pulmonary atresia with intact ventricular septum and hypoplastic right ventricle in an Arabian foal. *J Vet Cardiol*. 2016 Sep;18(3):284-9. doi: 10.1016/j.jvc.2016.04.002.

Lin CM, Saif LJ, **Marthaler D**, Wang Q. Evolution, antigenicity and pathogenicity of global porcine epidemic diarrhea virus strains. *Virus Res*. 2016 Dec 2;226:20-39. doi: 10.1016/j.virusres.2016.05.023. Review.

Macedo N, Oliveira S, Torremorell M, **Rovira A**. Immune response to oligopeptide permease A (OppA) protein in pigs naturally and experimentally infected with *Haemophilus parasuis*. *Res Vet Sci*. 2016 Aug;107:62-7. doi: 10.1016/j.rvsc.2016.05.006.

McCluskey BJ, Haley C, **Rovira A**, Main R, Zhang Y, Barder S. Retrospective testing and case series study of porcine delta coronavirus in U.S. swine herds. *Prev Vet Med*. 2016 Jan 1;123:185-91. doi: 10.1016/j.prevetmed.2015.10.018.



Mirajkar NS, **Gebhart CJ**. Comparison of agar dilution and antibiotic gradient strip test with broth micro-dilution for susceptibility testing of swine *Brachyspira* species. *J Vet Diagn Invest*. 2016 Mar;28(2):133-43. doi: 10.1177/1040638716629154

Mirajkar NS, Davies PR, **Gebhart CJ** Antimicrobial Susceptibility Patterns of *Brachyspira* Species Isolated from Swine Herds in the United States. *J Clin Microbiol*. 2016 Aug;54(8):2109-19. doi: 10.1128/JCM.00834-16.

Mirajkar NS, Johnson TJ, **Gebhart CJ**. Complete Genome Sequence of *Brachyspira hyodysenteriae* Type Strain B-78 (ATCC 27164). *Genome Announc*. 2016 Aug 18;4(4). pii: e00840-16. doi: 10.1128/genomeA.00840-16 Erratum in: *Genome Announc*. 2017 Jan 19;5(3):.

Mirajkar NS, Phillips ND, La T, Hampson DJ, **Gebhart CJ**. Characterization and Recognition of *Brachyspira hampsonii* sp. nov., a Novel Intestinal Spirochete That Is Pathogenic to Pigs. *J Clin Microbiol*. 2016 Dec;54(12):2942-2949.

Phan TG, **Giannitti F**, **Rossow S**, **Marthaler D**, Knutson T, Li L, Deng X, Resende T, **Vannucci F**, Delwart E. Detection of a novel circovirus PCV3 in pigs with cardiac and multi-systemic inflammation. *Virol J*. 2016 Nov 11;13(1):184.

Schwabenlander M, Stepaniuk K, Carstensen M, **Armién AG**. Dental Lesions of a Free-ranging Gray Wolf (*Canis lupus*) Implicated in a Human Attack in Minnesota, USA. *J Wildl Dis*. 2016 Jan;52(1):131-7. doi: 10.7589/2015-01-01410.1177/1040638715626486

Sharafeldin TA, Chen Q, **Mor SK**, **Goyal SM**, **Porter RE**. Altered Biomechanical Properties of Gastrocnemius Tendons of Turkeys Infected with Turkey Arthritis Reovirus. *Vet Med Int*. 2016;2016:7829138. doi: 10.1155/2016/7829138.

Sibley SD, Finley MA, Baker BB, Puzach C, **Armién AG**, Giehlbrock D, Goldberg TL. Novel reovirus associated with epidemic mortality in wild largemouth bass (*Micropterus salmoides*). *J Gen Virol*. 2016 Oct;97(10):2482-2487. doi: 10.1099/jgv.0.000568

Singh A, Bekele AZ, **Patnayak DP**, Jindal N, **Porter RE**, **Mor SK**, **Goyal SM**. Molecular characterization of quail bronchitis virus isolated from bobwhite quail in Minnesota. *Poult Sci*. 2016 Dec 1;95(12):2815-2818.

Singh A, **Mor SK**, Jindal N, **Patnayak D**, Sobhy NM, Luong NT, **Goyal SM**. Detection and molecular characterization of astroviruses in turkeys. *Arch Virol*. 2016 Apr;161(4):939-46. doi: 10.1007/s00705-016-2753-7.

Torremorell M, Alonso C, Davies PR, Raynor PC, **Patnayak D**, Torchetti M, McCluskey B. Investigation into the Airborne Dissemination of H5N2 Highly Pathogenic Avian Influenza Virus During the 2015 Spring Outbreaks in the Midwestern United States. *Avian Dis*. 2016 Sep;60(3):637-43. doi: 10.1637/11395-021816-Reg.1.

Tóth F, **Torrison JL**, Harper L, Bussières D, Wilson ME, Crenshaw TD, Carlson CS. Osteochondrosis prevalence and severity at 12 and 24 weeks of age in commercial pigs with and without organic-complexed trace mineral supplementation. *J Anim Sci*. 2016 Sep;94(9):3817-3825. doi: 10.2527/jas.2015-9950.



Trudeau MP, Verma H, Sampedro F, Urriola PE, Shurson GC, McKelvey J, Pillai SD, **Goyal SM**. Comparison of Thermal and Non-Thermal Processing of Swine Feed and the Use of Selected Feed Additives on Inactivation of Porcine Epidemic Diarrhea Virus (PEDV). *PLoS One*. 2016 Jun 24;11(6):e0158128. doi: 10.1371/journal.pone.0158128.

Valberg SJ, McKenzie EC, Eyrich LV, **Shivers J**, Barnes NE, Finno CJ. Suspected myofibrillar myopathy in Arabian horses with a history of exertional rhabdomyolysis. *Equine Vet J*. 2016 Sep;48(5):548-56. doi: 10.1111/evj.12493.