APPENDIX D
SAES-422
Format for Multistate Research Activity Accomplishments Report

Project/Activity Number: NC229

Project/Activity Title: PRRSV and other emerging viral diseases of swine

Period Covered: October 31, 2015 to September 1, 2016

Date of This Report:

Annual Meeting Date(s): December 4

Participants:

Eric Nelson South Dakota State U. (SDSU); eric.nelson@sdstate.edu
Osorio, Fernando A.; University of Nebraska-Lincoln (UNL); fosorio@unl.edu
Rowland, Raymond R.R.; Kansas State University (KSU); browland@vet.k-state.edu
Benfield, David, Ohio State University (OSU); benfield.2@osu.edu
Faaberg, Kay; National Animal Disease Center (NADC); kay.faaberg@ars.usda.gov
Gourapura, Renukaradhya J.; The Ohio State University (OSU); gourapura.1@osu.edu
Holland, Margo; USDA,CSREES; mholland@nifa.usda.gov
Johnson, Peter; USDA,CSREES; PJOHNSON@NIFA.USDA.GOV
Lunney, Joan; USDA-ARS, BARC, joan.lunney@ars.usda.gov
Mateu, E. CRESA Univ Autonoma de Barcelona, Spain; Enric.Mateu@uab.cat
Meng,X-J VPI (Virginia Tech); xjmeng@vt.edu
Murtaugh, Michael P; University of Minnesota (UMN); murta001@umn.edu
Prieto, Cinta; Universidad Complutense, Madrid, Spain; cprietos@vet.ucm.es
Pogranichniy Roman, Purdue University, rmp@purdue.edu
Ramamoorthy, S, North Dakota - North Dakota St Univ (ND) sheela.ramamoorthy@ndsu.edu
Zhang, Yanjin; University of Maryland; zhangyj@umd.edu
Zimmerman, Jeff; Iowa State University (ISU); jjzimm@iastate.edu
Zuckermann, Federico; University of Illinois at Urbana-Champaign (UIUC); fazaaa@illinois.edu
Yang, Hanchun; China Agricultural University; yanghanchun1@cau.edu.cn

Brief summary of minutes of annual meeting:

The 2016 NC229 meeting took place on December 4 2015, 8:00 am to 5:00 pm at Marriot Downtown Hotel in Chicago Illinois, as part of Pre-CRWAD satellite events and in a joint session with the North American PRRS Symposium. Both AM and PM sessions had an attendance that exceeded in both cases 150 persons. Stations represented are listed above. The Agenda for the meeting is shown in table 1. After the scientific sessions, future direction and funding opportunities were explored during the business meeting. In particular USDA NIFA staff provided an overview of NIFA funding opportunities for 2017. At 5:15 PM the meeting is adjourned.

Table 1: NC229 Annual Meeting Agenda of Activities

8:00am-8:15am	Opening remark
Session 1 **8:15am -10:00am**	**Moderators:** Ben Hause (Cambridge Technologies) & Luis Gimenez-Lirola (Iowa State University)
Diego Diel South Dakota State University	Pathogenesis and infection dynamics of Senecavirus A in pigs, Abstract #42
Alexandra Buckley USDA	Senecavirus A infection in sows, neonates, and market weight gilts with subsequent protective immunity, Abstract #35
Steven Lawson South Dakota State University	Development of antibody reagents & assays for Senecavirus A serodiagnosis, Abstract #10
Fangfeng Yuan Kansas State University	Construction and characterization of a full-length cDNA infectious clone of emerging porcine Senecavirus A, Abstract #24
Rachel Palinski Kansas State University	A novel porcine circovirus distantly related to known circoviruses is associated with porcine dermatitis and nephropathy syndrome and reproductive failure, Abstract #18
Chantale Provost University of Montreal	Development of a new molecular method to discriminate Porcine Epidemic Diarrhea Virus infectious viral particles, from non-infectious ones, which are contaminating pig derived food additives, Abstract #21
Rolf Rauh Tetracore, Inc.	Evaluation of a portable real-time PCR platform (T-COR 8™) for ASF during outbreaks in an endemically infected population in Uganda, Abstract #11
10:00am-10:15am	**Break**
Session 2 **10:15am-12:00am**	**Moderators:** Ying Fang (Kansas State University) & Gustavo Delhon (University of Nebraska-Lincoln)
Ignacio Correas University of Nebraska-Lincoln	Cross-reactivity of immune responses against Porcine Reproductive and Respiratory Syndrome virus, Abstract #38
Joseph Darbellay VIDO-InterVac.	The progression to T cell immunity after infection with porcine reproductive and respiratory syndrome virus, Abstract #40
Junru Cui University of Connecticut	A GP5 Mosaic T-cell Vaccine for Porcine Reproductive and Respiratory Syndrome Virus Is Immunogenic, Induces Broad Cellular Responses to Diverse Strains and Confers Partial Protection to Pigs, Abstract #64
Kay Kimpston-Burkgren University of Nebraska-Lincoln	Contribution of PRRSV minor glycoproteins to a protective immune response in swine, Abstract #51
Tanja Opriessnig University of Edinburgh	Iowa State University, An interferon inducing PRRSV vaccine candidate protects against challenge with a heterologous virulent type 2 strain in a conventional pig model, Abstract #71
Volker Gerdts VIDO-InterVac	Development of a Novel Vaccine for Porcine Epidemic Diarrhea Virus, Abstract #7
Jishu Shi Kansas State University	Pigs immunized with a novel E2 subunit vaccine are protected from subgenotype heterologous Classical Swine Fever Virus challenge, Abstract #76
12:00am – 1:30pm	**Lunch On your own**
Session 3 **1:30pm-3:00pm**	**Moderators:** Diego Diel (South Dakota State University) & Sheila Ramamoorthy (North Dakota State University)

Marti Cortey IRTA-CReSA	Changes in the genetic composition of PRRSV quasispecies and its relationship with long and short viral infections, Abstract #39
Rui Guo Kansas State University	Porcine reproductive and respiratory syndrome virus takes advantage of host intercellular mitochondria transferring pathway for cell to cell spreading of the infection, Abstract #48
Ana Stoian Kansas State University	Identification of CD163 domain involved in the infection with Type II Porcine Reproductive and Respiratory viruses, Abstract #86
Hanzhong Ke University of Illinois	SAP domain in nsp1-beta of porcine reproductive and respiratory syndrome virus (PRRSV) correlates with interferon suppression in cells and pathogenesis in pigs, Abstract #50
Federico Zuckermann University of Illinois	The unfolded protein response induced by porcine reproductive and respiratory syndrome virus infection of alveolar macrophages is involved in immune dysregulation, Abstract #62
Pengcheng Shang Kansas State University	A novel mechanism of protein-stimulated trans-activation of ribosomal frameshifting in porcine reproductive and respiratory syndrome virus: implication in improved vaccine development, Abstract #85
3:00pm-3:15pm	**Break**
Session 4 **3:15pm-4:30pm**	**Moderators:** Dan Rock (University of Illinois) & KJ Yoon (Iowa State University)
Susan Detmer University of Saskatchewan	Pathological findings at the maternal-fetal interface during the early type 2 PRRS virus infection of late gestation pregnant gilts, Abstract #41
Yanli Li UAB	Resolution of genotype 1 PRRSV attachment on bone marrow-derived dendritic cells, Abstract #53
Lei Zhou China Agricultural University	Attenuate Highly Pathogenic Porcine Reproductive and Respiratory Syndrome Virus by incorporating target site of hematopoietic-specific MicroRNA into viral genome, Abstract #82
Jenelle Dunkelberger Iowa State University	A major gene for host response under PRRS challenge is not negatively associated with overall performance in commercial pig lines under nonchallenged conditions, Abstract #44
Natasha Gaudreault Kansas State University	Genetically edited pigs lacking CD163 show no resistance following infection with the African Swine Fever Virus isolate, Georgia 2007/1, Abstract #47
4:30pm-5:00pm	NC229 business meeting

Accomplishments:

Objective 1. Control of PRRSV

In objective 1, the major areas of focus/achievements by the NC 229 group during 2016 included:

1.1 Innate immunity against PRRSV. Studies on the effect that different NSPs of PRRSV may have on innate immunity mechanisms, on apoptosis, or the capacity for modulating overall immune response by strains that cause stimulation of IFN rather than suppression. Also includes the effect of PRRSV of macrophages and cytokines modulation. The stations focusing in this area were: UCONN, UIUC, KSU, OSU, China Agr U, NE, NADC, SDSU and UMD

1.2 PRRSV immunity and vaccinology. Understanding correlates of immunity and mechanisms

to broaden protection, including neutralizing antibodies, developing of naturally occurring or synthetic strains of PRRSV inducing broader protection, alternative vectors for PRRSV antigens or epitopes, DIVA marker systems, mechanism of attenuation and immunogenic potential of NSPs etc. The stations that focused studies in this area were: UMN, UMD, VPI, NADC, UNL, UIUC, UWI, ISU, NE and KSU

1.3 Virulence of PRRSV. Understanding virulence factors/markers, some of these studies included co-infection with bacteria. The stations that focused studies on this area were: NADC and China Agr U

1.4 Genetic mapping of resistance to PRRSV infection (ISU, KSU, UMO, USDA), genetic modification of receptors (KSU)

1.5 Epidemiology of PRRSV transmission, which may include aerobiology, and virus evolution: UMN, ISU, VNIIVViM Russia and UWI, Detection of PRRSV in populations (ISU)

1.6 Economic Impact of PRRSV control; UMN, ISU

Objective 2 Developing effective and efficient approaches for detection, prevention and control of pressing viral diseases of swine of recent emergence.

In objective 2, the major areas of focus/achievements by the NC 229 group during 2016 included:

2.1 ascertaining pathogenesis and transmission of and establishing diagnostics and reagents for **PEDV**:(ISU, UMN, OSU, KSU, SDSU, VNIIVViM Russia, Purdue). Reverse genetics of PEDV (KSU). Studying the protective immune response to PEDV (OSU)

2.2 Genomics and replication of **PCV and novel ss DNA viruses** of swine (ISU, NADC)

2.3 Genetic and antigenic evolution of swine influenza virus (SIV) and epidemiology of transmission of SIV (NADC UMN, ISU, SDSU, CENSACuba) testing of SIV vaccines in vivo (NADC) and in vitro models (Purdue) testing of adjuvants for SIV inactivated immunogens (NADC)

2.4 Characterizing the ongoing outbreak of **Seneca valley virus**, development of diagnostic tools and characterization of pathogenesis, fulfillment of Koch's postulates: (ISU, NADC, UMN, KSU)

2.5 Characterization and diagnostic reagents for **Atypical Pestivirus of Swine** (KSU, ISU).

2.6 Classical swine fever pathogenesis & epidemiology (VNIIVViM Russia, CENSACuba, UCON) and vaccinology (CENSACuba)

2.7 African Swine Fever Virus, epidemiology (VNIIVViM Russia, UIUC) and protective immunity/vaccinology (VNIIVViM Russia, UIUC, KSU, TX A&M) and diagnostics

2.8 Swine vesicular disease virus (VNIIVViM Russia)

2.9 Population monitoring for various viral diseases (**PRRSV, SIV, CSFV, FMDV, ASFV**) utilizing oral fluids and body fluids (ISU, PIADC)

Impacts:

General impacts of the NC-229 program

- First, it should be mentioned that a very important verifiable impact has been the excellent reception (in respect to record attendance, and active interest of engaged audience) of the high quality scientific presentations that the NC-229 meeting featured this year jointly with the *North American PRRS and other Emerging Viruses Symposium*.
- A positive parameter that permits to anticipate important long term impacts for this current 5 year project is the number of publications submitted by the group during the year 2016 (third year of the project). As shown in the document attached (under "Publications"), the NC-229 group has published in 2016 a total of 135 refereed journal publications in the area of PRRSV, PCV2, influenza virus, swine enteric coronaviruses and senecavirus. The number would be higher if other publications are included.

A non-comprehensive list of impacts related to major swine viral pathogens, consisting only of some examples for 2015, follows:

Impacts in PRRSV Control:

- Possible role of IFN-positive PRRSV strain on vaccine improvement (UMD)
- Possible role of molecular attenuation in attaining better MLV vaccines (OHIO)
- Advances in understanding virulence of highly pathogenic PRRSV (CHINA Agr U)
- Patent (PCT132015/052214) for a synthetic PRRSV virus serving as seed vaccine candidate for broad protection against PRRSV type II. The invention received the "2015 Breakthrough of the Year Award" conferred by UNL (UNL/UIUC).Currently explored by industry
- Focus on broadly neutralizing antibodies and swine genetics may provide a bio-marker for broadly protective vaccine (KSU)
- Focus on DIVA marker candidates (NADC)

Impacts in PEDV and other endemic swine viruses research

- PEDV pathogenesis, and SVV pathogenesis and diagnostic tools (ISU, MN,SDSU, KSU)
- Elucidation of risk of feed transmission for PEDV (SDSU)
- Swine health monitoring program for studies on virus transmission (SIV) (MN)
- Strains and platforms to improve current SIV vaccines (NADC,ISU,MN)

Impacts in FAD :

- Vigorous emphasis for development of noninfectious diagnostic reagents (probes, microarrays, Elisas, Mabs) to be used in US labs (ISU,KSU,SDSU,MN)
- ASFV: international collaboration on ASFV virulence and protective immunity conducted in the field (VNIIVViM Russia/UIUC)
- CSFV: Regional Surveillance of CSFV in the Caribbean area, and OIE twinning project for validation of CSF regional diagnostic tools (CENSACUBA/Hannover U. Germany)

Publications: See the attached

Authorization: Submission by an AES or CES director or administrative advisor through NIMSS constitutes signature authority for this information.

*Limited to three pages or less exclusive of publications, details may be appended.

Refereed publications by NC229 participants

PRRS virus:

1. Sun Y, Ke H, Han M, Chen N, Fang W, Yoo D. Nonstructural Protein 11 of Porcine Reproductive and Respiratory Syndrome Virus Suppresses Both MAVS and RIG-I Expression as One of the Mechanisms to Antagonize Type I Interferon Production. PLoS One. 2016 Dec 20;11(12):e0168314. doi: 10.1371/journal.pone.0168314.eCollection 2016. PubMed PMID: 27997564; PubMed Central PMCID: PMC5172586.
2. Piñeyro PE, Subramaniam S, Kenney SP, Heffron CL, Giménez-Lirola LG, Meng XJ. Modulation of Proinflammatory Cytokines in Monocyte-Derived Dendritic Cells by Porcine Reproductive and Respiratory Syndrome Virus Through Interaction with the Porcine Intercellular-Adhesion-Molecule-3-Grabbing Nonintegrin. Viral Immunol. 2016 Dec;29(10):546-556. Epub 2016 Sep 19. PubMed PMID: 27643915.
3. Sun H, Pattnaik AK, Osorio FA, Vu HLX. Identification of viral genes associated with the interferon-inducing phenotype of a synthetic porcine reproductive and respiratory syndrome virus strain. Virology. 2016 Dec;499:313-321. doi: 10.1016/j.virol.2016.09.018. Epub 2016 Oct 11. PubMed PMID: 27736706.
4. Evenson D, Gerber PF, Xiao CT, Halbur PG, Wang C, Tian D, Ni YY, Meng XJ, Opriessnig T. A porcine reproductive and respiratory syndrome virus candidate vaccine based on the synthetic attenuated virus engineering approach is attenuated and effective in protecting against homologous virus challenge. Vaccine. 2016 Nov 4;34(46):5546-5553. doi: 10.1016/j.vaccine.2016.09.049. Epub 2016 Oct 11. PubMed PMID: 27742217.
5. Ma Z, Yu Y, Xiao Y, Opriessnig T, Wang R, Yang L, Nan Y, Samal SK, Halbur PG, Zhang YJ. Sustaining Interferon Induction by a High-Passage Atypical Porcine Reproductive and Respiratory Syndrome Virus Strain. Sci Rep. 2016 Nov 2;6:36312. doi: 10.1038/srep36312. PubMed PMID: 27805024; PubMed Central PMCID: PMC5090871.
6. Chung CJ, Cha SH, Grimm AL, Chung G, Gibson KA, Yoon KJ, Parish SM, Ho CS, Lee SS. Recognition of Highly Diverse Type-1 and -2 Porcine Reproductive and Respiratory Syndrome Viruses (PRRSVs) by T-Lymphocytes Induced in Pigs after Experimental Infection with a Type-2 PRRSV Strain. PLoS One. 2016 Oct 31;11(10):e0165450. doi:

10.1371/journal.pone.0165450. eCollection 2016. PubMed PMID: 27798650; PubMed Central PMCID: PMC5087905.
7. Schlink SN, Lager KM, Brockmeier SL, Loving CL, Miller LC, Vorwald AC, Yang HC, Kehrli ME Jr, Faaberg KS. Enhancement of innate immunity with granulocyte colony-stimulating factor did not mitigate disease in pigs infected with a highly pathogenic Chinese PRRSV strain. Vet Immunol Immunopathol. 2016 Oct 15;179:70-6. doi: 10.1016/j.vetimm.2016.08.007. Epub 2016 Aug 10. PubMed PMID: 7590428.
8. Yu Z, Huang C, Zhang Q, Feng WH. Porcine reproductive and respiratory syndrome virus (PRRSV) induces IL-12p40 production through JNK-AP-1 and NF-κB signaling pathways. Virus Res. 2016 Oct 2;225:73-81. doi: 10.1016/j.virusres.2016.09.009. Epub 2016 Sep 20. PubMed PMID: 27663131.
9. Wang X, Yang X, Zhou R, Zhou L, Ge X, Guo X, Yang H. Genomic characterization and pathogenicity of a strain of type 1 porcine reproductive and respiratory syndrome virus. Virus Res. 2016 Oct 2;225:40-49. doi: 10.1016/j.virusres.2016.09.006. Epub 2016 Sep 13. PubMed PMID: 27619842.
10. Du L, Liu Y, Du Y, Wang H, Zhang M, Du Y, Feng WH. Porcine reproductive and respiratory syndrome virus (PRRSV) up-regulates IL-15 through PKCβ1-TAK1-NF-κB signaling pathway. Virology. 2016 Sep;496:166-174. doi: 10.1016/j.virol.2016.06.007. Epub 2016 Jun 16. PubMed PMID: 27318153.
11. Tabynov K, Sansyzbay A, Tulemissova Z, Tabynov K, Dhakal S, Samoltyrova A, Renukaradhya GJ, Mambetaliyev M. Inactivated porcine reproductive and respiratory syndrome virus vaccine adjuvanted with Montanide™ Gel 01 ST elicits virus-specific cross-protective inter-genotypic response in piglets. Vet Microbiol. 2016 Aug 30;192:81-89. doi: 10.1016/j.vetmic.2016.06.014. Epub 2016 Jul 1. PubMed PMID: 27527768.
12. Sun D, Khatun A, Kim WI, Cooper V, Cho YI, Wang C, Choi EJ, Yoon KJ. Attempts to enhance cross-protection against porcine reproductive and respiratory syndrome viruses using chimeric viruses containing structural genes from two antigenically distinct strains. Vaccine. 2016 Aug 5;34(36):4335-42. doi: 10.1016/j.vaccine.2016.06.069. Epub 2016 Jul 9. PubMed PMID: 27406935.
13. Workman AM, Smith TP, Osorio FA, Vu HL. Complete Genome Sequence of Highly Virulent Porcine Reproductive and Respiratory Syndrome Virus Variants That Recently Emerged in the United States. Genome Announc. 2016 Aug 4;4(4). pii: e00772-16. doi: 10.1128/genomeA.00772-16. PubMed PMID: 27491998; PubMed Central PMCID: PMC4974319.
14. Serão NV, Kemp RA, Mote BE, Willson P, Harding JC, Bishop SC, Plastow GS, Dekkers JC. Genetic and genomic basis of antibody response to porcine reproductive and respiratory syndrome (PRRS) in gilts and sows. Genet Sel Evol. 2016 Jul 14;48(1):51. doi: 10.1186/s12711-016-0230-0. PubMed PMID: 27417876; PubMed Central PMCID: PMC4944421.
15. Li L, Zheng Q, Zhang Y, Li P, Fu Y, Hou J, Xiao X. Antiviral activity of recombinant porcine surfactant protein A against porcine reproductive and respiratory syndrome virus in vitro. Arch Virol. 2016 Jul;161(7):1883-90. doi: 10.1007/s00705-016-2838-3. Epub 2016 Apr 21. PubMed PMID: 27101074.
16. Zhang L, Zhou L, Ge X, Guo X, Han J, Yang H. The Chinese highly pathogenic porcine reproductive and respiratory syndrome virus infection suppresses Th17 cells response in

vivo. Vet Microbiol. 2016 Jun 30;189:75-85. doi: 10.1016/j.vetmic.2016.05.001. Epub 2016 May 3. PubMed PMID: 27259830.
17. Huang C, Du Y, Yu Z, Zhang Q, Liu Y, Tang J, Shi J, Feng WH. Highly Pathogenic Porcine Reproductive and Respiratory Syndrome Virus Nsp4 Cleaves VISA to Impair Antiviral Responses Mediated by RIG-I-like Receptors. Sci Rep. 2016 Jun 22;6:28497. doi: 10.1038/srep28497. PubMed PMID: 27329948; PubMed Central PMCID: PMC4916416.
18. Hess AS, Islam Z, Hess MK, Rowland RR, Lunney JK, Doeschl-Wilson A, Plastow GS, Dekkers JC. Comparison of host genetic factors influencing pig response to infection with two North American isolates of porcine reproductive and respiratory syndrome virus. Genet Sel Evol. 2016 Jun 20;48(1):43. doi: 10.1186/s12711-016-0222-0. PubMed PMID: 27324857; PubMed Central PMCID: PMC4915112.
19. Yuan S, Zhang N, Xu L, Zhou L, Ge X, Guo X, Yang H. Induction of Apoptosis by the Nonstructural Protein 4 and 10 of Porcine Reproductive and Respiratory Syndrome Virus. PLoS One. 2016 Jun 16;11(6):e0156518. doi: 10.1371/journal.pone.0156518. eCollection 2016. PubMed PMID: 27310256; PubMed Central PMCID: PMC4911139.
20. Binjawadagi B, Lakshmanappa YS, Longchao Z, Dhakal S, Hiremath J, Ouyang K, Shyu DL, Arcos J, Pengcheng S, Gilbertie A, Zuckermann F, Torrelles JB, Jackwood D, Fang Y, Renukaradhya GJ. Development of a porcine reproductive and respiratory syndrome virus-like-particle-based vaccine and evaluation of its immunogenicity in pigs. Arch Virol. 2016 Jun;161(6):1579-89. doi: 10.1007/s00705-016-2812-0. Epub 2016 Mar 23. PubMed PMID: 27008569.
21. Chen N, Trible BR, Kerrigan MA, Tian K, Rowland RR. ORF5 of porcine reproductive and respiratory syndrome virus (PRRSV) is a target of diversifying selection as infection progresses from acute infection to virus rebound. Infect Genet Evol. 2016 Jun;40:167-75. doi: 10.1016/j.meegid.2016.03.002. Epub 2016 Mar 4. PubMed PMID: 26961593.
22. Niederwerder MC, Jaing CJ, Thissen JB, Cino-Ozuna AG, McLoughlin KS, Rowland RR. Microbiome associations in pigs with the best and worst clinical outcomes following co-infection with porcine reproductive and respiratory syndrome virus (PRRSV) and porcine circovirus type 2 (PCV2). Vet Microbiol. 2016 May 30;188:1-11. doi: 10.1016/j.vetmic.2016.03.008. Epub 2016 Mar 11. PubMed PMID: 27139023.
23. Wilkinson JM, Bao H, Ladinig A, Hong L, Stothard P, Lunney JK, Plastow GS, Harding JC. Genome-wide analysis of the transcriptional response to porcine reproductive and respiratory syndrome virus infection at the maternal/fetal interface and in the fetus. BMC Genomics. 2016 May 20;17:383. doi: 10.1186/s12864-016-2720-4. PubMed PMID: 27207143; PubMed Central PMCID: PMC4875603.
24. Zhang L, Cui Z, Zhou L, Kang Y, Li L, Li J, Dai Y, Yu S, Li N. Developing a Triple Transgenic Cell Line for High-Efficiency Porcine Reproductive and Respiratory Syndrome Virus Infection. PLoS One. 2016 May 16;11(5):e0154238. doi: 10.1371/journal.pone.0154238. eCollection 2016. Erratum in: PLoS One. 2016 Jul 26;11(7):e0160325. PubMed PMID: 27182980; PubMed Central PMCID: PMC4868347.
25. Xiao Y, Ma Z, Wang R, Yang L, Nan Y, Zhang YJ. Downregulation of protein kinase PKR activation by porcine reproductive and respiratory syndrome virus at its early stage infection. Vet Microbiol. 2016 May 1;187:1-7. doi: 10.1016/j.vetmic.2016.03.004. Epub 2016 Mar 7. PubMed PMID: 27066702.

26. Guo R, Katz BB, Tomich JM, Gallagher T, Fang Y. Porcine Reproductive and Respiratory Syndrome Virus Utilizes Nanotubes for Intercellular Spread. J Virol. 2016 Apr 29;90(10):5163-75. doi: 10.1128/JVI.00036-16. Print 2016 May 15. PubMed PMID: 26984724; PubMed Central PMCID: PMC4859731.
27. Wilkinson JM, Ladinig A, Bao H, Kommadath A, Stothard P, Lunney JK, Harding JC, Plastow GS. Differences in Whole Blood Gene Expression Associated with Infection Time-Course and Extent of Fetal Mortality in a Reproductive Model of Type 2 Porcine Reproductive and Respiratory Syndrome Virus (PRRSV) Infection. PLoS One. 2016 Apr 19;11(4):e0153615. doi: 10.1371/journal.pone.0153615. eCollection 2016. PubMed PMID: 27093427; PubMed Central PMCID: PMC4836665.\
28. Khatun A, Shabir N, Seo BJ, Kim BS, Yoon KJ, Kim WI. The Attenuation Phenotype of a Ribavirin-Resistant Porcine Reproductive and Respiratory Syndrome Virus Is Maintained during Sequential Passages in Pigs. J Virol. 2016 Apr 14;90(9):4454-68. doi: 10.1128/JVI.02836-15. Print 2016 May. PubMed PMID: 26889041; PubMed Central PMCID: PMC4836337.
29. Hu Y, Cong X, Chen L, Qi J, Wu X, Zhou M, Yoo D, Li F, Sun W, Wu J, Zhao X, Chen Z, Yu J, Du Y, Wang J. Synergy of TLR3 and 7 ligands significantly enhances function of DCs to present inactivated PRRSV antigen through TRIF/MyD88-NF-κB signaling pathway. Sci Rep. 2016 Apr 5;6:23977. doi: 10.1038/srep23977. PubMed PMID: 27046485; PubMed Central PMCID: PMC4820752.
30. Cao QM, Subramaniam S, Ni YY, Cao D, Meng XJ. The non-structural protein Nsp2TF of porcine reproductive and respiratory syndrome virus down-regulates the expression of Swine Leukocyte Antigen class I. Virology. 2016 Apr;491:115-24. doi: 10.1016/j.virol.2016.01.021. Epub 2016 Feb 16. PubMed PMID: 26895249.
31. Zhang J. Coinfection with type 1 and type 2 PRRSV. Vet Rec. 2016 Mar 19;178(12):288-90. doi: 10.1136/vr.i1505. PubMed PMID: 26993451.
32. Ouyang K, Hiremath J, Binjawadagi B, Shyu DL, Dhakal S, Arcos J, Schleappi R, Holman L, Roof M, Torrelles JB, Renukaradhya GJ. Comparative analysis of routes of immunization of a live porcine reproductive and respiratory syndrome virus (PRRSV) vaccine in a heterologous virus challenge study. Vet Res. 2016 Mar 17;47:45. doi: 10.1186/s13567-016-0331-3. PubMed PMID: 26988085; PubMed Central PMCID: PMC4797253.
33. Schroyen M, Eisley C, Koltes JE, Fritz-Waters E, Choi I, Plastow GS, Guan L, Stothard P, Bao H, Kommadath A, Reecy JM, Lunney JK, Rowland RR, Dekkers JC, Tuggle CK. Bioinformatic analyses in early host response to Porcine Reproductive and Respiratory Syndrome virus (PRRSV) reveals pathway differences between pigs with alternate genotypes for a major host response QTL. BMC Genomics. 2016 Mar 8;17:196. doi: 10.1186/s12864-016-2547-z. PubMed PMID: 26951612; PubMed Central PMCID: PMC4782518.
34. Kuhn JH, Lauck M, Bailey AL, Shchetinin AM, Vishnevskaya TV, Bào Y, Ng TF, LeBreton M, Schneider BS, Gillis A, Tamoufe U, Diffo Jle D, Takuo JM, Kondov NO, Coffey LL, Wolfe ND, Delwart E, Clawson AN,Postnikova E, Bollinger L, Lackemeyer MG, Radoshitzky SR, Palacios G, Wada J, Shevtsova ZV, Jahrling PB, Lapin BA, Deriabin PG, Dunowska M, Alkhovsky SV, Rogers J, Friedrich TC, O'Connor DH, Goldberg TL. Reorganization and expansion of the nidoviral family Arteriviridae. Arch

Virol. 2016 Mar;161(3):755-68. doi: 10.1007/s00705-015-2672-z. Epub 2015 Nov 25. PubMed PMID: 26608064; PubMed Central PMCID: PMC5573231.
35. Zhang Q, Huang C, Yang Q, Gao L, Liu HC, Tang J, Feng WH. MicroRNA-30c Modulates Type I IFN Responses To Facilitate Porcine Reproductive and Respiratory Syndrome Virus Infection by Targeting JAK1. J Immunol. 2016 Mar 1;196(5):2272-82. doi: 10.4049/jimmunol.1502006. Epub 2016 Jan 29. PubMed PMID: 26826240.
36. Valdes-Donoso P, Jarvis LS, Wright D, Alvarez J, Perez AM. Measuring Progress on the Control of Porcine Reproductive and Respiratory Syndrome (PRRS) at a Regional Level: The Minnesota N212 Regional Control Project (Rcp) as a Working Example. PLoS One. 2016 Feb 19;11(2):e0149498. doi: 10.1371/journal.pone.0149498. eCollection 2016. PubMed PMID: 26895148; PubMed Central PMCID: PMC4760934.
37. Alkhamis MA, Perez AM, Murtaugh MP, Wang X, Morrison RB. Applications of Bayesian Phylodynamic Methods in a Recent U.S. Porcine Reproductive and Respiratory Syndrome Virus Outbreak. Front Microbiol. 2016 Feb 2;7:67. doi: 10.3389/fmicb.2016.00067. eCollection 2016. PubMed PMID: 26870024; PubMed Central PMCID: PMC4735353.
38. Piñeyro PE, Kenney SP, Giménez-Lirola LG, Opriessnig T, Tian D, Heffron CL, Meng XJ. Evaluation of the use of non-pathogenic porcine circovirus type 1 as a vaccine delivery virus vector to express antigenic epitopes of porcine reproductive and respiratory syndrome virus. Virus Res. 2016 Feb 2;213:100-108. doi: 10.1016/j.virusres.2015.11.005. Epub 2015 Nov 7. PubMed PMID: 26555162.
39. Wang X, Zhang H, Abel AM, Nelson E. Protein kinase R (PKR) plays a pro-viral role in porcine reproductive and respiratory syndrome virus (PRRSV) replication by modulating viral gene transcription. Arch Virol. 2016 Feb;161(2):327-33. doi: 10.1007/s00705-015-2671-0. Epub 2015 Nov 7. PubMed PMID: 26547579.
40. Alvarez J, Valdes-Donoso P, Tousignant S, Alkhamis M, Morrison R, Perez A. Novel analytic tools for the study of porcine reproductive and respiratory syndrome virus (PRRSv) in endemic settings: lessons learned in the U.S. Porcine Health Manag. 2016 Jan 21;2:3. doi: 10.1186/s40813-016-0019-0. eCollection 2016. Review. PubMed PMID: 28405429; PubMed Central PMCID: PMC5382381.
41. Li Y, Shyu DL, Shang P, Bai J, Ouyang K, Dhakal S, Hiremath J, Binjawadagi B, Renukaradhya GJ, Fang Y. Mutations in a Highly Conserved Motif of nsp1β Protein Attenuate the Innate Immune Suppression Function of Porcine Reproductive and Respiratory Syndrome Virus. J Virol. 2016 Jan 20;90(7):3584-99. doi: 10.1128/JVI.03069-15. PubMed PMID: 26792733; PubMed Central PMCID: PMC4794661.
42. Alonso C, Raynor PC, Davies PR, Morrison RB, Torremorell M. Evaluation of an electrostatic particle ionization technology for decreasing airborne pathogens in pigs. Aerobiologia (Bologna). 2016;32(3):405-419. Epub 2015 Dec 8. PubMed PMID: 27616810; PubMed Central PMCID: PMC4996881.
43. Lunney JK, Fang Y, Ladinig A, Chen N, Li Y, Rowland B, Renukaradhya GJ. Porcine Reproductive and Respiratory Syndrome Virus (PRRSV): Pathogenesis and Interaction with the Immune System. Annu Rev Anim Biosci. 2016;4:129-54. doi: 10.1146/annurev-animal-022114-111025. Epub 2015 Nov 20. Review. PubMed PMID: 26646630.
44. Tian D, Meng XJ. Amino acid residues Ala283 and His421 in the RNA-dependent RNA polymerase of porcine reproductive and respiratory syndrome virus play important roles

in viral ribavirin sensitivity and quasispecies diversity. J Gen Virol. 2016 Jan;97(1):53-9. doi: 10.1099/jgv.0.000316. Epub 2015 Oct 19. PubMed PMID: 26487085.

45. Whitworth KM, Rowland RR, Ewen CL, Trible BR, Kerrigan MA, Cino-Ozuna AG, Samuel MS, Lightner JE, McLaren DG, Mileham AJ, Wells KD, Prather RS. Gene-edited pigs are protected from porcine reproductive and respiratory syndrome virus. Nat Biotechnol. 2016 Jan;34(1):20-2. doi: 10.1038/nbt.3434. Epub 2015 Dec 7. PubMed PMID: 26641533.

Porcine circovirus:

1. Xiao CT, Harmon KM, Halbur PG, Opriessnig T. PCV2d-2 is the predominant type of PCV2 DNA in pig samples collected in the U.S. during 2014-2016. Vet Microbiol. 2016 Dec 25;197:72-77. doi: 10.1016/j.vetmic.2016.11.009. Epub 2016 Nov 11. PubMed PMID: 27938686.
2. Rogers AJ, Huang YW, Heffron CL, Opriessnig T, Patterson AR, Meng XJ. Prevalence of the Novel Torque Teno Sus Virus Species k2b from Pigs in the United States and Lack of Association with Post-Weaning Multisystemic Wasting Syndrome or Mulberry Heart Disease. Transbound Emerg Dis. 2016 Nov 23. doi: 10.1111/tbed.12586. [Epub ahead of print] PubMed PMID: 27878979.
3. Phan TG, Giannitti F, Rossow S, Marthaler D, Knutson TP, 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. doi: 10.1186/s12985-016-0642-z. Erratum in: Virol J. 2017 Apr 28;14 (1):87. PubMed PMID: 27835942; PubMed Central PMCID: PMC5105309.
4. Palinski R, Piñeyro P, Shang P, Yuan F, Guo R, Fang Y, Byers E, Hause BM. A Novel Porcine Circovirus Distantly Related to Known Circoviruses Is Associated with Porcine Dermatitis and Nephropathy Syndrome and Reproductive Failure. J Virol. 2016 Dec 16;91(1). pii: e01879-16. Print 2017 Jan 1. PubMed PMID: 27795441; PubMed Central PMCID: PMC5165205.
5. Matzinger SR, Opriessnig T, Xiao CT, Catanzaro N, Beach NM, Slade DE, Nitzel GP, Meng XJ. A chimeric virus created by DNA shuffling of the capsid genes of different subtypes of porcine circovirus type 2 (PCV2) in the backbone of the non-pathogenic PCV1 induces protective immunity against the predominant PCV2b and the emerging PCV2d in pigs. Virology. 2016 Nov;498:82-93. doi: 10.1016/j.virol.2016.08.011. Epub 2016 Aug 24. PubMed PMID: 27564544.
6. Shi X, Liu X, Wang Q, Das A, Ma G, Xu L, Sun Q, Peddireddi L, Jia W, Liu Y, Anderson G, Bai J, Shi J. A multiplex real-time PCR panel assay for simultaneous detection and differentiation of 12 common swine viruses. J Virol Methods. 2016 Oct;236:258-265. doi: 10.1016/j.jviromet.2016.08.005. Epub 2016 Aug 6. PubMed PMID: 27506582.
7. Dvorak CM, Yang Y, Haley C, Sharma N, Murtaugh MP. National reduction in porcine circovirus type 2 prevalence following introduction of vaccination. Vet Microbiol. 2016 Jun 30;189:86-90. doi: 10.1016/j.vetmic.2016.05.002. Epub 2016 May 3. PubMed PMID: 27259831.
8. Niederwerder MC, Jaing CJ, Thissen JB, Cino-Ozuna AG, McLoughlin KS, Rowland RR. Microbiome associations in pigs with the best and worst clinical outcomes following co-infection with porcine reproductive and respiratory syndrome virus (PRRSV) and

porcine circovirus type 2 (PCV2). Vet Microbiol. 2016 May 30;188:1-11. doi: 10.1016/j.vetmic.2016.03.008. Epub 2016 Mar 11. PubMed PMID: 27139023.
9. 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. Epub 2016 Mar 3. PubMed PMID: 26948261.
10. Piñeyro PE, Kenney SP, Giménez-Lirola LG, Opriessnig T, Tian D, Heffron CL, Meng XJ. Evaluation of the use of non-pathogenic porcine circovirus type 1 as a vaccine delivery virus vector to express antigenic epitopes of porcine reproductive and respiratory syndrome virus. Virus Res. 2016 Feb 2;213:100-108. doi: 10.1016/j.virusres.2015.11.005. Epub 2015 Nov 7. PubMed PMID: 26555162.

Swine enteric coronaviruses:

1. Poonsuk K, Zhang J, Chen Q, Gonzalez W, da Silva Carrion LC, Sun Y, Ji J, Wang C, Main R, Zimmerman J, Giménez-Lirola L. Quantifying the effect of lactogenic antibody on porcine epidemic diarrhea virus infection in neonatal piglets. Vet Microbiol. 2016 Dec 25;197:83-92. doi: 10.1016/j.vetmic.2016.11.002. Epub 2016 Nov 11. PubMed PMID: 27938689.
2. Crawford K, Lager KM, Kulshreshtha V, Miller LC, Faaberg KS. Status of vaccines for porcine epidemic diarrhea virus in the United States and Canada. Virus Res. 2016 Dec 2;226:108-116. doi: 10.1016/j.virusres.2016.08.005. Epub 2016 Aug 18. Review. PubMed PMID: 27545066.
3. 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. Epub 2016 Jun 8. Review. PubMed PMID: 27288724.
4. Song Q, Stone S, Drebes D, Greiner LL, Dvorak CMT, Murtaugh MP. Characterization of anti-porcine epidemic diarrhea virus neutralizing activity in mammary secretions. Virus Res. 2016 Dec 2;226:85-92. doi: 10.1016/j.virusres.2016.06.002. Epub 2016 Jun 7. PubMed PMID: 27287711.
5. Langel SN, Paim FC, Lager KM, Vlasova AN, Saif LJ. Lactogenic immunity and vaccines for porcine epidemic diarrhea virus (PEDV): Historical and current concepts. Virus Res. 2016 Dec 2;226:93-107. doi: 10.1016/j.virusres.2016.05.016. Epub 2016 May 19. Review. PubMed PMID: 27212686.
6. Zhang Q, Yoo D. Immune evasion of porcine enteric coronaviruses and viral modulation of antiviral innate signaling. Virus Res. 2016 Dec 2;226:128-141. doi: 10.1016/j.virusres.2016.05.015. Epub 2016 May 19. Review. PubMed PMID: 27212682.
7. Diel DG, Lawson S, Okda F, Singrey A, Clement T, Fernandes MHV, Christopher-Hennings J, Nelson EA. Porcine epidemic diarrhea virus: An overview of current virological and serological diagnostic methods. Virus Res. 2016 Dec 2;226:60-70. doi: 10.1016/j.virusres.2016.05.013. Epub 2016 May 14. Review. PubMed PMID: 27189041.
8. Gerber PF, Lelli D, Zhang J, Strandbygaard B, Moreno A, Lavazza A, Perulli S, Bøtner A, Comtet L, Roche M, Pourquier P, Wang C, Opriessnig T. Diagnostic evaluation of assays for detection of antibodies against porcine epidemic diarrhea virus (PEDV) in pigs exposed to different PEDV strains. Prev Vet Med. 2016 Dec 1;135:87-94. doi: 10.1016/j.prevetmed.2016.11.005. Epub 2016 Nov 8. PubMed PMID: 27931933.
9. Gerber PF, Xiao CT, Lager K, Crawford K, Kulshreshtha V, Cao D, Meng XJ, Opriessnig T. Increased frequency of porcine epidemic diarrhea virus shedding and

lesions in suckling pigs compared to nursery pigs and protective immunity in nursery pigs after homologous re-challenge. Vet Res. 2016 Nov 21;47(1):118. PubMed PMID: 27871312; PubMed Central PMCID: PMC5118895.
10. Liu C, Ma Y, Yang Y, Zheng Y, Shang J, Zhou Y, Jiang S, Du L, Li J, Li F. Cell Entry of Porcine Epidemic Diarrhea Coronavirus Is Activated by Lysosomal Proteases. J Biol Chem. 2016 Nov 18;291(47):24779-24786. Epub 2016 Oct 11. PubMed PMID: 27729455; PubMed Central PMCID: PMC5114425.
11. Niederwerder MC, Nietfeld JC, Bai J, Peddireddi L, Breazeale B, Anderson J, Kerrigan MA, An B, Oberst RD, Crawford K, Lager KM, Madson DM, Rowland RR, Anderson GA, Hesse RA. Tissue localization, shedding, virus carriage, antibody response, and aerosol transmission of Porcine epidemic diarrhea virus following inoculation of 4-week-old feeder pigs. J Vet Diagn Invest. 2016 Nov;28(6):671-678. Epub 2016 Oct 3. PubMed PMID: 27698163.
12. Hain KS, Joshi LR, Okda F, Nelson J, Singrey A, Lawson S, Martins M, Pillatzki A, Kutish GF, Nelson EA, Flores EF, Diel DG. Immunogenicity of a recombinant parapoxvirus expressing the spike protein of Porcine epidemic diarrhea virus. J Gen Virol. 2016 Oct;97(10):2719-2731. doi: 10.1099/jgv.0.000586. Epub 2016 Aug 24. PubMed PMID: 27558814.
13. Song Y, Singh P, Nelson E, Ramamoorthy S. A Computationally Designed Serological Assay for Porcine Epidemic Diarrhea Virus. J Clin Microbiol. 2016 Aug;54(8):2039-46. doi: 10.1128/JCM.00460-16. Epub 2016 May 25. PubMed PMID: 27225413; PubMed Central PMCID: PMC4963506.
14. Liu X, Wang Q. Reverse transcription-PCR assays for the differentiation of various US porcine epidemic diarrhea virus strains. J Virol Methods. 2016 Aug;234:137-41. doi: 10.1016/j.jviromet.2016.04.018. Epub 2016 Apr 28. PubMed PMID: 27134071.
15. Zhang J, Tsai YL, Lee PY, Chen Q, Zhang Y, Chiang CJ, Shen YH, Li FC, Chang HF, Gauger PC, Harmon KM, Wang HT. Evaluation of two singleplex reverse transcription-Insulated isothermal PCR tests and a duplex real-time RT-PCR test for the detection of porcine epidemic diarrhea virus and porcine deltacoronavirus. J Virol Methods. 2016 Aug;234:34-42. doi: 10.1016/j.jviromet.2016.03.016. Epub 2016 Apr 6. PubMed PMID: 27060624.
16. Wang L, Hayes J, Byrum B, Zhang Y. US variant porcine epidemic diarrhea virus: histological lesions and genetic characterization. Virus Genes. 2016 Aug;52(4):578-81. doi: 10.1007/s11262-016-1334-x. Epub 2016 Apr 8. PubMed PMID: 27059242.
17. Gao X, Li D, Zhao J, Xu F, Ge X, Guo X, Han J, Yang H, Zhou L. Complete Genome Sequence of Porcine Epidemic Diarrhea Virus from an Outbreak in a Vaccinated Farm in Shandong, China. Genome Announc. 2016 Jul 7;4(4). pii: e00619-16. doi: 10.1128/genomeA.00619-16. PubMed PMID: 27389267; PubMed Central PMCID: PMC4939784.
18. 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. eCollection 2016. PubMed PMID: 27341670; PubMed Central PMCID: PMC4920390.
19. Bjustrom-Kraft J, Woodard K, Giménez-Lirola L, Rotolo M, Wang C, Sun Y, Lasley P, Zhang J, Baum D, Gauger P, Main R, Zimmerman J. Porcine epidemic diarrhea virus

(PEDV) detection and antibody response in commercial growing pigs. BMC Vet Res. 2016 Jun 10;12:99. doi: 10.1186/s12917-016-0725-5. PubMed PMID: 27287624; PubMed Central PMCID: PMC4902975.

20. Chen Q, Gauger PC, Stafne MR, Thomas JT, Madson DM, Huang H, Zheng Y, Li G, Zhang J. Pathogenesis comparison between the United States porcine epidemic diarrhoea virus prototype and S-INDEL-variant strains in conventional neonatal piglets. J Gen Virol. 2016 May;97(5):1107-21. doi: 10.1099/jgv.0.000419. Epub 2016 Feb 3. PubMed PMID: 26841768.
21. 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. PubMed PMID: 27103712; PubMed Central PMCID: PMC4841127.
22. Poonsuk K, Giménez-Lirola LG, Zhang J, Arruda P, Chen Q, Correa da Silva Carrion L, Magtoto R, Pineyro P, Sarmento L, Wang C, Sun Y, Madson D, Johnson J, Yoon KJ, Zimmerman J, Main R. Does Circulating Antibody Play a Role in the Protection of Piglets against Porcine Epidemic Diarrhea Virus? PLoS One. 2016 Apr 6;11(4):e0153041. doi: 10.1371/journal.pone.0153041. eCollection 2016. PubMed PMID: 27050556; PubMed Central PMCID: PMC4822964.
23. Chen Q, Thomas JT, Giménez-Lirola LG, Hardham JM, Gao Q, Gerber PF, Opriessnig T, Zheng Y, Li G, Gauger PC, Madson DM, Magstadt DR, Zhang J. Evaluation of serological cross-reactivity and cross-neutralization between the United States porcine epidemic diarrhea virus prototype and S-INDEL-variant strains. BMC Vet Res. 2016 Apr 5;12:70. doi: 10.1186/s12917-016-0697-5. PubMed PMID: 27044253; PubMed Central PMCID: PMC4820917.
24. Perez AM, Alba A, Goede D, McCluskey B, Morrison R. Monitoring the Spread of Swine Enteric Coronavirus Diseases in the United States in the Absence of a Regulatory Framework. Front Vet Sci. 2016 Mar 14;3:18. doi: 10.3389/fvets.2016.00018. eCollection 2016. PubMed PMID: 27014703; PubMed Central PMCID: PMC4789556.
25. Dee S, Neill C, Singrey A, Clement T, Cochrane R, Jones C, Patterson G, Spronk G, Christopher-Hennings J, Nelson E. Modeling the transboundary risk of feed ingredients contaminated with porcine epidemic diarrhea virus. BMC Vet Res. 2016 Mar 12;12:51. doi: 10.1186/s12917-016-0674-z. PubMed PMID: 26968372; PubMed Central PMCID: PMC4788872.
26. Schweer WP, Pearce SC, Burrough ER, Schwartz K, Yoon KJ, Sparks JC, Gabler NK. The effect of porcine reproductive and respiratory syndrome virus and porcine epidemic diarrhea virus challenge on growing pigs II: Intestinal integrity and function. J Anim Sci. 2016 Feb;94(2):523-32. doi: 10.2527/jas.2015-9836. PubMed PMID: 27065122.
27. Schweer WP, Schwartz K, Burrough ER, Yoon KJ, Sparks JC, Gabler NK. The effect of porcine reproductive and respiratory syndrome virus and porcine epidemic diarrhea virus challenge on growing pigs I: Growth performance and digestibility. J Anim Sci. 2016 Feb;94(2):514-22. doi: 10.2527/jas.2015-9834. PubMed PMID: 27065121.
28. Zhang Q, Shi K, Yoo D. Suppression of type I interferon production by porcine epidemic diarrhea virus and degradation of CREB-binding protein by nsp1. Virology. 2016 Feb;489:252-68. doi: 10.1016/j.virol.2015.12.010. Epub 2016 Jan 14. PubMed PMID: 26773386.

29. Beall A, Yount B, Lin CM, Hou Y, Wang Q, Saif L, Baric R. Characterization of a Pathogenic Full-Length cDNA Clone and Transmission Model for Porcine Epidemic Diarrhea Virus Strain PC22A. MBio. 2016 Jan 5;7(1):e01451-15. doi: 10.1128/mBio.01451-15. PubMed PMID: 26733065; PubMed Central PMCID: PMC4724997.
30. Alonso C, Raynor PC, Davies PR, Morrison RB, Torremorell M. Evaluation of an electrostatic particle ionization technology for decreasing airborne pathogens in pigs. Aerobiologia (Bologna). 2016;32(3):405-419. Epub 2015 Dec 8. PubMed PMID: 27616810; PubMed Central PMCID: PMC4996881.
31. Miller LC, Crawford KK, Lager KM, Kellner SG, Brockmeier SL. Evaluation of two real-time polymerase chain reaction assays for Porcine epidemic diarrhea virus (PEDV) to assess PEDV transmission in growing pigs. J Vet Diagn Invest. 2016 Jan;28(1):20-9. doi: 10.1177/1040638715621949. Epub 2015 Dec 23. PubMed PMID: 26699519.
32. Goede D, Morrison RB. Production impact & time to stability in sow herds infected with porcine epidemic diarrhea virus (PEDV). Prev Vet Med. 2016 Jan 1;123:202-207. doi: 10.1016/j.prevetmed.2015.11.010. Epub 2015 Dec 28. PubMed PMID: 26748596.
33. 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;123:175-184. doi: 10.1016/j.prevetmed.2015.10.020. Epub 2015 Nov 10. PubMed PMID: 26611651.
34. Sasaki Y, Alvarez J, Sekiguchi S, Sueyoshi M, Otake S, Perez A. Epidemiological factors associated to spread of porcine epidemic diarrhea in Japan. Prev Vet Med. 2016 Jan 1;123:161-167. doi: 10.1016/j.prevetmed.2015.11.002. Epub 2015 Nov 7. PubMed PMID: 26588869.
35. Alvarez J, Goede D, Morrison R, Perez A. Spatial and temporal epidemiology of porcine epidemic diarrhea (PED) in the Midwest and Southeast regions of the United States. Prev Vet Med. 2016 Jan 1;123:155-160. doi: 10.1016/j.prevetmed.2015.11.003. Epub 2015 Nov 7. PubMed PMID: 26586344.
36. Madson DM, Arruda PH, Magstadt DR, Burrough ER, Hoang H, Sun D, Bower LP, Bhandari M, Gauger PC, Stevenson GW, Wilberts BL, Wang C, Zhang J, Yoon KJ. Characterization of Porcine Epidemic Diarrhea Virus Isolate US/Iowa/18984/2013 Infection in 1-Day-Old Cesarean-Derived Colostrum-Deprived Piglets. Vet Pathol. 2016 Jan;53(1):44-52. doi: 10.1177/0300985815591080. Epub 2015 Jun 25. PubMed PMID: 26113613.
37. Schumacher LL, Woodworth JC, Jones CK, Chen Q, Zhang J, Gauger PC, Stark CR, Main RG, Hesse RA, Tokach MD, Dritz SS. Evaluation of the minimum infectious dose of porcine epidemic diarrhea virus in virus-inoculated feed. Am J Vet Res. 2016 Oct;77(10):1108-13. doi: 10.2460/ajvr.77.10.1108. PubMed PMID: 27668582.
38. McCluskey BJ, Morrison R. Another emerging disease: Swine Enteric Coronaviruses. Prev Vet Med. 2016 Jan 1;123:154. doi: 10.1016/j.prevetmed.2015.12.001. PubMed PMID: 26773474.

Influenza viruses:

1. Lee J, Henningson J, Ma J, Duff M, Lang Y, Li Y, Li Y, Nagy A, Sunwoo S, Bawa B, Yang J, Bai D, Richt JA, Ma W. Effects of PB1-F2 on the pathogenicity of H1N1 swine

influenza virus in mice and pigs. J Gen Virol. 2016 Dec 23. doi: 10.1099/jgv.0.000695. [Epub ahead of print] PubMed PMID: 28008819.

2. Anderson TK, Macken CA, Lewis NS, Scheuermann RH, Van Reeth K, Brown IH, Swenson SL, Simon G, Saito T, Berhane Y, Ciacci-Zanella J, Pereda A, Davis CT, Donis RO, Webby RJ, Vincent AL. A Phylogeny-Based Global Nomenclature System and Automated Annotation Tool for H1 Hemagglutinin Genes from Swine Influenza A Viruses. mSphere. 2016 Dec 14;1(6). pii: e00275-16. eCollection 2016 Nov-Dec. PubMed PMID: 27981236; PubMed Central PMCID: PMC5156671.
3. Abente EJ, Kitikoon P, Lager KM, Gauger PC, Anderson TK, Vincent A. A highly pathogenic avian influenza virus H5N1 with 2009 pandemic H1N1 internal genes demonstrates increased replication and transmission in pigs. J Gen Virol. 2016 Dec 9. doi: 10.1099/jgv.0.000678. [Epub ahead of print] PubMed PMID: 27959778.
4. Artiaga BL, Yang G, Hutchinson TE, Loeb JC, Richt JA, Lednicky JA, Salek-Ardakani S, Driver JP. Rapid control of pandemic H1N1 influenza by targeting NKT-cells. Sci Rep. 2016 Nov 29;6:37999. doi: 10.1038/srep37999. PubMed PMID: 27897246; PubMed Central PMCID: PMC5126553.
5. Nelson MI, Stucker KM, Schobel SA, Trovão NS, Das SR, Dugan VG, Nelson SW, Sreevatsan S, Killian ML, Nolting JM, Wentworth DE, Bowman AS. Introduction, Evolution, and Dissemination of Influenza A Viruses in Exhibition Swine in the United States during 2009 to 2013. J Virol. 2016 Nov 14;90(23):10963-10971. Print 2016 Dec 1. PubMed PMID: 27681134; PubMed Central PMCID: PMC5110178.
6. Schicker RS, Rossow J, Eckel S, Fisher N, Bidol S, Tatham L, Matthews-Greer J, Sohner K, Bowman AS, Avrill J, Forshey T, Blanton L, Davis CT, Schiltz J, Skorupski S, Berman L, Jang Y, Bresee JS, Lindstrom S, Trock SC, Wentworth D, Fry AM, de Fijter S, Signs K, DiOrio M, Olsen SJ, Biggerstaff M. Outbreak of Influenza A(H3N2) Variant Virus Infections Among Persons Attending Agricultural Fairs Housing Infected Swine - Michigan and Ohio, July-August 2016. MMWR Morb Mortal Wkly Rep. 2016 Oct 28;65(42):1157-1160. doi: 10.15585/mmwr.mm6542a1. PubMed PMID: 27787493.
7. Panyasing Y, Goodell C, Kittawornrat A, Wang C, Levis I, Desfresne L, Rauh R, Gauger PC, Zhang J, Lin X, Azeem S, Ghorbani-Nezami S, Yoon KJ, Zimmerman J. Influenza A Virus Surveillance Based on Pre-Weaning Piglet Oral Fluid Samples. Transbound Emerg Dis. 2016 Oct;63(5):e328-38. doi: 10.1111/tbed.12307. Epub 2014 Dec 9. PubMed PMID: 25488821.
8. Abente EJ, Anderson TK, Rajao DS, Swenson S, Gauger PC, Vincent AL. The avian-origin H3N2 canine influenza virus that recently emerged in the United States has limited replication in swine. Influenza Other Respir Viruses. 2016 Sep;10(5):429-32. doi: 10.1111/irv.12395. Epub 2016 May 18. PubMed PMID: 27110913; PubMed Central PMCID: PMC4947940.
9. Bliss N, Nelson SW, Nolting JM, Bowman AS. Prevalence of Influenza A Virus in Exhibition Swine during Arrival at Agricultural Fairs. Zoonoses Public Health. 2016 Sep;63(6):477-85. doi: 10.1111/zph.12252. Epub 2016 Jan 11. PubMed PMID: 26750204.
10. Abente EJ, Santos J, Lewis NS, Gauger PC, Stratton J, Skepner E, Anderson TK, Rajao DS, Perez DR, Vincent AL. The Molecular Determinants of Antibody Recognition and Antigenic Drift in the H3 Hemagglutinin of Swine Influenza A Virus. J Virol. 2016 Aug

26;90(18):8266-80. doi: 10.1128/JVI.01002-16. Print 2016 Sep 15. PubMed PMID: 27384658; PubMed Central PMCID: PMC5008105.
11. Hernandez LA, Miller CL, Vaughn EM. Particle and subunit-based hemagglutinin vaccines provide protective efficacy against H1N1 influenza in pigs. Vet Microbiol. 2016 Aug 15;191:35-43. doi: 10.1016/j.vetmic.2016.05.011. Epub 2016 Jun 2. PubMed PMID: 27374905.
12. White SK, Ma W, McDaniel CJ, Gray GC, Lednicky JA. Serologic evidence of exposure to influenza D virus among persons with occupational contact with cattle. J Clin Virol. 2016 Aug;81:31-3. doi: 10.1016/j.jcv.2016.05.017. Epub 2016 May 31. PubMed PMID: 27294672.
13. Paccha B, Jones RM, Gibbs S, Kane MJ, Torremorell M, Neira-Ramirez V, Rabinowitz PM. Modeling risk of occupational zoonotic influenza infection in swine workers. J Occup Environ Hyg. 2016 Aug;13(8):577-87. doi: 10.1080/15459624.2016.1159688. PubMed PMID: 26950677.
14. Sandbulte MR, Gauger PC, Kitikoon P, Chen H, Perez DR, Roth JA, Vincent AL. Neuraminidase inhibiting antibody responses in pigs differ between influenza A virus N2 lineages and by vaccine type. Vaccine. 2016 Jul 19;34(33):3773-9. doi: 10.1016/j.vaccine.2016.06.001. Epub 2016 Jun 17. PubMed PMID: 27325350.
15. Gutiérrez AH, Loving C, Moise L, Terry FE, Brockmeier SL, Hughes HR, Martin WD, De Groot AS. In Vivo Validation of Predicted and Conserved T Cell Epitopes in a Swine Influenza Model. PLoS One. 2016 Jul 13;11(7):e0159237. doi: 10.1371/journal.pone.0159237. eCollection 2016. PubMed PMID: 27411061; PubMed Central PMCID: PMC4943726.
16. Balzli C, Lager K, Vincent A, Gauger P, Brockmeier S, Miller L, Richt JA, Ma W, Suarez D, Swayne DE. Susceptibility of swine to H5 and H7 low pathogenic avian influenza viruses. Influenza Other Respir Viruses. 2016 Jul;10(4):346-52. doi: 10.1111/irv.12386. Epub 2016 Apr 5. PubMed PMID: 26946338; PubMed Central PMCID: PMC4910171.
17. Rajão DS, Chen H, Perez DR, Sandbulte MR, Gauger PC, Loving CL, Shanks GD, Vincent A. Vaccine-associated enhanced respiratory disease is influenced by haemagglutinin and neuraminidase in whole inactivated influenza virus vaccines. J Gen Virol. 2016 Jul;97(7):1489-99. doi: 10.1099/jgv.0.000468. Epub 2016 Mar 31. PubMed PMID: 27031847.
18. Poulson RL, Tompkins SM, Berghaus RD, Brown JD, Stallknecht DE. Environmental Stability of Swine and Human Pandemic Influenza Viruses in Water under Variable Conditions of Temperature, Salinity, and pH. Appl Environ Microbiol. 2016 Jun 13;82(13):3721-6. doi: 10.1128/AEM.00133-16. Print 2016 Jul 1. PubMed PMID: 27084011; PubMed Central PMCID: PMC4907172.
19. Souza CK, Rajão DS, Loving CL, Gauger PC, Pérez DR, Vincent AL. Age at Vaccination and Timing of Infection Do Not Alter Vaccine-Associated Enhanced Respiratory Disease in Influenza A Virus-Infected Pigs. Clin Vaccine Immunol. 2016 Jun 6;23(6):470-82. doi: 10.1128/CVI.00563-15. Print 2016 Jun. PubMed PMID: 27030585; PubMed Central PMCID: PMC4895012.
20. Kong W, Liu Q, Sun Y, Wang Y, Gao H, Liu L, Qin Z, He Q, Sun H, Pu J, Wang D, Guo X, Yang H, Chang KC, Shu Y, Liu J. Transmission and pathogenicity of novel reassortants derived from Eurasian avian-like and 2009 pandemic H1N1 influenza viruses

in mice and guinea pigs. Sci Rep. 2016 Jun 2;6:27067. doi: 10.1038/srep27067. PubMed PMID: 27252023; PubMed Central PMCID: PMC4890009.
21. Paccha B, Neira-Ramirez V, Gibbs S, Torremorell M, Rabinowitz PM. Swine Worker Precautions During Suspected Outbreaks of Influenza in Swine. J Environ Health. 2016 May;78(9):22-6; quiz 45. PubMed PMID: 27263180.
22. Hiremath J, Kang KI, Xia M, Elaish M, Binjawadagi B, Ouyang K, Dhakal S, Arcos J, Torrelles JB, Jiang X, Lee CW, Renukaradhya GJ. Entrapment of H1N1 Influenza Virus Derived Conserved Peptides in PLGA Nanoparticles Enhances T Cell Response and Vaccine Efficacy in Pigs. PLoS One. 2016 Apr 19;11(4):e0151922. doi: 10.1371/journal.pone.0151922. eCollection 2016. PubMed PMID: 27093541; PubMed Central PMCID: PMC4836704.
23. Lewis NS, Russell CA, Langat P, Anderson TK, Berger K, Bielejec F, Burke DF, Dudas G, Fonville JM, Fouchier RA, Kellam P, Koel BF, Lemey P, Nguyen T, Nuansrichy B, Peiris JM, Saito T, Simon G, Skepner E, Takemae N; ESNIP3 consortium, Webby RJ, Van Reeth K, Brookes SM, Larsen L, Watson SJ, Brown IH, Vincent AL. The global antigenic diversity of swine influenza A viruses. Elife. 2016 Apr 15;5:e12217. doi: 10.7554/eLife.12217. PubMed PMID: 27113719; PubMed Central PMCID: PMC4846380.
24. Dwivedi V, Manickam C, Dhakal S, Binjawadagi B, Ouyang K, Hiremath J, Khatri M, Hague JG, Lee CW, Renukaradhya GJ. Adjuvant effects of invariant NKT cell ligand potentiates the innate and adaptive immunity to an inactivated H1N1 swine influenza virus vaccine in pigs. Vet Microbiol. 2016 Apr 15;186:157-63. doi: 10.1016/j.vetmic.2016.02.028. Epub 2016 Mar 2. PubMed PMID: 27016770.
25. Rajao DS, Sandbulte MR, Gauger PC, Kitikoon P, Platt R, Roth JA, Perez DR, Loving CL, Vincent AL. Heterologous challenge in the presence of maternally-derived antibodies results in vaccine-associated enhanced respiratory disease in weaned piglets. Virology. 2016 Apr;491:79-88. doi: 10.1016/j.virol.2016.01.015. Epub 2016 Feb 11. PubMed PMID: 26874588; PubMed Central PMCID: PMC4825855.
26. Krishna VD, Wu K, Perez AM, Wang JP. Giant Magnetoresistance-based Biosensor for Detection of Influenza A Virus. Front Microbiol. 2016 Mar 29;7:400. doi: 10.3389/fmicb.2016.00400. eCollection 2016. PubMed PMID: 27065967; PubMed Central PMCID: PMC4809872.
27. Artiaga BL, Yang G, Hackmann TJ, Liu Q, Richt JA, Salek-Ardakani S, Castleman WL, Lednicky JA, Driver JP. α-Galactosylceramide protects swine against influenza infection when administered as a vaccine adjuvant. Sci Rep. 2016 Mar 23;6:23593. doi: 10.1038/srep23593. PubMed PMID: 27004737; PubMed Central PMCID: PMC4804283.
28. Goodell CK, Prickett J, Kittawornrat A, Johnson J, Zhang J, Wang C, Zimmerman JJ. Evaluation of Screening Assays for the Detection of Influenza A Virus Serum Antibodies in Swine. Transbound Emerg Dis. 2016 Feb;63(1):24-35. doi: 10.1111/tbed.12214. Epub 2014 Feb 27. PubMed PMID: 24571447.
29. Bowman AS, Nolting JM, Workman JD, Cooper M, Fisher AE, Marsh B, Forshey T. The Inability to Screen Exhibition Swine for Influenza A Virus Using Body Temperature. Zoonoses Public Health. 2016 Feb;63(1):34-9. doi: 10.1111/zph.12201. Epub 2015 Apr 17. PubMed PMID: 25884907; PubMed Central PMCID: PMC4609228.
30. Nelson MI, Wentworth DE, Das SR, Sreevatsan S, Killian ML, Nolting JM, Slemons RD, Bowman AS. Evolutionary Dynamics of Influenza A Viruses in US Exhibition Swine. J

Infect Dis. 2016 Jan 15;213(2):173-82. doi: 10.1093/infdis/jiv399. Epub 2015 Aug 4. PubMed PMID: 26243317; PubMed Central PMCID: PMC4690152.

31. Neira V, Rabinowitz P, Rendahl A, Paccha B, Gibbs SG, Torremorell M. Characterization of Viral Load, Viability and Persistence of Influenza A Virus in Air and on Surfaces of Swine Production Facilities. PLoS One. 2016 Jan 12;11(1):e0146616. doi: 10.1371/journal.pone.0146616. eCollection 2016. PubMed PMID: 26757362; PubMed Central PMCID: PMC4710569.
32. Alonso C, Raynor PC, Davies PR, Morrison RB, Torremorell M. Evaluation of an electrostatic particle ionization technology for decreasing airborne pathogens in pigs. Aerobiologia (Bologna). 2016;32(3):405-419. Epub 2015 Dec 8. PubMed PMID: 27616810; PubMed Central PMCID: PMC4996881.
33. 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. PubMed PMID: 26733728; PubMed Central PMCID: PMC4686030.

Senecavirus:

1. 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. Epub 2016 Oct 14. PubMed PMID: 27902357.
2. Chen Z, Yuan F, Li Y, Shang P, Schroeder R, Lechtenberg K, Henningson J, Hause B, Bai J, Rowland RRR, Clavijo A, Fang Y. Construction and characterization of a full-length cDNA infectious clone of emerging porcine Senecavirus A. Virology. 2016 Oct;497:111-124. doi: 10.1016/j.virol.2016.07.003. Epub 2016 Jul 25. PubMed PMID: 27459668.
3. Gimenez-Lirola LG, Rademacher C, Linhares D, Harmon K, Rotolo M, Sun Y, Baum DH, Zimmerman J, Piñeyro P. Serological and Molecular Detection of Senecavirus A Associated with an Outbreak of Swine Idiopathic Vesicular Disease and Neonatal Mortality. J Clin Microbiol. 2016 Aug;54(8):2082-9. doi: 10.1128/JCM.00710-16. Epub 2016 May 25. PubMed PMID: 27225408; PubMed Central PMCID: PMC4963487.
4. Montiel N, Buckley A, Guo B, Kulshreshtha V, VanGeelen A, Hoang H, Rademacher C, Yoon KJ, Lager K. Vesicular Disease in 9-Week-Old Pigs Experimentally Infected with Senecavirus A. Emerg Infect Dis. 2016 Jul;22(7):1246-8. doi: 10.3201/eid2207.151863. PubMed PMID: 27315363; PubMed Central PMCID: PMC4918149.
5. Guo B, Piñeyro PE, Rademacher CJ, Zheng Y, Li G, Yuan J, Hoang H, Gauger PC, Madson DM, Schwartz KJ, Canning PE, Arruda BL, Cooper VL, Baum DH, Linhares DC, Main RG, Yoon KJ. Novel Senecavirus A in Swine with Vesicular Disease, United States, July 2015. Emerg Infect Dis. 2016 Jul;22(7):1325-7. doi: 10.3201/eid2207.151758. PubMed PMID: 27314645; PubMed Central PMCID: PMC4918180.
6. Canning P, Canon A, Bates JL, Gerardy K, Linhares DC, Piñeyro PE, Schwartz KJ, Yoon KJ, Rademacher CJ, Holtkamp D, Karriker L. Neonatal Mortality, Vesicular Lesions and

Lameness Associated with Senecavirus A in a U.S. Sow Farm. Transbound Emerg Dis. 2016 Aug;63(4):373-8. doi: 10.1111/tbed.12516. Epub 2016 May 23. PubMed PMID: 27213868.

7. Hause BM, Myers O, Duff J, Hesse RA. Senecavirus A in Pigs, United States, 2015. Emerg Infect Dis. 2016 Jul;22(7):1323-5. doi: 10.3201/eid2207.151591. PubMed PMID: 27314580; PubMed Central PMCID: PMC4918151.
8. Wang L, Prarat M, Hayes J, Zhang Y. Detection and Genomic Characterization of Senecavirus A, Ohio, USA, 2015. Emerg Infect Dis. 2016 Jul;22(7):1321-3. doi: 10.3201/eid2207.151897. PubMed PMID: 27314491; PubMed Central PMCID: PMC4918170.
9. Joshi LR, Mohr KA, Clement T, Hain KS, Myers B, Yaros J, Nelson EA, Christopher-Hennings J, Gava D, Schaefer R, Caron L, Dee S, Diel DG. Detection of the Emerging Picornavirus Senecavirus A in Pigs, Mice, and Houseflies. J Clin Microbiol. 2016 Jun;54(6):1536-45. doi: 10.1128/JCM.03390-15. Epub 2016 Mar 30. PubMed PMID: 27030489; PubMed Central PMCID: PMC4879313.

Others: