Farmers and Feces: A One Health Approach to Emerging Swine Zoonoses

Annette Greer, PhD and Emily S. Bailey, PhD
March 27, 2019
Zoonotic Viruses

Close contact

Wild and domestic

Asymptomatic Adaptations Transmission

Human infections originate from animals (60-80%)

From http://www.iisertvm.ac.in/faculties/stalin/research_areas.phpx
Where are large groups of people and animals mixing?
A Mini Review of the Zoonotic Threat Potential of Influenza Viruses, Coronaviruses, Adenoviruses, and Enteroviruses

Emily S. Bailey, Jana K. Fieldhouse, Jessica Y. Choi and Gregory G. Gray

During the last two decades, scientists have grown increasingly aware that viruses are emerging from the human-animal interface. In particular, respiratory infections are problematic; in early 2003, World Health Organization issued a worldwide alert for a previously unrecognized illness that was subsequently found to be caused by a novel coronavirus (severe acute respiratory syndrome (SARS) virus). In addition to SARS, other respiratory pathogens have also emerged recently, contributing to the high burden of respiratory tract infection-related morbidity and mortality. Among the recently emerged respiratory pathogens are influenza viruses, coronaviruses, enteroviruses, and adenoviruses. As the genetics of these emerging viruses is not well understood and their detection normally occurs after they have crossed over and adapted to man, ideally, strategies for such novel virus detection should include intensive surveillance at the human-animal interface, particularly if one believes the paradigm that many novel emerging zoonotic viruses first circulate in animal populations and occasionally infect man before they fully adapt to many early detection at the human-animal interface will provide earlier warning. Here, we review recent emerging virus traits for these four groups of viruses.
Because of Hurricane Florence, at least 110 lagoons in North Carolina have either released pig waste into the environment or are at imminent risk of doing so.
NC Pork Production

Five largest pork export countries
2016 statistics

Who Imports U.S. Pork?
- Mexico: 1.61 billion pounds
- China: 1.2 billion pounds
- Japan: 854 million pounds
- Canada: 452 million pounds
- Korea: 298 million pounds

Fig 1. Pork Consumption in China and the United States, 1960-2012 (Source: USDA)

Each year, North Carolina exports about $650 million worth of pork

https://www.ncpork.org/exports/
CAFOs in the Scientific Literature

Addressing Externalities From Swine Production to Reduce Public Health and Environmental Impacts

The Potential Role of Concentrated Animal Feeding Operations in Infectious Disease Epidemics and Antibiotic Resistance

Mary J. Gilchrist,1 Christina Greko,2 David B. Wallinga,3 George W. Beran,4 David G. Riley,5 and Peter S. Thorne5

1University Hygienic Laboratory, Iowa City, Iowa, USA; 2National Veterinary Institute, Uppsala, Sweden; 3Institute for Agriculture and Trade Policy, Minneapolis, Minnesota, USA; 4Iowa State University, Ames, Iowa, USA; 5College of Public Health, The University of Iowa

Impacts of Waste from Concentrated Animal Feeding Operations on Water Quality

JoAnn Burkholder,1 Bob Libra,2 Peter Weyer,3 Susan Heathcote,4 Dana Kolpin,5 Peter S. Thorne,3 and Michael Wichman6

1North Carolina State University, Raleigh, North Carolina, USA; 2Survey, Iowa City, Iowa, USA

Health Effects of Airborne Exposures from Concentrated Animal Feeding Operations

Dick Heederik,1 Torben Sigsgaard,2 Peter S. Thorne,3 Joel N. Kline,3 Rachel Avery,4 Jakob H. Bønløkke,2 Elizabeth A. Chrischilles,1 James A. Dozman,5 Caroline Duchaine,5 Steven R. Kirkhorn,7 Katarina Kulhankova,3 and James A. Merchant3

1University of Utrecht, Utrecht, the Netherlands; 2University of Aarhus, Aarhus, Denmark; 3The University of Iowa, Iowa City, Iowa, USA

Community Health and Socioeconomic Issues Surrounding Concentrated Animal Feeding Operations

Kelley J. Donham,1 Steven Wing,2 David Osterberg,1 Jan L. Flor3, Carol Hodne,1 Kendall M. Thu,4 and Peter S. Thorne1

1College of Public Health, The University of Iowa, Iowa City, Iowa, USA; 2Department of Epidemiology, University of North Carolina, Chapel Hill, North Carolina, USA; 3Department of Sociology, Iowa State University, Ames, Iowa, USA; 4Department of Anthropology, Northern Illinois University, DeKalb, Illinois, USA
CAFOs and Zoonotic Pathogens

Definitions

Zoonoses - a disease that can be transmitted from animals to people

Reverse Zoonoses - a disease that can be transmitted from people to animals

• Occupational exposures to zoonotic pathogens
  • Influenza A Viruses
  • E. coli
  • S. aureus
  • S. suis
  • Campylobacter

• Antimicrobial Resistance

www.cdc.gov
Figure 1. Graphical summary of the reports of human and animal infections with the various influenza viruses (Genes influenza virus A, B, C, & D). It is interesting to note that humans and pigs are thought to be susceptible to all four influenza genera. Among the animals with documented influenza infections, many are domestic animals. In particular, poultry and pigs serve as important amplifying reservoirs for influenza A virus infections in man.
Emerging and re-emerging coronaviruses in pigs

Qiuhong Wang, Anastasia N Vlasova, Scott P Kenney, Linda J Saif

https://doi.org/10.1016/j.coviro.2018.12.001

Highlights

- Three coronaviruses are emerging/reemerging in pigs.
Chain of Transmission

- Infectious Agent
- Susceptible Host
- Reservoir
- Portal of Entry
- Portal of Exit
- Mode of Transmission

Surveillance
Current Surveillance

• Disadvantages:
  • Disrupts production
  • Undue stress on animals
  • Compromises biosecurity
  • Fear of economic backlash
  • Expensive
  • Humans often serve as sentinels for novel diseases

Surveillance methods that are less invasive and more readily accepted by production managers are needed
“The integrative effort of multiple disciplines working locally, nationally, and globally to attain optimal health for people, animals, and the environment” - AVMA
Slurry Sampling
A Feasibility Study of Conducting Surveillance for Swine Pathogens in Swine Slurry in North Carolina Swine Farms

Collaborating Institutions:
- Duke University
- NC Agromedicine Institute

Objectives:
- Establish non-invasive slurry sampling as a means of routine surveillance for the detection of pathogens of zoonotic and economic concern
- Train farm owners/managers to collect slurry samples and to implement surveillance of their swine herds

Overall Goal: To determine if slurry sampling was a viable alternative non-invasive method for virus surveillance on swine farms.
Proportion of Viruses Detected in 105 Swine Slurry Samples

- Influenza virus
- Adenovirus
- Coronavirus
- EMCV
- PRRSV
- Enterovirus
- PCV2
- PCV3
- Seneca Valley Virus

Percent Positivity for EV Over Time by Farm

- Farm 1
- Farm 2

Bars represent the percent positivity for EV over time from April to November.
Bivariate Risk Analysis

Key Findings:

- Detections of both enterovirus and coronavirus associated with pig weight (more positives in young pigs)
- Enterovirus was significantly associated with more pigs in the barn (OR 4.29; 95% CI 1.77, 10.43)
- Detection of coronavirus and senecavirus often coincided with detection of enterovirus (OR 3.76; 95% CI 1.55, 9.15 and OR 3.56; 95% CI 1.10, 11.52)
Viral breakdown

Fanning shape hints at new viral strain
What did we learn?
Emerging Viruses at the Human/Animal Interface

Among Domestic Animals Harboring Influenza A Viruses with Threaten Man, Which has the Greatest Risk of Sharing Virus with Humans?

- Surveillance for novel viruses in pigs is sporadic.
- Influenza A viruses in swine were associated with the 1918, 1957, 1968 and 2009 pandemics.
- Through limited study we know there are multiple unique influenza A viral strains circulating in pigs which could generate new pandemic viruses.
Duke One Health Research & Training Network, 2018-2019

One Health Research & Training Sites
- Duke managed
- Collaborators

Duke University, UNITED STATES
Duke-NUS Medical School, SINGAPORE
Duke Kunshan University, CHINA
Duke-NUS-Medical School, SINGAPORE
EGYPT
PAKISTAN
MONGOLIA
CHINA
PHILIPPINES
VIETNAM
MALAYSIA
SOUTH AFRICA
MYANMAR
Why does it matter?
SARS OUTBREAK, 2003:
Rapid spread worldwide by movement of people

“Disease is only a plane flight away”
Acknowledgments

- Duke University
  - Gregory Gray, MD, MPH
  - One Health Team

- North Carolina Agromedicine Institute (ECU, NCSU and NC A&T)
  - Annette Greer, PhD

- Duke-NUS
  - Kristen Coleman, PhD
  - Tham Nguyen, MPH

- DKU
  - Emma Wang, MSc
Questions?

https://sites.globalhealth.duke.edu/dukeonehealth/