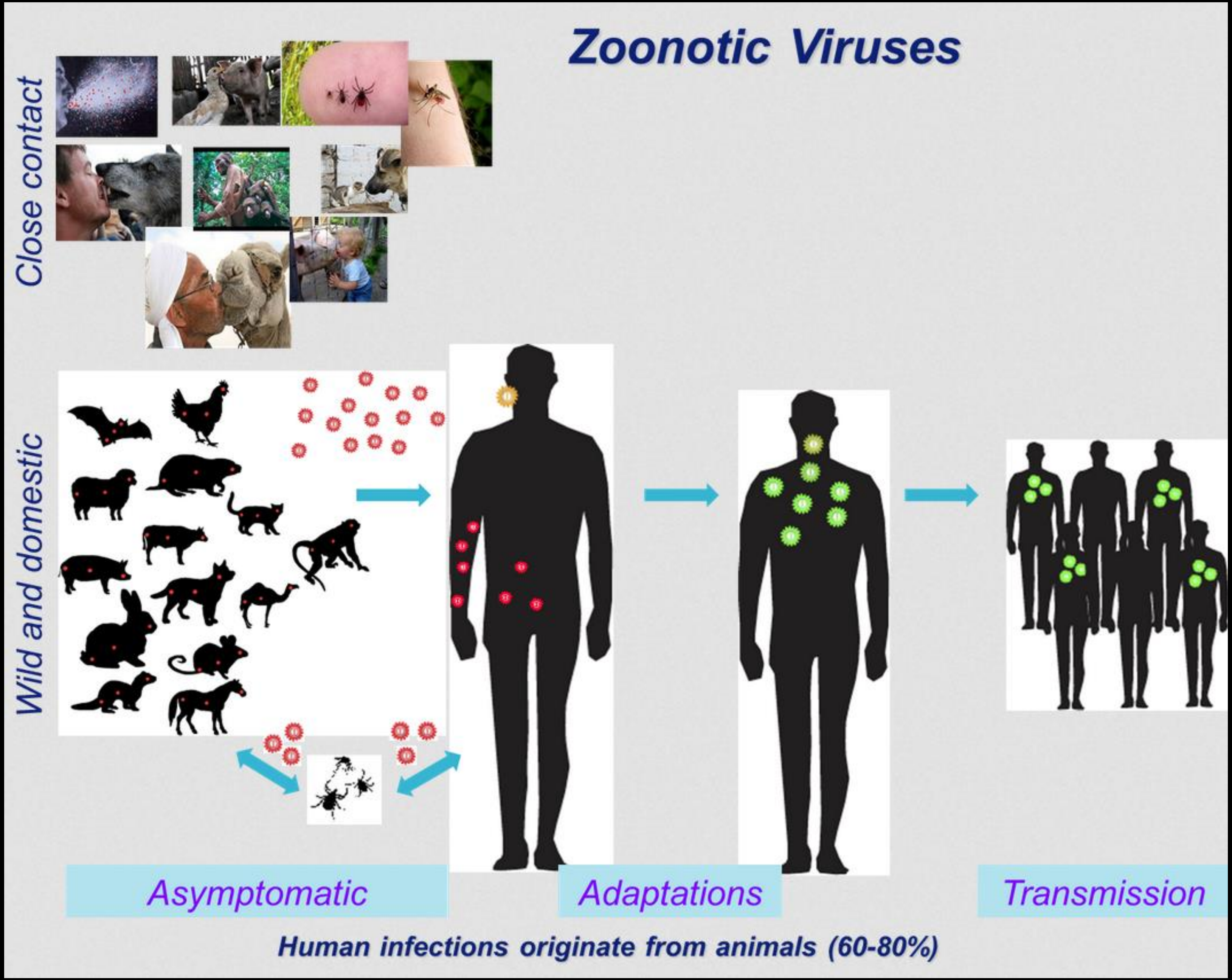
# Farmers and Feces: A One Health Approach to Emerging Swine Zoonoses


Annette Greer, PhD and  Emily S. Bailey, PhD

March 27, 2019


PANDEMIC
TOKYO
INFECTION RATE
2 2 2 3 3 4 4
OUTBREAKS
0
1
2
3
4
5
6
7
SAN FRANCISCO
CHICAGO
MONTREAL
NEW YORK
WASHINGTON
LONDON
ESSEN
ST. PETERSBURG
PARIS
MILAN
MADRID
MOSCOW
ISTANBUL
ALGIERS
CAIRO
BAGHDAD
TEHRAN
RIYADH
KARACHI
DELHI
KOLKATA
MUMBAI
CHENNAI
BEIJING
SEOUL
SHANGHAI
HONG KONG
TAIPEI
OSAKA
BANGKOK
HO CHI MINH CITY
MANILA
JAKARTA
SYDNEY
LOS ANGELES
MEXICO CITY
MIAMI
BOGOTA
LIMA
SANTIAGO
BUENOS AIRES
SÃO PAULO
LAGOS
KHARTOUM
KINSHASA
JOHANNESBURG
CURED DISEASES/FLIP TOKEN IF ERADICATED
BAGHDAD
PLAY
1.Do 4 actions
2.Draw 2 cards
•Resolve any epidemics
•Discard to 7 cards
3.Infect cities

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# Where are large groups of people and animals mixing?

frontiers in Public Health

MINI REVIEW
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# A Mini Review of the Zoonotic Threat Potential of Influenza Viruses, Coronaviruses, Adenoviruses, and Enteroviruses

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**Specialty section:**

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 genesis 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 man; early detection at the human–animal interface will provide earlier warning. Here, we review recent emerging virus treats for these four groups of viruses.



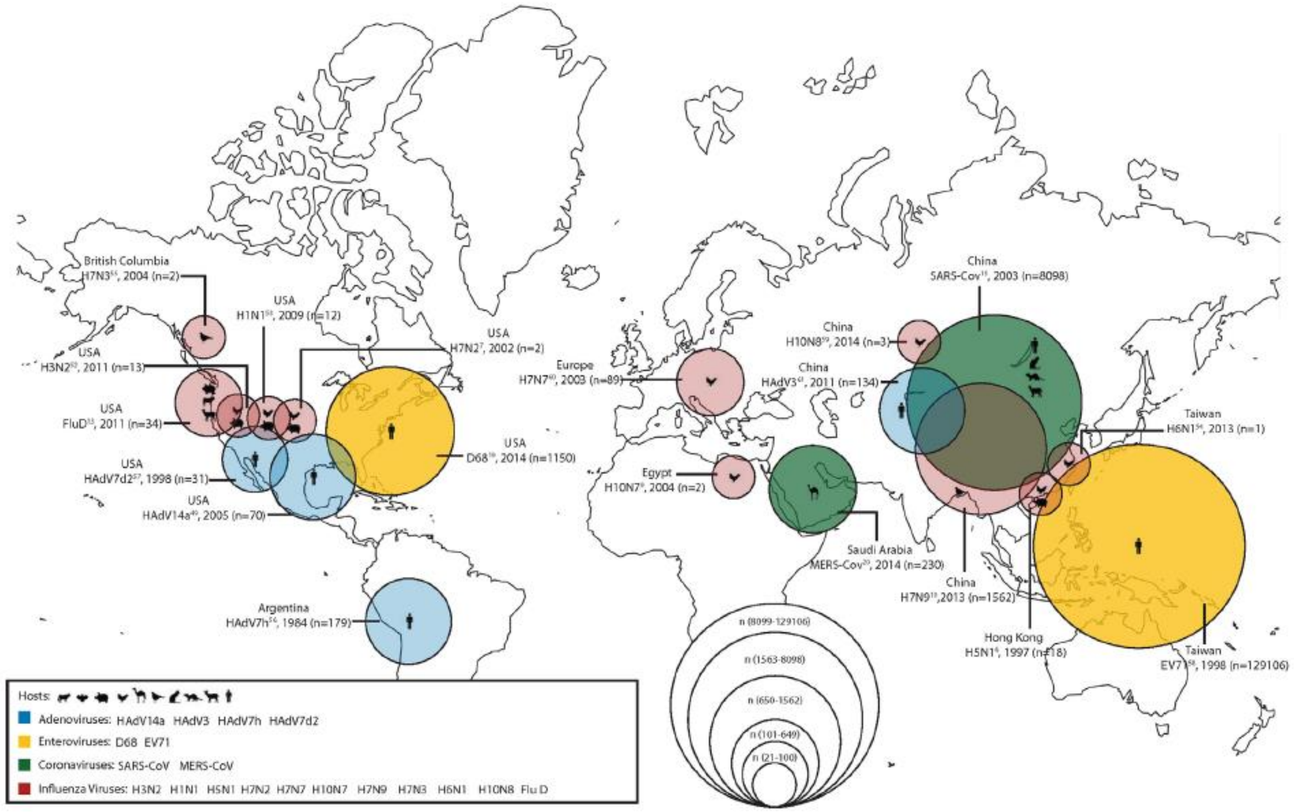



**FIGURE 1** | The geographical location of first detections (with known reservoirs) for recently emerged adenoviruses (Ads), enteroviruses (EVs), coronaviruses, and influenza viruses. Zoonotic (coronaviruses and influenza viruses) and non-zoonotic viruses (Ads and EVs) are shown. For zoonotic viruses, the hosts range from cattle, bats, chickens, camels, wild birds, cats, ferrets, goats, and humans (from left to right). The different sizes of the circles represent the number of human cases during the first outbreaks of the emerging respiratory viruses. Human cases of adenoviral infections are shown in blue; human cases of enteroviral infections are shown in yellow; human cases of coronaviral infections are shown in green; and human cases of influenza viral infections are shown in red.

# Small Family Farm

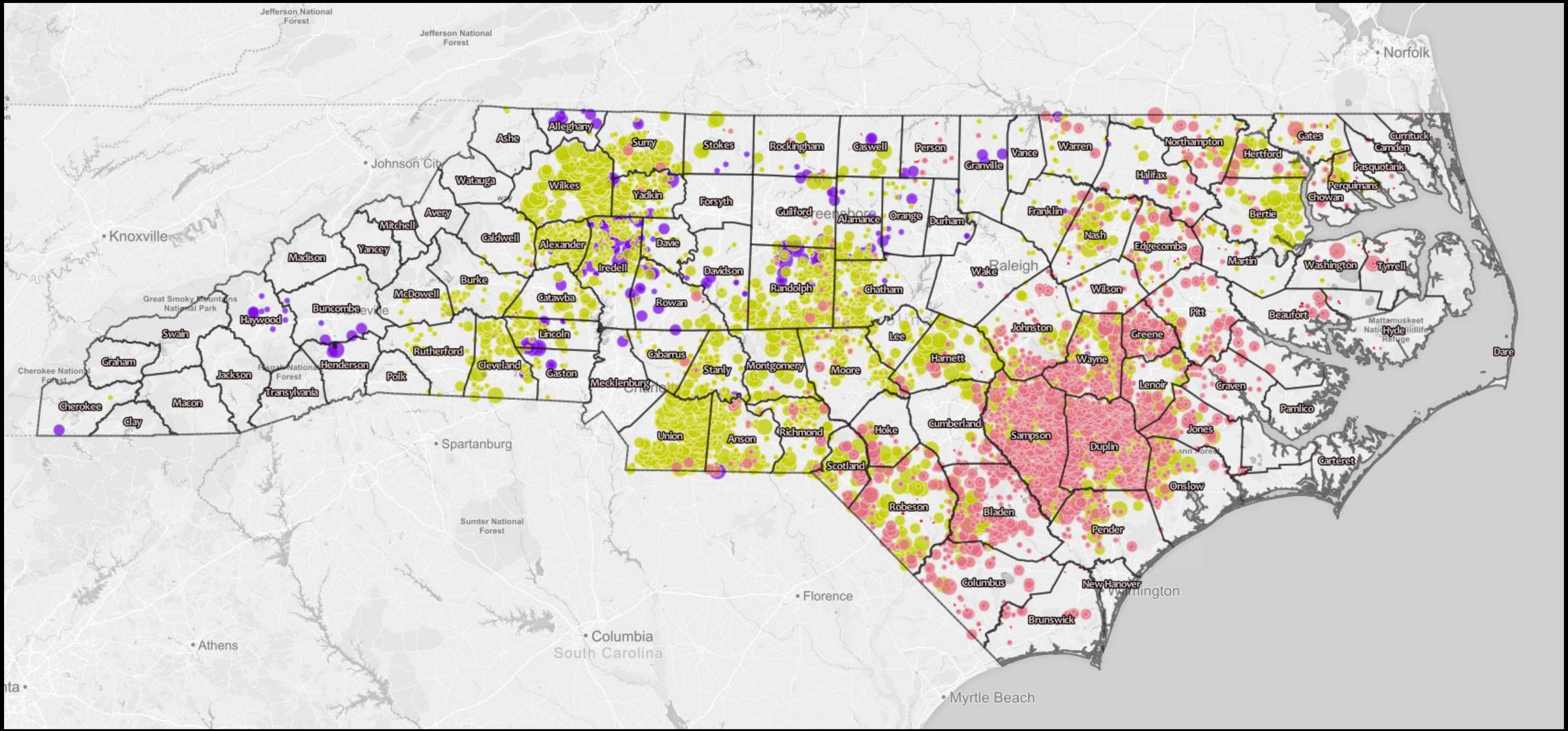
**The New York Times** @nytimes · 6h

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

**Lagoons of Pig Waste Are Overflowing After Florence. Yes, That's ...**

At least 110 lagoons in North Carolina have either released pig waste into the environment or are at imminent risk of doing so, according to state offi...

nytimes.com




*Waterkeeper Alliance and the Environmental Working Group used public data to create maps of CAFO locations in North Carolina in 2016. For more information and interactive maps, visit https://www.ewg.org/interactive-maps/2016_north_carolina_animal_feeding_operations.php#.W6KBLPZReUk.*

# NC Pork Production

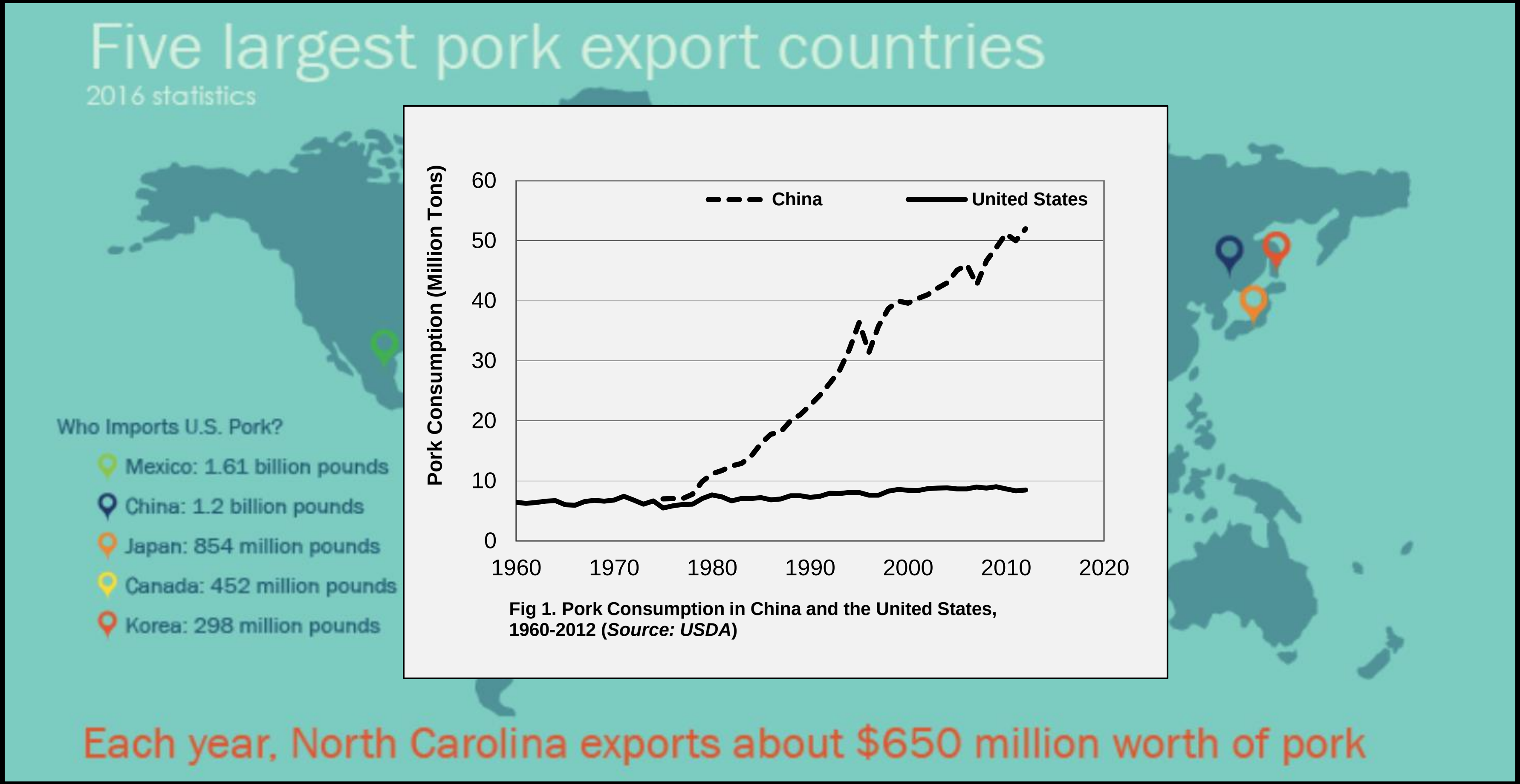



**Fig 1. Pork Consumption in China and the United States, 1960-2012 (*Source: USDA*)**

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. Thorne[5]*

[1]University Hygienic Laboratory, Iowa City, Iowa, USA; [2]National Veterinary Institute, Uppsala, Sweden; [3]Institute for Agriculture and Trade Policy, Minneapolis, Minnesota, USA; [4]Iowa State University, Ames, Iowa, USA; [5]College 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 Wichman[6]*

[1]North Carolina State Un
Iowa City, Iowa, USA; [4]Io
Survey, Iowa City, Iowa,

## 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,[3] James A. Dosman,[5] Caroline Duchaine,[6] Steven R. Kirkhorn,[7] Katarina Kulhankova,[3] and James A. Merchant[3]*

[1]University of Utrecht, Utrecht, the Netherlands; [2]University of Aarhus, Aarhus, Denmark; [3]The University of Iowa, Iowa City, Iowa, USA;
van, Canada; [6]Laval

## Community Health and Socioeconomic Issues Surrounding Concentrated Animal Feeding Operations

*Kelley J. Donham,[1] Steven Wing,[2] David Osterberg,[1] Jan L. Flora,[3] Carol Hodne,[1] Kendall M. Thu,[4] and Peter S. Thorne[1]*

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

# CAFOs and Zoonotic Pathogens

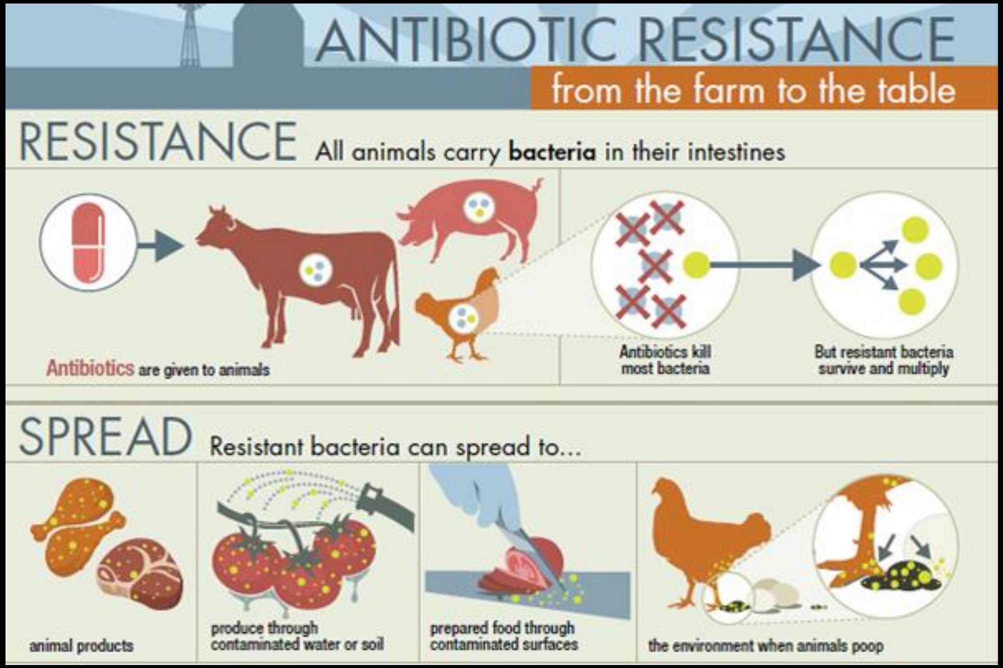
Definitions

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

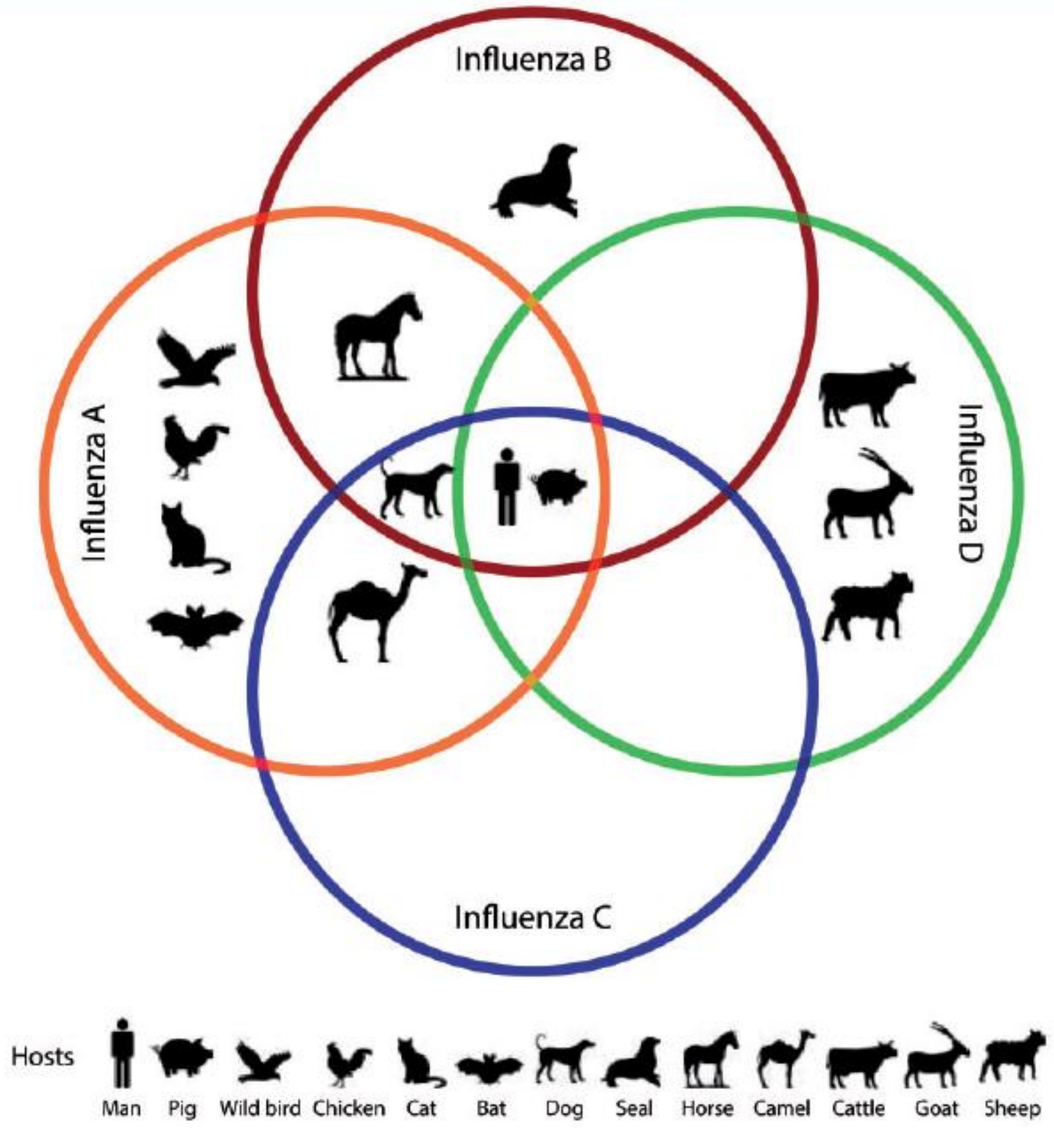



**Figure 1.** Graphical summary of the reports of human and animal infections with the various influenza viruses (Genera influenza virus A, B, C, & D). It is interesting to note that humans and pigs are thought to be susceptible to all four influenza genera. Among the animals with documented influenza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

Evolution, Medicine, and Public Health [2018] pp. 192–198
doi:10.1093/emph/eoy013

# Emerging Coronaviruses in Swine

Volume 24, Number 7—Jul

*Research Letter*

## Spillover of Swine C

**Sarah N. Bevins✉, Mark Lutman, I**
Author affiliations: US Departmen
Collins, Colorado, USA (S.N. Bevin

Cite This Article

ELSEVIER

Current Opinion in Virology
Volume 34, February 2019, Pages 39-49

## Emerging and re-emerging coronaviruses in pigs

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

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

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Highlights

- Three coronaviruses are emerging/reemerging in pigs.

VIROLOGY JOURNAL

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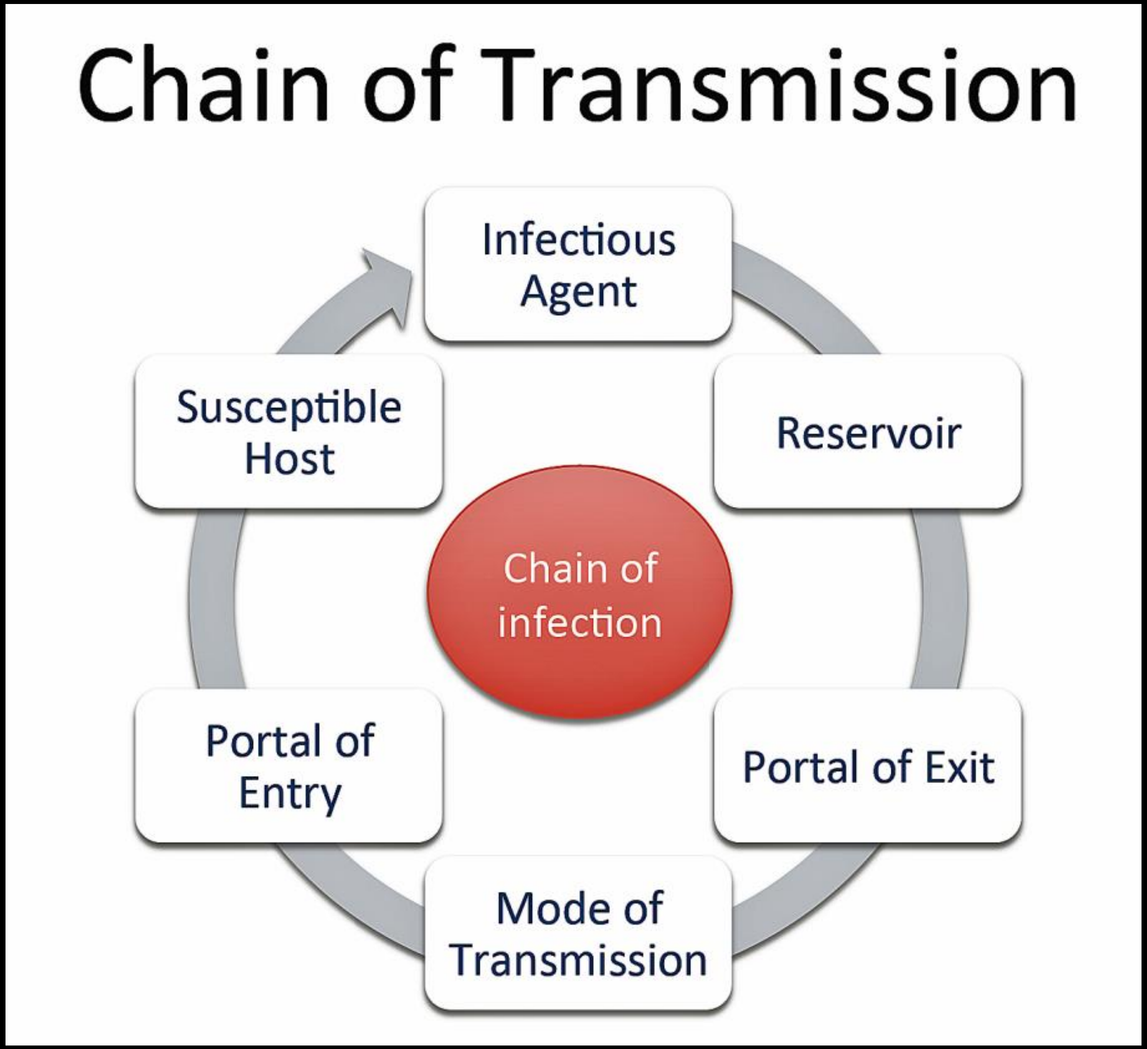


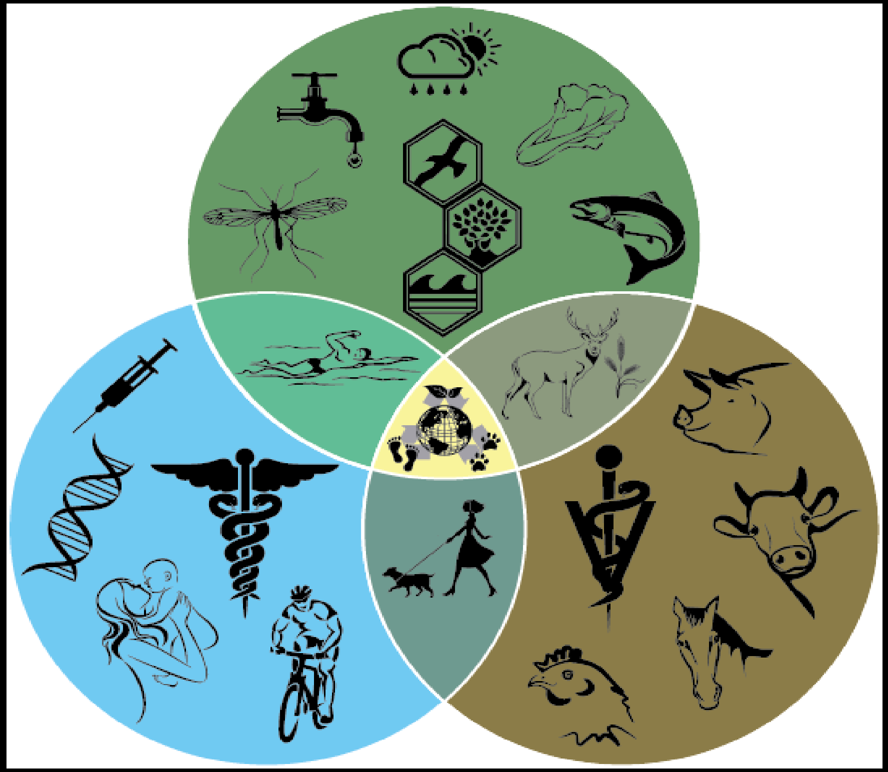

Surveillance

# Current Surveillance

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

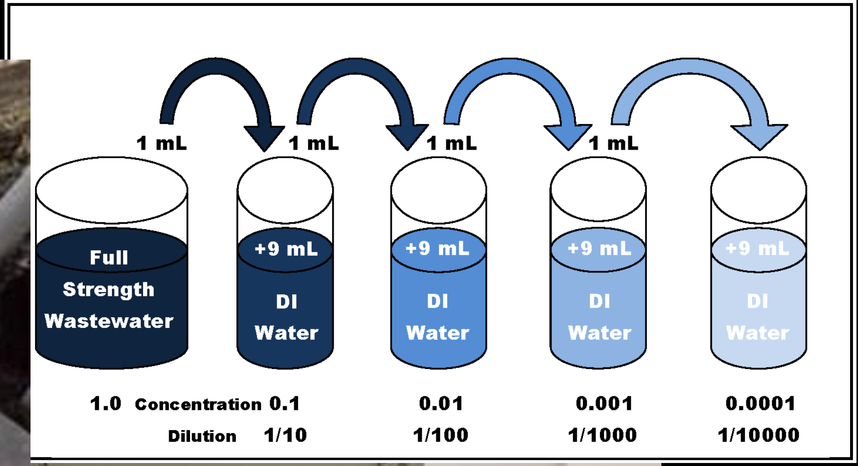
Surveillance methods that <u>are less invasive</u> and more <u>readily accepted</u> by production managers are needed

# One Health



*"The integrative effort of multiple disciplines working locally, nationally, and globally to attain optimal health for people, animals, and the environment"* -AVMA

# Slurry Sampling




Duke One Health

Animal

# A Feasibility Study of Conducting Surveillance for Swine Pathogens in Swine Slurry in North Carolina Swine Farms

**Collaborating Institutions:**

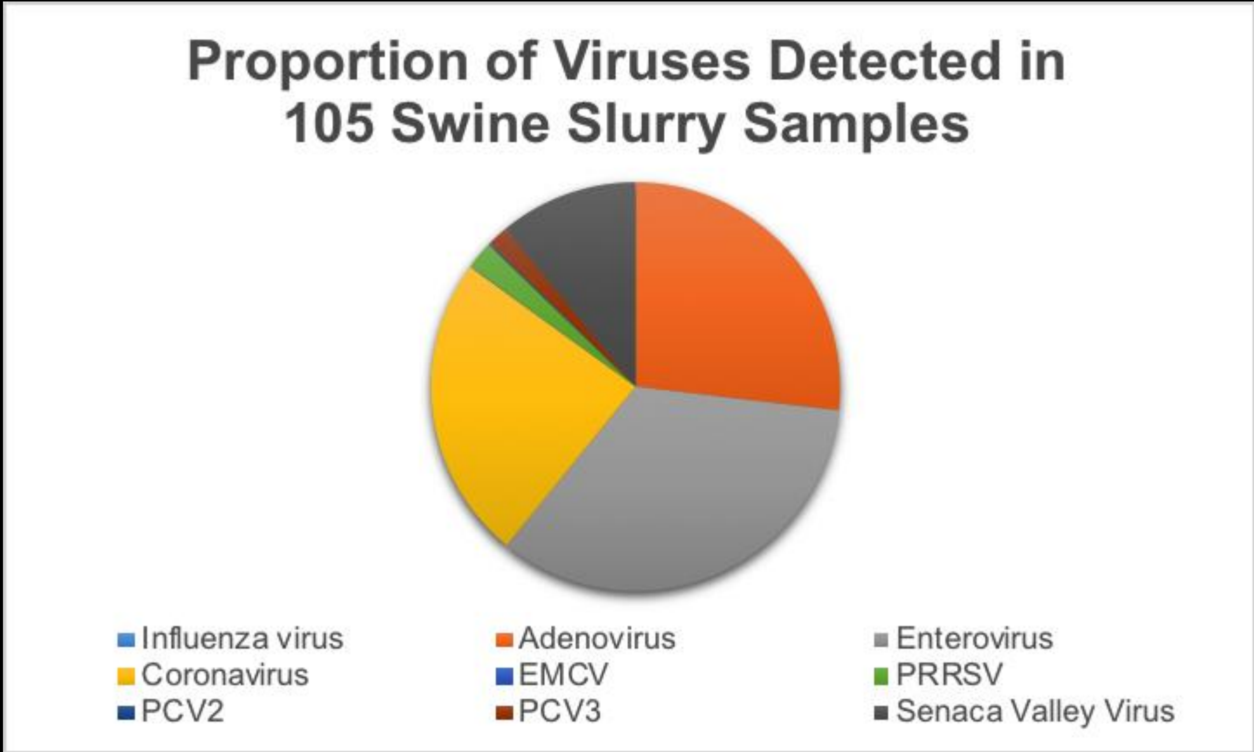
- Duke University
- NC Agromedicine Institute

**Overall Goal:** To determine if slurry sampling was a viable alternative non-invasive method for virus surveillance on swine farms.

**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

Animal


Proportion of Viruses Detected in 105 Swine Slurry Samples
Influenza virus
Adenovirus
Enterovirus
Coronavirus
EMCV
PRRSV
PCV2
PCV3
Senaca Valley Virus

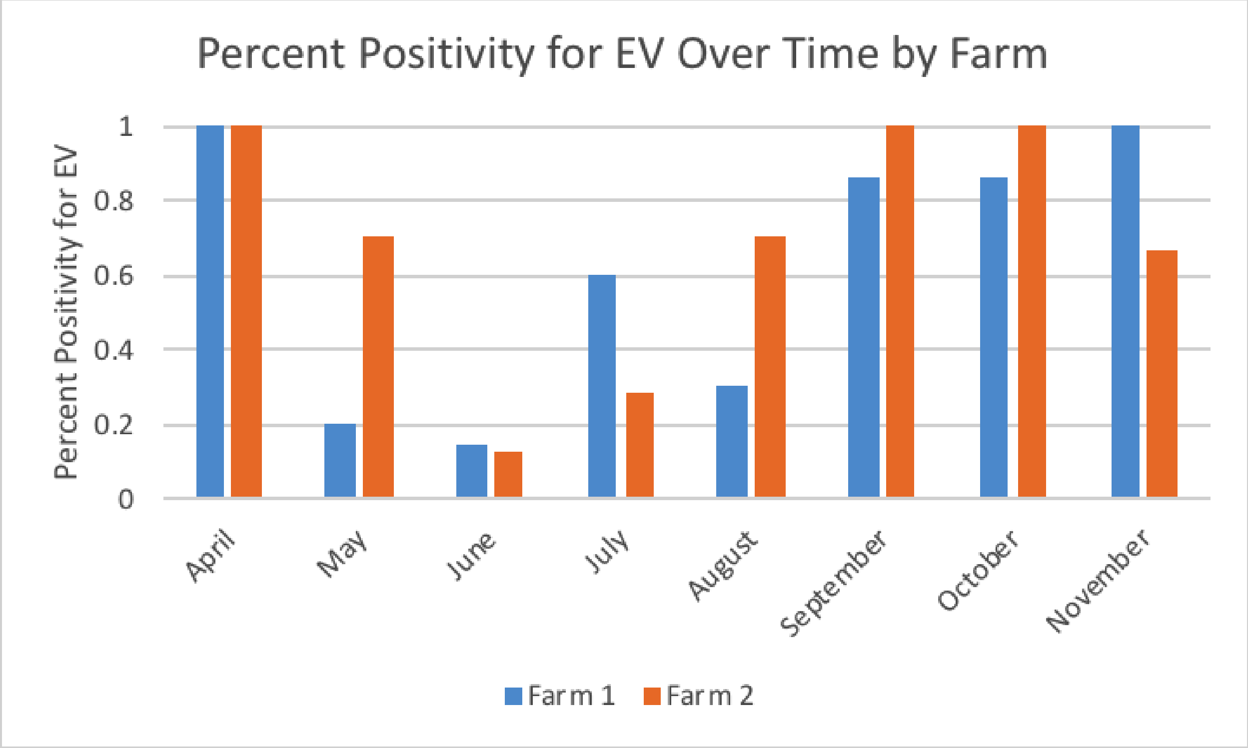

Percent Positivity for EV Over Time by Farm
Percent Positivity for EV
1
0.8
0.6
0.4
0.2
0
April
May
June
July
August
September
October
November
Farm 1
Farm 2

**Table 1. Unadjusted odds ratios for risk factors associated with virus positivity in 105 swine slurry samples.** Samples were collected from swine waste pits at two pig farms in North Carolina between April and November 2018.

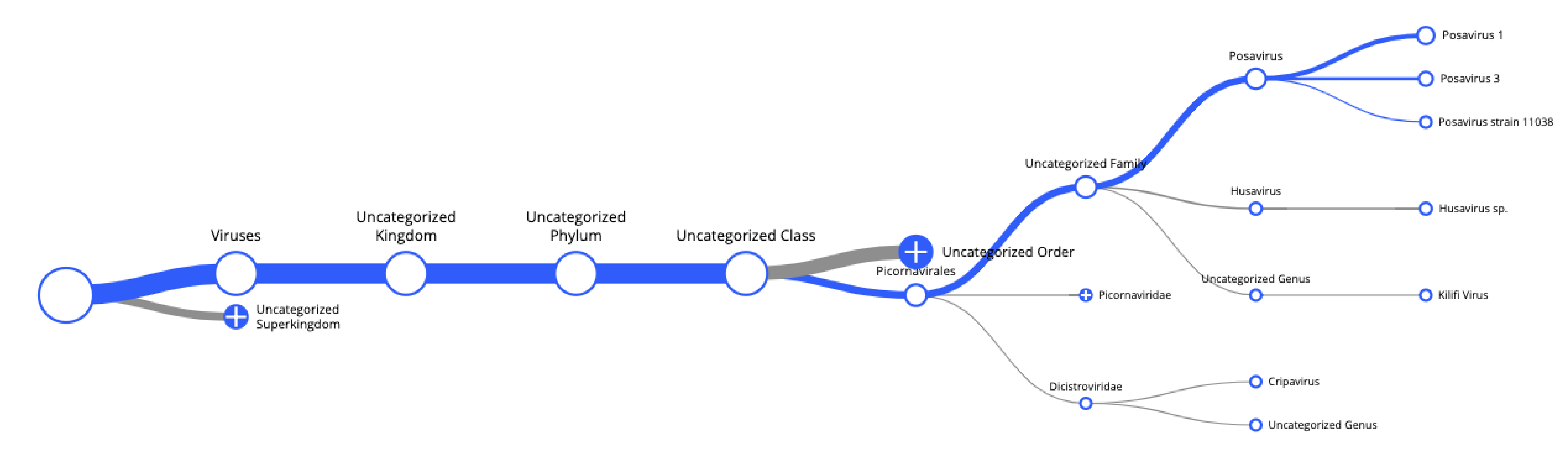
| | Adenovirus | | Enterovirus | | Coronavirus | | Senecavirus | | Any Positives* | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Predictor** | **No. (%)** | **OR (95% CI)** | **No. (%)** | **OR (95% CI)** | **No. (%)** | **OR (95% CI)** | **No. (%)** | **OR (95% CI)** | **No. (%)** | **OR (95% CI)** |
| Month | | | | | | | | | | |
| July | 1 (8.3) | 0.10 (0.01, 1.02) | 5 (41.7) | 4.64 (0.71, 30.42) | 3 (25.0) | 1.33 (0.22, 8.22) | 0 (0.0) | ---- | 8 (66.7) | 1.00 (0.20, 5.00) |
| August | 6 (30.0) | 0.50 (0.12, 1.97) | 10 (50.0) | **6.50 (1.16, 36.57)** | 6 (30.0) | 1.71 (0.35, 8.37) | 4 (20.0) | 0.46 (0.11, 1.94) | 8 (66.7) | 2.83 (0.55, 14.47) |
| September | 6 (42.9) | 0.86 (0.20, 3.71) | 13 (92.9) | **84.50 (6.80, 1050.80)** | 5 (35.7) | 2.22 (0.42, 11.83) | 9 (64.3) | 3.34 (0.80, 13.94) | 17 (85.0) | ---- |
| October | 8 (57.1) | 1.52 (0.35, 6.60) | 13 (92.9) | **84.50 (6.80, 1050.80)** | 13 (92.9) | **52.00 (0.474, 570.53)** | 0 (0.0) | ---- | 14 (100.0) | ---- |
| November | 3 (50.0) | 1.14 (0.17, 7.60) | 5 (83.3) | **32.50 (2.38, 443.14)** | 6 (100.0) | ---- | 0 (0.0) | ---- | 6 (100.0) | ---- |
| April | 4 (100.0) | ---- | 4 (100.0) | ---- | 0 (0.0) | ---- | 0 (0.0) | ---- | 4 (100.0) | ---- |
| May | 12 (60.0) | 1.71 (0.44, 6.63) | 9 (45.0) | 5.32 (0.94, 29.99) | 3 (15.0) | 0.71 (0.12, 4.11) | 7 (35.0) | Ref. | 15 (75.0) | 1.50 (0.34, 5.56) |
| June | 7 (46.7) | Ref. | 2 (13.3) | Ref. | 3 (20.0) | Ref. | 0 (0.0) | ---- | 10 (66.7) | Ref. |
| Weather | | | | | | | | | | |
| Sun | 29 (44.6) | 1.29 (0.38, 4.36) | 38 (58.5) | 1.64 (0.50, 5.43) | 24 (36.9) | 3.22 (0.66, 15.77) | 9 (13.8) | 0.88 (0.17, 4.66) | 53 (81.5) | 1.32 (0.32, 5.56) |
| Sun & Wind | 3 (37.5) | 0.96 (0.16, 5.90) | 5 (62.5) | 1.94 (0.32, 11.76) | 6 (75.0) | **16.50 (1.83, 148.61)** | 4 (50.0) | 5.50 (0.71, 42.60) | 7 (87.5) | 2.10 (0.18, 24.60) |
| Cloudy/Overcast | 8 (66.7) | 3.20 (0.62, 16.49) | 6 (50.0) | 1.17 (0.24, 5.62) | 5 (41.7) | 3.93 (0.59, 26.11) | 2 (16.7) | 1.10 (0.13, 9.34) | 12 (100.0) | ---- |
| Rain & Wind | 2 (28.6) | 0.64 (0.09, 4.66) | 6 (85.7) | 1.94 (0.32, 11.71) | 2 (28.6) | 2.20 (0.24, 20.40) | 3 (42.9) | 4.12 (0.49, 34.49) | 6 (85.7) | 1.80 (0.15, 21.40) |
| Rain | 5 (38.5) | Ref. | 6 (46.2) | Ref. | 2 (15.4) | Ref. | 2 (15.4) | Ref. | 10 (76.9) | Ref. |
| Temperature (°F) | | | | | | | | | | |
| <70 | 6 (75.0) | **8.00 (1.25, 51.14)** | 6 (75.0) | 3.60 (0.59, 21.93) | 4 (50.0) | 2.14 (0.41, 11.17) | 1 (12.5) | 0.49 (0.05, 4.94) | 8 (100.0) | |

Bivariate Risk Analysis

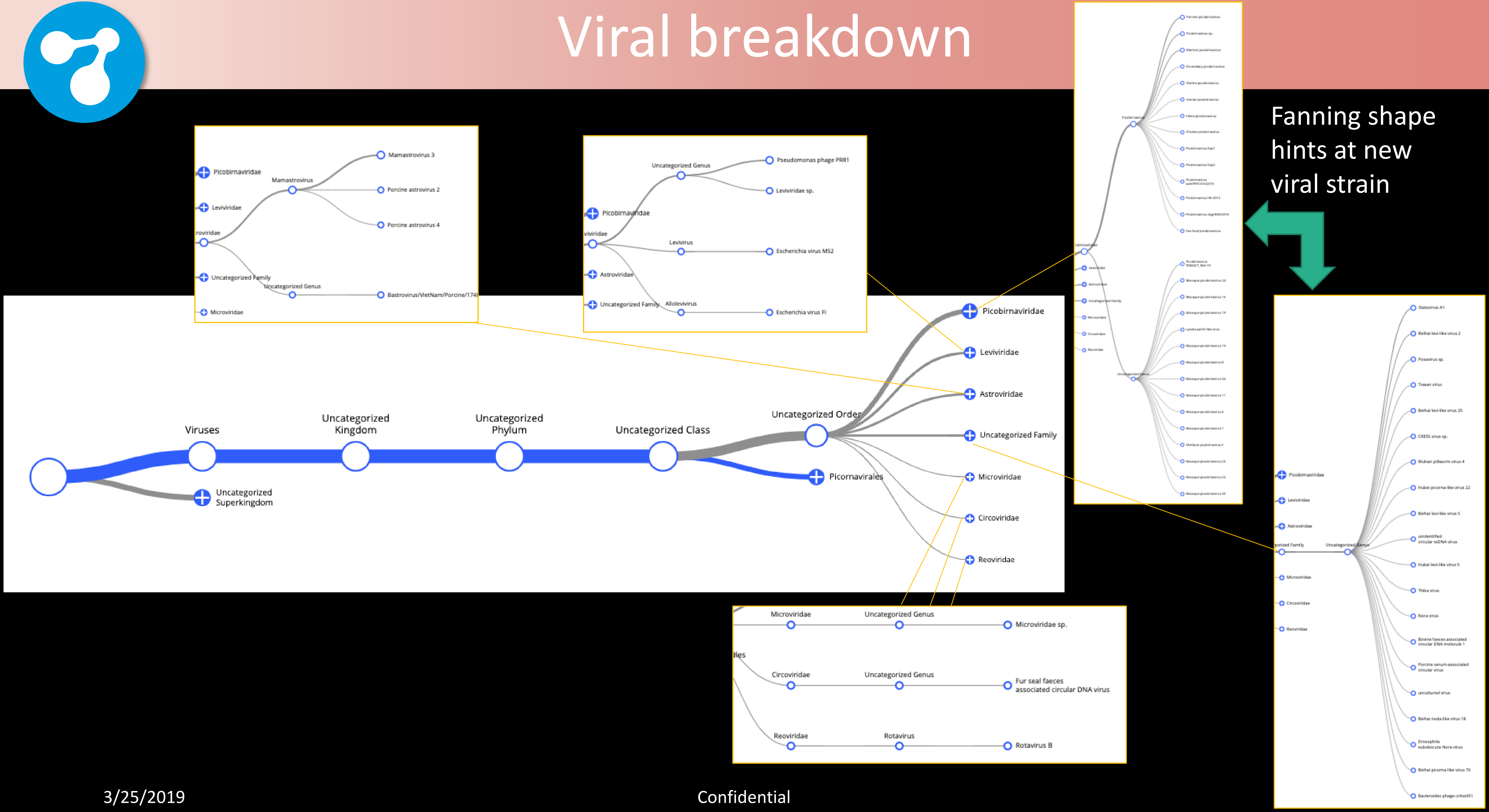
Key Findings:

- 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



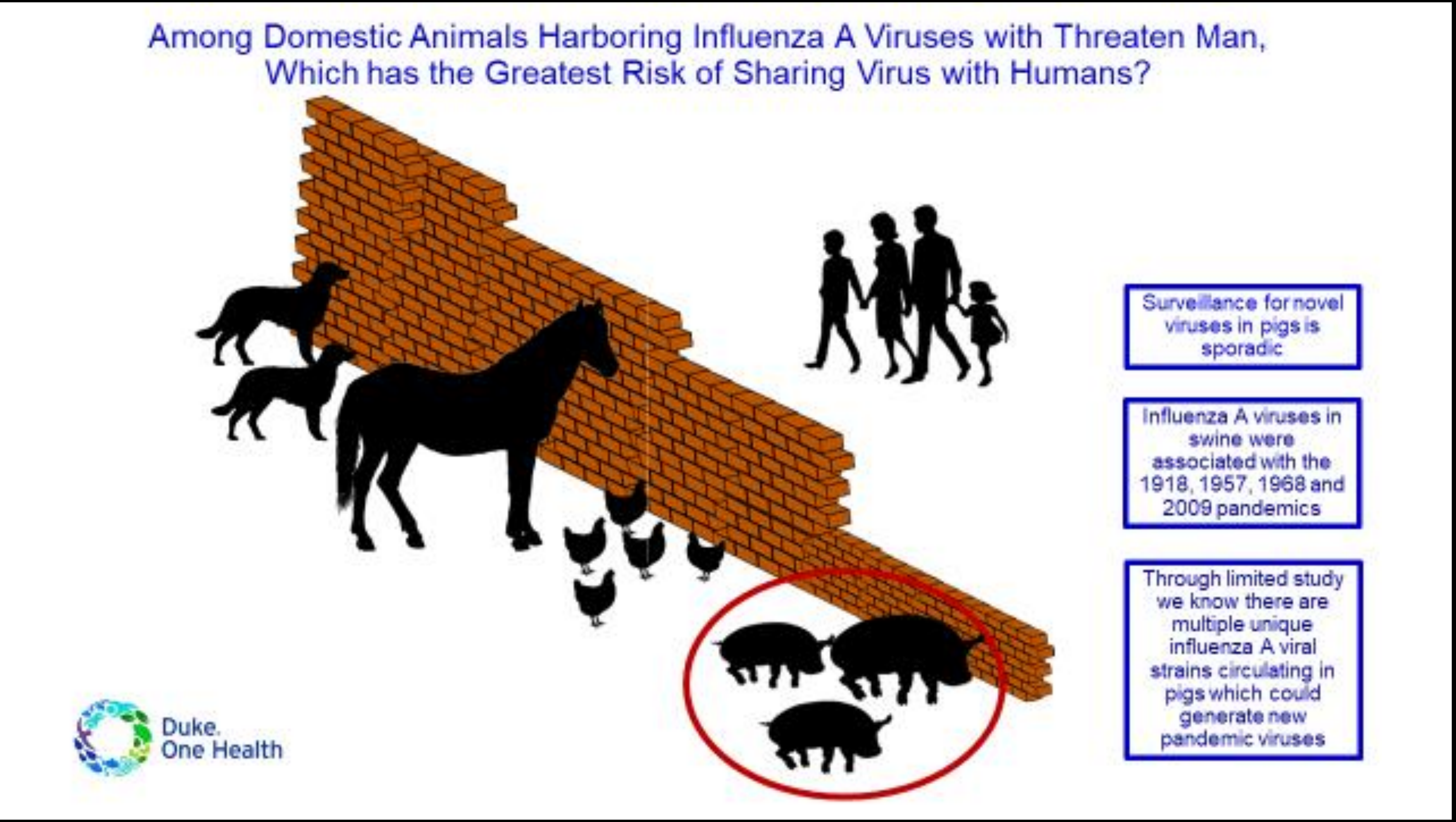
# Viral breakdown



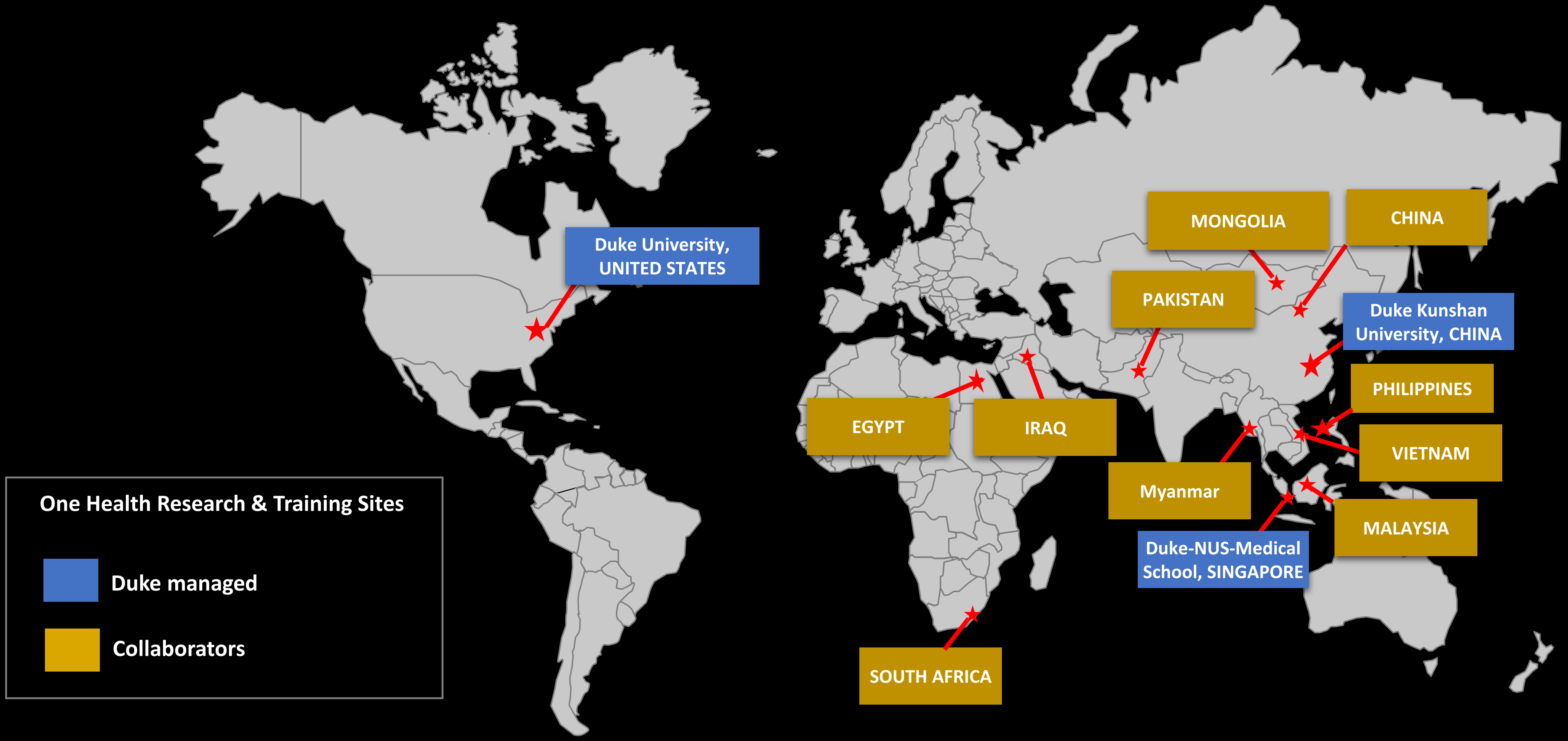

Fanning shape hints at new viral strain

# What did we learn?

# Emerging Viruses at the Human/Animal Interface



# Duke One Health Research & Training Network, 2018-2019



# Why does it matter?

SARS OUTBREAK, 2003:
Rapid spread worldwide by movement of people

# Acknowledgments


- Duke University
  - Gregory Gray, MD, MPH
  - One Health Team
- North Carolina Agromedicine Institute (ECU, NCSU and NC A&T)
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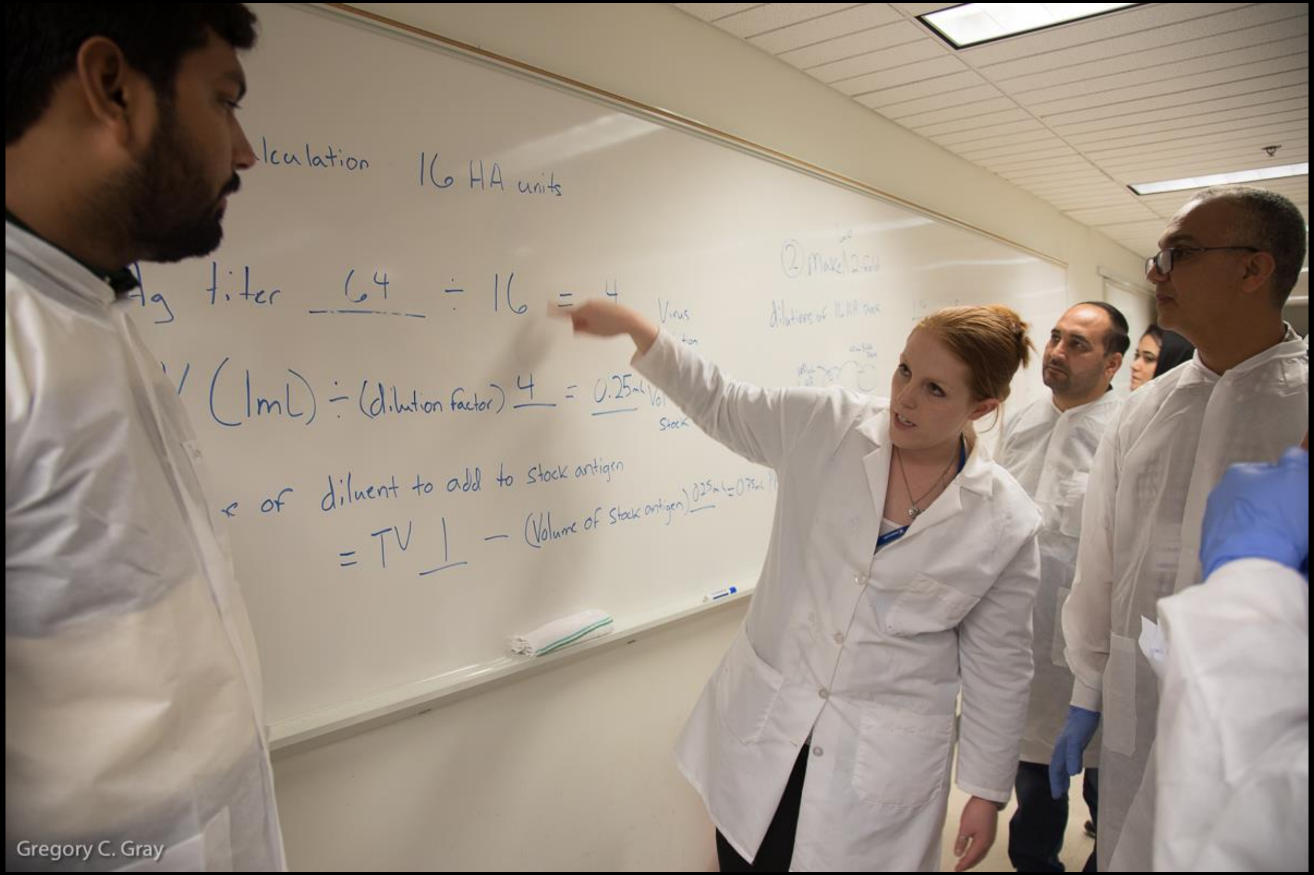
- Duke-NUS
  - Kristen Coleman, PhD
  - Tham Nguyen, MPH
- DKU
  - Emma Wang, MSc

# Questions?




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