One Health: Emerging Diseases and Opportunities for Collaboration

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Characteristics of a “Wicked Problem”

- Difficult to clearly define
- Many interdependencies and often multicausal
- Attempts to address the problem often lead to unforeseen consequences
- Frequently not stable
- Usually no clear solution
- Socially complex
- Rarely is the responsibility of only one stakeholder
- Solutions involve changing behaviors
- Can be characterized by chronic policy failure

From PDA letter May 4, 2016
Wicked Infectious Disease Problems

- Food security/safety
- Antimicrobial resistance (AMR)
- Emerging infectious diseases

While unique I argue that these are interrelated
The Centers for Disease Control and Prevention (CDC) estimates that each year in the USA foodborne illnesses cause:

- 1 in 6 (48 million) Americans to become sick
- 128,000 to be hospitalized
- 3000 persons to die

https://www.medscape.com/features/slideshow/foodborne-illness-outbreaks#page=10
The Well-Traveled Salad. Do You Know Where Your Food Has Been?

As consumers, many of us fail to recognize that even our domestic and local food supplies are part of a global network. The daily activity of consuming food directly links our health as humans to the health of crops and produce, food animals, and the environments in which they are produced.

A “One Health” approach to food safety—bringing together expertise and resources from the clinical, veterinary, wildlife health, and ecology communities—has the potential to reveal the sources, pathways, and factors driving the outbreaks of foodborne illness and possibly prevent them from occurring in the first place.

NOTE: Countries are listed in alphabetical order and not by volume of export.
How Drug-Resistant Bacteria Travel from the Farm to Your Table

Antibiotic-resistant bacteria from livestock pose a deadly risk to people. But the farm lobby won't let scientists track the danger

By Melinda Wenner Moyer on December 1, 2016
Global Examples of Emerging and Re-Emerging Infectious Diseases

- Antimicrobial-resistant threats
  - MRSA
  - C. difficile
  - N. gonorrhoeae

- H3N2 influenza
- Cyclosporiasis
- E. coli O157:H7
- Measles
- Human monkeypox
- Listeriosis
- Bourbon virus
- 2009 H1N1 influenza
- Adenovirus 14
- Anthrax bioterrorism
- Chikungunya
- Hantavirus pulmonary syndrome
- Dengue
- Zika virus
- Yellow fever
- Human African trypanosomiasis
- Cholera
- Marburg hemorrhagic fever
- MDR/XDR tuberculosis
- Plague
- HIV
- E. coli O104:H4
- Cryptosporidiosis
- Ebola virus disease
- Drug-resistant malaria
- Diphtheria
- MERS-CoV
- Akhmeta virus
- Rift Valley fever
- Typhoid fever
- SFTSV bunyavirus
- H10N8 influenza
- H7N9 influenza
- H5N1 influenza
- SARS
- Nipah virus
- Hendra virus
- Enterovirus 71
- Human monkeypox
- Ebola virus disease
- Zika virus

- Newly emerging
- Re-emerging/resurging
- "Deliberately emerging"

Source: Anthony S. Fauci, NIAID (2015)
• No one discipline is trained to engage such wicked infectious disease problems
• No one agency or organization can control such wicked infectious disease
Frustration
Poor cooperation

CDC
USDA
EPA
Consumer
Industry
FDA
One Health Defined

“One Health is the collaborative effort of multiple disciplines - working locally, nationally, and globally - to attain optimal health for people, animals, and our environment.”

AVMA One Health Initiative Task Force 2008
A One Health approach gains cooperation from all parties involved and employs public health, veterinary health, and environmental health approaches to bring balance to solving difficult public health problems.
97 organizations that have endorsed the One Health Initiative as of March 2018

SIAARTI Study Group in Animal Anesthesia Naples, Italy
Agronomes et Vétérinaires Sans Frontières
American Academy of Family Physicians
American Academy of Pediatrics
American Association of Public Health Physicians
American Association of Veterinary Laboratory Diagnosticians
American Association of Wildlife Veterinarians
American College of Preventive Medicine
American College of Veterinary Laboratory Diagnosticians
American College of Veterinary Pathologists
American College of Veterinary Preventive Medicine
American Medical Association
American Meteorological Society
American Mosquito Control Association
American Nurses Association
American Physiological Society
American Phytopathological Society
American Society for Microbiology
American Society of Tropical Medicine and Hygiene
American Veterinary Medical Association
Animal Medical Center, New York, USA
Animal/Human Health for Environment and Development for Great Limpopo Transfrontier Conservation Area
ANIMALS 24-7
Association of Academic Health Centers
Association of American Medical Colleges
Association of American Veterinary Medical Colleges
Association of Schools of Public Health
Auburn University’s College of Veterinary Medicine, Auburn, Alabama, USA
Bella Moss Foundation, United Kingdom
Biomedical Technology, Epidemiology and Food Safety Global Network: Brno, Czech Republic
CAB International
Center for One Health Research - University of Washington, USA
CGIAR Research Program – Agriculture for Nutrition and Health
Colegio de Médicos Veterinarios de PR
College of Veterinary Medicine and Biomedical Sciences, Texas A&M University, USA
Conservation through Public Health
Corporation Red SPVet, Bogota-Columbia
Council for Agricultural Science and Technology
Council of State and Territorial Epidemiologists
Croatian Society for Infectious Diseases
Department of Molecular and Comparative Pathobiology, Johns Hopkins University School of Medicine
Exuberant Animal
Faculty of Veterinary Medicine at the Universidad Autonoma de Nuevo Leon, Mexico
Federation of European Microbiological Societies
Federation of Veterinarians of Europe
Global Alliance for Rabies Control
Horizon International, Yale University
Immune Macro Biotic Technology, UK
Immuno Valley Consortium in The Netherlands
Indian Veterinary Public Health Association
Infection Prevention and Control, Canada
Institute of Tropical Medicine, Department of Animal Health, Antwerp, Belgium
Interacademy Medical Panel
International Association of Risk Management in Medicine
International Federation of Ageing
International Journal of One Health, India
International Livestock Research Institute
Italian Society of Preventive Medicine
Kansas City Area Life Sciences Institute – Kansas City, MO, USA
National Academies of Practice
National Association of State Public Health Veterinarians
National Centre for Animal Health, Bhutan
National Environmental Health Association
National Forum of Comparative Medicine, Romanian Academy of Medical Sciences
National Park Service, USA
New Zealand Centre for Conservation Medicine, Auckland
Nigerian Biomedical and Life Scientists
Nigerian Veterinary Medical Association
One Health Commission, USA
One Health in Epidemiology, Massey University, New Zealand
One Health New Medical Concept Association in Romania
Ovarian Cancer Symptom Awareness, USA
Pak One Health Alliance
Pet Partners formerly Delta Society
Praecipio International
SAPUVET III Project
Silent Heroes Foundation
Society for Tropical Veterinary Medicine
South Africa Society of Travel Medicine
SpayFIRST, Inc.
State Environmental Health Directors
The National LINK Coalition
United States Animal Health Association
University of Girona, Catalonia, Spain, Institute of Aquatic Ecology, Oceans & Human Health
Urban Health and Climate Resilience Centre, Surat, India
Vermont Veterinary Medical Association
Vermont Veterinary Medical Association One Health Committee
Veterinarians without Borders/ Vétérinaires sans Frontières, Canada
Veterinarni Medicina, the international journal for biomedical and veterinary sciences
Veterinary Bioscience Institute
Vida Volunteer
WiLDCOAST/COSTASALVAJE
Wildlife Disease Association
World Association of Veterinary Laboratory Diagnosticians
World Medical Association
World Organization of Family Doctors
Zoonotic and Emerging Diseases, Edinburgh, UK
Interest in One Health is Spreading

Known academic One Health training, research, and outreach programs in North America

Universities that offer formal One Health, academic credit-earning programs

Universities with non-academic credit-earning One Health programs or research

One Health Initiative will unite human and veterinary medicine

The One Health Initiative is a movement to forge co-equal, all inclusive collaborations between physicians, osteopathic physicians, veterinarians, dentists, nurses and other scientific-health and environmentally related disciplines, including the American Medical Association, American Veterinary Medical Association, American Academy of Pediatrics, American Nurses Association, American Association of Public Health Physicians, the American Society of Tropical Medicine and Hygiene, the Centers for Disease Control and Prevention (CDC), the United States Department of Agriculture (USDA), and the U.S. National Environmental Health Association (NEHA). Additionally, more than 900 prominent scientists, physicians and veterinarians worldwide have endorsed the initiative.

> more about one health

Please see MONOGRAPH in Veterinaria Italiana

"One Health - One Medicine": linking human, animal and environmental health

:: click here ::

HISTORY of the One Health Initiative team
(April 2006 through September 2015) and the One Health Initiative website since October 1, 2008

:: click here ::
Welcome to the One Health Platform web portal, the virtual meeting place for the fast growing One Health community.

The 5th International One Health Congress
Saskatoon, Canada
22-25 June 2018

Check the website

One Health Media Bulletin

Fellowship Fund
Due to the many Fellowship Fund applications received, the Review Committee members faced an impossible challenge to meet the original deadline of 15 January to announce their results.

One Health Communicator
Periodically printed publication in newspaper format brings the latest news and information from the One Health arena.

One Health Journal
An online-only, open access journal in public health and animal health.
One Health Research Publications

PUBMED search 4/24/2017 for "One Health", “One Health initiative” OR “One Health approach” in abstract or title by year

Citations

"One Health"
"One Health Approach" OR "One Health Initiative"
"One Health" or Three? Publication Silos Among the One Health Disciplines

From PLOS Biology | DOI:10.1371/journal.pbio.1002448 April 21, 2016. Number of papers captured by our search through time. Blue = veterinary community; gold = ecology community; red = group 3. Numbers are the annual percent growth rate within each community.

...“The number of publications fulfilling our search criteria increased by 14.6% per year, which is faster than growth rates for life sciences as a whole and for most biology subdisciplines.”
One Health Journals

International Journal of One Health
Open access and peer reviewed journal on Human, Animal and Environmental health

Infection Ecology & Epidemiology
International Journal

One Health Outlook
One Health Conferences

8th Scientific Meeting
Villa Aske, Bro – March 21st-22nd 2018
Human versus animal health – different aspects on three challenging pathogens

SAVE THE DATE for the Conference on
Creating impact for One Health and Ecohealth: advancements in implementation, evaluation and governance
One Health has now been mentioned as an approach in more than 100 active or archived requests for proposals (RFPs) since 2007 on www.grants.gov. On 9/8/18, we extracted summary data from 96 of these RFP records (HHS, USAID, USDA, DoD, EPA) and found grant funding to total $4,885,519,322.
National Action Plan For Combating Antibiotic-Resistant Bacteria

Goals

- Slow emergence / prevent spread
  - Foster antibiotic stewardship
- Strengthen “One Health” surveillance
- Develop rapid diagnostics
- Accelerate basic and applied R&D
  - New antibiotics
  - Other therapeutics
- Improve international collaboration

From James Hughes and US CDC
http://essays.biochemistry.org/content/61/1/11
G20 nations pledge to strengthen health systems, combat antimicrobial resistance

By PTI | Published: 09th July 2017 12:48 AM | Last Updated: 09th July 2017 12:48 AM

HAMBURG: The G20 nations, including India, today pledged to strengthen health systems and also combat the menace of antimicrobial resistance, which the grouping termed as a "growing threat" to public health and economic growth.

The declaration adopted by the nations said they would aim to tackle the spread of AMR through the implementation of their respective national action plans based on "one health" approach.

"We call on the UN to keep global health high on the political agenda and we strive for cooperative action to strengthen health systems worldwide, including through developing the health workforce," the declaration said.
CHAPTER 2
Value of Investing in One Health

Given the high cost of emerging diseases as well as the persistent burden of endemic diseases (see Figure 2.1 and Table 2.1), One Health should be considered to assist client countries in strengthening their ability to address known and potential disease threats at the human-animal-environment interface. For a One Health approach to be warranted, it must provide added value. Fundamentally, strong sectoral health systems (e.g., human health, animal health, environmental health) must be in place—or existing systems strengthened—to support effective coordination and collaboration. Relevant metrics for value generation depend on the goal of an investment or client country, but in general, One Health offers synergies among these sectoral systems, providing expanded capacity and effectiveness in prevention of damages and/or control of disease, efficiency, and ultimately financial savings.

Figure 2.1: Examples of economic impacts of disease outbreaks (see also Table 2.1); icons represent examples of highly-affected sectors.
‘Outbreak’ puts the life cycle of an epidemic on display

A new Smithsonian exhibit highlights how infectious diseases shape our world

In 1918, a pandemic of Spanish flu killed as much as 5 percent of the world’s population. A hundred years later, scientists know much more about how to prevent and treat such diseases. But in some ways, the threat of a global outbreak is greater than ever. All it takes is one plane ride for a few localized cases of a disease to become an epidemic.

March 22, 2018
U.S. Senate One Health Bill S. 2615 introduced to Congress: ‘Advancing Emergency Preparedness Through One Health Act of 2018’

A bipartisan Bill was introduced to the U.S. Senate floor by Senators Tina Smith (D-MN) and Todd Young (R-IN). If enacted, it would require the U.S. Department of Health and Human Services (HHS) and the US Department of Agriculture to coordinate with other relevant agencies to develop a U.S. Federal One Health Framework that would:

(https://goo.gl/6ydyng)

- advance workforce development for prevention and response to disease outbreaks in animals and humans,
- improve coordination between federal agencies who study human and animal health and the environment and
- advance scientific understanding of the connections between human, animal, and environmental health.

Description of Bill. (https://goo.gl/UbDT2) Supporters may wish to voice their opinions.
Superbugs: MEPs advocate further measures to curb use of antibiotics

Press Releases  PLenary SESSION  2017  Yesterday

• “One Health”: acknowledge clear link between human and animal health
• Curb use of existing antimicrobials, give incentives to develop new ones
• Need for comparable data and cheaper diagnostic tests

The growing threat posed by antibiotic-resistant bacteria can only be tackled through a “One Health” approach, MEPs said on Wednesday.

In the non-binding resolution, adopted with 589 votes to 12 and 36 abstentions, MEPs stress that the correct and prudent use of antimicrobials is essential to limit antimicrobial resistance (AMR) from emerging in human healthcare, animal husbandry and aquaculture.

The food chain and the environment also need to be taken into account, as they are potential sources of resistant microorganisms, say MEPs.
How do we apply the One Health approach to research in our Duke network?
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 animal mixing?
Our One Health Laboratory’s Focus - Novel Respiratory Virus Detection & Epidemiological Study

Panspecies (human and animal) diagnostics for:
- Influenza A,B,C,D
- Adenovirus
- Coronavirus
- Enteroviruses

Enterovirus D68 found in 4 patients who have died, including 10-year-old girl
By Jacque Wilson and Greg Botelho, CNN
Updated 9:16 AM ET, Thu October 3, 2014

Severe pediatric enterovirus 71 infection investigated in Hong Kong
Posted by Staff on November 25, 2015 // 1 Comment

CDC: Deadly Mutation of Common Cold Kills 10, Sickens 140 in Past 18 Months
Friday, November 16, 2007

Emerging Killer Virus Starts Like a Cold, But Kills Many
Saturday, July 19, 2008 by: David Gutierrez, staff writer

2 Swine Flu Cases Among 3 Fever Deaths in Tiruchy
Express News Service | Published: 21st November 2015 06:12 AM
Last Updated: 21st November 2015 06:12 AM
### Table 1. Characteristics of influenza viruses

<table>
<thead>
<tr>
<th>Virus type</th>
<th>Year of virus discovery</th>
<th>Number of gene segments</th>
<th>Available antiviral therapy</th>
<th>Seasonal vaccine routinely available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influenza A</td>
<td>1931</td>
<td>8</td>
<td>Oseltamivir, peramivir, zanamivir, amantadine, rimatadine</td>
<td>Yes</td>
</tr>
<tr>
<td>Influenza B</td>
<td>1940</td>
<td>8</td>
<td>Oseltamivir, zanamivir</td>
<td>Yes</td>
</tr>
<tr>
<td>Influenza C</td>
<td>1974</td>
<td>7</td>
<td>No effective antiviral treatment available</td>
<td>No</td>
</tr>
<tr>
<td>Influenza D</td>
<td>2011</td>
<td>7</td>
<td>No antiviral treatment available</td>
<td>No</td>
</tr>
</tbody>
</table>
Short communication

Serologic evidence of exposure to influenza D virus among persons with occupational contact with cattle

Sarah K. White, Wenjun Ma, Clinton J. McDaniel, Gregory C. Gray, John A. Lednicky

Abstract

Background: Influenza D virus (IDV), a novel influenza virus with proposed classification: family Orthomyxoviridae, genus Influenzavirus D, species Influenza D virus, has been associated with influenza-like illness in cattle and swine. More recently, anti-IDV antibodies have also been detected in small ruminants. A seroprevalence of approximately 1.3% has been estimated for the general human population.

Objectives: To gain insights on the zoonotic potential of IDV to human adults with occupational exposure to cattle in north central Florida.

Study: A cross-sectional serological study was performed on human serum samples from 35 cattle-exposed and 11 non-cattle-exposed adults to screen for IDV antibodies using hemagglutination inhibition (HI) and microneutralization (MN) assays.

Results: A seroprevalence of 91% was detected via HI assay, and 97% by MN assay among individuals working with cattle in Florida. Among non-cattle-exposed individuals, seropositivity determined via MN assay (only) was lower (18%).

Conclusions: IDV poses a zoonotic risk to cattle-exposed workers, based on detection of high seroprevalence (94–97%). Whereas it is still unknown whether IDV causes disease in humans, our studies indicate that the virus may be an emerging pathogen among cattle-workers.
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.
A Mini Review of the Zoonotic Threat Potential of Influenza Viruses, Coronaviruses, Adenoviruses, and Enteroviruses

Emily S. Bailey\textsuperscript{1,2}, Jane K. Fieldhouse\textsuperscript{1,2}, Jessica Y. Choi\textsuperscript{1,3} and Gregory C. Gray\textsuperscript{1,2,3,4}

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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.
Detecting Novel Respiratory Viruses that Emerge from the Human-Animal Interface

Molecular Detection Algorithms

December 17, 2015
Enrollment questionnaire & sera from 300 exposed and 100 nonexposed workers (6 farms)
Annual serum sampling
Annual risk factor questionnaire
Weekly monitoring for ILI & influenza A
ILI questionnaire
ILI sera and swabs

Monthly rope swab sampling of 50 pigs
Sample various ages (sows, boars, and production pigs)
50 pens x 6 farms per month = 300 rope swabs per month

CAFO questionnaire
Multiple CAFOs in separate provinces
Monthly environmental studies of CAFO environment for influenza A
144 total aerosol, fecal, environmental swab, and water samples/per month
Results

When visiting the farms our research teams noted a frequent lack of biosecurity and sparse use of personal protective equipment, especially in the older and smaller farms. In at least three farms, ducks, geese, chickens, or dogs were housed very near or found comingling with pigs. Often there were no barriers to separate pigs from birds or rodents.
Evidence for Cross-species Influenza A Virus Transmission Within Swine Farms, China: A One Health, Prospective Cohort Study

Mai-Juan Ma,1,4 Guo-Lin Wang,1,4 Benjamin D. Anderson,2 Zhen-Qiang Bi,3,4 Bing Lu,5 Xian-Jun Wang,3,4 Chuang-Xin Wang,6 Shan-Hui Chen,5 Yan-Hua Qian,5 Shao-Xia Song,5 Min Li,5 John A. Lednicky,7 Teng Zhao,1 Meng-Na Wu,3 Wu-Chun Cao,1,8 and Gregory C. Gray1,8

1State Key Laboratory of Pathogen and Biosecurity, Beijing Institute of Microbiology and Epidemiology, China; 2Global Health Institute, Division of Infectious Diseases, School of Medicine, Duke University, Durham, North Carolina; 3Shandong Provincial Center for Disease Control and Prevention; 4Shandong Provincial Key Laboratory of Disease Control and Prevention; 5Jinan, Shandong, China; 6Wuxi Center for Disease Control and Prevention, Wuxi, and 7Licheng District Center for Disease Control and Prevention, Jinan, China; 8Department of Environmental and Global Health, College of Public Health and Health Professions, University of Florida, Gainesville; 9Global Health Research Center, Duke-Kunshan University, Kunshan, China; and 10Program in Emerging Infectious Diseases, Duke-NUS Medical School, Singapore

Background. Our understanding of influenza A virus transmission between humans and pigs is limited.

Methods. Beginning in 2015, we used a One Health approach and serial sampling to prospectively study 299 swine workers and 100 controls, their 9000 pigs, and 6 pig farm environments in China for influenza A viruses (IAVs) using molecular, culture, and immunological techniques. Study participants were closely monitored for influenza-like illness (ILI) events.

Results. Upon enrollment, swine workers had higher serum neutralizing antibody titers against swine H1N1 and higher nasal wash total immunoglobulin A (IgA) and specific IgA titers against swine H1N1 and H3N2 viruses. Over a period of 12 months, IAVs were detected by quantitative reverse-transcription polymerase chain reaction in 46 of 396 (11.6%) environmental swabs, 235 of 3300 (7.1%) pig oral secretion, 23 of 396 (5.8%) water, 20 of 396 (5.1%) aerosol, and 19 of 396 (4.8%) fecal-slurry specimens. Five of 32 (15.6%) participants with ILI events had nasopharyngeal swab specimens that were positive for IAV, and 17 (53.1%) demonstrated 4-fold rises in neutralization titers against a swine virus. Reassorted Eurasian avian-lineage H1N1, A(H1N1)pdm09-like, and swine-lineage H3N2 viruses were identified in pig farms. The A(H1N1)pdm09-like H1N1 viruses identified in swine were nearly genetically identical to the human H1N1 viruses isolated from the participants with ILI.

Conclusions. There was considerable evidence of A(H1N1)pdm09-like, swine-lineage H1N1, and swine-lineage H3N2 viruses circulating, likely reassorting, and likely crossing species within the pig farms. These data suggest that stronger surveillance for novel influenza virus emergence within swine farms is imperative.

Keywords. One Health; influenza A virus; swine; China; emerging pathogens.
Dispatch from the Field: Sarawak, Malaysia

Virus Surveillance in Hospitals, Markets and Farms in Towns of Sibu and Kapit

https://www.youtube.com/watch?v=LGcNIEjYVFI
Surveillance for respiratory and diarrheal pathogens at the human-pig interface in Sarawak, Malaysia


Background
The large livestock operations and dense human population of Southeast Asia are considered a hot-spot for emerging viruses.

Objectives
To determine if the pathogens adenovirus (ADV), coronavirus (CoV), encephalomyocarditis virus (EMCV), enterovirus (EV), influenza A-D (IAV, IBV, ICV, and IDV), porcine circovirus 2 (PCV2), and porcine rotaviruses A and C (RVA and RVC), are aerosolized at the animal-interface, and if humans working in these environments are carrying these viruses in their nasal airways.

Conclusions
This study demonstrates that nucleic acids from a number of targeted viruses were present in pig oral secretions and pig fecal samples, and that several viruses were detected in bioaerosol samples or in the nasal passages of humans with occupational exposure to pigs. These results demonstrate the need for future research in strengthening viral surveillance at the human-animal interface, specifically through expanded bioaerosol sampling efforts and a seroepidemiological study of individuals with exposure to pigs in this region for PCV2 infection.
Bioaerosol Sampling to Detect Avian Influenza Virus in Hanoi’s Largest Live Poultry Market

Vuong N. Bui,¹ Tham T. Nguyen,² O Hung Nguyen-Viet,³ Anh N. Bui,¹ Katie A. McCallion,⁵ Hu Suk Lee,³ Son T. Than,¹ Kristen K. Coleman,² and Gregory C. Gray²,⁶

¹Virology Department, National Institute of Veterinary Research, Hanoi, Vietnam; ²Program in Emerging Infectious Diseases, Duke-NUS Medical School, Singapore; ³International Livestock Research Institute, Hanoi, Vietnam; and ⁴Center for Public Health and Ecosystem Research, Hanoi University of Public Health, Vietnam; ⁵College of Veterinary Medicine, North Carolina State University, Raleigh, North Carolina; and ⁶Division of Infectious Diseases, Global Health Institute, and Nicholas School of the Environment, Duke University, Durham, North Carolina; and ⁷Global Health Research Center, Duke-Kunshan University, China

Background. Newly emergent and virulent strains of H7N9 avian influenza virus are rapidly spreading in China and threaten to invade Vietnam. We sought to introduce aerosol sampling for avian influenza viruses in Vietnam.

Methods. During October 2017, National Institute for Occupational Safety and Health 2-stage aerosol samplers were assembled on a tripod and run for 4 hours. Concomitantly, up to 20 oropharyngeal (OP) swab samples were collected from chickens and ducks distant at 0.2–1.5 m from each sampler.

Results. The 3 weeks of sampling yielded 30 aerosol samples that were 90% positive for influenza A, by quantitative reverse transcription polymerase chain reaction, and 116 OP swab sample pools (5 samples per pool) that were 47% positive. Egg cultures yielded 1 influenza A virus (not H5 or H7) from aerosol and 25 influenza A viruses from OP swab sample pools (5 were H5 positive). The association between positive sample types (over time and position) was strong, with 91.7% of positive OP pooled swab samples confirmed by positive aerosol samples and 81% of influenza A positive aerosol samples confirmed by positive OP swab samples.

Conclusions. We posit that aerosol sampling might be used for early warning screening of poultry markets for novel influenza virus detection, such as H7N9. Markets with positive aerosol samples might be followed up with more focused individual bird or cage swabbing, and back-tracing could be performed later to locate specific farms harboring novel virus. Culling birds in such farms could reduce highly pathogenic avian influenza virus spread among poultry and humans.

Keywords. avian influenza; influenza A virus; Vietnam; poultry; epidemiology.
Field Validation of InDevR FluChip-8G Multiplexed, Multipurpose Influenza Diagnostic System

Funding:
National Institutes of Health
Biomedical Advance Research and Development Authority

Rationale:
Under the leadership of Dr. Gregory Gray, the Duke One Health team has been studying zoonotic influenza virus across Southeast Asia and the US. These cross-sectional and prospective studies have targeted various agricultural occupational groups with a focus on the transmission of zoonotic and emerging viruses. In this proposal, we will conduct a 12-month field validation study of the InDevR FluChip-8G assay using both human and animal origin samples.

Objective 1 - Early Warning System for Pandemic Preparedness: Work with Dr. Greg Gray/Duke University to field validate the FluChip-8G assay at Duke University, Durham, NC. FluChip-8G offers the ability to subtype ‘non-seasonal’ influenza viruses and could be added to the currently ongoing pneumonia studies in humans.

Objective 2 - Goal #2 – Non-seasonal Influenza Surveillance: Work with Dr. Greg Gray/Duke University/Duke Kunshan University (Kunshan, Jiangsu, China) to field validate the FluChip-8G assay both human and animal-origin samples in an area where significant potential for infection with non-seasonal influenza (swine, avian) exists.
Sampling Air for Viruses
Bioaerosol Sampling

Partners
North Carolina State University
University of Florida
NIOSH

Airborne Detection and Quantification of Swine Influenza A Virus in Air Samples Collected Inside, Outside and Downwind from Swine Barns
Cesar A. Corzo¹, Marie Culhane¹,², Scott Dee³, Robert B. Morrison¹, Montserrat Torremorell¹

Scientists still at a loss to explain spread of avian flu

Research shows airborne transmission of avian flu a possibility

SKC BioSampler

Midwest Micro Tek air sampling kits

NIOSH 2-stage sampler

SKC personal sampler and filter
Aerosol sampling a powerful screening tool


**Figure 1** | Graphical depiction of influenza A virus (IAV), porcine reproductive and respiratory syndrome virus (PRRSV), and porcine epidemic diarrhea virus (PEDV) RNA detection downwind from farms with infected source populations: (A) PRRSV RNA detected up to 9.1 km away from infected source population; (B) PRRSV RNA detected 4.7 km away from infected source population; (C) PRRSV infects naïve pigs 120 m away from infected source population; (D) IAV RNA detected up to 2.1 km away from infected source population; and (E) PEDV RNA detected up to 16.1 km away from infected source population.
Bioaerosol Sampling in Modern Agriculture: A Novel Approach for Emerging Pathogen Surveillance

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Background. Modern agriculture practices create environmental conditions conducive to the emergence of novel pathogens. Current surveillance efforts are aimed at assessing the burden of emerging pathogens in animal production facilities in China. To understand this issue, we conducted a study in Guizhou Province pig farms, comparing bioaerosol sampling for influenza A virus to surveillance in oral pig swabs.

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MAJOR ARTICLE

Environmental sampling for respiratory pathogens in Jeddah airport during the 2013 Hajj season

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Bioaerosol Sampling in Clinical Settings: A Promising, Noninvasive Approach for Detecting Respiratory Viruses

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Background. Seeking a noninvasive method to conduct surveillance for respiratory pathogens, we sought to evaluate the usefulness of two types of off-the-shelf aerosol samplers to detect respiratory viruses in Singapore.

Methods. In this pilot study, we ran the aerosol samplers several times each week with patients present in the patient waiting areas of 3 primary health clinics during the months of April and May 2016. We used a SCK BioSampler with a BioLite Air Sample Pump (run for 60 min at 1.8 L/min) and a SCK AirChek TOUCH personal air sampler with polytetrafluoroethylene Teflon filter cassettes (run for 180 min at 5 L/min). The aerosol specimens and controls were studied with molecular assays for Influenza A virus, Influenza B virus, adenoviruses, and coronaviruses.

Results. Overall, 16 (33.3%) of the 48 specimens indicated evidence of at least 1 respiratory pathogen, with 1 (2%) positive for influenza A virus, 3 (6%) positive for influenza B virus, and 12 (25%) positive for adenovirus.

Conclusions. Although we were not able to correlate molecular detection with individual patient illness, patients with common acute respiratory illnesses were present during the samplings. Combined with molecular assays, it would suggest that aerosol sampling has potential as a noninvasive method for novel respiratory virus detection in clinical settings.

Keywords: adenovirus; bioaerosol epidemiology; influenza viruses; respiratory viruses.

The Use of Bioaerosol Sampling for Airborne Virus Surveillance in Swine Production Facilities: A Mini Review

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Dear Editor,

Aerosolized avian influenza A (H5N6) virus isolated from a live poultry market, China

15 Centrifugal Filter Units (EMD Millipore, Billerica, MA) at 2500 g for 15 min. Total nucleic acid was extracted using the QIAextractor (Qiagen, Inc., Venlo, The Netherlands) and then tested for influenza A virus RNA (rRNA) using a real-time reverse transcription polymerase chain reaction (RT-PCR).

Positive samples were inoculated into embryonated
Other Respiratory Virus Aerosol Detection Research

Duke University Hospital Emergency and Trauma Center

Schools in Kunshan, China

Singapore’s KK Women and Children’s Hospital

Singapre MRT
Our One Health Training
One Health Training Program

4 graduate courses (May 17 through June 10, 2018)

➢ An Introduction to One Health Problem Solving (2 credits)
➢ Public Health Laboratory Techniques (1 credit)
➢ An Introduction to Entomology Zoonotic Diseases & Food Safety (3 credits)
➢ Introduction to Environmental Health (3 credits)

The 2018 Duke One Health Training Program class included 31 scholars from eight countries: China, Egypt, Lebanon, Morocco, Pakistan, Sri Lanka, The Philippines, and the USA.
One Health Training

- Epidemiology
- ID surveillance
- Analytical epidemiology
- Outbreak response
- Zoonotic diseases
- Entomology
- Food safety
- Viral culture
- Molecular diagnostics

- Ecology
- Serologic assays
- Modern dairy production
- Mosquito & tick collection
- Mosquito & tick control
- Modern meat production
- Aquaculture
- Environmental engineering
Duke One Health Training Program Alumni Distribution Map, 2008-2018

2008-2018 Total Alumni: 338

Note that early training was performed at University of Iowa (2008-9) or University of Florida (10-14) under similar summer short course programs as led by Professor Gray.
Recent novel pathogen detection workshops

Hanoi, Vietnam

Erbil, Iraq

Tbilisi Georgia

Singapore

Sibu, Malaysia

Hanoi, Vietnam
One Health Fellowships for Zoonotic Disease Research in Mongolia, NIH D43TW009373

Partners:
Institute of Veterinary Medicine
National Center for Zoonotic Diseases

- 2 Months of One Health Training at Duke University
- 22 Months of mentored research at the National Center for Zoonotic Diseases in Mongolia

Our long term goal is to develop a Global Health Training Program that elicits innovative, multidisciplinary team problem-solving solutions to develop products, alter disease processes, and guide policies in controlling zoonotic diseases in Mongolia.

Team 1 (2014-16):
Tick-borne Diseases

Team 2 (2015-17):
Zoonotic Influenza Surveillance

Team 3 (2016-18):
Zoonotic Parasite Ecology/Epidemiology

Team 4 (2017-18):
Zoonotic Surveillance of Mosquito-borne Arboviruses
Primary goal is to investigate the epidemiology of tickborne pathogens in differing Mongolian landscape types (forest, grassland, and a peri-urban area) & among people, livestock, wild rodents, and ticks.
Team 2: Detecting Influenza Virus in Rural Mongolia

We seek to demonstrate that it is possible to provide rapid diagnoses of human or animal influenza in rural settings such that human, public health and veterinary health officials may more rapidly respond with antivirals (for humans), seasonal influenza vaccine (for humans), or equine influenza vaccine (for camels or horses).
Primary goal is to investigate the epidemiology of zoonotic parasitic pathogens (*Cryptosporidia* spp., *Entamoeba histolytica*, *Giardia* spp., in human, animals, and rodents so as to suggest changes in medical policy in Mongolia.
Summary

One Health is an exciting research and training area.

One Health training is a good investment in your professional future as considerable employment, research, and training await those who are trained in One Health.