The One Health Newsletter is a collaborative effort by a diverse group of scientists and health professionals committed to promoting One Health.

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One Health Newsletter

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This quarterly newsletter is dedicated to enhancing the integration of animal, human, and environmental health for the benefit of all by demonstrating One Health in practice.


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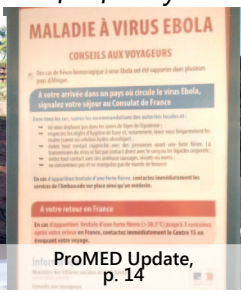

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One Health and Rabies Management in North American Wildlife

Amy Gilbert, PhD, and Kurt VerCauteren, PhD

A Primer on Rabies in North America

Rabies remains a significant wildlife-management and public-health challenge. Over the past 30 years, rabies management has grown in complexity in the United States (US) as wild animals, including skunks, raccoons, foxes, coyotes, and bats, have replaced the domestic dog as the primary reservoir for the disease. Rabies is caused by infection with RNA viruses in the genus *Lyssavirus*. Lyssaviruses are transmitted principally by bite contact with the saliva of an infected animal. Rabies virus (RABV) is the most important lyssavirus and is associated with over 69,000 human deaths on a global scale each year. In the Old World, RABV circulates in domestic dogs and also in limited mesocarnivore wildlife in the Arctic, Europe, southern Africa and Asia. In the New World, RABV circulation is complex and involves several distinct mesocarnivore and bat wildlife reservoirs. Among mesocarnivores in the US, stable foci persist among populations of raccoons (*Procyon lotor*) in the eastern US, striped skunks (*Mephitis mephitis*) in the Midwest and California, Arctic foxes (*Vulpes lagopus*) in Alaska, gray foxes (*Urocyon cinereoargenteus*) in Texas and Arizona, and small Indian mongoose (*Herpestes auropunctatus*) in Puerto Rico.

While the global human rabies burden is primarily associated with RABV circulating in domestic dogs, human rabies in the Americas is principally associated with RABVs circulating in bats. The human rabies burden has been reduced in the Americas in large part due to significant advances in the control of canine rabies through dog vaccination since the 1940s, with the recent elimination of canine rabies from the US. Despite this success, an estimated 11,000 – 36,000 persons in the US receive rabies post-exposure prophylaxis (PEP) each year, primarily in the region where the raccoon RABV variant is enzootic. Rates of cross-species transmission of terrestrial RABV variants to domestic and wild animals are also highest where the raccoon variant is enzootic compared to other regions where skunk and fox variants of the virus persist. The variation seen in epidemiological characteristics across the US underscores the need for a One Health approach to understanding and managing rabies at its source in wildlife populations.

Coordinated Prevention and Control: Oral Rabies Vaccination in the US

The prevention and control of rabies relies on targeted vaccination of animal reservoirs and regulation of animal translocation and these efforts, to date, have focused on domestic dogs and carnivore wildlife.

In the above photo, Are Berentsen holds a sedated gray fox captured during routine rabies research and control efforts. *Photo courtesy of Amy Gilbert*

Amy Gilbert examines a raccoon trapped (live trap visible on left) as part of ongoing rabies prevention efforts.
Photo courtesy of Amy Gilbert

Oral rabies vaccination (ORV) of free-ranging wildlife was field-tested in the late 1970s in Europe, following successful trials with captive red foxes in the US in 1969, and has been successful in control of fox rabies in several European countries, as well as Arctic fox and raccoon RABV variants in Canada. Large scale ORV in the US began with state-funded programs in Texas in 1995 and Ohio in 1997. In 1997, the USDA, APHIS, Wildlife Services (WS) program collaborated on ORV projects with State agencies in Vermont and Ohio and subsequently received its first federal appropriation in 1998 to cooperate and assist in the coordination of a national ORV program to prevent the spread of specific terrestrial variants of RABV. The mission of the WS National Rabies Management Program (NRMP) is to implement a coordinated, cost-effective, science-based program to contain and eventually eliminate rabies variants in terrestrial wildlife to reduce costs and impacts to human health, domestic animals, and wildlife for the benefit of the citizens of the US.

The WS NRMP collaborates with CDC; state wildlife, health and agriculture agencies; county and municipalities; Canada and Mexico; Universities; Native Americans; and NGO's as well as the private sector to prevent and control rabies to reduce burden of living with this deadly disease. A National Rabies Management Team (NRMT) was formed among public health, agriculture and wildlife partners, and included ten interdisciplinary teams established to evaluate ORV program progress and provide recommendations for cooperative rabies control planning. These teams cover critical ORV program aspects including, but not limited to, baiting strategies and planning, communications, economic analyses, contingency planning, and surveillance. Early goals of the ORV program were to limit the spread of raccoon rabies in the eastern US and eliminate circulation of distinct RABV variants in gray foxes and coyotes in Texas. Elimination of dog variant circulation in coyotes in Texas was achieved in 2000, although an ORV zone along the Rio Grande region is still maintained to prevent reintroduction of the virus from Mexico. In the eastern US, ORV efforts have effectively limited the spread of raccoon variant beyond the ORV zone. However, regular spillover of the raccoon variant into striped skunks represents a threat and concern, as ORV efforts have not led to appreciable population level immunity in striped skunks in the eastern zone.

The NRMP also functions as part of a larger international effort, outlined in the North American Rabies Management Plan (NARMP), which focuses on information exchange and coordinating rabies surveillance and control efforts with Canada, Mexico and the

Shylo Johnson examines a raccoon. *Photo courtesy of Amy Gilbert*

Navajo Nation. Coordination of efforts across borders is necessary for the long term success in the preventing the spread and eventual elimination of terrestrial rabies in North America.

A One Health Approach to Rabies Research

Part of any comprehensive plan for surveillance, control or elimination of rabies in wildlife involves research that addresses ecological, economic, and veterinary aspects of the virus. The mission of the Rabies Project, at the WS National Wildlife Research Center (NWRC), is to develop and evaluate practical tools and strategies for the NRMP's operational management of rabies in wildlife. Recent research by the Rabies Project at NWRC has focused on captive and field evaluations of novel rabies vaccines in target and nontarget wildlife, bait flavor optimization for vaccine delivery to target wildlife, biomarkers to measure bait uptake, population density estimation and ecological studies of target reservoir hosts, as well as epidemiological studies of cross-species transmission of terrestrial rabies virus variants among domestic and wild animals. The Economics Project at the NWRC is also a key partner in developing cost-benefit analyses of potential and existing ORV strategies directed at wildlife in the US, as well as regionally in North America. The NWRC works with local, state, federal and academic partners to address the research priorities of the NRMP for continued success and efficiency in the management of terrestrial rabies in North America.

Amy Gilbert, Ph.D., is a Research Biologist at the USDA-APHIS-WS National Wildlife Research Center in Fort Collins, Colorado. Her research focuses on ecology and cross-species transmission of rabies infections in wildlife, and the application of novel rabies biologics and techniques to improve vaccination of target wildlife for disease management.

Kurt VerCauteren, PhD, is a Supervisory Research Wildlife Biologist and leads the Rabies Management and Management of Ungulate Disease and Damage Projects at the USDA-APHIS-WS National Wildlife Research Center in Fort Collins, Colorado.

An Analysis of the Linkages Between Public Health and Ecosystem Integrity: Part 4 of 6

Steven A. Osofsky, DVM, Anila Jacob, MD, MPH, and Christopher D. Golden, PhD, MPH

Health & Ecosystems: Analysis of Linkages (HEAL) is a consortium of more than 25 institutions collaborating to analyze and quantify relationships between the state of ecosystems and public health. The consortium comprises many of the world's premier public health and environmental science institutions working in both developing and developed countries. HEAL's mission is to increase support for integrated public health and environmental conservation initiatives as intimately related, interdependent challenges. A cross-sectoral attitudinal change will ultimately help to improve public health outcomes, equity, and resilience for some of the world's poorest people, often living in the world's most remote areas, while simultaneously conserving some of the most important natural landscapes and seascapes left on earth. It is a mission directly aligned with that of One Health (Barrett and Osofsky, 2013).

The HEAL consortium believes that there are important public health impacts associated with changes in

Photo by Mike Kock, Wildlife Conservation Society

the state of different ecosystems and that, frequently, degradation of these ecosystems leads to negative public health impacts. However, relatively little peer-reviewed literature delves into the mechanisms underlying potential causal relationships between ecosystem degradation and public health outcomes. Policy-makers interested in understanding these relationships are left with largely anecdotal information that is clearly insufficient for informing decision-making in terms of conservation, public health, or both.

A key component of HEAL's approach is to explore what is currently known regarding linkages between human health and natural ecosystems, as a foundation for prospective applied research. In this 6-part series, we are exploring what is currently understood in terms of linkages between the state of various ecosystems and major public health challenges. We focused on communicable diseases in Volume 6 Issue 4 of the One Health Newsletter, non-communicable diseases in Volume 7 Issue 1, and nutrition in Volume 7 Issue 2. In this issue, we focus on mental health. In future issues we'll tackle the connections between ecosystems and the loss of biopharmaceuticals and vulnerability to extreme events.

Currently Understood Linkage #4: Ecosystem degradation and mental health

The World Health Organization (WHO) defines health as a 'state of complete physical, mental and social well-being and not merely the absence of disease or infirmity;' according to this definition, mental health is considered to be foundational for general well-being. WHO estimates that about 450 million people worldwide suffer from mental disorders such as depression, anxiety disorders, bipolar disorders, and schizophrenia. Mental health is influenced by a number of factors, including socioeconomic status, physical health, personality type, work conditions, exposure to violence, conflicts and disasters, and genetics, among others (WHO 2010).

The natural environment plays an important role in both physical and mental health. Overall, people living near green spaces like urban parks and nature reserves report better mood and physical health (Barrett et al. 2014, Hartig et al. 2014). With regards to mental health specifically, researchers have found a positive association between access to green space and stress relief; people who have exposure to natural spaces also report positive impacts on their ability to concentrate and on self-discipline (Bowler et al. 2010). In one recent analysis from the Netherlands, researchers looked at physician records to assess the impacts of proximity to green space on a number of conditions and found that patients living with more green space within 1 km of their homes had lower prevalence rates for depression and anxiety disorders (Maas et al. 2009). The relationship was particularly strong among patients from poorer households, and for children. Recognizing the benefits of interacting with nature, countries such as the United Kingdom and Japan have instituted programs that encourage residents to spend time in forests and other green areas to decrease stress and improve overall health (Karjalainen et al. 2010, Daniel et al. 2012).

Researchers have also found a relationship between environmental degradation and mental illness. In western Australia, scientists studying the linkages between a measure of ecosystem degradation (dryland salinity),

and mental illness in rural populations, found a positive association with depression in these communities (Speldewinde et al. 2009). The long-term impacts on the mental health of these communities could be significant, due to ongoing environmental degradation in this region.

Photo by Christopher Golden, 2014

The cultural services that healthy ecosystems provide, including aesthetically pleasing landscapes and seascapes, sacred places, and a sense of cultural identity, can also have important positive impacts on the mental health of communities. From the beginnings of human society, nature has influenced social interactions and stability; human culture has always been shaped by nature and the condition of the local ecosystem within which a community lives. The degradation of ecosystems can lead to the loss of cultural identity and heritage, which can result in social disruption and marginalization, especially among traditional societies (MA 2005a).

Although the theories behind these relationships are well-conceived ranging from biophilia (Wilson 1984) to nature deficit disorder (Louv 2008), the empirical evidence supporting these theories is still largely absent. It is imperative that we improve our understanding of the complex and dynamic impacts of ecosystem change on mental health. Particularly absent in this area of inquiry are connections between ecosystem integrity and mental health in the developing world. HEAL's applied research program aims to address these critical knowledge gaps through rigorous scientific inquiry aimed at comprehensively characterizing how ecosystem change affects human health, in order to progress a science to policy to action agenda.

In the next issue of the One Health Newsletter, our fifth installment explores the linkages between ecosystem change and resilience to extreme events.

Steven A. Osofsky, DVM is the Executive Director of the Wildlife Conservation Society's Wildlife Health & Health Policy Program, overseeing all of the Wildlife Conservation Society (WCS) Global Conservation Program's work in the health realm. He is also an adjunct assistant professor at the University of Maryland, College Park. Steve launched the Health & Ecosystems: Analysis of Linkages (HEAL) program.

Anila Jacob, MD is an internal medicine physician with an MPH in Global Environmental Health. Currently she is a senior technical expert at ICF International, where she works on the Measuring Impact project with USAID's Forestry and Biodiversity Office.

Christopher D. Golden, PhD, MPH is the Director of the Wildlife Conservation Society's Health & Ecosystems: Analysis of Linkages (HEAL) program. He is also a Research Associate at the Harvard School of Public Health's Department of Environmental Health and Department of Nutrition, and the Director of MAHERY (Madagascar Health and Environmental Research).

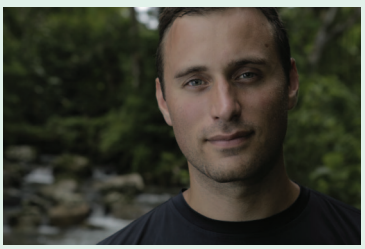


Photo Credit: Jon Betz/National Geographic

One Health Collaboration Methods and Systems Analysis

Tracey B. Lynn, DVM, MS, DACVPM

Fifty Federal and State participants from animal health and public health agencies participated in a train-the-trainer session on One Health Collaboration Methods in Fort Collins, Colorado, May 6-8. The workshop-based training led participants through the process of conducting a One Health Systems Analysis (OHSA), including the final step of defining actions to advance One Health at an operational level. Participants were VS Field Staff from each District and their State Animal Health and Public Health counterparts. District teams worked together to define how existing collaborations are perceived within their own multi-agency network, how that network actually works and how they could prioritize opportunities to fill gaps and build in best practices to strengthen collaboration and the One Health approach within their State and District.

This training is part of an innovative and exciting collaboration between the USDA APHIS Veterinary Services (VS) One Health Collaboration Center (OHCC) and the University of Minnesota (UMN). Working in partnership with the State agencies, we piloted a method for conducting a self-assessment of One Health infrastructure, and used the experience to develop the training for application in other States. The need for such a method was identified during the global meeting "Operationalizing One Health, a Policy Perspective", cohosted by the United Nations Food and Agriculture Organization, the World Organisation for Animal Health, the World Health Organization, and the U.S. Centers for Disease Control and Prevention in 2010. This meeting is also known as the Stone Mountain Meeting. A working group led by the World Bank drafted the "One Health Self-Assessment Guide" as a first step to meeting that need. Through our pilot of that initial guide, the VS OHCC and UMN developed the One Health Systems Analysis method as a tool that countries, states, or communities can use to improve effectiveness of cross-agency coordination and communication. Course participants were enthusiastic in their feedback — they spoke of the value of the training to operationalize One Health at the Field level and the need to offer the training in multiple locations.

USDA has long-standing partnerships with many public and private organizations. Historically, these partnerships focused on strengthening animal disease control and eradication programs and emergency preparedness and response activities. Our collaboration with UMN builds on that tradition, and creates opportunities to advance OH training and education efforts and optimize multi-agency contributions to the complex issues at the intersection of animal, human and environmental health.

For more information on the One Health Training and Education initiative, please contact the VS OHCC at vs.ohco@aphis.usda.gov or visit the following links:

USDA - What is One Health?
http://www.aphis.usda.gov/animal_health/one_health/downloads/one_health_info_sheet.pdf

VS OHCC Strategic Plan (2010-2014):
http://www.aphis.usda.gov/animal_health/one_health/downloads/one_health_strategic_direction.pdf

One Health Coordination Office:
http://www.aphis.usda.gov/animal_health/one_health/downloads/one_health_coordination_office.pdf

Dr. Tracey Lynn is part of a team coordinating the animal health component of One Health within the U.S. Department of Agriculture, Animal and Plant Health Inspection Service. Prior to joining USDA, Tracey spent 7 years as an epidemiologist in Federal and state public health agencies (CDC, Indian Health Service and the Alaska Department of Health and Human Services), working across the spectrum from outbreak investigation and response to policy development. Tracey specializes in facilitating the development of innovative partnerships with Federal Agencies, academia, and industry to increase efficiency and effectiveness of managing complex health threats through cross-disciplinary collaboration.

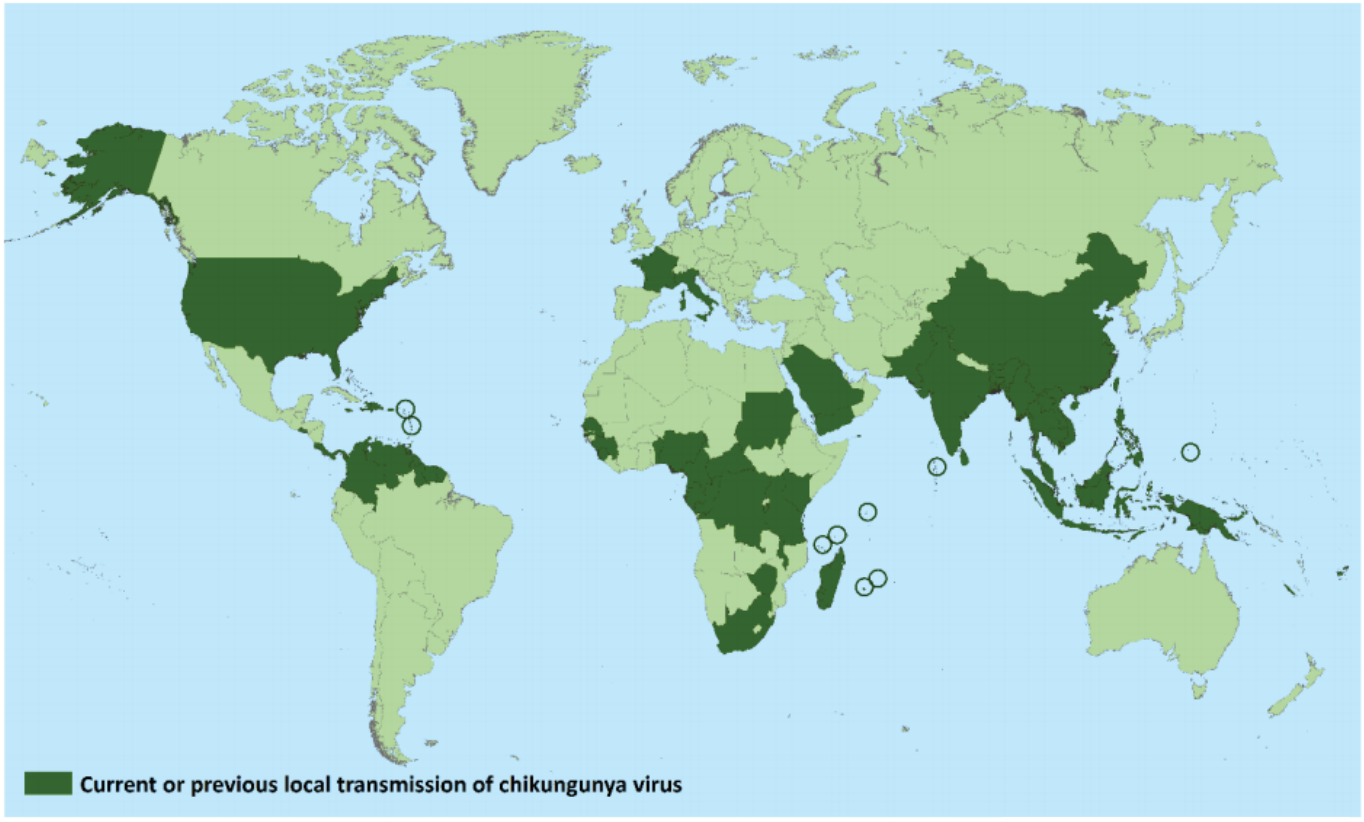
Chikungunya Fever Cases Detected in Florida

Carina Blackmore, DVM, PhD, Dipl. ACVPM

Chikungunya virus (CHIKV) transmission was reported on the Caribbean Island of St. Martin in December of 2013. This was the first documented evidence of autochthonous chikungunya virus transmission in the Americas, and the virus has since spread throughout the Caribbean. Local transmission of the virus has also been detected in Central (El Salvador) and South (Guyana, Suriname, French Guiana, Venezuela) America. More than 580,000 suspected or confirmed cases of chikungunya fever have been reported in the region as of August 15 (1). At the time of this report, eight locally acquired but unrelated cases have also been documented in south Florida since June (2).

CHIKV was first isolated in Tanzania in 1952, with major epidemics detected throughout Africa and Southeast Asia since. In 2004 CHIKV generated further public health interest when an outbreak in Kenya spread rapidly to India and countries in the Indian Ocean region via infected travelers. The Kenyan outbreak continued over the next few years and in 2007, a traveler returning to Italy likely started the local chikungunya outbreak detected there (3). Another wave of chikungunya fever outbreaks occurred in the Republic of Congo in 2011. As seen previously, outbreaks were documented throughout Africa, Southeast Asia and the Pacific, and in 2013 detected in the Americas.

Countries and territories where chikungunya cases have been reported*
(as of September 16, 2014)



*Does not include countries or territories where only imported cases have been documented.
Source: Centers for Disease Control & Prevention, http://www.cdc.gov/chikungunya/pdfs/ChikungunyaWorldMap_09-16-2014.pdf

The principal vectors of CHIKV, *Aedes aegypti* (the house mosquito) and *Aedes albopictus* (the Asian tiger mosquito) are commonly seen in subtropical regions, including Florida. In Florida, *Ae. albopictus* is found throughout the state while *Ae. aegypti* is more common in urban environments, including the Florida Keys. Both mosquito species are container breeders and lay eggs in small natural or artificial water reservoirs such as bird baths, abandoned pet food dishes, and empty flower pots. Any vessel that can hold water for a week or more is a potential breeding ground for these vectors. Like dengue virus, CHIKV is transmitted between infected mosquitoes and people, including asymptomatic carriers of the virus. *Ae. aegypti* feeds almost exclusively on people and tends to breed very close to human habitations (i.e. in people's back yards). *Ae. albopictus* feeds on a wide range of vertebrate hosts and is less dependent on humans, which also makes it a less effective CHIKV vector. The transmission cycle for dengue and chikungunya viruses is different than that seen for other arboviruses currently endemic to Florida (eastern equine encephalitis virus, St. Louis encephalitis virus and West Nile virus) which are maintained by *Culex spp.* mosquitoes and many avian species. Humans and other mammals, such as horses, serve as incidental hosts and do not develop viremia to levels that are infectious to mosquitoes.

Chikungunya fever presents as a non-specific flu-like illness; clinical signs include abrupt onset of fever, typically > 102°F, and severe arthralgia that cannot be explained by other medical conditions. The arthralgia is typically symmetric and bilateral and can be intense and debilitating, most often affecting joints of the extremities. Other symptoms include headache, back pain, myalgia, arthritis, a maculopapular rash (sometimes pruritic), nausea/vomiting and conjunctivitis. While the illness is fairly mild, joint symptoms can persist for weeks, months, and sometimes even years.

Older adults (i.e., >65 years), persons with underlying medical conditions (e.g., hypertension, diabetes or cardiovascular disease) and neonates exposed intrapartum are at higher risk for severe disease. Persons who have recently traveled to the Caribbean or another endemic area are at particular risk, but the disease should also be considered as a differential diagnosis for anyone in Florida exhibiting clinical signs. The incubation period is short, typically between 3-7 days (range 1-12 days). Symptoms generally resolve after about a week. Migratory, erratic, relapsing painful arthralgia most often experienced in the small joints of the hands, wrists, ankles and feet can be seen among adults and infrequently among children. Mortality has been observed, primarily among older adults.

Laboratory findings may include lymphopenia, thrombocytopenia, elevated hepatic transaminases and elevated creatinine. Diagnosis is primarily made by identification of virus or antibodies in serologic specimens (RT-PCR, IgM and IgG assays). It is important to consider the timing of the request when determining what laboratory test(s) to order. Virus can generally be detected by PCR for a week following clinical onset, and virus culture can also be performed. IgM antibodies are typically first detectable days 6-7 after disease onset, but can persist for months.

No antivirals exist for CHIKV, thus only symptomatic treatment is offered, which includes rest, hydration, and non-steroidal anti-inflammatory drugs (NSAIDs) (4). If dengue infection is included in the patient's differential diagnosis, acetaminophen may be preferred over NSAIDs that promote bleeding such as aspirin. Patients suspected to be infected with any arboviruses causing significant viremia should also be advised to avoid mosquito bites during the viremic period (typically the first week of illness).

The ecological parameters for mosquito-borne disease transmission are very complex making CHIKV

outbreaks challenging to predict. We anticipate periodic detection of locally acquired CHIKV cases in Florida based on current dengue surveillance data. Local CHIKV transmission detection is projected to be greater than auchtocthonous dengue transmission, since more than 70% of human CHIKV infections develop clinical symptoms (and are more likely to be diagnosed) (4), whereas only about 20% of infected dengue patients develop signs of the disease. The potential for outbreaks to occur exists in the state. The only strategy public health partners have to identify and locate disease transmission is through ongoing disease surveillance, primarily human disease surveillance. Routine virus testing of mosquitoes is both challenging and costly since, as mentioned previously, the vectors are common in Florida and mosquito infection rates are usually low. These surveillance data are disseminated weekly to stakeholders and posted on the Florida Department of Health's (FDoH) website (2). While FDoH is coordinating the efforts, due in part to the state disease reporting requirements (5), close collaborations with health, mosquito control, university and other community partners in both the private and public sector are vital to successful identification and mitigation of CHIKV.

Carina Blackmore, DVM, PhD, Dipl. ACVPM, is the Deputy State Epidemiologist for the state of Florida, USA and Chief of the Bureau of Public Health Laboratories with the Florida Department of Health.

Excerpts from "How to Prevent the Next Ebola Outbreak" Posted in the Bulletin of the Atomic Scientists on 13 July, 2014

Laura H. Kahn, MD, MPH, MPP

[Originally printed on the One Health Initiative website (onehealthinitiative.com)]

"The Ebola virus has emerged in three West African countries where it had not previously been reported: Guinea, Liberia, and Sierra Leone. In early July, health ministers from 11 countries and representatives from the World Health Organization (WHO) and relevant partner organizations met in an emergency two-day meeting in Accra, Ghana, to strategize on containing the worsening crisis. So far, the outbreak is the largest and deadliest since the disease was first recognized in 1976 in northern Zaire. As of July 8, there had been 888 cases and 539 deaths, with a mortality rate over 60 percent. Previous outbreaks, in Central African countries, typically had mortality rates closer to 90 percent."

"This is why a One Health approach—an approach that recognizes the connection between human health and animal and environmental health—is so important in Africa. Healthy livestock promote healthy humans. Unfortunately, developing countries have difficulty providing food for their human populations, let alone their livestock. Livestock production accounts for relatively little agricultural output in sub-Saharan Africa. Public health and agriculture experts must work together to improve agriculture and figure out how to meet Africans' demands for animal proteins in an environmentally sustainable way."

Please read the entire column at http://thebulletin.org/how-prevent-next-ebola-outbreak7312

Please visit the One Health Initiative website for more items related to the Ebola outbreak.

International One Health physician leader, Dr. Kahn is a Research Scholar at the Program on Science and Global Security' Woodrow Wilson School of Public and International Affairs, Princeton University and Co-Founder of the One Health Initiative Autonomous Pro Bono team and website.

Will Ebola Strike the USA?

Jack Woodall, PhD

By now we have all heard of the "deadly Ebola virus" epidemic in West Africa that is alleged to kill 90% of everyone it infects. How the media love to sensationalize everything! The estimated number of suspected and lab confirmed cases as of 17 September was 5000 and the death rate was about 50% (WHO data). Unfortunately, those are only the numbers that get reported – there are estimated to be very many more, because victims prefer to remain at home where they will have better care and a traditional burial, rather than in an isolation ward and be buried in a white body bag sprayed with disinfectant and interred far away in the forest.

The death rate for rabies is 100% unless you get treated in time. More than 60,000 people die of rabies every year, mostly in Asia and Africa – and every year, approximately 29 million people worldwide receive a post-exposure vaccination to prevent the disease, at an estimated cost of US$2.1 billion (WHO data). But nobody gets very concerned about that, because at least there is a vaccine. For Ebola, the media love to repeat "There is no vaccine and no cure." In fact a lot of patients in the current epidemic are being cured by intravenous fluids and good food, which is what you'll be treated with if you come down with it in the USA, or any country with a decent healthcare system.

You have heard about the two Americans, a doctor and an aid worker, who got infected in Liberia in July and survived. They were treated with an experimental antibody cocktail called ZMapp grown in genetically modified tobacco plants, were repatriated back to the USA and survived. They may or may not have been saved by the drug (an elderly Spanish missionary who was repatriated to Spain and an African doctor who received the same drug both died), and in any case, the only existing doses of that drug have run out, and further supplies of it or an alternative drug are not yet available. The first human trials of an American vaccine started in the United Kingdom and the USA in September and large numbers of doses may not be available before the end of the year.

But you are not going to get infected unless: you go to West Africa and come into close contact with somebody who is already sick or you are a volunteer not wearing properly donned PPE (personal protective equipment of impermeable apron over sterile gown, hood, respirator, goggles or face shield, rubber boots and double gloves), nor properly disinfected before removal, or come in close contact with somebody recently arrived from there who falls ill in the USA.

What about all the bushmeat that is being smuggled into the USA and other countries, you may ask? Is that not a risk? The only risk is if you handle bleeding bushmeat or don't cook it through. Not every fruit bat or monkey in West Africa is infected, so the risk is vanishingly small. The USA does not have the same species of fruit bat or monkey as West Africa.

What about African illegals crossing into the USA from Mexico? Well, they are likely to have spent more than 21 days en route, so should not be infected, and if they fall ill after arrival they are given health care where they are held at the border for processing.

So no need for anybody to have nightmares about Ebola in the USA.

The CDC has an excellent Q&A page about Ebola on its website at http://www.cdc.gov/vhf/ebola/outbreaks/guinea/qa.html.

The World Health Organization (WHO) also has a useful Fact Sheet about Ebola at http://who.int/mediacentre/factsheets/fs103/en and updates on the epidemic at http://who.int/csr/don/en.

Important notices:

(1) Médecins Sans Frontières (MSF – Doctors Without Borders) is appealing for doctors and nurses to spend 6-8 week tours at their isolation hospitals in West Africa. To apply go to http://www.doctorswithoutborders.org/work-us/work-field/applying-msf. In 30 years of responding to Ebola outbreaks in Africa, MSF have never lost a doctor or nurse to Ebola.

(2) There is also an urgent need for pediatric doctors and nurses at the Ola During Children's Hospital (ODCH) in Sierra Leone, the only tertiary-level facility in the country, that received its first x-ray machine from Kansas last year – contact info at http://www.g3f.org.uk/welbodi.html.

(3) Save the Children is recruiting for many non-medical support jobs (as well as medical) -- see: Emergency response: west Africa EVD outbreak operations http://www.savethechildren.net/jobs/job-details/1493.

(4) UNICEF also needs professional from non-medical fields – see: Ebola Crisis Response, http://www.unicef.org/about/employ/index_75734.html.

Jack Woodall is a virologist who has worked in the lab with yellow fever, Bolivian haemorrhagic fever, Congo-Crimean haemorrhagic fever and other nasties, in Amazonia and Africa.

One Health Example During U.S. Centers for Disease Control and Prevention Laboratory Accident Reports

[Originally printed on the One Health Initiative website (onehealthinitiative.com)]

The United States Centers for Disease Control and Prevention (CDC) issued a press release July 11, 2014 outlining their recognition of and plans for remedying disclosures about a recent regrettable anthrax episode. Steps for improving laboratory quality and safety were highlighted.

Noted in the second paragraph of the press release was, "While finalizing this report, CDC leadership was made aware that earlier this year a culture of non-pathogenic avian influenza was unintentionally cross-contaminated at the CDC influenza laboratory with the highly pathogenic H5N1 strain of influenza and shipped to a BSL-3 select-agent laboratory operated by the United States Department of Agriculture (USDA). There were no exposures as a result of that incident. The CDC influenza laboratory is now closed and will not reopen until adequate procedures are put in place. Further investigation, review, and action is underway." Repeat: "There were no exposures as a result of that incident."

The New York Times report on July 12, 2014 mentioned this important item describing it as, "In a second accident, disclosed Friday, a C.D.C. lab accidentally contaminated a relatively benign flu sample with a dangerous H5N1 bird flu strain that has killed 386 people since 2003. Fortunately, a United States Agriculture Department laboratory realized that the strain was more dangerous than expected and alerted the C.D.C."

This potentially life saving "One Health in Action" by an essentially veterinary medical oriented USDA laboratory issuing an alert to CDC was wisely and promptly accepted; this is instructive. It demonstrates how the One Health (One Medicine) approach—a collaborative, multidisciplinary and interdisciplinary paradigm—can and does significantly advance the public's health. The CDC maintains a One Health Office, more information

about which can be found at http://www.cdc.gov/ncezid/dhcpp/one_health.

The salient point is that the majority of the dangerous pathogens are zoonotic agents, and thus all biosafety systems and protocols used by policy makers should involve both animal and human scientists thereby leading to a higher standard.

One Health Perspectives from International Health Professionals

Mohamed El Ghazaly, MD, MPH, Sorin Răpuntean, DVM, PhD,
and Angkana Sommanustweechai, DVM, Grad. Dip. of Vet. Clin. Sci.

One Health Certificate Class of 2014 during orientation at the Emerging Pathogens Institute, University of Florida
Photo by Greg Gray

As a follow-up to our Volume 7 Issue 2 article "Graduate-level Certificate in One Health Training at the University of Florida," we asked six of the One Health Certificate trainees, all health professionals in their respective countries, to elaborate on the importance of One Health in their countries and in their work. We interviewed them and asked a variety of questions focusing on One Health and the roles it plays in public policy, disease outbreaks and its perception in their respective countries. In this article, we feature **Dr. Mohamed El Ghazaly from Egypt**, **Dr. Sorin Răpuntean from Romania**, and **Dr. Angkana Sommanustweechai from Thailand**. Issue 4 will feature responses from three additional certificate trainees.

How do you define One Health?

Dr. Mohamed El Ghazaly:

One Health is not merely about human and animal health. However, it consists of a broader concept that involves other important health parties, for example environmental health. Thus, for One Health to succeed, it requires a multisectoral approach. To illustrate, in Egypt, we include other ministries, such as the Ministry of Agriculture, other political Ministries and different NGOs [when responding to public health issues].

Dr. Sorin Răpuntean:

The One Health concept represents the recognition that animal health, environmental health and public health are closely linked. It is clear today that human health cannot be provided without ensuring the health status of the animals, especially due to closer contact among species (farm animals, pets or wildlife). It is a concept that shows us and teaches us how diseases are spread between humans, animals and the environment. One of the important objectives offered by this concept is that it facilitates information sharing and

collaboration between different disciplines and professions.

Dr. Angkana Sommanustweechai:

One Health is the health linkage between humans, animals and the environment, which are inter-related and affect each other both positively and negatively. It is like the "butterfly effect," in that a tiny change can result in a larger impact.

The practice of One Health is useful for solving complex health problems by applying a holistic approach to coordinate the health practice of humans, animals and the environment. This involves multiple disciplines from multiple sectors at all levels: locally, nationally, and globally in a united effort.

Have there been any recent disease outbreaks or health issues in your country where a One Health approach was taken? How so?

Dr. Sorin Răpuntean:

In Romania we have good cooperation between the public health and veterinary health sector, especially for zoonotic diseases like rabies. Given the geographical landscape of Romania, which includes many mountains and forests, we have many wild animals, especially foxes. In the case of contact with these animals via a bite or scratch, veterinarians will immediately notify colleagues from the department of public health to apply preventive measures (vaccination). Meanwhile, the forest department representatives are informed and help capture these animals and send them to veterinary laboratories for diagnostic purposes. The forest department also assists veterinarians in vaccinating wild animals. In conclusion, this model of cooperation is required, especially in medical emergencies.

What are your perceptions about the level of cooperation between medical, public health, veterinary, and environmental health professionals in your country?

Dr. Mohamed El Ghazaly:

Currently, medical, public health, veterinary, and environmental health professionals in Egypt collaborate by sharing reports of findings among disciplines. This kind of end point collaboration will need to change to empower One Health concepts. Collaboration is most effective when it's a project-based relationship where you can see teams on different sectors working together, sharing information and tackling health problems in a One Health way. We need to have this kind of teamwork and synergy on a routine basis. This can be easily accomplished through technology, project management techniques, and political commitment. In order to attain a very high level of synergy, an evaluation of current ongoing systems, identification of gaps in communication, and implementation of different control measures is fundamental. This will allow development of a system for collaboration that can ultimately promote and support One Health concepts.

Pictured from left to right, Ariful Islam, Ausraful Islam, Sorin Răpuntean, Giorgi Maghlakelidze, and Mohamed El Ghazaly during the One Health Certificate training.
Photo by Greg Gray

What are your thoughts on the role of health policy in encouraging One Health approaches among government agencies?

Dr. Angkana Sommanustweechai:

In Thailand, multidisciplinary collaboration was established even before the emergence of the One Health concept, particularly under the zoonotic disease control and prevention programs, many decades ago. In 2013, the Thailand Ministry of Public Health included the One Health concept in the National Strategic Plan for Preparedness, Prevention and Resolution of Emerging Infectious Diseases.

Project implementation is predominately a formal government process, headed by the National Steering Committee chaired by the Deputy Prime Minister, with the Permanent Secretary and the Director-General of relevant Ministries serving as members. However, with the long history of collaboration among many partners in Thailand, this approach can also effectively support horizontal (informal) collaborations through trusted partnerships as part of existing formal collaborations.

Mohamed El Ghazaly, MD, MPH is a Field Epidemiology Training Program Resident with the Central Department of Communicable Disease at the Egyptian Ministry of Health and Population. He serves as the point of contact for supporting the development of awareness and countermeasures for zoonotic diseases.

Sorin Răpuntean, DVM, PhD is an Associate Professor in the Department of Microbiology/Epidemiology at the Faculty of Veterinary Medicine, Cluj-Napoca, Romania. He is also Senior Advisor at the Directorate of Veterinary Health and Food Safety in Cluj County, Romania.

Angkana Sommanustweechai, DVM, Grad. Dip. of Vet. Clin. Sci. worked as a wildlife pathologist for six years with the Zoological Park Organization in Thailand. She recently shifted gears to engage in health policy under the International Health Policy Program, Thailand, Ministry of Public Health. Her current research focuses on One Health policy analysis in Thailand.

ProMED Quarterly Outbreak Roundup, June-August 2014

Jack Woodall, PhD

This review covers selected reports posted on the ProMED-mail outbreak early warning website <www.promedmail.org> and e-mailed to 60,000 free subscribers during the quarter June though August 2014.

Ebola

West Africa was hit by its first **Ebola virus disease (EVD)** outbreak in March this year. In the previous quarterly update we reported that as of 28 May 2014 it had caused a cumulative total of 291 clinical cases of EVD, including 193 deaths, in Guinea; and a total of 12 cases including 9 deaths in Liberia. Since then, the epidemic has exploded – so much so that in August WHO declared the epidemic an international emergency. WHO reported the case count of probable and confirmed cases in the current outbreak of EVD in four affected countries as reported by the respective Ministries of Health of Guinea, Liberia, Nigeria, and Sierra Leone as passing the

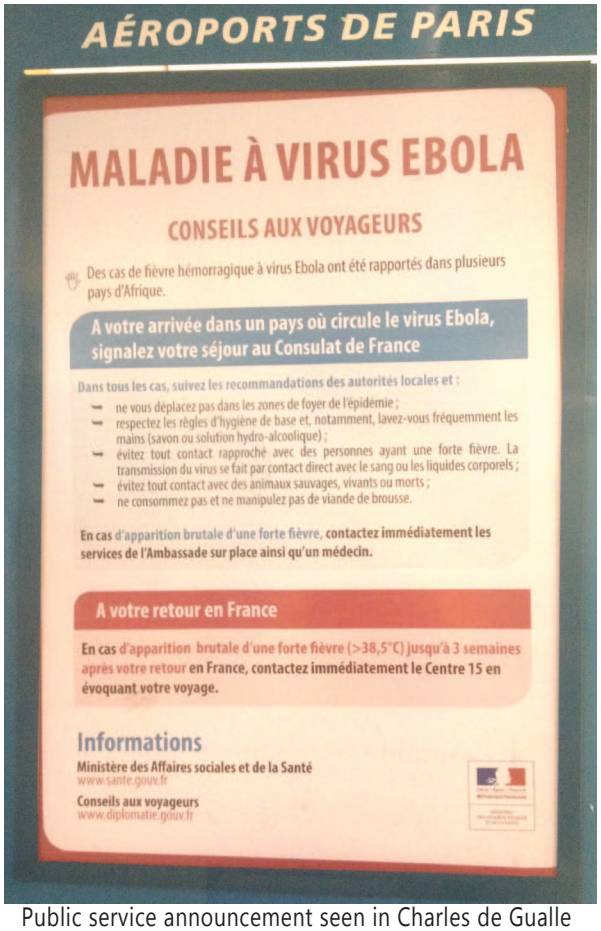
- 1000 mark on 17 July,
- 2000 mark on 13 August,
- 3000 mark on 26 August, and
- 6000 mark in late September, with nearly 3000 deaths.

These are the official figures; estimates are that there are 2-4 times as many cases being cared for and dying at home, either for fear of going to hospital to die in isolation, or for lack of floor space in the isolation hospitals -- all the beds are already taken -- with WHO projecting the need for 760 beds in Monrovia, Liberia's capital, alone.

It took 4 weeks for the 2nd 1000 cases to appear, but only 2 weeks for the third 1000, and less for the fourth thousand. The numbers doubled in just the last two weeks of August – the epidemic was accelerating, with no end in sight. The case fatality rate (CFR) was just over 50 percent, ranging from 39 percent in Sierra Leone to 64 percent in Guinea varying by how early the patients seek medical care. In addition, an unknown number are dying from other causes because they are frightened of going to hospital, or are, like one Indian missionary in Liberia with (probably) a serious case of malaria, turned away from hospitals for lack of floor space. WHO estimates 980 EVD treatment centre beds were required as of the beginning of September, with 760 of them in Monrovia alone.

Tracking potential cases by monitoring contacts of EVD infected persons presents a staggering task. Nigeria is trying to trace more than 400 contacts from its two commercial hubs, Lagos and Port Harcourt. All contacts originate from a single diplomat infected by a conference delegate who came in from Liberia; the delegate was sick on arrival in Lagos airport and later died in a local hospital. Senegal is also tracing 67 contacts related to an EVD patient who escaped quarantine in Guinea. The patient later arrived in Senegal and recovered. Although it has not yet seen a single suspected case, India is tracking over 1000 of its nationals who have recently arrived, fleeing from EVD infected countries.

Three Americans: two doctors and a nurse, a British nurse and a Spanish missionary have become infected in spite of using PPE (personal protective equipment),



Public service announcement seen in Charles de Gualle Airport in Early September 2014 (both French and English versions were available as pamphlets.)

and have been evacuated to their home countries. As of the time of writing (8 Sept. 2014) two Americans and the British nurse have recovered and been discharged from hospital; the Spaniard died. A Senegalese WHO consultant was also infected and evacuated to a hospital in Germany, and several doctors, nationals of the affected countries, have died. Some were treated with an experimental serum, ZMapp; some survived, others didn't. Production of another drug and a vaccine are being scaled up for distribution to local and foreign health workers. There are critical shortages of PPE and basic infection control supplies in EVD-stricken countries, and Doctors Without Borders (MSF), WHO and USAID are appealing for more health professionals, supplies and hospital beds to cope with the rapidly increasing case load. Still, some labs and hospitals have been closed and international staff withdrawn because of safety concerns.

The World Health Organization (WHO) warned that the number of people affected by EVD could rise to 20,000 within the next 9 months and a projected half a billion dollars would be needed to fund efforts aimed at stopping the spread of the disease.

The spread has been due to the cumulative effects of a number of factors. The infection is transmitted by:

- contact with the blood, vomit and excrement of the sick;
- contact with the infectious bodies of the deceased;
- contact with surfaces contaminated by patients;
- unrestricted cross-border traffic which has taken ebola virus to the capitals of the four countries, from which it travelled abroad by airline passenger;
- refusal by apparently healthy contacts of patients to accept quarantine;
- refusal to accept that EVD is a treatable disease (albeit with a 50% death rate);
- suspicion of foreign medical personnel and rumors that they are actually transmitting the disease; and
- blatant disregard of isolation requirements by some infected doctors.

There is also a serious lack of personal protection equipment (PPE) and precautions in putting it on and taking it off, as a consequence of which 240 doctors and health workers have been infected, and 120 have died.

Middle Eastern Respiratory Syndrome coronavirus (MERS-CoV)

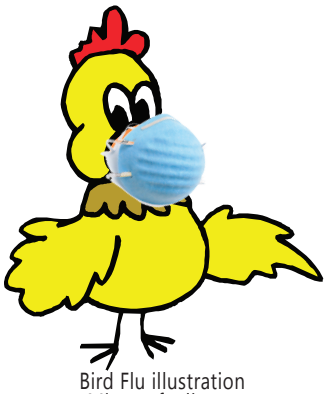
Transmission of this highly fatal pneumonia seems to have dropped off since mid-June 2014. Since 27 July there have been only five new laboratory-confirmed cases and five deaths reported from Saudi Arabia. In addition, five cases are reported to have recovered during this time. The total number of laboratory-confirmed MERS-CoV cases reported by Saudi Arabia since September 2012 is 726, including 302 deaths, and according to the most recent European Centre for Disease Control (ECDC) Communicable Disease Threats Report, as of 2 Sept. 2014, there has been a global total of 854 laboratory-confirmed cases of MERS-CoV infection, including 334 deaths (CFR just under 40%, compared to just over 50% for Ebola virus disease). The reason for the drop may be connected with the dromedary camel breeding season, since young camels are suspected of being carriers of the virus. Fruit bats are suspected to be the reservoir (just as they are for ebola virus, although the viruses belong to completely different families), but nobody has so far worked out how the virus gets from bats to camels.

Cartoon camel
CC BY-NC-SA 3.0 by
Autodesk Premium

Bird flu in poultry

The alphabet soup of avian flu viruses continues to splash around the world. Low pathogenic (LPAI) strains that kill only a small proportion of an infected flock have to be monitored in case they become high pathogenic (HPAI) strains that kill most of a flock. LPAI H7N7 showed up on several ostrich farms in South Africa, with some mortality, and H7 was found in New Jersey, USA during routine surveillance of a duck breeding farm and pheasant hunting preserve with thousands of birds, without any observed mortality.

HPAI H5N8 attacked a farm in South Korea, resulting in the precautionary culling of 42,000 ducks and 2,000 chickens. In January a local South Korean government culled over two million ducks and chickens infected with the same strain. Lastly, a new strain, HPAI H5N6, showed up for the first time in Viet Nam, probably spread from Laos or China.



Bird Flu illustration
Microsoft clip art

Livestock diseases

First reports (never seen in the country before) came in of bovine anaplasmosis in Tahiti, French Polynesia; bovine lumpy skin disease in Azerbaijan and Iran; and multi-resistant *Staph. aureus* (MRSA), an important human pathogen, in pigs in Australia. African swine fever, a serious disease of pigs, has spread unchecked this quarter from Russia, via the other Baltic states, to pigs in Latvia, carried across the frontiers by wild boar.

A case of atypical L-type bovine spongiform encephalopathy (BSE, or "mad cow disease") was reported from Romania.

Wildlife diseases

This quarter there have been first reports of a new fungal disease in a wild mud snake in the state of Georgia, USA, and of rabbit hemorrhagic disease in Norway in a hare and a rabbit, probably spread from Sweden, which reported cases last year. White nose syndrome, a fatal fungal disease of bats, has been spreading southwestward across the USA from eastern states and is now reported for the first time from three caves and a culvert in Mississippi. Bats are important fruit tree pollinators and consumers of mosquitoes and other insect pests, according to the species.

As mentioned above, African swine fever has spread to pigs in Latvia, carried across the frontiers by wild boar, which can crash through or burrow under most types of fence.

Crop plant diseases

There were first reports of lethal necrosis of maize in Rwanda and tomato chlorosis virus in Tunisia.

Why consider crop plant diseases?

Infectious diseases continue their relentless march around the world, attacking humans and their food supply. The emergence of new zoonoses – disease transmitted from animals to humans (like AIDS, from apes, and SARS, from palm civets) has been blamed on climate change and destruction of wild habitat, but in fact they have also often stemmed from a predilection for bush meat (forest animals) or farmed animals sold live in wet markets. From those sources there has been rare, unlucky spread from an infected animal to a hunter or cook and from the index case to the community and patients and health workers in hospitals lacking infection control equipment or procedures.

Fall crop illustration
Microsoft clip art

Luckily, plant infectious diseases do not affect humans. Sickness from eating vegetables or fruit instead stems from contamination by bacteria carried by human or livestock excrement. However, crop plant diseases can have severe detrimental effects on the human and livestock food supply, and must thus also be considered of importance to human and animal health.

For more on these and other outbreaks, please go to www.promedmail.org. Click on the Hot Topics tab, or click the Search tab to enter a keyword and date limits.

Jack Woodall, PhD, is Co-founder and Associate Editor of ProMED-mail. He is also a member of the One Health Initiative team.

Advancements in One Health

CDC Partnership with USDA and 4-H

CDC has partnered with USDA and 4-H to form the CDC-USDA-4-H Public Health Youth Education Program to educate youth, parents, and local leaders on the transmission and prevention of zoonotic diseases. The program will have graphic novellas (comic books) of youth leaders, public health professionals, and animal health professionals working together to solve outbreaks. The novellas will focus on explaining how zoonotic diseases are spread, how communities can prevent their spread, and the roles of state, local, and federal entities involved in outbreaks and prevention. The program also partnered with the University of Georgia's College of Agricultural and Environmental Sciences Cooperative Extension Office to produce a magazine for fifth graders. The magazine, *Friends*, has been piloted with lesson plans in Georgia public schools (2013-2014 school year).

For more information please visit the CDC website at: http://www.cdc.gov/onehealth/domestic-activities/index.html

Ebola and Ecological Health featured in New York Times Blog

The Ebola epidemic in West Africa displays the need for One Health by linking ecosystem health with human health. When ecosystems are altered the interactions of humans, animals, and the environment are affected. Emerging infectious zoonotic diseases can be partially attributed to ecosystem health, as this blog piece highlights is true in the case of Ebola. Human forces have effects on ecosystem health, and one such force in the case of the West Africa Ebola epidemic is deforestation. The growing need for firewood increases deforestation, which in turn affects the natural ecosystems. Wildlife is displaced and more likely to come in contact with humans, potentially transmitting diseases like Ebola.

To read the original blog article as well as learn more about this topic, visit the following links: New York Times blog article, New York Times blog article (2), & Plos Pathogens article

New Online One Health Course

[Originally printed on OHI website (onehealthinitiative.com)]
The Center for Food Security and Public Health (CFSPH) at Iowa State University College of Veterinary Medicine is offering an online course titled Zoonoses: Protecting People and Their Pets. The course is a great resource for medical,veterinary, and public health professionals and students to enhance knowledge of key zoonotic diseases. This course

includes textbook and case studies. It is currently being offered at a discounted rate of $90 for registration prior to October 18th, 2014. The course is offered from October 20th- November 10th, 2014.

For more information and to register please visit: http://www.cfsph.iastate.edu/Zoonoses-Course/index.php or contact CFSPH directly via phone: 515-294-7189 or email: zoonoses@iastate.edu

Upcoming Events

Epizone European Research Group Summit
Copenhagen, Denmark September 23-25, 2014
http://www.epizone-eu.net/en/Home/Annual-meeting.htm

3rd International Conference on Responsible use of Antibiotics in Animals
Amsterdam, the Netherlands September 29-October 1, 2014
http://www.bastiaanse-communication.com/rua2014/

3rd Global Risk Forum One Health Summit
Davos, Switzerland October 5-8, 2014
http://onehealth.grforum.org/fileadmin/user_upload/Call_for_Abstracts-3rdOHS_web.pdf

Antibiotic use and Resistance: Moving Forward through Shared Stewardship
Atlanta, GA November 12-14, 2014
http://www.animalagriculture.org/2014AntibioticsSymposium/Agenda

American Public Health Association Annual Conference
New Orleans, LA November 15-19, 2014
http://www.apha.org/meetings/annual/

International Symposium for One Health Research
Guangzhou, Guangdong, China November 22-23, 2014
Abstract deadline: October 20, 2014
http://onehealth.csp.escience.cn/dct/page/1

3rd International One Health Congress
Amsterdam, the Netherlands March 15-18, 2015
http://www.iohc2015.com/

Impact of Environmental Changes on Infectious Diseases
Melia, Sitges, Spain March 23-25, 2015
http://www.iecid2015.com

32nd World Veterinary Congress
Istanbul, Turkey September 13-17, 2015
http://www.wvcistanbul2015.com

Recent Publications in One Health

Journal Articles

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Uncovering zoonoses awareness in an emerging disease 'hotspot'. S. B. Paige, C. Malavé, E. Mbabazi, J. Mayer, T. L. Goldberg. Social Science & Medicine. July 2014. pii: S0277-9536(14)00498-5. doi: 10.1016/j.socscimed.2014.07.058. http://www.sciencedirect.com/science/article/pii/S0277953614004985

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One Health in action: the work of the HAIRS group. D. Morgan. Veterinary Record. July 2014. 175(3):61-3. doi: 10.1136/vr.g3641. http://veterinaryrecord.bmj.com/content/175/3/61.long

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One Health Book Publication Notice

Confronting Emerging Zoonoses: The One Health Paradigm

Hardcover – Available November 14, 2014

by Akio Yamada (Editor), Laura H. Kahn (Editor), Bruce Kaplan (Editor), Thomas P. Monath (Editor), Jack Woodall (Editor), Lisa Conti (Editor)

[Originally printed on OHI website (onehealthinitiative.com)]

"This book provides readers with information on the factors underlying the emergence of infectious diseases originating in animals and spreading to people. The One Health concept recognizes the important links between human, animal, and environmental health and provides an important strategy in epidemic mitigation and prevention. The essential premise of the One Health concept is to break down the silos among the different health professions and promote transdisciplinary collaborations. These concepts are illustrated with in-depth analyses of specific zoonotic agents and with examples of the successes and challenges associated with implementing One Health.

The book also highlights some of the challenges societies face in confronting several specific zoonotic diseases. A chapter is included on comparative medicine to demonstrate the broad scope of the One Health concept. Edited by a team including the One Health Initiative pro bono members, the book is dedicated to those studying zoonotic diseases and comparative medicine in both human and veterinary medicine, to those involved in the prevention and control of zoonotic infections, and to those in the general public interested in the visionary field of One Health."

Preorder today from Springer or Amazon.

Recent Publications (continued)

Journal Articles (continued)

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Zoonoses: protecting people and their pets. Edited by G. Dvorak, J.A. Roth, G.C. Gray and B. Kaplan. Iowa State University, USA, 2013. 239 pages. Price $75. ISBN 9780984627035. In: S. Page. Australian Veterinary Journal. July 2014. 92(7):249. doi: 10.1111/avj.12210

Journals Featuring One Health Manuscripts

Veterinary Record Journal
(http://veterinaryrecord.bmj.com/)
During 2014, featured articles will present the concept of One Health, including current issues, history or future challenges.

Infection Ecology & Epidemiology: The One Health Journal
(http://www.infectionecologyandepidemiology.net/index.php/iee)
This One Health journal features original research articles, review articles, or other scientific contributions in One Health, that motivate interdisciplinary collaborations between researchers in various clinical and environmental health disciplines.

International Journal of One Health
(www.onehealthjournal.org)
This journal publishes papers focusing on One Health; all articles published are made freely and permanently accessible online.

Miscellaneous Publications

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