

Abstracts

1st International One Health Congress Abstracts

Plenary Abstracts

The following abstracts are listed by Theme and corresponding sub-Theme. Abstracts are organized within sub-Theme alphabetically by the last name of abstract presenter as of 01 December 2010.

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The One-World of Infection and Immunity

Peter Doherty

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Has there ever been the slightest doubt in the minds of those of us who research infection and immunity that we are part of one, related world comprised of the spectrum of higher vertebrates? From the likely crossover of bovine rinderpest to cause measles at the dawn of plant and animal agriculture some 10,000 years back, through the continuing toll of plague (rat/flea/human) that blighted much of the past millennium, to Jenner's use of cowpox as the first vaccine against variola, then the realization that the influenza A viruses that afflict us are primarily infections of aquatic birds, to the establishment of a chimpanzee virus that causes human HIV/AIDS, we have come to understand that the apparent barriers limiting this or that infection to a particular species can, at time, be very fragile. Also, "though mice can lie and monkeys don't always tell the truth", it is irrefutable that much of our conceptual understanding of human immunity, vaccine development and so forth has come from experimental studies with rodents and sub-human primates that cannot, for obvious reasons, be done in people. This equation has changed to some extent with the rise of modern molecular technology but, as with so many areas of science from cancer to neurobiology, the availability of mice that are transgenic for the expression of a particular protein, or proteins, or have those genes disrupted (knockout) to prevent their function, has driven biology forward in the most extraordinary way and provided insights that have led to the development of new vaccines and therapies. We are part of the animal kingdom. While we might celebrate that we are different from other species when it comes reasoning ability and the size of our frontal cortex, there is much to be learned from careful analysis of the full spectrum of life, particularly when it comes to growing dangers like the threat of anthropogenic climate change.

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One Health - An Australian Veterinary Perspective

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Animal health has an impact on all of us. It can directly affect our own health through exposure to zoonotic diseases; it can affect human health, welfare and security when it decreases food security (especially in developing countries) and it can affect national economies—especially those with a substantial agricultural base. Animal health can also affect our environment and, in turn, be influenced by the environment.

While Australia is not as dependent on agricultural production as it once was, animal industries still play a crucial role in maintaining the strength of Australia's economy and promoting our high level of food security. Australians also continue to have a great deal of interaction with animals and, therefore, face high levels of exposure to any diseases they may carry. Looking to our international region, many countries are more sensitive to food security issues, outbreaks of high-impact transboundary animal diseases and diseases which suppress animal production. These diseases pose a direct threat to their food security by affecting nutrition as well as the income of rural communities dependent on livestock.

Unfortunately, with the combined effects of trade globalisation, increased human mobility, global climate changes, and demographic and land use changes, the risks of animal disease epidemics are increasing. Continual advances in veterinary science and the efforts of international bodies such as the OIE and FAO position us well to face these new challenges, but these efforts must be sustained to ensure the welfare of all.

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***Clostridium difficile* in Animals - a Significant Risk to Humans!**

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Clostridium difficile causes infectious diarrhoea in humans, the leading nosocomial infection in the developed world, costing an estimated US\$3 billion/annum in the USA alone. *C. difficile* has been isolated from various diarrhoeal and non-diarrhoeal animals, as well as chickens and turkeys. Indeed, 20-40% of meat products (beef, pork, turkey) in Canada and the USA contain *C. difficile*, suggesting the possibility of food-borne transmission, although this has not been proven. PCR ribotype 078 is the most common ribotype of *C. difficile* found in pigs (up to 83%) and cattle (up to 100%). Recently there has been overlap of pig and human ribotypes of *C. difficile*, particularly in The Netherlands where 22% of human isolates are ribotype 078. Ribotype 078 *C. difficile* is now the 3rd most common human isolate in Europe, and human and pig 078 strains are identical. Why is this happening? In the 1980s, *C. difficile* infection in humans was driven by cephalosporin use – *C. difficile* is intrinsically resistant to cephalosporins. Today veterinarians are giving cephalosporins to animals, initiating a cycle of scouring followed by significant environmental contamination with *C. difficile* spores which persist for years to infect other animals and humans. In countries where high human and pig population densities meet, such as The Netherlands, this is a problem. If it occurs in China, home to half the world's pigs, it's a recipe for a disaster. The amplification of *C. difficile* is invariably driven by antimicrobials; additional effort is required to target cephalosporin use in veterinary medicine.

Disease Emergence Stream - Sponsored by the Department of Primary Industries, Victoria

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Emerging Infectious Diseases: Rethinking Zoonoses

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Given that over 60% of emerging infectious disease events are caused by the transmission of an infectious agent from animals (zoonoses), with 75% of these originating from wildlife, employing a systemic One Health approach is of great relevance to microbiology as a unifying discipline across the domains of animal, human, and environmental health and has great potential for reducing threats to global health from infectious diseases. A holistic One Health approach for surveillance is needed for the early detection of evolving pathogens and to determine where and when the critical events in the evolution of new pathogens

occurs. A much broader approach to the movement of virulence genes is needed to recognize critical molecular level exchanges that drive the emergence of new animal and human infectious agents. We to extend our research on emerging infectious diseases to the molecular level to understand the evolution of pathogens, environmental survival, the exchange of virulence factors, and changes in host ranges. We also need for a new paradigm to broaden the meaning of the term zoonoses so as to recognize that the flow of microbes and their genes is multidirectional and includes environmental reservoirs. Modern molecular methods, especially metagenomics, are providing insights into the relationships between microorganisms and virulence genes in animal populations (both domestic and wildlife), humans, and diverse environments. Ideally a One Health approach to management of zoonotic diseases can prevent human outbreaks and minimize animal culling.

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Rift Valley Fever in Madagascar, Tanzania and Sudan: Collaboration Between FAO, OIE, WHO and GOARN Partners (CDC, NAMRU and the Pasteur Institute)

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From the end of 2006 until 2010, Rift Valley fever (RVF) has dramatically affected the Horn of Africa, Sudan, southern Africa countries and islands in the Indian Ocean. The respective emergency intervention systems of WHO (GOARN) and FAO-OIE (CMC-AH), promptly answered the support requests received from countries and, through collaborative actions between central and regional/national offices of the United Nations agencies, deployed adequate intervention teams to support investigations and implement national action plans.

The international organizations benefited from the expertise of collaborative centres for field activities conducted with national counterparts. This support was determinant for early diagnostic, virus isolation, epidemiological investigation and risk assessment. It also later facilitated the characterization of the virus and possible vectors, and the building of capacities and capabilities in the countries.

Tanzania, Sudan and Madagascar are examples where joint strategies between public and livestock health authorities have been particularly efficient. WHO and FAO jointly promoted concerted development of the national action plan, based on (i) establishment of a coordinated inter-ministerial management taskforce; (ii) communication, social mobilization and at-risk population awareness; (iii) strengthening of case reporting and surveillance systems; (iv) human case management; (v) livestock management, i.e. animal movements, slaughtering and vaccination.

Detailed Standard Operational Procedures were developed and implemented. Also, the joint taskforce managed to facilitate funds mobilization from UN emergency funds and other donors. Finally, these activities facilitated the management of these crises, contributed to linking authorities in charge of public health and livestock health, and strengthened capacities in these countries.

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Reston Ebolavirus Emergence at the Human-Animal interface in Philippines: Collaboration Between Animal and Health Sectors

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Reston ebolavirus (REBOV) infection discovery in pigs in Philippines in 2008 marked the first time it was found in pigs. An intensive collaborative effort of animal health and public health authorities, at national, regional and international levels, was necessary to assess the risk of REBOV in animal and humans.

Ebolavirus genus comprises Ebola species known to be highly pathogenic for humans. To date, the number of people with proven REBOV infection - 15 persons - is too small to draw any conclusions on possible clinical spectrum. With other Filovirus species, relatively minor genetic change could result in significantly different clinical outcomes with serious health implications, thus REBOV should be considered potentially pathogenic for humans (http://www.who.int/csr/resources/publications/WHO_HSE_EPR_2009_2/en/index.html).

Possible routes of infection from pigs to humans include: transmission when handling infected pigs in farms, during slaughtering activities and preparation of meat, food chain, xenotransplantation, vaccine, cosmetics, etc. Human studies are necessary to assess possible human-to-human transmission in the community and in health care settings. Based on results from studies in Africa, it seems that fruit bats of the family Pteropodidae should be considered as natural hosts of REBOV.

Given the likelihood of further infections and potential pathogenicity of REBOV for humans, public health authorities should reduce the risk of human infections: by implementing control measures to avoid pig-to-human infections including strengthening the food production system, by controlling REBOV infection in the swine population, and by implementing appropriate biosafety and biosecurity measures to avoid novel introduction of REBOV in pigs from bats putative reservoirs.

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Investigating the Origin of SARS - One Health in Practice

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The sudden emergence of SARS in late 2002 and its rapid global spread brought the concept and consequence of infectious disease emergence into sharp public focus. By the end of June 2003, when the outbreak was declared over, more than 8000 cases had been reported in 33 countries across five continents.

In a practical example of a 'one health' approach, the peak global human and animal health bodies - WHO, FAO and OIE - assembled a succession of teams of international scientists to work with Chinese scientists to understand the origins and control the outbreak. The effectiveness of the approach was illustrated by the early identification of a likely wildlife reservoir within the wet markets of Guangzhou in southern China. The increasing collaboration between human and animal health authorities at all levels reflects the increasing awareness and relevance of the inter-dependence of human, livestock and wildlife health.

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The Role In-situ Conservation Organizations Play in Disease Surveillance Programs

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Central Africa is a "hot spot" for emerging infectious diseases of global and local importance. Ebola virus (EBOV) has repeatedly passed from infected apes to hunters, leading to multiple epidemics and more than 350 human deaths in Gabon and the Republic of Congo alone since 1994, with case-fatality rates of up to 88%. EBOV also kills wild great apes and has been described as a significant threat to the survival of western lowland gorillas and chimpanzees in central Africa. Ebola virus is believed to kill up to 95% of the great apes it infects and is estimated to have killed 50 percent of the Gabon populations. If this trend continues, all great apes in this region are at risk, and the western lowland gorilla may face

extinction. Since human Ebola outbreaks are linked to contact with infected bush meat, efforts aimed at identifying great ape outbreaks, quickly report them to national and international public health partners and rapidly educating communities could have a profound impact on public health in local communities. The Wildlife Conservation Society (WCS), conservation NGO, has an in-situ wildlife health program and has been systematically collecting information on the health status of wild apes since 1999. As part of this work, WCS has developed a hunter-based great ape health surveillance program in more than 80 villages located in Ebola endemic regions of Congo. Along with this surveillance they have been performing ape population health surveys, collecting samples for diagnostic testing, and educating local communities about disease risks. As a result of these activities, WCS researchers have been among the first to respond to wildlife outbreaks in the region and report these events to appropriate public health agencies. A summary of how the surveillance system works, its role in the national epidemic response plan and examples of how this collaboration has been mutually beneficial for both animal and public health will be presented.

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Social Mobilization and One Health: Collaboration Between National, Regional and International Partners

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The fundamental premise of One health is the cooperation between human and veterinary medicine to protect and improve animal and human health. Nowhere is this premise more relevant than for diseases which intersect the animal-human interface that require interventions which heavily rely upon community engagement, participation and ownership as well as intersectoral coordination and collaboration for preventive, control and mitigation strategies to work.

Experiences from responding to outbreaks such as avian influenza, ebola, rift valley fever, and Nipah has shown that achieving the collaboration, co-operation and partnerships at local, national and international levels is not always straightforward and are incredibly complex and challenging, especially during crises.

This paper will focus on “behavioural and social interventions” as a core pillar for preparedness and response. Drawing upon experiences from avian influenza, rift valley fever, Nipah and ebola, it will illustrate the impact of ignoring this dimension. The paper will conclude that an inclusive, holistic view of “strategic health communication” is needed that embraces multiple approaches and methodologies, that we need to have clear expectations of its purpose and role and that we need to invest and strengthen capacities at key critical levels. As such, it can be an important vehicle for demonstrating the principles and foundation of the One Health concept in practice.

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Smart Surveillance: Analyzing Environmental Drivers of Emergence to Predict and Prevent Pandemics

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EcoHealth Alliance

New pathogens seem to emerge in a random pattern, in an unpredictable way. The appearance of new zoonoses in particular seems to happen with increasing frequency, and with increasing impact. These pathogens emerge from a wide array of wildlife species (e.g. bats, primates, rodents), and are often new to science. Their impacts are complex and costly, whether measured in lives lost, economic damage through disruption of trade networks (e.g. drop in travel to SE Asia during SARS outbreak) or through the public response to the negative publicity surrounding a new pathogen (e.g. the drop in pork consumption during H1N1 ‘swine’ flu outbreak).

The global pattern of disease emergence and impact creates a classic tragedy of the commons dilemma whereby their emergence in one country (often a developing country) can have the highest impacts on another country once a new pathogen gets into the global network of human travel and trade. For example, the emergence of SARS coronavirus in Guangdong province in China in 2003 led to significant disruption of travel within Southeast Asia, and significant (1-2%) drop of GDP in a series of countries within the region (Brahmbhatt, 2005). Likewise, the emergence of HIV in Africa has led to significant mortality across the globe, as it has expanded through travel and trade routes. At the same time, our global disease surveillance strategy seems to be costly and ineffective, even with the development of the International Health Regulations. National surveillance programs in the developing countries where diseases often first emerge are often less effective than those in the developed countries where their impact is highest. Trade in animals and their products are often poorly regulated for the spread of novel emerging pathogens, leading to the emergence of a series of new pathogens (e.g. West Nile virus and monkeypox in the USA). In the USA, for example, the legal wildlife trade involves around 120 Million individual animals p.a., with mandatory surveillance for less than 5, already-known, pathogens (Smith, 2009).

One solution is a 'Smart Surveillance' strategy that uses predictive models of the environmental and anthropogenic drivers of EIDs to identify where zoonoses will most likely emerge in the future. Targeting these regions for surveillance will enable the best use of scant global resources. Recent developments in mathematical modeling have been very successful in helping develop control strategies for outbreaks (e.g. FMD) and in tracing the origins of new pathogens (e.g. SARS). These approaches work best when they use real-time data to 'fine-tune' the models and produce more accurate projections. Models using global datasets of the underlying causes of emerging diseases (Jones et al., 2008) have been able to 1) demonstrate that emerging diseases will continue to increase in frequency over the next few decades, and 2) identify global EID 'hotspots' – the regions where the next pathogen is most likely to emerge (See Figure 1, below). These regions are largely in tropical developing countries where wildlife biodiversity is high (i.e. the diversity of new pathogens ready to emerge is high) and human populations dense and growing (i.e. the pressures on wildlife bring humans into closer contact with them).

This approach provides a tool for geographical targeting of resources to those places most likely to produce the next emerging disease, and therefore increases the potential for early outbreak control. If we target wildlife in these 'hotspots', and use molecular biological tools for pathogen discovery, we may be able to identify novel pathogens before they first 'spillover' from wildlife to people. Of course, huge scientific challenges remain. For example, as we discover new pathogens in wildlife, we need to develop a strategy to more accurately predict which pathogens will be most likely to emerge. Ultimately, we also need to develop better approaches to working locally to understand how best to reduce the activities that are driving emergence.

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The Veterinary Biologics Industry Response to Emerging Disease

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Pandemic H1N1 and Rift Valley Fever are used as examples of the Veterinary Biologics industry response to emerging diseases for two scenarios: pH1N1, a new virus which rapidly spread globally, and Rift Valley Fever, a zoonotic, well characterized, geographically confined virus with the potential for rapid geographic expansion through accidental or intentional means.

The rapid emergence of pandemic H1N1, its global spread and the subsequent isolation of pH1N1 from swine provided an opportunity for the veterinary biologics industry in the United States and the United States Department of Agriculture to work together to rapidly bring a vaccine solution to the US domestic swine industry. A risk based development process, using seed virus supplied by the USDA allowed for a conditional licensed vaccine to be developed and licensed in approximately 4 months. Rift Valley Fever, a vector transmitted disease primarily of cattle and sheep, but capable of causing serious and occasionally fatal disease in humans is well established in Africa. Vaccines for use in cattle and sheep have been

developed and are currently in use in certain regions. A more sequential, less risk based development pathway is outlined leading to the development of a potential vaccine for veterinary stockpiles.

Using appropriate risk based development approaches and through close communication with the Regularity Agencies, the veterinary biological industry can be prepared, and respond rapidly to emerging disease situations.

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The UN System High Level Task Force (HLTF) on the Global Food Security Crisis and the Updated Comprehensive Framework for Action (UCFA)

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In 2008, soaring prices of staple foods led to increased numbers of people experiencing poverty and hunger, increased political instability and an increased awareness that agriculture and food systems throughout the world are not working.

Since then, governments and the international community have engaged in a constructive dialogue aimed at finding a more sustained, action-oriented and effective responses to the global food security crisis. In 2008, nations spoke of the need for a Global Partnership for agriculture and food security. In April that year, the UN Secretary-General established the High Level Task Force (HLTF) on the Global Food Security Crisis. He asked 22 different United Nations and Bretton Woods institutions to come together and work out how to address food insecurity in a more sustainable and comprehensive way. The HLTF was designed to ensure coordinated UN system support for governments and other stakeholders as they responded to the food security crisis.

Last year, nations transformed their political commitments into a series of concrete actions. They developed plans for a new governance approach (the revitalized Committee on World Food Security); a renewed pledge of financial support for food security (the L'Aquila Food Security Initiative); a new pooled funding mechanism (the Global Agriculture and Food Security Programme); a new system for ensuring effective scientific analysis of food security issues (the High Level Panel of Experts); major regional efforts (e.g. the Comprehensive Africa Agriculture Development Programme) and specific initiatives on nutrition (the Scaling Up Nutrition), research (the reform of the Consultative Group for International Agricultural Research), public-private partnerships (the World Economic Forum New Vision for Agriculture) and a range of policy initiatives around the right to food, ethical investment in agriculture, protracted crises and food price volatility. Many of these were taken up by the G20 at the Seoul Summit (November 2010).

Among the first tasks of the HLTF was to develop a comprehensive strategy for responses to the food security crisis. This strategy – the Comprehensive Framework for Action (CFA) – was designed to encourage concerted responses to the food price crisis with actions that respond to the immediate needs of vulnerable populations and contribute to longer-term resilience (the twin-track approach). It was aimed at inspiring the achievement of common outcomes through coordinated efforts by the UN system for the achievement of food security as well as at stimulating synergy of action and inspiring a comprehensive, multi-stakeholder and multi-level approach.

As the context changed during the last two years, there was a growing sense that the CFA would need to be updated to better reflect this new scenario for food security. The Updated CFA¹ is – like the original - based on the twin-track approach but it covers a wider range of issues and contains a more detailed treatment of all aspects of food security, including the right to food, ecosystem management, access to land, water security, nutrition, urban hunger, pastoralism, gender, employment, and involvement of the private sector. The Updated Comprehensive Framework for Action is now being pursued throughout the United Nations family.

¹<http://un-foodsecurity.org/node/842>

One Health Plenary Thoughts - Sponsored by Abbott Molecular

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Towards One Health: The Economic Rationale

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Zoonotic diseases with pandemic potential threaten human health and the global economy, while the ‘neglected’ ones impose persistently heavy health and economic burdens on lives and livelihoods throughout the developing world. The Spanish Influenza of 1918-1919 caused between 50 and 100 million deaths at a time when the global population was 1.6 billion. At the time, the economic costs that the pandemic entailed were incalculable, and they remain so today. More recently, SARS, H5N1, and H1N1 have provided ominous reminders of the threat of zoonotic diseases. The economic costs could be staggering. The World Bank estimated that a severe influenza pandemic would result in a decline of up to 5 percent in global GDP, or economic costs of US\$3 trillion, causing far-reaching disruptions in the lives of people, communities, and countries.

Better detection, prevention, and control strategies for zoonotic diseases, at both the global and national levels, warrant more attention and support from decision makers, but this has ebbed and flowed with proximity to an actual outbreak. The threat of these diseases exists across the health sectors but may best be acted upon at the animal-human-ecosystem health interface, and will require systematic forms of communication and coordination among the professional disciplines and the respective institutions that house them. The One Health approach proposes to facilitate this.

The economic rationale for adopting One Health is compelling. Three reasons in particular stand out. The first is the prospect of facilitating earlier detection than is attained by current systems, in which surveillance is undertaken sector-by-sector. Early detection reduces the amount of time that elapses between an outbreak and the introduction of control efforts. The costs of control increase exponentially as this period of time grows longer.

Second, substantial efficiency gains can be achieved where joint equipment, facilities (e.g. labs), and field-based operations are feasible – leading to lower capital investments and operating costs. In addition to improved efficiency, more purposeful cooperation among agencies and better deployment and use of human resources should result in increased effectiveness.

Third, the strict compartmentalization of surveillance and detection efforts contributes to inferior quantity and quality of data, and under-reporting of disease incidence, which severely hamper impact assessment, cost benefit analysis and planning. In addition to limited capacity to detect disease outbreaks, countries are often reluctant to report because of the economic and other consequences that are likely to follow. This fear also applies at the level of the individual farmer, who dreads the economic and social consequences of being perceived as the cause of an outbreak or being the first to report it. Improved surveillance capabilities and expanded use of compensation payments are essential features of One Health at the national level, but could also become important incentives for early reporting among countries.

This presentation examines, in both qualitative and quantitative terms, the economic reasons for embracing One Health at the national and the global levels.

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Plenary Panel Science, Policy and Political Action - Sponsored by IDRC

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One Health faces several challenges to be an effective conduit for change. Innovations are needed on several fronts for effective intersectoral collaboration for achieving change on the ground. There is a need for coherent linkages between science and policy. Research (meaning researchers and research infrastructure (from donors to universities to private sectors) need to develop stronger mechanisms to connect with policy development and decision-making, and decision-making must find mechanisms to get the knowledge needed to fill critical gaps in a timely manner. Inter-sectoral collaboration in science and in policy-making is already a challenge, but innovation in linking different sectors in the push-and-pull science policy interface is also needed. Clever ideas are needed to foster effective institutional arrangements. New approaches are also needed to implement inter-sectoral activities, with operational-type (evaluative) research continues to inform policies. Finally, these need to be achieved at the national level in all countries, and at the international level. Infectious diseases do not respect national borders. With globalization economies are increasingly inter-dependent, effectively globalizing social and economic determinants of health. Further, global environmental and social challenges are now facing societies around the world: climate change, global health, equity and sustainability. One Health can contribute by using integrated research approaches for generating evidence as well as generating demand from policy makers for better evidence. It must also implement, evaluate and report on how policies are being implemented, or not.

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Shifting from Emergency Response to Prevention of Pandemic Disease Threats at Source

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High profile outbreaks such as SARS, H5N1 avian influenza and the H1N1 pandemic influenza have provided a potent reminder of our increasing vulnerability to the emergence of infectious diseases that are transmitted from animals to humans. Public health authorities traditionally respond by identifying disease in humans and then identifying the cause among animals, or at best by identifying risk factors related to human infection from animals. The focus is thus on rapid detection of disease outbreaks in humans, and an emergency response to contain and then eliminate the infections in human and animal populations.

The global community is now moving towards a 'One Health' approach that recognises the inter-relatedness of human, animal and environmental sectors, and calls for coordinated prevention, detection and control strategies. Better prevention and control could be achieved through the 'One Health' approach by addressing the underlying factors which, although not traditionally seen as related to animal and human health, facilitate the emergence and spread of these infections. These factors shape disease risks by changing the nature of interactions among and between wildlife, livestock and humans – through, for instance, land-use change, trade practices and climate change. To prevent serious emerging infectious disease outbreaks in the future, collaborative efforts will need to focus on identifying the most cost-effective and feasible intervention strategies and mobilise the necessary political and financial support to implement them.

Out of the Box Abstracts

Emerging Zoonoses

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Leptospirosis in Malaysia: A Re-emerging Zoonosis with Severe Outbreaks and High Mortalities in Humans

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There have been many outbreaks of leptospirosis in the last few years in Malaysia and neighbouring countries. These were severe outbreaks in humans culminating with a high number of mortalities. Rats are the main maintenance hosts of the

many leptospiral serovars and they are found throughout the country: from cities, farms, countryside to the deep forests. Apparently each rat species prevails in specific ecological niche and carries specific leptospiral serovar. It is seen that the new outbreaks were subsequent of new lifestyle whereby people are going to the countryside or forests for recreational and/or occupational activities. Climatic changes resulting in floods and wet environment have also led to outbreaks of leptospirosis. Control and prevention of leptospirosis are being organized. Studies done on the epidemiology of leptospirosis in the past decade would greatly help to develop good strategies in the prevention of the disease.

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Revisiting the Ecology of Rift Valley Fever: Primary and Secondary Emergence Areas in Africa and the Middle East

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From the end of 2006 to date, major RVF outbreaks have occurred in Eastern Africa and are still on-going in Southern Africa. According to WHO, in Kenya, Somalia and Tanzania alone, a total of 100,000 human cases can be estimated. During these outbreaks, RVF transmission was reported in contrasting eco-epidemiological patterns. Joint WHO/FAO field investigations in most of the affected countries provided an opportunity to review the ecology of RVF and to distinguish primary and secondary emergence sites. In primary foci the virus is maintained between outbreaks in the vectors and/or through low level, year-round transmission, while in secondary foci the virus is imported through livestock movement, or passive wind-borne dispersal of mosquitoes, and is spread by blood feeding arthropods either cyclically or mechanically. Irrigation schemes, where populations of mosquitoes are abundant for long periods, are highly favourable places for secondary disease amplification. An innovative RVF primary vs secondary area map is proposed, based on expert opinions and reviews of historical and recent outbreaks. A joint FAO/WHO database including approximately 2000 records from official and unpublished data has been developed and complements a further 2000 published records gathered by the University of Oxford. These data are now being used to identify key environmental and other differences between primary and secondary RVF foci, to improve real-time monitoring carried out by collaborative centres, with the ultimate objective of improving disease forecasting and warning.

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The Effect of Keeping Pigs on the Number of Vectors for Japanese Encephalitis Virus in an Urban Area

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Urban and peri-urban agriculture (UPA), often with pigs and poultry, is an important source of food and income in developing countries. High population densities of animals and humans may however increase the risks for transmission of

zoonotic diseases. In addition vector-borne viruses are thought to emerge to new areas following the climate changes. This study aims at assessing the influence of urban pig-farming on the number of mosquitoes, the vectors for the zoonosis Japanese Encephalitis Virus (JEV).

Mosquitoes were caught overnight in four households without and 13 with 1-110 pigs in the dry and rainy season using unbaited mini light-traps in Can Tho city in southern Vietnam where JEV is endemic. Traps were placed both close to the house and close to the pigs. Mosquitoes were counted and identified. To study the effect of the presence of pigs, other animals, people, ponds or rice-fields on the number of vectors in the traps placed close to the households, multivariable regression models was used. The analyses showed that the number of two vector species, *Culex tritaeniorhynchus* and *Culex gelidus*, as well as the total number of mosquitoes, increased with the number of pigs ($P = 0.007$, $p = 0.004$ and $p = 0.03$ respectively), whereas the number of the mosquito *Culex quinquefasciatus* was independent of the presence of pigs. This shows that keeping pigs is associated with an increase in the number of vectors, which may be a concern in urban agriculture.

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A Retrospective Study of Bovine Tuberculosis Eradication Project and Human Tuberculosis

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Tuberculosis (TB) is a chronic and zoonotic disease, had known for many years. the cause of the disease is acid-fast bacillus of mycobacteriaceae, mycobacterium tuberculosis. Weakness, emaciation and chronic respiratory symptoms are common signs of the disease. The main group of human TB is pulmonary TB and the other is extra pulmonary TB. It seems that many cases of extra pulmonary TB is related to animal tuberculosis.

This is a retrospective study during ten years (1991- 2000) on the incidence of human and bovine TB and evaluation of bovine TB control project to human TB incidence in city of kerman, IRAN. Bovine TB control project is a national project that has performed many years in IRAN.

All data were taken from the veterinary office in Kerman for bovine TB control project and the only centre of human tuberculosis control for human cases. Data were analyzed and variables of age, gender, root of infection and social situation were considered in human section. The bovine positive cases have been omitted and sent to the slaughter house before.

This study showed that the most patients were over 60 years old and then 21 to 30 years old. Women showed more incidence of the disease. The prevalence of the extra pulmonary TB in the first year of the study was 11.9 in 100,000 and two years later was relatively higher than. In remaining years the prevalence showed a decreasing slope and reached to half of early year.

Among the 219375 cows were tested for TB in ten years, 65 cows were reactor. The most incidence was belong to first and second years, that is, 37 and 18 cases respectively. In later years, there was obviously a decreasing slope with only one or two reactor in 1993 to 1998 and no cases in 1999 and 2000.

There is positive relation between decrease in human TB (extra pulmonary TB) and control of bovine TB in kerman, so that with the obvious decreasing of bovine reactors in last year of this study, human cases also had a decreasing slope, although the human extra pulmonary TB is nearly one third of total human cases and it needs supplemental projects to control of human tuberculosis.

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Multidisciplinary Approaches for Rift Valley Fever Detection, Surveillance and Control

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Rift Valley fever (RVF) is a serious viral disease of animals and humans in Africa and the Middle East that is transmitted by mosquitoes. First isolated in Kenya during an outbreak in 1930 subsequent outbreaks have had a significant impact on animal and human health, as well as national economies. The disease is of concern to international agricultural and public health communities. The USDA-ARS has assembled a multidisciplinary team of government and university scientists who are developing novel methods to conduct surveillance and control of RVF in Africa and the Arabian Peninsula. New research on the ecology of RVF transmission has permitted development of a highly accurate forecasting system based upon global climate variability, permitting early warning for disease outbreaks of up to one year. This information has been used for timely targeted implementation of disease mitigation for both animals and humans in the Horn of Africa in 2006-2007, and in southern Africa in 2008-2010. The risk monitoring and mapping system permits focused and timely implementation of disease control strategies several months before an outbreak. Additionally, novel diagnostics for accurate and timely detection of virus, and animal vaccines to protect populations at high risk, are being developed and field-tested with international partners in Kenya, Egypt, South Africa and Yemen. Detection, surveillance and control research products have been and are being developed by the team to allow for timely, targeted implementation of mosquito control, animal quarantine, vaccine strategies, and public education to reduce or prevent animal and human disease.

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A One Health Approach to Rabies Control in Togo

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Anecdotal reports across West Africa suggest that canine and human rabies are a serious health problems and may be increasing. Hospital-based surveillance for human rabies in Togo has reported 159 cases in the 10-year period from 2001 to 2010. All of the cases were diagnosed clinically, without laboratory confirmation. All patients died in hospital or were lost to follow-up after being removed from hospital by family. In May 2010, an evaluation of the national capacity for rabies surveillance in human and animal populations was done, which suggested that there is underreporting of rabies in all species. In August 2010, the Food and Agriculture Organization of the United Nations (FAO) began work with the Togo ministries of Health and Agriculture, and local human and animal health practitioners to improve rabies surveillance and prevention activities in the country. The launch of a national effort to apply a One Health approach to rabies control in Togo took place in conjunction with World Rabies Day 2010. Improving animal and human rabies surveillance will be based upon strengthening case definitions, standardizing clinical reporting and instituting laboratory confirmation. Epidemiological and sociological surveys will be done in collaboration with the FAO, to collect data on risk factors for rabies exposure and high risk behaviour post exposure to aide in strengthening rabies prevention and control. Lessons learned in creating a One Health strategy for rabies control in Togo may be useful throughout West Africa.

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Identifying Research Priorities for Zoonoses Research in India (2010–2015)

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- Identify priority areas of research on zoonoses control in India with an implementation perspective
- Examine the multi-sectoral and systems based determinants of priority research on zoonoses

We built upon existing research prioritization methodology developed by CHNRI to systematically assess priority research options relating to zoonoses in India.

A multidisciplinary expert group identified priority zoonoses and knowledge gaps related to them. These knowledge gaps were converted to research options that were subsequently scored by an independent group of experts on a set of five criteria. Research options were classified on the basis of disease group, type of health research, discipline, factors, human population groups impacted and commodities (animal species, humans, etc).

The knowledge translation approach of the original methodology was then refined to work with a greater diversity of sectors, disciplines, approaches and populations to examine the collaborative potential of identified priority research.

Majority of research options involved collaborations. Social, political and economic research options received higher scorings compared to options related to ecological, biological or environmental research. Health policy and systems research received the highest scores followed by research to improve existing interventions, basic epidemiological research and research for development of new interventions.

Zoonoses are a result of complex interplay of factors that are a significant barrier to achieving MDGs in developing countries. Research to understand zoonoses and design effective interventions requires a multi-sectoral and systems based approach. This exercise allows preparation of collaborative research agenda that can inform systemic interventions for zoonoses prevention and control.

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Identification of Key Areas for Wildlife Surveillance by Combining Spatial Distribution of Wild Birds and an Epidemiological Indicator of Avian Influenza Virus circulation

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Predicting areas of disease emergence when no epidemiological data is available is essential for the implementation of efficient surveillance programs. The Inner Niger Delta (IND) in Mali is a major African wetland where >1 million Palearctic and African waterbirds congregate. Waterbirds are the main reservoir of Avian Influenza Viruses (AIV). Our objective was to model their spatial distribution in order to predict where these viruses would be more likely to circulate.

We developed a generalized linear model and a boosted regression trees (BRT) model based on total aerial bird counts taken in winter over six years. We used remotely sensed environmental variables with a high temporal resolution (10 days) to predict the spatial distribution of four waterbird groups. The predicted waterbird abundances were weighted with an epidemiological indicator based on the prevalence of low pathogenic AIV reported in the literature.

The BRT model had the best predictive power and allowed prediction of the high variability of waterbird distribution. Years with low flood levels showed areas with a higher risk of circulation and had better spatial distribution predictions. Each year, the model identified a few areas with a higher risk of AIV circulation.

This model can be applied every 10 days to evaluate the risk of AIV emergence in wild waterbirds. By taking into account the IND's ecological variability, it allows better targeting of areas considered for surveillance. This could enhance the control of emerging diseases at a local and regional scale, especially when resources available for surveillance programs are scarce.

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Community Awareness and Understanding of Rabies in Nairobi Kenya

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Rabies is a preventable disease that is estimated to cause 55000 human deaths globally every year. The majority occur in the developing world and are likely due to misconceptions regarding rabies and inadequate post exposure prophylaxis. A knowledge, attitudes and practice survey with respect to rabies was carried out in three informal settlements around Nairobi from April to July 2009.

The aims of the study were: to establish the current local knowledge of rabies transmission and prevention; to determine the current practices with respect to animal bites and rabid animals; and to identify at risk groups for future education campaigns.

A cross sectional survey using a structured questionnaire was undertaken in randomly selected households in Kawangware, Kangemi, and Mathare.

A total of 585 interviews were conducted with individuals aged between 18 and 83 years. The majority (86%) of people had heard of rabies and 76% knew it was contracted through dog bite. Over 40% of respondents knew that rabies could be prevented in dogs via vaccination. Conversely less than 10% of respondents knew human rabies could be prevented through vaccination. Proposed wound treatment following a dog bite was generally inadequate with only 26% of people washing the wound.

The results of this study suggest that rabies awareness is high in these areas but knowledge of the measures needed to prevent infection is poor. Education programmes targeted at youth groups stressing the importance of wound treatment and the necessity of post exposure prophylaxis is recommended.

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A Bird in Hand: The Power of Zoo Sentinels

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Zoos, with their captive collections of exotic species that may be sensitive to emerging infectious diseases, routine veterinary care, medical record keeping systems and blood and tissue banks, offer sustainable, point source, urban epidemiological monitoring beneficial to public health. Since 2000, Lincoln Park Zoo (LPZ) Davee Center for Epidemiology and Endocrinology has coordinated national efforts among 200 + Association of Zoos and Aquariums (AZA) zoos to act as sentinels by testing and/or monitoring for zoonotic disease outbreaks. In 2001, after the CDC recognized that traditional means of

surveillance had not been predictive of human risk, it partnered with the zoo community to create the National Surveillance for WNV Zoo Network. This network successfully integrated data from the private sector source into ArboNet adding robustness to that system with a layer of animal data previously not captured.

Today, that network has grown into The Zoo Animal Health Network (ZAHN). LPZ has developed a unique relationship with the AZA (Association of Zoos and Aquariums) and USDA APHIS AC (United States Department of Agriculture, Animal and Plant Health Inspection Service, Animal Care) in the creation of ZAHN. It acts as an early warning system to the nation by identifying and characterizing novel threats should they emerge in the zoo population. ZAHN is an excellent example of a successful public-private public health collaboration and serves as a model for other countries.

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Veterinarians as Important Biosecurity Information Providers During the 2007 Equine Influenza Outbreak in New South Wales, Australia

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The first ever Australian outbreak of equine influenza (EI) in 2007 resulted in the issuing of biosecurity guidelines by animal health departments. However, like any policy concerning human behaviour modification, the uptake of biosecurity measures is dependent on a number of determinants such as the perceived efficacy of the protective measures. We aimed to identify factors associated with high perceived biosecurity efficacy.

In 2009, 200 face-to-face interviews were conducted with horse owners from highly EI affected regions of New South Wales (NSW), randomly selected from lists of infected and uninfected properties obtained from the NSW Department of Primary Industries. The interview included questions about biosecurity perceptions and information sources. Perceived biosecurity efficacy (low, high), as determined by participants' responses to a 17-item question on the efficacy of various biosecurity measures, was used as outcome for binomial logistic regression analyses.

Most participants (83%) perceived biosecurity efficacy to be high. Men and women and people of different ages did not perceive efficacy differently, however, the 123 (62%) participants, who experienced EI infection in their horses during the 2007 outbreak were less likely to deem biosecurity measures effective (OR = 0.24; CI: 0.07-0.68; $p = 0.006$). Interestingly, participants who received biosecurity information from a veterinarian during the EI outbreak were 5.5 times more likely to believe in the efficacy of biosecurity measures (CI: 2.24-14.18; $p < 0.001$).

Veterinarians should be considered as information providers when designing infection control programs, in order to alter horse owners' perception regarding biosecurity efficacy and to ultimately increase their biosecurity compliance.

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Salmonella Source Attribution in Japan by a Microbiological Subtyping Approach

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In order to estimate the number of human Salmonella infections attributable to each of major animal-food source, and help identifying the best Salmonella intervention strategies, a microbial subtyping approach for source attribution was applied. We adapted a Bayesian model that attributes illnesses to specific sources and allows for the estimation of the differences in

the ability of Salmonella subtypes and food types to result in reported salmonellosis. The number of human cases caused by different Salmonella subtypes is estimated as a function of the prevalence of these subtypes in the animal-food sources, subtype-related factors, and source-related factors. National-surveillance serotyping data from 1998 to 2007 were applied to the model. Results suggested that the relative contribution of the sources to salmonellosis varied during the 10 year period, and that eggs are the most important source of disease, being responsible for over 50 % of the cases in most years. Broilers followed in importance in 1999, 2000, 2001, 2002 and 2005, while swine was the second most important source in 2000, 2004 and 2007. Salmonella was seldom isolated from cattle and few cases were attributed to this source. The proportion of cases attributed to an unknown source varied substantially between years. We conclude that this is valid approach to attribute salmonellosis in Japan, and that an improved dataset would substantially improve results. This is the first indication of the relative contribution of different foods for human salmonellosis, and results may be used for further research, risk management and public health strategies.

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New Developments, Challenges and Controversies in Rabies

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Rabies is expanding to previously rabies free regions. Vaccines and immunoglobulins are expensive and often unavailable. Vaccines are potent conferring long lasting immune memory. Efforts to further shorten schedules, reduce cost utilizing low dose intradermal vaccination are promising. The intramuscular regimen has been reduced to 4 injections within 2 weeks. New data show more efficient antigen delivery from dermis to receptor-processors. More effective mass dog vaccination remains an elusive goal. Anti fertility vaccines offer promise for dog population control. The unmanaged rabies epidemics on Flores and Bali islands are reminders that educating officialdom is still needed to prevent such outbreaks from becoming a permanent presence.

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Reproductive Diseases of Livestock as a Threat to Food Security

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As the most devastating and prominent food animal diseases, such as foot and mouth disease and rinderpest, come under control in the developing world, other diseases will become apparent which also negatively affect production animals. Reproductive diseases which cause abortion, early embryonic death, failure to conceive, and high neonatal mortality, will be chief among these. Ghana, a west-African nation with a growing economy, stable government, and active agriculture sector, is a prime example of a nation which has entered this next phase of disease control. Having recently eradicated rinderpest, this nation's cattle industry is poised to grow to meet its substantial in-country and export needs. In addition, increased efficiency of production can reduce the environmental impact of cattle production. However, in many herds, fecundity is not increasing. When we evaluated a herd in the coastal region near the capital, Accra, serology indicated that infectious bovine rhinotracheitis and trichomoniasis were prevalent at rates of approximately 38% and 45% respectively, with lower rates of Bovine Viral Diarrhea Virus (2%), Bovine Herpesvirus-4 (8%), coxiellosis (18%), and neosporosis (6%). Ghana has been aggressively controlling brucellosis nationwide, and in the herd examined here, there was no serologic evidence of *Brucella abortus*. This herd had an inter-calf ratio of 2.5 years, much longer than that of developed nations. This study demonstrates that while great strides have been made in controlling

major livestock diseases, more insidious reproductive diseases still may provide a barrier to obtaining national self-sufficiency and food security in the cattle industry.

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Parasite Community Ecology and Epidemiological Interactions at the Wildlife/Domestic/Human Interface: Can We Anticipate Emerging Infectious Diseases in Their Hotspots?

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Identified hotspots of emerging infectious diseases are often characterised by an extensive wildlife/domestic/human interface in tropical ecosystems, thus creating complex multi-hosts and multi-pathogens systems. How can we anticipate emerging events in these hotspots?

The parasite communities shared by wild and domestic populations at this interface reflect the historical of epidemiological interactions between them. A new pathogen entering this host system is most likely to use the transmission pathways already used by other pathogens. Using recent advances in community ecology and evolutionary molecular biology, we present a research framework to identify these transmission pathways.

We applied this framework to 34 macroparasites and 7 microparasites shared by 14 rodents and the human species in a study site in Thailand. Based on a comparative study of component communities between host populations using the Jaccard index (presence/absence data), we build a network of interactions between the host populations. This network is characterised by the frequency, intensity and direction of interactions and can be explored using classical network analysis.

We discuss the challenges and possibilities of this innovative approach. It provides a description of the transmission pathways between host species the most used by pathogens. This network can provide direct inputs for targeted disease surveillance at the wildlife/domestic/human interface to detect pathogen emergence when it occurs or host most likely to provide a source for future emergence.

More generally, this approach could support the exploration of hypothesis about the general properties of transmission ecology at the wildlife/livestock/human interface.

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Avian Influenza Surveillance in Wild Birds at Moreton Bay, Queensland

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Avian influenza (AI) is an infectious disease of birds caused by influenza type A viruses. AI viruses are ubiquitous in wild bird populations, especially in aquatic birds. They cause disease in domestic poultry with varying severity according to the virus subtype. The recent highly pathogenic AI (HPAI) H5N1 is a virulent virus with the potential to cause deaths in wild and domestic birds, humans and some other species. Migration of water birds represents the main risk of carrying AI viruses over long distances and provides a complex network because different bird flyways overlap geographically. Australia is located at the East Asian – Australasian Flyway and many migratory birds come from areas in which HPAI cases have been confirmed in the recent past. Further, their migration routes bring them down the heavily populated east coast of Australia in which there are large flocks of commercial poultry. The Redlands district in south-east Queensland is located within an hour drive of Brisbane, and supports 30% of Queensland's commercial poultry industry production.

The Redlands is bordered by Moreton Bay, a major stopover for migratory wader species. There is concern that the risk of spilt-over of AI viruses to the commercial sectors in this region.

Surveillance started in November 2009 with pooled faecal samples been collected from the migratory and resident water birds in the Moreton Bay area for AIV testing.

The paper describes multiple AIV detections as well as comparing wild bird surveillance programs in the USA and the southeast Asian countries.

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One Health - Contribution of the Veterinary Industry

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Alliances work best when the legitimate interests of the different partners combine to further a common goal.

In Europe, through an initiative of the European Commission, a range of technology platforms have been established, led by the respective industries, to drive technological development, resulting amongst others in the creation of the European Technology Platform for Global Animal Health (ETPGAH).

Its focus is on threats to Europe and its animal and human population through emerging diseases but it also takes a global perspective. It looks at the availability of tools for diagnosis, prevention (vaccines) and treatment (pharmaceuticals). It brings researchers in the relevant areas to one table and thus facilitates the exchange of experience and the development of new projects.

This is a tangible contribution to the One Health objective as it aims to prevent or control diseases in animals thus eliminating the zoonotic threat. By identifying and focusing research on the most critical gaps, progress will be made more quickly in developing our capacity to control diseases.

To date, it has succeeded in stimulating cross border research collaboration and is working on a detailed model to identify gaps and prioritise diseases.

This in turn has led to an international project that looks at coordinating the international scientific knowledge on specific animal diseases – STAR IDAZ. IFAH, the international industry association is a part of this new project, bringing to the table the tools and the output achieved through the ETPGAH.

A successful example of policy initiated public-private cooperation.

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RVF Outbreak in Kenya: Resource Capacity, Tasks and Constraints of the Public Health and Livestock Sectors

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The first response measures in the 2006/2007 Rift Valley Fever (RVF) outbreak in Kenya were poorly coordinated between the health and livestock sectors and the governmental, international, and NGOs. Soon after the outbreak, we have evaluated the response capacity, tasks and constraints of the public health and livestock sectors and households with a questionnaire survey in the affected provinces and interviews with key professionals at central level. Major constraints to early detection and response included: lack of preparedness; weak collaboration with the livestock sector; unavailability of emergency funds; delay in diagnosis and inadequate logistics. In the course of the outbreak, tasks were assigned in national/provincial

and district agreements. Practical difficulties of disease control such as lack of vehicles, poor infrastructure, and inaccessible roads became evident as a hindering factor for effective control during the outbreak. Lack of staff was particularly impeding for the livestock services, who were in charge of controlling the disease in livestock – the main source of infection for people, but had 5 times fewer staff available than the public health sector. As to laboratories, namely the central veterinary laboratory was understaffed in trained employees and could not handle all samples in a timely way. The lesson on importance of an intersectoral preparedness and contingency plan of all line ministries was acknowledged by respondents to better ensure a high level of preparedness and allow a rapid response for a future outbreak.

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Mitigating the Impact of Diseases Affecting Biodiversity - Retrospective on the Outbreak Investigation for Chytridiomycosis

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The worst disease affecting vertebrate biodiversity in recorded history is chytridiomycosis. It is thought to have caused the severe decline of up to 200 species of amphibians globally with many of these now believed to be extinct.

This provides a unique opportunity to develop methods that will help mitigate the impact that diseases have on biodiversity. An important component of mitigation is conducting an outbreak investigation.

We retrospectively examined the outbreak investigation conducted on chytridiomycosis to highlight the reasons for success as well as opportunities for improvement.

The investigation did not progress until a “One Health” approach was adopted approximately 14 years after the initial outbreak. This then led to analysis of the outbreak data by an epidemiologist and a tentative diagnosis of a novel pathogen spreading into naïve amphibian populations. The lack of belief that disease could cause population decline by wildlife biologists was one reason for this delay. Initial resourcing of the spreading pathogen hypothesis was inadequate requiring a PhD student to be recruited to undertake the investigation as the only possible option which meant progress was slow. There was also little expertise or baseline data to inform the investigation. Another key gap was not being able to readily adapt the outbreak investigation to new information.

Establishing formal networks, baseline knowledge and capacity in the wildlife health sector and providing a framework and resources for end users to engage experts to respond to outbreaks in real time are needed.

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Thinking Outside the Terrestrial Box: How High-priority, Emerging, and Zoonotic Marine Mammal Pathogens Reflect Those of Human Pathogens

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Emerging infectious diseases in marine mammals can reflect environmental, host, and pathogenic changes that may also impact human health. Emerging viral diseases among marine mammals have spread at rates many times greater than the highest epidemic spread rates in the terrestrial environments, demonstrating that the marine environment is particularly efficient at rapidly spreading novel pathogens. The marine environment, however, is often overlooked as a source of emerging zoonotic diseases. To better characterize marine mammal diseases and their associations with human health,

pathogens for small cetaceans (dolphins and porpoises), otariids (sea lions), and phocids (seals) were prioritized among 72 microbes based upon their likelihood of marine mammal exposures, illnesses, deaths, and epizootics. High priority pathogens were then assessed for their relevance to public health. The top ten marine mammal pathogens of interest were *Leptospira interrogans*, morbillivirus, parapoxvirus, herpesvirus, calicivirus, *Pseudomonas* species, West Nile virus, *Uncinaria*, *Toxoplasma gondii*, and *Pasteurella* species. At least 49% of all 72 pathogens were zoonotic, 17% were reportable human diseases in the U.S., and 28% were emerging human diseases. This is the first formal prioritization of pathogens among many marine mammal populations in relation to epizootic potential and human health. In conclusion, active surveillance of infectious diseases among marine mammals may not only facilitate animal conservation efforts, but may help document movement of pathogens between terrestrial and marine environments and enable prediction of ocean-based emerging diseases among humans.

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The Role of Avian Influenza Viruses in the Genesis of Mammalian Strains

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Aquatic birds of the world are recognized as the natural reservoirs of all influenza A viruses; they replicate predominantly in the intestinal tract and are spread mainly via fecal-oral transmission through the water. Intermediate hosts including pigs and turkeys are involved in transmission to mammalian species including humans. Studies with the highly pathogenic Asian H5N1 influenza viruses have demonstrated that live poultry markets play an important role in transmission between wild bird reservoirs and domestic poultry with the genesis of many different genotypes. Surveillance of apparently healthy aquatic birds and other domestic poultry in live poultry markets and pigs at slaughterhouses have provide important information in the genesis and evolution of both the highly pathogenic H5N1 and the 2009 H1N1 pandemic influenza viruses. Gene segments of influenza viruses from wild aquatic birds were passed to pigs apparently in Europe and in the Americas and a complex reassortant of Eurasian and American swine lineage viruses gave rise to the pandemic 2009 H1N1 influenza viruses.

The key unanswered questions include:

- Is highly pathogenic Asian H5N1 being perpetuated in wild aquatic birds and changing the established paradigm.
- Will the pandemic H1N1 and highly pathogenic Asian H5N1 viruses reassort and acquire high transmissibility.
- The need for a global surveillance system for influenza in apparently healthy pigs

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Spatial and Temporal Magnitude of Highly Pathogenic Avian Influenza (H5N1), Bangladesh, 2007-2009

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To determine the behaviour and magnitude of the progression of highly pathogenic avian influenza A subtype H5N1 virus outbreaks over space and time in poultry from 2007 to 2009 in Bangladesh, we systematically applied descriptive and analytical geospatial statistics. The descriptive analyses confirm that the magnitude of the second wave was the highest.

Exploratory mapping of the infected flocks revealed that the highest intensity and magnitude of the outbreaks was systematic and persistent in an oblique line that connects south-east to north-west through the central part of the country. The line follows the major poultry trading route in Bangladesh. Moreover, several migratory bird stopovers were identified along the line. Directional statistics revealed that the outbreaks were introduced in the south-eastern part of the country and followed a significant south-east to north-west direction of the epidemic progression. Survival analysis of time to the first outbreak describes the temporal evolution of the epidemic. We estimated that the highest number of the subdistricts to be infected at a given week was 15. This information is of practical value and could be useful to assess possible infectiousness at spatial scale and to estimate the resources required to address an outbreak with certain magnitude at a given point in time. In conclusion, the persistence of the line of magnitude and direction over the past 3 years indicates the necessity of mobilizing maximum resources not at random, but on this line to strengthen the existing surveillance particularly prior to and in the winter months.

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Pandemic H1N1 Influenza: One Health Discovery with Emphasis on the Veterinary Sector

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Following the emergence of pandemic H1N1 virus (pH1N1) in 2009 a unique scientific opportunity presented to study a zoonotic pathogen in the human-animal interface. Specific antigenetic data derived from ongoing swine surveillance programmes was utilised to gain insights into the origin of pH1N1 and define their relatedness to endemic strains of H1 influenza viruses in pigs. This data was utilised to guide development of assays for application to the veterinary sector for the detection of pH1N1 by the OFFLU community. A testing algorithm suitable for application to pH1N1 surveillance in animal populations was developed. The design of surveillance programmes took into account complicating factors such as potential absence of clinical signs, extended virus shedding in infected pigs and impact of prior influenza immunity. This information was important for the identification of appropriate and proportionate control measures that could mitigate against the spread of the virus both within the veterinary sector and through zoonotic infection. The widespread occurrence of influenza in pig populations since June 2009 was due to primary infection via contact with infected humans and secondary spread within pigs. Movement of virus in the interface between animals and humans in particular those occupationally exposed revealed transmission but the virus has not yet had sufficient time to genetically evolve independently from contemporary human strains, although further genetic diversity through reassortment has been detected. Scientific datasets from OFFLU relevant to the 'One Health' concept made an important contribution to the management and control of pandemic influenza.

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Overuse of Tamiflu® Could Result in a Pandemic with an Oseltamivir Resistant Influenza Virus - the Fate of Oseltamivir from a One Health Perspective

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Oseltamivir (Tamiflu®) is a key antiviral drug for influenza treatment and prophylaxis, and considered a cornerstone in pandemic preparedness plans. We present a broad, multidisciplinary approach to assess the effects of oseltamivir in the

environment including the potential to induce resistance in influenza viruses of dabbling ducks, the natural influenza reservoir.

We have found that the active substance of oseltamivir, oseltamivir carboxylate (OC), is poorly degraded in sewage treatment processes and in surface water. Furthermore, the substance was detected in river water in Japan during a seasonal influenza period, as well as in UK and Sweden during the recent A(H1N1) pandemic. Dabbling ducks, such as mallards, could thus be exposed to OC in aquatic environments. When mallards were infected with influenza A(H1N1) virus and exposed to OC at levels of the same magnitude as detected in the environment, we found evidence of resistance development.

In conclusion, our work describes how the active substance from a drug used by humans can enter the environment and potentially cause resistance development in animal hosts. As influenza can cross species barriers, the resistance could spread to human strains and result in a pandemic with an oseltamivir resistant influenza virus. We believe that our work demonstrates the use of the one health concept by investigating the interactions between humans, animals and the environment from several different angles. Our results further emphasize the need to apply this concept to deal with complex issues such as the fate of pharmaceutical agents.

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Analysis of Three Highly Pathogenic Avian Influenza Surveillance Systems of Domestic Poultry in Indonesia: SIKHNAS, INFOLAB and PDSR, 2008–2009

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Since 2003, three surveillance systems and databases of HPAI H5N1 were established in Indonesia including clinical surveillance database (SIKHNAS), laboratory surveillance database (INFOLAB), and Participatory Disease Surveillance and Respond (PDSR) database that has existed since 2006 specifically to capture HPAI from village poultry. These databases had not been previously evaluated collectively.

This study aimed to describe HPAI surveillance activities and situation during 2008 to 2009 in six districts and Bali province and to provide recommendations to improve national HPAI surveillance system.

Three databases were retrieved from MoA–FAO collaborating centre (PDSR) and MoA sub-organization (SIKHNAS and INFOLAB). The databases were descriptively analyzed taking into consideration their validity and limitation. Totally, 1,486 of 2,343 (63.42%) villages in the studied area were covered by PDSR, while 99 of 2,341 (4.23%) villages were included in INFOLAB databases. For PDSR, only 3 of 1,540 (0.2%) routine scheduled visits resulted in detection of infected villages. PDSR report visits, which were commenced in response to community reports of suspected cases, resulted in 154 of 238 (64.7%) detection of infection. PDSR reports had higher coverage, more consistent and timely than reports of INFOLAB and SIKHNAS. However, laboratory test results of PDSR were less reliable because they relied on results from rapid antigen test kits.

The results demonstrated that clinical notifications from communities were more effective than routine scheduled visits in finding HPAI cases. Hence, strengthening clinical notification from local communities could enhance HPAI surveillance. Information sharing among existing surveillance systems should be strengthened especially at local levels.

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Lessons from the Frontline on 'One Health' Approaches - H5N1 Highly Pathogenic Avian Influenza, 1997-2011

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Experiences with avian influenza viruses of the H5N1 subtype since their emergence in Hong Kong in 1997 provide insights into the successes and difficulties in application of 'One Health' approaches to diseases that cross the boundary between animals and humans. This paper explores the problems encountered with the initial diagnosis and management of highly pathogenic avian influenza (HPAI) caused by viruses of the H5N1 subtype, and the application of 'One Health' approaches to preventive measures introduced in Hong Kong from 1998 onwards. The paper also explores control and prevention programs implemented since H5N1 HPAI viruses spread to more than 60 other countries from 2003 onwards, including the merits of the initial response in South East Asia and issues arising from joint programs involving both Health and Agriculture Departments which, in practice, tend to operate as separate programs with minimal crossover. It examines the problems encountered in conducting surveillance for animal influenza, including the disincentives for disease reporting by farmers, the effects on livelihoods of changes to the way that poultry are reared and marketed, the huge benefits achieved by sharing of genetic information on influenza viruses, and the practical limitations of studies on wild birds and models constructed to assist in understanding avian influenza. Better disease investigations locally would arguably provide a much greater return on investment than these studies and would provide improved data on which better models can be built.

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A Sero-molecular Epidemiological Study of Pandemic H1N1 Influenza Virus Infection in Companion Animals and its Relevance to the One Health Initiative

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Influenza viruses remain a significant infectious disease of One Health concern. Avian reservoirs can provide sources of viral recombinants, but the role that companion animals play in viral evolution remains relatively unexplored. We reported the first confirmed case of pH1N1 influenza virus infection in an indoor domestic cat following presumptive human-to-cat transmission. This index case raised awareness of pH1N1 infection in household pets and initiated our ongoing sero-molecular epidemiological study to monitor infection rates and viral evolution at human-animal contacts.

This study utilizes RT-PCR, virus isolation, genome sequencing, ELISA and HI assays on pandemic and post pandemic samples.

Our study confirmed pH1N1 infection in four cats following apparent reverse zoonosis from humans. Clinical signs include lower and/or upper respiratory disease, lethargy and inappetance, 3-5 days following influenza-like illness (ILI) in contact humans. Importantly, radiographic and pathologic features of cats with pH1N1 pneumonia were consistent with small airway disease (bronchointerstitial pneumonia with severe alveolitis) and are very similar clinical findings in humans with severe pH1N1 infection. Detection of pH1N1 by real-time RT-PCR and virus isolation has proved diagnostic. In a multicat household and in our retrospective study, serology aided in the presumptive diagnosis of pH1N1 in eight cats.

This ongoing study continues to provide evidence of pH1N1 infection in atypical hosts and the discovery of an alternate animal model for influenza. Results reinforce the possibility of influenza evolution with human-companion animal contacts which may complicate preparedness plans and reinforces the need of the One Health Initiative.

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Characterisation of A(H1N1) 2009 Pandemic Influenza Viruses from Across the Human-Animal Interface in Australian Swine Herds

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The novel swine origin A(H1N1) 2009 influenza virus that caused the 2009 influenza pandemic is also able to infect a number of animal hosts. Outbreaks of A(H1N1) 2009 influenza in farmed swine continue to be reported to the OIE by numerous countries around the world. In July 2009 Australia was the third such country to report A(H1N1) 2009 influenza in farmed pigs. It was also the first report of swine influenza A virus in this country. Following the first outbreak, in NSW, two further outbreaks affecting pigs were reported in Victoria and Queensland respectively. Nasal swabs and other samples collected from infected pigs in these outbreaks were subjected to virus isolation and nucleic acid purification. Sequences of all eight genes of virus isolated from pigs confirmed high homologies to A(H1N1) 2009 viruses circulating in Australia. During the Queensland piggery outbreak, diagnostic specimens were also obtained from two farm in-contact persons who developed influenza like illness following onset of illness in pigs. Haemagglutinin gene sequences showed that viruses from each person were identical to viruses from different pigs, indicating that each person could have been infected by different pigs with distinct strains of A(H1N1) 2009 virus. Gene phylogenies could also distinguish viruses from the different Australian piggery outbreaks. Pyrosequencing of discriminatory regions of all eight genome segments also showed that reassortment had not occurred in viruses from these Australian cases. This study provided opportunity to examine A(H1N1) 2009 viruses involved in probable inter-species transmission between pigs and humans.

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Clinico-pathological Features and Risk Factors Associated with Rift Valley fever Outbreaks in South Africa, 2008-2010

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Rift Valley fever (RVF) is a zoonotic disease caused by a mosquito-borne virus of the family Bunyaviridae. Transmission of RVF to humans occurs through direct contact with the blood and tissues of infected animals, and less commonly through mosquito bites and unpasteurized milk. Most infections in humans are asymptomatic or present as a self-limiting influenza-like illness. Severe disease occurs in less than 1% of infected persons. Focal outbreaks of RVF in animals occurred in South Africa in 2008 and 2009 with an epizootic in 2010. The likely mode of transmission and clinical presentation and complications in affected humans are described.

There were 25 laboratory-confirmed human cases in 2008 and 2009. Encephalitis complicated disease in three of the cases, two of whom were HIV co-infected. All cases were farm workers or veterinarians and reported direct contact with animal tissue.

From February to August 2010, 237 laboratory-confirmed human cases and 26 deaths were associated with a RVF epizootic in South Africa. Data on occupation is available for 94% of the total cases, 82% worked in occupations where

direct contact with animals frequently occurs (e.g. farm workers, abattoir workers, meat inspectors and hunters). A minority of persons likely acquired disease through mosquito transmission or ingestion of unpasteurized milk. Observed complications of disease included haemorrhagic fever, encephalitis, hepatitis and retinitis. Control measures focused on health promotion to limit unprotected contact with infected animal tissue. Ongoing cases, however, occurred on farms due to difficulties with compliance with preventative measures.

While most disease associated with RVF is mild, severe and fatal illness does occur. It is important to explore appropriate ways to limit contact in the occupational setting. Close communication between veterinary and human health practitioners is critical to guide a combined response to outbreaks of RVF.

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Watching 'One's Health'

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Emerging infectious diseases (EIDs), most of which are zoonoses, continue to be a threat in the Asia Pacific Region. The World Health Organization has predicted that this region will be the most likely epicentre of any future EID pandemic. In particular Northern Australia is at risk of the introduction of exotic diseases because of its proximity to Asia and Papua New Guinea. The health and agriculture sectors both recognise the need to work together in preparing for and responding to EIDs in humans and animals where these have zoonotic potential. In this presentation the Department of Health and Ageing will consider several examples of zoonotic disease outbreaks and describe how information was shared to ensure the best outcome for Australia. Examples will include the discovery of Hendra and Australian Bat Lyssavirus, the Influenza A (H1N1) pandemic in people and pigs and jurisdictional and national responses to Hendra virus outbreaks.

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Zoonotic Diseases at the Animal/Human Interface in the Arctic

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In the Arctic, there is a close tie between native communities and animals, especially reindeer/caribou and marine mammals, both for nutrition and as an important part of the communities' culture. This provides an important human/animal interface and enhances the risk for transmission of zoonotic diseases.

To document the occurrence of (re)-emerging zoonotic diseases in the Arctic

Trichinella nativa and *Toxoplasma gondii* have extended host ranges. For example, polar fox (*Alopex lagopus*), polar bear (*Ursus maritimus*), walrus (*Odobenus rosmarus*) and bearded seal (*Erignathus barbatus*) have been found infected. Warble fly (*Hypoderma tandari*) infestation is very high in reindeer (*Rangifer tarandus*) in Fennoscandia. The prevalence of *Brucella pinnipedialis* in hooded seals (*Cystophora cristata*) is high and *B. pinnipedialis* was isolated from several organs in infected seals.

The life cycle of *T. gondii* is not known in the absence of a final host in the Svalbard archipelago where a stage of endemicity has been reached for *T. nativa* infection in polar bears. High prevalence rate of *B. pinnipedialis* infection in hooded seals may partly explain the drop in pup production as documented these last years in the absence of commercial hunting.

Acquiring *T. nativa* and *T. gondii* from the consumption of marine mammals remains a possibility. Ophthalmomyiasis caused by the reindeer Warble fly is documented. The zoonotic potential of *B. pinnipedialis* is unknown and needs to be studied.

All together these results highlight the importance of Arctic animals as reservoirs of zoonotic diseases for native communities in the Arctic.

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A Systematic Review of Zoonoses Transmission and Livestock/Wildlife Interactions

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Around 60% of all human pathogens are zoonoses and domestic animals and wildlife are of equal importance as reservoir hosts. Moreover, most emerging infectious diseases are zoonoses and most emerge from wildlife. There have been several recent initiatives to categorize zoonoses and their reservoirs but their socio-economic impact remains poorly defined and previous reviews lacked both poverty and gender perspectives.

We present the initial findings of a multi-disciplinary, systematic review commissioned by the Department for International Development (UK) to synthesize best available scientific knowledge about zoonotic disease transmission through direct or indirect domestic livestock/wildlife interaction, with emphasis on risk factors, drivers and trajectories of transmission, and promising interventions for controlling important zoonoses based on managing domestic livestock/wildlife interaction.

The review covers: zoonoses transmission and relative importance of the wildlife/livestock route; wildlife pathogens capable of recombining with analogous organisms in domestic livestock; risk factors and drivers for zoonoses transmission at the human/livestock/wildlife interface; historical changes in transmission and trends; livestock production systems as primary drivers of zoonotic disease load in the environment and role of wildlife as amplifiers, spill-over/indicator hosts and reservoirs; socio-economic, institutional and political factors influencing risk of transmission between wildlife and domestic livestock and from wildlife/livestock to people; risk management and control interventions and their success or failure with emphasis on interventions based on managing interaction between hosts (wildlife/livestock/humans).

This review summarizes best evidence on livestock/wildlife interactions and zoonoses transmission.

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The Burden and Diagnostic Challenges of Neglected Zoonotic Diseases of Bacterial Origin in Sub-Saharan Africa Through the Eyes of a Veterinarian

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Neglected tropical diseases affect an estimated 1 billion people, primarily poor populations living in tropical and subtropical climates. Mostly all low-income countries are affected by at least five neglected tropical diseases simultaneously. Amongst the noticeable risk factors worthy of mention involves a high level of interaction between humans and their livestock, and possibly wildlife as seen in poor economies in developing countries. Of all human pathogens, 60% are zoonotic and attributed to animals and unlike newly emerging zoonoses that attract the attention of the developed world, these zoonotic diseases which are often endemic are by comparison neglected. This is presumably a consequence of under-reporting, resulting in underestimation of their global burden. Their attenuated importance in the eyes of administrators and funding agencies has led to a reduced output in terms of research, diagnosis and reporting of these diseases. This paper attempts to evaluate the disease burden in humans and animals of two bacterial diseases-tuberculosis and brucellosis in Sub-saharan Africa as well as highlighting their health impact in humans. The effect of the diagnostic tools used as routine tools in the health sector Sub-sharan Africa will also be assessed versus the efficacy of these diagnostic tools. Factors which are indicative of these diseases as being underreported will also be highlighted and suggestions as well as recommendation will be proffered in the light of these two bacterial diseases. This review will highlight what has been published and is currently ongoing regarding NZD.

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The Current State of Knowledge of Zoonoses and the Implications for Research Outcomes in Disease Prioritization in Canada

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Zoonotic diseases are complex with the involvement of both animals and humans in disease transmission. Knowledge of disease transmission in animals is essential for an understanding of transmission in humans, and ultimately, for the control and prevention of human disease. However, significant research gaps exist within the current state of knowledge of zoonoses. This has considerable impact on research outcomes, particularly in disease prioritization. In order to prioritize diseases, it is necessary to make decisions based on scientifically valid information; yet disease prioritization to date has relied on the best available information that often lacks scientific evidence. Identifying these gaps would lead to an improvement in research outcomes.

To identify systematic gaps in the literature on epidemiological characteristics of zoonoses that can be used for their prioritization in Canada. In doing so, we highlight areas where further research can improve future prioritization studies.

6 focus groups identified 29 epidemiological characteristics of zoonoses relevant for disease prioritization. A systematic literature search was performed to identify and summarize literature on these characteristics for 63 zoonoses.

Research gaps were primarily identified in animal-related characteristics (68% of missing data), although significant research gaps were also identified in human-related characteristics. Most frequently missing was information on disease pathogenicity, incidence, immunogenicity, case-fatality and the duration of communicability and illness.

We identified gaps in the current state of knowledge of zoonoses in Canada for which targeted research in these areas will ultimately improve research outcomes in disease prioritization.

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Responding to Highly Pathogenic Avian Influenza - Surveillance in Indonesia

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Since 2003, H5N1 HPAI has spread to 31 out of 33 provinces in Indonesia, causing extensive poultry mortality, disrupting the livelihoods of millions, and killing over 100 people. It is now endemic in many areas. In response, Indonesia has received over US\$138 million from the international community of which some US\$23 million (2005 – 2009) has been disbursed by the UN FAO on developing a surveillance programme focused on free-ranging village or 'backyard' poultry: the Participatory Disease Surveillance and Response (PDSR) programme.

Emerging data however indicate that 'backyard' poultry represent the sentinel victim of infection, rather than the 'engine room' of disease dynamics. This presentation asks: why did PDSR focus on poultry smallholders and not the commercial sector?

It is argued:

- (a) FAO had to act quickly and so exercised their influence where they could;
- (b) Industrial corporations were extremely guarded in their participation;
- (c) FAO is not experienced in working with industrial corporations;
- (d) PDSR was imposed on Indonesia, and the project was driven to grow too rapidly;
- (e) The ethos of government, implementers and funders leaned towards supporting the poor;

- (f) Techno-scientific biases led to misplaced assumptions which were not challenged;
- (g) With humans at risk, implementation was distorted.

Technical and scientific groups responding to infectious animal diseases, especially zoonoses, must critically examine biases provoked by donors, client groups, and their own institutional cultures.

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Potential Spread of Highly Pathogenic Avian Influenza H5N1 by Wildfowl: Dispersal Ranges and Rates Determined from Large-scale Satellite Telemetry

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Our study combine experimental exposure data and telemetry based data to quantify the dispersal potential of pathogens associated with wild bird migration, with direct relevance to the management of the risk of spread of avian-borne diseases. In recent years, wildfowl have been suspected to contribute to the rapid geographic spread of highly pathogenic avian influenza (HPAI) H5N1 virus. We here evaluated the dispersive potential of HPAI H5N1 viruses by wildfowl through analysis of the movement range and movement rate of birds monitored by satellite telemetry, in relation with the asymptomatic infection duration measured in experimental studies. We analysed the first large-scale data set of wildfowl movements, including 228 birds from 19 species monitored by satellite telemetry in 2006-2009 over the main regions of Asia, Europe and Africa reporting occurrence of HPAI H5N1 viruses.

Our results indicate that individual migratory wildfowl have the potential to disperse HPAI H5N1 over extensive distances (up to 2900 km kilometres). However, the likelihood of such virus dispersal over long distances by individual wildfowl is low: we estimated that for an individual migratory bird there are, on average, only 5 to 15 days per year when infection could result in the dispersal of HPAI H5N1 virus over 500 km. Staging at stopover sites during migration is longer than the period of infection and viral shedding, preventing bird from dispersing a virus over several consecutive but interrupted long-distance movements. Intercontinental virus dispersion would be more likely through relay transmission between a series of successively infected migratory birds.

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Cellular Pathogenesis of Bluetongue Virus: Should we be Looking at the Host or the Insect Vector?

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Bluetongue is a disease of sheep and cattle caused by bluetongue virus (BTV), which is spread by culicoides midges. Not all midge species are competent vectors of BTV. Over the last decade, BTV has increased its range, with dramatic incursions in

Northern Europe in 2006 where it is now endemic. This has been facilitated by adaptation of the virus to new midge vectors that can survive the Northern winter and a link to global warming has been proposed. Despite the importance of insects in the epidemiology of the disease, many aspects of BTV replication and vector competence remain unresolved. We have used confocal and electron microscopy to investigate the relationship of the virus with mammalian and insect host cells. We have followed the infection process of BTV in sheep and correlated pathology findings with confocal imaging and shown that small capillaries in a number of organs including the skin (not previously reported as a site of viral replication) are an early site of replication of BTV. The role of the 4 non-structural proteins (NS1,2,3,3A) in mammalian and particularly insect cells is not clear. Our in vitro studies have shown novel interactions of NS2 with the cytoskeleton resulting in aberrant cell division. Future studies will focus on the insect vector using advanced imaging techniques and reverse genetics to generate novel probes (eg GFP-labelled viral proteins) to elucidate the replication process of BTV and the factors underlying vector competence. Results from these studies may be applicable to other virus/host systems.

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Biosecurity Intelligence-Gathering: An Analysis of an Avian Influenza Network

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Within the context of the Australian Government Department of Agriculture, Fisheries and Forestry (DAFF) work on animal and plant health work, intelligence-gathering covers a wide range of activities, including the collation of data and information on border and post-border detections, monitoring reports of pest and disease outbreaks overseas, and identifying, scanning and analysing emerging issues affecting animal and plant health and production. The focus of many of these activities is immediate — particularly border operations activities and changes in import conditions — but other animal intelligence-gathering and analysis activities focus on a medium to longer-term view.

A project with the Australian Centre of Excellence for Risk Analysis (ACERA) is evaluating existing animal biosecurity intelligence networks in Australia and overseas, including consideration of associated human networks. The project has undertaken a network analysis of an e-mail distribution list that shares open source information on avian influenza and has been operated by DAFF for six years.

The results of this analysis and its implications for biosecurity intelligence-gathering and analysis will be reported in this presentation.

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Urban Habituation, Connectivity, and Stress Synchrony: Hendra Virus Emergence from Flying Foxes (*Pteropus* spp.)

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Hendra virus (HeV) is a lethal zoonotic virus that has repeatedly emerged from flying foxes (*Pteropus* spp.) into horses and humans. Our ability to understand HeV dynamics in flying foxes has been limited by the Biosecurity Level IV

classification of the virus, and the logistical difficulty of temporal surveillance in migratory animals. With the aim of constructing hypotheses that can be tested in the field, we developed a spatially structured SEIR model of HeV in wild flying fox populations, and parameterized the model with field and laboratory data. Using our model we explored three hypotheses that could explain viral persistence in flying fox populations—metapopulation dynamics, long infectious periods and waning immunity—and compared model output to patterns observed in field data. To investigate potential drivers of HeV emergence, we examined the impact of recent changes to flying fox ecology, including urban habituation, declining migratory behaviour and the physiological impacts of pregnancy and nutritional stress. Urban habituation increased the number of flying foxes in contact with humans and horses while declining migratory behaviour decreased herd immunity, allowing more intense outbreaks to occur after viral reintroduction, an effect that was more pronounced using the metapopulation model of virus persistence. Nutritional stress and pregnancy have the potential to create “stress synchrony” which could lead to an increased risk of viral spillover. Finally we discuss the sampling protocols that will help us develop a mechanistic explanation for the sporadic temporal pattern of HeV emergence.

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On the Distribution of Henipaviruses In the Australasian Region: Does Nipah Virus Occur East Of the Wallace Line?

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The aim of this study was to investigate the occurrence of henipaviruses in fruit bat populations to the north and west of Australia.

Two hypotheses were tested:

- (1) That Nipah virus is restricted in distribution to west of the Wallace Line, and
- (2) That henipaviruses are restricted to Pteropus bat species in Australia and Asia.

Fruit bats were sampled from Australia, Papua New Guinea, East Timor and Indonesia (Sulawesi and Sumba) and were tested for the presence of antibodies to Hendra virus (HeV) and Nipah virus (NiV) with a subset being tested for the presence of HeV, NiV or henipavirus RNA by PCR. Evidence was found for the presence of Nipah virus in both *Pteropus vampyrus* and *Rousettus amplexicaudatus* from East Timor. Serology and PCR also suggested the presence of a henipavirus that was neither HeV nor NiV in *Pteropus alecto* and *Acerodon celebensis* from Sulawesi, and in *P. alecto* from Sumba.

These results suggest the presence of NiV in the fruit bat populations of East Timor on the eastern side of the Wallace Line and within 500 km of Australia. Clear evidence was also obtained for henipaviruses in *R. amplexicaudatus* in East Timor and in *A. celebensis* from Sulawesi.

This work contributes to management of the risk posed by henipaviruses in fruit bat populations to domestic animal and public health in the Australasian region. It also highlights the need for further work to determine the distribution and diversity of viruses in the Genus Henipavirus and their epidemiology in reservoir hosts.

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Integrating Nipah Virus Ecology in Pteropodid Bats into a Comprehensive Surveillance Program in Bangladesh

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Nipah virus (NiV) emerged in Malaysia in 1998 as a respiratory and neurologic disease in pigs and caused a severe febrile encephalitis in humans associated with a 40% mortality rate (n = 265). Ten Nipah virus outbreaks and several sporadic cases in Bangladesh (case fatality rate \approx 71%; n = 122) and two outbreaks in West Bengal, India associated with Nipah virus (case fatality rate \approx 55%; n = 96) have been reported since 2001. Serological evidence and viral isolates suggest that several genera of bats may become infected with henipaviruses. Bats of the genus *Pteropus* are considered a primary natural reservoir for Nipah virus and other related henipaviruses throughout a large part of their range, including regions where human infections have occurred. In Bangladesh, Nipah virus outbreaks in humans show a strong seasonal and spatial pattern. While domestic animal amplifying hosts may also play a role in human infection, several outbreaks appear to involve direct bat-to-human transmission, in some cases via a food-borne route. To characterize the spatial distribution and temporal dynamics of Nipah virus in *Pteropus giganteus* and the ecology of *P. giganteus* in Bangladesh in order to assess the risk of Nipah virus spillover to humans and livestock. Coordinated investigation of zoonotic agents in human, livestock and wildlife populations is important for assessing the risk of spillover from wildlife to human or livestock hosts. Preliminary data on Nipah virus in bats offers insight into risk management for spillover.

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Island Flying Foxes - an Insight into Hendra Virus Persistence?

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Island flying fox populations may provide a unique opportunity to better understand how henipaviruses persist in the natural host over time.

Epidemiologic studies suggest that, at a population level, Hendra virus exhibits a pattern of pulsating endemicity, with the infection status of any given sub-population at any given time determined by the proportion of 'resident' susceptibles, the presence or immigration of infected individuals, and the rate of immigration of additional susceptibles. This would seem to be a biologically plausible mechanism for maintenance of infection in a nomadic host that exists in a geographic mosaic of sub-populations, connected to a varying extent by vagrant individuals, groups or large scale movements. Interestingly, while epidemiologic analyses and experimental studies indicate that horizontal transmission is the primary mode of bat-to-bat transmission of Hendra virus, the possibility of recrudescence of latent infection in individuals followed by vertical and horizontal transmission has also been suggested by some data.

Might this indicate an evolutionary 'belt and braces' approach to long-term viral persistence that provides an alternative mechanism to 're-seed' infection under ecological conditions when contact between disparate sub-populations is inadequate? For infection to be persistent in small, closed island populations, there has to be an alternative to the meta-population model. We have recently sampled individuals from one island population (and expect to sample a second island population before December 2010) to determine the disease ecology of identified henipaviruses.

Evidence of infection will fundamentally change our understanding of infection dynamics, transmission and persistence in flying fox populations.

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Hendra Incidents Re-visit – What can we Learn from the History?

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Since first being identified as equine morbillivirus in 1994 as a result of an incident in which 13 horses and one human died, Hendra virus has made its appearance 14 times among horses and human population in Australia. Among these 14 incidents, 13 have occurred in Queensland and one in New South Wales. Past hypotheses have been proposed which have suggested that the spatial clustering of equine cases and the flying fox species biodiversity could be important determinants of the pattern of Hendra virus infection in flying foxes or the risk of spillover.

Due to the small number of outbreak incidents, it has been difficult to make robust inference regarding trends or associations among Hendra outbreaks. There have been reports or publications describing and discussing most of the Hendra incidents. However, we have now identified archived information relating to the cases which have not been published. This archived information is potentially an important piece of the puzzle with our increasing knowledge of Hendra virus transmission in recent years.

It is important that we re-examine the information gathered from all Hendra incidents during the past 16 years and to identify whether there are individual or common incident features, temporal and/or spatial patterns, environmental factors (such as climate, vegetation, etc) and any linkage to spatial distribution of flying fox. This paper will discuss the critical incubation period analysis, non-fatal case analysis and spatial analysis for the horse and flying fox population.

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Emerging Virus Infections of Bats: Old Relationships, New Paradigms

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Most human pathogens are zoonotic, that is they are naturally transmitted between humans and other vertebrates, and the majority of zoonotic Emerging Infectious Disease pathogens originate in wildlife. Bats are the putative origin of several relatively recent spill-over events leading to serious morbidity in people (HeV, NiV-M, NiV-B, SARS-CoV) as well as less severe human disease (MeV, Melaka virus). There are many knowledge gaps about associated emergence mechanisms and how these pathogens become established in people, but nascent understanding of these factors is beginning to guide the development of smarter surveillance strategies within identified emerging disease “hotspots”. However, it remains unclear as to what is the optimum mechanism for acquisition of meaningful surveillance data from viral reservoirs in which there may have been prolonged co-evolution of virus and host.

To assist this discussion, data has been assembled from a series of experimental studies conducted over several years in pteropid bats. Therein are described possible mechanisms of, primarily, HeV and NiV spill-over from bats, using homologous host/virus infection systems including a pregnant bat model. The study outcomes offer novel insights into the dynamics of such viral infections in bats, and raise important questions about mechanisms of persistence of zoonotic viruses in bat populations as well as interpretation of conventional surveillance data.

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Evidence of Henipaviruses and Lyssaviruses in Isolated Island Populations of African Fruit Bats

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The African straw-coloured fruit bat, *Eidolon helvum*, is a reservoir for potentially zoonotic viruses (henipa- and lyssaviruses) and a common source of bushmeat. We have determined through genetic metapopulation analyses that *E. helvum* exists as one large panmictic population with extensive gene flow throughout sub-Saharan Africa, with no evidence of segregation according to presumed migration routes. This population structure appears to have resulted in widespread seroprevalence to henipaviruses and Lagos Bat Virus. However, it is currently unknown whether isolated non-migratory populations of *E. helvum* in the Gulf of Guinea islands are also reservoirs of these viruses.

E. helvum bats were sampled on the islands of São Tomé, Príncipe, Bioko and Annobón to investigate further the genetic population structure and to assess the viral infection status of these populations. Island populations show genetic and morphological differentiation from continental populations. Interactions with human populations varied between each island, from co-habitation without hunting within large cities, to locations where bats are a favoured bushmeat species and roost far from urban populations. City residents may be at greater risk from aerosol-borne zoonoses, whereas hunters may be at greater risk from bat bites or blood-borne zoonoses. Serological analyses are currently underway to determine the seroprevalences to henipavirus and LBV in these island bat populations.

Investigating the ecology and potential reservoir status of *E. helvum* in closed populations could provide great insight into zoonotic viral infection dynamics and subsequent risks to public health.

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Identification and Inter-species Transmission of Australian Bat Coronaviruses: the Precursors for Emergence and Indications of Host Taxonomy Tropism Suggesting Co-evolution

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One hundred and eight (108) species of bats, representing 12 families and 43 genera, have been surveyed globally for coronaviruses. Coronaviruses have been identified in 36 of these species and anti-coronavirus antibodies have been detected in an additional seven. It is suspected that a previously unrecognized large diversity of coronaviruses is present in bats. The identification and characterisation of coronaviruses found in Australasian bats is essential to advance our understanding of this diversity and elaborate on the ecology and evolution of bat coronaviruses, and to inform global biosecurity preparedness. We tested 2,195 Australasian bats, sampled between 1997 and 2009 for evidence of coronavirus infection. We have identified four coronaviruses in seven species of Australian bats and detected anti-coronavirus antibodies in an additional 18 species from Australia, East Timor, Indonesia, Malaysia and Papua New Guinea. This evidence of coronavirus infection increases the known global distribution of bat coronaviruses into Australasia. We also identified the inter-species

transmission of a Group 1 Australian bat coronavirus from bats of the genus *Miniopterus* to *Rhinolophus*, which supports the hypothesis that *Rhinolophus* spp. may be more likely to foster host shifts than other species of bats and may pose a risk for the emergence of SARS-like and other bat coronaviruses. This inter-species transmission also indicates that we have detected the precursors required for the emergence of an Australian bat coronavirus; however, given the lack of evidence for the establishment of coronaviruses in Australian *Rhinolophus* spp., this appears unlikely.

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Henipavirus: From Emergence to Control

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The genus Henipavirus currently contains two members, Hendra virus (HeV) and Nipah virus (NiV), both of which are highly virulent zoonotic viruses responsible for more than 300 human deaths world wide. The first emerged in Brisbane, Australia in 1994. Since that time an ongoing scientific effort across a diverse range of disciplines has worked to answer the many questions that arise when a novel, lethal zoonotic pathogen emerges in the human population. In comparison to studies on other high profile emerging zoonotic agents, such as Ebola and SARS viruses, greater achievements have been made in a relatively short period of time for henipaviruses. A brief review will be provided in this presentation to summarise the work on pathogen discovery, molecular characterization, pathogenesis, natural reservoir host, novel diagnostics, vaccine candidates and human therapeutics. The successful story of henipavirus research demonstrates that rapid and effective response to the emergence of previously unknown zoonotic pathogens is achievable when a OneHealth approach is adopted at the very beginning, and open and transparent collaboration is an integral part of the multi-disciplinary investigation.

Pathogen Discovery and Early Detection

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Next Generation Surveillance? A metaviromic Study of a West African Bat Population Using Next Generation Sequencing

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Bats constitute a significant reservoir of pathogens that can spill-over and/or emerge in both animal and human populations. This is illustrated by past outbreaks of SARS-CoV and Ebola in humans, as well as Hendra and Nipah in humans, horses and pigs. A detailed characterization of the viral richness within bat populations is thus critical to determining the potential for the emergence of new and known viruses.

Next generation sequencing (NGS) technology has greatly enhanced sequencing capabilities (with respect to both depth and rapidity) and has proved a unique tool to detect previously uncharacterized viruses. We applied an NGS approach for the detection of viral genomic sequences from a population of African straw-coloured bats (*Eidolon helvum*) from Accra, Ghana, which roosts in close association with the human population, are consumed as bushmeat and harbour neutralising antibodies against Henipaviruses and type II Lyssaviruses. Nucleic acid was extracted and prepared for NGS from pools of urine, saliva and lung tissue, followed by sequencing on an Illumina platform.

By applying high-throughput sequencing technology to samples from bats we have identified numerous pathogen sequences (multiple bacteria and viruses), and will discuss the importance of these findings for our approach to and understanding of the process of viral emergence.

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Enhancing the Capability for Pathogen Detection and Surveillance Using Protein Microarrays

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Protein microarray technology is ideally suited to the identification of immunodominant antigens from complex microorganisms for the development of serodiagnostic tests or subunit vaccines. However, the technology also provides a platform for detecting antibodies against known immunodominant antigens of infectious disease agents. Current formats enable up to 14,000 proteins to be printed on a single chip, offering a multiplexing capability far exceeding that of any technology currently available.

To enhance the capability for surveillance of known viruses of bat origin, many of which are serious zoonoses, we developed a prototype chip containing thirty-one proteins representing eighteen viruses from five families and seven genera (including Hendra, Nipah, Ebola, Marburg, Melaka and rabies viruses, as well as SARS coronavirus and Australian bat lyssavirus).

Standard laboratory techniques including PCR, *in vivo* recombination cloning and an *Escherichia coli*-based *in vitro* transcription/translation system were used to generate recombinant proteins of interest. Proteins were printed, without the requirement for purification or concentration, onto nitrocellulose coated glass slides. Chips were probed with test sera and the captured antibodies quantified using fluorescently labelled conjugates.

Formatted for testing sixteen sera simultaneously, protein microarray chips were probed with well-characterised sera from various species, including bats from within the Australasian region. Analytical sensitivity and specificity were clearly acceptable, although testing of additional sera is required to establish robust assay performance characteristics.

Preliminary evaluation demonstrates the potential utility of the platform for undertaking large scale, population-based serosurveillance studies to detect infectious disease threats in any animal species.

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The Prevalence and Diversity of Astroviruses in Insectivorous Bats: Manifestation of an Unusual Virus-Host Interaction?

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The role of bats as the reservoirs for zoonotic diseases (Rabies, Hendra, Nipah, Ebola, the putative precursor of the SARS coronavirus) has been highlighted. Given that bats and rodents are the most diverse mammalian species, the observation that bats are prominent as a reservoir for a number of emerging infectious diseases may merely reflect this diversity. Alternatively, there may be an unusual virus-host interaction in bats that allows persistence and an opportunity for virus adaptation and recombination.

Our studies have shown that astroviruses (a cause of diarrhoea in many mammalian species) can be detected from many insectivorous bat species in Hong Kong and in China, with an overall detection rate of 44.9%. In Hong Kong, astroviruses were detected from 36% to 100% of *Miniopterus* bats in a single habitat during different seasons in a year. The genetic diversity of astroviruses in bats in this single habitat was remarkably high. The mean value of RNA polymerase gene

nucleotide sequence differences of astroviruses in *M. magnater* and in *M. pusillus* was 26.4% and 25.1% respectively. For comparison, a similar analysis for different serotypes of typical human astroviruses worldwide shows about 10-15% nucleotide difference. Taken together, these observations suggest virus persistence in the bat population, rather than repeated epidemic sweeps caused by successive novel astroviruses.

Overall, these findings reveal a previously unknown diversity of astroviruses in bats and suggest that, in comparison to other mammalian species (humans, rodents), that the virus-host interaction in bats is an unusual one.

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Laboratory and Molecular Epidemiological Aspects of the 2010 Rift Valley Fever Outbreak in Humans in South Africa

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Rift Valley fever (RVF) is a mosquito-borne viral zoonosis with severe health and socio-economic impacts. In 2010 South Africa experienced an intensive outbreak of RVF. We report the extent of the outbreak with special emphasis on laboratory and molecular epidemiology findings.

A total of 1378 serum specimens from suspected human RVF cases were tested during the period of February to September 2010 using virological, molecular and serological techniques. RVF virus isolates were subjected to partial sequencing of the M segment.

Of a total of 237 cases laboratory-confirmed, 85 (35.9%) were diagnosed by detection of IgM alone, 14 (5.9%) by PCR alone, 117 (49.4%) by PCR and virus isolation, and the remaining cases were diagnosed by either combination of the three methods. In some cases there was an evidence of recent infection with other arboviruses endemic to the country. Of 17 isolates recovered from representative cases all but two were most closely related to the 2004 Namibian strain of the virus.

The laboratory findings show the importance of using different diagnostic assays for laboratory confirmation of recent infection with RVF virus. Available sequencing data indicate that during the 2010 outbreak of RVF in South Africa, most cases resulted from infection with very closely related virus strains, however, compared to previous large outbreaks of the disease in the country, incidence and fatality rates in humans appear to be unusually high.

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Brucellosis: New Demands for Diagnostic Innovations to Aid Public Health in India

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Diagnosis of brucellosis in endemic country like India is routinely carried out by ELISA in cattle; RBPT and STAT in sheep and goats, pigs and human; and isolation and PCR in limited studies. In this study, separate indirect ELISA protocols have been standardized for sheep and goats, pigs and human, using smooth LPS antigen from *B. abortus* S₉₉. Random serum samples {sheep (n = 1702); goats (n = 2362); pigs (n = 1734) and human [n = 499 -comprising of 123 blood donors;

179 veterinarians and 197 having pyrexia of unknown origin (PUO)} from different states of the country were screened using the standardized indirect ELISAs. Prevalence percentage of anti-Brucella antibodies in pigs (22.43%), goats (5.14%), sheep (6.22%), and veterinary professionals (40.79%), patients having PUO (11.67%) and blood donors (4.87%) were recorded. To overcome the problem of using separate iELISA for diagnosis of brucellosis in each species, a common iELISA for both livestock and human using recombinant protein-G has been standardized. On comparative evaluation of 400 sera samples (50 each RBPT positive and 50 negatives from cattle, sheep and goats, pigs and human), the relative diagnostic sensitivity of the assay varied from 100% in pigs followed by 92% in both human and sheep and goats, and 88% in cattle. The relative diagnostic specificity ranged from 100% in human and cattle to 96% in pigs and sheep and goats. The study revealed prevalence of brucellosis in livestock, its transmission to humans in endemic regions is obvious and its implications are enormous. A common ELISA reported useful for screening both human and animals and aid the present diagnostic procedures in both veterinary and medical professionals and public health.

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A Real-time PCR Assay for Detection and Differentiation of Mycoplasma Species in Biological Samples from Various Hosts

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Some Mycoplasma species are considered pathogens in human and animal medicine, while others are considered opportunistic pathogens. Mycoplasma have fastidious growth requirements making detection difficult. We present the development, validation and utilization of a rapid, sensitive, cost effective SYBR real-time PCR (qPCR) detection assay for this genus.

PCR primers specific for this genus results in PCR amplicons of various lengths. Sizes and sequence of amplicons determine the melt temperature (TM) and melt profile following High Resolution Melt, thus allowing differentiation of numerous Mycoplasma species in many different hosts and/or organ systems.

The SYBR qPCR assay has equal sensitivity to conventional nested PCR assay for *M. bovis* and is able to detect 1 CFU *M. bovis* in the linear range of sensitivity, but has a detection limit of 0.1 CFU. Purified stocks of various mycoplasma species found in bovine, caprine, ovine, avian and porcine hosts are detected. Greater than 30 species and 300 plus clinical samples from various hosts and sample types have been tested to date. Occasionally testing results in detection of multiple species from one sample or discovery of novel pathogen.

Here we present a novel real time PCR assay that can detect and potentially differentiate all known Mycoplasma species tested thus far. Furthermore we provide examples of the utility of this assay in diagnosis, discovery, surveillance, control and eradication of Mycoplasma associated disease in multiple host species. This universal Mycoplasma detection assay truly represents an assay employable in the context of one health surveillance and represents a proof of concept for similar future assays.

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Bats and SARS Coronavirus

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Severe acute respiratory syndrome (SARS) was caused by a newly emerged and previously unrecognised coronavirus, now known as SARS coronavirus (SARS-CoV). In spite of the early success of etiological studies and molecular characterization of this new virus, efforts to identify the exact animal origin of SARS-CoV have been less successful. Although there was strong evidence suggesting infected masked palm civets as the source of human infections that precipitated the SARS

outbreaks, infection in this and other mammalian species in animal markets was more likely a reflection of an ‘artificial’ market cycle in naïve species. The discovery of SARS-like coronaviruses (SL-CoVs) in Chinese horseshoe bats in China has focused global attention on bats as the most likely natural host of the SARS-CoV responsible for the human outbreaks. In vitro studies on ACE2 molecules, a known functional cellular receptor for SARS-CoV, indicated that bats other than those in the genus *Rhinolophus* may also be susceptible to SARS-CoV infection, and hence could potentially act as the natural reservoir host. Based on these and serological studies of different bat species, infection experiments were conducted in the BSL4 animal facility at AAHL using two Australian species, *Rhinolophus megaphyllus* and *Pteropus alecto*. As predicted from the receptor studies, successful infection was established in *Pteropus alecto* in the absence of clinical signs. Further laboratory studies, in conjunction with more extensive field investigation, are required to provide insight into the elusive key first step of SARS emergence, the jump of SARS-CoV from reservoir species to an intermediate host.

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Virus Discovery Utilising Bat Cell Lines

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Bats are suspected to be the natural reservoir of a number of new and emerging zoonotic viruses including Hendra (HeV), Nipah, SARS-CoV and Ebola virus. Internationally, attempts to isolate viruses of bat origin using various mammalian cell lines have been largely unsuccessful. The primary focus of our research group has been on investigating the relationship between the highly pathogenic henipaviruses and pteropid bats since the discovery of flying foxes as the natural host of HeV in Australia. Recently, primary cell lines from four different species of bats (one pteropid and three micro bats) were established. These cell lines will be essential tools for our study of bat immunology and host-virus interactions. Here, we will present data to demonstrate that these cell lines are also very useful for isolation of both known and unknown bat viruses. These cell lines, in conjunction with improved sampling strategies in the field, has led to multiple isolation of HeV from bat urine samples collected in several locations across Queensland, including those associated with human and horse spill-over events. This is a significant outcome since, despite an intensive search over many years, there had only been one isolation of HeV from bat samples previously. This HeV-targeted surveillance program has also led to discovery of a number of novel viruses including paramyxovirus, herpesvirus and adenovirus. Our continuing investigation of virus infection dynamics in bats will improve the understanding of bat-virus interaction and, hopefully provide insight into the key factors which trigger spill-over events of bat-borne zoonotic viruses.

Wildlife Diseases and the One Health Paradigm

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Wildlife Networking in a One Health Space

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The Australian Wildlife Health Network coordinates more than 300 wildlife health professionals around Australia including federal and state conservation, agriculture and human health departments, universities, zoos, private practitioners and wildlife carers, hunting industries and diagnostic pathology services. This gives Australia a unique framework in the One Health arena; AWHN’s role is to improve communication and coordination between these stakeholders across jurisdictions: facilitating better investigation and management of wildlife health in support of human and animal health, biodiversity and trade. Core business is wildlife disease surveillance; AWHN manages Australia’s national wild animal health

database (eWHIS). Data from eWHIS contributes to Australia's National Animal Health Information System, and is used by animal and human health agencies to inform policy. AWHN is Australia's Wildlife Health Focal Point for the OIE, the international animal health organization and its data underpins Australia's reporting to the OIE.

This paper will discuss Australia's unique approach to surveillance of wild and feral animals, working within a federated system where each jurisdiction has responsibility for animal and human health within its borders. We will discuss how the AWHN works to engage private stakeholders in public policy, encouraging multi-organisational collaboration amongst federal, state, local government and non-government agencies.

Central to this is management of national wildlife health information within Australia. Rapid and timely access to information, and a network of wildlife health professionals, improves decision making by those in Australia and is crucial to enable coordinated response to disease incidents.

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Rinderpest Virus in Wildlife - a Valuable Lesson in Disease Emergence

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Rinderpest virus is believed to be extinct in nature. This is the result of a long and successful eradication campaign, based on strategic surveillance and vaccination of domestic bovids, globally. In Africa, the disease persisted for the longest in a mild form of infection in cattle, which spilled into wildlife populations in East Africa. This occurred on a regular basis causing severe disease, up to the beginning of the 21st century.

Rinderpest has lessons, pertinent to the increasing emergence of viral disease at the human, animal and environment interface. This paper describes a number of probable ecological and epidemiological factors that led to emergence and re-emergence over the decades, determined through examination of the wildlife indicators.

The changing landscape in Africa mirrors that which occurred in many other continents, resulting from an exploding human and domestic animal population. The roots of this change started in Africa in the 19th century. Population growth was accompanied by increasing contact between wild and domestic animals, according to season and concentrations of forage resources. Pathogen flow into wildlife was often traced to these seasonal activities and provided a window on the infection in livestock, and contributed to spread but not overall persistence. The reason being that landscape change has significant impacts on demographics of wild species, their behaviour and host potential. This was fortunate, in the case of rinderpest but this may not be so for an increasing number of infections with multiple hosts. Possible future scenarios for some important diseases, as contact rates increase, will be discussed in light of what we learnt from rinderpest.

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Brucellosis at the Rural Community and Wildlife Interface in Africa

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Brucellosis, a neglected zoonosis, is thought to be widely distributed in sub-Saharan livestock and wildlife. All mammalian livestock species are potential reservoirs, but the presence of brucellosis, particularly in sheep, goats and pigs, is rarely

demonstrated. Furthermore, it is not clear whether wild ruminants act as reservoir or spillover hosts and human brucellosis is rarely diagnosed among non-commercial rural communities.

To assess the presence of brucellosis and evaluate the risk of transmission between wildlife, livestock and humans in sub-Saharan Africa.

Brucella serological surveys were carried out in cattle, small ruminants and pigs in rural non-commercial livestock in Zambia, Kenya and on the border of the Kruger National Park (KNP) in South Africa.

There was no evidence of *Brucella abortus* in cattle bordering KNP in spite of clinical brucellosis reported in buffalo. Cattle brucellosis was found endemic in Zambia and Kenya. Cattle brucellosis was highly prevalent in pastoral communities in the Rift Valley. A small proportion of small ruminants in Zambia and Kenya were sero-positive, while a high proportion of Zambian pigs carried *Brucella* antibodies.

The absence of brucellosis in cattle bordering the KNP indicates there is no transmission from buffalo to cattle regardless of clinical cases reported in buffalo. In Zambia and Kenya, *B. abortus* was suspected to spill over from cattle to small ruminants whereas *Brucella melitensis* was probably absent. The high porcine brucellosis could result from bovine *B. abortus* spillover. Spillovers are indicative of a high circulation of *B. abortus* and thus a high zoonotic risk.

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Emergent Information and Communication Technology - Enhancing Wildlife Health and Biosecurity Outcomes

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Australia has been faced with a unique and unexpected series of wildlife disease emergence events. There has been remarkable commonality in the challenges faced and the recommendations made by those responding to these events. Ultimately, these events have improved our understanding of the cross-sector nature of risk posed by wildlife disease and have resulted in locally unprecedented research investment in the wildlife health sector.

There is now a greater recognition of the need to integrate wildlife health systems within national biosecurity structures and the need to invest in the underlying infrastructure and capabilities required to achieve a rapid diagnosis, to better understand the factors leading to disease emergence, and to better communicate the risks posed to biodiversity, primary industries and public health.

The Australian Registry of Wildlife Health has a 25 year history of operating a diagnostic service and national resource centre regarding the health and disease of free ranging wildlife. Through partnership with the Australian Biosecurity Intelligence Network (ABIN), a program funded through the National Collaborative Research Infrastructure Strategy, these resources have been brought into a secure, online environment to be more readily available to the research and biosecurity communities.

Through ABIN, wildlife and biosecurity professionals will gain access to a unique national collaborative environment to support disease diagnosis, surveillance, research and training activities. Specific examples will be provided regarding how this emerging infrastructure will be applied to improve disease detection and diagnosis, provide rapid alert mechanisms and create biosecurity intelligence (through mapping, tracking, predictive analysis, risk assessment, and risk prioritisation).

This project epitomises the One Health philosophy of sharing both information and resources across sectors and jurisdictions to better protect collective health, whilst at the same time providing a mixture of innovation, practicality, immediacy and achievability.

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Australian Bat Lyssavirus in Australia – an inter-sectoral “One Health” Approach to Disease Management

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Australian bat lyssavirus causes disease in bats and, on two occasions in the 1990 s, also caused a fatal meningoencephalitis in humans; there have been no reports of disease in other animals resulting from ABLV infection.

Data on bat diseases in Australia have been collected under the Bat Surveillance Project Australian Wildlife Health Network since 1996. The data have informed understanding of the potential risks of ABLV to human and animal health and the development of relevant animal and public health policy.

In Australia human rabies immunoglobulin (RIG) is used as part of an ABLV post exposure treatment protocol. In recent years there has been increased demand for RIG for post exposure prophylaxis of Australians exposed to potentially rabid animals while overseas. There is now considerable pressure on this increasingly scarce resource.

This paper discusses the commitment of Commonwealth and State Government health and wildlife agencies to a ‘partnership’ approach under the One Health” concept, relating to the use of scarce therapeutic resources, and national surveillance capabilities for diseases emerging from wildlife, many of which affect trade, human health and biodiversity.

Integrating Surveillance Systems

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EpiCollect – A Mobile Phone/Web Application Framework for Epidemiological Data Collection and Visualisation

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EpiCollect is a generic smartphone/web data collection tool that allows the collection and submission of geotagged (using the phones GPS) data forms (along with photos) to a central project website (hosted using Googles AppEngine) from suitable mobile phones (Android or iPhone). For example, questionnaires, surveys etc ^[1,2].

All data synchronised (ie a copy sent from the phone to the central website) from multiple phones can then be viewed/ charted/filtered at the project website using Google Maps/Earth or downloaded. Furthermore, data can be requested and viewed/filtered from the project website directly on phones using Google Maps.

Multiple projects can be undertaken on the same phone with data sent to one or many central servers. We provide a simple, intuitive on-line form builder at epicollect.net for the definition of form fields and project websites hosted using Googles AppEngine, however data can be sent to other servers easily.

More complex form descriptions and server locations can be defined within an XML project file which allow multiple table questionnaires, form validations and the specification of data fields such as ‘video’ ‘photo’, ‘barcode’ and the linking, via Bluetooth, to external devices offering a very flexible framework for questionnaire based projects.

We will demonstrate the ease of setup and submission of data to a project and demonstrations of the current use of EpiCollect will be given with a focus on One Health. For example, the monitoring and evaluation of preventative chemotherapy interventions for Neglected tropical Diseases, use within surveillance of animal diseases in Africa and work undertaken with the Southern African centre for infectious disease surveillance (SACIDS).

1. Aanensen DM, Huntley DM, Feil EJ, al-Own F, Spratt BG (2009) EpiCollect: Linking Smartphones to Web Applications for Epidemiology, Ecology and Community Data Collection. *PLoS ONE* 4(9): e6968
2. <http://www.epicollect.net>

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Contrasting Features and Opportunities for ‘One health’ Infectious Diseases Surveillance System in Tanzania

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A study was undertaken to assess infectious disease surveillance and preparedness analysis across the public and animal health sectors in Tanzania, focusing on two districts. This was undertaken by rapid situation analysis, field surveys and the identification of the location of surveillance points by GPS and the next-generation Android driven mobile telephones. Analytical mapping was undertaken using EpiCollect, Google-earth and ArcView. Although there were unique sector specific issues, the surveillance and reporting hierarchy was similar for the two sectors with the district being the hub. Both sectors had vertical programmes surveillance systems which were centrally coordinated from Ministry Headquarters. In the public health sector, the focal point for disease surveillance was a health-facility and the surveillance system was based on the IDSR model, by which the 13 priority diseases were categorised into 3 groups. The frequency of disease reporting depended on the category of the disease. For the animal health sector surveillance was community based and priority diseases were categorised into 4 groups. The response in the public health sector was a function of the district medical office whereas for the animal health sector it was vested with the zonally-located veterinary investigation centres, which on average cover some 20 districts. There was no formal, routine collaboration between the two sectors although in the case of disease emergencies such cross-sector collaboration was readily triggered. A new protocol is being developed with the collaboration of the two sector Ministries for One Health surveillance. Mobile technologies are being employed as the technology enablers.

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The Russian Anti-Plague System: An Overlooked Zoonotic Disease Surveillance and Response System

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In the past decade, there has been increased recognition of the need to address diseases at the human–animal interface. The United Kingdom’s Foresight report of 2006 stated that the increasing threat of zoonoses requires better integration between

human and animal disease research and surveillance. A 2009 study by the Royal Society stressed that a more integrated approach to infectious diseases would lead to overall improvements in public health and decrease response times to major outbreaks. However, another recent report by the Institute of Medicine (USA) was unable to identify a single example of a well-functioning, integrated zoonotic disease surveillance system across human and animal health sectors.

This statement is not entirely accurate. While it may apply to countries in the West, it overlooks the fact that Russia and the central Asian states have had a formal zoonotic disease detection and response system for many years. The AntiPlague System, which was established in response to the threat of plague but which now covers all “especially dangerous pathogens” (EDPs), has features worth review. Although the system has fallen on hard times since the collapse of the Soviet Union, it still has well defined reporting and response systems and mandatory training programs in the recognition of zoonotic threats and legislation. This unique approach to zoonotic threats might inform efforts in other countries as they struggle to develop their own systems and will be reviewed.

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MAX: An Innovative Software Tool for Emergency Disease Response

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Biosecurity Victoria has developed and implemented MAX (Maximum Disease and Pest Management) as a software tool for the total management of disease outbreaks.

The system manages epidemiological data from the disease outbreak, records of response activities, task tracking, staff deployment and analytical outputs in a paperless environment. MAX can be deployed within response control centres and is also accessible via intranet to senior managers and others outside of the control centres, allowing all concerned to keep up to date with all events related to an emergency response.

Data input is rapid and easy and learning curves for users are short. Outputs are provided in the form of queryable tables and interactive maps.

The MAX management system is integrated with Biosecurity Victoria’s property and disease surveillance databases, and with the National Livestock identification System (NLIS). Progress of a disease outbreak and control actions can be mapped, as can cattle movements into and out of an outbreak area.

MAX represents a new approach to disease control in that it (a) allows for paperless operation of control centres (b) is integrated with property and disease surveillance databases to allow for spatial and temporal analysis of an outbreak (c) provides reports and analysis across a wide range of disease response activities and (d) provides visual displays of cattle movements which enhance disease tracing.

Biosecurity Victoria has successfully deployed MAX responses including: Anthrax and H1N1, in various plant pest/disease outbreaks, and in a large-scale foot-and-mouth disease simulation.

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Socio-Economical Evaluation of Surveillance Systems for Emerging Animal Diseases: Merging Veterinary and Public Health Issues

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Surveillance and control of transboundary animal diseases remains a major challenge for animal production in developing countries. This has become a major public health issue for the developed world with the SARS episode in 2003 and again recently with the threat of pandemic influenzas. Innovative methodologies are greatly needed to evaluate the socio-economical added value of animal disease surveillance adapted to the specific socio-economic contexts of the developing countries. This should come with the integration of modeling (risk-based surveillance; spatio-temporal immunity levels), socio-economy and epidemiology. Since the emerging and endemism of avian influenza H5N1 subtype in several countries in South East Asia, surveillance networks have been setup and are running but the outcomes of such investments (financial and human resources) have not been carefully evaluated. The objective of our research programme is to develop a novel methodology to evaluate the socio-economical added value of animal disease surveillance and more especially H5N1 surveillance network in South East Asia. In order to do so we apply and integrate different methodology based on social sciences (Social Network Analysis (SNA); participatory approaches), public and animal health economics (DALYS, QUALYS, cost-effectiveness and cost-benefit methods) and epidemiology (risk analysis, spatial modeling). Results such as the use of SNA to evaluate the role and positioning of the different actors of the surveillance network will be presented and discussed during the conference. Such study allows the understanding of interaction between actors and the benefit they get with the outcomes of the surveillance network. The aim of this work is to provide valuable tools to decision makers to help them evaluate the best surveillance program to implement within their animal disease risk management policy. Extension off this work to evaluate the socio-economical added value of intervention programs (e.g. vaccination) is ongoing.

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Healthscapes: A Web Platform for Integrating and Analyzing Health and Environmental Data Across Scales

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Open, interdisciplinary access to crosscutting tools will be necessary to improve our understanding of the health connections between wildlife, livestock, and humans. The flow of information is often limited by a lack of tools to integrate datasets, maps, and knowledge across scales. Advances in database-driven web design and mapping technologies (neography) present new opportunities for navigating and sharing data, participating in collaborative analysis, visualizing complexity, and creating new social networks among researchers.

We are developing healthscapes.org—a web service for global environmental health research. This is an open, community-driven initiative intended to address three principal challenges: 1) difficulties identifying relevant data in the midst of plenty, 2) barriers to the exchange of analytical tools across disciplines and regions, and 3) poor knowledge transfer across fractured research networks.

Our goal is to facilitate access and sharing to environmental data and analyses among global health researchers, towards an improved understanding of the environmental determinants of disease. Our web service uses adaptive algorithms, powered by the scientific literature and recommendation engines, to connect researchers with relevant data; provides customizable visualization tools for analyzing data on the fly; and helps build social networks among users on the basis of common interests, such as statistical methods, regions, or diseases.

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The Use of Information and Communication Technologies in the Integration of Disease Surveillance and Outbreak Response Systems

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A comparative analysis of the Democratic Republic of Congo (DRC) disease surveillance and outbreak response systems shows a lack of connection between human, livestock and wildlife health systems. Within each system, shortcomings have been identified. Insufficient number of qualified and motivated human resources, lack of funding, absence of legal frameworks and operating procedures and poor information collection, processing and sharing mechanisms characterize the three systems.

Challenges stemming from zoonotic disease threats such as avian influenza, monkey pox and rabies and the implementation of the revised WHO guidelines for Integrated Disease Surveillance and Response (IDSR) offer an opportunity to revisit the role information and communication technologies could play in connecting and improving the performance of human, livestock and wildlife epidemiological systems in DRC.

This paper presents a comparative analysis of DRC human, livestock and wildlife disease surveillance and response systems. It highlights opportunities and challenges for the introduction of information and communication technologies to enhance intersectoral linkages and improve the collection and flow of data and information within and across systems. The Rwandese experience in the introduction of wireless telephone and the internet for HIV/AIDS data collection and sharing is used to draw similarities and potential pitfalls. The authors conclude that information and communication technologies are one of the solutions to improve and integrate disease surveillance and response systems. However, the introduction process requires careful planning, appropriate selection of technologies, consensus building within and across sectors to establish sustainable systems and avoid cost overrun and delays.

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Comprehensive Analysis of OIE World Animal Health Data as a Means to Identify Global Disease Trends

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OIE member countries' animal health reports are published by OIE. This data set is the most comprehensive of its kind and in fact the only one of near-global reach and uniform data format. Nevertheless, this important source of information has been vastly underutilized, mainly because the data are very fragmented, but also due to a potential reporting bias resulting from countries' different levels of reporting transparency and competency.

We have analysed WAHID data for the years 2006 – 2008 (update with 2009 data in progress at time of submission) from 176 countries on 71 livestock diseases, and transformed them into losses of livestock units (LSUs) for comparability. In total, the scope of the analysis comprises more than 2 million data points.

The three diseases that have claimed the largest losses are highly pathogenic avian influenza, echinococcosis and enzootic bovine leukosis.

Of all the LSUs lost to the diseases taken into account, 46% came from poultry, 38% from cattle, 10% from swine and 5% from small ruminants. Overall, 801'155 LSUs per year were reported as lost to one of the 71 diseases, thereof 53% to zoonotic and 47% to non-zoonotic diseases.

The presentation will aim to familiarize the audience with the analyses that can be run on this database including rankings of losses by country, by species or by disease, as well as changes over time (to identify emerging hot spots) and trends in geographical distribution.

(OIE is not responsible for any inaccuracies or misinterpretation of the analysed OIE data and information.)

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Ensuring Biosecurity, Food Safety and Food Security During Animal Disease Outbreaks: U.S. Proactive Risk Assessments and the Secure Egg Supply Plan

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Emergency response management for zoonotic disease outbreaks such as highly pathogenic avian influenza (HPAI) often involves several different priorities, including protecting animal and human health, food safety and food availability. Disease control measures including livestock and poultry quarantines and commodity movement restrictions may disrupt market continuity and food security. In the case of egg production, facilities often do not have sufficient capacity to store eggs or egg products for prolonged periods. The U.S. Department of Agriculture is working proactively to ensure products and animals move securely and safely during animal disease outbreaks. The U.S. Secure Egg Supply (SES) plan is one such initiative to ensure food availability, food security and animal health protections through continuity of business planning. The SES plan includes proactive risk assessments performed prior to any HPAI outbreak to facilitate timely permitting decisions for egg or egg product movements during an outbreak. In this paper, we discuss the benefits of the One Health approach to HPAI emergency response planning based on the SES plan and the proactive risk assessments. The active surveillance, movement control and product specific biosecurity components of the SES plan provide a high degree of confidence that eggs and egg products from HPAI control areas are not contaminated and support animal disease control and food safety. The HPAI disease transmission models used in the proactive risk assessments are consistent with and developed in collaboration with an inter-agency workgroup for public health risk assessment for consumption of HPAI contaminated meat and eggs. This approach, combining production biosecurity, food safety and security, and animal health emergency response demonstrates the importance of coordination of risk management and risk mitigation decisions across multiple agencies and disciplines.

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Connecting Health Organizations for Regional Disease Surveillance (CHORDS): Transforming International Dialogue to Counter Biological Threats

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Regional and sub-regional infectious disease surveillance networks have demonstrated that even in parts of the world historically or currently rife with conflict, veterinary and public health officials from neighboring countries can come together while preparing for emergency situations and successfully coordinate efforts to prevent the spread of infectious disease when the threat comes true.

An ambitious new global initiative known as CHORDS: Connecting Health Organizations for Regional Disease Surveillance is a non-governmental platform where regional infectious disease surveillance networks across the globe engage in dialogue both with each other and with the WHO, OIE, FAO and other partners to strengthen core capacities in surveillance.

CHORDS is a One Health focused global partnership of regional disease surveillance networks concerned with enhancing local capacity to counter infectious disease threats. CHORDS convenes and supports networks in a “community of practice.” Through this social fabric of experts and by serving as a platform for dialogue with WHO, OIE, and other partners, CHORDS is creating a global architecture for responding to epidemics and biothreat events – one that is built on a foundation of trust and social capital, making it different from any other global infectious disease surveillance network.

CHORDS has achieved early success by facilitating and initiating multisectoral dialogue between networks in Southeast Asia, the Middle East, and Africa. CHORDS has the potential to grow into a very powerful mechanism for collectively building national and regional infectious disease surveillance capacity and, by doing so, strengthening global health security.

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Establishing a Virtual Microscopy Laboratory Network Through the Australian Biosecurity Intelligence Network

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The creation of a virtual microscopy laboratory network and a supporting animal disease knowledge repository is a proof-of-concept project of the National Collaborative Research Infrastructure Strategy to establish the Australian Biosecurity Intelligence Network (ABIN) for on-going use.

The project is networking sites around Australia with the necessary components to allow disease diagnosis and surveillance collaboration within and between sectors, including the animal, aquatic, wildlife and plant sectors. The components include a microscope camera connected to a workstation with access to video-conferencing, collaboration space and a web portal to integrated knowledge repositories. The workstations are deployed in multiple facilities allowing access by scientists from across sectors, underpinned by ABIN’s secure online infrastructure and tools.

Scientists using the using the virtual microscopy laboratory network are able to:

- Capture and share real time microscope images in a peer-to-peer or group context.
- Communicate and collaborate, from their work place, in a virtual environment and shared workspace, using video-conferencing and collaboration platforms.

When used in conjunction with the knowledge repository they are also able to:

- Access, share and add to information on disease surveillance through disease profile and image reference collections, standards for testing, registers of expertise and research related activities.
- Analyse disease surveillance laboratory accession data using a variety of tools including mapping technologies.

The project is creating a unique national collaborative environment to support disease diagnosis, surveillance, research and training activities across biosecurity sectors. The project will integrate with existing virtual microscopy initiatives in Australia and other ABIN proof-of-concept projects (<http://www.abin.org.au/projects>).

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Assessing Seasonality of Vectorborne and Zoonotic Infectious Diseases

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Environmentally sensitive infectious diseases typically exhibit strong seasonal patterns with a series of outbreaks followed by low endemic levels. Occasionally, the period of low incidence contains secondary peaks of small magnitude which are difficult

to detect using traditional methods. Although seasonality is a well-known phenomenon in the epidemiology of numerous infections, analytical tools for systematic examination, evaluation, and comparison of seasonal patterns are limited.

The goal of this communication is to demonstrate tools available for assessing seasonal patterns of infections, with particular emphasis on the estimation of multiple annual peaks. To demonstrate these techniques we compared the seasonality of seven vectorborne and/or zoonotic infections as reported to Australia's National Notifiable Diseases Surveillance System. We applied a Poisson harmonic regression model with polynomial components to capture non-linear trends, and estimated major seasonality characteristics (peak timing, amplitude, duration) and their confidence intervals using recently introduced delta-methods. We explored the potential synchronization of seasonal peaks across years and infections.

The proposed models explained 53% to 90% variability in seasonal patterns with the lowest value being observed for leptosporidiosis and the highest for cryptosporidiosis. We also detected very specific oscillations in dengue with 5-7 year periodicity compounded by increasing seasonal peaks, suggesting that seasonal variability in the probability of exposure combined with a partial immunity may add to the complexity of seasonal patterns.

The findings illustrate how comprehensive and systematic seasonality assessments enrich our understanding of how multiple outbreaks occurring within a relatively short interval form seasonal patterns typical for a specific pathogen.

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The World Small Animal Veterinary Association One Health Committee: Positioning Animals in Global Infectious Disease Surveillance

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To date the One Health concept has focused largely upon the interactions between human and production animal health against a background of wildlife disease and environmental change. The global significance of small companion animals (principally dogs and cats, but also including birds, fish, rabbits and other small mammals, and increasingly farm pets and poultry) and the integral relationship between man and pets has not been fully appreciated. The World Small Animal Veterinary Association (WSAVA) represents approximately 75,000 small animal veterinary practitioners in 80 countries through an Assembly of national representatives. In 2010, the WSAVA formed a One Health Committee to highlight the significance of the small companion animals in One Health and to develop strategies to impact upon infectious and zoonotic disease surveillance in these species. The keeping of pet dogs and cats occurs on a vast scale in developed nations, but is also commonplace in developing countries where there is closer interrelationship between these species and wildlife and domestic production animals and poultry. Additionally, many developing nations face the vast public health issues related to stray dog and cat populations. These companion animals are closely integrated into family units worldwide and share the human domestic environment. There is already clear recognition of the importance of small companion animals as reservoirs for major zoonotic diseases such as rabies and leishmaniosis. However, the potential for these pet animal species to act as reservoirs for many emerging zoonoses is not fully appreciated. For example, the cat has been shown to be susceptible to SARS coronavirus, and both H5N1 and H1N1 influenza virus infections, and has the potential to act as a mammalian species for influenza virus reassortment, leading to novel human infections. Companion animals are also susceptible to infection by West Nile virus, Nipah virus, Hendra virus and others. The risk of emergent zoonotic infection in companion animals is now compounded by the unprecedented increase in the global movement of these species through international pet travel schemes. The WSAVA One Health Committee has a unique opportunity to impact in this area. The WSAVA Assembly provides the means of rapidly disseminating electronic information to a global network of frontline companion animal practitioners in all areas of the world. This communication network may prove invaluable in educating and advising in the face of any global infectious disease pandemic involving a companion animal reservoir. For this reason, the WSAVA One Health Committee includes representation from the CDC and OIE. More importantly this global network may act as an international disease surveillance network-providing early warning of disease clusters through national representatives back to the One Health Committee. Establishment of an effective global companion animal infectious disease surveillance network would require major investment, but should remain a key goal of the One Health community.

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Can My Database Talk to Your Database? Why Data Standards Matter, But Implementing them Matters Even More

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Health data – whether it be diagnostic, surveillance, research or biosecurity related, exists in multiple diverse databases and other record keeping systems that are typically integrated poorly or not at all.

While the general importance of linking data sources is commonly recognised, practical and useful outcomes are less than common. There is an increasing need to coordinate and link data sources not only within sectors, but across diverse sectors and knowledge domains.

At the same time, getting broad agreement to, and implementing, data standards is a complex and time-consuming process that presents a considerable up-front barrier to successful integration.

The STARS project, working with ABIN, is linking laboratory databases across the Australian animal health sector. It is also extending the linkage framework to non-laboratory databases and to other data repositories relevant to animal health.

Recognising the challenges in establishing firm data standards across a heterogeneous range of data sources and owners, the STARS project takes an agile and flexible approach to the challenge, working on two key fronts:

1. Establishing standards by, as appropriate:
 - Adopting or adapting existing standards
 - Codifying existing agreements and processes as standards
 - Establishing new standards by consensus from existing systems
2. Simultaneously providing a translation layer to enable systems that have varying levels of compliance to the standards to communicate effectively.

This approach provides a rapid path to implementation so that the system can achieve key functional goals early, while the details of the data standards can evolve towards true integration over time.

Predictive Modeling

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Emerging Zoonosis: The Dutch Approach

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In the Netherlands, a small country which is densely populated with people and animals, extensive monitoring and surveillance were already present in public health and food production animal chains, but interaction between both domains has recently been intensified. A large programme has been executed to describe all public and veterinary surveillance systems, to compare diagnostic techniques, and to identify diagnostic “gaps”. In the programme several institutes participated: the Faculty of veterinary medicine, the Central Veterinary Institute, the Animal Health Service, and the Centre for Infectious Disease control. The programme was funded by the Ministry of Agriculture, Nature and Food quality and has led to several initiatives to improve veterinary and public health systems.

For example, a dynamic web-based tool has been developed as a prioritising tool for (emerging) zoonotic diseases. Also, a formal signalling structure was initiated in which veterinary and public health professionals exchange (confidential) information, and a specific communication tool for veterinarians and public health professionals was developed. Several recommendations were defined such as: develop a specific “rodent-surveillance”; develop a syndromic surveillance system in companion animals and horses. Important issues in the programme were: the combination of public and private domains, communication with several stakeholders, how to proceed with confidential information, and funding. During the process, it appeared that mutual understanding of the different stakeholders was of utmost importance. Experiences of this process, milestones and pitfalls will be discussed.

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One Health in NSW – Human and Animal Health Sector Management of Zoonoses of Public Health Significance

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Zoonoses of public health significance may occur in wildlife, livestock or companion animals, and may be detected by the human or animal health sector. Of particular public health interest are endemic food-borne zoonoses, diseases transmitted from living or dead animals, diseases spread between animals and humans by insects, and emerging zoonoses (known and unknown, endemic and exotic). The animal health sector is primarily concerned with minimising any adverse impact of zoonoses on productivity and trade, particularly emerging zoonoses through use of biosecurity measures. A coordinated One Health approach is necessary for management of zoonoses to give the best outcome for both sectors.

Management of zoonoses by the human and animal health sectors in NSW was reviewed.

Mutually agreed policies and procedures for detection of, and response to, zoonoses of public health significance are in place in both the human and animal sectors in NSW. Jurisdictional and national notification systems are used by both sectors to monitor occurrence of defined endemic and exotic diseases, including zoonoses, and to comply with international reporting requirements.

Regular strategy meetings are held between the sectors to ensure currency of response plans, which are tested in periodic joint exercises. Communication between the sectors during a response ensures effective management and reduces any potential conflict due to the different interests of each sector.

A coordinated One Health approach by the human and animal health sectors in NSW is effective in management of zoonoses of public health significance, and ensures the different interests of each sector are addressed.

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Rabies Control in Rural India: A Model-based Assessment of Mass Vaccination Strategies

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Most regions of the developing world have large, poorly supervised and mostly unvaccinated dog populations, which provide suitable conditions for the persistence of enzootic canine rabies. Mass dog vaccination has been the mainstay of successful canine rabies control programs and the World Health Organization recommends vaccination coverage of 70% or higher to prevent epidemics and eliminate endemic rabies. In a developing country like India, it may be logistically difficult to repeatedly access a large population of free-ranging dogs so as to provide and maintain the recommended 70% vaccination coverage. It is therefore desirable to set realistic region-specific targets for vaccination coverage to ensure sustainability of rabies control programs.

We used a modeling approach to assess mass vaccination strategies for rural dog populations. As majority of the human rabies deaths in India occur in rural areas, we have structured our model on data from rural Indian dog populations. We analyzed effects of dog density, frequency of rabies introduction and vaccination coverage on canine rabies incidence.

Based on our model outputs, we recommend setting an achievable target ($\sim 25\%$ coverage) for rural dog populations for control of canine rabies, and therefore human rabies. Eliminating the dependence on 'outside help' for achieving and sustaining the necessary vaccination coverage could be an incentive for community involvement in rural areas, where more than 90% of the human rabies deaths occur.

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Integrated Assessment of Brucellosis Prevalence and Cost of Disease in Kyrgyzstan

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Since the end of Soviet Union, Kyrgyzstan has one of the highest brucellosis incidence worldwide, 74 per 100 000 (2007). The main concern is to identify and plan strategic operations that effectively reduce the occurrence and the burden of the disease in humans and animals. The cost estimate of brucellosis to the Kyrgyz economy was undertaken in 2006-2007 within an international scientific partnership.

A representative and cross-sectional study on the sero-prevalence of brucellosis in humans ($n = 1800$), cattle, sheep and goats ($n = 5369$) was simultaneously undertaken in cooperation between public health and veterinary services. Three different serological tests were used in human and animal and complemented by a socio-economy household questionnaire on livestock production and a patient based survey on the cost of brucellosis. Cost estimates were made using the FAO/LDPS by assuming a 15% loss of fertility and milk production in sero-positive ruminants.

Apparent country sero-prevalence of human brucellosis was 15.6% (95% CI 8.4-26.9%), for cattle 2.8% (1.6-4.9), for sheep 3.3 (1.5-6.9) and goats 2.4 (1.4-4.5). Annual social and private health costs are estimated at least at 0.6 Mio US\$. Annual losses to the livestock sector are estimated at 10 Mio US\$ and the range of annual losses for the country is estimated at 5-15 Mio US\$. Results were presented, discussed and validated by stakeholders. Ongoing mass screening and elimination should be reduced as not effectively reducing transmission. Freed human and financial resources from the current surveillance system could cover already an important part of the cost of mass vaccination.

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Direct Estimation of the Dynamic of Contact Between Poultry and Wild Ducks in African Villages Using Distribution Modeling Based on Satellite Telemetry and Remote Sensing Data

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Understanding and modeling the wildlife-livestock interface is essential for controlling emerging infectious diseases (EIDs). The contact rate between hosts is a key parameter for mathematical modeling of EIDs dynamics. Because modifications of the contact rate can modify greatly the epidemiologic dynamic, it is important to take into account its seasonal variability. We developed a distribution model based on satellite telemetry and remote sensing data to directly evaluate the dynamic of contacts between wild birds and domestic poultry in African villages.

In the Inner Niger Delta of Mali, five Comb ducks (*Sarkidiornis melanotos*), were tracked with satellite transmitters providing GPS data for seven months. We used 250-meter spatial resolution and 8-day temporal resolution remotely sensed environmental indicators to model the distribution of these wild birds with the MAXENT method. For each 8-day period, we estimated the potential contacts between wild and domestic birds by calculating the number of villages harbouring predicted suitable habitats for Comb ducks.

A period of increased potential contacts occurred at the end of the dry season when wild birds were looking for the last suitable habitats. Comb ducks subsequently performed regional movements to reach their breeding grounds during the rainy season.

We could directly estimate the seasonal variation of potential contacts between Comb ducks and domestic poultry. It allowed us to identify period of potential transmission and spread of pathogens by wild birds. The estimation of the dynamic of contacts between wild and domestic animals with our method could feed epidemiological models of the wildlife-livestock interface.

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Assessment by Modeling of the Effectiveness of Vaccination Against Q Fever in Dairy Cattle

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Q Fever is a worldwide zoonosis caused by *Coxiella burnetii* which induces reproductive disorders in livestock. Moreover, ruminants are recognized as the most important source of human contamination. The control of this infection in cattle is then crucial to limit both the infection spread in livestock and the zoonotic risk. Although vaccination is currently advised on the field, the comparative relevance of different protocols according to the duration of the vaccination campaign and category of animals to be targeted has never been explored. Our objective was to compare, by simulation, the effectiveness of three different vaccination strategies in an infected dairy cattle herd.

We developed a stochastic individual-based epidemic model coupled with a model of herd dynamics to simulate the temporal dynamics of two outputs (shedders prevalence, environmental bacterial load) and to calculate the infection extinction rate. For all the scenarios, the temporal outputs strongly decrease with time at least in the first years of vaccination. However, vaccinating for only three years is ineffective for stabilizing the temporal outputs at a low level. Vaccinating both cows and heifers is more effective than vaccinating heifers only: in the latter case, (i) the outputs decrease is much slower and never catch up the level of the former case outputs, (ii) the infection extinction rate is twice as low as in the former case.

This work provides the first assessment, through an original modeling approach, of vaccination strategies implemented on the field, and supports decision makers in the design of control programs.

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One Health Leadership: Nursing Perspectives

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A holistic and innovative approach to One Health requires the engagement of all human, animal and environmental health professionals working in communities, academia, and government. Nurses represent the largest group of public health workers worldwide and often are the only human health professionals in rural communities of less developed countries where emerging disease threats are highest. In many countries, nursing is not yet a major partner in the planning and development of One Health frameworks and strategies. This presentation provides theoretical and practical information from nursing (both art and science) that will strengthen the interdisciplinary thinking, cross training, and collaboration needed to adequately prepare for and respond to emerging infectious diseases. Nursing is by tradition and academic foundations a holistic discipline, incorporating systems theory, complexity theory, social change theory, and social network theory into practice at the individual, community, and policy levels. In the most remote communities in the world nurses practice in villages “where the forest meets the farm” and are often the first observers of and responders to emerging infections in animals and humans. Thus nursing is well prepared to lead interdisciplinary teams to improve response capacity for emerging infections. The University of Minnesota School of Nursing (USA) is engaged in bi-directional learning partnerships with East and Central African universities within the context of a One Health initiative that includes nursing, veterinary medicine, medicine, public health, agriculture, wildlife ecology, and education. These partnerships illustrate the pivotal role of nursing in One Health.

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EPIZONE, Network on Epizootic Animal Disease Diagnosis and Control

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EPIZONE is the EU Network of Excellence on epizootic animal diseases diagnosis and control. The mission of this network is to improve research on preparedness, prevention, detection, and control of epizootic diseases within Europe with the overall aim to reduce the economic and social impact of future outbreaks of epizootic diseases like Avian influenza, Swine Influenza, Foot-and-mouth disease and Classical swine fever, through increased excellence by collaboration. EPIZONE includes more than 300 acknowledged experts working on animal diseases research in partner institutes from 11 EU countries, China, Turkey and the FAO.

EPIZONE implements its research within 4 scientific themes: -Diagnostics-, -Intervention Strategies-, -Surveillance and Epidemiology- and -Risk assessment-. Cooperation between partners is strengthened by supporting short term missions, organizing courses, workshops and (open) scientific meetings. With the “Young EPIZONE” programme, the network invests in the future generation scientists.

EPIZONE facilitates the rapid exchange of samples, reference materials, tests and related scientific expertises, and supports the development of new methods, the standardization and harmonization of diagnostics and vaccine strategies, through an active laboratory network. Since many EPIZONE institutes have statutory tasks and run international reference labs, EPIZONE also has the opportunity to advise policy makers as well as international bodies such as the OIE, and WHO.

The risk of emergence of infectious diseases has increased during recent years due to increased travel and animal movements and global warming. Recent epidemic threats like Swine Influenza, and animal disease outbreaks like Blue tongue, have emphasised the importance of exchanging, implementing and maintaining appropriate diagnostics and adequate animal disease surveillance. EPIZONE has anticipated by allocating budgets for preparing and sharing reference materials and protocols, and by organizing laboratory ring trials. By launching an internal call for new integrating activities yearly, EPIZONE aims to respond to new developments, unexpected outbreaks and disease threats.

Sustaining a good laboratory network within EPIZONE guarantees the capacity to timely implement or optimize diagnostic tools through cooperative research in order to early detect and control emerging and re-emerging epizootic diseases.

Emerging Diseases, Factors and Their Control

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Sikkim Anti-Rabies and Animal Health Programme - a Local Solution in a Small State of India

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The Sikkim Anti-Rabies and Animal Health (SARAH) Programme SARAH is the first state wide Animal Birth Control and Anti-Rabies (ABC/AR) Programme in India. The programme was created in 2006 to control street-dog populations and the incidence of rabies and other zoonotic diseases in a humane and sustainable manner.

It is a collaborative project between the Government of Sikkim, Fondation Brigitte Bardot (FBB), and the Australia-based NGO, Vets Beyond Borders (VBB). Critical factors in the success of the programme have been (1) a strong local advocate for animal welfare (2) political and financial commitment to the project by the Government of Sikkim, (3) significant funding for animal expenses provided by FBB and (4) training of local staff and professional expertise provided by veterinary volunteers (VBB). In 2009 SARAH became a Division within the Dept of Animal Husbandry, Government of Sikkim.

Long-term sustainability was a key factor in programme design and implementation. Local veterinary and para-veterinary staff have been trained in both formal and on-the-job training programmes relating to surgical and diagnostic techniques, dog-catching, animal welfare, administration of an animal hospital.

Key Achievements:

- > 18,500 dog/cat sterilizations
- > 35,000 vaccinations against rabies
- fewer human deaths from rabies in Sikkim
- reduction in canine rabies and dog bite injury
- 15 Indian veterinarians trained in surgery
- rapid veterinary response to suspect rabies cases
- Hundreds of injured stray animals treated, sterilised and vaccinated

The SARAH programme is a successful state-wide anti-rabies programme made possible by collaborative effort and political will.

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People Within Chains

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Rapid increases in poultry populations and modifications in poultry production systems are creating some of the biggest one health challenges the world has seen. In order to think outside the box on poultry disease control, it is necessary to look

at the people who live and work within the poultry value chains. Using research done in the Greater Mekong Sub-region, this paper argues that value chains and trade flows play an important role in HPAI virus maintenance, spread and hence disease control. Value chain analysis can provide information on volume, on type of products, on the people engaged, the relationships linking people, and the practices at each node. How these value chains operate is dictated by human behaviour and actions, which if understood provide critical insights into risk management. There are two benefits from looking more closely at the poultry value chains:

- Poultry product (specific bird types and products) movement can be assessed through an understanding of supply and demand between consumption centres and production clusters. This can then be utilised to refine the epidemiological understanding of risk points, spatial and temporal and identification of intervention points.
- Once risky points and interventions have been identified with the people involved at the important points, information on their behaviour and rule structures provide a much stronger basis to plan how to work with them in order to add value to their livelihoods and hence reducing the risks that an intervention will be rejected.

This paper presents how to approach often complex poultry sectors, breaking them down into manageable chains that provide income and food to a many people, in order that the one health disease risks they can pose can be managed and minimised in a sustainable manner.

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Emergency Vaccines Against Viral Hemorrhagic Fevers

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Numerous viral diseases have emerged/re-emerged over the past decades. Aside from many others, the so called 'viral hemorrhagic fevers' present a particular threat to our health systems. Most of the causative agents of viral hemorrhagic fevers are zoonotic in origin and remain a major challenge for animal (wildlife, livestock) and human health worldwide. Many countries have established infectious disease centers with primary responsibility for disease surveillance, reference microbiology and quality assurance, and preparedness and response to these threat agents. However, the development of countermeasures is still in early stages and has not yet produced effective licensed products. This paper discusses the development of proper animal disease models and the utilization of live attenuated and replication-deficient vaccines for prophylaxis and treatment of viral hemorrhagic fevers caused by hantaviruses, filoviruses and arenaviruses. Despite promising vaccine candidates the mechanisms of protection remain largely unknown, but certain correlates of protection have been identified. Remaining issues such as safety and licensure are either currently addressed or need to be addressed in the future. The minimum goal would be the approval of emergency vaccines for the use in humans within the next few years.

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An Online Monitoring and Surveillance System for the Early Detection and Identification of Emerging Animal Diseases: www.moss.be

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To ease the early detection of (re)emerging animal diseases, the Belgian sanitary authorities promoted the study on and the implementation of a web based application designed to manage with three categories of diseases: unknown emerging diseases, diseases with an unusual clinical expression and identified diseases when usual treatment seems to be inefficient.

This “Monitoring and Surveillance System” website (MoSS) allows for the detection of unusual syndromes in domesticated and wild animals, via an online notification system to be used by veterinary field practitioners. The web application, developed in PHP-MySQL, aims at managing clinical description, animal typology, epidemiologic data and spatio-temporal proximity to run a hierarchical ascending classification process (HACP) that results into the identification of “clusters” of cases grouped by similarity.

The configurable HACP will be optimized using recorded information in previously identified cases of emerging diseases in Belgium.

The identification of a new cluster automatically generates an alert in the system, linked with the sending of emails to the sanitary authorities and expert(s). The selection of expert(s) is automated taking into account fields of expertise, geographical proximity and the mainly affected anatomo-physiological system in the specific animal species involved in the new cluster.

Additional information about the evolution of the disease, lab results and treatments can be published on dedicated Forum pages and read by authorized veterinarians.

The whole website has been designed to be easily managed by non-IT professionals. The application runs now in English, French and Dutch and supports the cross-border reporting.

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OFFLU: Contributions Toward Improved Vaccine Strain Selection for Poultry

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In Egypt and Indonesia, where highly pathogenic avian influenza subtype H5N1 (H5N1 HPAI) has become enzootic, FAO has undertaken two technical projects under the OFFLU banner in collaboration with national agencies to understand the characteristics and epidemiology of circulating viruses, determine efficacy of available influenza vaccines for poultry, and to develop national systems to support the use of efficacious poultry vaccines as part of a comprehensive strategy to combat HPAI. To further understand the evolution of the H5N1 HPAI virus in Indonesia and the subsequent impact of vaccines applied to poultry, the OFFLU project pioneered the application of antigenic cartography, developed to characterise human influenza viruses, for avian influenza viruses. The resulting map can be used help assess vaccine immunity against circulating strains. Laboratory capacity building and technology transfer supports these activities in national veterinary laboratories to develop a sustainable mechanism to monitor viruses and inform vaccine selection. This is the first coordinated effort of its kind for monitoring of influenza in animals at a national level.

The majority of the clade 2.1 viruses characterised from Indonesian village-based poultry during 2007-2008 cluster together in subclade 2.1.3, suggesting that little variation has occurred among this group of viruses; however, a few significant outliers have been detected that represent viruses capable of escaping the protection afforded by current vaccines against H5 avian influenza. Overall, the outcome of biologic, genetic and antigenic analyses of these viruses in Indonesia has contributed to the identification of updated candidate vaccine strains for poultry.

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Natural Disasters and Communicable Diseases in the Americas: Contribution of Veterinary Public Health

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The region of the Americas experiences natural disasters due to its geographical vulnerability, and the human impact is often amplified by socio-economic conditions. This risk may be increased by climate-related changes.

The public health effects of a natural disaster include not only fatalities, but also an increased risk of communicable diseases. Many of these diseases are related to the veterinary public health (VPH) domain, particularly in the control of zoonoses and food safety. The objective of this article is to provide an overview of the importance of natural disasters for the Americas and to link it to possible contributions of VPH professionals focusing primarily on communicable diseases. An analysis of the characteristics of natural disasters that occurred in the Americas between 2004 and 2008 was carried out. Five cases studies illustrating the contributions of VPH in situations of disaster were presented. The magnitude of the data in terms of number of events and people affected and killed shows that natural disasters, particularly storms and floods, are a very important public health problem. Central America and the Caribbean, particularly Haiti, presented a higher risk.

From the point of view of VPH and communicable diseases, two major areas of technical cooperation could be suggested for the region: reducing the risk of leptospirosis outbreaks as well as other vector borne diseases related to floods and hurricanes; and improving food safety and other food chain issues among the affected population. The participation of different disciplines and sectors in the disaster preparedness and response is of particular importance.

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Animal Health Clubs in Sierra Leone

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The eleven year civil war in Sierra Leone decimated public and animal health services in the country. There are approximately 70 physicians for a population of 6 million persons, and only 5 veterinarians nationally with 21 livestock officers to assist them. This lack of human and animal health care capacity has handicapped zoonotic disease prevention and control, particularly for rabies, which is endemic in Sierra Leone. In 2007, the Animal Science Department of Njala University established Animal Health Clubs (AHCs) in five local schools as a One Health approach to empowering communities to improve their lives. AHCs provide basic training in animal husbandry, nutrition, sanitation, environmental hygiene, and the prevention and control of zoonotic diseases, particularly canine rabies. In September 2010, with support from the Government of Sierra Leone and the Food and Agriculture Organization of the United Nations, World Rabies Day activities were held nationally to support ongoing AHC health activities, including community participation, health education and theatre. AHCs provide a One Health model for community development under challenging conditions which may be adapted and applied in other developing nations.

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Sequencing and Phylogenetic Analysis of the Orbiviruses: A New Approach to their Classification, Molecular Identification and Diagnosis

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The orbiviruses are transmitted by ticks or hematophagous-insect-vectors and have a wide host-range that collectively includes cattle, wild ruminants, equines, marsupials, sloths, bats, birds, humans, etc. Bluetongue virus (BTV) is the type species of the genus *Orbivirus* within the family *Reoviridae*. The recent emergence of multiple BTV serotypes in Europe and the southern USA, as well as BTV-2, BTV-7 and other orbiviruses in Australia (events linked to climate change), illustrates the continuing threat posed by these viruses.

Although sequence data are available for multiple isolates of BTV, African horsesickness virus, Epizootic haemorrhagic disease virus and Equine encephalosis virus, most of the 22 *Orbivirus* species remain unsequenced. This makes molecular-diagnosis (e.g. by RT-PCR) and unequivocal identification of virus-isolates by phylogenetic analyses difficult.

We report full-genome sequence-data for Umatilla virus, Chobar Gorge virus, Wad Medani virus (representing established species) and Andasibe virus (an 'unassigned' isolate), as part of a project to generate representative data for each *Orbivirus* species. Subsequent phylogenetic analyses have revealed the evolutionary relationships of these viruses and provide a molecular basis for classification of existing and novel isolates.

Comparisons to Stretch Lagoon orbivirus (SLOV) indicate that it is a member of the Umatilla virus species and not a new species, as proposed earlier. However, Andasibe virus is distinct from other orbiviruses, and a proposal will be made to ICTV to recognise it as a member of a new *Orbivirus* species.

Phylogenetic grouping of the orbiviruses suggests that they have evolved along with their vectors through a process of 'co-speciation'.

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Atypical BSE - Knowns and Known Unknowns

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Transmissible spongiform encephalopathies (TSEs), or prion diseases, are a class of diseases that includes bovine spongiform encephalopathy (BSE). Three strains of BSE have been identified to date. Classical BSE (C type BSE) is the strain responsible for the epidemic in bovine animals. Widespread surveillance for C type BSE in a number of countries in the past 10 years has identified two rare strains, called low-type (L type) BSE and high-type (H type) BSE because of diagnostic differences in the abnormal prion protein compared to C type BSE. L type BSE and H type BSE are collectively called 'atypical BSE'.

This presentation discusses what is known about atypical BSE strains, what we don't know and whether specific risk management measures are justified.

Evidence, sourced from published studies, supports the view that the two atypical strains are epidemiologically unrelated to C type BSE. Parenteral challenge studies have shown that both atypical strains can infect cattle and that one may pose a zoonotic risk. However, there are some important unknown features of these strains. Detailed study of additional naturally occurring cases would help confirm the hypothesis that they are sporadic or genetic diseases in aged cattle and are not contagious. Experiments underway overseas may help to clarify if any tissues outside of the central nervous system in

infected cattle harbour significant levels of infectivity and whether these strains can be orally transmitted to cause disease in cattle, other livestock or humans. Adding to our knowledge base will help establish if specific risk management measures are justified.

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Emergence of Bovine Tuberculosis in Wildlife in Southern Africa: A Threat for Livestock

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Bovine tuberculosis (bTB) is an important emerging disease in wildlife and a poorly studied zoonosis in Southern Africa. Introduced through livestock to the African buffalo population in the South of Kruger National Park (KNP), the pathogen has spread towards the unfenced northern boundary of KNP which coincides with the boundary with Zimbabwe. If most of KNP is fenced, the adjacent Gonarezhou National Park (GNP) in Zimbabwe is unfenced allowing contacts between wildlife and livestock.

We investigated the risk of emergence of bTB in African buffalo and in communal cattle in and around GNP.

In Zimbabwe, between 2008 and 2009, 48 buffalos and 120 cattle heads were tested for bTB. We equipped with GPS collars 12 buffalos in four herds and 12 cattle heads in 12 herds in the periphery of the GNP. We collected one year of GPS data.

Four buffalos were positive to bTB with the gamma interferon test. Two of them were post-mortem and culture isolation of a KNP bTB strain was confirmed. No cattle were confirmed bTB positive. After constructing matrices of contacts between cattle and buffalo, we used network analysis to analyse these contacts for different temporal windows chosen on the basis of bTB modes of transmission.

We report the emergence of bTB in GNP buffalo from KNP buffalo. Direct contact between buffalo and cattle were rare but few indirect contacts were compatible with bTB transmission. We discuss the bTB emergence in buffalo in relation to the wildlife/livestock/human interface in southern Africa.

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Molecular Diagnostics in 2011: New Targets and New Technologies

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Discovered thirty years ago, today molecular techniques underpin veterinary and public health research and diagnostics. From disease outbreak investigations to disease surveillance, and from cancer detection to prognostics, molecular diagnostic techniques are becoming more sensitive and more specific, providing the answer to questions once thought facetious.

New targets are emerging. The diagnostic potential of exosomes has recently been exposed. Exosomes are small, 40-100 nm sized, membrane vesicles released from many different cell types and found in many types of bodily fluids. Exosomes contain signaling molecules such as ligands and receptors as well as proteins, mRNA and microRNA. The

exacerbated release of exosomes from tumour cells makes them an ideal target in diagnosis and biomarker studies. Analysis of exosomes provides a non-invasive tool for disease diagnosis and monitoring.

New technologies are paving the way. Developed at the turn of the century, digital PCR amplifies a single DNA template from minimally diluted samples. It has the potential to generate amplicons that are exclusively derived from one template. Detection is either with fluorophores or sequencing. Digital PCR transforms the exponential analog signals obtained from conventional PCR to linear, digital signals, allowing statistical analysis of the PCR product. It has obvious applications in quantification providing a promising molecular diagnostic tool for cancer detection. Digital PCR has many other applications, including detection and quantification of low-level pathogens, rare genetic sequences, gene expression in single cells, and the clonal amplification of nucleic acids for the identification and sequencing of mixed nucleic acids samples or fragments.

The applications of these new molecular targets and technologies, and the impact they will have on public and veterinary health will be discussed.

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Bartonella: The Pet Cat-Human Connection

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Bartonella cause identical diseases in cats and humans and cats are the major reservoir for human infection.

Define Bartonella diseases of cats and humans and determine zoonotic transmission parameters from cats to people.

Bartonella infection of cats was determined by western blot serology and 186 cat owners, who developed a Bartonella disease, were interviewed.

Cats: Serologic evidence of Bartonella infection was present in 38% of 49,921 healthy and 47% of 156,407 cats with inflammatory diseases.

Zoonotic Transmission: The offending cats were identified in 126 of 186 (68%) cases, where the route of zoonotic transmission was identified. All cats were serologically positive, 68% were healthy and 47% were kittens under 1 year old. Routes of infection were: 57 scratches, 9 scratches/bites, 6 bites, 4 administering medication to cats, and 50 by unknown routes.

Human Disease: The Bartonella disease spectrum of 186 people was: 1) 151 (81%) developed classical CSD with a prodrome of lymphadenopathy (83%), fever (65%) and papule (26%) at the scratch or bite site. 106 of 151 (70%) had no sequelae after the prodrome, whereas 45 patients developed sequelae such as chorioretinitis, endocarditis, and encephalitis. 2) In contrast, 35 (19%) patients had no prodrome and only developed sequelae. Excluding 26 veterinary professionals, only 9 (6%) of the 160 patients were informed of the zoonotic potential of feline Bartonella by their veterinarian before their illnesses developed.

Our study demonstrates that veterinarians and physicians must become more aware of Bartonella in order to prevent zoonotic transmission.

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An Outbreak of Acute Hemorrhagic Syndrome in Newborn Calves: An Example of a New Emerging Disease

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As result from the Dutch veterinary surveillance system, a new syndrome in cattle was detected and analysed. A pilot study was performed. Every reported calf with hemorrhagic syndrome was investigated: Blood samples were taken from the dam and the calf, and investigated for thrombocytes, leucocytes and blood parasites, and specific pathogens. When the calf died,

necropsy was performed at the Animal Health Service in Deventer. The farmers and the veterinarians answered a questionnaire. The questions were focused on general information of the farm, the use of medication and vaccinations and routine management of the calves. All epidemiologic and diagnostic data were analysed. With international cooperation, many known infectious agents were ruled out. The calves developed the haemorrhagic disease, caused by a thrombocytopenia, because of bone marrow depletion. The exact cause of this depletion is still unknown, but the use of a certain vaccine in the dam, was identified as a very high risk factor. Further research is ongoing. Following these preliminary results, a specific vaccine was withdrawn from the European market.

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Ecology of Emerging Viruses: Bridging the Gap Between Field and Experimental Research

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Emerging infectious diseases are a major challenge to the safety of the world in the 21st century. Renewed effort, resources, scientific innovations, as well as new degrees of scientific integration are required to meet this challenge. Animals are the source of more than 70% of these emerging infections. Outbreaks of avian influenza, SARS-CoV, Henipah and Ebola virus have often put negative focus on the role of wild animal populations in the transmission and maintenance of these emerging diseases. Whereas the focus often has been on the public health aspect of these emerging infectious diseases the environmental impact is equally important, with special concern for endangered wild animal populations.

The biocomplexity of emerging infectious diseases implies that a multidisciplinary approach is our best hope for effective intervention strategies. This multidisciplinary approach will ideally allow for the integration of host ecology (breeding behaviour, physiology, migratory behaviour) with host factors (temperature, receptor distribution, immune response) and pathogen ecology (tissue tropism, pathogenicity and evolution).

Despite the obvious need for such an integrative approach, we think that there are currently limited research approaches that tackle the risk assessment of emerging infectious diseases in the proposed multidisciplinary fashion. We suggest that linking comprehensive pathogen surveillance of wild animals with fundamental ecological host studies will make an important contribution to the control of emerging zoonotic infections and ideally have a positive effect on public health as well as the conservation of wild animal species. Here we focus on a few examples of such an integrated research approach.

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Endo/Exophagy and Circadian Rhythm of *Culicoides* Biting Midges (Diptera: Ceratopogonidae), Vectors of Bluetongue Virus

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The bluetongue emergence and spread in Western Europe in 2006-2008, having disastrous consequences on livestock production, showed the unexpected ability of Palaearctic *Culicoides* species to transmit intensively the virus. Some aspects

of *Culicoides* bionomics remain unclear mainly due to methodological concerns (identification or trapping and sampling difficulties).

Our aim was to describe the circadian biting activity of *Culicoides* species and their endo/exophagic behaviour.

Culicoides were collected in an experimental station of western France using 2 drop-traps and 3 suction traps each baited with 4 sheep, during 6 collections of 24 hours. Both traps were localized in a pasture and a semi-closed sheep pen; a suction trap was situated in an open stable. The experiment was repeated in spring, summer and autumn 2010 to analyze seasonal fluctuations. Individuals were morphologically identified to species level; sex and female physiological stages were recorded and sibling species were molecularly identified.

A total of 907 *Culicoides* (874 females, 33 males), belonging to 13 species, was collected during spring and summer (autumn collections are under process). During both seasons, collections were maximum in the pasture (99% of total catch in spring and 94% in summer, with inter-specific variations) and during the sunset (76% and 89% of total catch 2 h around the sunset). These results clearly illustrated the *Culicoides* exophagic behaviour and confirmed that most of the activity occurred around the sunset for spring and summer. This understanding has direct consequences for the protection of domestic animals against *Culicoides* biting and the development of vector control strategies.

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Multidisciplinary Approach for Cutaneous Leishmaniasis Prevention Through Community Participation, Iguazu Falls Area, Argentina

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I) An outbreak of Cutaneous Leishmaniasis (ACL) was reported during 2004, at Iguazu, Argentina, among settlers in a recent deforested area, also vulnerable to malaria and yellow fever. Vectors of ACL have a metapopulation structure, microfocal distribution, and higher abundances in forest-edge interfaces. II) Interactive multidisciplinary base-line research (partial results discussed between disciplines): Vector/reservoir incrimination: *Lu. whitmani* (PCR), *Akodon* sp.-forest, *Rattus rattus-synanthropic* (space association, compatible lesions). Time/space distribution of vectors/reservoirs (trapping) at different scales (weather correlations, seasonality, forest-edge and animal dwellings related risk). Practices and representations: In-depth interviews (ACL cases, householders ≤ 300 m forest, cue informants) and participant observation (local market) about ACL disease meaning, origin and treatment; vector prevention/control; environment and risk; land use and distribution of house-animal dens-forest; water, animal and forest related activities: householders overnight inside houses, represented themselves out of the forest (62% houses ≤ 100 m forest), the diseases come from abroad/city garbage, and 44% farming free of pesticides as main income. III) Qualitative risk assessment and identification of possible multi-approach interventions. IV) Discussion with the community and the NGO to select the design on cases surveillance (native medicine sellers), intervention (environment-animal breeding management in each domestic unity, permethrin impregnated curtains for houses), validation (low-cost insect-traps by supervised householders), and sustainability (impregnation by three trained and supervised local leaders, re-impregnation with agreed costs to seed a cooperative). V) The ACL prevention through community participation with informed consent is currently implemented as a sustainable, cultural-environmental sensitive strategy, together with the surveillance by local health agents.

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Case Studies of Neglected Tropical Diseases at the Human-Animal Interface in East Africa

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We present results from three integrated human and animal research projects on neglected tropical diseases in different ecosystems in East Africa, encompassing a spectrum of urban and rural environments, and discuss lessons learned from these for One Health.

In a rural agropastoralist community in western Kenya, spotted-fever group (SFG) rickettsiae were found to be highly prevalent in arthropod vectors, with 157/162 (96.9%) pools of non-engorged adult *Amblyomma variegatum* ticks collected off cattle, and 73/75 (97.3%) pools of *Ctenocephalides felis* fleas collected off domestic dogs and cats, and from household environments, positive for *Rickettsia*. Of 699 acute febrile human patients tested, 50 (7.2%) were positive for *Rickettsia* by PCR.

The utility of domestic dogs as indicator species for anthrax surveillance in the Serengeti ecosystem is presented and discussed. Age-seroprevalence patterns of anthrax antibodies in this species are useful to determine infection levels, to pinpoint the timing of outbreaks, and to demonstrate the presence of anthrax in areas where no disease had been reported previously.

Preliminary results of studies on neglected rodent-borne zoonoses (*Leptospira* and *Bartonella*) in urban slums are presented, and contrasted with results from similar studies in a rural environment. The informal urban site was characterised by a high abundance but a low diversity of rodent species. In the urban site, 11% of blood samples were positive for *Bartonella* species by isolation vs. 21% in the rural site. 18% of urban rodents tested positive for human pathogenic leptospires by PCR. Pathogen prevalence differed significantly by rodent species and trap site.

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Cystic Echinococcosis Prevention in the Highlands of Peru -A Multidisciplinary Perspective

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Cystic echinococcosis (CE) is a zoonotic disease highly endemic in Latin America, particularly in the Peruvian Andes. It is caused by the gastrointestinal parasite *Echinococcus granulosus* and its life cycle includes dogs, sheep and humans. Because of its close association with both animal species and people, this disease provides us with an excellent example for a One Health approach with inter-professional cooperation and thus, effective control measures should be aimed at both animal and human hosts alike. Our main initiatives in the highlands of Peru consist of designing a Knowledge Attitude and Practices (KAP) survey to identify potential risk factors predisposing infection in people and to design an appropriate control program. Control measures include treatment of dogs with praziquantel, health education and reduction of stray dog populations. Other goals include studying the prevalence of *Echinococcus granulosus* in dogs and people as well as other zoonotic diseases harboured by dogs. This study incorporates intimate cooperative work between all health professionals at a local level and a strong interaction with at-risk populations. Preliminary results showed a very high prevalence of infection in humans and animals alike and ideal conditions for the transmission of the parasite from dogs to people and livestock, thus warranting a comprehensive approach to control the disease involving both physicians and veterinarians. Other factors favouring human infection include significant poverty, lack of education about CE and practices that are conducive to infection such as feeding infected sheep offal to dogs or the close interaction between children and pets.

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Wild Mammals and *Leptospira* Transmission Risk in the French West Indies

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Leptospirosis is a zoonotic disease affecting all mammals and distributed worldwide with a higher incidence in tropical regions. The aim of this study was to assess *Leptospira* prevalence in four wild mammal species in the French West Indies (*Rattus rattus*, *R. norvegicus*, *Mus musculus* and *Herpestes auropunctatus*) and the subsequent risk for humans and domestic animals. In 2000, wild mammals were trapped in different biotopes (with and without freshwater) and sampled for blood examination by serology (MAT) and for bacteriology (culture of kidneys and strain characterization (PFGE)). Evidence of leptospiral infection was found, by serology and/or isolation, in 65 (40%, 95% CI: 32.4–47.6) of the 160 animals investigated in Guadeloupe and 28 strains (*Icterohaemorrhagiae*, *Australis*, *Sejroe* and *Ballum*), were isolated from 71 non-contaminated cultures. This study pointed out that specificity between the host and *Leptospira* serogroups could be more (*M. musculus* and *Ballum*) or less strict (*H. auropunctatus* and Serovar *Icterohaemorrhagiae*, *Sejroe* or *Australis*). The presence of leptospire appeared to be determined by the availability of freshwater in the habitat. This is the first report of bacteriological and serological findings in wild mammals of the island. Four common species of Guadeloupean wild fauna were shown to extensively excrete leptospire of the main serogroups encountered in human and animal infections. These wild mammals widely infest leisure (forest) and working areas (banana and sugar cane plots), where workers are usually without any protection, but also houses (e.g. mice). This situation implies a need for prophylactic health measures.

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Characterisation of *Listeria monocytogenes* Strains Recovered as Persistent and Sporadic Food Factory Contaminants Subjected to Non-lethal Stress

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Persistent food factory contamination by *L. monocytogenes* represents a threat to public health and has serious economic implications for the contaminated facility. Actions taken to minimise contamination can cause physiological stress, and it has been shown that sub-lethal stress can augment *L. monocytogenes* virulence and may facilitate persistent contamination. This study aimed to compare the mechanisms facilitating persistent contamination by *L. monocytogenes* strains recovered from a food factory survey. Isolates recovered from a food factory were characterised using multilocus typing. Relevant attributes thought to enable persistent environmental contamination were compared, including biofilm production and the proteomics of alkaline stress adaptation. Biofilm production during temperature/pH stress was assessed by colourimetric assay and electron microscopy. A temperature response was observed, as was environmentally induced homogeneous biofilm production by non-clonal *L. monocytogenes* strains. Importantly, it was concluded that biofilm production does not determine the persistent *L. monocytogenes* phenotype. Qualitative and relative protein abundances following alkaline adaptation were compared using MudPIT. Findings showed alkaline adaptation involves cytoplasmic acidification, energy and cell wall adjustment, and stabilisation of cellular processes. No difference in these mechanisms was evident between strains; however the response was greater in persistent contaminants. Results of this study imply food facilities can induce/select for the persistent *L. monocytogenes* phenotype. This may be caused by operational complexity within these facilities, leading to concentration fluxes of growth limiting challenges, and subjecting the strains to sub-lethal stresses. This requires consideration when assessing food factory operations, and for the development of effective risk mitigation strategies.

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Stamp Out Sleeping Sickness (SOS): An Innovative One Health Approach to Neglected Zoonotic Disease in Uganda

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Uganda is the only country in Africa to harbour both the acute and chronic forms of the neglected zoonosis Human African Trypanosomiasis (sleeping sickness). Progression of molecular technologies this decade has shown domestic livestock to be the major reservoir for this fatal human infection.

Stamp Out Sleeping Sickness (SOS) is a Public Private Partnership (PPP) launched in Uganda 2006. At the time, the two forms of human disease were threatening to converge in the north of the country, which would have resulted in a public health nightmare. The programme facilitates control of human disease through an innovative community-based livestock spraying intervention known as “restricted application technique” (RAP). Combining scientific research with corporate and local commercial interests, SOS has grown into a significant partnership between the Ugandan government, medics, veterinarians, academia and the private sector, resulting in local business creation and significant institutional and policy change in Uganda. Change of the veterinary curriculum at Uganda’s Makerere University has been an additional positive output of the initiative, with final year veterinary students contributing to the ongoing programme.

The SOS intervention has demonstrated both advantages and challenges of the practical implementation of neglected zoonotic disease control, and many lessons can be learned. Cutting edge molecular research, combined with political goodwill and private sector engagement, has resulted in a change of approach from traditional tsetse control or “reactive” treatment of human cases, to a holistic intersectoral One Health approach for the sustained control of this fatal human disease in Uganda

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The Global Programme for the Elimination of Lymphatic Filariasis (GPELF) its Health Impact. After 9 Years and Challenges Ahead

Dato Dr. C.P.Ramachandran

Lymphatic Filariasis (LF) is a vector-borne, chronically disabling parasitic infection causing Elephantiasis, Lymphedema, and Hydrocele. The infection is endemic in 83 Countries worldwide, with more than 1.2 billion people at risk and 120 million already infected. Since the year 2000 the global programme to eliminate Lymphatic Filariasis (GPELF) has targeted elimination of LF by the year 2020. In its first 9 operational years, the programme has scaled-up to provide more than 2.7 billion treatments through annual, single dose mass drug administration (MDA) to over 695 million individuals living in 52 LF-Endemic countries. Not only the GPELF drugs prevent the spread of LF, they also stop the progression of disease in those already infected, especially in children. In addition, since two of the three drugs used for LF elimination have broad anti-parasitic properties, treated populations are also freed from both intestinal worms and from skin infections with *Onchocerca*, lice and scabies. To better understand the public health benefit of this ongoing global health initiative an analysis was made of the programme data made available to W.H.O. by participating countries. Between 2000-2009 GPELF prevented LF disease in an estimated 8.7 million newborns who would otherwise have acquired LF, Thus averting in their lifetime nearly 6.6 million cases of Hydrocele, 4.1 million cases of Lymphedema and sub-clinical disease. In conclusion conservative estimates

show that the GPELD has had an unprecedented public health impact on both LF and other neglected tropical diseases and it justly deserves the accolade of “a best buy” in global health. The challenges ahead will also be discussed.

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Local Knowledge and Perception of Zoonotic Hydatidosis in High Atlas (Morocco)

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Hydatidosis, a neglected zoonosis, is caused by the larval stage of *Echinococcus granulosus*. Adult *E. granulosus* parasites live in the intestine of dogs. Eggs expelled with faeces are infective to a wide range of animals, including man. Dogs are infected through predation or scavenging. Human hydatidosis is a severe chronic disease that often requires surgical treatment. Though various control tools are available, hydatidosis remains a heavy burden in many developing countries where extensive sheep breeding is practiced.

To develop an effective control strategy this qualitative study assessed the communities' knowledge and perception of hydatidosis and of its control and investigated the role of the dog in the society.

Twenty focus group discussions (5-13 participants) were organised with men, women and butchers in a human hydatidosis endemic area in High Atlas, Morocco.

This Berber community considers human hydatidosis as a serious and relatively prevalent disease but poorly understands the cycle of the parasite. At risk behaviours and factors inhibiting disease control measures are mostly related to cultural aspects of sheep breeding, dog keeping and offal disposal by the butchers.

The study highlighted the need for more accurate education of the communities and, indirectly, health professionals on the transmission cycle of the parasite. The communities fail to control stray dogs and dog access to offal and the transmission pathway to humans is not clearly understood. Intersectoral collaboration between health personal, veterinaries and social scientists on this issue is crucial.

Environmental Drivers

Climate Change

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Climate Change Impacts on Infectious Diseases – What Decision Makers Need to Know

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The relationship between climate change and disease incidence and spatial distribution is complex and controversial. The scientific community continues to debate and discuss these issues in the peer reviewed literature. Some researchers argue that climate change seems more likely to shift rather than expand the geographic ranges of infectious disease and in some cases that the geographic distribution of some infectious disease may decrease especially as climate change will reduce biodiversity. However, because the epidemiology of many diseases is the product of complex and non-linear interactions

between a range of disparate factors including not just climate, but abiotic and biotic factors, predictions need to be treated with caution.

This paper will explain why for decision makers, it makes little sense to look at climate change in isolation from the other major drivers that will affect the incidence and spatial distribution of diseases.

Policies do need to be underpinned by sound science, but decisions must be made in the face of incomplete information and a lack of full understanding of all the intricacies inherent in a multi-scale complex adaptive system. Decision makers need to understand that they are embedded within the system, not acting on it from 'outside'. This perspective is critical to better integrate the range of diverse views and scientific opinion with the social motivations and responses to climate change which will emerge in the future.

More scientists and decision makers will need to appreciate and truly understand 'post normal science' to address future disease challenges.

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Emerging and Re-emerging Diseases of Wildlife and Domestic Animals - Defining the Role of Climate Change

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In contrast to vigorous debate over the past 20 years of how climate change might affect human health, the role of this driver on disease of livestock and wildlife has received comparatively little research. This however is changing, particularly as two important epidemic diseases – bluetongue in ruminant livestock and chytridiomycosis in amphibians – have been directly linked to global warming. But to what extent is there hard evidence linking these (and other emerging and re-emerging diseases) to the direct effects of climate change?

We undertook a systematic review of the literature of five disease in which there have been claims of a direct link between their emergence/re-emergence and climate change. Besides chytridiomycosis and bluetongue, our review included the zoonotic diseases Rift Valley Fever, Lyme Disease and West Nile Virus fever. Drivers for emergence of each of these diseases were classified as "Biotic", "Socio-economic" and "Abiotic", the latter including climate change, and rankings for their relative importance assigned.

The main direct drivers for disease emergence for the studied diseases are animal movements – facilitated by transport and trade – and landscape change. A possible role for climate change is indicated through climate variability leading to long, hot summers or unseasonably wet years, but the direct evidence for climate change as a driver is weak.

A critical examination of the published literature does not currently support claims that climate change has become an important driver for the emergence and re-emergence of infectious diseases in wildlife and livestock.

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Adapting Livestock Systems to Climate Change: Communicating One Health

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The theory, concepts, and practices related to health, environmental, and climate change communication have been studied and well-documented over the past decade. However, few research studies have explored how to integrate these approaches effectively for one-health communication that mainstreams climate change impacts into policy discussions. I will discuss

the theory and concepts related to the integration of these approaches and how I plan to apply them and measure their effectiveness in the management of integrated research, the development of policy, and the coordination of research themes related to adapting livestock systems to climate change.

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The Impact of Environmental Change on Disease Exposure in Canada's Aboriginal People

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Health Canada, Ontario, Canada

Many of Canada's Aboriginal people live in rural, remote settings and practice traditional lifestyles. 'Traditional' includes partial to substantial reliance on 'country foods' which are hunted or gathered; and prepared, stored and consumed according to custom. Exposure to zoonoses occurs in the environment; during handling of animals, sea mammals, birds and fish during hunting; and in food preparation and consumption. Increased risk to human health arises when environmental and climate change, natural events, and habitat disruption impact distribution of disease vectors, emergence of new diseases and challenge traditional food preparation.

This paper describes key zoonoses to which Canada's Aboriginal people may be exposed through traditional lifestyles, and reviews the impact of climate and environmental changes on risk factors for these diseases. Evidence for the influence of changes to traditional food supplies and the relationship between animal health and the health of indigenous peoples is examined and the relevance to Aboriginal peoples in other countries is explored.

Understanding and addressing challenges to the traditional lifestyles of Canada's Aboriginal populations, as posed by climate and environmental change, requires culturally sensitive approaches to risk identification and communication. Reducing risk of disease exposure without undue impact on traditional lifestyles is an important public health challenge, and approaches to risk reduction and adaptation to a changing environment are described.

Climate and environmental change are challenging the traditional lifestyles of Canada's aboriginal populations and are reflected in the relationship between animal and human health. Public health responses must be sensitive to traditional ways and cultural values.

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Drought-Rainfall Cycles as Potential Environmental Drivers of Fowl Plague and Newcastle Disease Outbreaks in Australian Poultry

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Climatic conditions in Australia are erratic and characterised by periods of intense rainfall followed by periods of intense drought. This has considerable impact on the population dynamics and ecology of many Australian species of waterfowl, which are thought to form the reservoir of avian influenza viruses (AIV) but may also be important carriers (and possibly reservoirs) of other diseases (e.g. bursal disease, Newcastle disease). During the wet, waterfowl numbers increase with many serologically naive juveniles entering the population. During the subsequent period of drought, bird densities increase in the few remaining wetlands. We hypothesise that it is during this period of increasing densities of naive birds that the population's viral prevalence of some infectious diseases may increase dramatically. Indeed, there exists a remarkable and suggestive coincidence between outbreaks of fowl plague and Newcastle disease in Australian poultry farms and the periods

of drought following a very wet period. In other words, we suspect a link between increased risk for disease outbreaks in poultry farms and the hypothesised high in the prevalences of the viruses causing these diseases in waterfowl. Given that poultry farms may provide ideal conditions for development of high-pathogenic strains, there is also a reciprocal risk for wildlife involved during these periods.

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The Effect of Climate Variation on Infectious Diseases in Humans in New Zealand

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The emergence and spread of disease is a major issue associated with environmental change. Contributing to this is climate variability and change may play in altering disease risk. The aims of this study were to investigate the association between climate and infectious diseases in humans throughout New Zealand, and then use these outcomes to build prediction models for estimating the burden of disease in 2015, 2040 and 2090 with respect to future climate change scenarios. This is a joint collaboration between the fields of human epidemiology at the Institute of Environmental Science & Research Limited, veterinary epidemiology at the EpiCentre (Massey University) and incorporates climate data supplied by the National Institute of Water & Atmospheric Research.

Four infectious diseases were investigated: campylobacteriosis and cryptosporidiosis with a primarily zoonotic reservoir, and influenza and meningococcal disease with a primarily human reservoir. Preliminary analysis of three regions indicated that weather variables were significantly associated with disease risk.

The modelling was based on the Knorr-Held Richardson model, previously applied to campylobacteriosis in New Zealand by French, Spencer and Marshall whereby livestock density in rural areas and social deprivation index in urban areas were associated with disease risk. In our Bayesian prediction models we adjusted for spatial and temporal correlation, demographic explanatory variables, and also explored additional associations with environmental drivers such as land use and river flow. The prediction models will be used in a web-based tool to identify communities at risk and help aid the implementation of informed strategies for disease risk reduction.

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Greenhouse Gas Emissions from Australian Diets

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Mitigating climate through reducing greenhouse gas emissions (GHG) from food may guide dietary recommendations and choices.

We modelled the life cycle GHG of four different dietary patterns using input-output analysis. The diets were a lacto-ovo-vegetarian diet (LVD), a high carbohydrate diet modelled on the Australian Guide to Healthy Eating (AGHE), a high protein diet modelled on the CSIRO Total Wellbeing Diet (TWD) and the average Australian diet (AAD).

Information was categorised according to major food groups and matched to food production sectors data from the input-output model. Quantities of food eaten in restaurants, taken from the ABS household expenditure data and takeaway food, were added for the three other diets. GHG expressed as kg CO₂ per kg of food were converted to kg CO₂ per dietary pattern per person per annum.

Beef was a major contributor of GHG – 27% of AGHE, 37% of TWD and 25% of AAD GHG emissions. Lamb provided 7%, 9% and 6% respectively. On LVD Dairy products were the main source of GHG at 27%. Current Australian eating patterns derived a large proportion of GHG from high kilojoule nutrient poor foods.

Although beef was the single highest GHG emitter per unit weight, it is an important nutrient dense food providing protein, iron, zinc and long chain omega3 fatty acids. Prioritising reductions in nutrient poor foods and reducing portion size has implications for benefitting both obesity as well as the environment.

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Addressing One Health in a Changing Climate

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Climate Change has an impact on environmental health, human health, animal health and plant health. There are multiple pathways through which climate change may impact “One Health” including: changes in temperature and precipitation patterns, increased frequency and intensity of extreme weather events, ocean warming and acidification, and changes in complex contaminants’ transport pathways among others. Climate and environmental change also affects socio-economic determinants of “One Health” such as development, demographics, agriculture, animal production, global trade, food prices, poverty etc.

The objective of this paper is to provide an overview of the impacts of climate change and variability on One Health and identify adaptation and mitigation strategies and policies to address these impacts in different geographical regions.

There is a lack of progress in achieving the Millennium Development Goals of which health is a key dimension. In order to address the challenges of Climate Change on One Health there is a need for adaptation and mitigation strategies in the context of sustainable and resilient development. This is very complex and requires trade-offs. Decisions made in the agricultural sector impact environmental and social factors driving development, in other sectors. Health makes this complexity more evident. When a health lens is adopted, it facilitates decision-making since it highlights social and development aspects.

To address the impacts of global climate and environmental change on One Health it is necessary to develop adaptation and mitigation strategies that are integrated in resilient development plans.

Agricultural Intensification

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Beware of Pigs Near Wings: Piggeries, Birds, Bats and Human Health

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Increasing affluence, economies of scale and population pressure is driving the expansion of intensified raising of livestock, including pigs, chickens, aquaculture and some wildlife. This has been dramatically observed in Asia and it is anticipated that other developing regions will follow. This presentation examines the link between intensive animal production and some emerging infectious diseases. It considers the extent to which we might limit further zoonotic and livestock diseases acquired through contact with wildlife as economic development progresses.

Intensive livestock production provides a habitat that may favour increased virulence, because of population density and a high proportion of immunologically naïve animals. There is also potential for novel pathogens to evolve if there is interaction between livestock and wildlife. In several cases, intensive livestock production appears to have formed a stepping stone to novel human infection (e.g. Nipah virus, Avian influenza serotypes, Ebola Reston).

Sub-Saharan Africa, to date with few intensive animal production units, appears particularly vulnerable to new and severe pathogenic expression. African bats are likely hosts for significant viral taxa, including henipaviruses and filoviruses. Great prudence is thus warranted to avoid overlapping bat activity with intensive piggeries, especially given the high mortality of human and non-human primates from some African filoviruses.

We argue that a framework to guide and evaluate the expansion of intensive livestock into new regions can be constructed. There needs also to be recognition that farmed and wild species (including bats) need to co-exist, but not (as far as possible) interact.

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Innovative Approaches in Veterinary Public Health by Embracing the One Health Framework

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²CDC

WHO, FAO and OIE defined Veterinary Public Health (VPH) as “The contributions to the physical, mental and social well being of humans through an understanding and application of veterinary science”. Outbreaks of highly pathogenic avian influenza (H5N1/HPAI) generated a great interest in the One Health approach which was further developed as a way of addressing emerging pandemic threats beyond HPAI, including emerging diseases. VPH is also an essential discipline to address endemic or so-called “neglected zoonotic diseases” through its systematic, multidisciplinary focus and better management of interactions between humans, animals and the environment. Through the One Health approach, VPH has expanded beyond strictly veterinary limitations to engage resources of public health and hygiene in a more effective manner, engaging a variety of sectors and professionals. FAO with partners is developing new approaches and tools such as integrated simulation exercises and the establishment of stakeholder negotiation platforms that can be used to address diseases institutional cooperation, coordination and communication and the streamlining of policies that can make an important contribution to enhancing the prevention and control of zoonotic diseases at the human-animal-environment interface.

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Responding to Highly Pathogenic Avian Influenza - Contract Farming, Market Chains, and Debt Relations

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Indonesia is badly affected by H5N1 HPAI. Since 2003, the disease has spread to 31 out of 33 provinces, caused extensive poultry mortality, disrupted the livelihoods of millions, and killed over 100 people. Jakarta, the national capital, centre of a conurbation of some 30 million people, consumes over one million chickens daily. Most of these birds are produced by contract farmers, and are transported live to be slaughtered and sold at some 350 ‘traditional’ markets. This area is a centre of persistent H5N1 infection.

The Indonesian poultry industry represent about 1% of GDP, with three large conglomerate companies responsible for about 70% of the market. Contract farming sees poultry, feed, day-old chicks and waste products widely transported,

increasing disease risk. This presentation explains why the large integrator companies have low incentives to change the system, which allows them to avoid financial risk associated with disease, and undertaking capital investment. It also highlights the role of the “brokers” or “middlemen”, who provide essential liquidity to farmers and market traders, but make disproportionate profit, and inhibit change in the market chains.

If HPAI is to be controlled in a lax regulatory environment where consumers demonstrate little concern, attention must be paid not just to production and marketing systems but also to financial structures, especially existing debt relations. Attempts to ‘restructure’ the poultry industry in Indonesia will struggle unless incentives can be found to generate capital investment and share disease risk more equitably.

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The Role of International Agriculture Research in Addressing Human Disease Associated With Agriculture

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Agriculture-associated disease sickens and kills millions of poor people. Food-borne disease is the most common illness in the planet. Zoonoses (diseases transmissible between animals and man) and diseases recently emerged from animals make up 25% of the infectious disease burden in least developed countries. Other urgent problems (include: fungal toxins (mycotoxins) in staple crops and animal source foods; water-borne disease; misuse of agricultural chemicals and antibiotics; and health impacts of agricultural alteration of ecosystems (e.g. irrigation & malaria).

The Consultative Group on International Agriculture Research (CGIAR) was formed in 1971 for the coordination of international agricultural research with the goals of poverty reduction and achieving food security in developing countries through agricultural research. Traditionally the CGIAR has focused on increasing the benefits of agriculture rather than decreasing the risks. However, while food insecurity remains an important problem, the burden of agriculture associated disease now out-weighs that of malnutrition and we describe how the CGIAR has been increasingly involved in agricultural research relevant to human health and some major current activities.

We also report on the ongoing re-structuring of the CGIAR which includes the development of a Mega Program bringing different research centers together to work on agriculture-associated diseases.

The One Health (and related Ecohealth) thinking, now prominent in the health community, recognizes agriculture-based interventions as a key component of multi-disciplinary approaches for managing agriculture-associated diseases and provides both a justification and clientele for increasing involvement of international research in enhancing human health.

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Approach to Managing Emerging Disease Threats in Australia - An Example for Successful Government - Industry Co-operation

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Australia, with its climate ranging from tropical to temperate and its closeness to the vast reservoirs of biological diversity of the Asia-Pacific region, is at particular risk regarding emerging diseases.

The importance of the livestock sector to the Australian economy necessitated the development of unconventional concepts to achieve timely control of emerging diseases.

Australian governments through their instrument Animal Health Australia, and the veterinary pharmaceutical industry in Australia have developed a co-operative approach. On a biannual basis, Animal Health Australia produces a list of diseases of concern.

The list is then shared with the Animal Health Alliance, the Australian association representing the veterinary pharmaceutical industry, with a request for feedback on the world-wide availability of control tools for the diseases of interest. Through its direct membership, and by being a member of IFAH – the International Federation for Animal Health – the Animal Health Alliance reached producers world-wide.

With the feedback received, Animal Health Australia is then able to undertake steps that will ensure availability of appropriate control tools.

The approach will be explained in more detail using a recent example of emerging diseases.

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Ebola Reston Virus Infection of Pigs: Disease Significance and Transmission Potential

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From September 2007 through to May 2008, disease outbreaks were reported on several pig farms in the Philippines. Pigs of all ages were affected, demonstrating a wide variety of clinical signs including fever, coughing and skin lesions. During the investigation by the Philippines' Department of Agriculture with assistance from the United States Department of Agriculture (USDA) several viruses were isolated from affected animals. These included Porcine Reproductive and Respiratory Syndrome virus, Porcine Circovirus 2 and Ebola Reston virus. The role of Ebola Reston virus in the clinical disease was uncertain.

To determine the consequence of infection of pigs with Ebola Reston virus, and assess the role of Ebola virus in the disease seen in the Philippines, an experimental infection in pigs was carried out. Pigs were challenged with 106 TCID₅₀ of the Philippines' 2008 isolate of Ebola Reston virus either via the oronasal or subcutaneous route. Following challenge pigs were monitored daily for disease and viral shedding. Animals were euthanased at days 6 and 8 post exposure for collection of tissues for virus isolation and immunohistochemistry. Evidence of virus shedding and replication of virus in internal organs in the absence of clinical disease represents a potential risk to farm, veterinary, and abattoir workers. This appears to be an unprecedented emergence of filovirus infection in a new host that may have important biosecurity implications for both livestock health and emergence in the human food chain.

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Infection Ecology and Epidemiology, IEE Network – A New Interdisciplinary Collaboration of Researchers in Zoonotic Infections

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Combating zoonoses effectively requires an approach where researchers take in account the “one health” concepts. The Infection Ecology and Epidemiology, IEE network was started to stimulate interdisciplinary projects with potential to increase knowledge of the emergence, spread and effects of infectious disease in humans, domestic animals and wildlife. The main objective for IEE is to provide a platform where researchers from multiple medical and ecological disciplines can interact and create synergies through collaboration, annual meetings and workshops.

The first IEE meeting, in March 2010, served as a unique opportunity for Swedish researchers (veterinarians, physicians, ecologists, epidemiologists and others with relevant backgrounds) interested in infectious diseases to interact over disci-

plinary boundaries. The meeting was a great success with almost 100 participants from across the nation. Since the meeting interest in IEE has continued to increase and the number of researchers supporting IEE now has now passed 150.

The projects within the IEE network range from antibiotic resistance in bacteria to the genetic virology of vector-borne pathogens, zoonotic viroses and gastrointestinal pathogens. The rationale is not to build up new laboratory facilities, but to use and collaborate within already established research structures. Within the network we have access to original samples of animal, human and environmental origin for collaborative projects for detection and characterization of viruses and bacteria. We hope that the IEE network will provide a sustainable platform for interdisciplinary collaborations and a strong international research environment for research on zoonotic infections.

Education to Respond to One Health

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Building the Foundation for a One Health Perspective Through Professional and Graduate Student Educational Experiences

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Since the Medical Sciences Library (MSL) at Texas A&M University provides informatics education, collaborative learning spaces, and library services to schools serving both human and animal medicine, and public health, it is keenly interested in the One Health initiative. Building a One Health perspective in our students and faculty is an MSL strategic initiative.

To identify, pilot and evaluate strategies employed to encourage a One Health perspective among our user community. To partner with faculty from various disciplines in implementing interprofessional efforts that support One Health perspectives. To use feedback received to enhance models for integrated curriculum and service delivery that encourage multi-disciplinary collaboration and foster a One Health perspective.

MSL librarians have developed curriculum modules, learning space designs and service assessment plans to encourage multidisciplinary collaborations that foster a One Health perspective. Partnering with faculty from all our professional schools, informatics curriculum modules and interdisciplinary courses were implemented. Feedback forms were used for each educational event. Learning spaces within the library were redefined to support more collaborative study and special events such as World Health Day were held in the library. In spring 2010, the LibQUAL + ® customer service satisfaction survey was administered to faculty and students across the Health Science Center professional schools and the College of Veterinary Medicine.

Aggregate data and participant comments from curriculum activities and LibQUAL + ® survey results confirmed the value and feasibility of the One Health initiatives.

One Health will continue as an MSL strategic initiative, with updated action plans.

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Building Capacity for Ecohealth Research in Asia

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Knowledge and skills in ecohealth need strengthening in geographic regions such as Southeast Asia where newly emerging infectious diseases (nEIDs) such H5N1 have caused widespread economic and health damage to humans, animals, the environment. A growing network of ecohealth researchers from a wide range of disciplines has been developing new approaches to ecohealth research to build capacity in SE Asian ecohealth.

The objectives of the network of ecohealth researchers in SE Asia is to build capacity in ecosystem approaches to health management, thereby reducing the risks of nEIDs and improving livelihoods.

Ecohealth is still an emerging field of study and practice that uses systemic and participatory approaches to understanding and promoting health and wellbeing in the context of complex social-ecological interactions. Understanding and awareness of opportunities for trans-disciplinarity, community participation, equity, and sustainability are at the core of building ecohealth capacity in SE Asia. To reinforce such understanding and awareness, researchers have focused on learning through case study, field visit, follow-up discussion, and trans-disciplinary exchange of information and viewpoints. This has increased awareness and developed opportunities for an integrated ecosystem approach to health management and research. Policy influence remains needed but underdeveloped in order to support integrated approaches to ecohealth.

Ecohealth researchers and practitioners can develop capacity from training, sustained communication, case studies, field visits, etc. but without policy support for ecohealth research and application, ideas remain academic. A number of ecohealth initiatives are growing in SE Asia but policy support is still lacking.

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Constructing a One Health Curriculum

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The need for One Health curriculum development is imperative as undergraduate, graduate and professional programs begin to incorporate one health content and redefine classical issues through a one health lens. Opportunities exist for designing new curricula or interdisciplinary degree programs that prepare one health professionals for careers on the ground. This is the case with conservation medicine.

Since 2008 faculty members from four schools at Tufts University have collaborated to create a one health graduate program in conservation medicine. We designed the curriculum around the basic knowledge and skills that a conservation medicine professional should possess. Individual course learning objectives were integrated with overarching program goals defined around four themes: principles of conservation medicine, applying conservation medicine, interdisciplinary work/communication and leadership skills, and fundamental themes in conservation medicine.

Faculty course leaders adopted a common pedagogy that would provide an environment for a diverse group of students to learn, communicate, and solve problems together. This pedagogy included becoming familiar with the language, tools and approaches of contributing fields; providing guidance and opportunities to develop team building organizational and leadership skills; providing guidance and opportunities to teach and communicate outside each student's chosen field; and developing writing, project management, grant seeking and career building skills to better prepare students for successful conservation medicine careers.

Introducing one health content across a broad spectrum is important, but a cohesive One Health program should also incorporate a uniform pedagogy, learning objectives and highly integrated courses sustained across an interdisciplinary learning platform.

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Curriculum Co-Development (Ccd): A Novel Pedagogical Method for One-Health Education

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Nations and educational institutions have historically been, and are, at different states of resource endowment. This includes faculty capacity, availability of learning and teaching materials, human resources, and material infrastructure. Curriculum co-development (CCD) helps bridge these differences. CCD promotes interdisciplinary education and collaborative delivery of learning materials.

The CCD methodology entails: faculty in different institutions/countries finding willing colleagues or being linked by third parties; physically meeting to review their curricula and agree on content to be shared; discussion and agreement on delivery logistics including modes, media, timing; and actual curriculum delivery, monitoring and evaluation. CCD pedagogy has several key advantages particularly relevant to One Health education.

We have applied this model to teaching public and ecosystem health between Tufts University in Boston USA and East African universities (the East African Curriculum Consortium, EACC). The under-resourced (in terms of current learning materials) EACC universities benefited from Tufts' digital library while the students and educators across all institutions enhanced their understanding of One Health, while respecting each site's inputs and insights. Synchronous teaching and learning was not possible due to time differences thus asynchronous content delivery, and mentored student discussions, were adopted. CCD enhanced the social construction of knowledge effectively creating a One Health model of education and practice, befitting the current global village.

Our innovative application of CCD has allowed faculty experts in human, animal, and environmental health to collaborate on holistic teaching and learning at different locations using internet based technologies, creating a truly global community of knowledge and practice.

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Using a Competency-Based Enterprise Architecture for Teaching and Learning to Support One Health Education in the Classroom and the Field

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The knowledge of One Health is found at the intersection of human, animal and environmental public health. A sophisticated technology is required to manage this complex knowledge. The Tufts University Sciences Knowledgebase (TUSK) is an open source enterprise architecture for teaching and learning developed at Tufts University and adopted by health sciences institutions as an efficient tool to manage, create, share and reuse health sciences and One Health content.

At Tufts TUSK serves the Dental, Medical and Veterinary Medical schools and the Public Health program. A single repository stores all learning objects. Faculty access, share and reuse content across schools using a rich search utility that employs common indexing concepts from the US National Library of Medicine's Unified Medical Language System.

TUSK's architecture supports competency-based education. Clearly defined published competencies can be mapped to the curriculum with matched assessment processes, which can support a One Health education as it manifests itself throughout the curriculum and among schools and courses. A single content repository allows faculty to create and share educational building blocks to develop and share One Health education within and across Universities. TUSK's import/export tools also support curriculum co-development (CCD). TUSK mobile provides users with access to a One Health curriculum while they work in the field or participate in distance education.

Integrating One Health competencies and assessment into the workflow of an enterprise system for teaching and learning with reusable content can bring the promise of One Health education a step closer to reality.

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Global Health Institute – One Health Training Experiences from Uganda

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The Global Health Institute (GHI) is an annual International Educational Program whose activities are aimed at raising awareness of the One Health concept and supporting the cross cultural, multi-disciplinary/sectoral approach to human, animal and environmental health. In August 2010, it conducted a 2-weeks One Health training hosted by Makerere University School of Public Health, Kampala, Uganda in collaboration with Tufts and Minnesota universities to officially launch the One Health strategy in the country. The courses offered at the training were zoonotic diseases, global public health concepts and practices, participatory epidemiology and applied biostatistics. The GHI activities also hosted a series of public educational events including a television talk show, a public lecture and accompanying panel discussion, and a Global Food Safety and One Health Leadership seminar. The over 80 trainees were postgraduate students and junior faculty of Makerere University (School of Public Health, Faculty of Veterinary Medicine), University of Minnesota, Schools of Public Health from Tanzania, Rwanda, Congo (DRC), Ethiopia and Kenya, and local staff from hospitals, districts and nongovernmental organizations. Other participants in the public events included a diverse array of international and local, governmental and nongovernmental organizations. The courses were facilitated by faculty from University of Minnesota, Makerere University, Ministry of Health and Uganda Wildlife Authority. The launch of the One Health initiative clearly brought together various stakeholders involved in the concept who are expected to work towards a better ‘One Health’ in the future. Countries that have not already done so can learn some lessons from Uganda.

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Paving the Road to One Health: Veterinary Medicine and Interprofessional Education

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The concept of “one medicine/one health” is not foreign to veterinary medicine and education. After understanding and mastering the basic concepts of biology, pathology, and medicine through comparative medicine approach, student doctors recognize early their professional role in public health arena: emergence of zoonotic diseases; bio- and agroterrorism threats; international veterinary medicine; animals, especially wildlife, as sentinels for human health; farm animal industry with large scale food safety challenges that include residues, zoonotic agents, and contaminants; bioaccumulation of the pollutants and heavy metals; human-animal bond that brings various animal species in the close contact with people. Historically, veterinary medicine recognizes its role in global health (veterinarian’s oath), but the recognition from the public health domain, and especially human medicine, is very slow and sporadic. In the light of recent zoonotic disease outbreaks and new health challenges in the modern world, there is a need for change. With the political and scientific support, the education needs to take a leadership role in bridging the gap between different medical professions. Policy-making needs to start with education, and centered team approach is the key. Industry and organizations (CDC, WHO, AFIP), public/animal health centers and MPH programs should follow by re-structuring their internship and externship programs with this more inclusive interprofessional team-approach. One novel model already exists: Interprofessional Education program at Western University of Health Sciences (USA) with two objectives: awareness of interprofessional teamwork and all inclusive approach to different medical professions centered around global health issues via Problem Based Learning.

Social Demographic Drivers

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Peoples' Perception of Hpai: Lessons Learned From Live Bird Movement Studies In Bali And Lombok – Indonesia

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Highly Pathogenic Avian Influenza (HPAI H5N1) is a recognized threat to the global community and continues to have a severe impact in several developing countries. Indonesia is one of these with over 794 HPAI outbreaks in poultry and a case fatality rate of 83% among the 168 confirmed human cases. Realising the cost and risk of ongoing outbreaks, the aim of this research was to identify high-risk movements and practices for HPAI among chickens and ducks in Bali and Lombok – Indonesia. As part of this research, we investigated community perceptions of HPAI through interviews with 618 respondents (poultry vendors, collectors, and buyers) at 17 live bird markets in Bali and Lombok during 2008–2009. The results highlight unfavourable community perceptions toward HPAI and recommended biosecurity measures, to practices related to the management of sick and dead birds and to the management of birds during transportation and at live bird markets, activities that pose a high transmission risk. In Lombok, an island that has not experienced extensive poultry outbreaks, poultry vendors and collectors considered HPAI to be “not significant” and “only seen on TV”. Respondents in Bali and Lombok reported consumption of sick birds to be safe and considered mixing birds of different species and from different sources to not be problematic. A positive perception in terms of biosecurity along the market chain was a strong preference for purchasing healthy birds. Reducing HPAI at source and preventing its spread through the market chain requires extension targeting these perceptions.

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Gender and Culturally Sensitive Participatory Surveillance of Emerging Pandemic Threats

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In the western Congo Basin RESPOND project, one of the five projects under USAID's Emerging Pandemic Threats program, aims to develop regional human and technical expertise to identify and respond to emerging pandemic threats.

The One Health approach is a core concept to integrate environmental aspects, human and animal health and, for it to realize its potential, the integration of socio-cultural aspects is crucial.

Risk and disease are embedded in the social construction of gender due to gender-based differential exposure and vulnerability. In some settings due to cultural and economical constraints women cannot travel alone to a clinic or take their children to the clinic without the authorization of their male partner. Thus, while some diseases or afflictions can be gender specific, gender roles and cultural and economic characteristics explain gender differences in health perception and reporting.

The importance of ancestors, spirits, witchcraft and cultural taboos to explain disease and afflictions cannot be ignored. However, understanding of disease and misfortune and actions to be taken to prevent and treat them are specific to a

context and influenced by religious and secular beliefs. Cultural and religious issues also have an impact on the way people frequent health facilities. Understanding the culturally specific aetiologies of diseases, systems of healing and people involved in prevention and treatments allow the development of gender and culturally sensitive interventions.

To achieve a desired impact on the lives of local community, gender and cultural issues have to be integrated in the One Health approach.

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Contribution of Transdisciplinary Studies to Risk Analysis Concept: Insight into Milk Safety in Mali

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Meat and milk demand is transforming production systems and shifting societal preferences towards market-oriented value-chains in developing countries. Even in countries dependent on import of foodstuffs, local production, mostly informal, is developing.

In Mali, a huge quantity of milk reaches urban markets everyday through numerous networks of collectors generating income for value chain actors and offering consumers an alternative to imported milk products. A frequent concern is the quality and safety of dairy products. To understand the socio-cultural determinants of the provision of “good” or “healthy” milk, we investigated actors’ motivations and conceptualization of quality and risk in the periphery of Bamako (Kasséla) and Ségou (Cinzana) in Mali.

We found peoples categorization of milk as “good”, “bad”, “pure”, “healthy” was not dichotomized or fixed, but rather plastic and dynamic according to motivation and contexts. Thus if milk provides more money, women still consider the adulterated milk good. Likewise, herders consider milk pure if has not undergone any transformation; they consider milk healthy if it does not cause visible illness (even if antibiotic residues and brucella spp. are present). On the other hand, cattle owners consider that if milk is heated it is ‘bad’ for herd productivity and loses nutritional value.

We conclude that perception of milk quality and associated risks and benefits depend on beliefs, perceptions and incentives. The development of good practices of hygiene must take into account all actors and be implemented at all levels of the chain, especially the households often neglected in past dairy development interventions.

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Investigating the ‘why’ and ‘where’ of Hendra Virus Infection in Horses.

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Hendra virus sporadically infects horses. The distribution of horses and flying foxes (the natural host) overlap in eastern Australia, yet thirteen of the fourteen identified equine incidents have been in Queensland.

Horse density correlates with human density, and in eastern Australia, firstly maximises towards the coast, and secondly concentrates around larger towns, regional cities, and conurbations. Thus, the intuitive expectation is that (at similar bat-horse densities), incidents would equally occur in NSW and QLD, and would spatially cluster in the conurbations of south-east Queensland and central NSW.

This is not the observed occurrence, and might intuitively be plausibly explained by the overall decreasing density of flying foxes from north to south. However, if the geographic occurrence of equine incidents only reflects probability of effective contact, high horse density in parts of central NSW should still have supported Hendra incidents to date, notwithstanding a lower flying fox density. Similarly in Queensland, on the basis of horse density alone, there should have been a greater proportion of incidents in SEQ than FNQ, whereas the observed proportions are more or less equal. So the relationship between horse and flying fox density alone does not adequately explain the observed spatial pattern. We are currently examining the relationship between bats and horses in the context of sub-regional ecosystems.

Will this more complex analysis provide a better fit of the observed data? It may be that ecosystem type/diversity is an unidentified contributing risk factor for the spillover of Hendra virus from bats to horses.

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Cysticercosis in a Population of Epileptics in Western Kenya: Relating Human and Pig Risk Factors

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One Health recognizes the inter-dependence of human, animal and environmental health and is especially relevant to understanding zoonotic diseases such as cysticercosis. Cysticercosis, caused by larval stages of the pig tapeworm *Taenia solium*, is an important disease in developing countries and a major cause of adult onset epilepsy.

We report on a study of 1051 epileptics in western Kenya. In total, 628 respondents answered a detailed questionnaire on risk factors on socio-economic determinants including pig husbandry. We describe the profile of a typical epileptic in western Kenya and their typical pig husbandry system. We also assess risk factors related to pig husbandry, pork consumption, poverty, occupation, practices around water and sanitation, education and knowledge.

A quarter of households kept pigs at the time of survey and half had kept pigs in the past, most kept local breeds and at most pigs were at least partially free-range. Meat inspection was infrequently practiced. One third of the epileptics reported observing nodules in pork meat and one half had observed tapeworm segments in their own faeces. Sanitation practices, spatial location and occupation were the most important risk factors. Contrary to our initial hypotheses, neither poverty nor intensifying pig-keeping were predictive of disease, and possible reasons for this are discussed.

By conducting disease surveys that simultaneously address humans and animal risk factors additional insights can be gained into zoonoses epidemiology.

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Perceptions of the Impact of Wildlife on the Health and Livelihood of Humans and Domesticated Animals Near the Limpopo National Park, Mozambique

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The area around Limpopo National Park in Mozambique is a unique community where humans, domesticated animals, and wildlife live in close proximity. The impact of wildlife on the health and livelihood of human and their domestic animals is unknown.

To assess the perceptions of the impact of wildlife on human and domestic animal health and livelihood in communities near the Limpopo National Park.

A cross-sectional survey using mixed methods was conducted in May 2007. Village leaders, government officials, and farmers were interviewed.

16 of 52 (32%) villages were surveyed. Most interviewees had seen wildlife in their villages; 42% had noted wildlife interacting with livestock. Farmers were most concerned with crop damage (due to elephants, hippopotamuses, baboons, monkeys and antelope). Rabies was most commonly identified zoonosis (27%). Interviewees did not perceive that wildlife increased the tuberculosis (TB), anthrax, brucellosis or foot and mouth disease. Six persons and 82 livestock were killed by wildlife over the last few years. Improved infrastructure after the park's creation has led to better access to human health services.

The creation of large national parks in sub-Saharan Africa have resulted in the close proximity of humans, domesticated animals, and wildlife. The identification of important zoonoses will improve vector control and vaccination strategies. To maximize benefits to humans and animals, improved education and policies should be established. Further studies to assess the interface between these three groups are needed.

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The Screening of Canine Populations for Parasites with Zoonotic Potential, as part of a Canine Health Program in Australian Indigenous Communities

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In many Indigenous communities, people cohabit with dogs in often overcrowded and poorly maintained houses. The potential for spread of diseases between dogs and humans is considerable.

In conjunction with local government, The University of Melbourne has developed a dog health program in communities in the West Arnhem region of the Northern Territory, which includes surgical desexing of dogs, euthanasia of sick injured and unwanted dogs, regular ivermectin treatments against parasites, and annual dog population audit, involving evaluation of breeding status as well as skin and body condition. During six years, improvements in all of these measures of dog health have been recorded. In addition, parasitic infections are considered. As traditional methods do not usually allow specific diagnosis of infections with intestinal parasites, identification and genetic characterization of canine parasites are central to assessing the potential risk of transmission to humans, and underpin disease prevention and control programs.

We have employed molecular tools to screen canine populations for the presence of gastrointestinal parasites with zoonotic potential. In particular, polymerase chain reaction (PCR)-based mutation scanning and sequencing was utilised to screen for helminths and protozoa of such potential. Initial results have indicated a high prevalence (21% of 130) of *A. caninum* infection and the presence of *Giardia duodenalis* (1% of 130). Future work should focus on expanding the application of molecular tools to address key epidemiological questions, including those relating to transmission, reservoir hosts and parasite-host relationships. Such insights will inform health management strategies in the context of Indigenous populations.

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Demographics, Communal Cattle Dynamics and Potential Exposure to Uncertified Meat

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As an adjunct to a spatial risk model, routine surveillance data were collected on home slaughter and sales of communal cattle in three rural study sites adjacent to the Kruger National Park, South Africa. The three sites all fall within a Foot and Mouth Disease control zone and therefore have restricted marketing opportunities and access to commercial abattoirs/feedlots outside the control zone. The northern site had a low human density (0.23/ha) and relatively high cattle: cattle owner's ratio of 16.8 compared to 5.31 people/ha and 7.2 cattle: cattle owners in the south.

In the northern site, relatively isolated from commercial areas, only 0.44% of cattle are slaughtered annually compared to 9.90% in the south. This is paradoxical considering the limited access to certified meat in stores in the north compared to the more urbanised south. Comparing the ratio of cattle sold: home slaughtered cattle, further emphasizes this disparity in the consumption of uncertified meat between the areas. In the south, 4.85 cattle are home slaughtered for every one sold, compared to only 0.03 in the north. More specifically, one animal was home slaughtered for every 69 and 186 people resident in the central and southern areas, respectively, compared to more than 500 people per animal home slaughtered in the north, pointing at a much higher risk of exposure to uncertified meat in more urbanized southern and central areas.

These data pose important questions regarding the influence of disease control restrictions on marketing and consequently meat safety in urbanising rural areas.

Public Health in the Future

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One Health Central and Eastern Africa: Bringing Health Professionals Together

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Deans of Public Health and Veterinary Medicine from 16 universities in 6 African countries (DRC, Ethiopia, Kenya, Rwanda, Tanzania, and Uganda) and the US established "One Health Central and Eastern Africa (OHCEA) in October 2010 with support from the United States Agency for International Development. The One Health approach adopted allows multiple academic disciplines (e.g. public health, ecology, animal [livestock, wildlife and companion animals] health, anthropology, communication, others) to link academic training to actions and activities involved in the day-to-day control and prevention of both normative and emerging diseases. The OHCEA Deans and their schools will support and facilitate National One Health Core Working Groups that bring government, communities and educational institutions together to address issues of normative and emerging infectious disease prevention and control using a One Health approach. OHCEA provides an evolving platform to: transform the way the health leaders of tomorrow understand and practice their professions; transition the current health workforce through continuing education to adopt One Health approaches to disease investigation and response; and broaden the public health base by including community-based health workers. The aim is to ensure that: each One Health professional is well-trained for their role, and mandated and appropriately equipped; professionals have improved skills to work collaboratively with each other and with government, the private sector and the community; and health systems will benefit from One Health efficiencies.

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Gender Implications for One Health Approaches

Julia Landford

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Gender considerations can lead to improved One Health strategies and outcomes for endemic zoonotic and emerging infectious diseases.

At the recent MDG Summit world leaders reiterated the importance of addressing inequalities between men and women - or between rural and urban women – noting that accelerating progress towards achieving all of the MDGs depends on this. Gender is also a fundamental factor for consideration when addressing the risks and challenges brought about by interactions between animals, humans and the environment.

There are a number of gender variables that can be tackled through One Health approaches for improved responses to endemic zoonotic and emerging infectious diseases. WHO has identified that gender influences patterns of exposure to infectious diseases as well as treatment outcomes. FAO and the World Bank have identified that gender roles (as seen in the agriculture or public health sectors) can influence where men and women spend their time, the infectious agents they come into contact with, as well as the nature of exposure, disease frequency and intensity. Differences in the provision of health care for men and women (or for rural and urban women) as well as veterinary health care for domestic or livestock animals can influence the outcomes of diseases.

By giving gender a high priority as an integral part of targeted and collaborative One Health approaches, governments, international agencies and NGOs will strengthen progress towards achieving the MDGs as well as reducing risks of endemic zoonotic and emerging infectious diseases in men, women and children.

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A Social Science Perspective on Diseases of Poverty and One Health Approaches

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International Development Consultant

Back in 1996, scientists at Harvard University were investigating the contributions of social inequalities to disease emergence. Social inequalities have been responsible for not only the distribution of disease but also the course of disease in those affected. Their view was that critical perspectives on emerging infections required genuine transdisciplinary collaboration between scientists, public health clinicians, veterinarians, epidemiologists and social scientists.

In the 1980's several pioneers of medical practice argued that “the key task for medicine was not to diminish the role of the biomedical sciences in the theory and practice of medicine but to supplement them with an equal application of the social sciences in order to provide both a more comprehensive understanding of the disease and better care of the patient.” The essence of this problem was “not too much science” but too narrow a view of the sciences relevant to medicine”.

The debate continues but with international recognition of the need for One Health approaches – bringing animal-human-environmental health disciplines together to address associated risks and challenges. The anthropology of emerging infectious diseases remains somewhat in the shadows however, despite clear indications of the importance of understanding the socio-cultural context of endemic zoonotic and emerging infectious diseases.

It is poverty and other socio-economic factors that enable infectious diseases to take advantage of their environment and to spread. The same factors also make it challenging for implementation of effective control measures. Gender has a major impact on the distribution of disease, risks of transmission, diagnosis and patterns of care – but there are many other social and economic variables that need to be considered including ethnicity, age and socio-economic status. Recent studies continue to

underline the need for a social science perspective on diseases of poverty and emerging disease threats; One Health approaches must ensure that equity remains an underlying principle in policy development, resource allocation and implementation.

Trade, Food Security and Food Safety

Globalization

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Unpeeling the Analysis Myopia

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Economic and policy reviews are generally designed to consider one issue at a time within specific guidelines. Explicit terms of references allow for the allocated resources to achieve a set goal by a set date with hopefully notations made about further areas of future research. This work feeds into other reports from which new steps are taken and further outcomes are derived. This approach can and does lead to knowledge gaps that impacts directly on the issue at hand and indirectly on raft of other policies. Perhaps even here the goal of One-Health needs to consider that the influences on long term human, animal and environment health may be wider than this identified trinity. This paper will examine some of the entangled influences that economics should consider when examining import risk analysis (IRA) that may influence one-health outcomes.

The IRA is Australia's formal structure to meet its World Trade Organisations (WTOs) Sanitary and Phytosanitary (SPS) obligations. The IRA process distils down to a 6*6 matrix determining the qualitative risk of changes to quarantine barriers. Economic inputs into this scientific approach have and continued to be limited not only in terms of the tools used but the boxes in the IRA process it influences. Perhaps it's time to take a scalpel to this myopia and unpeel these specific guidelines to examine if economics could help examine the probability and probable extent of harm to humans, animals, plants, the environment and other economic activities.

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Global Eradication of Classical BSE - When; and What Will It Mean?

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Classical bovine spongiform encephalopathy (C type BSE) is a zoonotic, non-contagious transmissible spongiform encephalopathy (TSE) that primarily affects bovine animals. The disease was spread from its origin in the United Kingdom to some other countries through the global trade in live cattle and livestock feeds. Cases of C type BSE were subsequently identified in indigenous cattle in mainland Europe, Japan, Canada and Israel. The 217 (as of June 2010) primary cases of variant Creutzfeldt-Jakob disease (vCJD) in people were orally acquired through foods containing specified risk materials from C type BSE-infected cattle. This same route led to C type BSE causing naturally occurring cases of TSE in domestic cats, some zoo animals, two goats and non-human primates.

This presentation aims to discuss whether global eradication of C type BSE is achievable and what this may mean for current C-type BSE risk reduction measures.

Measures were established in international standards and the legislation of many countries to minimise the risk of new cases in susceptible species attributable to C type BSE. Published epidemiological evidence points to the global eradication of C type BSE being within sight, provided measures are kept in place which prevent recycling of C type BSE in ruminant feeds. Global eradication of this disease may mean that current risk reduction measures can be rationalised in the future.

There are a number of possible options for rationalising these measures in the areas of feed controls and food safety measures, as well as the associated surveillance in cattle.

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Impact on Human, Animal, and Ecosystem Health and Food Security from Restructuring of Livestock Production Farming Practices in Vietnam

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The incidence of several emerging infectious diseases (EIDs) has increased rapidly with alarming threat of global pandemics and significant negative implications to human and animal health and economic development. The responses so far have focused primarily on short term control-based interventions targeting single EIDs rather than longer-term sustainable multidisciplinary solutions that address precipitating factors. The midterm evaluation of the Government of Vietnam-UN Joint Program on Avian Influenza indicates that wider knowledge of the Ecohealth Approach is needed to integrate management roles relating to the interfaces of animals, humans, and the environment. Importantly, this must be directed at EIDs in general, rather than (e.g.) HPAI or H1N1.

To improve policy that supports an integrated ecohealth approach, leading to adoption of recommended changes in livestock production, sustainable reduction in EIDs, and improved livelihoods.

Evidence-based multidisciplinary research is needed to show increased productivity of livestock, improved village level nutrition, reduced risk of EIDs, and better understanding of the impact from addressing livestock disease on ecohealth and food security in Asia. This fundamental change in approaches to disease control needs to be supported with policy based advocacy addressing multidisciplinary approaches to health management.

The concept of sustainable ecosystem health (managing the interface of animals, humans, and the environment) to prevent EIDs requires a stronger integrated approach, not only in principal but also in implemented programmatic activities. Such a multidisciplinary research and application approach requires support from stronger health policies.

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Operationalizing One Health at the Grass-Root Level

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Community animal health workers (CAHWs) are defined as community members who obtain the basic training in disease recognition and provide basic animal health services at village or sub-district levels and mainly serve as connectors between community and animal health authorities to promote animal health. During the crisis of highly pathogenic avian influenza (HPAI), CAHWs actively participated in HPAI control in many countries including those of Greater Mekong Sub-region. Grass-root level field surveillance and early warning networks have been established using the CAHWs networks as existing village social structures to create culturally compatible information gathering systems. In countries with limited veterinary services, an operative and sustainable CAHWs system may contribute significantly to the livelihoods of the resource poor rural communities through providing basic animal health services as well as through early detection of disease foci and thus facilitating rapid control measures. Due to the close relationship with the community, it makes them a very important resource for communicating risks and for undertaking preventive measures against animal diseases. Inter-sectoral collaboration between animal and public health authorities at community level has been demonstrated in Thailand through the integration of Village Health and Animal Health Volunteers for surveillance and early warning regarding HPAI and other

zoonotic diseases in both animals and humans at the community level. Similar efforts can be applied to expand community participation not only for disease surveillance but also for monitoring any changes of environmental and socio-economic drivers that potentially lead to any emerging health problems in the future.

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OzFoodNet: Establishment of a Network; Ten Years and One Thousand Outbreaks

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Investigating enteric diseases can be very challenging due to the many possible sources of infection. Collaboration between health, agriculture and food-safety agencies is necessary to detect and prevent foodborne diseases. In 2000, the Australian Government established a national network—OzFoodNet—to enhance surveillance of foodborne diseases. Prior to the establishment of the network, there was no formalised national surveillance of foodborne disease outbreaks or systematic analysis of notification data. We examined the burden of foodborne disease using information from applied research, disease surveillance, and foodborne disease outbreaks. 5.4 million cases of foodborne disease were estimated to occur annually, costing society \$AUD1.2 billion. To learn about the causes of foodborne disease, the network conducted case control studies, such as Shiga Toxin producing *E. coli* associated with eating hamburgers and working with animals; and hyper-endemic *Salmonella* Mississippi in Tasmania transmitted from drinking untreated water and contact with native animals and birds. The network conducted surveillance of over 1000 foodborne disease outbreaks throughout Australia, highlighting trends in high-risk foods and settings. These included emergences of *Salmonella* outbreaks associated with eggs, and outbreaks associated with internationally-distributed foods, including sesame-seed products, oysters and semi-dried tomatoes. Collaboration with Food Standards Australia New Zealand and other government agencies have proven important for the development of food safety policy. Australia has participated in international collaborations to understand the burden of foodborne disease and strengthen food safety, as well as international outbreak investigations. Networks are an important means of strengthening surveillance to prevent foodborne diseases.

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One Health Policy Options for Biodiversity, Livelihoods and Transboundary Disease Management in Southern Africa

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A key economic driver behind southern African transfrontier conservation areas (TFCAs) is nature-based tourism that seeks to maximize returns from marginal lands in a sector where southern Africa enjoys a global comparative advantage. Nature-based tourism (photographic safaris, trophy hunting, etc.) now contributes about as much to the GDP of southern Africa as agriculture, forestry, and fisheries combined – a remarkable and relatively recent development documented by the Millennium Ecosystem Assessment. However, the management of wildlife and livestock diseases (including zoonoses) within the envisaged larger transboundary landscapes remains unresolved and an emerging policy issue of major concern to livestock production, associated access to export markets, and other sectors, including public health, in the region. Essentially, the TFCA concept and current internationally accepted approaches to the management of transboundary animal diseases (TADs) are largely incompatible. The TFCA concept promotes free movement of wildlife over large

geographic areas, whereas the present approach to the control of TADs is to use vast fences to prevent movement of susceptible animals between areas where TADs occur and areas where they do not, and to similarly restrict trade in commodities derived from animals. A new policy paradigm is needed to help resolve the incompatibility between (a) current regulatory approaches for the control of diseases of agro-economic importance and (b) the vision of vast conservation landscapes without major fences- now that SADC countries have chosen to pursue transfrontier conservation initiatives in the interest of regional risk-diversification of land-use options and livelihood opportunities.

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Enhancing Joint Delivery of Human and Animal Health Services in Remote Areas

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Vaccination and other health services for people and livestock often fail to achieve sufficient coverages in remote rural settings of resource poor countries. Organizations such as the International Committee of the Red Cross have implemented human and livestock vaccinations to make best use of the available infrastructure/personnel and field visits by professionals, but these approaches were hardly documented. Following a recommendation of the Chadian Ministries of Health and of Livestock Production as well as mobile pastoralist communities, we have facilitated the implementation and assessed the feasibility and costs of joint human and livestock vaccination services in communities who previously were not covered by public health services, but where livestock vaccination was done regularly. A team of physicians and veterinarians shared transportation and cold chain to reach the remote families during several campaigns. Next to vaccination, other health services were offered on the sites, including appropriate information. Combined health and veterinary vaccination reduced operational costs and were highly valued by all partners involved, particularly the livestock keeping families. Based on the positive outcomes of these pilot campaigns, Chadian public health and veterinary officials had workshops to discuss policy formulation on integrated services in rural areas. By optimizing the use of limited logistical and human resources, public health and veterinary services can be strengthened, especially at the district level.

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Leveraging One Health: Lessons from Partnerships with International Organisations, Industry and the Public Sector

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The One Health concept has experienced unprecedented revival in the last decade. The catalysts for this revival are many and varied: advances in science showing close genomic relationship between animals and humans, emerging infectious diseases including zoonotic diseases, environmental and pandemic threats among others. At no time in history has there been a greater need for an integrated approach to meet global public health challenges. The over specialisation of disciplines and the reductionist approaches to scientific research are continually being proven to be inadequate and inappropriate. Similarly, the traditional roles between the public and private sectors are increasingly blurred.

Using our work on Trypanosomosis and Porcine Cysticercosis, the presentation provides practical approaches employed by our organisation in working with varied stakeholders to leverage One Health.

At the heart of the One Health concept are the ideas of partnership, coalition and alliance, multidisciplinary and cross sectoral collaboration. Our organisation brokers partnerships and works collaboratively with a broad spectrum of organisations and stakeholders in making livestock technologies accessible and affordable to the millions for whom livestock is a lifeline. Other organisations could benefit from a similar integrated approach.

An integrated approach that recognises the potential of Public Private Partnerships, the role of donors, the commercial sector, governments and international organisations is crucial as is the need for organisational and institutional change in order to ensure the delivery of technologies; science is important but the ability to deliver is equally important in order to leverage One Health.

Antimicrobial Resistance

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Development and Implementation of Multi-Disciplinary, Multi-Sectoral Training Modules Through the Regional Field Epidemiology Training Program for Veterinarians

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Comprehensive health promotion, disease prevention and early detection are critical to implement a One Health approach. Two training modules were developed through the Regional Field Epidemiology Training Program for Veterinarians to increase awareness of the Animal-Human-Environmental and the Socio-Economic-Communications interfaces. The target group included veterinary and medical field epidemiologist trainees, wildlife professionals and FAO national consultants. A multi-disciplinary team with expertise in veterinary epidemiology, wildlife medicine and ecology, animal health, human health, sociology, economics and communication developed applied modular training methods and materials based on specific learning objectives and problem based learning exercises including case studies. A total of sixty participants from human health, agriculture and environmental sectors from nine countries participated in both training modules. Evaluation of teaching methods and relevance to participants was conducted. Thirty-one of 35 (88%) participants agreed or strongly agreed that the Animal-Human-Environmental interface training would contribute to improved multi-sectoral collaboration and 28 of 33 (85%) respondents indicated that the module was relevant to current situations and needs in their respective countries. Eleven of 11 (100%) and nine of 11 (75%) respondents either agreed or strongly agreed that the Socio-Economic-Communications module lectures either was useful or that exercises increased their awareness, respectively. Classroom exercises and case studies will need to be further adjusted to address feedback and suggestions from participants and trainers. Innovative multi-disciplinary, multi-sectoral training for field epidemiologists promotes team building and it provides a more comprehensive approach to better inform decision makers for disease surveillance and outbreak investigation of emerging infectious diseases.

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Ask the Expert: Difficulty in Expert Estimation of Transmission of Meticillin-Resistant *Staphylococcus aureus* (MRSA) Between the Environment, Pets and Humans

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Elicitation of formal expert opinion, through expert judgement exercises, has been used to populate simulation, mathematical and conceptual models in animal and human health fields. The aim of this study was to obtain data through implementation of an expert opinion questionnaire, enabling the initial, and fully updateable, parameterisation of a quantitative risk assessment model in the area of acquisition of MRSA in pet dogs.

A mailed questionnaire was developed using a novel application of previously utilised expert opinion techniques and administered to 34 multidisciplinary experts. The outcome of the study was a set of composite expert estimates of prevalence, environmental contamination and transmission variables.

The use of calibration variables provided an estimate of the accuracy of the experts, resulting in the exclusion of a single expert and demonstrating confidence in all others. Despite this, while many questions returned narrow and informative combined distributions, markedly divergent opinions were obtained for some estimates, resulting in wide and minimally-informative combined expert distributions. In particular, the responses for questions estimating environmental contamination and the routes and probabilities of transmission of MRSA between humans, the environment and dogs, obtained responses with marked variation in confidence, uncertainty and absolute values. These findings were also reflected in the difficulty reported by the respondents in completing the questionnaire with respect to estimation of transmission variables.

The results of this study highlight the difficulty in defining probabilities of transmission of pathogens between humans and animals, which are unlikely to be resolved through either observational or experimental studies.

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Molecular Mechanism of Antibiotics Resistance in Poultry Isolates of *Campylobacter jejuni*

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Campylobacter is the part of normal intestinal flora in chicken. However, contaminated poultry is a transmission factor in humans for which *Campylobacter* is most common cause of gastroenteritis. Therefore the presence of drug resistant strains in poultry might provide a niche for the spread of antibiotic resistant human infections. This study describes the antimicrobial resistance mechanisms of chicken isolates of *Campylobacter jejuni*. A total of 600 chicken cloacal swabs, collected from different poultry farms were screened. Isolates were characterized for antibiotic susceptibility and analyzed for integron analysis and resistant determinants of commonly available drugs. 81% samples were found positive with *Campylobacter jejuni*, of them resistance against tetracycline, nalidixic acid, ciprofloxacin, sulfonamides and erythromycin was high. In agreement with R-phenotype, they possessed class I integron with 1650 bp variable region assorting R-cassettes for tetracycline and sulfonamide. Further characterization revealed amino acid substitution at 6 different places in QRDR and downstream region of *gyrA* gene pertaining fluoroquinolone resistance. Out of them 3; L133F, V149I and A157 V are first time observed. Erythromycin resistance (MIC > 32 µg/ml) was observed in 18% cases with 3 different mechanisms including A2075G mutation in DMV region of 23SrRNA, V80I and V121Ala amino acid substitutions in *rplD* gene leading to structural modification in L4 ribosomal protein which provides the first evidence for the role of L4 ribosomal protein modification equally important with change in DMV region for R-type. The study provides useful information about prevalence and mechanism of drug resistance in *Campylobacter* isolates of poultry origin.

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Synthetic Neuraminidases: Nanostructured Materials for Environmental Monitoring

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The risks to society associated with the spread of new strains of influenza with human pathogenicity, or with impact on agriculture are significant. Our capacity to challenge the threat of the virus is dependent upon our ability to develop new vaccines, and upon our access to effective virus-targeted small molecule pharmaceuticals. The current primary small molecule weapons oseltamivir (Tamiflu) and zanamivir (Relenza) currently form our last line of defence against this virus. More recently, the identification of strains resistant to (in particular) drugs targeting neuraminidase has awoken serious concern. Equally as worrying is the clear evidence of the presence of these substances in the World's water systems which has now come forth. Collectively, this makes the development of techniques giving us better insight into the virus and antiviral agents a priority. Robust methods for the rapid and sensitive determination of these substances are required, especially as the monitoring methods should be able to withstand the rigours of environments not normally conducive to biomacromolecules (temperature, toxic substances etc) e.g. antibodies.

Advanced materials fulfilling these requirements can be obtained by Molecular Imprinting, which is a technique for producing highly selective synthetic receptors for biochemical and chemical structures in synthetic polymers. The polymers contain nano-structured cavities that are of complementary functional and structural character to predetermined target. The technique entails the judicious selection of a monomer or monomer mixture with chemical functionality complementary to that of the imprint species (template). The complementary interacting functionalities (reversible covalent or non-covalent) form predictable solution structures, which after polymerisation in the presence of a suitable cross linking agent and removal of the template lead to the defining of recognition sites of complementary steric and functional topography to the template molecule. These sites give selective recognition of the template. Furthermore, by analogy to catalytic antibody production, using transition state analogues as templates yields synthetic enzymes.

Synthetic polymers with neuraminidase-like behaviour have been designed through the screening of candidate polymer systems using a combination of molecular dynamics and NMR studies. The characterisation of the resulting materials has demonstrated systems with selectivity for the targeted antiviral agents. Our studies illustrate the potential of these unique nanostructured materials for the monitoring of these antiviral agents in the environment, which is an important aspect in efforts aimed at limiting the development of resistant strains, and as a tool for policy makers.

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Understanding the Transfer of Resistance from Animals to Man - An Example: Campylobacter in Poultry

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Use of antimicrobials in the veterinary field is commonly (and to the uninformed reader frighteningly) discussed as a major source of resistance development in bacteria of relevance to human health. Given the complex nature of the equilibrium of microbes, environment and of the resistance mechanisms that bacteria have developed, this is a very complex topic. While data have been published on aspects of this intricate network of interaction, few studies have examined the complete evidence chain. This review of the published literature examines one example of resistance development in animals and its implication to human health, i.e. Campylobacter in poultry; it takes into account data generated following intervention strategies and additionally makes comment whether what we have learned from Campylobacter and poultry can also be applied to Salmonella originating from other food-producing animals.

Campylobacter is a bacterium that is present in the gut of healthy poultry without causing disease. It is also one of the most common causes of food-borne infection (in developed countries) in man.

This review of the published literature initially looks at antibiotics commonly used in poultry and in the human population to treat campylobacteriosis. It then investigates whether the hazard of resistance development through antibiotic use in poultry is transferred to Campylobacter implicated in human infections and considers whether this results in actual risk to human health, as evidenced by treatment failure of campylobacteriosis in man. Recent data is considered and the review questions whether this is a cause for a paradigm shift in our thinking.

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Divergent, and Locally High, Levels of Antibiotic Resistant Bacteria in European Herring Gulls (*Larus argentatus*) Conform to Patterns of Human Clinical Antibiotic Usage

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Antibiotic usage varies between regions due to different structure of animal production and health care standards. This results in geographical variation in resistance levels among Enterobacteriaceae. While the current clinical situation is fairly known, knowledge on environmental impact from antibiotic usage is minute. We use wild gulls as bio-indicators of environmental resistance levels. Gulls live in proximity to humans and are, due to their feeding behaviors, prone to pick up human-associated bacteria.

We collected >2,500 fecal samples from herring gulls in nine European countries, from the Baltic States, Scandinavia, Western Europe and the Iberian Peninsula. From each sample, we randomly selected one *Escherichia coli* strain and tested for susceptibility to eleven antibiotics commonly used in clinical and veterinary practices.

There were clear geographical trends in the prevalence of resistance phenotypes for most tested antibiotics. The proportion of resistant isolates increased with decreasing latitude, being highest in the Mediterranean region. Highest resistance levels were seen for ampicillin and tetracycline, but resistance was observed to all antibiotics. In Spain 61.7 % of isolated *E. coli* were resistant to >1 antibiotic and 5.5 % resistant to 6 antibiotics. In contrast, in Denmark 90.7 % of isolated *E. coli* were susceptible to all 11 antibiotics.

Our results show that gulls are exposed to resistant bacteria relating to veterinary and clinical settings and that level tend to conform to patterns of antibiotic usage in the investigated countries. This survey is the first comprehensive study on antibiotic resistance load in environmental bacteria.

Food Safety and Food Security

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Persistent Phenotypes in *Listeria monocytogenes* Revealed by a High Throughput Proteomics Approach

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The incidence of listeriosis in Australia like Western Europe has recently shown an increasing trend. We hypothesize this increase could be due to an increased incidence of persistent *Listeria monocytogenes* in the food supply chain. These strains may have acquired additional stress protection traits enhancing an already formidable level of robustness. We used 2-dimensional liquid

chromatography LTQ-orbitrap mass spectrometry to investigate the proteome of a strain found to be persistent in the food supply chain and that belongs to a clonal complex responsible for much of the sporadic listeriosis in Australia. A total of 1443 proteins could be confidently identified while out of 229 proteins identified that belong to the *L. monocytogenes* non-core proteome, 78 proteins were identified that so far have only been detected in other *Listeria* species or in *Enterococcus*. Non-core elements identified of interest include plasmid-associated proteins that provide resistance to chemical stress. Some of these proteins contribute to heat, acid and oxidative stress tolerance and thus may represent persistence-related phenotypes. State-of-the art 2D LC/MS-MS-based proteomics represents a powerful tool to investigate microbial physiology especially in species already furnished with comprehensive genomic data. With it we were able to reveal specific non-core genome features of a non-genome sequenced strain; obtain snapshots of its physiological state, and also reveal specific phenotypes that could be relevant to environmental persistence of a microorganism that impacts public health. By better understanding these traits *Listeria* in the food chain may provide benchmarks to improve control strategies and improve food safety.

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The One Health Challenge of Implementing Cattle Vaccination Against *E. coli* O157 to Reduce the Risk of Human Infection: A Case Study

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Canada is the first country with access to a fully licensed vaccine (Econiche™) for use in cattle to decrease the amount of *E. coli* O157 that enters the environment and poses a risk to humans through food, water or direct contact.

The challenge with implementing use of this risk reduction tool at the source, is that cattlemen receive no direct benefit or compensation to justify the cost of immunization. Traditional zoonotic agents, cause disease which justifies control in the animal, however *E. coli* O157 infection in cattle is asymptomatic.

Studies indicate that patients infected with *E. coli* O157 have an acute risk of severe, bloody diarrhea and haemolytic uremic syndrome. In addition there is an increased long term risk of hypertension, heart disease, diabetes, renal impairment, Irritable Bowel Syndrome and reactive arthritis. The costs to treat the primary outcomes of *E. coli* O157 infection in addition to the costs associated with secondary health consequences are substantial.

Globally, it appears there will be different approaches to this one health issue. The United States Department of Agriculture's Food Safety Inspection Service (May, 2010) published guidelines recommending "that slaughter establishments receive their cattle from beef producers that implement one or more documented pre-harvest management practices to reduce faecal shedding". An alternate approach is being considered in Sweden where experts are designing a national on-farm control program for *E. coli* O157.

As a case study, the Canadian experience demonstrates that multiple groups must be engaged for an innovative "one health" initiative to be implemented.

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Comparing Knowledge, Attitude and Practice of Meat Safety in Three Developing Countries (Nigeria, India, Vietnam)

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Livestock consumption is rapidly increasing in poor countries, but as value chains evolve from rural to urban and from short to long food safety may deteriorate. Given the lack of adequate testing and inspection, it is important to understand the factors that influence choices made by meat value chain actors.

We describe three related studies of knowledge, attitude and practice (KAP) of meat value chain actors in three very different countries. The studies involved mapping value chains followed by participatory appraisal, and administering questionnaires and check-lists to pork slaughterers, retailers and consumers in Nigeria, India and Vietnam (n = 403, n = 198, n = 246 respectively) and collecting meat samples for laboratory analysis.

The study revealed interesting similarities and differences. In all countries, practices and knowledge were most problematic at the abattoir and least in the household. In Vietnam, concern over meat safety was high but self-reported gastrointestinal disease was low: the situation was reversed in India and Nigeria. Retailer knowledge and practices were better in meat sold in shops compared to those sold through traditional outlets; however, only in Nigeria was meat safer. Participatory methods revealed risky practices: retailers in Nigeria often taste raw meat in order to convince consumers it is safe; consumers in Nagaland keep pork in the chimney (a traditional preservation method of unknown efficacy).

KAP studies can help understand behavior that influences food safety and hence development of messages and interventions that are appropriate and motivating.

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Trade, Food Security and Food Safety: A Canadian Perspective

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The international context of the food trade and food safety is characterized by continued globalization of the supply, advances in technology with an increased ability to identify micro-biological and chemical contamination of food and the ready availability of more information to consumers who demand greater safety and less risk.

Incidents of disease from foods that cross international boundaries are not uncommon and are well-known to consumers.

Countries such as Canada have to balance the need to import food and ingredients to satisfy demand against the knowledge that food production beyond their boundaries is out of their jurisdiction and control.

With increased challenges in a resource constrained environment, cooperation is key to the protection of health from contaminated foods. In Canada the mandate of Health Canada is standard setting and food policy. The responsibility for enforcement domestically and of exports, lays with other government departments including those responsible for animal health. International instruments such as the Codex Alimentarius, international regulations e.g., the International Health Regulations, collaborative surveillance mechanisms such as INFOSAN and Global Foodborne Infections Network are vital to food safety and the prevention of transmission of disease as well as the identification of, and response to outbreaks. It is imperative that there is a close collaborative relationship between those responsible for surveillance and control in the realms of animal health and human public health

This presentation will discuss some of the recent food safety issues in an evolving environment. It will also outline current and future building blocks towards increased international collaboration and capacity development to face such challenges.

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More than a Brochure - Getting the Food Safety Message Out Using Dofoodsafely

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In 2008, the Victorian Competition and Efficiency Commission (VCEC) released a report of their enquiry into food regulation in Victoria, entitled “Simplifying the Menu”. Their recommendations included “that the Victorian Government develop more effective and targeted food safety approaches”. In response, the Food Safety & Regulation unit elected to use e-learning tools to improve communication of food safety practices to both the general community and to workers in food industries. This “Dofoodsafely” program was launched in December 2009 by the Victorian Chief Health Officer, Dr John Carnie.

Dofoodsafely provides a free, interactive program that allows participants to learn about food safety at their own pace. It is particularly suitable for people who are new to the food industry, or are looking to gain employment as food handlers. It comprises six units addressing fundamental concepts of hygienic food handling, including personal hygiene of food handlers, safe food storage, and food handlers’ obligations under Victorian laws. Successful completion of the assessment unit allows the participant to print a certificate of completion of the course.

The program was awarded a prize at the recent International Union of Food Scientists and Technologists (IUFoST) conference in South Africa for “communicating science-related knowledge to consumers aimed at improving their life-style”.

This presentation will include discussion about the development of the program, the issues that arose out of the development process, the reception of the program, and the plans the department has for this and other e-learning programs.

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You Are What You Eat: Influence of Host Ecology on Infection Risk in Populations and Individuals

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It is widely accepted that wild aquatic birds are the major reservoir for Avian Influenza viruses (AIV), and also play a significant role as vectors for the disease. However, despite intensive surveillance, we still know very little about the role individual wild birds (and their populations) play in the transmission and maintenance of these viruses. Traditionally, combinations of single-location surveillance and historical migration patterns have been used to estimate the degree to which different species may be involved. However, this broad scale approach tends to neglect the ecology of the virus, and just as importantly, the ecology of the host. Over 100 species have been found infected with these viruses worldwide, with many more purportedly negative for the disease. Using data from ten years of wild bird surveillance in the Netherlands we catalogued the ecological properties of each species sampled, in order to determine whether infected species are ecologically separated from those that are not. Using stable isotope analysis of feathers and blood components, we also examine whether infection risk of individuals within a species known to be infected by AIV can be attributable to antecedent foraging habitats. The use of an aquatic habitat is strongly associated with infection risk at all levels analysed, including individuals and populations of a single species, and between species. These unique findings underscore the usefulness of stable isotope methods in disease ecology, particularly when compared to broader-scale inter-species patterns, and the potential role of host ecology in transmission and maintenance of AIV.

Use of Bats as Bushmeat: Implications for Human Health in Ghana, West Africa

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Recently, antibodies to several viruses deadly to humans have been found in blood samples from fruit bats living in Accra, the capital city of Ghana. We estimate from local interviews with over 600 people that nearly one half of the south-eastern Ghana population may eat bats—a documented pathway for disease transmission from wild animals to humans—yet these animals fail to appear in other studies on Ghanaian wildlife meat markets. Few studies focus specifically on bats, which may be why bats are so under-represented in bushmeat projects. This study began to answer a few of unknown questions about bats as bushmeat, including the discovery of an extensive trade system for bat meat that stretches more than 400 km across south-eastern Ghana. Our interviews also helped to identify “risk factors” for contact with bats. Members of certain regions, rather than of certain tribes, are more likely to hunt and consume bats; bat consumption also may increase with increasing age. Various hunting and butchering methods may increase the likelihood of contact with bat blood and therefore increase the risk of zoonotic disease transmission. Understanding the human groups at risk of pathogen transfer, the possible modes of transfer, and the importance of bushmeat meat socially and economically are all crucial to developing efficient and effective management plans.

Stochastic Modelling of Environmental Survival of *E. coli* and Changes in Risk to Public Health

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This work aims to develop tools for prediction of the risk from animal faecal contamination of recreational and irrigation waters, and their use to estimate consequences of climate change on risk from these sources.

Survival of gastro-intestinal pathogens in the environment is apparently dictated largely by water availability and temperature. Desiccation hastens inactivation and, as do warmer temperatures. This knowledge has been incorporated into predictive models for food safety, e.g. for *E. coli* inactivation in foods such as fermented meats that, due to their formulation, do not support pathogen growth and lead to passive inactivation at (otherwise) non-lethal temperatures.

Stochastic models are widely used in many fields, including microbial food safety management, to assess “risk”, i.e., the probability of occurrence, and overall consequences of, the realization of a hazard. The models are used to better understand how risks arise, and minimised. Formal risk assessment of microbial food-borne risk is now well developed, but less so for risk management of environmental waters.

Using data and knowledge on “passive” inactivation of pathogenic *E. coli* due to desiccation and temperature in foods, faeces and the environment a stochastic model for *E. coli* survival in the environment was developed. The model was used to gauge the influence of climate on pathogen survival in soils and water, and to estimate potential consequences for public health risk under various scenarios. It is concluded that existing microbiological knowledge and modeling techniques can be used to inform public health risk management in response to climate change.

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Climate Change and Food and Nutrition Security

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More than one billion people are suffering hunger and malnutrition. Food security has deteriorated and reductions in child malnutrition are proceeding too slowly to meet the Millennium Development Goal (MDG) target of halving hunger by 2015. Three major challenges threaten current and future efforts to overcome food and nutrition insecurity: climate change, the growing use of food crops as a source of fuel and the soaring food prices.

The general objective of this paper is to review the current and projected effects of climate change and bioenergy on food and nutrition security and proposes policy recommendations to address these challenges.

Climate change is projected to affect the health status of millions of people through increases in malnutrition. Climate change could exacerbate climate-sensitive impediments to sustainable development faced by developing countries. To address these challenges requires integrated approaches for adaptation, mitigation and sustainable development. Strategies should include measures that would simultaneously reduce pressures on biodiversity and food security and contribute to carbon sequestration. Agriculture, food and nutrition issues need to be placed onto national and international climate change agendas, in order to devise effective and pro-poor policies.

Efforts to improve food security and better nutrition in the face of current challenges, including climate change must continue to place the achievement of the MDGs, as internationally agreed-upon development targets, at the centre of human endeavour. In particular, it remains essential to accelerate progress in reducing poverty, hunger and malnutrition while mitigating risk and protecting the environment.

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Examples of Applied “One Health” Policies in the EU

Alain Vandersmissen

European Commission

The European Union (EU) is supporting the “One Health” (OH) approach both inside the Union and in its External Relations policies and actions. This paper addresses OH actions inside the Union.

The EU has a long history of harmonised rules on the fight against zoonoses which represent 60% of human infectious diseases. Decennia ago strategic frameworks were successfully introduced against tuberculosis and brucellosis. Food crises in the 90ies obliged the EU to extend this strategy to food-borne infections such as salmonellosis, listeriosis and BSE. In 1998, the EU put zoonoses and food-borne diseases under EU-wide epidemiological surveillance along with other communicable diseases representing a threat to public health. More recently, the need for a multidisciplinary and transversal approach was identified for emerging risks such as influenza and antimicrobial resistance. The bases for applying OH inside the EU are harmonised monitoring at all stages (animals, food and humans) and control at the source based on a priority setting from a public health and animal health perspective with respect for welfare. The objective is to gradually integrate the OH approach into national and regional strategies and policies to reduce the risks to health originating at the interface Humans-Animals.

In addition, focus is on prevention through bio-security measures and good hygiene practice in humans, food and animals. Inter-disciplinary, trans-disciplinary and multi-disciplinary collaboration and communication between scientific bodies, reference laboratories, stakeholders and risk assessors and managers ensures the most satisfactory approach. Finally,

trying to address health threats at international fora is considered as a must. Examples of OH strategies, actions and results will be presented as regards traditional zoonoses such as brucellosis, Q fever and West Nile Virus, food-borne infections such as salmonellosis, influenza, and cross-sectoral health issues of particular concern such as antimicrobial resistance.

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One Health Alliance of South Asia (OHASA): Predicting and Preventing the Next Emerging Disease on the Indian Subcontinent - Sponsored by the Rockefeller Foundation

Alonso Aguirre, Peter Daszak

EcoHealth Alliance, New York, USA

Emerging zoonotic diseases are a major threat to public health globally. These diseases emerge from wildlife or livestock, and include HIV/AIDS, SARS, H5N1 avian influenza and the new H1N1 strain of flu. Diseases emerge when environmental and demographic changes alter our relationship with animals, and provide new ways for pathogens to spread to people. Despite recent outbreaks of avian influenza H5N1 and H1N1, the world's pandemic prevention strategy fails to take the broader view as it focuses so intensely on the machinations of each strain, and on the politics of surveillance, reporting, and trade regulation. For zoonotic diseases the key factors that drive their emergence are a combination of human changes to the environment, agriculture, healthcare, and changes in demography, all against a background of a large pool of potential new zoonoses. The EcoHealth Alliance is fostering the growth of a collaborative initiative across Bangladesh and India among both ministry officials and scientists. The initial step was a meeting with high-level officials that helped identified mid-career decision-makers in the relevant ministries (Wildlife/Forestry, Health, Agriculture), in universities, research institutes and NGOs across India and Bangladesh who are interested in this critical issue. To bring these people together, we organized the 1st South Asian Transboundary Conservation Medicine Network meeting West Bengal, India during 4-6 November 2009 and drafted the One Health Alliance of South Asia (OHASA) Bengal Declaration. We are working with the relevant authorities to propose a strategy to prevent the spillover of these pathogens by advising wildlife traders of the risk of infection and working with them to find alternative solutions to high-risk activities. The objective of this symposia is to present the advances and current perspectives of OHASA of building a long-term cross-border collaboration in emerging diseases and one health. We hope that OHASA will serve as the basis to combat emerging infectious diseases in South Asia and represents a key example for other countries to work collaboratively to predict and prevent the next pandemic.

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Networking for Promoting Change Towards One Health in South Asia

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Along with many other countries, South Asian countries are facing threats from emerging infectious diseases that involve wildlife, domestic animals and people. Recent outbreaks of nipah virus, avian influenza H5N1, novel influenza H1N1 etc in south Asian countries highlight the critical need for a regional One Health approach. In a globalize world, the regional and global implications of local problems are demonstrated and the need for critical linkages and partnership is sought. How networking among regional counties can promote change towards one health approach is envisioned. Recently formed South Asia Veterinary Education Network (SAVE-Network) and One Health Alliances of South Asia (OHASA) are presented as the beginning of the regional one health collaboration. Multidisciplinary approaches and a whole new set of core competencies are needed to be successful. The greatest advantage in the 21st century is collaboration through strategic planning and effective networking. One Health movement leading to the formation of a scientific organization known as One Health Bangladesh is

discussed and how its activities are influencing its neighboring countries to bring physicians, veterinarians, agriculturists and environmentalists together to promote change towards one health concept is also elaborated.

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The Mekong Basin Disease Surveillance Network: A One Health Approach for Training and Surveillance in South Asia

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In 1999, delegates from Ministries of Health in six Mekong countries agreed to collaborate in disease surveillance and outbreak management through the Mekong Basin Disease Surveillance (MBDS) Network. The six countries include Cambodia, Yunnan and Guanzhi Provinces of China, Laos, Myanmar, Thailand and Vietnam. A Memorandum of Understanding (MOU) signed by each country's Minister of Health formalized this collaboration in 2001. A new MOU was signed in May 2007, reinforcing the MBDS partnership. MBDS facilitates new and stronger relationships to influence the way health officials in the region interact with each other. MBDS helped establish a working relationship between WHO country offices in Asia. The MBDS Network demonstrates systems that facilitate compliance with the International Health Regulations through development and testing of guidelines and protocols with multiple sectors at border sites. Data from routine surveillance on priority diseases in each site are exchanged through the national coordinators and the adjacent province's site coordinator. Reports of suspected outbreaks are also conveyed as appropriate. Information exchanges are carried out daily, weekly, monthly, or quarterly across border provinces. Cross-border teams made up of health, customs, immigration, and border officials established in 2006 facilitate several activities including dengue fever investigation between Laos and Thailand; typhoid investigation between Laos and Vietnam provincial sites; avian influenza investigation of cases in humans, triggered by the discovery of an infected Laos citizen in Thailand. The joint Thai-U.S. CDC Field Epidemiology Training Program, Mahidol University, and the Southeast Asian Ministers of Education Organization -TropMed programs coordinate annual training for MBDS participants. Members of MBDS are working to create and maintain existing field epidemiology capacity via a new Southeast Asia network - called The International Group for Epidemiology and Response (TIGER). The network produces graduates and tracks capacity building of field epidemiology training program (FETP), FE(lab)TP, FE(vet)TP, with particular attention to the increasing formal and informal scientific communication among MBDS countries and mentoring countries. Communication between the lists of ProMED-mail and ProMED-MBDS will permit the reporting of important outbreaks that are occurring in the region and allowing for an early notification of outbreaks within the region (<http://www.ghsi.org/projects/mbds.html>).

608C

Improving Preparedness and Response to Emerging Zoonotic Diseases by Strengthening Community Surveillance in Pakistan: Plan for Inter-Sectoral Collaboration

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Overall goal of this plan is to improve preparedness, develop and strengthen surveillance systems, and identify means of assessing the risks of zoonotic disease emergence, in order to better prevent or contain them. Effective collaboration has to be formed between concerned departments like Health, Agriculture, Environment, Local Governments and Population. An emerging zoonosis is a type of disease that is newly recognized or newly evolved or that has occurred previously but shows an increase in incidence or expansion in geographical, host or vector range. Emerging and re-emerging zoonotic diseases pose a profound challenge both to national and global public health. Recent outbreaks of severe dengue fever and acute

respiratory syndrome (SARS) have shown once again the potential of microorganisms from animal reservoirs to adapt to human hosts. Early and accurate detection of new outbreaks of epidemic livestock diseases including emerging zoonoses, and the capacity for prediction of spread of such diseases to new areas, is an essential pre-requisite to their effective containment and control.

A wide variety of animal species, domesticated, peri domesticated and wild, can act as reservoirs for these pathogens, which may be viruses, bacteria or parasites. Considering the wide variety of animal species involved and the often complex natural history of the pathogens concerned, effective surveillance, prevention and control of zoonotic diseases pose a real challenge to public health. In Pakistan like in most countries, there is inadequate support for building public health and veterinary core capacities in the zoonoses field, including a lack of basic training and education, database templates and standards, risk management and assessment, and communication skills.

Immediate Activities Planned: There is a realization in the Government quarters to improve inter-sectoral coordination to curtail Zoonotic Diseases. This plan has thus been approved. There is a need to improve the basic infrastructure of human and veterinary health systems in order to control endemic zoonotic diseases.. Specific actions include: a) Conducting studies to provide evidence for priority setting and guiding action; b) Building on existing data and information sharing; c) Preparing educational materials based on research findings, and training public health and agricultural extension workers as well as school teachers; d) Strengthening preparedness through identification of an appropriate structure for the prevention and control of zoonotic diseases, strengthening of laboratory capacity, improving case management and developing tools for risk assessment and prediction; e) Linking zoonotic disease prevention and control programs with existing initiatives like national Integrated Disease Surveillance Program of Ministry of Health.

608D

Developing One Health Approaches in India

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India has been identified as global hotspot for emergence and spread of EIDs, including zoonoses and diseases likely to emerge from wildlife reservoirs. One health paradigm is ideally suited to counter these threats since it looks at human and animal health as inextricably linked to the health of ecosystems. However, its operationalization in India, like in many other countries, is hampered by several constraints including weak intersectoral collaboration, limited technical capacity, a lack of research-informed policy-making and irregular surveillance and response across human and animal health sectors. Expectedly, recent instances of intersectoral collaboration at national and sub-national levels were materialized in the wake of crisis situations like H5N1, SARS and H1N1 outbreaks. Recently, recognition of interconnectedness of various sectors has grown thus giving support to this call to coordinated action. Several mechanisms are being explored to promote these linkages in routine settings including in policy formulation, research, outbreak response and control of endemic zoonoses like rabies. An environment of strong political will, evidence-based policy innovations, clearly defined roles and responsibilities of agencies, coordination mechanisms at all levels, and a culture of open information exchange rooted in the “One Health” approach have been observed as the factors contributing to early success of these models.

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Infectious Disease Issues in Bangladesh Requiring a One Health Approach

Mahmudur Rahman

Bangladesh is a country of around 160 million people with a population density about 1100 per square kilometers. In many rural villages of Bangladesh, people live in close proximity with their animals. Emerging infectious disease pose a threat to

human health in Bangladesh. About half of the outbreaks reported in Bangladesh in last couple of years are zoonotic origin. Every year more than 2000 people die in Rabies. There are several outbreaks of Nipah each year. Till 2010, one hundred and forty seven people have been affected in Nipah with mortality 74%. Recent anthrax outbreak created panic in Bangladesh; a total of 607 cases have been identified from 2009 in 12 (19%) districts. One human H5N1 case was identified in 2008. The government started vaccination of livestock after outbreak of cutaneous anthrax in humans, where the departments of health and livestock worked together in close collaboration. Bio-security measures have been enhanced in the poultry sector following avian influenza. Training to all tiers of health, livestock and other sectors were done in a one health approach. Rabies control program have also started jointly. It is evident that the One Health approach is required in many instances and more so during outbreak situations. Collaboration with livestock has improved in last couple of years in Bangladesh due to avian influenza; this partnership has also worked during recent anthrax outbreak. However, One Health requires coordination between all parties including laboratories and exchange of their data. Laboratory and Human capacity should be enhanced. Transboundary communication should be established for proper surveillance and combating of emerging zoonotic infectious diseases. Pesticide poisoning which is the recent major threat also requires One Health approach for effective mitigation. Community awareness programs jointly organized in One Health approach have been successful for prevention and control of avian influenza and anthrax. Therefore, a One World One Health approach should be used for effective and efficient prevention and mitigation of outbreaks mainly zoonoses.

608G

Economically Important Animal and Zoonotic Diseases in Bangladesh

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Animal diseases are a big concern for public health and pro poor economic growth of the country. The country has a high density of human population with wide spread poverty in particular in rural areas. The high animal and human density has brought human and animal population in very close proximity creating potential threat of transmission of disease agents from animal hosts to human host. Major diseases having zoonotic and economic importance frequently noticed in the country are Foot and Mouth Disease (FMD), Peste des Petits Ruminants (PPR), Highly Pathogenic Avian Influenza (HPAI), Newcastle Disease (NCD), Infectious Bursal Disease (IBD), Anthrax, Rabies, Brucellosis, Tuberculosis, Salmonellosis, etc. Furthermore protozoal and diseases caused by different type of worms are common in the country. Bangladesh has experienced many outbreaks of Nipah and Nipah like diseases. Among the zoonotic diseases the presence of Highly Pathogenic Avian Influenza was first declared by the Government of Bangladesh in 22nd March 2010. Since then 358 outbreaks have been recorded in Bangladesh. Out of these 358 outbreaks, 54 occurred in backyard settings and the rest 304 outbreaks occurred in commercial setting. The highest number of outbreaks were observed in 2008 and the number of outbreaks reduced in the following years. It appears from the pattern of last outbreak that most of the outbreak occurred during winter season. A single human case was detected in the country in 22nd June, 2008 but the affected boy was recovered. Anthrax is a century old problem in Bangladesh. An outbreak of human case were detected in the northern part of Bangladesh. An animal anthrax case was reported in 19 August from Shahjadpur subdistrict of Serajganj district. Since then 8 districts and 18 upazilas were affected. Awareness meetings were held, communication materials distributed, check points instituted, multisectoral committees formed to control and contain the spread of the disease. Rabies, Brucellosis, Tuberculosis, Nipah and salmonellosis are detected in animals. Like many other countries fragmented approach has been undertaken to control zoonotic diseases in the country resulted in little success. Issue of collaborative approach came in forefront during the HPAI outbreak in the country and collaborative approach functioned well. A group of enthusiastic veterinarians, physician, environmentalists, wild life experts have formed a coordination body for one world one health. Institutionalize the concept and introduce the approach of one health is urgent for confront any challenge of zoonotic diseases.

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One Health Training Programme: OIE Collaborating Centre for Training in Livestock and Wildlife Health and Management

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Since May 2009, the World Animal Health Organisation (OIE) has recognized the Department of Veterinary Tropical Diseases (DVTD) and its consortium partners [University of Pretoria (Centre for Veterinary Wildlife Studies, Department of Animal and Wildlife Sciences, Department of Agricultural Economics, Extension and Rural Development); Onderstepoort Veterinary Institute (OVI), SA; Animal Health Department of the Institute of Tropical Medicine (ITM), Antwerp, Belgium; National Institute for Communicable Diseases, SA; Department of Agriculture, Fisheries and Forestry, SA] as Collaborating Centre for Training in Integrated Livestock and Wildlife Health and Management. One of the major roles of the Collaborating Centre is to assist the OIE in developing and offering training in the management and health of livestock and wildlife with special emphasis on sub-Saharan Africa. The training will follow an integrated One Health approach linking animal and human health, animal production, marketing and trade of animals and their products, land-use options, rural development, conservation and environmental health.

The information used for the training will be partly based on the material currently used in the successful web-based MSc programme in Veterinary Tropical Diseases that is organized jointly by the DVTD and ITM's Animal Health Department. This training material will be re-packaged in appropriate formats to support –undergraduate and postgraduate training as well as Continuing Professional Development (CPD).

To improve access to important veterinary information, the training material will be presented on an interactive electronic delivery platform called “VetHub”, which includes blogs, interactive course material, videos, quizzes and discussions. The information will be presented at an introductory and more detailed expert level, all accessible free of charge. Where accreditation for CPD is required (implying involvement of experts in evaluating quizzes and rewarding credit points) people will have to registered and pay a fee.

Moreover, to support animal health management, up-to-date synthesized information on outbreaks of specific high-impact diseases or important research development will be provided and made accessible to field personnel in the form of quarterly or 4-monthly electronic bulletins.

The VetHUB currently uses an Open Source Content Management System called Joomla for the Information Sharing Part and an Open Source Learning Management System, Moodle.

The VetHub is currently being developed and it is envisaged that it will be opened at the end of 2010.

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Educating One Health Policy Makers: Content and Methodological Challenges

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The U.S. National Public Health Performance Standards Program (NPHPSP) at CDC defines the public health system as a broad collection of partners, each making a unique contribution towards achieving standards that describe the essential functions (services) of the public health agency core. This “One Health” approach asks individuals from a variety of disciplines to apply their collective efforts to improving the health of people, but the “all for one” emphasis on human health at the expense of other “healths” can lead to unplanned outcomes that can ultimately harm human health.

In 2008 Tufts University launched the University Seminars, a Provost-level initiative designed to support interdisciplinary inquiry among schools of Tufts University which are in three geographical locations. The topic of the inaugural seminar was One Health: Interdisciplinary Approaches to People, Animals and the Environment.

Among lessons learned, the most important are: teaching a diverse class of students was far more challenging than anticipated; well-focused topics are important and objectives/expectations must be exceedingly well-defined; creating a comfortable and productive group environment is critical to intellectual sharing and doesn’t necessarily come naturally to faculty or students; an interdisciplinary course requires faculty and students to retool the way they teach and learn; all participants must develop a level of comfort with interdisciplinary uncertainty.

In order to develop One Health policy, the world needs a range of well-prepared “health” professionals that can understand, communicate and collaborate to address a broader concept of human health in the context of the natural world.

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Curriculum Asset Mapping for One Health: A Problem-Oriented Approach

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The major premise of One Health is engagement of multiple disciplines to address shared problems spanning human, animal and ecosystem health. The current model of academic specialization encourages development of disciplinary silos within the university setting, thereby creating barriers to resource sharing and academic collaboration. The aim of this project was to develop a systematic approach to mapping university assets that could be harnessed in training for One Health.

Asset in this context was defined as a course, program or faculty expertise relevant to a particular One Health problem. The adopted approach comprised the following steps: (1) Identifying a current problem that would benefit from an integrated, interdisciplinary perspective (e.g. emerging infectious diseases, EIDs); (2) Identifying cross-disciplinary teaching areas pertinent to the problem (e.g. health communication, wildlife ecology); (3) Identifying competencies expected to be attained by graduates who will address the problem (e.g. respond to outbreaks); (4) Surveying faculty on their teaching areas and curricular offerings that address these competencies; and (5) Compiling responses in a database that is searchable by teaching area and competency.

We will discuss our recent experiences mapping the assets at Tufts University that are relevant to the problem of EIDs with emphasis on zoonotic disease surveillance, outbreak investigation and response. Using 13 teaching areas and 16 competencies relevant to applied epidemiology, we identified and characterized previously untapped resources across the university. Asset mapping is thus a useful tool for identifying university resources and opportunities that can be leveraged to support interdisciplinary training for One Health.

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Realising One Health: How the Food and Agriculture Organization of the United Nations Envisions Success

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In a globalized world where pathogens can travel the world in a day, emerging diseases of humans, livestock or wildlife can have severe implications for public health, livelihoods, food security, international trade and tourism. Moreover, they can threaten the survival of wild animal populations and even species. In response, under the Food Chain Crisis Management Framework, FAO recently (2010) developed a One Health programme; A Comprehensive Approach to Health: People, Animals and the Environment to guide implementation of FAO work in animal health drawing on expertise from forestry, fisheries and aquaculture, natural resources and law. External partnerships with governments, international organisations, NGO's, universities, and public-private partnerships compliment in-house expertise.

Specifically, the Agriculture and Consumer Protection Department has partnered, under the One Health context, with the Forestry, Fisheries and Aquaculture, Natural Resources Management and Environment, and Technical Cooperation Departments as well as the Legal Office, regional and sub-regional offices and networks. Enhanced collaboration has enabled new approaches to improve public and animal health, enhance food safety and food security, improve livelihoods of poor smallholder farming communities, while protecting ecosystems.

Hunting, trade, consumption and farming of wildlife and wildlife products demonstrate a complexity of issues including forest ecosystem services, biodiversity preservation, food and livelihood security, marketing, cultural and socio-economic dynamics. Aquaculture, integrated farming systems, wetland and coastal conservation, aquatic animal disease prevention, threats of biological invasions involve issues being addressed at FAO through interdepartmental collaboration. These examples demonstrate the labyrinth we must dissect and the inter-disciplinary balance we must strike as FAO strives to achieve the Millennium Development Goals and strategic objectives across departments, divisions and services.

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Developing Practical Risk Assessment into Public Health: A Multidisciplinary Approach

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The International Health Regulations call on all Member States of the World Health Organization to strengthen and maintain capacity for the early detection, verification, risk assessment, notification and response to public health events of national and international importance. Risk assessment is a systematic way of organising information within a risk management framework but until recently little guidance has been provided to public health authorities on how to undertake risk assessment.

During 2010, the authors developed and delivered a series of training workshops in the South-East Asian and Western Pacific region to help provide such guidance and to build capacity in the application of risk assessment in disease outbreaks and other public health emergencies. The workshops were multidisciplinary and explored risk management frameworks and approaches to risk assessment used in related areas such as animal health and food safety assessment. Workshop participants undertook multiple risk assessments on case studies, based on actual events, that were developed across a range of

examples of infectious diseases (including zoonoses), non-infectious diseases, and large events (such as explosions and mass gatherings).

The workshops demonstrated the value of risk assessment to assist in severity assessment, to assess and rank priorities in a public health event, to inform policy-makers and underpin communications, and to help determine when to report public health events as part of the obligations under the International Health Regulations.

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The Role of Non-Governmental Organisations in Supporting Veterinary Services in Developing Countries: Case Study of a Newcastle Disease Vaccination Programme in Malawi

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Veterinary services in Malawi are poorly resourced, farmers in poor communities have limited or no access to veterinary services. The Lilongwe Society for the Protection and Care of Animals (LSPCA), set up in 2008 and supported by RSPCA International, provides vital veterinary support to local communities. A key initiative is improving the health and welfare of village poultry through delivery of a Newcastle disease (ND) vaccination programme. ND is the most serious problem affecting the health, welfare and productivity of village poultry. It has a devastating economic impact on rural livelihoods and consequently the health of local communities. The project aimed to develop a sustainable programme for ND vaccination in the Lilongwe district and collaborate with government through provision of data on the dynamics of village poultry production including socio-economic and poultry mortality data. Community vaccinators were trained to ensure sustainability of the programme. Control of ND is limited by lack of: baseline data on chicken production dynamics; awareness of economic impact of ND; awareness or extension services; trained vaccinators.

LSPCA's poultry programme demonstrates the value of effective vaccination programmes and highlights the successes and difficulties in developing and delivering vaccination programmes in rural communities. International and local ngos have a significant role to play in supporting veterinary services in developing countries. They can provide the resources and expertise to support government and communities to improve the health and welfare of their animals, reduce disease transmission and contribute to livelihoods protection.

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Development and Utilization of a Network of Laboratories to Support Early Disease Detection and Epidemiological Studies of Zoonotic Diseases

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The Regional Laboratory Network for Highly Pathogenic Avian Influenza (HPAI) Diagnosis in Southeast Asia was initiated in 2004 to enhance disease control for HPAI and to promote more efficient response to other transboundary and emerging diseases that may potentially threaten social livelihoods. Outputs from the Regional Laboratory Network for HPAI Diagnosis include improved assessment of needs, harmonization and quality assurance of test results, better coordination of

inputs and increased interaction among laboratories in the region including sharing experience, expertise, results and biological materials. This Regional Laboratory Network also provides the basis for conducting epidemiological studies based on harmonized testing protocols among countries in the region with potential for expanding services to address other zoonotic or emerging diseases. In 2010, FAO together with OIE and WHO began a collaborative program to provide confirmatory diagnostic testing services as well as pathogen characterization including the technical support of regional- or global-level reference laboratories from both human-health and animal-health sectors. The Regional Laboratory Network contributes to a global cooperative network that can more rapidly diagnose and report disease events of potential international public health concern. Strong and continuing collaboration and effective regional coordination is required in order to maximize the outcomes and outputs from a network of laboratories that operates with limited resources and to provide early detection and support epidemiological studies of zoonotic diseases on a regional level.

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The Policy of Science in Government

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The post-border management of biosecurity threats and incursions is a role for state governments in Australia. Responses need to be underpinned by an operational and policy capacity, good science and access to expertise. While government is expected to maintain these capacities it is not always seen as the natural science leader or expert in the field. This paper identifies the important areas of science requiring government investment and investigates options for modernising existing science capacities. The investment balance between science, policy and operations is also discussed.

Traditionally the strength of state government biosecurity science is based on the application of scientific knowledge to practical problems (applied science). Government is also well known for the provision of analytical or diagnostic services enabling the identification of pests, diseases or contaminants (diagnostic science). While important, basic science and blue sky research are better addressed by non-government research organisations.

However there is an increasing need for both government and non-government sectors to invest in targeted risk assessment, social research, modelling and forecasting science (intelligence science). This work needs to inform the six themes of biosecurity, namely prevention, preparedness, surveillance, response, recovery and ongoing management.

Queensland has commenced a process of science reform. Starting with a Biosecurity Strategy and a Science Action Plan for the state, Biosecurity Queensland is now reforming its \$18 M science investment. A critical element is the establishment of an intelligence capacity. In this paper we explore these changes and what role partnerships with other research providers will play.

Ethics, Dual Use, and Research Programs - Sponsored by CAPPE

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The WSAVA One Health Committee: Promoting Comparative Clinical Research - the Value of the Companion Animal Model

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The World Small Animal Veterinary Association (WSAVA) is a global organization representing some 75,000 small companion animal veterinary practitioners in almost 80 countries. In 2010, the WSAVA established a One Health

Committee to raise the profile of small companion animal species (principally dogs and cats) within the growing international One Health platform. A major focus for this Committee will be addressing the key position of small companion animals as reservoir populations for zoonotic infectious disease and the potential for these species to be involved in the emergence of new pandemics. However, the second remit of the committee will be to promote the importance of comparative medicine and the major insights that might be achieved through study of spontaneously arising disease in small companion animals. To date the wide spectrum of human degenerative, neoplastic and immune-mediated diseases has been modelled using experimental rodent systems. These diseases in such models must often be induced by experimental manipulation or genetic modification. The value of comparative studies in small companion animals, particularly the domestic dog, has not been fully appreciated. The dog is a relatively long-lived species that may spontaneously develop the full range of idiopathic diseases that affect man. This in part relates to the fact that pet dogs are now fully integrated into the domestic environment and share numerous human lifestyle factors that predispose to such diseases. For example, the single most significant health-related issue facing the human and canine populations in developed nations is obesity. The neoplastic, allergic, autoimmune and age-related degenerative diseases of the dog are extremely close clinical and pathological mimics of the equivalent human disorders. In recent years there has been rapid development of the scientific tools for the study of canine disease, including gene expression and snp microarray technology permitting large scale genome wide association studies (GWAS). The major advantage of investigating the genomic basis of disease in the canine model is the fact that the diseases of interest are often tightly breed-associated and that the phenotypic characteristics of dog breeds have been achieved through close inbreeding – meaning that canine breeds are also genetically restricted. These advantages have been recognized by establishment of the European LUPA consortium that is currently investigating the genetic basis of a series of canine diseases that are models for the equivalent human disorders. The WSAVA has long recognized the benefits to be gained from refining the phenotypic definition of small companion animal disease and has established expert panels to address the classification of diseases affecting the liver, kidney and gastrointestinal tract. The WSAVA One Health Committee will continue to promote comparative medicine and will work to bring together stakeholders from the veterinary and medical research communities and funding bodies that might support such comparative research.

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An Australian Code of Conduct on Biosecurity

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Laboratory research on pathogenic micro-organisms can bring about important scientific discoveries leading to improved health outcomes, but scientists conducting such research are also in a position to perpetrate or inadvertently assist a biological attack. There is a need to promote and maintain ethical awareness among life scientists about the security implications of their work, while acknowledging that it can (and usually does) serve a broader health purpose. The challenge for governments and the scientific profession is to reduce biological weapons risks while maximizing the research output necessary to resist infectious diseases. A possible solution to this governance dilemma is the formulation and adoption of an Australian Code of Conduct on Biosecurity. The Australian Government takes a traditional, ‘top-down’ approach to risk reduction by enforcing legislation including the Crimes (Biological Weapons) Act 1976 and the National Health Security Act 2007. Legal mechanisms aimed at preventing the harmful misuse of pathogens may be necessary, but they are not sufficient. The law does not (and probably cannot) offer guidance for scientists deciding, for example, whether to pursuing particular lines of research or communicate research results. These are best regarded as ethical rather than legal issues. A biosecurity code of conduct would be a ‘bottom-up’ governance mechanism, sensitive but not beholden to the interests of scientists. It would provide a framework for decision-making in such areas as: education and awareness-raising, dual-use aspects of research and publication, and internal accountability and oversight. Codes existing in other countries could serve as useful models for Australia.

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An Empirical and Quantitative Approach to the Prioritization of Zoonotic Diseases of Public Health Importance in Canada

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Zoonotic diseases account for over half of all communicable diseases causing illness in humans. As resources are limited for the control and prevention of zoonoses, it is necessary to prioritize diseases to direct resources into those with the greatest needs. While there is consensus amongst medical and veterinary professionals for the need to prioritize zoonoses, there is no uniformity in methodological approaches. Despite methodological differences, experts recommend priority setting should be empirical and quantitative, founded on good science, informative to public policy and have the ability to be iterative for recurrent evaluations.

We used conjoint analysis, a well-established quantitative method satisfying these criteria, to identify the relative importance of key characteristics of zoonoses to be used for their prioritization. Relative importance weights were used to develop a point-scoring system to derive a recommended list of zoonoses for prioritization in Canada.

6 focus groups identified 29 characteristics for determining prioritization; this was used to construct a conjoint analysis. 1,500 health professionals and individuals from the public are currently participating in this study. Scoring based on the conjoint analysis were applied to 63 zoonoses of importance to Canada and internationally.

Our pilot data suggests conjoint analysis can be used successfully for the prioritization of zoonoses. Diseases recommended for prioritization include Nipah virus encephalitis, variant Creutzfeldt-Jakob disease and H1N1 influenza.

The priority list will help formulate a framework for policy development for the control and prevention of zoonoses in Canada. Additionally, conjoint analysis should be considered as a potential tool for priority setting.

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Promoting Human and Animal Health Through Early Humane Education: Perspectives and Future Directions Based on HAI Research

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One of the leading causes of injury in children and companion animals is interspecies violence. Animal violence against humans (e.g., dog bites) and human violence against animals (e.g., animal abuse) are prevalent problems worldwide. Many of these incidences may be preventable. Animal violence towards humans can stem from a lack of knowledge of safe and respectful human-animal interactions. Human violence towards animals, especially during childhood, is often indicative of psychological disorder. Data from the emerging field of Human Animal Interaction (HAI) research provides insight into the reduction of interspecies violence through early humane education.

Humane education generally refers to an effort to educate humans about how to interact with and care for non-human species with empathy and compassion. It has been utilized as a means of educating children about safe interactions with animals to prevent human and animal injury, as well as to promote psychological health and reduce psychological disorder. For example, new data will be presented from a sample of children with Autism Spectrum Disorder in Australia, indicating that an 8-week animal-assisted intervention in the classroom can ameliorate core social symptoms of the disorder and educate children on how to engage in safe and respectful human-animal interactions. Future cross-disciplinary research bridging the fields of public health, veterinary science, animal behavior, psychology, and education will be necessary in order to improve human and animal health by reducing interspecies violence through research-based humane education programs.

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The Health Impact Fund

Thomas Pogge

Yale University

I propose the Health Impact Fund (HIF) as a complement to the current patent regime. The HIF is a pay-for-performance mechanism that would offer innovators the option — no obligation — to register any new medicine. By registering a product, the innovator would agree to make it available, during its first decade on the market, everywhere at no more than the lowest feasible cost of production and distribution (to be determined through competitive tenders submitted by generic manufacturers). In exchange, the HIF would each year divide an annual reward pool among all registered products in proportion to their assessed health impact in that year. The HIF would not merely foster the introduction of new high-impact medicines, especially against the long-neglected diseases of the poor, and facilitate access to registered products by tightly limiting their price. The HIF would also motivate registrants to ensure that their products are widely available (perhaps at even lower prices), competently prescribed and optimally used.

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Public Health Surveillance Ethics

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Often referred to as “the eyes of public health”, surveillance is widely considered to be one of the most basic public health activities. The role of surveillance in global health policy has recently been magnified by the new WHO International Health Regulations’ call for increased infectious disease surveillance. The drive for increased surveillance is largely motivated by the growing problem of emerging and re-emerging infectious diseases in recent decades and, more recently, fears regarding bioterrorism. Recent technological advances, meanwhile, have facilitated improvements in surveillance capabilities. Though health surveillance is closely related to medical research—and though they often involve the very same activities (e.g., medical record review)—the two are treated much differently in practice. While the requirement of voluntary informed consent is a central tenet of research ethics, for example, many would argue that informed consent is neither ethically required for—nor compatible with the goals of—public health surveillance.

Bioethics to a large extent grew out of research ethics, and research ethics is one of the best developed areas of bioethics. The situation regarding surveillance ethics at present, however, is similar to that of research ethics prior to 1947 (when the Nuremberg Code was established)—i.e., virtually nonexistent. While guidelines/principles for the ethical conduct of public health surveillance are therefore needed, their development requires (1) clarification of the technical distinction between research and surveillance and (2) analysis of whether or not, or the degree to which, there are morally relevant differences between the two.

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WHO Project on Responsible Life Sciences Research for Global Health Security: An Integrated Approach Towards Global Health Security

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The project “Responsible life science research for global health security” promotes excellent, safe, secure and responsible life sciences research through an integrated approach that recommends investing capacities in three pillars supporting public

health: research excellence; ethics; biosafety and laboratory biosecurity. The promotion of a culture of scientific integrity and excellence is one of the best protections against the possibility of accidents and deliberate misuse of life sciences research and offers the best prospect for scientific progress and development.

There is no single solution that will suit all countries. A self-assessment questionnaire has been developed to help health researchers, laboratory managers and research institutions to identify strengths and to address weaknesses in each of the three pillars. Going through this process will provide an assessment of the extent to which systems are in place in the national public health system and laboratories to address the risks of accidents and the potential deliberate misuse of science and to identify priority areas where action is necessary to ensure high-quality, safe, secure and responsible life research practices. This self-assessment tool is a simple and cost-effective way for interested countries and institutions to raise awareness about responsible life sciences research and for assessing local problems associated with the above three pillars. In coordination with other stakeholders, the knowledge gained through this process will help countries to align available resources with local needs and circumstances. This is therefore a sustainable way to enhance global health security. The tool will be used by several countries in 2011.

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The Mnisi Community Programme: Innovative Platform for Applied Training and Research Within the “One Health” Concept

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Internationally, the ‘One Health’ concept continues to grow in its acceptance as a viable scientific approach to global health threats. At the same time, it is widely acknowledged that due to centuries of disciplinary isolation, a new generation of scientists and professionals are required. These scientists should be familiar with holistic and ‘out of the box’ thinking together with the ability to strategically channel expertise across disciplines in order to collaboratively resolve the complex challenges posed by the modern world.

The University of Pretoria (UP) recognised the need to develop a platform where local and international, under- and post graduate students could be exposed and challenged by real-life scenarios requiring applied ‘One Health’ thinking. The ‘One Health’ approach in research programmes and as a tangible feature in undergraduate curricula will develop mindsets with a spontaneous affinity towards the ‘One Health’ approach. In its vision to develop a ‘One Health’ training and research platform for applicable disciplines, the UP initiated the Mnisi Community Programme (MCP) as an innovative, multi-disciplinary research and development programme driven within the context of the ‘One Health’ concept.

The Mnisi community is situated at a multidimensional interface next to conservation areas where wildlife, livestock, humans, and the environment interact daily. A community-based veterinary clinic and a wildlife research station were developed at the interface to support training, research and community development. The MCP strives to serve as a model from where new information and knowledge could be generated to serve the greater region – nationally and internationally.

One Health Policy, Implications and Benefits

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Implementing One Health Policies in Bureaucratic Organizations: Moving from Forming, Storming, and Norming to Performing

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The concepts and principals of One Health are an anathema to inherently bureaucratic organizations. Yet, it is just such organizations, be they governmental or non-governmental that are being expected to embrace the concept. These One Health concepts increase the synergy of ideas while reducing redundancy and enhance program effectiveness. However, the central tenants of bureaucratic organizations suggest they have well-defined divisions of labor amongst people and offices, a hierarchical organizational structure, such that authority and status are vertically distributed. As the world's efforts to control highly pathogenic avian influenza has taught us, the practice of One Health necessitates an interconnected network of interdisciplinary specialists willing to share divisions of labor and authority, ignore status quo, overcome organizational boundaries, and employ a multi-faceted organizational structure to eliminate barriers. One hundred years ago, the term bureaucracy was seen as a positive organizational approach to derive order from complex and frequently chaotic systems. It is because of this trend to organize complex systems that we established silos between organizations to maintain order. The US Department of Agriculture (USDA) has recognized complex biological systems do not follow such organizational tenants and has created Department-wide, interdisciplinary groups to support inter-Departmental initiatives, at both the policy and technical levels. Moreover, USDA is summoning other agencies and organizations to establish the necessary interconnected network and partnerships of specialists, share divisions of labor and authority, ignore the status quo and organizational boundaries, to improve synergy, reduce redundancy, and improve the global health of people, animals, ecosystems, and society.

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Proof of One Health Concept: Towards Capacity Building and Intersectoral Interventions

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Considering the marginalized mobile pastoralists, innovations are needed to improve their well-being by filling health services gap and reducing their exclusion from the decision-making centres. When they exist, access to health services is difficult and women and children are particularly the most vulnerable. We aimed at identifying determinants and conditions of equity-effectiveness disease control in developing countries.

Planning priorities was assessed by stakeholder seminars, linking science and society, as well as the interests of communities and authorities representing local and central interests, political power and technical expertise. In this way, the research process and products could be translated into national policy planning. The main lines and area of research were pastoral communities' health in Chad, milk market in Mali and brucellosis control in Kyrgyzstan.

In Chad, estimated coverage of fully immunized children 0 – 11 months ranged from 7 to 13% with cost savings of 15% compared to individual human and animal campaigns. In Mali, the social business allowed farmers to triple heat-treated milk thus preventing growing brucellosis infection. In Kyrgyzstan, the range of annual total losses due to brucellosis is estimated at 5-15 Mio US\$. Mass vaccination campaigns for 10 years are cost-effective to reduce transmission of brucellosis and thus the incidence in humans. 'One Health' framework offered good opportunities for operational adaptive health system, evidence on zoonoses surveillance and dairy value chain promotion. The individual and institutional capacity building initiative on "One health" will contribute to bridge knowledge and applicability gaps and promote new generation of intersectoral health actors.

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The Value of Biodiversity to Human Health: An Australian Perspective

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Biodiversity provides the framework for the natural capital upon which life on our planet and human societies depend. However species loss and environmental degradation is occurring at an unprecedented rate, while at the same time arguably the majority of species are yet to be discovered. Climate change will increasingly intensify these adverse trends. Australia contains up to 10% of all species on earth and the majority of these species occur nowhere else on earth.

Recent international collaborations including the Millennium Ecosystem Assessment have highlighted the importance of biodiversity to human health, primarily in four areas: ecosystem services, disease regulation, medical and genetic resources, and quality of life. The One Health philosophy is consistent with the broader view of human health in the context of healthy ecosystems and protection of biodiversity. In the Australian context however, exploration of these themes has been minimal, and the value of biodiversity to health is rarely reflected in policy.

We will examine the value to human health of biodiversity within broad internationally recognised categories, using Australian examples where these can be identified.

Understanding the value of biodiversity to human health is critical, particularly in an era of increasing climate change. Providing a local Australian context increases relevance to public understanding and policy development.

This presentation draws together evidence supporting the value of biodiversity to sustaining and improving human health, and places this in a locally relevant Australian context.

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One Health: A Canadian Approach

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Canadians interact with animals in a number of ways including through agricultural activity, as food sources, as wild animals in both natural and urban settings and as companion animals (pets). The Public Health Agency of Canada (PHAC) is acutely aware of the current and potential health and economic impacts of emerging infectious zoonotic diseases. The outbreak of SARS in 2003 produced 438 suspected cases in Canada including 44 deaths (by August 2003). SARS related health costs for the province of Ontario reached \$824 million (2003-2004) and the Conference Board of Canada estimated losses of \$570 million from the travel and tourism sectors during 2003 as well as \$222 million from Pearson International Airport. Other emerging infectious diseases in Canada include avian influenza, variant Creutzfeldt-Jakob disease, West Nile virus and Lyme disease.

PHAC has a unique role to play in facilitating understanding, integration and collaboration between areas of human health, animal health and ecosystem health. Currently, PHAC is leading the discussions at the federal level to support collaborations between these three areas. PHAC is also developing a policy to incorporate and implement One Health into its own activities. PHAC is focussing on the integration of animal, human and ecosystem health in four main areas: surveillance, research, communication and education. This presentation will highlight Canadian One Health examples and describe initiatives that PHAC is undertaking in the area of One Health.

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Inter Professional Education: A Novel Curriculum Bridging the Educational Divide of Medical, Veterinary and other Health Professional Students

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One challenge to the successful implementation of the one health initiative remains the absence of an integrated education of health professionals from multiple disciplines. Veterinarians and physicians are educated separately and may only

develop an appreciation of each other's professional capacity at a post graduate level, through either a Master's of Public Health curriculum or even more inefficiently through professional experience. Energy best dedicated to valuable capacity building in One Health has to be diverted to convincing uninformed health professionals that other disciplines may have vital contributions.

Western University of Health Sciences presents a novel curriculum that requires all entry level, first year students from each of its 9 health professional colleges (Colleges of Veterinary Medicine, Osteopathic Medicine, Dentistry, Graduate Nursing, Pharmacy, Optometry, Podiatry, Graduate Biomedical Sciences, and Allied Health Professionals) to attend its university course: Inter-Professional Education (IPE). 847 students participated in the inaugural case based course. Inter-professional teams of one student from each college along with a faculty facilitator shared their unique perspectives through discussion of real life medical cases. While enhancing communication, collaborative and team building skills, students will also better appreciate the specialized skills that each health professional offers in effecting positive health outcomes. Future IPE courses include clinical scenarios with standardized patients, disaster preparedness and interprofessional practice at the new Interprofessional clinic at the WesternU Patient Care Center. This revolutionary curriculum may serve as an ideal model for other educational institutions to better bridge the educational divide and prepare more competent future One Health professionals.

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Enhanced Partnerships Among Animal, Human, and Ecosystem Health Sectors in New Zealand: Recommendations Toward a Convergent Path

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Increasingly complex interactions among humans, animals, and the environment have contributed to growing concern about the emergence of diseases and other health threats.

Through country-level analysis in New Zealand, this presentation aims to provide guidance to improve human, animal, and ecosystem health through common sense approaches that acknowledge the interdependence of people, domestic animals and wildlife, and the environment.

Project methodology was straightforward. Qualitative interviews were conducted with New Zealand policy-makers, researchers, educators, and community members, ranging in expertise across human, animal, and ecosystem health disciplines. The discussions revealed examples of successful transdisciplinary coordination, consistent themes, and recommendations.

In New Zealand, past transdisciplinary actions have led to striking achievements in control of bovine brucellosis, bovine tuberculosis, hydatids, and more recently, campylobacteriosis, pandemic influenza, and eradication of the southern salt-marsh mosquito.

The report provides policy, research, education, and community level recommendations intended to provoke discussion when coordinating transdisciplinary health actions. The overarching recommendation is that effective health strategy must diffuse artificial boundaries between disciplines by collectively addressing health threats according to disease pathway, i.e., from the pest or pathogen's perspective. This requires a dual top-down, bottom-up approach, from policy to education to community efforts. Skilled transdisciplinary leadership ability is crucial. Ecosystem health importance must be mainstreamed for increased public and policy-maker support.

Lessons from within-country analysis of New Zealand's successful transdisciplinary coordination and future recommendations hold international relevance, as health sectors around the globe address human, animal, and ecosystem health.

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One Health in Switzerland: A Visionary Concept at the Crossroads?

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‘One health’ will most likely be the global strategy to further strengthen our health systems. The powerful spirit of lots of encouraging meetings must now be transformed into the development of a sustainable ‘one health’ strategy on a global and a multitude of local platforms. Our study aimed at determining the opportunities of implementing the ‘one health’ concept as a mutual strategy for a better integrated health system in a small and assessable country like Switzerland. 18 participants, selected from a range of stakeholders, opinion leaders and policy makers in the field of human, animal and environmental health in Switzerland were involved in this study by using semi-structured in-depth interviews in the period of April to July, 2010. The personal contact of the author with these most relevant key experts stimulated their interest in ‘one health’. The interviews led to identifying areas where such an integrated approach already exists and/or could be developed. They also revealed administrative and cultural barriers. The results led to the conclusion that, despite a broad acceptance of the concept, finding leaders who are committed to boost the concept will remain a challenging task. Building bridges between sectors and disciplines requires a subtle and empathic approach. In order to successfully put the idea of ‘one health’ into action, a framework of relevant stakeholders and a road map for future activities are needed. The experiences and lessons learnt in Switzerland will be of interest to other countries and help communicate and further promote the ‘one health’ concept.

Global, Regional, or Bilateral Approaches to Managing Risks

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How Can Foresight Approaches Help to Shape Shared ‘One Health’ Visions Across Sectors and Disciplines?

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‘One Health’ principles have been most extensively discussed at the global and regional scales. However, most of the decisions that will support and coordinate the concrete activities that will improve and enhance the integration of animal, human, and environmental health for all species will take place at national and sub-national scales. As a useful starting point, people from these three sectors need to better understand each other’s perspectives and motivations. Real conversations need to take place. Pilot foresight workshops have been conducted in southeast Asia to set up a framework for these conversations to begin and be maintained. This is innovative work which has not been reported on previously.

This paper discusses how foresight approaches have been used to bring scientists and policy makers from different sectors and disciplines together to shape shared ‘one health’ visions.

The barriers to the implementation of a ‘one health’ approach are primarily not technical— but social, cultural and political. Scientists and policy makers will not begin to address these issues adequately until they truly understand the worldviews and perspectives of their counterparts and colleagues working in other disciplines and sectors. This is not easy work, but it is critical. Foresight approaches can open up these conversations.

One of the key strategies to manage the growing risks to global health should be to better understand the non-technical barriers to the implementation of ‘one health’. Foresight approaches can clearly assist in this process.

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Estimating and Validating a Dynamic Risk Factor Model for Pathogen Transmission Using Community-Level Bird Census Data: Avian Influenza at the Waterfowl/Domestic Bird Interface in Zimbabwe

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The ecology of hosts is crucial in understanding mechanisms of pathogens transmission and spread in complex multi-hosts systems. This paradigm is used to infer epidemiological interactions in the context of Avian Influenza Virus (AIV) maintenance and spread at the interface between wild and domestic birds in a southern African ecosystem.

We counted and sampled waterfowl community every two months during two years in the Chivero-Manyame catchment, an important wetland of Zimbabwe. We used the overlap in space and time of bird communities combined with ecological dynamic and non-dynamic risk factors to evaluate a risk of AIV maintenance in waterfowl and a risk of transmission of AIV to the domestic populations (backyard and intensive poultry, farmed ostriches) through the identification of potential “bridge species”. We tested the validity of this risk model using: 1) AIV prevalence data in the waterfowl community estimated in parallel with counting; 2) AIV prevalence data in bridge species identified.

The waterfowl risk identified is related to the AIV prevalence but with time lag. Prevalence in the potential bridge species indicates that some of them can play a role as bridge species in the ecosystem.

We believe this protocol is a) reproducible using available bird census data and useful to explore AIV risk and identify wild bird species potentially acting as reservoir or spreader of pathogens at a local scale; b) can be used as a management tool to improve surveillance at a local level.

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Strengthening and Supporting Capacity in Veterinary Epidemiology at Individual and Institutional Levels to Promote a One Health Approach in the Region of Asia and the Pacific

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Ineffective disease detection and response in many countries reflect the need for national and regional strategies to build veterinary capacity in epidemiology in support of a One Health approach. A review of regional training since 2006 indicates that past training was largely donor driven and training was often not directed at the appropriate target group. Country level needs assessments have been conducted in South and Southeast Asia since 2008 to support curriculum development for a regional veterinary field epidemiology training program. The sub-national level was consistently identified as the most important target group for field epidemiology training. A gap analysis of thirty-two skills was conducted and used to establish training needs that are responsive to country and regional application. Recently, CVO and technical representatives conducted a self-assessment of human, physical and financial resources; technical capabilities at institutional and individual levels; and coordination and communication. All countries stated they have formal epidemiology units however, eight of 11 (73%) countries are inadequately staffed and seven of 11 (64%) countries are inadequately funded to support these units. Key challenges include providing appropriate incentives as well as the appropriate level and duration of training

using a multi-disciplinary and multi-sectoral approach. Member countries are increasingly being engaged to take stock of available resources and consult with international organizations to discuss their needs in line with national mandates.

National and regional strategies for epidemiology capacity building and curriculum development for One Health are needed based on needs assessments, national ownership and regular consultation with CVO.

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Managing the Ecological and Human Health Impacts of Dogs: A Global Issue with Local Solutions

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Dogs live closely with people globally. Whilst they can have important roles in physical, mental, and spiritual health in many cultures, they can also pose significant human and environmental health risks.

This situation is aggravated in developing contexts, where inadequate dog health knowledge can be compounded by difficulties in accessing services and resources. Further, these communities are often in close association with ecologically valuable habitat, potentiating the risks of environmental degradation and disease crossover where dog populations are not well managed.

These issues arise across the world, from the Canadian Arctic to the deserts of Australia, from the base of the Himalaya to the Andes.

In the Australian Indigenous context, unmanaged dog populations threaten dingo conservation through cross-breeding and disease exchange, predate on wildlife, and impact on community residents' health through skin and gastrointestinal pathogens (such as scabies and salmonella), as well as worry, shame and frustration. Collaborative dog management initiatives significantly improve dog health.

In India, feral dogs threaten endangered wildlife (e.g. black necked crane) and pose a risk to human health because of their involvement in rabies and gastrointestinal disease epidemiology. Dog culls have been shown not to be effective, however, dog health programs including desexing and vaccination have been associated with reduced human rabies prevalence.

Because dogs are not viewed as economically or ecologically important, and zoonotic epidemiology is often misunderstood, these issues often fall through administrative gaps. Collaborating on locally appropriate and sustainable strategies is starting to address these issues for the better health of all.

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OFFLU, A Novel International Partnership Approach to a Major Zoonotic Threat

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Two of the most disruptive and potentially catastrophic One Health threats of the last decade have been from influenza viruses. Both the major international veterinary epidemic of H5N1 avian influenza and the human pandemic of H1N1 2009 influenza virus were caused by viruses that arose in animal populations. These created quite different challenges for

mankind, but both required almost unprecedented levels of responses from the international agencies with global responsibilities for the management of public health and animal health. Arising from these experiences is the OFFLU partnership, offering a new way of conducting aspects of the One Health business.

OFFLU is the joint OIE-FAO coordinated global network of expertise on animal influenzas. It has developed governance arrangements to provide focus and administrative arrangements with responsive flexibility including the co-opting of expertise from numerous sources. Outputs include the delivery of advice and training, collated information not available from any one source, and scientific project implementation. OFFLU has conducted international consultations and collaborations to deliver diagnostic protocols updated to match emerging situations, minimum biosafety guidelines for laboratory workers, virus characterization and molecular epidemiological studies, antigenic matching of vaccine strains to circulating field viruses and strategic guidance on animal influenza surveillance. Created in response to H5N1 avian influenza, OFFLU responded rapidly to pandemic H1N1 2009 to help develop and manage key functionality at the human-animal interface. It is currently developing sustainable and effective mechanisms for monitoring influenza viruses in animals and for quickly communicating significant findings to all partners such as the WHO.

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Building the Bridges Between Human and Animal Health, Environmental Management and Land-Use Planning

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It is widely accepted that anthropogenic activities such as urbanization, expansion and intensification of animal production and degradation of natural habitat are drivers of emerging infectious diseases. These particular drivers correspond to environments or land use zones in which diversity of species is reduced but number of individuals of the selected species are increased. This increases the epidemic potential of suitable pathogens where they arise. Diseases of and from wildlife are a particular concern as species adapt to these human modified environments. Equally disturbing is the loss of biodiversity, driven primarily by natural habitat loss; loss of productive land to urbanization; and the growth of energy intensive cities in which the majority of the world's population live, often in substandard conditions. Considerable co-benefits are likely to be associated with efforts to decrease environmental potential for emerging infectious diseases. These diseases may also be examined as indicators of degraded ecosystem function.

However research and institutional bridges between health and the environment have been difficult to build. It is now widely recognised that the obesity epidemic needs institutional involvement to “de-obesify” the built environment with transport and food choices. Similarly management of disease from wildlife needs input at the land-use and conservation planning levels. Signatories to the international conventions on the Conservation of Biological Diversity and Sustainable Development, have the instruments if not the funding to tackle this complexity. This presentation explores the interconnectedness of health, biodiversity and land-use and discusses where empirical evidence is missing and where research is required.

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Creation and Evaluation of a Practical “One Health” Veterinary and Medical Student Training Program in Rural South Africa

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In traditional medical and veterinary school curricula, zoonoses are taught from the perspective of the respective disciplines. However, valuable lessons can be learned from studying human and animal health in a combined curriculum.

In South Africa, a unique One Health training program was created for senior veterinary and medical students. The program is located in one of the poorest and most underdeveloped parts of the country. Abundant wildlife live in the nearby Kruger National Park and the local farmers have livestock and other domesticated animals. Brucellosis, rabies and tuberculosis are believed to be important zoonoses but data is lacking.

The program consists of 17 hours of interaction between the veterinary and medical students over 2 weeks. As a group, the veterinary and medical students visit a primary health clinic, an animal health clinic and a traditional healer. They receive lectures on the One Health concept, Ecology and Health and Identification and toxins of poisonous spiders and snakes and a practical on clinical comparisons between species. A final assignment in the national park involves a game drive followed by creation of an intervention for a zoonotic health topic and a plan for its monitoring and evaluation.

This program breaks down barriers between the veterinary and medical disciplines, and increases the understanding of both professions (activities, strengths, weaknesses and challenges). Feedback from the students has been uniformly positive; however, the longer-term impact of the type of training still needs to be measured.

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Spontaneous Canine Model for Bulbar-Onset Neurodegeneration

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Innovative molecular therapies are emerging as a promising way of correcting genetic and acquired diseases, thus making the value of a naturally-occurring, large animal model of human disease even more apparent. Intense selective breeding and cohabitation with humans have made domesticated dogs eminently suitable to the study of genetic-environmental interactions. Furthermore, the physiology, disease expression and clinical responses to therapy in dogs often mimic those in humans.

For years, veterinarians have performed surgery on “idiopathic laryngeal paralysis”, a condition common in older dogs, especially Labradors. In a controlled cohort study, we recently documented that affected dogs have concurrent swallowing dysfunction, and subsequently develop generalized and progressive neurological deterioration. Paraplegia and eventual tetraplegia is inevitable within several years. Amyotrophic lateral sclerosis (ALS) is a devastating, insidiously progressive and fatal neurodegenerative disease in humans. Approximately 25% of ALS patients begin with bulbar signs (laryngeal dysfunction and impaired swallowing), before developing the inevitable limb involvement.

Bulbar-onset ALS in humans and “idiopathic laryngeal paralysis” in dogs appear clinically identical. No spontaneous animal model for bulbar-onset ALS exists, and validation to establish such a model is clearly required. Our current aim is to perform an indepth clinical and pathological characterization of this neurodegenerative disorder in dogs, with the intent of establishing a model of bulbar-onset neurodegeneration. The combined efforts of veterinary and medical researchers can act synergistically to advance understanding of the pathology, anatomic and genetic basis of neurodegeneration. Future genetic investigations and subsequent potential biomedical applications will benefit both man and his best friend.

Global Outbreak Alert and Response (GOARN)

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A World Health Organization Framework for Zoonoses in the Asia-Pacific Region

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Sustainable and effective coordination mechanism between the human and animal health sectors is vitally important for zoonoses prevention and control. Under Asia Pacific Strategy for Emerging Diseases (APSED 2005), a unique zoonoses framework has been developed to guide collaboration between human and animal health sectors. This framework can be used to address any zoonotic disease events and emergencies. It covers all areas of work including risk reduction, surveillance for information sharing, coordinated response, and collaborative research. Rather than calling the establishment of a new programme, the framework strengthens links between human and animal health sectors, clearly defines the roles and responsibilities of each and take advantages of the resource and expertise within existing structures. As both sectors continue to build capacity within their own fields, the zoonoses framework avoids duplication to create a practical and sustainable coordination mechanism. A joint Guide has been published by WHO, FAO and OIE in 2008. Countries implementing the Guide for example in Laos and Mongolia, has experienced successful response and coordinated actions for risk reduction interventions to anthrax. In Philippines, the mechanism has brought the two sectors together to contain Ebola reston in pig population quickly with further collaboration in research to identify natural reservoirs and possible mode of disease transmission. The coordination mechanism is the way forward to manage zoonoses risk at the human-animal interface. Under APSED 2010 and within the concept of “One Health” the coordination mechanism will further be strengthen and link with food safety, environment, wildlife and other relevant sectors.

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Global Health Security Agenda in a Millennium Development Goal context

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Global health security (GHS) implies a marked reduction in the disease burden in humans and animals, old and new. The proposed and currently developing FAO contribution to the initiative requires effective emergency response mechanisms to redress new outbreaks and endemic disease burdens and, ultimately, will have to address the root causes of disease emergence at the human-animal-environment (HAE) interface. The latter implies a broadening of the health management approach to incorporate the notion that health security cannot be viewed in isolation from the 8 Millennium Development Goals (MDGs). In much of the developing world, food and health security are critical to the livelihoods of the more vulnerable groups in society (MDG 1 and 3). Similarly, health management applies to husbandry and marketing practices in food and agriculture, thereby improving maternal and child health and the fight against diseases (MDGs 4, 5 and 6). A more robust health management and secure safe supplies of food not disrupted by market shocks, outbreaks or natural disasters. There will be a need to clarify the drivers of disease flare-up at the HAE interface, critical control points along complex food chains, farming landscapes and ecosystems, thus GSH also includes incorporation of the natural resource base for wildlife

and ecosystem health (MDG 7 and 8). Successful management of all interactions would lead sustainable disease control strategies adapted from an ecosystem approach. Finally, enhancing health management adequate to achieving GHS requires collaboration and partnerships, from local to global (MDG 8). FAO, OIE and WHO are leading by example.

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The Joint FAO/OIE/WHO Global Early Warning and Response System

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The Global Early Warning System for Animal Diseases including major Zoonoses (GLEWS) is a joint mechanism that builds on the added value of linking the alert mechanisms of FAO, OIE and WHO and triangulating needed expertise and disciplines from the three organizations to provide a unique opportunity for joint risk assessment of potential health threats. FAO, OIE and WHO use their organizational systems to detect threats, verify information via national authorities, other country representation and relevant networks.

A closed electronic platform has been developed to manage, present and store the GLEWS data. The GLEWS Task Force in FAO, OIE and WHO, regularly tracks disease events, conducts epidemiological analyses and maintains a web platform to facilitate information exchange on disease threats at the animal-human interface.

There is potential for strengthening GLEWS and supplementing joint risk assessment with information on drivers for emergence and persistence of disease to build a more complete body of evidence towards understanding trends, epidemiology and build on preventive and predictive capacity to better assess risks and to ultimately aid prevention, control and effective containment of these disease risks.

The presentation will describe the current status of GLEWS and the potential for its future use to advance the renewed tripartite commitment to reduce the impact of disease threats on animal and human health and development.

More information is available at www.glews.net

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Zoonotic Events of Potential International Public Health Concern - WHO's Operational Perspective

Angela Merianos, **Stephanie Williams**, Erika Garcia, Patrick Drury and Thomas Grein (On behalf of WHO Alert and Response Operations team, 2001–2009)

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WHO's Event Management System (EMS) is a selective subset of the universe of acute public health events, including emerging infectious diseases, that WHO has risk-assessed for decision support. This presentation is a global analysis of events occurring from 2001- mid 2009, considered of potential international public health concern, with a focus on events linking human, animal and environmental health.

Data were exported from EMS, linked to field deployments of the Global Outbreak Alert and Response Network (GOARN) and analysed in Stata and Excel to produce descriptive statistics, focusing on events associated with the human-animal interface. GOARN missions were used to identify events of particular concern to WHO.

Of the 2,886 events, 442 (15%) were zoonotic events of which 359 (82%) were associated with human cases of disease. Over half of all zoonotic events were due to animal or avian influenza viruses (130, 29%) and vector borne zoonoses (122, 28%).

GOARN responded to 45 zoonotic events (9%) in 29 countries, of which 19 countries exist within currently defined global hotspots of biodiversity and 15 have UNDP human development indicators of less than 0.5. Zoonotic events were positively associated with GOARN response compared to non-zoonotic events (RR 4.3, 2.8-6.5, $p < 0.05$). Thirty-one (69%) of the zoonotic events requiring GOARN response were emerging infectious diseases.

Although they represent only 15% of acute public health events in EMS, zoonotic events were positively associated with GOARN missions highlighting the importance of these events as emerging infectious diseases of potential international public health concern.

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“One Health”: Points of Leverage of Closer Cooperation of Human and Animal Health

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Faced with complex patterns of global change the inextricable interconnection of humans, pet animals, livestock and wildlife and their social and ecological environment is evident and requires integrated approaches to human and animal health and their respective social and environmental contexts. We validate the added value of “one health” through practical implementation: By a “one health” approach: A) The detection of sources of emerging zoonoses is accelerated by joint human and animal survey design. B) In an African city we can show that rabies control in dogs is more cost-effective than human post-exposure treatment after 6 years. C) If all benefitting sectors contribute to the cost of control, brucellosis mass vaccination in Mongolian livestock becomes highly profitable to public health and to society as a whole. D) Joint animal and public health services serve children and women with preventive and curative interventions in remote rural areas not covered otherwise by public health. These examples show clearly an added value of cooperation compared to both medicines working separately. Evidence for an economic, social and ecological added value of inter-sectoral collaboration between animal and human health serves as a “blue print” for work claiming to be under a “one health” paradigm, allowing identifying points of leverage improving animal and public health. Examples are: Joint surveillance of communicable diseases, Joint cancer registries for animals and humans, Integrated surveillance of antimicrobial resistance, Joint health services and packaged integrated control of zoonoses.

508

Enough One Health Talk: Achieving Effective Integrated Cross-Sectoral Action for Better Health (a Two-Part Symposium) - Sponsored by IDRC-ILRI

Tri Satya Putri (TaTa) Naipospos

UN Food and Agriculture Organization (FAO) Laos

One Health is built on the understanding that disease risks resulting from interactions between animals, humans and the environment need to be addressed through greater inter-sectoral collaboration in both science and its application. There are many other health issues beyond zoonotic pandemic threats that link people, animals, and environment and that also require more coordinated approaches. Global environmental change, globalization, economic growth and increased demand for food and energy; increased travel and migration – these drivers are complicating disease control and public health on many different fronts. Achieving changes in these areas has requires collaborative and coordinated action from more than just health and agricultural sectors – there implications for finance, education, planning, and more. One Health faces several challenges to be an effective conduit for change. There is a need to move out of boardrooms and lecture halls and

into making changes that improve the health of people, animals and ecosystems, particularly in developing regions where the needs are greatest. Consideration of a healthy environment must be integrated into One Health thinking and action. One Health efforts must widen beyond zoonotic disease to address interconnected and up-stream drivers of health: environmental, social and economic factors. This symposium in two panels presents how to meet these challenges, focusing on SE Asia where changes are occurring fastest, capacity to respond is lowest, and new threats are emerging. The first part addresses implementing innovative and practical policy making. The second part presents experiences of implementing action-research projects, from ecohealth to One Health.

508A

Institutional Arrangements for Achieving One Health and Ecohealth Outcomes

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Unprecedented changes to ecosystems and agriculture are resulting in complex health challenges (human, animal and ecosystem) requiring innovative and systemic solutions, such as ecohealth and one health. A central concept of one health and ecohealth is inter-sectoral work between agriculture, health, environmental and other sectors. Understanding the priorities, types of institutional arrangements and mechanisms for working is still evolving and can vary greatly depending on local context and the type of inter-sectoral engagement. Case studies for developing countries in Latin America, Africa and Asia are reviewed, across the spectrum of cross-sectoral integration. Options for institutional arrangements have included joint task forces around specific emergencies, the establishment of joint offices for specific diseases, shared labs and other infrastructure, joint research, integrated disease surveillance, inter-sectoral programs such as veterinary units in public health departments and delivery of services through one health practitioners. From these we present a framework on assessing the efficiency, effectiveness and feasibility of different types of institutional arrangements and for better understanding the barriers and bridges to working across sectors in different countries. This includes criteria for assessing impacts within and between sectors. Lessons learned for prioritizing and implemented joint actions are summarized.

508B

Development of Avian Influenza Policies in SE Asia - Lesson for One Health

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Avian Influenza as a zoonotic disease has posed public health emergence of international concern in Indonesia. A wide range of policies and risk communications has been exercised to control and prevent the epidemics. This policy analysis aims at exploring the governance changes as a result of improved networking in EID/AI control.

The primary data were collected through in-depth interviews. A systematic literature review was used to collect and to analyze policy & research materials. The interviews were carried out during the service of KOMNAS FBPI, March 2008 - November 2009 and after the termination of KOMNAS FBPI, June - August 2010. There were 25 national & provincial stakeholders who dealt with Influenza Pandemic Response interviewed.

Critical interactions are shown between human health and animal health organizations and its governance to support One Health. The strengths, gaps and constraints related to resources, resource mobilization, and communication are shown. The strength resulted from SARS and H5N1 experiences showed by the availability of: pandemic preparedness and response strategies, SOP for Influenza pandemic, 100 referral hospitals and referral laboratories. The management constraints are

related to budget & disbursement mechanism and management linkages from national to local pandemic preparedness and response. Members of Indozone communication network indirectly influence recent establishment of National Commission of Zoonotic Diseases and DG for Animal Husbandry & Animal Health, Ministry of Agriculture.

KOMNAS FBPI has introduced One Health concept and created public awareness necessary for Influenza pandemic preparedness in Indonesia. Indozone communication network, which supports One Health, serves as an effective media platform for dialog & info sharing among animal-human health stakeholders.

508C

Land Use Change and Health in a Transboundary Context - Implications for Decision-Making

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Driven by economic development policies, population growth, globalization and other driving forces, land use change has been taking place in eastern Himalayas in the last decades. This has profound implications for mountain ecosystems and the livelihoods of people who live in them. However, little is known about the impact of this change on human health.

Using an EcoHealth approach, we have been conducting action research to understand the land use changes and their impact on human health in eastern Himalayas. Three study sites, namely Tibet autonomous region, Yunnan province of China and the middle hilly areas of Nepal were selected to undertake this research. The major land use changes identified in the study sites are sedentarization of nomads, agricultural intensification and modernization, and the major health problems that the research teams chosen to work on are malnutrition in Nepal site, fluorosis and pesticide-related health issues in Yunnan site, and zoonotic diseases in Tibet site.

The result reveals that there are multiple, direct and indirect links between land use changes and the identified human health issues in the three study sites. A systematic and holistic framework is required in order to understand the complex and the socioeconomic and ecological drivers embedded in those links, and a flexible and reflective approach is also needed to work out sound solutions. Policies or interventions that are designed to address those health problems but are based on the perspective of one single discipline or sector are often inadequate to solve the problems, and they may create secondary generation of problems. Thus, an EcoHealth approach that includes transdisciplinarity, stakeholder participation and social equity, particular gender equity is an essential in developing socially equitable and environmentally sustainable solutions.

508D

Avian Influenza and Backyard Poultry Systems in Cambodia

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This presentation is based on three years of participatory research in three Agro-Ecological zones in Cambodia. It discusses the basic characteristics of backyard poultry raising systems in these zones and how these relate to the risk of avian influenza infection and spread. This includes livelihoods and farming systems and the role of poultry in them, farm biosecurity, farmers' interaction with veterinary and health care systems, and the patterns of poultry trade and movement. Particularly important risks are associated with the movement and mixing of birds of different species and ages during collecting and transport of poultry in and between villages and to markets. To address these, action research were undertaken with farmers and other local stakeholders in which chickens bio-security production system was tested and village poultry trading activities were placed in specific parts of the village to minimize diseases risks and strengthen farmers' bargaining power.

508E

Addressing Zoonotic Threats in the Food System in Vietnam

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During the last decade, Vietnam has been among the countries most affected by outbreaks of avian influenza and SARS, both zoonoses with a substantial public health impact. Zoonotic threats in food have also emerged as a major concern for the country. The efforts made by Vietnam to mitigate the impact of these health problems and improve health and well-being of people and animals have been evaluated positively by the international community. However, these efforts still lack coordination and inter-sectoral collaborations between related fields of expertise. We present here the current practice of managing zoonoses in Vietnam on the one hand, and on the other hand propose an EcoHealth framework to better manage zoonotic threats in the food system. In this approach, research, evidence-based interventions, and management of zoonotic food-borne diseases are conceived from interdisciplinary spirit combining human and animal health, environmental and social perspectives. Such an approach requires cross-sectoral collaboration from related fields such as health, agriculture, commerce, education and involvement of the communities with socially and culturally accepted measures for intervention tailored to local context. The challenge of applying an EcoHealth approach in developing country settings is also presented.

508F

Eco-Bio-Social Research for Dengue Prevention and Control in Asia - A study in 6 Countries

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The WHO-TDR/IDRC initiative on “Eco-Bio-Social Research on Dengue in Asia”, initiated in 2006, aims at improving community-based dengue control in six countries in Asia. Integrated eco-environmental, biological and social determinants gathered during phase I provided insights and baseline data to develop country-specific pilot implementation programmes for dengue prevention and control in phase II. Phase I findings contributed to detect significant differences in ecological, biological and social factors influencing dengue incidence in different urban and semi-urban community settings. In this context, an ecosystem approach has been applied to determine and implement locally adapted combinations of interventions for phase II. The processes of inter-sectoral interventions in phase II, to address the environmental issues underlining dengue epidemics and integrated community-based strategies for dengue prevention and control, will be discussed. Effective inter-sectoral activities were related to management of waste and water storage at household level which in turn had an effect on breeding habitats of dengue vectors and eventually may have the potential to mitigate local dengue outbreaks. Country examples of the successful implementation programmes will be highlighted and possible applications to other emerging and re-emerging diseases will be discussed in this presentation.

508G

Avian Influenza H5N1 Threats Wild Bird Conservation and Eco-health - Qinghai Lake Case Report

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The highly pathogenic avian influenza (HPAI) H5N1 viruses from 2003 to update have already infected large areas of the global continent of the world, and still exist. Diversified wild bird species including the global endangered or threatened species have been killed by these viruses. The outbreak of HPAI H5N1 in Qinghai lake China in 2005, caused the death of thousands of wild birds, especially the bar-headed goose. Qinghai Lake may become the natural epidemic disease reservoir of this AI because they may maintain the viruses and spread them through wild bird migration, of course, the lake may also face the risk of this disease. This suggests wild birds and their habitats especially waterfowls and wetlands conservation are seriously challenged by HPAI H5N1 prevalence, and a conservation strategy in maintaining the eco-health of this International Important wetland is urgently necessary. The risk for introduction of H5N1 in and out of the Qinghai Lake was revealed that it would be high during spring (April and May) and autumn (September and October), however, species diversity and abundance were different at each location around the Lake. The results finally recommended the conservation priority in geospatial perspective under the eco-health program.

One Health and Human Prosperity: Insights from H5N15 - Sponsored by U.S. Agency for International Development

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Trade, Disease Risk and the Global Shell Game: A Supply Chain Approach to Identifying and Evaluating Risks for Entry of Highly Pathogenic Avian Influenza (H5N1) into Southern Africa

Gary Mullins¹, Shahn Bisschop² and Andrew Ross¹

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²*University of Pretoria*

Highly pathogenic avian influenza (H5N1) has been confirmed in multiple countries in West and East Africa, yet to date, southern Africa has remained free of the disease. With its dependence on imported food products – including poultry, promotion of and extensive intraregional trade patterns, locally porous borders and limited resources to enforce disease control regulations, it is crucial to public authority efforts to prevent entry of the disease into the region that they are focused on those highest risk points. But with so many products entering the region and then quickly being redistributed, how does one analyze this market-driven ‘shell game’?

The authors report in detail their findings from a rapid survey of the commercial poultry product supply chains in six southern African countries – South Africa, Botswana, Zimbabwe, Malawi, Zambia and Mozambique – noting both international and intra-regional movement of poultry products, including live poultry of various generations, as well as wild captured birds, their modes of conveyance and other supply chain factors and attributes. Unexpected findings include the extent to which poultry products are moved intra-regionally, not only within southern Africa, but also to West Africa and in both directions between southern and East Africa. The complex trade patterns that emerge, driven by a rapidly expanding commercial poultry sector in Africa, pose difficult challenges for animal and human health regulatory authorities. The information generated by the authors’ study, however, facilitates decision-making by highlighting potential risks, their entry points and suggests key steps to be taken to limit those risks.

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Public-Private Partnerships Improve Live Bird Markets in Bangladesh

Rich Magnani

DAI, MD, USA

The Stamping Out Pandemic and Avian Influenza (STOP AI) program in Bangladesh developed a public-private partnership to inhibit the spread of Highly Pathogenic Avian Influenza (HPAI) in two major live bird markets in Dhaka through a cleaning and disinfection (C&D) program. Partners included the Department of Livestock Services, Dhaka City Corporation, market committees, transporters serving the markets, and the private market vendors. The objectives were to institutionalize a fee-based cleaning program to reduce viral load, minimize the spread of HPAI, and document lessons learned to share with the FAO and others working on similar efforts. STOP AI provided, on a cost-sharing basis with the partners, spraying equipment, cleaning materials, waterlines, drainage, and electricity infrastructure, trained group leaders and vendors on C&D procedures, and provided oversight in preparation for the winter 2009 peak season for HPAI. The program demonstrated the benefits of C&D to the market committees managing the markets, the market vendors, and operators of delivery vehicles. Prior to the C&D program, stall cleaning in both markets consisted of sweeping and washing only with water and spraying disinfectant directly on live birds or organic matter, neither of which is an effective means of preventing HPAI. Previously, no vehicle C&D took place in the markets. The most significant lesson learned was that securing assurance of the local governments and the market committees to supply C&D service was not adequate to institutionalize the service. Continued demand for C&D from the vendors and drivers who accepted the value of the service was essential.

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A Breakthrough in Public & Private Sector Dialogue in Egypt

Rich Magnani

DAI, MD, USA

Egypt has struggled to control HPAI since the first reported outbreak in February 2006. The containment of HPAI has been constrained by high population density in key Delta poultry production areas, weak biosecurity practices, ineffective enforcement and movement controls, and inadequate responses by the GoE. The result has been a significant absence of trust between the GoE and the industry. STOP AI bridged the gap by organizing workshops with many of the largest producers and key GoE officials to discuss the regulatory environment and ways to reduce the HPAI threat. As a result the GoE is reconsidering several regulations that producers claim are ineffective and unrealistic such as minimum distance between production units, and requiring vehicle drive-through dips for vehicles. The producers also voiced objection to the regulation that existing farms must move to meet the regulatory minimum distance of 500 meters between production units. The workshop discussions also revealed discontent among producers of biosecurity standards required to obtain an operating license. The regulations go well beyond internationally recognized best practice, may be ineffective, and may not be feasible for many producers. This results in numerous unlicensed producers essentially making them invisible to GoE health and safety authorities. It is a significant barrier to cooperation among poultry producers and between producers and the GoE. Another promising outcome has been the agreement by the large producers and GoE representatives to participate in a series of STOP AI facilitated meetings in October and November establish consensus on meaningful and realistic biosecurity standards.

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Development of Safe, Free-Range Poultry Supply Chains for Small Farmers in Vietnam

John Bowman and Patrice Gautier

STOP AI Project, Development Alternatives Inc., Maryland, USA

Given the outbreaks of highly pathogenic avian influenza (HPAI) which have occurred in Vietnam since 2003, the government and donor community are interested in innovative, market-driven approaches which will improve the overall biosecurity and safety of poultry supply chains. As compared to so-called “safe”, mass-produced industrial poultry products, the Vietnamese public generally prefers the taste and texture of “traditionally-raised” native poultry grown under “backyard” conditions (where disease and food hygiene are highly unpredictable). This STOP AI activity has established a number of integrated poultry supply chains which provide the discriminating consumer with the right combination of poultry “taste + quality + safety” coming from semi-confined, free-range production systems. Project training in production efficiency and biosecurity suppress HPAI (and many other diseases) and give the farmers potential for higher profits. Food safety testing and marketing support are also provided. The STOP AI project and the farmers have also co-invested in small-scale hygienic slaughterhouses and cold chain transport, which enable more direct selling to retailers. Products coming from these supply chains are branded with a project logo – “Naturally Vietnam” – and only farmers internally certified by the project are permitted to sell under this private label. Our paper will examine how this activity seeks to convince the Government and private sector that increased investment in certifiable schemes for safe native products, coupled with increased enforcement against unsafe/uncertified products and slaughterhouses, are valuable tools to be employed in the re-structuring of Vietnam’s poultry industry in an HPAI environment.

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Partnering with Live Bird Marketers, Producer Associations and Local Municipal Government to Reduce HPAI H5N1 Risks in West Africa

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The STOP AI (Stamping Out Pandemic and Avian Influenza) West Africa Regional programme introduced low-cost, improved biosecurity measures in live bird markets (LBM) and small scale commercial poultry farms in Mali, Cote D’Ivoire, Ghana and Benin to address HPAI H5N1 disease risks identified in West African countries. Interventions were carried out in partnership with live bird market and producer associations and with local municipal government. STOP AI provided, among other items, initial supplies of cleaning and disinfection equipment, model metal cages for holding birds in the markets, and plastic poultry transportation cages that could be easily cleaned and disinfected. Participating markets and model farms were then used as in situ training facilities for poultry sellers, transporters and producers, with support from STOP AI-trained national consultants. Target outcomes included; establishment of improved biosecurity measures in the sales and processing areas of LBM’s to reduce potential human exposure to H5N1 virus, formation of cadres of informed marketers and producers capable of disseminating biosecurity messages among fellow association members, and thereby wide-scale introduction of low cost, effective biosecurity measures across the smallholder poultry sector. Challenges, opportunities and lessons learned regarding formation and use of private sector and municipal government partnerships to reduce disease risk are highlighted and discussed.

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Establishing Incentives for Improved Farm Biosecurity Through Private Sector Partnerships: the CBAIC Experiment in Indonesia

Gary Mullins, Caesar Layton and Gerald Martin

Development Alternatives Inc., Maryland, USA

Recent studies in Indonesia indicate that commercial production is a major vehicle for H5N1 transmission among poultry and from poultry to people. Therefore, being able to engage and motivate private sector farmers is critical for reducing disease threat to humans, food sources, and livestock. Between 2008–2010, the USAID-funded Community-Based Avian Influenza Control Project (CBAIC) developed and tested models to reduce the risk of H5N1 transmission in Indonesian commercial poultry through training, one-on-one technical assistance, and farm commodity support. This approach was implemented in 330 broiler farms with total annual production of 17 million birds in West Java, an area reporting the majority of H5N1 cases in animals and humans in Indonesia.

The business case made to industrial (Sector 1) poultry producers and industry associations argued that the marginal returns from implementing biosecurity measures and good management practices would offset their marginal costs. Participating farmers received one-on-one technical assistance, performance monitoring, and data collection. Data were collected on depletion, feed conversion (FCR), productivity, and biosecurity compliance through eight production cycles. Analysis was conducted on data from 330 assisted farms and 50 control group farms.

Results show that complying farms had lower rates of depletion than control farms, maintained these lower rates, had lower FCR's and indicated that a 5000-bird farm may recoup its basic investment in 4 – 8 production cycles. This analysis supports building stronger private sector initiatives to address H5N1 and other poultry diseases by linking improved biosecurity and improved farm management practices to disease reduction and improved farm performance.

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Investments and Challenges in Developing a Risk-Based Approach for Predicting and Preventing Emerging Pandemic Threats: An Overview and Strategic Framework for Addressing Emerging Threats

Dennis Carroll

U.S. Agency for International Development, Washington, DC, USA

Nearly 75 percent of all new, emerging, or re-emerging diseases affecting humans at the beginning of the 21st century have originated in animals. Notable reminders of just how vulnerable the increasingly interconnected world is to such diseases have emerged in recent decades. They include HIV/AIDS, severe acute respiratory syndrome (SARS), H5N1 avian influenza, and the pandemic 2009 H1N1 influenza virus. The speed with which these diseases can surface and spread presents serious public health, economic, and development concerns. It also underscores the need for the development of comprehensive disease detection and response capacities, particularly in areas where disease threats are likely to emerge.

Recognizing this need, the United States Agency for International Development (USAID) has launched an Emerging Pandemic Threats (EPT) program that seeks to aggressively pre-empt or combat diseases that could spark future pandemics. The EPT program draws on expertise from across the animal- and human-health sectors to build regional, national, and local capacities for early disease detection, laboratory-based disease diagnosis, rapid disease response and containment, and risk reduction. These efforts target a limited number of geographic areas, known as “hot spots”, where new disease threats have emerged in the past. In this symposium, the panel and participants, will discuss the investments and issues involved with moving towards a global surveillance and response system for emerging zoonotic diseases, including a “One Health” strategy for wildlife pathogen discovery, risk determination through the use of geo-temporal models, and strengthening capacities for investigating and responding to disease outbreaks.

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Modeling Risk: The Use of Geo-Temporal Models for Focusing Risk Reduction Interventions

Peter Daszak¹, Tiffany Bogich¹, Parvize Hosseini¹, Carlos Zambrana-Torrel¹, Kevin Olival¹, Jonna Mazet² and Stephen S. Morse³

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Work over the past two decades has shown that the process of zoonotic disease emergence is essentially an ecological one in which anthropogenic factors drive the spillover and spread of wildlife microbes in human hosts. Because these ‘drivers’ of emergence are measurable, and to some extent their future trajectory is known, analysing them provides a basis from which to predict the patterns of future zoonotic disease emergence. In this talk, I present an approach to identify the regions where the next emerging infectious diseases (EIDs) are most likely to emerge (EID ‘hotspots’) and our current efforts to refine our recently published work (Jones *et al.* Nature 2008), with updated driver data, and new analyses. Using data on human travel and trade patterns we can take this strategy further by identifying the hotspot regions which are most likely to propagate the spread of a new EID. This research may provide a cost-effective strategy for pandemic prevention, by allowing us to allocate global resources to the regions where the next pandemic is most likely to originate. The large sets of data on zoonotic disease risk and pathogen discovery to be collected through the USAID EPT program will provide a unique opportunity to test the efficacy of this approach. As part of this strategy, we have set up a series of large-scale transects across disease ‘hotspots’ where our USAID-funded ‘PREDICT’ group is conducting targeted wildlife surveillance. These surveillance transects represent gradients of deforestation, population density, biodiversity (of hosts and pathogens), agricultural intensification, and other factors that are important in disease emergence. The aim of this approach is to ultimately produce far more accurate predictions of where the next emerging zoonoses are most likely to originate, and from which species of wildlife.

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The U.S. Government’s Strategic Framework for Addressing Emerging Threats

Richard Hatchett

Director for Medical Preparedness Policy, National Security Staff, The White House, USA

We are now in an era of new, re-emerging and recurring global health threats that argue for a longer-term, more strategic approach to global health preparedness. The ongoing threat from recently emerging zoonotic infections such as SARS, H5N1 (avian) influenza and, most recently, H1N1 influenza has raised awareness of the global interdependence of human and economic security and the need for a more systematic effort to identify and respond to sudden global public health emergencies including, but not limited to, zoonotic diseases. The 2005 revision of the International Health Regulations (IHRs) under the auspices of W.H.O. and their entry into force in 2007 signaled a normative shift in the responsibility of states to build their internal capacities to monitor and report emerging disease threats, intended in part to help reduce the risk of inter-state spread of health threats that could harm the sovereign interests of *other* states.

Given these events, there is a clear need for the member states of the global community to act pre-emptively and systematically to improve individual countries’ abilities to identify and mitigate the severity of health threats arising within their borders. Recognizing this need the United States, with its leadership capacity and unique assets in training, operational research, systems strengthening, information systems and logistics is committed to working in partnership with other nations to build global capacities for disease surveillance, detection, diagnosis, reporting, and control, while simultaneously

supporting efforts to mitigate the risk of new disease emergence. This session will discuss the strategic framework guiding United States government efforts to support these efforts.

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A “One Health” Strategy for Building Capacities to Prevent and Respond to Disease Outbreaks

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The impact of infectious disease outbreaks can be substantially decreased by both effective prevention and early detection when outbreaks do occur. The lack of coordination among individuals and institutions engaged in human, animal and environmental health is frequently a major challenge to effective prevention and control of emerging infectious diseases. The United States Agency for International Development’s Emerging Pandemic Threats (EPT) program is taking a One Health approach to facilitate collaboration among sectors and professions to build stronger and more efficient public health systems. The program is working to: transform systems and professions to promote and manage effective disease prevention and control; and engage with private sector actors currently active in locations where animal-human-environment interaction is a daily reality.

Strengthening the One Health concept at educational institutions in hot-spot regions is a cornerstone of the RESPOND Project within the EPT program. Key RESPOND activities include: twinning with public health, veterinary medicine, biology/environment and anthropology schools in hot spot areas; reinforcing the capacities of countries to train current and future professionals to identify and respond to outbreaks of nascent emerging diseases in a timely, sustainable and culturally sensitive manner; enhancing collaboration among animal human and environmental health networks; training frontline responders at community and district levels; and providing professionals with skills to work collaboratively across the One Health landscape.

Investment in education and One Health multi-disciplinary networks is a key mechanism to tackle the underlying problems that contribute to the severity of disease outbreaks and to the evolution of pandemics.

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Lowering Risk: From Policy to Practices

Kama G. Garrison

United States Agency for International Development

The impact of emerging infectious diseases, specifically those of animal origin, on human health and economic loss can be mitigated with a broader focus on community and industrial practices and policies that inhibit the introduction and spread of disease.

While there is a recognition that the emergence of zoonoses is caused by human behaviour, including extractive industry practices (e.g. mining, logging) that increase encroachment on wildlife habitat, the settlement patterns of communities near wildlife habitat, the increased trade and consumption of exotic foods including bushmeat, and other practices that place humans in more intimate proximity to wildlife, little has been documented on how to directly address those practices.

The United States Agency for International Development’s Emerging Pandemic Threats (EPT) Program, is developing a strategy to address the human causal factors that increase the risk of the emergence and spread of zoonotic disease. Public education, historically, has done very little to mitigate disease spread, especially those diseases which rarely occur. Along

with increased surveillance, USAID's EPT program will document, test and disseminate community and industry practices that mitigate the emergence and spread of disease, recognizing the economics of targeting behaviour change strategies at the point in which a zoonotic disease of public health significance gains traction, amplifies and spreads.

520A

Predicting Pandemics: Using a One Health Approach to Identify and Mitigate the Emergence and Spread of Zoonoses from Wildlife

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In order to predict, respond to, and prevent the emergence of novel infectious diseases, we must identify them at their source. Rapid human population growth and environmental changes have resulted in increased numbers of people living in close contact with animals. The resulting increased contact has altered the ecological balance between pathogens and their human and animal hosts. We have built a One Health team with a SMART (Strategic, Measurable, Adaptive, Responsive, and Targeted) surveillance vision responsive to the fact that zoonotic pathogens account for the majority of emerging infectious diseases in people, and that more than three quarters of these are the result of wildlife-origin pathogens. Our approach employs integrated risk modelling, molecular diagnostics, and intensive field studies to detect novel diseases with pandemic potential early, giving health professionals the best opportunity to prevent emergence or control epidemics at the source of spill-over. It also targets important sentinel species at active human interfaces in hotspot regions to improve surveillance efficiencies. Our targeted and adaptive wildlife disease surveillance system includes the introduction of new technologies at the local level, as well as the use of cutting-edge information management and communication tools with the potential to bring the world closer to realizing an integrated, global approach to emerging zoonotic diseases. Our team is assisting in the development of global capacity to monitor diseases at the animal-human interface and has implemented a risk-based approach to concentrate efforts in surveillance, prevention, and response at the most critical points for disease emergence from wildlife.

Poster Abstracts

Disease Emergence

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Contraception Health Surveillance in Wildlife and Zoos; A Tool for Comparative Reproductive Pathology

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Hormonal control of reproduction is common in human and veterinary medicine. For example, hormonal manipulation is a key tool for zoo and wildlife veterinarians to manage animal populations. Yet in animal and human applications, contraception is not without risks. The Contraception Health Surveillance Program (CHSP), associated with the Wildlife Contraceptive

Center at the St. Louis Zoo (<http://www.stlzoo.org/animals/scienceresearch/contraceptioncenter/>), has been collecting, evaluating, collating, and interpreting the findings from reproductive tracts from both contracepted and non-contracepted zoo mammals for over 20 years. For example, the progestin melengestrol acetate (MGA) has been effectively used in zoos for critical population control, with the understanding that safety and efficacy would be evaluated as the product was used. Recent CHSP studies have revealed elevated risks of mammary and uterine disease in big cats and severe uterine lesions in canids subjected to prolonged MGA use. This information has an immediate impact on the management of endangered species, but also provides valuable comparative data. Fully understanding the breadth of hormonal control mechanisms across species can impact the management of reproduction in many species, including humans, but may also demonstrate the pitfalls of inappropriate extrapolation between species. In the future, animal reproductive disease monitoring may also reveal the effects of hormonally active environmental contaminants. In summary, monitoring the reproductive health of zoo and wild animals not only impacts the effective and safe management of these often endangered populations, but also can provide powerful comparative insights into the effects of both regularly prescribed and inadvertent exposure to hormonally active compounds.

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Rift Valley Fever. A Need for a One Health Approach to Curb. Case Study from Sudan

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Rift Valley Fever (RVF) is an emerging zoonotic disease that crosses national borders and leads to considerable public health and economic impact. It is caused by RVF virus (RVFV) and spreads over different climatic zones. There is a concern that RVF could spread further due to global climatic changes.

In Sudan, the tenth largest country in the world and the main exporter of live animals to Middle East, a RVF outbreak occurred in 2007 in three agricultural states. The outbreak revealed the interplay between environment, animal health and human health. Most of the affected persons were from rural areas and belonged to the productive age group. The RVF outbreak in Sudan was a good example of the severe economic consequences of RVF on rural and national economy where the live animals' trade contributes significantly to the gross domestic product. It also showed how the spread of RVF disrupted the regional animals' trade.

Notably, the Sudan outbreak was discovered in humans before animals and vectors. This highlights the lack of sustainable surveillance and collaboration between the veterinary and health authorities. However, the task force that was assigned later helped to mitigate the outbreak consequences. This situation enhances the importance of one health approach where the deployment of a multi-disciplinary team was crucial to control RVF. Interestingly, the Sudan case study also showed signs of an urban RVF outbreak.

This case study implies that the passive efforts at country level was not enough, while the collaboration with international agencies helped significantly in confirming and curbing the outbreak.

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Semen Borne Infections and Public Health Concerns

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Artificial insemination technique plays a major role in animal reproduction in developed and developing countries. However many infections can be transmitted through semen if not cared properly. There is high risk of infectious agents

being transmitted between animals via the venereal route or by use of infected semen. For national and international trade the transport of genetic material in small frozen packages and with prolonged viability for the purpose of A.I. is convenient and advantageous. A condition of cryopreservation designed to prolong the life of spermatozoa also often prolongs the life of many infectious organisms too. This technique may result in potentially widespread dissemination of infectious diseases through cryopreserved semen. Semen can be contaminated by preputial smegma, skin, atmospheric contents and diluents. The different types of organisms encountered in the semen are Bacilli, Diptheroids, Micrococci, Coliform, Streptococci, Staphylococci, Pseudomonas, Actinomyces, Proteus, Yeast, Viral Agents and Mycoplasma etc. Other contagious organisms that infect cows through semen are Brucella, Vibrio, Trichomonas, Leptospira and Mycobacterium. Tuberculosis, John's disease and Brucellosis have been reported to be of great concern for human health which can be transmitted to human accidentally or due to unhygienic handling of infected semen at the time of A.I. The pathogenesis of these diseases involve all the body systems. Brucellosis and Tuberculosis are considered very important in semen due to their greater public health significance. Hygienic measures (laboratory hygiene and personal hygiene) to be taken at the time of semen collection to prevent the spread of semen borne infections concerning human health.

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Emerging and Re-Emerging Diseases and Human Health

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The protection of human and animal health lies in combating with several emerging and re-emerging diseases from time to time. In recent years, both the species have suffered from several such diseases mostly as anthroozoonoses, Avian influenza virus (avian species to man), HIV 1 (primates to man), Sin Nombre virus and Hantaan virus (rodents to man), Ebola virus in monkeys, West Nile virus (birds to human), Nipah virus (bat to pig to human), Haniba virus (pigs and human) and monkey pox (rat to dog to man) are some of the examples. India too has witnessed such diseases in the form of outbreaks. Avian influenza has been a focus of both national and international concern due to its emergence as pandemic which has considerable economic impact on animal production as well as adverse effects on human health. Globally, Italy (1999-2000), Dutch (2003) and Canada (2004) have encountered serious epidemics. In India, the worst affected state West Bengal lost thousands of birds resulting in serious economic losses in 2007-2008. The emerging and re-emerging nature of the disease is attributed to nature of virus, its mutation, perpetuation in susceptible host and its transmission between animals and to human as well. Chikungunya and Dengue are the major re-emerging diseases in recent months which have become a serious problem to reckon with. The prevention and control of such diseases lies in serological, virological and biotechnological diagnostic capability, development of vaccines and breaking down the transmission mode by any means to protect human health.

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Devil Facial Tumour Disease (DFTD): Using Genetics and Genomics to Investigate Infectious Disease in an Endangered Marsupial

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The Tasmanian devil (*Sarcophilus harrisii*), so named for its blood-curdling, nocturnal shrieks and snarls, is the largest of the carnivorous marsupials. Wild devil populations have crashed since the emergence of devil facial tumour disease (DFTD), an invariably fatal tumour transmitted between devils by biting. Elegant cytogenetic and genomic experiments demonstrate that the infectious agent is the neoplastic cell itself. This somatic cell parasite exploits the devil's paucity of

genetic diversity to out-manoeuvre the immune system, enabling tumour transmission by allograft. The emergence of DFTD has had a profound effect on the conservation status of the devil; populations have diminished by up to 90% with alarming rapidity and extinction is projected to occur within 25-35 years. This trend confounds prevailing theory, which suggests it is unlikely for a single-host pathogen to cause extinction of a wild species. DFTD's tendency to remain prevalent even as devil numbers dwindle poses a challenge for disease management. Nevertheless, strong multi-disciplinary collaborations have made considerable progress in understanding the aetiology of DFTD, ultimately informing conservation efforts. High-throughput sequencing technology is proving essential to conservation genomics and, in the case of the devil, the recent elaboration of the devil/DFTD transcriptome has equipped conservationists with the means to judiciously manage insurance populations. Additionally, in providing a gene-level insight into DFTD pathogenesis, this data brings us closer to preventative or curative therapy. With progressive habitat fragmentation and introduced species contributing to the tenuous future of the devil, continued efforts to mitigate the extinction of this important species are crucial.

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Detection and Differentiation of Avian and Zoonotic Pathogens by a Luminex Liquid Bead Array Multiplex Assay

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Influenza virus is a prime example of an avian virus with zoonotic and pandemic potential. Other avian pathogens such as West Nile virus and Newcastle disease virus are also threats to animal and human health. We have developed multiplex liquid bead array assays for detection and differentiation of important avian and zoonotic viral disease agents. The assays were designed for the Luminex xTAG system. This technology utilises uniquely designed TAG/anti-TAGs and isothermal hybridisation coupled with target gene-specific primer extension and labelling reactions to identify multiple targets in a single reaction.

We have developed panels of avian/zoonotic 10-plex assays and evaluated the performance in comparison with the corresponding singleplex assays. The analytical sensitivities of multiplex assay panels were on par with singleplex assays. The multiplex assay can detect influenza A virus, Newcastle disease virus (NDV), infectious bursal disease virus and West Nile virus, and discriminate between strains. The panel was able to identify influenza H5 and H7 subtypes and the current 2009 pandemic (H1N1) strains, and differentiate between NDV field isolates and vaccine strains. All strains were correctly identified in a double-blind experiment using reference strains. The diagnostic performance of the Luminex multiplex assays will be evaluated in comparison with real-time PCR assays using diagnostic submissions.

We are planning to include other endemic and exotic pathogens to expand our current assay panels. The Luminex xTAG open platform is well suited for the development of custom multiplex assays for syndromic surveillance and index case diagnosis.

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Nipah Viruses from Malaysia and Bangladesh: Differences in Transmission and Pathogenesis

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Nipah virus (NiV) is a bat-borne paramyxovirus capable of infecting humans and a range of domestic animals. NiV first emerged in 1998-9 in Malaysia and Singapore, with over 200 people infected and a case fatality rate of approximately 40%. This outbreak was characterised by transmission of infection from bats to pigs and pigs to humans, with no documented

human to human transmission. A divergent NiV strain emerged in 2001 in Bangladesh and India and has since resulted in numerous outbreaks of human disease, with nearly annual occurrence and mortality rates higher than 90% in some outbreaks. In contrast to the Malaysia strain, human to human transmission of NiV Bangladesh has regularly occurred and there is no recognised host intermediate to bats and humans. Higher virulence and an increased incidence of respiratory involvement in human cases of infection with NiV Bangladesh, compared with NiV Malaysia, may facilitate human to human transmission. No *in vivo* or *in vitro* comparisons of the two viral strains have been reported to date. This study compared features of infection and viral shedding between the Malaysia and Bangladesh NiV strains in a mammalian infection model using ferrets as a human surrogate. Two groups of ferrets were infected with either NiV Malaysia or NiV Bangladesh to test the hypothesis: NiV Bangladesh is capable of human to human transmission, as characteristics of infection, tissue tropism, and shedding differ from NiV Malaysia.

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Henipaviruses and Mice - Are They Truly Resistant to Infection?

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Hendra virus (HeV) and Nipah virus (NiV) are closely related paramyxoviruses that have independently emerged in the past 15 years. Pteropid bats, the natural animal reservoir of these viruses, have not been observed to show clinical signs associated with infection, however spill-over events from these animals have led to clinical disease in several mammalian species including humans, horses, and pigs. Infection in humans can present as a rapidly progressive severe meningo-encephalitis often resulting in death. Several animal models have been developed for use in studies of disease progression, transmission, preventatives and therapeutics including guinea pigs, hamsters, pigs, horses, monkeys and ferrets, but the lack of a mouse model has severely limited the opportunities for pathogenesis research.

This project has reassessed the possibility of using mice as an animal model for henipavirus infection. Previously recorded attempts to infect mice with henipaviruses have failed, with no observation of clinical disease or seroconversion. In our studies we have exposed inbred strains of both juvenile and aged mice to Henipavirus. Thus far our results suggest that aged mice may be uniformly susceptible to infection of the central nervous system when challenged by the intranasal route. These studies may form the basis of a new animal model that can be used for investigating the mechanisms by which viremia is controlled and henipaviruses cross the blood-brain barrier resulting in encephalitis. Along with determining the basis of age susceptibility, this model offers great promise in contributing to development of improved treatment options for human cases of disease.

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CliPAR - A Web-Based Portal to Speed up the Delivery of Climate and Weather Data for Vector-Borne Disease Surveillance Systems of Humans and Livestock

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Arthropod-borne viral (“arboviral”) diseases are regarded as the group that will be responsible for many emerging / reemerging diseases in humans and livestock under climate change. Important examples in Australia include Murray Valley Encephalitis, Kunjin Virus and bluetongue, all of which have insect vectors highly susceptible to climatic extremes. Whilst

Australia has excellent climate and meteorological data collected and curated by the Bureau of Meteorology (BOM), it is often difficult for vector-borne disease biologists, epidemiologists and ecologists to readily access this data due to licensing restrictions, data formatting and availability.

To improve the accessibility of climate and weather data through the development of web-based portal called CliPAR – the Climate Portal for Arboviral Research

The CliPAR application is built from three software components: (1) Oracle Spatial 11 g for storing spatial climate and weather data and metadata; (2) Geoserver to enable a complete web mapping service (wms), web feature service (wfs) and web coverage service (wcs); and (3) Geonetwork an open source standards based geographic data and information management system used for managing spatial data, including tools for the selection (“clipping”) of areas of interest to view or download.

The CliPAR application was designed in-house, but for the actual software development a specialist external contractor was engaged. This enabled the application to be built on-time in a cost effective manner. CliPAR will be fully operational by the time of the conference, and will be demonstrated to interested delegates.

The development of CliPAR has provided the biosecurity community in Australia with an important component of surveillance systems for vector borne diseases.

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Modelling the Airborne Spread of Vectors and Insect Pests into Northern Australia within a Risk Analysis Framework

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Vector-borne viral infections of livestock, such as bluetongue, occur across much of northern and eastern Australia. Serological surveillance, genotyping of isolates and historical epidemiological records suggest that these and other arboviruses are introduced into Australia via winds originating in south – east Asia.

In this project atmospheric dispersion models are being used to develop a spatially and temporally explicit risk analysis for the movement of Culicicoides into northern Australia. A number of Culicoides species are proven vectors for bluetongue virus.

The basic methodology of using meteorological data to understand the patterns of bluetongue spread has a long history, beginning with the work by Sellers et al (1978) who investigated the possible introduction of BT to Portugal in 1956. The recent outbreaks of BT-8 in northern Europe have motivated extension of this basic methodology with the use of near-real time datasets and more complex models. In the Australian context, the most direct example with parallels to our approach is that by Ritchie & Rochester (2001) who use meteorological models to investigate the introduction of Japanese encephalitis into northern Australia by wind-blown *Culex annulirostris*.

These modelling systems can be adapted to a wide range of virus vectors and insect pests affecting human health and impacting animal and plant health and production.

Ritchie, S.A., Rochester, W., 2001. Wind-blown mosquitoes and introduction of Japanese encephalitis into Australia. *Emerg Infect Dis* 7, 900-3.

Sellers, R.F., Pedgley, D.E., Tucker, M.R., 1978. Possible windborne spread of bluetongue to Portugal, June-July 1956. *Journal of Hygiene* 81, 189-196.

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Bat Splats and Spats – Exploring the Hendra Virus Transmission Pathway

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The first indication of the origin of Hendra virus came in 1996 (18 months after the virus was identified), when neutralizing antibodies were detected in flying foxes (*Pteropus* sp.) in central Queensland. Virus was isolated from two foetal flying foxes later the same year. Subsequent sero-epidemiologic studies revealed a moderate to high seroprevalence in flying fox populations across Australia, yet attempts to detect viral genome in the saliva, urine or faeces of wild caught, free-living flying foxes were frustratingly unsuccessful. Similar attempts to detect genome in the saliva-laden masticated fibrous food pulp dropped by flying foxes were equally unsuccessful.

As sample sizes grew, it became increasingly evident that limited sensitivity, rather than low infection prevalence, was most likely responsible for the lack of success. In 2008, field and laboratory protocols were revised to maximize sensitivity at every step, and almost immediately, pooled urine samples from multiple roost locations revealed viral genome by Taqman PCR.

These findings have enabled calculation of infection prevalence rates, and provided an insight into infection dynamics within and between colonies. Over a two year period, viral genome was detected in 30% of sampling events, with a median 10% infection prevalence in infected roosts. Infection was not always present at sampled locations, though no temporal pattern was discernable. Notably, infection persisted in one colony for 12 weeks. Detection was more likely from June – October than at other times. The same ‘maximized sensitivity’ approach is currently being applied to spat collections. Test results are pending.

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A Loop Mediated Isothermal Amplification (LAMP) Assay for Detection of Hendra Virus (HeV) in the Field

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Hendra virus is a zoonotic paramyxovirus, first isolated from horses in Queensland in 1994. Thirteen outbreaks of Hendra virus (HeV) in horses have been reported. During four outbreaks, seven people became infected, four fatally, the most recent in September 2009. Bats of the Pteropid genus (Fruit bats) are the natural host of HeV, but do not show signs of disease. Horses can become infected and transmit the virus from one to another, as well as to humans. Early identification of HeV in suspect horses would be valuable for outbreak control.

We have developed a Loop Mediated Isothermal Amplification (LAMP) assay specific for HeV. The analytical sensitivity for detection of HeV was equal to a published TaqMan (real-time PCR) assay detecting the same target gene as the LAMP assay. Both TaqMan and LAMP assays were able to detect HeV in nasal swabs from experimentally infected horses before manifestation of clinical signs. Different methods were assessed for visualization of LAMP products, and a lateral flow device was identified that could provide simple and robust interpretation of results in the field.

The LAMP assay was simple to perform and could be completed in 45-60 min. A major advantage of the LAMP assay over other PCR technologies is that no expensive equipment or complicated procedures are required. This makes LAMP assays suitable for point-of-care diagnostics or application in resource limited laboratories.

Detection of Hepatitis E Virus in Domestic Swine and Wild Boars in Croatia

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Hepatitis E is one of the most common causes of acute hepatitis in humans with a possibility of zoonotic transmission through contact with infected animals. Therefore, veterinary professionals, animal breeders, especially pig breeders, may be at higher risk of developing the disease. The causative agent of hepatitis E is a RNA virus (HEV) belonging to the genus *Hepevirus*, family *Hepeviridae*. Four HEV genotypes have been recognized so far. Genotypes 1 and 2 are human specific and mostly isolated in areas where HEV is endemic. Genotypes 3 and 4 are isolated from humans and other mammals. In spite of the nucleotide diversity among HEV isolates, only one serotype has been recognised.

The aim of our study was to investigate the presence of HEV in known animal reservoirs, the domestic pig and wild boar in Croatia. The method we used was nested PCR for the detection of viral RNA. Our results indicate that both, domestic pigs (in 9 out of 11 districts included in the study) and wild boars (in 3 out of 7 districts included in the study) in Croatia could be potential reservoirs of HEV. Most of the positive domestic pigs found were fattening pigs, whereas in wild boars the virus was mostly detected in animals up to one year of age. We conclude that a thorough epidemiological study, including results of HEV infection in humans is needed to determine the true role of infected animals in the chain of viral spread.

Seroprevalence of Neosporosis in Intensive and Semi-Intensive Dairy Cattle Herds in Senegal

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Neosporosis is a worldwide parasitic disease caused by *Neospora caninum*. Abortions and neonatal diseases in many domestic and wild animals indicates the clinical onset of this disease. The aim of this study was to evaluate the seroprevalence of *N. caninum* in intensive and semi – intensive dairy herds in Senegal. It was conducted from 2006 to 2009, on 1039 cows from 2 to 10 years of age. Blood sample was collected from each cow and the sera obtained were analysed to determine antibodies against *N. caninum* using competitive ELISA kit multi – species (VMRD Inc., Pullman, WA 99163, USA). The eating habits of families at risk were recorded, particularly the consumption of unpasteurized or pasteurized milk. The seroprevalence of neosporosis was 39.08% in these herds and statistically higher in semi – intensive farms (62.44%) compared to intensive farming (17.56%) ($p < 0.05$). The milk produced in semi – intensive herds is drunk unpasteurized, while that produced in intensive farms is pasteurized. Because of the eating habits of the senegalese population including the consumption of undercooked meat and unpasteurized milk, the risk of contracting neosporosis is real. Therefore, the morphological and biological similarities between *Neospora caninum* and *Toxoplasma gondii* require routine screening of women who have several miscarriage and of immunosuppressed patients with lesions known as “cerebral toxoplasmosis” diagnosed by medical imaging. The serological test is still the best way to anticipate the treatment of patients infected by this opportunistic coccidiosis.

Seroprevalence of Dogs Neosporosis in Breeding Areas of Dakar and Thies - Senegal

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Described for the first time in 1984 in Norway from dogs affected by encephalopathy and myositis, *Neospora caninum* has a structure and a life cycle similar to the *Toxoplasma gondii*. Neosporosis is a cattle disease. Dog and some canids are known as definitive hosts of *N. caninum*. Abortions and nervous neonatal diseases in many domestic and wild mammals are the clinical onset of neosporosis.

The purpose of this study is to evaluate the serologic prevalence of *N. caninum* in 162 dogs from Dakar (74) and from Thies (88) using a competitive ELISA Kit (VMRD, Pulman-USA). Seroprevalence of *N. caninum* is 14.2%. The seroprevalence in domestic dogs (11.6%) did not differ significantly from the seroprevalence in wanders dogs (17.1%) ($p > 0.05$). Wanders dogs from Thies (20%) and domestic dogs from Dakar (15.1%) were highly infected ($p < 0.05$). Sex, age and breed did not influence these results ($p > 0.05$). These dogs may contaminate pasture and water ponds with oocysts shedding. Thus, the animals (cattle and small ruminants) rearing mainly in extensive and semi – intensive modes in these areas are exposed to *N. caninum* infection.

Consequently, the cohabitation between human and canine populations, definitive host excretory of oocysts of *N. caninum*, raises fears of human infection and thus requires that doctors perform routine screening of women who have several miscarriage and immunosuppressed patients with lesions known as “cerebral toxoplasmosis” diagnosed by medical imaging. The serological test is the tool that will anticipate the care of patients infected by this opportunistic coccidiosis.

Prevalence of Sarcocystis cysts in the Muscles After Slaughter of Cattle in West Africa

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The sarcosporidiosis is a muscle protozoosis due to *Sarcocystis* sp which affects the herbivores mammals and omnivores including men. The muscles of breeding animals are sometimes the centre of lesions of sarcosporidies cysts that can make them improper to human consumption. These cysts are not identifiable through the classic method of ante and post mortem inspection. Their identification requires the use of histological techniques which are not used on a daily basis to control meat in slaughterhouses. The aim of this study is to determine the frequency of sarcosporidies cysts on 800 samples of 5 muscles (Sternocéphalicus, Infraspinatus, Pectoralis descendens, Obturatorius and Diaphragma) taken from 160 cattle slaughtered in Dakar (80) and Abidjan (80). These samples were treated by histological techniques in paraffin and colored with l'Hémalun-Eosine-Safran. The microscopy (X40) enabled to assess the topography of the tissues and to estimate the number of quantifiable sarcosporidies fibers on 5 microscopic fields. Thus, 31.5 % (Dakar) and 27.2 % (Abidjan) of the samples have parasites. All the muscles are infested with higher rates in the Diaphragma (Dakar and Abidjan) Infraspinatus (Abidjan), Obturatorius (Dakar) and Sternocéphalicus (Dakar).

Living conditions as well as the extensive breeding methods which facilitates the contact between infecting faecal material of carnivores and breeding animals could maintain the protozoosis. The use of histological techniques is to be considered to improve the monitoring of this meat in these slaughterhouses.

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Risk Factors for Introduction of Avian Influenza Virus in French Breeder Ducks Flocks During the 24 First Weeks of Laying

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A study was undertaken in breeder ducks flocks, in 2008-2009 in France, to identify practices and events associated to the introduction of avian influenza virus (AIV) in flocks. All types of AIV were searched and no typing was done, only serological examination (ELISA NP, Pourquier®, France). Flocks were visited every 4 weeks from the beginning of the laying period until their seroconversion or up to 6 months of lay. An epidemiological questionnaire was filled-in with the farmer and 20 ducks were randomly sampled for blood examination. Only flocks that were seronegative at the first visit were included (n = 151 flocks with natural mating or artificial insemination). Survival analysis was performed on the data. Several risk factors of introduction of AIV were identified, such as: type of production link with artificial insemination practice, presence of poultry farms in vicinity, lack of disinfection practices (of the air ante-room and of the eggs stocking room, of the ground outside the house) and disinfection of the building done by the farmer instead of an hygiene specialist. Likewise, some events increase risk of contamination of flocks such as manure spreading near the barn, presence of rodents in the house or of wild birds close to the building and introduction of vehicles in the building when litter is introduced. This is one of the rare studies, producing original data about AIV and domestic ducks, that will provide keys to increase the sanitary level of this production regarding all AIV infections.

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Increasing Disease Threats in Biotically Interfered Wildlife Landscapes of Jammu and Kashmir State, India (With special reference to Dachigam National Park and Hirpora Wildlife Sanctuary)

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Biotic interference-driven declines in wildlife populations are a common worldwide phenomenon. These biotically interfered landscapes have become the main risk factor for the health of the living components of an ecosystem i.e. domestic animals, wild animals and Humans. It has been observed, over the last about a decade, through our regular wildlife health monitoring surveys that there has been a progressive decline in the population of some eco-sensitive species e.g. hangul (*Cervus elaphus hanglu*), markhor (*Capra falconeri*), musk deer (*Moschus moschiferous*), Himalayan brown bear (*Ursus arctos isabellinus*) etc., which apparently coincides with the degraded habitat conditions, increasingly narrowed down interface between the domestic livestock, wild animal species and humans besides, apparently poor individual health status of wild animal species.

Since, the wildlife landscapes in Jammu and Kashmir State of India are not only preserved from wildlife conservation point of view, but have a very important ecological value as potential watershed/catchment areas. Hence, the implications of the level of degradation faced by these wildlife landscapes is likely to be reflected down in the health of human populations and their domestic livestock, dependent on these catchment areas.

It has been with this proposition, that the two Wildlife Protected Areas namely, Dachigam National Park and Hirpora Wildlife Sanctuary, both located in Kashmir province of Jammu and Kashmir State, have been assessed for likely disease threats faced by wild animal species and domestic livestock on account of level of biotic interference and narrowed down interface between the two with possible recommended measures to overcome the same.

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Lumpy Skin Disease (LSD) Severe Occurrence in Central Africa: Natural Clinical Disease in Naïve Population Within a N'dama Cattle Farm in the Democratic Republic of Congo (DRC)

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Lumpy Skin Disease (LSD) is a bovine disease caused by a virus (LSDV) of the capripoxvirus genus in chordopoxvirus sub – family and poxviridae family. LSD is a transboundary disease and has high negative impact on both international trade and rural economy. In terms of spatial distribution, LSD was first confined to sub – Saharan Africa but recently it has spread to neighbouring regions such as Madagascar, Mauritius (2008) and Middle East (2007, 2008), which is an indication of its potential to occur in other disease – free parts of the world. Within the sub – Saharan Africa, LSD was mostly reported in Southern, Eastern and other countries of West Africa. According to initial data including the recent distribution map (AU – IBAR) in 2008, the Central Africa region had only reported non – georeferenced cases in Cameroon, despite the fact LSD was the most declared disease on the continent during the same period of time. This communication reports on field and laboratory investigations following a case history of a massive and severe skin disease observed in September 2009 within a N'dama Cattle ranching in the West of the Democratic Republic of Congo (DRC). LSDV was detected, for the first time in this area, using Histopathology, Polymerase Chain Reaction (PCR) and Transmission Electronic Microscope (TEM) techniques. The outbreak was successfully controlled using immunization of the herds with a freeze – dried, live attenuated (Neethling type virus) vaccine. The slaughtering of exposed animals including movements' restriction were also applied.

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A Survey of Bovine Tuberculosis Infection in Dairy Farms of Tehran Province (Iran)

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Bovine tuberculosis has an important role in public health and economy all over the world. In the past four decades, Iranian veterinary organization took serious measures against the disease. On the other hand, epidemiological investigation on this zoonosis is rare. In this article, a perspective about trend and distribution of the infection has been drawn in dairy farms of Tehran province.

According to registered data of bovine tuberculosis control program by Tehran province of veterinary organization, an ecological investigation was conducted to provide the epidemiological features of the disease during 1996-2006. Data analyses were performed by SPSS software.

Although a small variation of infection was found from 1996 to 2006, but the overall trend of reaction rates had decreasing form. It was seen that the infection rate reached to 0.065 percent in 2001 (from 0.242% in 1996) and finally was lower than 0.01 percent in 2006. Karaj city had the highest prevalence with 6 years and Firuzkuh (9 years without any infection) had the lowest infection rate. In comparison of Tehran province with national pattern of infection, it was obvious that this province had lower infection than the country (especially from 2003 to 2006).

With continuing the campaign against bovine tuberculosis and conducting more epidemiological studies, elimination of the disease in different regions of Iran is seemed to be possible.

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Neuropathology During Henipavirus Convalescence: Resolution of Infection or Virus Persistence?

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Henipavirus (Hendra [HeV] and Nipah viruses) infections induce acute febrile encephalitis in people as well as in various domestic and laboratory mammals. Each virus has also been reported to cause severe relapsing encephalitis in humans months to years after the initial infection event. The pathogenesis of relapsing encephalitis is not clearly understood and very few cases have been available for pathological examination, but recurrent infection with rapid replication of quiescent virus has been proposed. Lesions of the nervous system that are immunopositive for HeV antigen have been identified in horses that have recovered clinically from naturally acquired acute HeV infections; similar observations have been made in ferrets that have survived exposure to HeV following administration of a neutralising monoclonal antibody that recognises the HeV G glycoprotein. Here, we describe HeV-associated lesions of the central nervous system observed in convalescent animals, and discuss the potential for associated virus persistence and recrudescence of disease.

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If a Parrot Falls Off Its Perch Dead Does It Make a Sound?

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Beginning in the late 1970's and ending only a few years ago, hundreds of thousands parrots were wild caught and exported around the world to be sold as pets. In this process many species of birds were held in close proximity providing optimum conditions for disease transmission. Efforts to prevent the spread of disease were either absent or focused exclusively on Exotic Newcastle Disease. In this study, a review of the literature was made to determine the impact of the wild parrot trade on the spread of viral diseases. Nine DNA viruses and five RNA viruses were found to have disseminated globally in wild caught parrots. The impact of each virus varied widely. Some viruses caused significant disease in recently imported birds, but never became established in aviculture. Others became enzootic and continue to cause disease. The success of these viruses was the result of their ability to establish unapparent infections in some species, allowing infected birds to pass undetected into new collections and continents. The impact of these viruses on native parrots in countries where they were introduced is uncertain, but may be real. Of concern is the recent documentation of Psittacine Beak and Feather Disease in parrots being submitted for rehabilitation in Brazil and the detection of Avian Bornavirus and 2 genotypes of Psittacid Herpesvirus in pet parrots in Australia. In conclusion, the trade in wild caught parrots has resulted in the world-wide dissemination of an extraordinary number of viruses, with little notice by regulatory agencies.

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Histological Study of Cervix Uteri in Caspian Miniature Horse

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Uterine cervix which separates the uterus from the vagina, shows remarkable anatomical and histological differences among mammalian species. Since no cleared observations have been found in regards with the Caspian miniature horses' cervix, the aim of the present study was to supplement this missing information which could be helpful for providing a stricter basis in detecting reproductive diseases and abnormalities in this valuable species. Cervices from 4 female adult healthy Caspian miniature horses dissected immediately after death and samples of 1 cm thickness from 3 regions of cervix (endocervix, midcervix and exocervix) fixed with 10% buffered formalin. Routine histological laboratory methods were used and 6 µm paraffin slides stained with hematoxylin-eosin, Periodic acid-Schiff, Masson's trichrome and verhoeff methods and studied under light microscope. Heights of primary, secondary and tertiary folds and mucosal glands measured with computer software.

The cervix comprised of primary, secondary and tertiary fold with Simple columnar epithelium in endocervix and midcervix and most cranial part of the exocervices and changes into the non keratinized stratified squamous and a transitional form with stratified squamous with columnar cells, near the vagina. Lamina propria and sub mucosa made of collagenous dense connective tissue with abundant arterial and venues plexus. Simple tubular glands observed at the base of secondary folds of endocervix and midcervix. The muscularis layer contained of inner circular and outer longitudinal smooth muscles. Serous layer covered the cervix from the outside.

Our finding showed that the cervix uteri in Caspian miniature horse, like other horses and ruminants, are a collagenous structure, with tall longitudinal fold throughout the length. Secretion of mucus from the mucosal glands is less obvious than ruminant.

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Epidemiology of a Rabies Outbreak in a Rural South African Setting Near a National Park

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Rabies virus infection is seen as an invariably fatal and although controllable is endemic in many parts of the world. The frequent appearance of the disease in a rural setting where control measures are applied and the disease is not normally seen constitutes an outbreak.

The methods include retrospective analysis of brain samples submitted for rabies diagnosis, a door-to-door household survey and geographical information systems mapping of the cases and vaccination coverage.

270 cases were sampled over a 3-year period. 50% of the samples were positive for rabies virus and 3% were undiagnosed. In the positive samples 76% were dogs, 15% were cattle, 8% were goats and less than 1% were pigs and wildlife. The ratio of dogs to humans was found to be 1:10. Only half the household dogs had been vaccinated in the last year.

Rabies prevention through annual dog vaccination was found to be ineffectual in preventing an outbreak of the disease. This is suspected to be due to the high proportion of dogs less than a year old, the quality of the vaccination coverage and the lack of vaccination of stray animals. The role of stray dogs in the outbreak is unknown, although infected dogs were found to travel long distances. The high proportion of production animals infected highlights an additional economic burden of the disease in addition to the cost of control and post-exposure prophylaxis. The few wildlife cases indicates that they are more at risk than a reservoir.

Murine typhus: An Emerging Disease in New Zealand?

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Murine typhus is a flea-borne disease mainly of rodents caused by the bacterium *Rickettsia typhi*, and humans are incidental hosts. It is one of the most widely distributed arthropod-borne infections, yet it is frequently misdiagnosed due to its flu-like symptoms. The first reported New Zealand acquired human case occurred near Auckland in 1989. Up to 2010, 47 locally acquired cases had been recorded as far south as the Waikato region. A third of the cases occurred in recent years, and based on their timing and distribution it appeared that murine typhus was escalating and spreading southwards.

We aimed to determine the prevalence of murine typhus in Waikato and if it was spreading southwards. A PCR based survey of 263 wild rats and an IgG seroprevalence study of 989 blood donors were carried out. In addition to indirect immunofluorescence assays, we established Western blot and cross-adsorption assays for distinguishing *R. typhi* and *R. felis* infections (the only rickettsia species known in New Zealand). Murine typhus was detected in 0.53% of rats and 1.2% of human sera had *R. typhi* antibodies. Murine typhus appears to be well established in Waikato and is unlikely to have recently spread. Evidence of past *R. felis* human infections was detected for the first time in New Zealand. Murine typhus is probably under-diagnosed and infection from *R. felis* should also be considered. Our findings have important public health implications for diagnostics, surveillance and vector management since the animal vectors and exposure route for both diseases can differ.

Molecular Characterization of Rabies Virus from Nepal

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Rabies virus is a lyssavirus (genotype 1) from the family Rhabdoviridae. It contains a single-stranded negative sense RNA genome of approximately 12 kb in size. This zoonotic disease infects domestic and wild animals, and is spread to people through close contact with infected saliva (via bites or scratches). The disease is present in nearly every continent with more than 55,000 people dying of rabies each year. About 95% of human deaths occur in Asia and Africa. Once infection becomes symptomatic, there is no treatment and the disease is almost always fatal.

Rabies is an endemic disease in Nepal. According to their Health Authority, 100-200 human deaths occur and 35,000 people receive post exposure vaccination every year. Both sylvatic and urban cycles of rabies virus exist in Nepal, providing potential risks from jackals, foxes and dogs to act as potential reservoirs and vectors transmitting rabies to domesticated animals as well as humans. Representative viruses from this country are also rarely submitted for characterization.

In this study we characterized one human and four recent dog isolates from Nepal by sequencing of both the nucleoprotein (N) and glycoprotein (G) genes respectively. Phylogenetic characterization of the gene sequences revealed that the isolates grouped into two distinct clusters within genotype 1. The human derived isolate and two dog isolates grouped closest to the artic-related phylogeography whilst the other two dog isolates grouped within the Indian sub

continent phylogeography. This may indicate that the epidemiology of rabies in Nepal is complicated with transboundary introduction a possibility.

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pdpC Gene Determines the Virulence of *Francisella Tularensis*

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Francisella tularensis is a causative agent of zoonotic disease tularemia. A strain SCHU S4 is known as a prototype of *F. tularensis* subspecies *tularensis* (type A) which is thought to be most pathogenic to human and animals. However, the SCHU strain propagated in our laboratory was found to be extremely attenuated to mice probably because of extensive passages in artificial medium. During serial passages of our SCHU in mice, we observed that the strain recovered its high virulence. In this study, we attempted to determine the virulence factor(s) by comparing the attenuated and pathogenic *F. tularensis* strains.

Original bacterial stock, and SCHU P5 and P9 obtained by passages in mice 5 and 9 times, respectively, were grown in CDM medium after colony isolation. All mice injected with 10^3 CFU of SCHU P9 intraperitoneally succumbed to infection, but 10^6 CFU of SCHU P0 or P5 survived. All strains grew similarly both in liquid medium and cultured macrophages, but SCHU P9 grew more efficiently in bone marrow derived dendritic cells. Whole genome DNA sequence analyses showed that SCHU P0 and P5 harbored one nucleotide deletion in both pdpC1 and pdpC2 genes. In contrast, SCHU P9 possessed intact pdpC2 gene. Indeed, intact PdpC protein was detected in only SCHU P9 by western blotting analysis. No other mutations were observed. We concluded that PdpC contributed to pathogenicity of *F. tularensis* SCHU.

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Seroprevalence of Q Fever in Naturally Infected Dairy Cattle Herds and Implications for Within-Herd Control

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Coxiella burnetii is the causal agent of Q fever, a worldwide spread zoonosis. Prevention of *Coxiella burnetii* shedding in cattle is a critical point for controlling the spread of the pathogen between animals, and from animals to human. Hygienic measures are classically implemented, but their relative impact on *Coxiella burnetii* diffusion remains unknown. Vaccination with a phase 1 vaccine has been shown to be effective to prevent shedding in susceptible animals, even in infected cattle herds, making pivotal to identify them prior to vaccination. Thus, the objectives of this study were to describe the distribution of within-herd apparent seroprevalence among cows and nulliparous females and to explore the association of management practices and herd characteristics with these seroprevalence.

The study was conducted through a cross-sectional design in 100 naturally infected cattle dairy herds. While nulliparous females were found quite systematically susceptible (median prevalence = 0.01), a high value and variability were observed in cows (median prevalence = 0.42). Only a few herd characteristics and management practices were found to be related to higher seroprevalence (number of cows < 46, seasonal calving, abortion products not systematically removed, and contact through the fence with other ruminants).

Our findings support, in addition to classically recommended hygienic measures, the relevance to target nulliparous females for vaccination to control the spread of *Coxiella burnetii* within an infected herd given there quite systematically susceptible status.

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You Can Lead a Horse to Water..... Why Human Behaviour Is Central to Effective Control of Emerging Diseases

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The adoption of protective behaviours is subject to a variety of mediating factors. To ensure optimum compliance with disease control response it is important to understand what drives and inhibits such behaviours. The A/H1N1/09 “swine flu” pandemic has shown that public reaction to novel vaccinations, and low levels of perceived threat result in poor uptake of vaccination. Simply having a vaccine available is not enough to guarantee uptake.

This presentation will compare two streams of data: one from public health, with data collected in 2007 and 2010 relating to population willingness to adopt protective health behaviours in the event of a future influenza pandemic, e.g. mask wearing and receiving vaccination, and a second from an emergency animal disease, with data collected during the 2007 equine influenza outbreak and a year later, and additional data collected in 2010 on biosecurity behaviour, e.g. hygiene and access control. Analysis of factors influencing the uptake of these behaviours identifies a range of common drivers and barriers. Lower levels of threat perception and fearfulness and low personal vulnerability, attitudes towards response effectiveness and past experience are important in current and future practices, as are a number of demographic factors.

Understanding these differences allows planners and policy makers an opportunity to tailor information, messaging, and interventions to their target populations, and enables modellers to develop more realistic models. Low cost, non-pharmaceutical control measures are likely to continue to be the first line of defence in emerging diseases globally, the one common factor..? The human being.

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Vector-Host Relationship Assessment: Comparison of Two Animal Baited-Traps in the Collection of Bluetongue Virus Vectors

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The emergence and massive spread of bluetongue in Western Europe in 2006-2008 had disastrous consequences on sheep and cattle production and revealed the unexpected ability of European *Culicoides* (Diptera: Ceratopogonidae) to transmit the virus. Some aspects of *Culicoides* bio-ecology, especially host-seeking and feeding behaviours, remain unclear due to the difficulty to catch *Culicoides* directly on animal baited, the most reliable method to evaluate biting rates.

Our aim was to compare reference animal-baited traps (drop trap and direct aspiration) to both gold standard surveillance method (OVI light trap) and a new sticky cover trap in order to determine their relevance.

Collections were carried out during the 3 hours surrounding sunset in June/July 2009 in an experimental station (INRA, Nouzilly, western France), with 3 replicates of a 4 sites/4 traps randomized Latin square. Species were morphologically identified; sex and female physiological stages were recorded. Sibling species were identified using molecular tools.

A total of 648 Culicoides belonging to 18 species was collected. Abundance and diversity were maximal with the drop trap (241 females and 4 males from 11 species) and the mini-light trap (194 females and 8 males from 16 species) and equivalent between the direct aspiration and the sticky cover (87 females from 6 species and 114 females from 8 species, both without male). The difference between sites illustrated the local variability in adult abundance and diversity. Trapping method comparison will help to develop appropriate protocols for a better understanding of Culicoides bio-ecology.

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Modulation of Interferon Response by Henipavirus Infection

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Hendra and Nipah viruses, members of the genus Henipavirus within the family Paramyxoviridae, cause lethal infection in humans and animals. The exact mechanism of pathogenesis for these viruses is unknown. Henipaviruses encode several proteins from the P gene (SB, C, V and W), of which V and W have been demonstrated to antagonise the innate immune response. Viral proteins that act as interferon antagonists are important virulence factors, and their identification and characterisation should provide valuable insights into viral pathogenesis. It has been hypothesised that the pathogenicity of henipaviruses is related to the ability of the virus to circumvent the host interferon response via the combined action of the P-gene products. Due to the limitation of conducting infection experiments in a high containment laboratory, previous work by others on the henipavirus P gene products, specifically looking at innate immunity, has used transient expression of transfected single genes. This study outlines the suspected roles of these proteins during live virus infection studies conducted at Biosafety Level 4 and confirms that there are differences between the results determined by single gene transfection studies and the live virus infection studies. We will present data examining the interferon response of henipavirus infected human and bat cell lines, analysing both the interferon production and signalling pathways.

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Detection and Differentiation of Flaviviruses Using Real-Time PCR and High Resolution Melting Curve (HRM) Analysis

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Flaviviruses are arthropod-transmitted viruses that belong to the Flaviviridae family. Flaviviruses have worldwide distribution and are responsible for considerable morbidity and mortality, causing severe encephalitic, haemorrhagic, and febrile illnesses in humans and animals. Molecular assays such as PCR based techniques have been increasingly used for clinical diagnosis and epidemiological investigations. A real-time PCR detection system was developed for rapid detection and differentiation of members of flaviruses. The PCR uses a pair of primers targeting a region (around 270 nt, depending on different strains tested) at the N terminal end of NS5 gene. Thirteen flaviviruses belonging to different serogroups were tested by the PCR assay, including several viruses of public health importance, such as West Nile virus (New York 99) (WNV), Japanese encephalitis virus (JEV), Kunjin virus (KUNV), Murray Valley encephalitis virus (MVE), Yellow fever virus (YFV) and Dengue virus (DENV). Following high resolution melting curve (HRM) analysis of amplified PCR products, flavivirus could be distinguished at the species (or serogroup) level. The utility of this assay was further evaluated

using serum samples from pigs experimentally infected with JEV. The sensitivity of PCR-HRM assay compared well with species-specific real-time TaqMan PCR assays for detection of JEV and WNV. The method combines broad spectrum real-time PCR with product-specific identification to enable simultaneous detection and grouping of flaviviruses. It would provide an alternative to multiple type specific real-time PCR assays or conventional PCR amplification-sequencing approaches. High throughput testing can be performed.

Environmental Drivers

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Changing the Landscape - How Veterinary Medicines Have Benefited Society

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International Federation for Animal Health, Belgium

Advances in veterinary medicines have changed human health and the way we live with animals or produce our food today.

While today main drivers for the use of animal medicines are to reduce or prevent suffering in animals, or, in economical terms for food-producing animals, prevent production losses caused by disease that causes suffering in animals, the relevance to human health is manifold.

Veterinary medicines, together with the appropriate policy, have enabled mankind to successfully combat human health threats such as brucellosis and tuberculosis transmitted through milk, and have made the eradication of rabies possible.

Antiparasitics have changed the way we live with pets – an immense benefit that changed modern society.

Many of the newly emerging or re-emerging diseases are zoonoses, where protection of human health may depend on fighting the disease in the animal population (avian influenza), and the approach to successful control may vary according to the production system.

As we look to the future, we know that the population will expand by 50% to 9 billion by 2050, necessitating a 100% increase in food production. Given land availability restrictions, 70% of this increase will have to come from new technologies. Animal diseases reduce production by at least 20% today with the greatest impact being felt in developing economies who can least afford it. The animal health industry will play a key role in contributing to the future food challenge by attempting to minimise the impact of disease.

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Increased Food Security in Bangladesh from One Health and Integrated Agriculture

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Landless and ultra-poor inhabitants of the island Chars area of northern Bangladesh (Bogra, Jamalpur, and Sirajganj Districts) face severe food shortages exacerbated by extreme flooding and drought. As well, livestock management patterns result in exposure to pathogens from livestock waste, increasing the risk of zoonotic and newly emerging infectious diseases (nEIDs). Education and employment opportunities for women are extremely limited. Recent transfers of livestock, training focusing on integrated agriculture, and support for one health concepts has resulted in dramatic positive changes.

Objectives of the work were to increase integrated sustainable agriculture, generate sustainable economic activities, and heighten awareness and opportunities for a one health approach to health management, thereby reducing zoonotic and nEIDs and improving livelihoods.

Village community interventions included agricultural and ecohealth training, improved market access, delivery of animal and human health services, improved housing, and cash transfers used to purchase household assets including livestock and crops.

Household income increased 60-70% when farmers invested in cattle. Increase of livestock products in diets was low (less than 10%) but sales of those products and purchase of other food resulted in increased consumption of protein and energy. Sanitation and access to human and animal health services was improved, enhancing the value of agricultural changes adopted. Impact is still being monitored.

Food security can be improved through a one health approach incorporating integrated sustainable agricultural techniques. Household preferences may result in unexpected sale of food products for purchase of other foodstuffs, enhancing food security.

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Defining Interactions Between Humans and Pet Dogs

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The contribution of companion animals to the burden of zoonotic disease is gaining recognition. This study aimed to define the nature and extent of interaction between humans and pet dogs and to explore differences between dog-owners (DO) and non DO with respect to hygiene and knowledge of zoonotic disease.

An oral questionnaire was administered over a 10 day period in public locations. Ninety four of the 300 respondents (31.3%) were DO. An overall median of 14 (range 0-79) human contacts per dog per day were reported, within which patting was most common. It was found that 56 (59.6%) DO allowed their dog on the sofa, 72 (76.6%) allowed dogs to lick hands, 41 (43.6%) to lick faces, 39 (41.5%) to sleep on a household bed and 18 (19.1%) to eat from household plates. Hygiene measures and understanding of zoonotic disease did not differ between DO and non-DO ($P > 0.05$). It was found that, while closer contact occurred between DO and their own dogs compared with non-owned dogs ($P < 0.01$), there were no appreciable differences in the types of interactions that DO had with non-owned dogs compared with non-DO.

The outcome of this questionnaire provides estimates that are useful in quantifying human-dog exposure for potential infectious disease transfer. It also implies that the potential routes for pathogen transfer from non-owned dogs is similar for DO and non-DO humans, in contrast to the comparatively greater number of routes that are likely to be present between DOs and their own dogs.

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Utilizing an Asset Based Livelihoods Approach to Mitigate Household Economic Vulnerabilities (Economic, Food and Water) Associated with HIV/AIDS

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Hundreds of thousands of Cambodians are affected by or infected with HIV/AIDS, and the economic impact for many is crippling, calling for the widespread scale-up of care, support, and treatment programs. While mainstream treatment and

care schemes are prolonging lives, many individuals are highly food and economically insecure, lacking the basic resources or skills to sustainably stabilize or improve the living conditions for themselves or their families. Working with the Cambodian Khmer HIV/AIDS NGO Alliance (KHANA), DAI designed and conducted a household economic survey among 1,136 households between June and July 2010 to measure the impact of the disease at KHANA beneficiaries' household level and provide the analytical foundation for the newly launched asset based livelihoods approach.

To use data to obtain a clear understanding of the specific economic opportunities and needs of KHANA's distinct beneficiary groups, and identify an applicable asset based livelihoods approach specifically designed to be more focused on economic empowerment, rather than aid or direct support.

Sustainable strategies to mitigate the economic impact of HIV/AIDS among KHANA beneficiaries cannot focus on financial assets alone. Building capacity to stabilize and maximize tangible, non-financial household economic assets and savings usually held in the form of land, water, agricultural commodities, animals, and micro-business is critical to addressing the root causes of household food and financial insecurity.

Using an asset based livelihoods approach to assess Cambodian households' economic stability was a successful tool in identifying alternative drivers of economic growth.

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Theoretical and Conceptual Advances. The Backlog of Trees

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What if the environment is lacking – trees, water, food, mindfulness, care, cooperation, fresh air, friends, parents, family?

The answer is failure to thrive in some way, whether through intellectual stunting, growth retardation, psychological and emotional development delay, depression and over exposure to threatening elements to life on this planet – including marauding councils and spreading “civilization and development”.

Responsible people are defined as “globally aware and locally active”. This concept, “to think globally and act locally” is not new – it exists since G-d created heaven and earth.

Disease is defined as “a condition where the response of the organism to change in the environment results in an inner change, one that alters the function, behaviour and or physiology of the exposed organism unable to respond appropriately or adequately to the change and without the means to escape to another “friendly” environment similar to that which the organism is used to living in”.

The answer to disease is the challenge to provide the optimal environment opportunity for animals and man to live and thrive on earth from which there is no escape.

The concept of “the constancy of the milieu exterieur”¹ drives this understanding and serves as a model for enhanced survival resulting in adaptive evolutionary change as well as providing an understanding of processes that lead to disease and death.

The diversity that constitutes “world” is guaranteed first by caring for and secondly by planting a tree in your own back yard.

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Avian Beak and Keratin Disorder in Wild Birds: An Emerging Disease in North America?

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High prevalence of gross deformities in a wild population may signal an emerging disease or underlying ecosystem health problem. We recently documented an epizootic of avian beak and keratin disorder among Black-capped Chickadees (*Poecile atricapillus*), Northwestern Crows (*Corvus caurinus*), and other non-migratory bird species in the Pacific Northwest region of North America. In affected birds, the keratin layer of the beak becomes grossly overgrown, often accompanied by abnormal skin and feathers. We investigated the pathology of this disorder in order to describe underlying physiological changes and identify possible mechanisms and causative agents. Examination of keratinized tissues using histology and scanning electron and x-ray microscopy revealed evidence of a keratin maturation problem in multiple tissues. We measured beak growth rates in captivity and documented significantly faster growth in affected birds. The deformities may also be indicators of other systemic health problems, suggested by high, unexplained mortality rates and increased susceptibility to secondary infectious agents, evidenced by skin lesions of bacterial and/or fungal origin. Occurrence of this disorder across a growing geographic area with apparent epizootic clusters raises concern about underlying environmental factors, including contaminants, infectious agents, and nutrient availability. Presence of deformities in ecologically dissimilar species indicates that etiological agents of this disorder occur across a broad environmental gradient, including both terrestrial and coastal systems. Resident avian species serve as important ecological indicators; an epizootic of this scope has implications not only for bird populations, but also for wildlife and human health.

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The Association Between Tick Bite Allergy and Red Meat Allergy: Pertinent Ecological Drivers

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Allergic reactions to red meat are rare (Werfel 1997), however, van Nunen et al (2007, 2009) have recently described 25 patients who developed anaphylaxis to red meat/s, of whom 24 of the 25 had suffered large local reactions to tick bites (*Ixodes holocyclus*). The anaphylaxis to red meat/s was usually delayed by several hours and commenced within approximately six months of the allergic tick bite/s. The authors concluded that the majority of cases of the rarely occurring condition of mammalian meat allergy are preceded by sensitisation to tick bites ($p < 0.001$). These patients were all residents of the peninsula region of Sydney, an area endemically infested with a number of tick species, however, the tick which is usually involved in allergic reactions in humans appears to be *Ixodes holocyclus*. Reports of this complaint along the length of the eastern seaboard prompted us to identify potential ecological drivers promoting this association.

Candidate ecological drivers:

1. Increasing tick numbers:

Ixodes holocyclus is widely distributed along the entire eastern seaboard of the Australian continent (Storer et al. 2005) and the natural host for *Ixodes holocyclus* is the bandicoot. Global warming may conceivably expand the length of the tick breeding cycle or increase habitat.

2. Resurgence of bandicoot numbers:

Successful predator eradication measures have allowed bandicoots to flourish.

3. Encroachment of human habitation into tick habitats:

Domestic dwellings abutting bushland have increased along many areas on the eastern seaboard.

4. The success of the tick's ability to induce Th2 responses;

Skalova et al 2008 showed that saliva of *Ixodes ricinus* modulates dendritic cells to promote Th2 responses, which induces allergic responses in the host.

We predict that this novel arthropod-food cross-allergic sensitisation syndrome is likely to become more widespread due to ecological drivers.

Trade, Food Security, Food Safety, and Water

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Assessing the Occurrence of Antibiotic Residues in Raw Cow Milk in Ghana

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The recent increase in the demand for fresh cow milk in Ghana, especially in the urban and peri-urban areas of the country has led to the emergence of local milk processors to meet this demand. However, concerns about human health risks associated with the consumption of fresh un-pasteurized cow milk with respect to antibiotic residues needs to be addressed.

To assess the occurrence of antibiotics residues in raw cow milk produced and marketed within the coastal savannah areas of Ghana.

Two hundred and twenty four (224) raw cow milk samples were collected from various sites in 14 districts of 4 coastal savannah regions of Ghana namely; Central, Greater-Accra, Eastern and Volta for the detection of antibiotic residues in the laboratory. The Charm Blue-Yellow kit (Charm Sciences Incorporated, MA, USA) was used.

Of the 224 cow milk samples, 3.1% (7/224) of the samples tested positive for antibiotic residues above the European Union Maximum Residue Limit (EU MRL). Antimicrobials detected include beta-lactams, sulphonamides, amino-glycosides, tetracycline and macrolides.

The presence of antibiotic residues in the raw cow milk is of public health concern because of the risk of developing drug-resistance of common human pathogens in people who are not allergic to the drug and may also cause allergic reactions in sensitive people and interfere with the growth of starter cultures used in making yoghurt and cheeses which may results in economic losses to raw milk processors.

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Pandemic of Hypovitaminosis D: Public Health Consequences, Unresolved Issues and Gaps in Management

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Recent studies have documented that the active form of vitamin D [1,25(OH) D₃] is a potent, pleiotropic hormone that targets 200 human genes responsible for a wide variety of biological processes, including cell growth, differentiation and function. The hypovitaminosis D pandemic (about 1 billion people are affected worldwide) has been linked to the pathogenesis of many degenerative, inflammatory, metabolic and malignant diseases. The limited quantity of vitamin D in food, insufficient sun exposure, wearing traditional veils and dark skin are among the main contributors of hypovitaminosis D. Prevalence of hypovitaminosis D is high and rising in the general population (30%-80%), particularly in older adults, children, women of child-bearing age and people of low socioeconomic status, even in sunny countries. However, the

effectiveness of vitamin D supplementation on the prevention of chronic illnesses remains uncertain. Studies and meta-analyses of effectiveness of vitamin D administration on cardiovascular and metabolic outcomes, cancer, falls and fracture prevention produced discrepant results. The major unresolved issues include also (1) the mechanism of action of vitamin D (role of calcium, calcium-sensing receptor, PTH, fibroblast growth factors), (2) the optimal level of serum of 25(OH) vitamin D, (3) the need of enrichment of food products, (4) the optimum dose, type of vitamin D and route of administration, (5) the need for calcium co-administration, and (6) when to check 25(OH) vitamin D level and how to adjust the dosage. Correcting hypovitaminosis D may have a significant effect on health worldwide, but further studies are required to define optimal practice.

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Addressing the Challenges of Urbanization in Ethiopia: the Urban Gardens Program

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Ethiopia has experienced dramatic demographic changes, including increased rural-to-urban migration and a “youth bulge.” Combined with poor health statistics—including highly incongruent HIV prevalence rates (7.7% in urban areas versus 0.9% in rural) and increasing food insecurity, the situation seems quite desperate. Fortunately, programs such as the USAID Urban Gardens Program for HIV-Affected Women and Children (UGP) take a multidisciplinary approach to address the growing problems of urbanization.

Working with 41 community-based organizations, this five-year, \$9.2 million PEPFAR-funded project currently in 17 cities improves the income and nutrition of its program beneficiaries through training and capacity building in urban gardening. UGP works with beneficiaries to create community and school based gardens, and holds group conversations around health topics (including, HIV, nutrition, savings and financial management), and makes referrals to HIV/AIDS services.

Over the first 18 months of implementation, 4,625 orphans and vulnerable children and caregiver beneficiaries representing 14,454 households were trained in all aspects of urban gardening including crop maintenance, pest management and irrigation. UGP works with local mayors to address major constraints around land access for HIV affected groups, and has addressed issues of land and water contamination and water access at garden sites by identifying location specific technologies (including irrigation, treadle pumps, and well development). Finally, UGP is working with the City Bureau for Urban Agriculture in Addis Ababa to address existing policy constraints to urban agriculture in the city.

UGP is proving to be a successful strategy to mitigating many of the challenges associated with urbanization in Ethiopia.

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Does Food Represent an Independent Source of Meticillin-Resistant *Staphylococcus aureus* (MRSA) for Pet Dogs?

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A published conceptual model for the acquisition of MRSA in pet dogs in the UK does not consider transmission through food independently to environmental sources. Whilst theoretically appropriate, the dissemination of MRSA ST-398 in animals and food products in countries outwith the UK and minimal dedicated surveillance for MRSA in farm animals is an

indication to explore further the potential hazard of MRSA in meat products to which dogs may be exposed. This pilot study aimed to identify if and at what prevalence *Staphylococcus aureus* and MRSA were present in meat samples and dried pig ear treats.

Meat (n = 100) and dried pig ear (n = 50) samples were obtained from butchers, supermarkets and pet shops in a defined geographical region in the UK. Samples were processed identically, using standard enrichment, culture, PCR and PFGE techniques. MRSA was found in butcher meat (2%, 95%CI 0.2 – 7.0%) and *S. aureus* in butcher meat (7%; 95%CI 2.9 – 13.9%) and pig ear treats (4%; 95%CI 2.2 – 19.2%). No ST-398 was isolated.

It was concluded, based on phenotypic, genotypic and geographical factors, that the MRSA were likely to represent contaminants from a human source, rather than true carriage by the animal prior to slaughter. Thus, lack of inclusion of meat and pet treats as an independent source of transmission seems reasonable. However, future intermittent surveillance of meat should be considered and raw meat should not be negated as a potential source (through contact rather than ingestion) of contamination with MRSA and *S. aureus*.

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Mycobacteria in the Food Chain: A Problem or Not?

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In developing countries the zoonotic risk from *M. bovis* exists unchanged owing to husbandry practices and a lack of control in the cattle population and livestock products (1). Apart from reports on the presence of *M. bovis* in fresh cow's milk (2), little is known on the longevity of *M. bovis* neither in traditionally soured milk from pastoral cattle nor in meat and edible organs from infected game animals.

Two studies were conducted to determine the longevity of *M. bovis* in 1. Cooked organ and dried muscle tissues (biltong) of naturally infected game animals (African buffalo, greater kudu) and 2. Traditionally soured milk spiked with serial dilutions (10^7 organisms/ml to 10^2 organisms/ml) of *M. bovis*. Sour milk preparations were maintained at 20°C and 33°C, respectively, and sampled for up to 8 weeks. All samples were processed and tested as reported previously (3, 4).

M. bovis could not be isolated from muscle subjected to the drying process nor from heart, liver, kidney, lung, lymph node and muscle cooked for either 10 minutes or 20 minutes. However, non-tuberculous mycobacteria (NTM) were isolated from various cooked samples.

In sour milk maintained at 20°C, *M. bovis* was isolated for up to 2 weeks after collection.

The risk of *M. bovis* infection for humans is negligible from dried or cooked meat but is considerably higher from infected sour milk as the organism's longevity exceeds the product's average shelf life. The recovery of NTM surviving the cooking process warrants further investigation.

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A Review on the Effects and Settling of Different Drugs in White and Red Meat and Milk

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The more increasing the population, the more requirements of protein content foods is needed. The residues of different drugs in meat and milk, not only brings pharmaceutical resistance, but it may cause cancer, poisoning, intense allergies, gastrointestinal infections, hepatic, hormonal, audition and vision damages. As a result, a general understanding of different drugs and their critical times is really necessary for all authorities and who are involved in animal and public health activities.

Different categories of drugs have different periods to excrete from the bodies of domestic animals and poultry that are known as the forbidding time or slaughter avoidance. Important examples are: from antibiotics group Oxytetracycline remains 18 days in red meat, 120 hours in milk and 1-5 days in poultry meat; Enrofloxacin 7 days in red meat, 168 hours in milk and 9-18 days in poultry meat and Sultrim 7 days in red meat, 120 hours in milk, and 5-10 days in poultry meat. From the category of antiparasite, Rafoxanide remains 28 days in red meat and 12 hours in milk. Oxytocin (from hormonal drugs) remains 3 days in red meat and 120 hours in milk; and Trichlorophen (Neguvon) (from poisons) remains 7 days in red meat. Diuretic drugs such as Furosemide remain 2 days in red meat, 48 hours in milk and 35 days in poultry meat. Tranquilizer/sedative drugs such as Rampon (xylazine) remain 3 days in red meat and 72 hours in milk. In this article the time required excreting the different categories of drugs will be separately discussed.

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Prevalence and Geographical Distribution of Sarcocystosis of the Ruminants in Slaughterhouses of Iran

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Sarcocystosis is one of the most important parasitological infections with significant economical impacts due to local and whole elimination of slaughtered ruminants and Zoonotic aspects of that are debatable. The condition has distributed throughout of Iran and Reducing of infection via controlling measures in abattoirs is so helpful.

This survey was conducted on the registered data of Sarcocystosis in slaughtered ruminants in all of the provinces of Iran from April 2004 to April 2008. The data were organized and relevant analyses performed by SPSS (version 15).

Among these years, the year of 2005 had the highest rate of infection in slaughtered cows (with 88 condemned carcasses). After that, the decreasing trend of infection led to 39 condemned carcasses in 2006. Moreover, total condemnation of slaughtered sheep and goats was the highest in 2006, with 8862 & 862 carcasses, respectively. There was an increased level of infection in the majority of provinces in 2006. Qazvin province had the highest rate of infection with 1393 cases of sheep (15.1%) in 2006 and Khorasan Razavi (12.9%) was the second in the same year.

According to the high level of Sarcocystosis, related economical losses due to condemnation of slaughtered ruminants and the wide distribution, more stringent monitoring and surveillance should be adopted in such conditions.

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Approach to Determining the BSE Food Safety Risk of Countries

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Australia's beef food safety policy changed on 1 March 2010 allowing BSE positive countries to apply for access to the Australia beef market. The new policy is a result of scientific evidence indicating that the BSE epidemic in cattle peaked in 1992 and that measures to reduce the risk of exposure to the BSE agent through the food chain can be effective. Under the new policy, risk assessment and country categorisation will be conducted by Food Standards Australia New Zealand (FSANZ) to ensure that beef and beef products from a country will not pose a risk to the health of Australian consumers. The key objectives addressed by FSANZ were to: (1) develop an evidence-based risk assessment process that is comparable to the World Organisation for Animal Health (OIE) methodology but incorporates criteria around traceability and identification; (2) develop methods for in-country inspections to verify country BSE control measures; and (3) set up effective collaboration between FSANZ and Biosecurity Australia (BA) who, in a parallel process, conduct Import Risk Analyses to assess animal biosecurity concerns. In meeting these objectives, effort has focussed on ensuring that an appropriate methodology which is consistent with scientific data on BSE risk factors and considers the interests of key stakeholders was developed. Several countries have submitted applications for BSE food safety risk assessment and assessment protocols and criteria, according to objectives described above, have been established and applied to the information provided by the applicant countries to determine their BSE risk status.

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African Research Consortium for Ecosystem and Population Health: "Expanding Frontiers in Health"

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"Afrique One" consortium considers that while research capacity requires strong institutions, institutional strength only comes through the contributions of talented and committed individuals. We have witnessed the inspirational abilities of single individuals in African institutions to lead and build exciting, sustainable and independent research programs. Therefore we have focused on a single, simple and distinctive primary goal: develop a group of a dozen outstanding post-doctoral researchers who will form the backbone of the core institutions for years to come.

Internationally competitive research in ecosystem health increasingly demands quantitative, interdisciplinary and transdisciplinary skills that are difficult to acquire without a broad network of collaboration. It demands effective partnerships, sharing of resources, and exchange programs among institutions, particularly those divided by regionalization and language.

The objectives are to (i) generate a critical mass of internationally-competitive African scientists and research groups with a focus on zoonotic diseases; to (ii) strengthen research and training links north-south, south-south and Francophone and Anglophone countries in Africa and to (iii) develop more robust research support and research administration infrastructures. Five activities are planned a) 11 Post-doctoral Research Fellowships grant; b) teaching buy-out grants; c) general demand driven training, d) short-term exchange visits and e) modest infrastructure and equipment support fund.

The consortium comprises a balance of core institutes with medical, veterinary and wildlife expertise and representation from both Francophone and Anglophone countries. The consortium will interact with several North and south institutions and research centres in sub-Saharan Africa through horizontal dissemination of research expertise in One health.

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The Parents' Participated Intention of Health Promoting School Program in Taiwan

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Health Promoting School (HPS) is an important health policy in Taiwan. While building the health promoting school process, the students' parents involvement and support are needed, especially.

The purpose of this study is to understand parents' participated intention and related factors when primary and high schools implement health promoting school programs.

Stratified random sampling was conducted to choose the participants who were elementary and high school students' parents from seven areas in Taiwan, 2008. This study used computer-assisted telephone interview method (CATI system). Among them, 669 parents completed the survey. Data were analyzed using Chi-square test, and multiple regressions.

The findings showed that only 14.9% knew the health promoting school program policy. Although 91.3% parents agreed to attend in HPS programs, 74.4% parents had no free time to involve in each HPS activities. According to multiple regression analysis, It was found that parents' self-efficacy and subjective norms significantly predicted parents' participated HPS program intention. (Adjusted R² = 0.269)

According to the research results, most of parents lacked of cognition about the HPS policy and efficacy of attending HPS program. For increasing the family participated intention on HPS program, We suggest that HPS programs should enhance parents' self-efficacy and normative belief through school health policy.

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The Perception and Behavior of Pandemic Influenza A (H1N1) Vaccination Among Health Care Workers in Taiwan

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The pandemic influenza A (H1N1) vaccination rate was the highest (82.9%) among Taiwan's health care workers (HCWs) in OECD countries. Taiwan CDC conducted the study to explore the HCWs behaviors and opinions during H1N1 pandemic in 2009.

To explore H1N1 vaccination perception and behaviors among HCWs.

A total of 1123 HCWs included physicians, nurses, and pharmacists were interviewed by using structure questionnaires on telephone from October 23-27. The interviewed hospital units included internal medicine, family medicine, obstetrics and gynecology, and pediatrics. Chi-square test was used in the analysis.

The correct recognition of H1N1 was higher (>80%) in HCWs than general population. The health information was mainly from hospital/clinic, and followings mass media and government health education promotion. The CDC's publication for HCWs had significant effects. The acceptance rate of H1N1 vaccination among HCWs was 72.3% and doctors were the highest. High acceptance rate also implied high vaccination rate. The willingness for H1N1 vaccination was significantly associated with occupation ($p < .001$), gender ($P < .001$) and age ($P < .05$). 12.1% HCWs would not receive H1N1

vaccination, and 41.9% subjects received vaccination worried vaccine-related side effects. The proportion of satisfaction and confidence on government control measures of combating H1N1 were 87.9% and 91.7%, nurses were the highest.

Higher confidence and satisfaction among HCWs could improve vaccination policy, control measures, and health promotion. A successful vaccination strategy should not only protect the HCWs, but also limit the outbreak spread to the community. Taiwan CDC's experiences on H1N1 prevention could provide the references.

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The National Bio- and Agro-Defense Facility: A One-Health Laboratory

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The food and animal agriculture industry is a highly integrated, open, global, and complex infrastructure. The global trade of agricultural products and increasing numbers of international travelers has increased the world's vulnerability to outbreaks of transboundary and zoonotic diseases. Many emerging diseases are zoonotic in nature, and these diseases pose real threats to both public and animal health. Solutions to these problems require a fundamental understanding of the same basic principles of disease physiology and require the same tools and technology to bring the solutions from concepts to reality.

The National Bio-and Agro Defense Facility (NBAF), will be a state-of-the-art biocontainment facility for the study of transboundary, emerging and zoonotic diseases that threaten the U.S. animal agriculture and public health. NBAF will include Biosafety Level 2, 3 and 4 laboratory and animal handling space to: (1) provide enhanced research capabilities to diagnose transboundary, emerging and zoonotic diseases in large livestock; (2) provide expanded vaccine and countermeasure development capabilities for large livestock; and (3) continue the partnership between the Department of Homeland Security and the Department of Agriculture (APHIS and ARS) and expand opportunities for collaboration with academia and industry.

NBAF will be located in Manhattan, Kansas, on the campus of Kansas State University, immediately adjacent to the Biosecurity Research Institute, the Kansas State School of Veterinary Medicine and College of Agriculture.

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Justice for All, Quality for Few

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The growth of population and the spread of urbanization forced Iran government to provide health care services for all of the people living in different parts of the country. They established health centers in rural and urban areas to deliver the rudimentaries to people and have enough information about the health standards in their society. The majority of newly graduated physicians were recruited to work in health centers and people were asked to refer to health centers not to be wandered in the corridors of the hospitals. The outcome was a predictable confusion for the patients and the physicians. The physicians thought about the money and the salary they earned in the early ages of post graduation and the people were relieved to refer to physicians in no time. The problem of drug and surgeries became critical for government in general and the people, in particular. The language and cultural interactions reduced the extent rapport between both groups. The conflict helped the physicians working out of governmental system to earn more money while the quality of health services became weaker and weaker.

This paper scrutinizes different aspects of this strategy and its outcomes in future. We focus on the drawbacks of the project and investigate the psych-social consequences to suggest some measures to change the imbalance between general distribution of health cares and quality.

All the strategies in health care systems must be directed toward quality and consider the low income classes. The ignorance of critical issues in health care system can reduce its efficacy.

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One Health Leadership: Nursing Perspectives

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A holistic and innovative approach to One Health requires the engagement of all human, animal and environmental health professionals working in communities, academia, and government. Nurses represent the largest group of public health workers worldwide and often are the only human health professionals in rural communities of less developed countries where emerging disease threats are highest. In many countries, nursing is not yet a major partner in the planning and development of One Health frameworks and strategies. This presentation provides theoretical and practical information from nursing (both art and science) that will strengthen the interdisciplinary thinking, cross training, and collaboration needed to adequately prepare for and respond to emerging infectious diseases. Nursing is by tradition and academic foundations a holistic discipline, incorporating systems theory, complexity theory, social change theory, and social network theory into practice at the individual, community, and policy levels. In the most remote communities in the world nurses practice in villages “where the forest meets the farm” and are often the first observers of and responders to emerging infections in animals and humans. Thus nursing is well prepared to lead interdisciplinary teams to improve response capacity for emerging infections. The University of Minnesota School of Nursing (USA) is engaged in bi-directional learning partnerships with East and Central African universities within the context of a One Health initiative that includes nursing, veterinary medicine, medicine, public health, agriculture, wildlife ecology, and education. These partnerships illustrate the pivotal role of nursing in One Health.

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Risk Assessment and Risk Management of Veterinary Biologicals with Special Regard to Emerging Diseases of Horses, Cattle and Sheep in Europe

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In our globalised world, animals and products of animal origin are world-wide transported and marketed. In view of the spreading of epizootic diseases and zoonoses most countries have replaced their former zero-risk policy by an assessed-risk policy. They perform a risk rating and decide – as a single country, a region or a continent – whether they consider the risk connected with the transport of animals and biological material as calculable. A risk can be rated as unacceptable, severe, medium, low or negligible. Newly developed biological material such as live vaccines must pass different application levels before first use: contained application under laboratory conditions, field application, and commercial application. This can be seen as a stepwise approach in risk assessment during the development process. In recent decades, not only risk communication and the pharmacovigilance network have been improved globally but the different national animal disease control programmes are increasingly being respected. Marker vaccines, which allow for the differentiation between vaccine and field antibodies, are of fundamental importance for this as well as complementary diagnostics of assured quality.

The poster illustrates the control of the West Nile Virus (WNV) and Bluetongue Virus (BTV) by vaccination and the factors and vectors (e.g. WNV = mosquito control programmes, BTV = culicoid control programmes) to be considered. For BTV, the importance of a rapid adjustment of the vaccination policy and vaccine composition to the current epidemiologic situation is pointed out (e.g. routes of introduction of BTV serotype 1 from Mediterranean countries to other parts of Europe).

Pandemic Avian Influenza: Comparative Policy Analysis in Three Southeast Asia Countries

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The aim of this study was to analyze the policies regarding pandemic avian influenza control in three Southeast Asia countries, Thailand, Indonesia and Vietnam. Two aspects of policy formulation were explored; poultry vaccination and antiviral stockpiling with Oseltamivir for human. This paper explores, through a comparative analysis of policy formulation, why different approaches were adopted in some countries from others in one policy arena.

It was found that while Indonesia and Vietnam introduced poultry vaccination programs, Thailand rejected this policy approach. By contrast, all three countries adopted similar strategic policies for antiviral stockpiling. Given the highly pathogenic avian influenza, economic imperatives are of critical importance. While Thailand's poultry economy is large and primarily an export economy, Vietnam and Indonesia's are domestic. The introduction of a poultry vaccination policy in Thailand would have threatened its potential to trade and thus, had a major impact on its economy. Powerful domestic stakeholders in Vietnam and Indonesia, by contrast, were concerned more about maintaining a healthy domestic poultry population. Evidence on vaccination was drawn upon differently depending upon strategic economic positioning.

With influenza A H5N1 endemic in some countries of the region, these policy differences raise questions around regional coherence of policies and the pursuit of an agreed overarching goal, be that eradication or mitigation. Moreover, while economic imperatives have been critically important in guiding policy formulation in the agriculture sector, questions arise regarding whether agriculture policy is coherent with public health policy across the region.

An Exploration of Prevalence and Risk Factors of Nonalcoholic Fatty Liver Disease in the Occupational Population in Taiwan

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Non-alcoholic fatty liver disease (NAFLD) is now the commonest liver disorder.

To explore the prevalence of NAFLD and risk factors related to NAFLD among occupational population in Taipei, Taiwan.

A total of 8191 healthy adults with different professional fields (5253 males and 2959 females) voluntarily admitted to annual physical check-up between January 1, 2009 and December 31, 2009. Blood samples and ultrasound-proved fatty liver sonography results were collected.

The prevalence of NAFLD for this study population was found to be 49.1%, the prevalence revealing a statistically significant decrease with increasing population age ($p < 0.001$). Males exhibited a greater prevalence of NAFLD than did females (57.7% vs 33.9%, $p < 0.0001$). Using multiple logistic regression analysis, in addition to male gender (OR = 1.32, 95%CI: 1.17-1.50), an older age (OR = 1.04, 95%CI: 1.03-1.05), higher BMI (OR = 4.79, 95%CI: 4.22-5.43, OR = 15.51, 95%CI: 12.70-18.90), higher GPT (OR = 3.21, 95%CI: 2.59-3.97), computer and mathematical occupations (OR = 1.44, 95%CI: 1.20-1.74), architecture and engineering occupations (OR = 1.49, 95%CI: 1.29-1.72), presence of hypertension

(OR = 1.28, 95%CI: 1.12-1.47), hyperuricemia(OR = 1.46, 95%CI: 1.29-1.65), hypercholesterolemia(OR = 1.39, 95%CI: 1.23-1.56), higher fasting plasma glucose(OR = 1.95, 95%CI: 1.40-2.71)and hypertriglyceridemia(OR = 2.17, 95%CI: 1.87-2.53) were the significant factors associated with NAFLD.

The higher prevalence of NAFLD was found in occupational population. Male gender, older age, higher BMI, higher GPT, computer and mathematical occupations, architecture and engineering occupations, hypertension, hyperuricemia, hypercholesterolemia, higher fasting plasma glucose and hypertriglyceridemia were related to prevalent NAFLD in this study.

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Clinical Correlation of Severity of Asthma in Preschool Children: Experience at a Teaching Hospital in Taipei, Taiwan

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Asthma in children is one of important public health problems in Taiwan. It takes high medical, family and social care costs for asthma children. The purpose in this study is to understand the distribution and related clinical and environmental factors of asthma children.

A total of seventy-two outpatient department children aged less than five years old identified as asthma or allergic rhinitis were studied based on the asthma-cared program from 2003 to 2010. Air pollution was collected by air monitoring stations.

31.9% and 68.1% were diagnosed as mild moderate degree of asthma, respectively. The severity of asthma in boys (54.2%) were higher than girls (45.8%). From the allergic examination, 69.3% subjects answered had dust-mite factor ($p = 0.85$ between mild and moderate degree asthma), followed by animal fur (18.1%, $p = 0.038$ between mild and moderate degree asthma). From the air pollution data, PM₁₀ had a statistical significance for asthma ($p = 0.009$ between mild and moderate degree asthma). All other allergic factors and the air pollutants had no statistical significance for children asthma severity.

This study indicated that animal fur and PM₁₀ could increase childhood asthma severity. It is essential to keep the environment clear, reduce the hairy pets feeds and avoid air pollutants exposure.

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Population-Based Study of Long-Term Survival and Clinical Implications Among Chinese with or Without Metabolic Syndrome in Kinmen, Taiwan

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To determine the survival rates of Chinese with or without MS and the prognostic factors related to all-cause mortality during a 16-year follow-up in Kinmen, Taiwan.

A total of 12,107 (5434 male and 6673 female) aged 30 years old or above received health screening in 1991-93 and then follow until 2007. The subjects with MS were diagnosed by ATP III. The Kaplan-Meier method and Cox regression were used to estimate survival and the independence of prognostic factors associated with all-cause mortality.

1413 out of 12,107 patients expired during the 16-year period. The overall survival rate was 87.26% (95%CI: 0.87-0.88); no MS was 94.26%(95%CI: 0.93-0.95); one factor was 87.97%(95%CI: 0.87-0.89); two factors was 82.90%(95%CI:

0.81-0.85); three factors was 80.20%(95%CI: 0.78-0.83); four factors was 74.16(95%CI: 0.69-0.79), and five factors was 59.07%(95%CI: 0.47-0.71), respectively. The survival rate significantly related to numbers of factors of MS (log-rank test = 330.66, $p < 0.0001$). The significant associated factors of mortality based on the Cox regression analysis were male gender (RR = 1.74, 95%CI: 1.54-1.97), numbers of risk factors of MS (one factor vs none, RR = 1.39, 95%CI: 1.18-1.65; two factors vs none, RR = 2.00, 95%CI: 1.68-2.39; three factors vs none, RR = 2.60, 95%CI: 2.12-3.19; four factors vs none, RR = 3.31, 95%CI: 2.51-4.36; five factors vs none, RR = 6.76, 95%CI: 4.50-10.17), smoking (RR = 0.99, 95%CI: 0.98-1.01), alcohol drinking (RR = 1.01, 95%CI: 0.99-1.03), higher AST (RR = 1.06, 95%CI: 0.82-1.36), higher ALT (RR = 0.98, 95%CI: 0.71-1.37).

The increased numbers of factors of MS were related to all-cause mortality.

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Long Term Follow-up Study of Coronary Revascularization Alone or with Combined Mitral Valve Operations for Ischemic Mitral Regurgitation

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The treatment outcomes among coronary revascularization alone, with mitral valve reconstruction, and with mitral valve replacement for \geq grade 3 + mitral regurgitation (MR) patients were still not clear.

To explore the long-term survival for MR patients after coronary artery bypass grafting (CABG) surgery and mitral valve surgery (MVS).

Between January 1997 and December 2003, three hundred seventy-two patients with \geq grade 3 + MR underwent CABG were defined and then follow-up to 2007, that is, group A: CABG only (n = 181), group B: CABG combined with mechanical MVS (n = 67), group C: CABG combined with tissue MVS (n = 42), and group D: CABG combined with mitral valve reconstruction (n = 82). Kaplan-Meier method was used to estimate the survival curve.

The mean follow-up time was 5.26 ± 5.69 years. 144 out of 372 patients (38.7%) expired during the 11-year period. The overall and four groups' survival rate were 56.1% (95%CI: $56.1 \pm 6.2\%$), 60.7% (95%CI: $60.7 \pm 9.1\%$), 52.2% (95%CI: $52.2 \pm 12.8\%$), 55.7% (95%CI: $55.7 \pm 15.5\%$), and 53.8% (95%CI: $53.8 \pm 11.1\%$), respectively (p -value = 0.0156 for log-rank test). There were about 75.7% patients with their MR condition regressed to grade 2 after surgery. The CABG combined with mitral valve reconstruction or replacement with both valves had better improvement of MR than those groups with CABG alone (56.2% for group A, 93.3% for group B, 97.3% for group C, and 84.9% for group D, $p < 0.0001$).

Although CABG combined with MVS may offer better improvement of MR regression, the long-term survival didn't improve in patients with \geq grade 3 + MR after CABG combined with MVS.

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Clinical Correlation of Metabolic Syndrome in Chinese Taxi Drivers in Taiwan: Experience at a Teaching Hospital

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Metabolic syndrome is a cluster of cardiovascular risk factors. The complications of metabolic syndrome could consume many medical resources. It is essential for early diagnosis and appropriate treatment to subjects with this disorder.

To explore the gender difference of the prevalence and associated risk factors of metabolic syndrome among taxi drivers based on the health examination in Taipei, Taiwan.

We studied a total of 1635 healthy taxi drivers (1541 males and 94 females) voluntarily admitted to physical check-up between January 2006 and December 2006 in a northern teaching hospital in Taiwan. The definition of metabolic syndrome is according to the criteria proposed by Department of Health in 2007, Taiwan.

The mean age is 49.6 ± 7.1 years in study patients. The prevalence of metabolic syndrome is 23.6% and male (24.1%) is not significant higher than female (16.7%) ($p = 0.07$). From the multiple logistic regression, gender difference is found in associated factors related to metabolic syndrome after adjustment for confounding factors. The abnormal waist circumference and fasting plasma glucose are the most significant risk factors related to metabolic syndrome in the male (OR = 1.21, 95%CI: 1.15-1.28) and in the female (OR = 1.10, 95%CI: 1.00-1.21), respectively.

The associated factors of metabolic syndrome showed the gender difference in this study. In order to prevent the incident metabolic syndrome, to encourage taxi drivers with the exercise habit, dietary improvement, and controlled central obesity is important.

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Time-Series Analysis of Seasonality for Children with Asthma in Taipei, Taiwan

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Asthma is a chronic disease in children, which leads to excessive costs for health care. Air contaminants may contribute to clinical asthma.

The purpose of this study is to determine the seasonal effect between environment pollution and asthma among children in Taipei, Taiwan.

A retrospective, population-based study is conducted to assess temporal patterns in the outpatient department for asthma among children from January 1, 2003 to March 13, 2010. A total of 1045 cases were diagnosed and recorded as asthma. The air pollution information was collected by air monitoring stations. Time series analyses were used to explore the monthly aggregations of patients in the outpatient department.

The mean asthma patients in the outpatient department were 14.22 per month. The PM10 density associated with the peak severity rate of asthma in Mar 2010. The asthma patients in the outpatient department were associated with O₃ ($r = 0.261$, $p = 0.02$) and NO₂ ($r = 0.263$, $p = 0.019$). The severity rate of asthma were also associated with asthma ($r = 0.544$, $p < 0.001$).

We found that asthma patients in the outpatient department were significantly related to O₃ and NO₂. Asthma exacerbations seemed to be associated with infections and exposure to allergens. To consider the environmental factors of asthma is essential.

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The Population-Based Study of Prevalence and Smoking Behavior Among Female in Tao-Yuan, Taiwan

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Although the individuals smoking rate is under control in Taiwan, the smoking rate of female population is increasing.

To explore the prevalence and factors related to females' smoking behavior in Tao-Yuan, Taiwan.

There were 6348 females aged 18 years old and above selected for telephone interviewed by stratified cluster random sampling in Tao-Yuan County. The information of smoking behavior was collected by a structural questionnaire. Chi-square test and logistic regression methods were used to interpret factors related to females' smoking behavior.

The prevalence of adult females' smoking in Tao-Yuan was 7%. According to logistic regression, the significant factors related to smoking behaviors included smokers at home (OR = 2.20, 95%CI = 1.75-2.77), exposure to cigarette advertisements (OR = 1.30, CI = 1.01-1.69), the acceptance level towards cigarette marketing (OR = 3.54, 95%CI = 2.48-5.07), knowledge of tobacco hazard (OR = 0.88, CI = 0.72-0.88), attitudes against smoking (OR = 0.68, CI = 0.65-0.72), marital status (divorce or widowed vs single, OR = 2.16, 95%CI = 1.22-3.85), place of residence (suburbs area vs city area, OR = 1.64, 95%CI = 1.17-2.31), occupation (half-technicians or executives, and representatives have 1.77 (95%CI = 1.32-2.38) and 2.10 times (95%CI = 1.32-2.33) than the unemployed, respectively) and race (mainlanders and aboriginal are 1.82 times (95%CI = 1.30-2.55) and 4.41 (95%CI = 2.45-7.92) times more than the southern min Taiwanese respectively)

Irregular marital status, lower socioeconomic status, frequently to expose smoking advertisement and marketing activities, smokers at home, a negative attitude towards smoking cessation and inadequate knowledge about smoking side effects are leading factors to females' smoking behavior. Therefore tobacco control campaigns should consider to the needs of each individual.