One health and biosecurity: a safeguard against diseases

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Introduction

One Health is a concept that relates to the intricate relationship between animal, human, and the environment with regards to health and disease. The Food and Agriculture Organization of the United Nations (FAO) sees One Health as a holistic vision to address complex challenges that threaten human and animal health, food security, poverty and the environments where diseases flourish. It is an approach to tackle complex public health problems that involve multiple disciplines, for example: emerging zoonotic diseases, food safety and selection of antimicrobial resistant pathogens. The increasing interdependence of people
with animals and their products has brought One Health to the forefront of the veterinary and medical professions. Fundamental to the One Health concept is the importance of coordinated multidisciplinary collaboration working locally, nationally and internationally, to attain optimal health for people, animals and our environment.

Biosecurity has been defined as a work of strategy, efforts and planning to protect human, animal and environmental health against pathogens. The FAO in 2003 adopted biosecurity as an all-inclusive term that includes policy and regulation to protect agriculture, food and the environment from biological risk. Biosecurity is based on the implementation of measures to prevent the introduction of disease into a population, for example use reputable sources of new and replacement cattle or establish an area of separation. Infection prevention and control has the aim to limit the impact of the introduction of pathogens into a population, for example proper heard vaccination to boost immunity or hand washing. Biosecurity and infection prevention must be practiced together in order to prevent and minimize the impact of disease in a herd.

The convergence of people, animal and our environment has created a new dynamic, in which the health of each group is inextricably interconnected. The three pillars of biosecurity (human, animal and environment) are shared by the One Health concept, and biosecurity should be implemented with One Health in mind, especially when it comes to collaboration and cooperation among sectors in order to control the spread of pathogenic microorganisms. For example, locally, veterinarian and producer groups can provide guidance on issues of importance to local health boards. Local human and veterinary medical associations could meet more frequently to discuss topics of mutual interest in their communities. Nationally and internationally, One Health stakeholder leaders could catalyze the concept to trickle down to local clinicians, producers and general public.

**Leadership and One Health**

Veterinarians must work together with other disciplines, including public health, human medicine, bio-engineering, animal science, environmental science, and wildlife. This collaborative work will be key to improve worldwide health, and having healthy animal production systems will help meeting the increasing
demand for animal protein in a sustainable way. Veterinarians are well grounded in population health, comparative medicine and preventative medicine. Therefore, the veterinary profession must assume key leadership roles in One Health efforts.

There are barriers to overcome the adoption of a One Health concept. The most important hurdle is the need for key leadership to embrace the concept, to obtain buy-in from medical, veterinary, industrial and environmental partners, in order to execute a One Health program. Lack of or misallocation of resources is another barrier for the broad implementation of One Health. In developed countries, resource constrains is likely the main barrier to One Health implementation.

Education and communication plays a fundamental role in the development of the One Health concept, thus it is important to integrate this concept into related disciplines’ education. Consumers and younger generations are far removed from the farm, hence their understanding of animal agriculture is less than optimal. Veterinarians and producers should take the lead at engaging with stakeholders in order to bring to light the important role that animal agriculture is playing in using biosecurity to prevent disease, improve antibiotic prescription practices and feeding the world sustainably.

I believe that, at all levels, leadership is key for the successful implementation of a One Health infection prevention program. Leaders must be able to communicate their vision to promote a culture by which infection prevention should be an integral part in providing the best care for animals, people and environment, as well as providing safe and wholesome food. Leadership by example should be paramount in creating and maintaining the culture of providing patient centered care and improving animal welfare. Even more important leaders must constantly listen to feedback from their team and stakeholders, as One Health, like biosecurity, are ever changing processes that require constant surveillance and adaptation.

**The challenge of infectious diseases**

Human and animal relationships will continue to intensify due to animal husbandry practices, the growth of the companion animal market, climate change
and ecosystem disruption, anthropogenic development of habitats, and global travel and commerce.\textsuperscript{7,8} Thus as the animal – human interactions intensifies, so does the potential for zoonosis and reverse zoonosis to occur. Sixty percent of pathogens are multi-host that is they can move across species, and approximately 75% of new emerging human infectious diseases are zoonotic.\textsuperscript{1,9} There is a close link between human and animal and this interrelation may be a critical risk factor to our own health and well-being.\textsuperscript{8} The emergence and re-emergence of pathogens will threaten the health and well-being of people and animals thought the 21st century.\textsuperscript{1,9} Agricultural biosecurity threats are diverse and have considerable impact on animal agriculture.\textsuperscript{10} Thus we need to adopt an integrated, holistic approach that reflects both our profound interdependence and the realization that we are part of a larger ecological system, exquisitely and elaborately connected.\textsuperscript{1}

Emerging and re-emerging diseases at the human-animal-ecosystems interface are happening frequently. These include highly contagious trans-boundary diseases with pandemic potential, as well as many food borne outbreaks. They also include neglected or endemic zoonosis, such as bovine tuberculosis and many parasitic diseases.\textsuperscript{10,11}

The “global mixing bowl” are a series of mostly man-made factors that are contributing for microbes to have a greater opportunity to create new niches, cross species boundaries, travel across the world and establish new beachheads in animal and human populations.\textsuperscript{1} Some of the most important factors are: microbial adaptation, global transport and travel, host susceptibility, climate change, economic development and land use, human demographics and behavior, poverty, and social inequality.\textsuperscript{1}

There is consensus that owing to globalization and the ‘four Ts’ (trade, travel, transportation and tourism) biosecurity problems are worsening, hence a more resilient biosecurity system must be put in place.\textsuperscript{10} Implementing measures to prevent the spread of infectious microbes must be an essential part of patient care and animal welfare. Excellent medical care is not possible without taking measures aimed at preventing and or minimizing the spread of contagious
infectious diseases among people and animals. Likewise limiting the introduction and spread of pathogens via biosecurity programs in livestock and poultry animal production systems is paramount for proper animal welfare, safeguarding our food supply, protecting human health and trade.

The use of antibiotics in human and animals has added to the selective pressures for development of microbial resistance and emergence of multi-resistant microorganisms.\textsuperscript{12,13} This is a One Health problem that requires multidisciplinary cooperation to revert the rising in antibiotic resistant bacteria. It is key to invest more resources into research and control of zoonotic diseases and complex food production systems management as this could be an effective strategy for improving the overall health of humans and animals.\textsuperscript{3} In the animal industry, properly implemented biosecurity along with vaccination plans and antibiotic stewardship, could decrease or eliminate the use of antibiotics, without compromising animal welfare.\textsuperscript{13}

**Biosecurity implementation**

Biosecurity practices, antibiotic stewardship, early diagnostics, and therapeutic innovations are important tools to combat and or control the emergence of pathogens resistance and the spread of contagious infectious diseases.\textsuperscript{13} However, the limited prospect for newer, safer and affordable antimicrobials and vaccines to cure and prevent disease, along with the emergence of multi-resistant microbes; makes prevention strategies even more vital.\textsuperscript{12,13} Implementing a comprehensive biosecurity plan to prevent infections with a One Health concept in mind would enhance collaboration, prevent or limit the spread of disease, hasten herd health, improve diagnostics, reduce antibiotic use, decrease costs and save lives.

Biosecurity should be proactive rather than reactive and involve all levels in the organization so everyone has a sense of ownership and everyone is accountable for implementing such measures. This is true at all levels (institutional, regional, national, and international) where a risk-based approach focused on prevention and anticipation of disease emergence should be adopted.\textsuperscript{10} For example, at the international level the World Organization for Animal Health (OIE) has adopted a single list for animal diseases and includes notification requirements as well as
patterns of emerging disease with significant morbidity/mortality or zoonotic potential.\textsuperscript{10}

A robust vaccination program should be a key element for the prevention of infectious diseases, but there are limitations to vaccination since it cannot fully protect the whole population, vaccines for many diseases are not available and vaccination cannot be used to control emerging diseases.\textsuperscript{14} Veterinarians use vaccination as a key tool to maintain heard health. Vaccination across species is a crucial element in maintain a good level of immunity which in turn helps lowering the incidence of diseases. For example in dogs, using vaccination to control influenza is very important not just for the individual dog but for the canine population as a whole. Furthermore, since dogs live in close contact with humans, vaccination aids with lowering the emergence of new viruses (i.e. influenza) in dogs with the potential of infecting humans, a zoonotic risk. This makes control of diseases such as canine influenza in the canine population not just important for dog health, but also for human wellbeing.\textsuperscript{15}

**Recent biosecurity outbreaks**

Pandemics caused by severe acute respiratory syndrome coronavirus (SARS-CoV), Middle East respiratory syndrome coronavirus (MERS-CoV), avian influenza and swine influenza, although contained, showed how easily viruses can mutate and jump from one specie to another.\textsuperscript{16,17}

The outbreak of porcine epidemic diarrhea virus (PEDv), exotic in the US until May 2013, spread rapidly through swine farms causing high mortality in young pigs, approximately 7 million pigs were lost.\textsuperscript{17,18} PEDv was introduced from China, likely via the use of flexible intermediate bulk containers or in feed additives.\textsuperscript{17-19} As exemplified with PEDv, accidental human assisted movement of pathogens across borders appears to be the major cause for animal biosecurity breaches.\textsuperscript{10}

In 2015 the poultry industry experienced the devastating impact of a highly pathogenic avian influenza virus (HPAI). Migratory wild birds were responsible for the introduction of the virus in the commercial flocks; however, transmission from farm to farm also occurred.\textsuperscript{20} Biosecurity failures appeared to have contributed to the spread of HPAI between farms, because farms shared
equipment, personnel movement between affected and non-affected premises occurred and transport vehicles were improperly cleaned and disinfected. As demonstrated by the HPAI outbreak, the movement of pathogens between wildlife and domestic animals has been a major driver for new disease emergence. Similar to PEDv, people were a factor for the biosecurity failures that contributed to the HPAI outbreak.

**Economics of biosecurity outbreaks**

The costs of an infectious outbreak can be divided into direct fixed costs (remodeling of the facility, labor, equipment, utilities), direct variable costs (medication, treatments, procedures, supplies, diagnostic testing), indirect costs (morbidity, mortality, affected athletic performance potential, decreased worker productivity, liability) and intangible (bad publicity, loss of clients, loss of teaching opportunities, decreased morale). Furthermore in animal agriculture, the impact of diseases that affect international trade or are zoonotic will have different economic impacts compared to those that do not.

Health-care associated infections (HAIs) impose significant economic burden to the human health care system. In the US 1.7 million patients per year suffer HAIs and one-third or more are believed to be preventable. The annual direct hospital costs of treating HAIs in the US ranges from $28.4 billion to $45 billion. As mentioned previously, the emergence of antimicrobial resistant organisms is a One Health issue and preventing HAIs is key for reducing resistant infections and improving antibiotic use.

Infectious disease outbreaks in large animal veterinary teaching hospitals reported losses of up to $ 4 million. A survey of veterinary teaching hospitals revealed that 82% of the institutions had reported an outbreak of an infectious disease. *Salmonella enterica* was the leading cause of outbreaks followed by methicillin resistant *Staphylococcus aureus*. As with human medicine improving hospital infection prevention will lead to lowering HAIs as well as decrease the emergence of resistant bacteria.

In recent years livestock biosecurity problems have emerged in different parts of
the world, characterized for their high costs and public profile. The classic swine fever outbreak in 1997 cost The Netherlands approximately £2.4 billion. The 2001 foot and mouth disease (FMD) outbreak cost the United Kingdom £7 billion and the slaughtered of 7 million animals.  

Animal agriculture is important to the US economy as it is a primary source of food and nutrition, a major contributor to exports and it is valued at $165 billion. The 2003 emergence of bovine spongiform encephalopathy cost US and Canada $3 to $4 billion in lost trade. The PEDv outbreak in the US cost the swine industry $900 million to $1.8 billion. The HPAI outbreak of 2015 had a significant economic impact to the poultry, turkey and egg industry due to the loss of animals and negative trade impact. In Iowa the outbreak was estimated to cost $1.2 billion due to the death of 30 million hens and 1.5 million turkeys. The emergence of a disease like Foot and Mouth in the US would have severe trade consequences that could amount to losses of more than $37 billion to the country’s economy. Currently African swine fever (ASFv) is devastating the swine market in China and spreading to other areas of Asia and Europe. It is estimated that if ASFv enters the US it would cost $16.5 billion during the first year of the outbreak.  

Conclusion  

Animal agriculture is becoming a highly integrated and global system, which is very important both domestically and internationally. This complex system combined with the increasing frequency of emerging infectious diseases puts at risk the stability of the US economy, food security, and livestock, poultry and public health. This vital industry to the US economy, needs to position itself to defend the thread for foreign animal diseases and zoonotic diseases. Therefore, the implementation of comprehensive biosecurity protocols at different levels of the supply chain (from farm to table), is a fundamental step toward safeguarding animal agriculture, trade and improving consumer confidence.  

In a recent equine consensus statement, it was concluded that veterinarians and managers need to be aware that there is a recognizable standard of care with regards to infection control. Meaning that measures geared towards minimizing
the spread of contagious infectious diseases and education must be part of the
care provided by veterinarians to their patients and clients. Not meeting these
standards constitutes malpractice and represents a failure to meet the ethical
responsibilities to patients and clients. This message can be very well translate
to animal agriculture, and highlights the importance of embracing a One Health
concept.

Not all biosecurity measures are possible to implement or necessary for every
dairy farm. Based on risk, producers in collaboration with their veterinarian will
decide what biosecurity protocols needs to be implemented. Some common facts
for such a program are animal identification, maintaining health records, disease
surveillance, personnel training and education, leadership involvement, control of
direct and indirect contact and optimizing personal and environmental hygiene.

Preventing infectious diseases should be a proactive rather than a reactive
practice. With foreign animal and zoonotic disease increasing in prevalence and
its potential for catastrophic impact to societies, understanding and estimating
the economic consequences of diseases is important. Neglecting infectious
disease control is unethical, constitutes malpractice and can be very costly in the
short and long term. Biosecurity does not stop with veterinarians. Veterinarians
must take a leadership role, educating clients and producers about the
importance of infection prevention practices and the costs of doing nothing.
Having in place a proper biosecurity plan and personnel education would help to
prevent or minimize the consequences of disease outbreaks, thus saving money
and lives.

About the Author

Lucas Pantaleon is a veterinarian advisor, founder of Pantaleon PLLC, and has
experience in different sectors of animal health. Lucas holds a Master in
Veterinary Sciences, an MBA, and is a Board Certified Large Animal Internal
Medicine Specialist. Being a member of the Board of Director and Executive
Committee for the National Institute for Animal Agriculture (NIAA) allows him to
be involved in topics that matter to animal agriculture, such as antibiotic use,
traceability, and innovations in agriculture. In his advisory role he works with
companies and individuals around topics that blend science, business,
cooperation and collaboration, such as infection prevention, One Health, and value-based care. Educating and speaking around the US and internationally is one of his passions. He has written many articles on topics related to infection prevention and improving patient care. lucaspantaleon@gmail.com

References


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