Poultry biosecurity evaluation and indicators

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Biosecurity can be defined as a way to assure safety from the transmission of infectious diseases, parasites and pests (Anonymous, 2011). Biosecurity is variably composed of structures anda series of human behaviors, procedures, and attitudes.Most birds and eggs produced in commercial settings in the developed world are protected by at least some measure of biosecurity. For commercially-raised animals, failing to implement biosecurity can be considerably more expensive than the cost of the biosecurity actions that could have protected the flocks or herds from infectious disease (Cardona, 2008).

Biosecurity is an essential element in making the production of poultry sustainable and economically viable. At the same time, the practice of biosecurity may be completely dependent on the decisions of the least invested employee on a farm or in a system. This conundrum points to the need for a way to evaluate the quality of biosecurity programs and to make sure that essential practices are consistently implemented.

Understanding biosecurity

There are good reasons to look at biosecurity in different ways. When all the inputs and outflows of a farm and all the variables that can be involved are considered, it is clear that a farm is no less complicated than any other ecosystem. With that in mind, it takes multiple perspectives to understand a complicated reality, which is an important part of developing biosecurity plans, evaluating biosecurity programs and in educating employees about biosecurity.

Biosecurity based on approach

One of the most useful ways to both build and evaluate biosecurity programs is to consider conceptual, operational, structural biosecurity as the basis of an approach(11). Conceptual biosecurity refers to the organization of the system within which a farm or company operates. It is the physical separation of functional entities in the poultry industry a good example of which is the separation of breeders from production flocks. Structural biosecurity refers to the physical environment either existing or engineered that provides the context for the poultry flock on a farm or in a system. Management approaches are also part of structural biosecurity. An all-in, all-out management system, for example, is part of structural biosecurity. The last component, operational biosecurity are all the activities of people that carry out the day to day activities of the farm. Preventing employees of poultry farms from owning poultry falls under operational biosecurity. In any biosecurity program, the weakest link is that which relies on human behavior to succeed, in other words, the operational part of the program.

Biosecurity based on goals

Biosecurity measures can be divided into the goals of its component parts, traffic control, sanitation and isolation. Traffic control includes both the traffic onto the farm, off the farm, and the traffic patterns within the farm. Sanitation addresses the cleaning and disinfection of materials, people and equipment entering the farm and the cleanliness of the personnel on the farm (Cardona, 2008).

Biosecurity based on a target

Biosecurity plans can be general but they are most effective when they focus on specific diseases or groups of diseases with similar transmission patterns. Non-fatal respiratory diseases like Newcastle disease, avian influenza, infectious bronchitis, infectious laryngotracheitis, avian metapneumovirus and mycoplasmosis are caused by disease agents in the upper respiratory tract and are in high concentrations in mucus and other respiratory tract secretions. They can be spread through these secretions from bird to bird by coughing or sneezing. Spread farm to farm is most usually through the movement of people and equipment that act as fomites for respiratory secretions. Biosecurity plans that address these diseases will focus on visitor policies and equipment and vehicle cleaning and disinfection and movements. In contrast, disease agents that

cause mortality will be present in carcasses at high levels. Biosecurity plans that address these diseases need to prioritize safe carcass disposal methods.

Some diseases, once they are introduced onto a farm, are there forever. The transmission of these agents to new birds is most likely to come from the farm itself. These organisms tend to be persistent in the poultry host and remain infectious for long periods in the environment. Marek's disease virus, chicken anemia virus and Clostridium sp. are typical of this type of pathogen. In addition to specific pathogens that are stable, there continuous flow management systems that result in many more infectious agents that are stably maintained on a farm though the continuous availability of naïve hosts. Biosecurity does not work for stable organisms once they are on a farm. Sanitation and the prevention of outbreaks will decrease their load in the environment but they cannot be eliminated and thus, they can't be excluded. Instead, the strategy for stable organisms is to protect the host commonly through vaccination or treatment.

Biosecurity based on scope

The best biosecurity plans are only as good as the environment in which they are implemented. If a farm is in a region in which diseases circulate at very high levels, then it may not be cost effective to implement biosecurity to keep them out as an individual entity. Starting with regional or national biosecurity might make more sense.

The focus of individual farm biosecurity is the protection of flocks by preventing exposure. This is done by controlling what comes in. Regional biosecurity is also concerned with protecting other birds in the region thus, it also includes the control of what goes out. Regional biosecurity is largely achieved through the separation of clean and dirty poultry traffic in a specified geographic area. Dirty trafficare the things that have a high likelihood of being contaminated with disease agents that could spread to clean traffic. Examples include manure trucks, rendering trucks, spent fowl, and live haul trucks.Clean traffic, if contaminated, can introduce infectious agents into poultry flocks. Examples of clean traffic include pullets, feed, chicks, poults, or clean supplies. In addition, regional biosecurity plans often include agreements about how to dispose of diseased flocks, how to monitor for infection and how to report infection within the group. Regional control plans have been implemented in a variety of places successfully (Halvorson, 1986; Vaillancourt, 2009; Yee *et al*., 2008).

National biosecurity programs focus on the exclusion of transboundary diseases like highly pathogenic avian influenza and virulent Newcastle disease. In the United States, the mission of protecting the health and value of American agriculture and natural resources and thus, US national biosecurity falls under the Animal Plant Health and Inspection Service in the United States Department of Agriculture (Anonymous, 2007). The major focus of national biosecurity is *traffic control* which is accomplished through an extensive permitting process that restricts the movements of animals, plants, products and infectious agents into the United States. Traffic control is subsequently validated through surveillance activities. When there is an introduction, of a foreign animal disease, then eradication is implemented. National biosecurity can only exclude the disease agents that are spread by the movement and activity of humans. Thus, national biosecurity will not prevent disease introductions that come from wildlife reservoir hosts. Those introductions and their subsequent spread can only be prevented by farm and regional biosecurity.

Biosecurity assessments

Examining biosecurity from many perspectives is part of assessing a program but systematically examining real risk and the biosecurity in place on a farm to manage it requires risk analysis. Risk analysis involves the identification and quantification of infectious disease hazards facing a farm and an evaluation of management strategies directed at managing those risks appropriately (Shapiro and Stewart-Brown, 2008). Audits are tools that are sometimes used to assure the compliance of a farm to a plan or a goal. Pure compliance audits are often performed within systems with established biosecurity goals that have been translated into concrete actions. More commonly, the need is for risk analysis, in which the assessor is asked to audit the elements of biosecurity (risk management) but also to assess the overall disease threat for the farm (risk assessment) and to communicate risk to the farm owners and operators (risk communication). The focus of this discussion will be on risk analysis and its role in assessing farms. Audits are discussed as a tool of risk analysis.

Evaluations of biosecurity can be conducted in all sorts of ways. A farm or system visit is an essential component of an assessment. Any other method simply will not work (Shapiro and Stewart-Brown, 2008). The results of any evaluation will universally depend on the qualifications of the assessor, the transparency of the farm or system being evaluated

and the frequency of the assessment visits. The value of an assessment will depend on the willingness and capacity of the farm or system to change as a result of the evaluation.

Assessors. Good assessors have broad knowledge of the type of farm that they are auditing. If the analysis is of a broiler farm, then the assessor should have experience with good and bad examples of biosecurity on live production farms. In addition, he or she must have excellent knowledge of infectious disease transmission andbe schooled in the tools needed to accurately assess biosecurity including interview methods that are open-ended and not leading and the ability to operate a GPS device in order to measure distances. With knowledge and experience in production, an understanding of infectious diseases and skill in investigation an assessoris qualified to conduct an accurate farm or system analysis (Van Sickle, 2007).

Access. In addition to the assessor's qualifications, a successful evaluation depends on the access given and the overall transparency of the system. An assessor should be able to read all signs and communicate freely with the people who work on the farm and in the system (Shapiro and Stewart-Brown, 2008). In addition, any assessor needs access to all records. Some believe that evaluators should be blinded to a farm's prior association with disease in order to assure that all aspects of biosecurity are viewed fairly and consistently (Shapiro and Stewart-Brown, 2008). However, prior disease outbreaks are indicators of biosecurity weaknesses either in regional biosecurity, i.e., a measure of disease risk for the site, and/or previous failures of on farm biosecurity that should have been addressed. An assessor should judge how historical problems have been addressed for the benefit of improving farm biosecurity.

Understanding an analysis. When considering the result of an analysis, one must understand how it was conducted. For this reason, although there is value in novel tactics, progress in improving biosecurity is best achieved with approaches that are consistent and provide an objective evaluation which can be compared with previous results. The findings of repeated visits should be compared as a measure of validity of the assessment as well as an indicator of the consistency of operational biosecurity. The frequency of visits should be determined based on the goals of the assessment. High risk high consequence scenarios need accurate assessments and thus, frequent visits may be warranted. Farms with good records, consistent results and with good structural biosecurity may not need frequent risk assessments.

Audits of compliance are important because they are a measure of the weakest part of biosecurity, adherence of humans to biosecurity rules. However, it is important to understand that audits evaluate adherence to rules. The difficulty is that if the rules do not address the most prominent disease threats to the farm, compliance with the rules will do nothing to enhance biosecurity or reduce real risk.

The tools of biosecurity

The biosecurity plan. Assessments of biosecurity should include an evaluation of the farm and system biosecurity plan. The plan should outline what, from the local perspective, are the highest risks facing the farm. The plan also provides a window into the understanding of risk from the perspective of the farm or system management. There should be congruence between the findings of the risk assessor, whose report should be considered the gold standard for real risk, and the biosecurity plan. For example, any farm in Minnesota should address wild ducks and all farms with urban encroachment should address security.

When evaluating a biosecurity plan, first look at the goals of the program. The goals of a breeder farm biosecurity plan will be very different from the goals of a meat bird farm. Examine the farm's disease history and gather information about the region. Have there been outbreaks in the region and if so, did the farm become infected or did it remain disease free? The plan should address how it was changed in response to an outbreak to decrease risk, if it was. The plan should also address any internal or external audits that resulted in the discovery of breaches and how they were corrected. The history of the farm will provide you with a map of the problem areas for this farm and/or the highest exposure risks.

A farm or regional biosecurity plan will include specific actions aimed at achieving a goal. For example, the plan might provide the following list under "prevent wild bird exposures":

- Protect poultry flocks from coming into contact with wild or migratory birds
- Wild bird nests must be removed as soon as they are discovered on the farm
- Will bird roosting sites and feed spills will be minimized
- Buildings should be maintained to prevent wild bird intrusion
- Keep poultry away from any source of water that may be contaminated by wild birds

If the rules listed are applied, will exposure to wild birds be prevented? Notably, environmental contamination and subsequent movement of disease by mechanical vectors or fomites is not addressed in the bulleted list. So, in areview of the plan, that might be a good question to ask in addition to evaluating the "hows" of the bulleted list i.e., How are poultry flocks protected from contact with migratory birds? How are nests removed? etc. Asking "how" something is done will prevent a yes or no answer with which it is easy to obfuscate the truth. The hows of the process should be addressed in farm standard operating procedures that are a part of any good biosecurity program.

Education and training. A biosecurity program can't be evaluated without addressing education, training and communication. Operational biosecurity is the weakest link in any program because it relies on human behavior and thus, the effectiveness of education, training and communication.

Educating about biosecurity

Educating adults is not a simple process. Adults have experience upon which they draw to reach conclusions and for this reason, they are less receptive to teaching methods that are successful with children, although that is usually how we try to teach them. The result is that while teaching children often leads directly to changes in behavior, adults can and do get stuck at any one of the steps in a thought process: **1)** recognizing that there is a problem, **2)** defining the problem, **3)** suggesting a possible solution, **4)** exploring alternatives, and **5)** resolution or change (5). Most training ends at measuring that people have made it to steps 2 or 3 in the process but an education program that has change as its outcome, like biosecurity training does, creates a very high standard for success. Effective adult education strategies often incorporate stages that allow the trainee to progress through the steps of the thought process. Learning stages such as scanning for problems followed by an evaluation of problems, learning the skills and knowledge to address a problem, and gaining experience will likely result in successful implementation of actions (Slotnick *et al*., 2002; Slotnick and Shershneva, 2002).

The importance of motivation for training success

Motivation has been demonstrated to improve learning, retention, and implementation of change in many species and under many different conditions from rats in mazes to humans in complex scenarios. Ensuring the success of an educational intervention is in large part dependent on figuring out what motivates your audience. When your target is biosecurity, the motivations of people that are needed to implement the program will vary based on their roles on the farm or in the system to be addressed, their commitment to the organization, their age and other personal factors including inherent personality traits (Racicot *et al*., 2012).

The ways that people are motivated are diverse and understanding motivational theories can help to make sense of the array of possible motivators and approaches to use for different settings. Taylor (Taylor, 1911) theorized that in work, humans do not naturally enjoy work and are motivated by pay. Following this theory, work should be divided into small supervised tasks that are rewarded with pay. In contrast, Mayo (Mackay, 2007) believed that workers are not just concerned with money but are also motivated by having their social needs met through their work. Maslow put forward a theory that there are five hierarchical levels of human needs: physiological, safety, social, esteem and self-actualization. People may be at different levels of the hierarchy and thus, are motivated to meet different needs (Mackay, 2007). For example, a hungry person (physiological need) is more motivated by hunger than by loneliness. These theories and others are needed to explain the complex interactions of personality, experience, job function and ethnic background among other factors in determining what motivates any individual person

Knowing that human motivation is complex,it is important that evaluations of compliance to biosecurity rules be accompanied by an assessment of why an employee, visitor or owner is compliant or is not. An understanding of motivation for compliance is the avenue to determining how to motivate people in different roles in a biosecurity program. Ricauldi *et al*., have demonstrated that monitoring cameras are an effective motivator for behavior (Racicot *et al*., 2012a) but that they work best with specific personality types (Racicot *et al*., 2012b).

Evaluating education as a component of a biosecurity program.

The education and training that leads to employee actions should be a part of a biosecurity evaluation. One of the underlying components of assessing effective training is, of course observation but another key way to monitor is to evaluate employee turnover. Turnover increases the challenges of education and motivation. A stable group of workers allows a company or system to make progress in

biosecurity because it allows time for employees to progress through the stages of learning and managers time to understand the variable ways their workers are motivated. A stable workforce is also a strong indicator that the motivations of the workforce are being met, whatever they might be.

The underlying assumptions of biosecurity

The concept of biosecurity and the practice of biosecurity on poultry farms are based on several assumptions. A failure to understand these assumptions has been one of the more common reasons that poultry flocks become infected despite excellent results on a biosecurity audit or evaluation.

One of the critical principles of biosecurity is that of exclusion. If there is something that a flock should not be exposed to, it is excluded from the poultry house, farm, region, or country. There is at least one scenario where this does not work because there are things which cannot be excluded from poultry farms, like the birds themselves and their human caretakers. This is one of the reasons to monitor chicks for diseases they might be carrying from breeder flocks and one of the key reasons for vertical integration. However, we have frequently failed to consider the human caretakers of flocks as potential sources of infection. While most biosecurity programs do everything possible to sanitize the outside of people entering the farm they fail to consider that infections that travel on the inside of a human are beyond biosecurity measuresand thus, cannot be excluded. Pandemic H1N1 in turkey breeder hens was a good example of this. Workers with influenza infections infected turkey breeder hens by contaminating semen with their infectious respiratory secretions. Through the process of artificial insemination, the virus was introduced into the flock and spread from bird to bird (Pantin-Jackwood *et al*., 2010). No matter what we do, flocks and their human caretakers will exchange microbes (**Figure 1**).

Because biosecurity depends on the behavior of people, it is susceptible to failures based on human frailties. Behavior is always most consistent in a system where there is immediate and sure feedback. The rat that gets the cheese at the end of the maze will go faster through the maze the next time. When lapses in biosecurity are invisible to farm workers or only known months later when specific behaviors are forgotten, there is no feedback loop for the worker and very soon there is drift away from compliance. Understanding what workers understand about biosecurity and why they do what they do can partially address this difficulty but the fact of the matter is that they remain human (Racicot *et al*., 2012b).

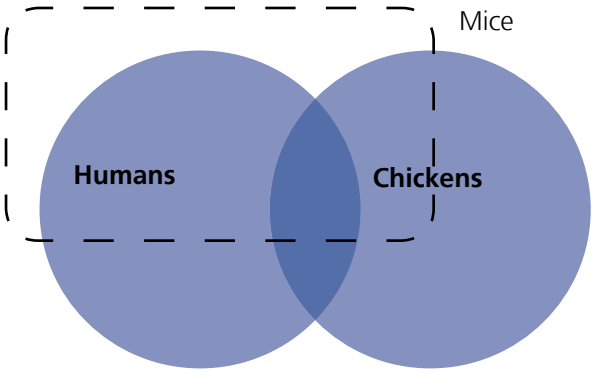

Figure 1. Biosecurity can be used to exclude disease agents associated with species or objects that are not essential to the operation of the farm. Exclusion cannot be used to eliminate disease causing agents that are part of essential components of the farm.

Evaluations and audits do not predict future behaviors. An evaluation is a snapshot in time and can only accurately reflect what went on in the assessor's presence. What happened when the auditor left or is not looking might be a completely different story (Racicot *et al*., 2012a),

Every biosecurity program is a living document because there is way more to disease prevention than we know about so far.

Conclusions

It is a truism that infectious diseases spread though the movements of people and equipment. The best biosecurity does not depend on entirely on people or their decisions but is structural or conceptual in large part with only small parts left to humans instead. An evaluation of biosecurity begins with measuring the quality of approaches selected to exclude disease agents.

Even with an optimized system, biosecurity remains dependent on human behavior. Understanding how to motivate workers, visitors and owners into compliant actions is difficult and the results are not always consistent. Monitoring is essential to assure compliance but should not be limited to observing actions but also include assessments of the education, training and motivation programs in place for the farm or system.

Biosecurity is the single most important

investment in disease prevention that a company, a system, a commodity or a country can make.

References

ANONYMOUS (2007) posting date. About APHIS. [Online.]

ANONYMOUS (2011) posting date. *Biosecurity in Livestock Production*. Manitoba Agriculture, Food and Rural Initiatives. [Online.]

CARDONA, C.J. (2008) Farm and Regional Biosecurity Practices, in: SWAYNE, D.E. (Eds) *Avian Influenza*, pp. 353-368 (Ames, IA, Blackwell Publishing Professional)

CARDONA, C.J. and KUNEY, D.R. (2002) Biosecurity on chicken farms, in BELL, D.D. & WEAVER, W.D. (Eds) *Commercial chicken meat and egg production*, 5th ed, pp. 543-556 (Norwell, MA, Kluwer Academic Publishers).

DEWEY, J. (1910) *How we think* (Lexington, MA, D.C. Health,).

HALVORSON, D. (1986) Presented at the Second International Symposium on Avian Influenza, Athens, GA, September 3-5, 1986.

MACKAY, A. (2007) *Motivation, Ability and Confidence Building in People*. (Burlington, MA, Elsevier, Ltd.).

PANTIN-JACKWOOD, M., WASILENKO, J.L., SPACKMAN, E., SUAREZ, D.L. and SWAYNE, D.E. (2010) Susceptibility of turkeys to pandemic-H1N1 virus by reproductive tract insemination. *Virology Journal* 7: 27.

RACICOT, M., VENNE, D., DURIVAGE, A. and VAILLANCOURT, J.P. (2012a) Evaluation of strategies to enhance biosecurity compliance on poultry farms in Québec: Effect of audits and cameras. *Preventive Veterinary Medicine* 103:208-218.

RACICOT, M., VENNE, D., DURIVAGE, A. and VAILLANCOURT, J.P. (2012b) Evaluation of the relationship between personality traits, experience, education and biosecurity compliance on poultry farms in Québec, Canada. *Preventive Veterinary Medicine* 103:201-207.

SHANE, S.M. (1997) Prevention of diseases, in: *Handbook on Poultry Diseases* pp. 20-23 (American Soybean Association, St. Louis, MO).

SHAPIRO, D. and STEWART-BROWN, B. (2008) Farm Biosecurity Risk Assessment and Audits, in: SWAYNE, D.E. (Eds) *Avian Influenza*, p. 369-390 (Ames, IA, Blackwell Publishing Professional).

SLOTNICK, H.B., MEJICANO, G., PASSIN, S.M. and BAILEY, A. (2002) The epidemiology of physician learning. *Medical Teacher* 24:304-312.

SLOTNICK, H.B. and SHERSHNEVA, M.B. (2002) Use of theory to interpret elements of change. *Journal of Continuing Education in the Health Professions* 22: 197-204.

TAYLOR, F.W. (1911) *The Principles of Scientific Management*. (New York, NY, USA and London, UK Harper & Bros).

VAILLANCOURT, J.P. (2009) Canadian experiences with avian influenza: a look at regional disease control--past, present, and future. *Poult Science* 88:885-891.

VAN SICKLE, J. (2007) Audits allow for added scrutiny, *National Hog Farmer*. Penton Media, Inc.

YEE, K.S., CARPENTER, T.E., MIZE, S. and CARDONA, C.J. (2008) The Live Bird Market System and Low-Pathogenic Avian Influenza Prevention in Southern California. *Avian Diseases* 52:348-352.