

Special Report

Comparison of published recommendations regarding biosecurity practices for various production animal species and classes

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Objective—To compare published recommendations regarding biosecurity practices for various production animal species and classes.

Design—Literature review.

Population—Educational materials available on the World Wide Web that provided biosecurity recommendations for dairy cattle, beef cattle, small ruminant, swine, and poultry producers.

Procedures—Web sites for national producer organizations, university cooperative extension services, and state departments of agriculture were searched to identify educational materials with biosecurity recommendations.

Results—A single national organization was selected as representing each animal agriculture commodity group. A total of 53 university Web sites were visited, and 65 publications prepared by university cooperative extension services were identified and evaluated. Web sites for all 50 state departments of agriculture were searched, and 29 were found to have at least 1 publication related to biosecurity practices, for a total of 46 publications. Evaluation of the biosecurity recommendations revealed wide variations by source and within and among commodity groups.

Conclusions and Clinical Relevance—Results suggested that educational materials for producers contained wide variations in recommended biosecurity practices. It is possible that some producers choose not to implement biosecurity recommendations because of confusion as to the specific recommendations they should follow. (*J Am Vet Med Assoc* 2008;233:249–256)

Investigators have reported that cattle owners across a number of states generally fail to implement commonly recommended biosecurity practices.^{1–4,a,b} In the USDA National Animal Health Monitoring System's study⁵ of biosecurity practices among dairy cattle producers, for instance, only a few dairy producers addressed potential contamination from people's feet by requiring the use of disposable boots or footbaths, only 13% reported controlling visitor access, only 44% had some controls in place for vehicle access, less than half had a vector control program, and less than 20% quarantined or tested new additions to the farm. Thus, there appears to be a gap between national biosecurity recommendations and on-farm practices. Producers may choose not to implement biosecurity recommendations

because of a lack of awareness about the potential risks to their farms and the industry as a whole or, among those who are aware of the potential risks, because of a lack of understanding of the value of implementing recommendations, a belief that the benefits did not outweigh the costs, or apathy or denial about the potential risks. It is also possible that some producers choose not to implement biosecurity recommendations because of confusion as to the specific recommendations they should follow. A number of quality assurance programs and lists of recommended biosecurity practices have been created by national organizations, cooperative extension programs, and state departments of agriculture, and it is possible that variations in recommendations and the resulting confusion this engenders have contributed to producers' failure to implement recommended biosecurity practices. Therefore, the purpose of the study reported here was to compare published recommendations regarding biosecurity practices for various production animal species and classes. Specifically, we wanted to identify and categorize the components of biosecurity programs described in current educational materials for poultry and the major livestock species, identify gaps that might increase vulnerability to foreign animal

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Supported by a grant from the Department of Homeland Security through the National Center for Foreign Animal and Zoonotic Disease Defense. Address correspondence to Dr. Moore.

(ie, transboundary) diseases, and provide suggestions on how to harmonize recommendations for biosecurity practices to potentially improve on-farm compliance.

Materials and Methods

A search of the literature and Internet was conducted to identify national quality assurance programs with biosecurity recommendations targeting dairy cattle, beef cattle, small ruminant, swine, and poultry producers. In addition, cooperative extension programs in animal and veterinary sciences as well as state and federal outreach materials on the World Wide Web were evaluated for biosecurity recommendations related to foreign animal diseases. Biosecurity recommendations specifically aimed at preventing the on-farm introduction of diseases and slowing the spread of endemic diseases were then compared within and among animal agricultural commodity groups. A standardized form was created to categorize and quantify recommendations, and themes in educational materials and biosecurity checklists that were identified were assigned to these predetermined categories. Only materials directed at animal agriculture producers were included.

Results

A single national organization was selected as representing each animal agriculture commodity group at the national level.⁶⁻¹⁰ A total of 53 university Web sites were visited, and 65 publications prepared by university cooperative extension services were identified and evaluated.¹¹⁻⁷³ In addition, Web sites for all 50 state departments of agriculture were searched for materials related to biosecurity. Twenty-nine states were found to have at least 1 publication related to biosecurity practices for animal agriculture producers, for a total of 46 publications (Table 1).⁷⁴⁻¹¹⁹

Evaluation of the biosecurity recommendations revealed wide variations among commodity groups (Table 2). For all commodity groups as a whole, the most common recommendations were vector control, equipment and tool disinfection, use of footbaths or disposable boots, and control of visitor access (approx 60% of the educational materials reviewed). About half of the educational materials specifically mentioned use of clean clothing, vehicle access control, and quarantining or isolating new additions or animals returning to the farm. Less than half of the educational materials discussed risk assessments of the farm's operational policies and infrastructure or animal identification. Overall, employee training, ani-

mal health record keeping, and restrictions on employee ownership of animals were rarely mentioned.

Examination of the educational materials revealed 4 additional recommendations that had not been included in our initial categorization of biosecurity recommendations: disposal of dead stock, maintenance of visitor logs, on-farm biosecurity signage, and shower-in recommendations. The most common of these included maintenance of a visitor log, with approximately 25% of governmental materials for all species and approximately 30% of all cooperative extension materials mentioning visitor logs, and recommendations for disposal of dead stock, with 20% of governmental materials and 30% of cooperative extension materials providing recommendations on disposal of dead stock.

Isolation or quarantine of new farm arrivals was a common recommendation, with 50% of governmental materials and 61% of cooperative extension materials including this recommendation. However, recommended times for isolation varied widely. For example, 16 sources recommended isolation times for dairy cattle, with recommended times ranging from 14 to 30 days (mode, 14 days; median, 21 days). For beef cattle, recommended isolation times ranged from 14 to 60 days.

Educational materials that provided general biosecurity recommendations for livestock tended to be more complete than materials that provided recommendations specifically for dairy or beef producers. In addition, biosecurity recommendations contained in cooperative extension materials for dairy producers differed from recommendations in materials for other commodity groups. There were no recommendations for employee or owner restrictions on owning livestock or home production and no recommendations for employee training, animal identification, or health record keeping mentioned in the 12 publications reviewed. However, these recommendations were mentioned in general animal or livestock publications provided by cooperative extension services (21 total publications).

Materials for avian species had the most extensive and consistent set of biosecurity recommendations, followed by materials focused on swine. Cooperative extension materials for poultry producers generally recommended restrictions on employees and owners raising the same species of animals at home. Two important aspects of biosecurity were mentioned only twice: formal evaluation or assessment of the farm and employee training. It is likely that these recommendations were implied in the materials but not captured as explicit recommendations. The number of cooperative extension materials specific

Table 1—Results of a search of cooperative extension service and state department of agriculture Web sites for educational materials providing biosecurity recommendations for animal agriculture producers.

Species focus	University cooperative extension services		State departments of agriculture	
	No. of institutions	No. of publications	No. of institutions	No. of publications
General livestock	15	22	16	17
Dairy cattle	9	12	4	4
Beef cattle	11	12	0	0
Poultry	12	13	20	25
Swine	3	3	0	0
Small ruminant	3	3	0	0

Table 2—Biosecurity recommendations found in educational materials on the World Wide Web and targeting dairy cattle, beef cattle, poultry, swine, and small ruminant producers.

Source of educational materials	Recommendation	Species focus					
		General livestock	Dairy cattle	Beef cattle	Poultry	Swine	Small ruminant
National organization*							
	Risk assessment	No	Yes	Yes	No	Yes	Yes
	On-farm evaluation	No	Yes	No	Yes	Yes	No
	Footbaths or disposable boots	Yes	Yes	No	Yes	No	No
	Hand sanitation	No	No	No	No	No	No
	Clean clothing	Yes	Yes	No	Yes	Yes	Yes
	Restriction on home production	No	No	No	Yes	Yes	Yes
	Employee training	Yes	No	Yes	Yes	Yes	No
	Control visitor access	Yes	Yes	Yes	Yes	Yes	Yes
	Perimeter fence or other control	Yes	Yes	Yes	Yes	Yes	No
	Locked gates and doors	Yes	No	Yes	Yes	Yes	No
	Vehicle disinfection	Yes	Yes	No	Yes	Yes	Yes
	Control vehicle access	Yes	Yes	Yes	Yes	Yes	Yes
	Vector control	Yes	Yes	Yes	Yes	Yes	Yes
	Equipment and tool disinfection	Yes	Yes	No	Yes	Yes	Yes
	Manure management or methods to prevent feed and water contamination	Yes	Yes	Yes	Yes	No	Yes
	Animal or lot identification numbers	Yes	Yes	No	Yes	No	No
	Maintain health records	Yes	Yes	Yes	Yes	No	No
	Quarantine new additions or returning stock	Yes	Yes	No	Yes	Yes	Yes
	Closed herd or all-in-all-out	No	Yes	No	Yes	Yes	Yes
	Limit new additions	Yes	Yes	Yes	Yes	Yes	Yes
	Test new additions	Yes	Yes	No	Yes	Yes	Yes
	Young stock management	No	Yes	No	Yes	No	No
	Encourage disease awareness	Yes	No	No	Yes	Yes	Yes
	Vaccinate	Yes	Yes	No	Yes	Yes	Yes
	Encourage disease reporting	Yes	No	Yes	Yes	No	Yes
Cooperative extension service†							
	Risk assessment	6 (27)	4 (33)	1 (8)	3 (23)	0 (0)	0 (0)
	On-farm evaluation	4 (18)	2 (17)	1 (8)	2 (15)	0 (0)	1 (33)
	Footbaths or disposable boots	15 (68)	7 (58)	6 (50)	10 (77)	2 (67)	1 (33)
	Hand sanitation	7 (32)	2 (17)	3 (25)	7 (54)	1 (33)	2 (67)
	Clean clothing	12 (55)	4 (33)	5 (42)	11 (85)	2 (67)	1 (33)
	Restriction on home production	4 (18)	0 (0)	1 (8)	9 (69)	1 (33)	0 (0)
	Employee training	6 (27)	0 (0)	2 (17)	2 (15)	0 (0)	1 (33)
	Control visitor access	13 (59)	6 (50)	7 (58)	9 (69)	2 (67)	3 (100)
	Perimeter fence or other control	9 (41)	3 (25)	5 (42)	6 (46)	2 (67)	1 (33)
	Locked gates and doors	8 (36)	2 (17)	1 (8)	6 (46)	2 (67)	0 (0)
	Vehicle disinfection	9 (41)	4 (33)	5 (42)	7 (54)	2 (67)	2 (67)
	Control vehicle access	13 (59)	6 (50)	6 (50)	6 (46)	2 (67)	3 (100)
	Vector control	9 (41)	6 (50)	10 (83)	12 (92)	2 (67)	3 (100)
	Equipment and tool disinfection	14 (64)	6 (50)	9 (75)	11 (85)	2 (67)	1 (33)
	Manure management or methods to prevent feed and water contamination	9 (41)	4 (33)	5 (42)	8 (62)	2 (67)	2 (67)
	Animal or lot identification numbers	2 (9)	0 (0)	2 (17)	0 (0)	0 (0)	1 (33)
	Maintain health records	5 (23)	0 (0)	2 (17)	2 (15)	0 (0)	2 (67)
	Quarantine new additions or returning stock	15 (68)	6 (50)	10 (83)	3 (23)	2 (67)	3 (100)
	Closed herd or all-in-all-out	6 (27)	1 (8)	4 (33)	8 (62)	1 (33)	1 (33)
	Limit new additions	12 (55)	6 (50)	7 (58)	6 (46)	2 (67)	3 (100)
	Test new additions	9 (41)	6 (50)	6 (50)	2 (15)	2 (67)	2 (67)
	Young stock management	5 (23)	2 (17)	3 (25)	6 (46)	1 (33)	0 (0)
	Encourage disease awareness	7 (32)	1 (8)	4 (33)	3 (23)	0 (0)	1 (33)
	Vaccinate	11 (50)	8 (67)	5 (42)	4 (31)	0 (0)	2 (67)
	Encourage disease reporting	5 (23)	1 (8)	4 (33)	1 (8)	1 (33)	1 (33)
State department of agriculture†							
	Risk assessment	2 (12)	2 (50)	NA	3 (12)	NA	NA
	On-farm evaluation	1 (6)	2 (50)	NA	1 (4)	NA	NA
	Footbaths or disposable boots	15 (88)	1 (25)	NA	18 (72)	NA	NA
	Hand sanitation	5 (29)	0 (0)	NA	0 (0)	NA	NA
	Clean clothing	14 (82)	1 (25)	NA	17 (68)	NA	NA
	Restriction on home production	3 (18)	1 (25)	NA	13 (52)	NA	NA
	Employee training	3 (18)	3 (75)	NA	4 (16)	NA	NA
	Control visitor access	14 (82)	4 (100)	NA	17 (68)	NA	NA
	Perimeter fence or other control	7 (41)	2 (50)	NA	7 (28)	NA	NA
	Locked gates and doors	3 (18)	3 (75)	NA	4 (16)	NA	NA
	Vehicle disinfection	9 (53)	0 (0)	NA	11 (44)	NA	NA
	Control vehicle access	11 (65)	4 (100)	NA	14 (56)	NA	NA
	Vector control	11 (65)	2 (50)	NA	17 (68)	NA	NA
	Equipment and tool disinfection	9 (53)	2 (50)	NA	17 (68)	NA	NA
	Manure management or methods to prevent feed and water contamination	7 (41)	3 (75)	NA	10 (40)	NA	NA
	Animal or lot identification numbers	3 (18)	1 (25)	NA	2 (8)	NA	NA
	Maintain health records	2 (12)	1 (25)	NA	1 (4)	NA	NA
	Quarantine new additions or returning stock	12 (71)	3 (75)	NA	11 (44)	NA	NA
	Closed herd or all-in-all-out	1 (6)	0 (0)	NA	9 (36)	NA	NA
	Limit new additions	9 (53)	1 (25)	NA	2 (8)	NA	NA
	Test new additions	4 (24)	1 (25)	NA	1 (4)	NA	NA
	Young stock management	1 (6)	1 (25)	NA	2 (8)	NA	NA
	Encourage disease awareness	4 (24)	1 (25)	NA	14 (56)	NA	NA
	Vaccinate	5 (29)	1 (25)	NA	2 (8)	NA	NA
	Encourage disease reporting	8 (47)	1 (25)	NA	13 (52)	NA	NA

*National organization refers to the national producer organization; data indicate whether each specific recommendation was or was not included in educational materials from the national producer organization. †Data are given as number (%) of publications that included each specific recommendation.

NA = Not applicable (no publications were identified).

For university cooperative extensive services, 22 publications addressed general livestock, 12 addressed dairy cattle, 12 addressed beef cattle, 13 addressed poultry, 3 addressed swine, and 3 addressed small ruminants. For state departments of agriculture, 17 publications addressed general livestock, 4 addressed dairy cattle, none addressed beef cattle, 25 addressed poultry, none addressed swine, and none addressed small ruminants.

to swine was limited. Many university sites highlighted or recommended national swine biosecurity programs. Many of the small ruminant biosecurity recommendations related specifically to scrapie control.

Many of the publications containing biosecurity recommendations that had been created by state departments of agriculture were embedded within educational materials for specific diseases, such as foot and mouth disease and avian influenza. These materials primarily focused on general livestock, poultry, and dairy producers, in that order. Publications available at state department of agriculture Web sites regarding biosecurity recommendations for general livestock and poultry producers included discussions of footbaths or disposable boots, clean clothing, control of visitor access, quarantine and isolation of new or returning animals, vehicle access control, equipment and tool disinfection, and vector control (including control of pets, wild animals, and insects). Twenty-two state sites had links to the USDA national biosecurity materials for poultry.¹²⁰ An additional item was a recommendation regarding the National Animal Identification System, which was developed to allow government regulatory officials to trace the movements of suspect animals within 48 hours after a foreign animal disease outbreak was identified.¹²¹ Forty-three state departments of agriculture made recommendations for such animal identification; 7 made no recommendation.

Discussion

Biosecurity recommendations in educational materials reviewed in the present study differed by source (ie, national organization, university cooperative extension service, or state department of agriculture) and within and between commodity groups. The present study focused on materials accessible through the World Wide Web and was not an exhaustive examination of all available educational materials. Nevertheless, our findings demonstrated substantive differences in recommendations within various production animal species and classes. The primary differences were in the extent of the recommendations provided (ie, how rigorous each recommendation was, such as hand sanitation vs shower-in–shower-out) and whether specific biosecurity practices were included in the recommendations.

Differences in recommended biosecurity practices for a given animal species or production class may encourage producers to select their favorite few recommendations and allow them to create an incomplete biosecurity program that does not substantially decrease the risk of introducing disease. Thus, we believe that harmonizing recommendations within each production class, especially when specific practices have been validated on the basis of empirical evidence, would be beneficial. As an example, quarantine times for new arrivals should be based on published findings and any wide ranges should be explained.

There is some question as to how extensive farm biosecurity programs need to be to prevent disease transmission. In the present study, we found that specific, detailed biosecurity recommendations had been published for the poultry and swine industries. The intense nature of these industries in combination with the nature of some

of the specific disease problems they have encountered necessitates an extensive list of recommendations to prevent disease exposure to large numbers of confined animals. More extensive production industries, such as sheep and beef cattle, had less explicit recommendations with fewer recommendations regarding biosecurity practices. Questions that need to be considered when creating biosecurity recommendations include what aspects of their farms producers can reasonably secure and what costs and benefits can be associated with securing a farm. Recommendations provided to producers should be predicated on the specific risks associated with the specific species being raised, the potential severity of the disease threats, and the location and operation of the farm or ranch. In addition, the degree to which precautions are taken will vary depending on the threat level, with more precautions taken during a disease outbreak.

None of the published recommendations reviewed for the present study weighted particular biosecurity recommendations as more important than others. The importance of specific disease prevention recommendations depends on the species, the disease, the routes of transmission, and the likelihood of exposure. Thus, regardless of whether one is concerned about endemic disease control or preventing transboundary disease introduction, establishing procedures for bringing new animals onto the farm is likely more important than rodent control, for example, and should be weighted accordingly. However, risk perception among farmers does not always equate with risk aversion behavior. In a study¹²² of swine producers, for instance, the fact that a biosecurity practice was perceived as important was not necessarily associated with its implementation and swine producers were more likely to implement biosecurity measures that affected disease transmission through people and wildlife, rather than measures to prevent disease transmission from replacement animals, which are more important in terms of preventing disease transmission. Thus, providing a weighting system for biosecurity recommendations may help motivate producers to implement the most important practices.

A single set of biosecurity recommendations will not be appropriate for all farm operations because even within a commodity group, risks vary by the type of management. For this reason, on-farm risk assessment is likely the best starting point for educating producers about farm-specific risks for disease introduction and potential biosecurity breaches.¹²³ However, few of the published materials examined in the present study provided information on biosecurity risk assessment tools. Examples of risk assessment tools that were identified include those developed by the US Poultry and Egg Association,⁶ the National Pork Board,¹²⁴ the Milk and Dairy Beef Quality Assurance Center,¹⁰ the sheep industry,⁷ and the Iowa State University Center for Food Safety and Public Health (beef and dairy).¹²⁵ In addition, disease-specific biosecurity risk assessment tools, such as for paratuberculosis, were identified.¹²⁶

Biosecurity programs cannot simply be announced and will be adopted only if they address the realities faced by those who must implement them. Beyond this, biosecurity programs will be adopted only if they address everyday enzootic threats, while still incorporat-

ing practices to protect from catastrophic transboundary epizootic threats. It likely will take all parties, including the cooperative extension services, infectious disease research community, state departments of agriculture, and producer groups, to develop acceptable biosecurity programs incorporating weighted biosecurity recommendations. We speculate that all organizations that provide biosecurity educational materials hope to inspire or motivate producers to assess their risk for disease introduction and eventually change some management practices to better secure their operations. To do so, they must engage producers during the development of biosecurity recommendations to promote buy-in and to identify practical solutions for problems associated with implementation of specific recommended practices.

One factor that could motivate producers to adopt biosecurity practices for their operations is the potential to maintain business continuity during a disease outbreak. As an example, producers might be more likely to adopt biosecurity practices if they knew that feed, products, and animals would be allowed to move within or around quarantined areas if producers could demonstrate through regular assessment and third-party verification that they had met a set of standards for biosecurity within their industry. Such a provision to allow for the movement of products and animals on and off the farm in the event of a foreign animal disease outbreak could allow for less business disruption and a more rapid return to normal business operations.¹²⁷

It is easy for mixed messages to reach producers because of disconnects in terminology use and interpretation.¹²⁸ This is especially true when messages are developed by different sources. When this happens, producers can become confused and may not make a decision about a change in management with regard to biosecurity. Thus, groups developing biosecurity recommendations should consider the communication model they are using if they expect producers to change their behavior. One such model¹²⁹ describes all the stages (ie, attention, comprehension, attitudes and beliefs, and motivation) an individual goes through before a behavior change is possible and helps to explain why some individuals do not always heed warnings about various hazards. At each point in the process, information can flow to the next stage or reach a bottleneck.¹³⁰ The process begins with the source of the information and the channel by which the information is delivered (eg, through a Web site or on-farm risk assessment). For the information to effect a change in behavior, however, it must attract the attention of the receiver (ie, producers), who must comprehend the message and create meaning, accept the message as corresponding with their beliefs and attitudes, and be motivated to accept the information before they will ever make a change in their behavior (ie, adopt new management practices). Gaining the attention of the receiver is a critical element in changing behavior. The individual must see the issue as a problem or opportunity worthy of someone's effort; personalize it by understanding that it is worthy of his or her own effort; and determine that solutions exist that are attainable given the individual's time, location, learning style, and cost preferences. Without satisfying these components, the receiver is not likely to engage

in active learning, and without engagement in active learning, behavioral changes cannot occur.

In conclusion, in the present study, the number and extent of specific biosecurity recommendations in educational materials varied both within and across animal agriculture commodity groups. We recommend that national producer organizations, state departments of agriculture, and cooperative extension services, working with producer input, review their biosecurity recommendations to develop standard lists of evidence-based recommendations. The lack of adoption of biosecurity practices by producers is a complex issue, but the lack of a consistent message likely plays an important role. The next logical step in motivating producers to adopt biosecurity measures is through on-farm assessments of risks.

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