Awareness, perceived relevance, and acceptance of large animal hospital surveillance and infection control practices by referring veterinarians and clients

Abel B. Ekiri, BVM, PhD; Amanda M. House, DVM; Traci M. Krueger, DVM, MPH; Jorge A. Hernandez, DVM, PhD

EQUINE

Objective—To assess awareness, perceived relevance, and acceptance of surveillance and infection control practices at a large animal referral hospital among referring veterinarians and clients who sent horses to the facility for veterinary care.

Design—Survey.

Sample—57 referring veterinarians and 594 clients.

Procedures—A 15-question survey targeting *Salmonella enterica* as an important pathogen of interest in horses was sent to clients who sent ≥ 1 horse to the University of Florida Large Animal Hospital for veterinary care during July 1, 2007, through July 1, 2011, and to veterinarians who had referred horses to the same hospital prior to July 1, 2011. Responses were summarized with descriptive statistics. The χ^2 test and the Wilcoxon rank sum test were used to examine associations among variables of interest.

Results—Survey response rates were low (57/467 [12%] for veterinarians and 594/3,095 [19%] for clients). Significantly more (35/56 [63%]) veterinarians than clients (227/585 [39%]) were aware that the hospital operates a surveillance and infection control program. Most veterinarians (56/57 [98%]) and clients (554/574 [97%]) indicated that sampling and testing of horses to detect *Salmonella* shedding in feces at admission and during hospitalization was justified. In addition, on a scale of 1 (not important) to 10 (very important), veterinarians and clients indicated it was very important (median score, 10 [interquartile range, 8 to 10] for both groups) that a referral hospital operates a surveillance and infection control program.

Conclusions and Clinical Relevance—Survey results indicated that awareness of hospital surveillance and infection control practices was higher among veterinarians than clients, and these practices were considered relevant and well-accepted among participant veterinarians and clients. (*J Am Vet Med Assoc* 2014;244:835–843)

In the past 20 years, several large animal veterinary referral hospitals have established surveillance and infection control programs.[1–6] The goals of such programs are to support high standards of veterinary care, reduce the risk of outbreaks of hospital-acquired infections (eg, salmonellosis) in patients, and minimize the risk of zoonotic infections in hospital personnel. Guidelines for developing, implementing, and evaluating surveillance and infection control programs that are tailored to the needs and limitations of veterinary hospitals have been published.[1,7–11] During an outbreak of nosocomial *Salmonella* infections in a large animal hospital in 2006,[12] active surveillance for *Salmonella enterica* allowed early detection of the outbreak strain and may have minimized the consequences of that outbreak. Disease transmission was limited to 8 animals, and 7 of those animals shed *Salmonella* in the absence of clinical signs or before the onset of disease.

From the Department of Large Animal Clinical Sciences, College of Veterinary Medicine (Ekiri, House, Hernandez), and the Department of Epidemiology, College of Public Health and Health Professions (Krueger), University of Florida, Gainesville, FL 32610.

The authors thank Loretta Rodriguez and Stephanie Kirchman for technical assistance.

Address correspondence to Dr. Hernandez (hernandezja@ufl.edu).

Abbreviation

IQR Interquartile range

Veterinary hospitals are required to deliver accessible, high-quality veterinary care services at reasonable costs to clients. During 2007 through 2009, a weak economy and decreasing caseload and frequency of horses shedding *Salmonella* at admission or during hospitalization as well as a low number of nosocomial *Salmonella* infections (ie, ≤ 1 case every month and ≤ 3 every year) created a need to assess the frequency of sample collection and testing, a key surveillance element, at the University of Florida Large Animal Hospital. From 2002 to 2008, fecal samples from equine inpatients at the study hospital were collected and tested at the time of admission and 3 times weekly. Beginning in 2009, the frequency of collection and testing was reduced to admission and once weekly. At the same time, environmental sample collection and testing was reduced from monthly to every other month (or more often if required). Hospital administrators and infection control personnel discussed further reductions in sample collection and testing to save hospitalization costs, such as limiting testing for early detection of *Salmonella*

shedding to patients with diarrhea detected at admission or during hospitalization. This recommendation was not implemented because surveillance data indicated that between 2007 and 2010 at the study hospital, 52 of 67 adult equine inpatients with colic that tested positive for *Salmonella* did not have diarrhea at admission or during hospitalization. A subpopulation such as this creates an infection control hazard because failure to detect *Salmonella* shedding can delay implementation of infection control measures required to mitigate disease transmission during hospitalization.

Although veterinary hospital administrators, clinicians, and staff recognize that disease surveillance and infection control practices are important components in the delivery of high-quality veterinary care services, to our knowledge, the degree of awareness and perceived relevance of hospital infection control practices by stakeholders (ie, clients and referring veterinarians) have not been evaluated. Feedback from these stakeholders can be an important source of information to help hospital administrators to make informed decisions for optimal management of hospital operations. The objective of the study reported here was to investigate the degree of awareness, perceived relevance, and acceptance of hospital infection control practices among referring veterinarians and clients who sent horses to a veterinary referral hospital for treatment.

Materials and Methods

The study protocol was approved by the Institutional Review Board at the University of Florida.

Surveillance and infection control procedures— From July 1, 2007, through July 1, 2011, all equine patients with signs of gastrointestinal disease (colic or diarrhea) admitted to the University of Florida Large Animal Hospital were targeted for early detection of fecal shedding of *S enterica* at the time of admission and during hospitalization; details of the surveillance and infection control procedures have been described elsewhere.[5,7] Briefly, a fecal sample was collected from each horse ≤ 12 hours after admission and was submitted for bacterial culture; if the sample was not readily available, a specimen was collected per rectum with a swab. Thereafter, additional fecal samples were collected from the stall floor each morning prior to cleaning at 48-hour intervals (ie, Monday, Wednesday, and Friday) until the patient was discharged from the hospital.

Fecal samples collected outside of regular business hours were refrigerated at 4°C until laboratory submission. For some horses, additional fecal samples were collected at the discretion of the attending clinician (eg, every 12 to 24 hours). Any equine patient that tested positive for *S enterica* or developed diarrhea or fever and leukopenia was placed in an isolation barn. Isolation procedures included use of barrier nursing care precautions (eg, gloves, plastic boots, gowns, and footbaths) for personnel attending to patients.

In addition to sample collection from hospitalized horses, routine environmental sampling was performed monthly to evaluate cleaning and disinfection procedures or more frequently when the observed daily or weekly number of horses shedding *Salmonella* was higher than expected. During each routine environmental sampling event, 25 hospital sites were targeted for sample collection, and bacteriologic culture was performed for recovery of *S enterica*. A hospital infection control officer was responsible for overseeing collection of fecal samples, microbiological procedures, and collection and analysis of epidemiological data. Typically, horses with signs of gastrointestinal disease were hospitalized for a mean of 5 days, and 2 fecal samples were collected and submitted for *Salmonella* testing during hospitalization. The cost of testing to the client was $28/sample or $56 for both samples at the time of the study (values are in US dollars). The cost of laboratory testing included bacteriologic culture, serogroup analysis, and antimicrobial susceptibility testing. From July 1, 2009, through July 1, 2011, the frequency of sample collection for equine inpatients was reduced so that these were obtained only at admission and once weekly on Monday or Thursday until the patient was discharged from the hospital, and routine environmental sampling was performed every other month or more frequently during periods when the observed daily or weekly number horses of shedding *Salmonella* was higher than expected.

The proportions of equine inpatients (with colic or diarrhea) that had a diagnosis of community-acquired or hospital-acquired *Salmonella* infection, respectively, were 43 and 1 of 762 in 2007, 40 and 2 of 610 in 2008, 33 and 3 of 231 in 2009, 18 and 1 of 188 in 2010, and 22 and 0 of 158 in 2011. Horses that tested positive for *Salmonella* spp in fecal samples collected at the time of admission and horses with clinical signs of salmonellosis (ie, diarrhea, fever, or leukopenia) at the time of admission with positive test results for *Salmonella* spp in fecal samples collected during hospitalization (ie, on the second or subsequent samples) that had no evidence of hospital-acquired infection were considered to have community-acquired *Salmonella* infections.[5] To rule out the possibility of hospital-acquired infection, surveillance data (*Salmonella* serotype, antibiogram profiles, stall location, and admission and discharge dates) as well as culture results for monthly environmental samples were reviewed. Horses that had negative results for culture of *Salmonella* spp in samples obtained at the time of admission and positive results ≥ 48 hours after admission were initially considered to have hospital-acquired *Salmonella* infections. One potential source of hospital-acquired infection would be a horse or a food animal with community-acquired *Salmonella* infection; isolates obtained from the source would have the same serotype and antimicrobial resistance profile as those collected from the horse with hospital-acquired infection. In addition, there would be an overlap between admission and discharge dates of animals with community-acquired and hospital-acquired infection. Another potential source of hospital-acquired infection would be evidence of environmental contamination (ie, when a horse that tested negative for *Salmonella* via culture at admission and positive later during hospitalization had the same serotype and antimicrobial resistance profile for an environmental sample during the hospitalization interval). In instances where environmental contamination was identified as the source of infection,

the horse with hospital-acquired infection had not been exposed to a horse with community-acquired infection (ie, there was no overlap of admission and discharge dates between horses with community-acquired and hospital-acquired infections).

Communications with referring veterinarians and clients regarding hospital surveillance and infection control activities—Communication methods (before, during, and after the study) included distribution of an infection control brochure to clients to educate them about early detection of disease and infection control measures instituted at the hospital to optimize patient care. Any time a patient tested positive for *Salmonella*, the attending clinician updated the owner and referring veterinarian about the patient's *Salmonella* shedding status and infection control measures implemented in the hospital for that patient. At the time of discharge, clients with *Salmonella*-positive horses were given a *Salmonella* fact sheet by the attending clinician. The purpose of the fact sheet was to educate clients about the potential risks of a *Salmonella*-positive horse on a farm and measures that should be implemented at the farm level to reduce the risk of exposure to humans and other animals. In addition to information on potential risks and precautionary measures at the farm or home, clients were advised to submit 5 consecutive fecal samples for bacteriologic culture, if possible, to assess whether the patient continued to shed *Salmonella*.

Study sample—All clients who sent ≥ 1 equine patient to the study hospital for veterinary care during July 1, 2007, through July 1, 2011, and whose contact information (complete mailing address or email address) was available were eligible for enrollment in the study. If a client sent equine patients to the hospital on ≥ 2 occasions during the study period, only information from the first visit was used, so that only 1 survey was sent to that individual. All veterinarians who referred ≥ 1 equine patient to the study hospital prior to July 1, 2011, and for whom a complete mailing address or email address was available were also eligible for study enrollment.

Survey design—Separate 2-page questionnaires[a] regarding infection control practices at the study hospital were designed for referring veterinarians and clients. The veterinarian questionnaire consisted of 15 questions organized into 3 sections: general information, awareness, and relevance. The general information section included questions on practice location (county), number of years in practice, practice type, species treated, number of horses referred to the study hospital in the 2 years prior to the survey, and knowledge that the hospital had a surveillance and infection control program. The awareness section included questions regarding specific infection control committee activities and infection control measures used at the hospital. The relevance section addressed whether it was important that the respondent be notified when the referred patient tested positive for *Salmonella*, whether the respondent found the level of testing used at the hospital to be justified, and whether the cost was perceived as expensive as well as importance (on a scale of 1 [not important] to 10 [very important]) that a referral hospital operate a surveillance and infection control program. Respondents were also asked to indicate whether, if the hospital had an outbreak of salmonellosis and was forced to close temporarily for cleaning and disinfection, they would consider referring horses to the hospital again after its reopening. Most questions (all except county) provided response categories that required a check mark; some allowed the respondent to select an option of other, with an open-ended field to provide additional information.

The veterinarian questionnaire was pretested during a University of Florida Veterinary Hospitals Referring Veterinarian Appreciation Day attended by 100 veterinarians on June 25, 2011. Questionnaires were handed out, and completed questionnaires were collected on the same day. Thirty-five of 100 veterinarians completed the draft survey, and questions in the survey instruments were revised to improve clarity on the basis of the responses received. Results for the draft version of the survey were excluded from analysis for the present study.

The client questionnaire consisted of 14 questions grouped into the same 3 sections described for the veterinarian survey. The general information section for this survey included questions on location of the horse farm or premises (county), number of horses on the premises and their main use, number of horses brought to the study hospital in the 2 years prior to the survey, and knowledge that the hospital had a surveillance and infection control program (yes or no). Questions on awareness and relevance were identical between the surveys, except that some layman's terms were used in the version for clients. The client questionnaire was not pretested owing to time limitations.

Electronic survey procedure—Referring veterinarian and client questionnaires were prepared in an electronic format and sent via email to veterinarians and clients who had email contact information, in consideration that email may be a preferred method of response for those individuals and that this could potentially enhance the response rate. The electronic survey was sent on September 9, 2011; the response period was closed 2 months later. The survey included an introductory letter and a Web link to the survey. The letter explained the purpose of the study and assured the respondents that identifying information and responses would remain confidential. A reminder email communication was sent to these recipients 10 days later to encourage the respondents to complete the survey. After the second email communication, data from all respondents were entered into an electronic spreadsheet[b] for analysis. Personal identifying information (name) was requested in the electronic surveys and was delinked by assigning codes to each respondent before data entry.

Hard copy survey procedure—On November 21, 2011, questionnaires prepared in a hard-copy format were sent via postal mail to veterinarians and clients who did not have email contact information. A cover letter and a postage-paid return envelope were provided with the survey. The cover letter described the purpose of the study and assured the respondents that identifying information and responses would remain confidential. To avoid duplication of

respondents and maintain anonymity, numeric codes printed on each mail survey were used as identification during data analysis. Two months were allowed for responses to be returned by postal mail, and then data were entered into the spreadsheet. Reminder communication was not sent to these individuals because other marketing surveys from the study hospital were ongoing at the same time.

Data analysis—Descriptive statistics were determined for each variable of interest. Frequency distributions were calculated for categorical variables. In addition, bootstrapping was used to derive proportion estimates and 95% confidence intervals for each categorical variable (eg, number of participants that responded yes when asked if they knew the study hospital operates a surveillance and infection control program divided by the total number of survey participants). Unrestricted random sampling was used to select samples for bootstrapping with 5,000 replicates.[c] Medians and first and third quartiles (25th and 75th percentiles) were calculated for continuous variables (eg, number of years in veterinary practice or number of horses on the premises). A χ^2 test[d] was used to compare frequencies among the following groups: referring veterinarians and clients who reported being aware that the study hospital operates a surveillance and infection control program, veterinarians and clients who considered the cost of sampling and testing of horses for *Salmonella* infection to be expensive, and clients who considered cost of testing expensive versus those who indicated specific primary uses for horses on the premises (eg, pleasure or racing). Clients who reported that horses were used for ≥ 2 purposes were excluded from that part of the analysis. Response rates for various counties in Florida were also compared via the χ^2 test. A Mann-Whitney test was used to compare the median number of horses between clients who considered the cost of testing for *Salmonella* to be expensive and those who did not and the median number of years in practice between veterinarians who considered the cost of testing for *Salmonella* to be expensive and those who did not. For all comparisons, values of $P \leq 0.05$ were considered significant.

Results

A list of 469 veterinarians who had referred equine patients to the study hospital prior to July 1, 2011, was available through hospital records. Two of these individuals were excluded because of missing or incomplete contact information. Of the remaining 467 veterinarians, 242 had email addresses and were sent electronic surveys; 225 had only mailing addresses and were mailed hard-copy surveys. The overall response rate for referring veterinarians was 57 of 467 (12%). Eighteen of 242 (7%) electronic surveys were completed and submitted by these individuals; 7 were completed after the first email request, and 11 were completed after the reminder email was sent. The proportion of veterinarians who responded via email (7%) was significantly ($P = 0.001$) lower than that of those who responded via postal mail (39/225 [17%]).

During the study period, 4,599 clients sent ≥ 1 equine patient to the hospital for treatment, and 1,504 were excluded from the study because of missing or incomplete contact information. Electronic surveys were sent to 483 clients who had email and mailing addresses, and hard-copy surveys were sent to 2,612 clients who had only mailing addresses. The overall response rate for clients was 594 of 3,095 (19%). Ninety-five of 483 (20%) electronic surveys were completed and submitted; 65 were completed after the first email request and 30 were completed after the reminder was sent. The proportion of clients who responded via email (20%) was similar ($P = 0.77$) to that of those who responded via postal mail (499/2,612 [19%]).

For electronic surveys, the referring veterinarian response rate appeared higher in the contiguous counties of Alachua and Marion (6/69 [9%]), compared with that in other counties (9/170 [5%]; **Table 1**), but this

Table 1—Response rates by county for referring veterinarians and clients who were sent a survey designed to assess the degree of awareness, perceived relevance, and acceptance of surveillance and infection control practices at the University of Florida Large Animal Hospital.

	Electronic survey			Hard-copy survey		
County and group	**Respondents**	**Nonrespondents**	**Total**	**Respondents**	**Nonrespondents**	**Total**
Marion						
Veterinarians	4	50	54	8	26	34
Clients	7	43	50	62	205	267
Alachua						
Veterinarians	2	13	15	1	5	6
Clients	10	40	50	31	175	206
Other counties in Florida						
Veterinarians	7	122	129	21	97	118
Clients	65	231	296	360	1,370	1,730
Counties outside Florida						
Veterinarians	2	39	41	9	58	67
Clients	7	74	81	45	363	408
Unknown Counties						
Veterinarians	3	0	3	0	0	0
Clients	6	0	6	1	0	1
Total						
Veterinarians	**18**	**224**	**242**	**39**	**186**	**225**
Clients	**95**	**388**	**483**	**499**	**2,113**	**2,612**

Surveys were sent via email or postal mail to veterinarians who referred equine patients to the hospital prior to July 1, 2011, and clients who sent ≥ 1 equine patient to the hospital for veterinary care during July 1, 2007, through July 1, 2011. Two months were allowed for electronic and hard-copy surveys to be returned. For veterinarians, counties are those in which practices were based; for clients, these reflect location of the horse farm or premises. County names for 3 veterinarians and 7 clients were not reported (unknown counties).

difference was not significant (P = 0.371). The client response rate in Alachua and Marion counties (17/100 [17%]) versus other counties (72/377 [19%]) also did not differ significantly (P = 0.772) for this survey. These analyses excluded 9 respondents (3 veterinarians and 6 clients) who did not provide county information.

For postal mail surveys, the referring veterinarian response rate was not significantly (P = 0.34) different in the contiguous counties of Alachua and Marion (9/40 [23%]), compared with other counties (30/185 [16%]; Table 1). The client response rate for postal mail surveys in Alachua and Marion counties (93/473 [20%]) was not significantly (P = 0.746) different from that in other counties (405/2,138 [19%]). One client who did not provide county name was excluded from this analysis.

General information for referring veterinarians—Of the 57 veterinarians who responded to the survey, most (12 [21%]) had their practice based in Marion County, Fla, with 6 (11%) indicating locations in Lake County, 3 (5%) each in Alachua, Broward, and Palm Beach counties, and 2 (4%) each in Hillsborough and Miami-Dade counties. Twelve (21%) respondents indicated practices based in 12 other Florida counties, and the remainder were in counties outside Florida (11 [19%]) or did not answer the question (3 [5%]). The University of Florida Large Animal Hospital is located in Alachua County (**Figure 1**)[13]; of the counties that had 2 or more referring veterinarians respond to the survey, Marion County is located closest to Alachua County, followed by Lake County and Hillsborough County.

When asked what type of clinical practice they worked in, most referring veterinarians selected mobile services only (29/57 [51%]) from the response options listed, followed by clinic and mobile (23 [40%]), clinic services only (4 [7%]), and teaching or referral hospital (1 [2%]). When asked about animal species seen in their practice, most respondents indicated equine (exclusive; 39 [68%]), followed by large animal–all species (equines, bovines, camelids; 9

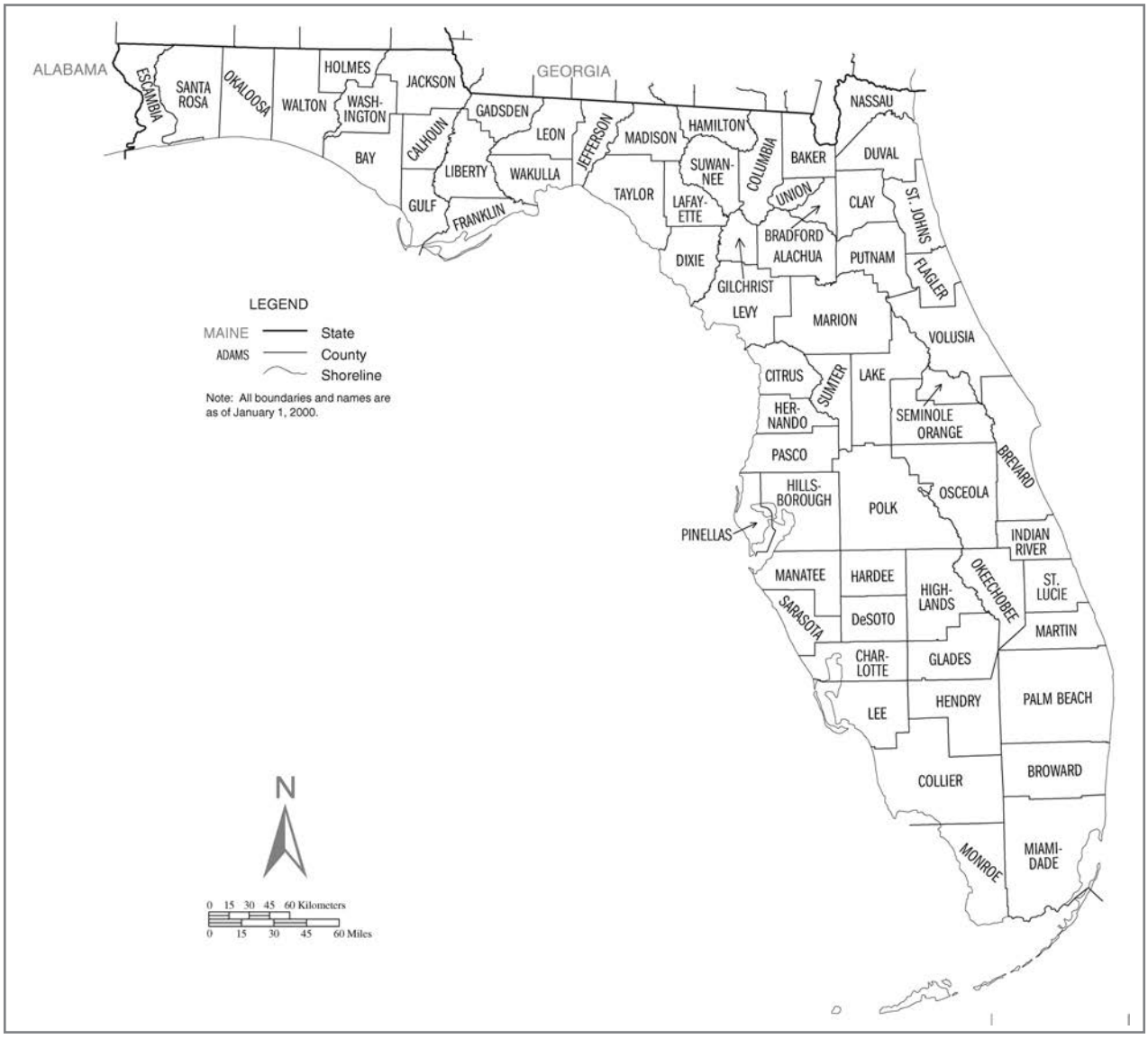

Figure 1—Map depicting the 67 counties in Florida (adapted from the United States Census Bureau website[13]). The University of Florida Large Animal Hospital is located in Alachua County.

[16%]), and mixed–large and small animals (8 [14%]); 1 respondent indicated other (exotics, birds, and reptiles; [2%]). The median number of years that respondents had practiced veterinary medicine was 25 (IQR, 16 to 31 years). The median number of horses that respondents had referred to the study hospital for veterinary care in the 2 years prior to the survey was 4 (IQR, 2 to 9).

General information for clients—Of the 594 clients who responded to the survey, most (69 [12%]) indicated their horse farm or premises was located in Marion County, Fla; others indicated Alachua (41 [7%]), Volusia (31 [5%]), Duval (26 [4%]), Lake (26 [4%]), Clay (23 [4%]), Brevard (23 [4%]), and St. Johns (23 [4%]) counties. Two hundred seventy three (46%) clients reported locations in 59 other Florida counties (ie, counties with < 23 respondents each). Fifty-two (9%) clients indicated locations outside of Florida, and 7 (1%) did not answer the question.

The main use of horses on client premises was for pleasure (71/594 [12%]). Other uses included show (dressage, reining, or eventing; 47 [8%]), jumping or hunting (45 [8%]), riding (trail, hiking, therapeutic, or draft; 32 [5%]), racing (flat, barrel, or endurance; 28 [5%]), kept as a pet (20 [3%]), breeding (17 [3%]), and roping or cutting (8 [1%]). Other uses indicated were cow work (3), rescue (2), carriage (2), circus or exhibition (1), or police work (1; < 1% each). One respondent (< 1%) indicated the horse had been retired; 306 (52%) reported ≥ 2 uses, and 10 (2%) did not answer the question. The median number of horses on the premises was 5 (IQR, 2 to 10), and the median number of horses brought to the study hospital for veterinary care in the 2 years prior to the survey was 1 (IQR, 1 to 1).

Awareness—Significantly ($P < 0.001$) more veterinarians (35/56 [63%]) were aware that the hospital operates a surveillance and infection control program, compared with clients (227/585 [39%]; **Table 2**). Among

Table 2—Responses from referring veterinarians and clients to survey questions regarding awareness of surveillance and infection control practices at the University of Florida Large Animal Hospital.

	Veterinarians		Clients	
Survey question and response category	**Proportion (%) of respondents***	**Proportion estimate (95% CI)†**	**Proportion (%) of respondents***	**Proportion estimate (95% CI)†**
Did you know the UF Large Animal Hospital operates a surveillance and infection control program to reduce the risk of hospital-acquired infections caused by pathogens such as *Salmonella*?				
No	21/56 (38)	—	358/585 (61)	—
Yes	35/56 (63)	0.62 (0.50–0.75)	227/585 (39)	0.38 (0.34–0.48)
Were you aware that the UF Large Animal Hospital has an infection control committee that meets quarterly (or more often) to assess the overall hospital infection control status?‡				
No	23/33 (70)	—	162/214 (76)	—
Yes	10/33 (30)	0.30 (0.15–0.45)	52/214 (24)	0.24 (0.18–0.30)
Were you aware that the UF Large Animal Hospital has an infection control officer who coordinates day-to-day surveillance and infection control activities under the supervision of a hospital epidemiologist?‡				
No	22/33 (67)	—	151/214 (71)	—
Yes	11/33 (33)	0.33 (0.18–0.48)	63/214 (29)	0.29 (0.23–0.35)
Did you know that horses presenting with signs of gastrointestinal tract disease are sampled and tested for diagnosis of *Salmonella* shedding at admission and during hospitalization?‡				
No	2/34 (6)	—	87/215 (40)	—
Yes	32/34 (94)	0.94 (0.85–1.00)	128/215 (60)	0.59 (0.53–0.66)
Did you know that horses with diarrhea, fever, and leukopenia or that test positive to *Salmonella* shedding at admission or during hospitalization are placed in isolation?‡				
No	0 (0)	—	61/215 (28)	—
Yes	34/34 (100)	—	154/215 (72)	0.71 (0.65–0.78)
Did you know that every time there is evidence that a horse has potentially acquired a nosocomial *Salmonella* infection during hospitalization, enhanced infection control measures are implemented immediately (eg, footmats with disinfectant, use of gloves and gowns are mandatory on every large animal inpatient)?‡				
No	4/34 (12)	—	57/215 (27)	—
Yes	30/34 (88)	0.88 (0.76–0.97)	158/215 (73)	0.73 (0.67–0.79)

Values are reported for electronic and hard-copy surveys combined; percentages were determined on the basis of the number of individuals who answered the question. Wording of the veterinarian and client survey questions was identical except that in the client survey, "low white blood cell count" was substituted for the term "leukopenia" and "hospital-acquired" was substituted for "nosocomial" in the last 2 questions.

*Proportions for positive (yes) and negative (no) responses were based on the number who answered the question. †Proportion estimates and 95% confidence intervals for a positive response (yes) were determined via bootstrapping. ‡Responses to these questions were only obtained from referring veterinarians (n = 35) or clients (227) who indicated that they were aware of the infection control program.

— = Not applicable. UF = University of Florida.

clients living in Florida (n = 535), program awareness (yes or no) was not different ($P = 0.179$) among counties < 100 miles from Gainesville, Fla, where the hospital is located (155/364 [43%]), 100 to 200 miles (48/140 [34%]), and > 200 miles (7/22 [32%]). Nine clients from Florida did not answer the question on program awareness and were excluded from the analysis.

Perceived relevance—Almost all referring veterinarians (54/56 [96%]) and clients (570/586 [97%]) indicated that it was important to be informed by the attending clinician when a patient (referred or owned by the respondent) tested positive for *Salmonella* shedding at admission or during hospitalization (**Table 3**). Most veterinarians (56/57 [98%]) and clients (554/574 [97%]) also indicated that they found testing of horses with colic or diarrhea for early detection of *Salmonella* shedding in feces at admission and once during hospitalization to be justified. However, significantly ($P = 0.004$) more clients (144/572 [25%]) considered the cost of testing (approx $56) to be expensive than did veterinarians (5/57 [9%]). The median number of horses owned by clients was similar ($P = 0.235$) among clients who considered the cost of testing to be expensive (5; IQR, 3 to 12), compared with those who did not (4; IQR, 2 to 10). We examined the association between the perception of cost as expensive (yes vs no) and the reported main use of horses by clients, but there were no significant ($P = 0.341$) differences among use categories with ≥ 17 respondents (pleasure [14/71], show [14/47], jumper-hunter [11/45], riding [9/32], racing [10/28], pet [2/20], or breeding [6/17]). The median time in practice was significantly ($P = 0.05$) lower for veterinarians who found the cost of testing expensive (median, 11 years; IQR, 6 to 17 years), compared with veterinarians who did not (median, 26 years; IQR, 17 to 33 years).

On a scale of 1 (not important) to 10 (very important), referring veterinarians and clients indicated that it was very important (median, 10 [IQR, 8 to 10] for both groups) that a referral hospital operates a surveillance and infection control program. Additionally, most veterinarians (51/57 [89%]) and clients who answered the question (480/583 [82%]) reported

Table 3—Responses from referring veterinarians and clients for survey questions regarding perceived relevance of surveillance and infection control practices at the University of Florida Large Animal Hospital.

	Veterinarians		Clients	
Survey question and response category	**Result***	**Proportion estimate (95% CI) †**	**Result***	**Proportion estimate (95% CI)†**
Is it important for you to be informed by the UF Hospital attending clinician when a horse (that you referred) tests positive for *Salmonella* shedding at admission or during hospitalization?				
No	2/56 (4)	—	16/586 (3)	—
Yes	54/56 (96)	0.96 (0.91–1.00)	570/586 (97)	0.97 (0.95–0.98)
On average, horses presenting with signs of gastrointestinal tract disease at the UF hospital are hospitalized for 5 days. This group of horses is sampled and tested for diagnosis of *Salmonella* shedding at admission and an additional time during hospitalization for a total of two fecal samples. The cost of testing to the client is $28 per sample or $56 for both samples. Do you find this level of testing justified?				
No	1/57 (2)	—	20/574 (3)	—
Yes	56/57 (98)	0.98 (0.94–1.00)	554/574 (97)	0.96 (0.94–0.97)
Do you find this cost expensive?				
No	52/57 (91)	—	428/572 (75)	—
Yes	5/57 (9)	0.08 (0.02–0.17)	144/572 (25)	0.25 (0.21–0.28)
Some clients have expressed that they would not consider sending their horses to a referral hospital that does not operate a surveillance and infection control program because of the perceived risk of disease transmission. Do you feel the same way? On a scale of 1 (not important) to 10 (very important), how important is it for you that a referral hospital operates a surveillance and infection control program?	10 (8–10)	—	10 (8–10)	—
In the past, several veterinary hospitals have been forced to close temporarily for 1 to 3 months for cleaning and disinfection because of *Salmonella* outbreaks in horses or food animals. While we don't anticipate such an event to occur in our hospital, if the UF Large Animal Hospital were to experience an outbreak of salmonellosis and was forced to close temporarily for cleaning and disinfection of hospital facilities, would you consider referring horses to the hospital again after re-opening?				
No	3/57 (5)	—	18/583 (3)	—
Yes	51/57 (89)	—	480/583 (82)	—
I am not sure	3/57 (5)	—	85/583 (15)	—

Wording of the veterinarian and client survey questions was identical except that in the client survey, the phrase "your patient" was substituted for the phrase "that you referred" in the first question.

*Data are reported as Proportion (%) of individuals who answered the question or median (IQR). †Proportion estimates and 95% confidence intervals for a positive response were determined via bootstrapping.

See Table 2 for remainder of key.

that if the hospital were forced to close temporarily for cleaning and disinfection of hospital facilities because of an outbreak of salmonellosis, they would consider referring horses to the hospital again after its reopening.

Discussion

In the present study, we used a survey instrument to assess the degree of awareness and perceived relevance of hospital surveillance and infection control practices to referring veterinarians and clients who sent horses to a large animal referral hospital for veterinary care. The overall survey response rate was low for both veterinarians (57/467 [12%]) and clients (594/3,095 [19%]). Our results indicated that among veterinarians and clients who participated in the survey, hospital surveillance and infection control practices were considered relevant and well accepted.

This study had several limitations that could have biased the results. As indicated, the survey response rate was low, which can result in nonresponse bias; thus, the reported results apply to the study sample and cannot be extrapolated to a larger population. It is possible that a higher response rate could have produced different results and altered the study conclusions. Additionally, although 242 of 467 referring veterinarians were contacted twice through email and the remaining 225 were contacted only once through postal mail, the response rate for veterinarians who were sent the survey via email (18/242 [7%]) was significantly lower than that for veterinarians who were sent the hardcopy version via postal mail (39/225 [17%]). We do not have an explanation for the observed lower response rate via email, and we do not know to what extent this difference may have affected the study results.

Unlike the referring veterinarian questionnaire, the client questionnaire was not pretested before use owing to time limitations. Although questions in the general information section were specific for veterinarians or clients, questions used to evaluate awareness and perceived relevance of the hospital's surveillance and infection control program were similar in the referring veterinarian and client surveys. Pretesting of the referring veterinarian questionnaire allowed revision of survey questions to improve clarity. The influence that lack of pretesting of client questionnaires may have had on study results is not known.

It is not known how the survey results would compare with results for other veterinary hospitals in the United States. A study that includes multiple hospitals from different states in the United States would be useful to better assess and compare the perceived relevance and acceptance of hospital surveillance and infection control programs by veterinarians and clients.

In the present study, we compared the frequencies of respondents and nonrespondents in the contiguous Florida counties of Alachua (location of the study hospital) and Marion versus other counties and found no relevant differences among referring veterinarians or clients. Although we had expected higher response rates in the contiguous counties of Alachua and Marion than in other locations, there was no evidence that geographic location played an important role in survey participation.

Among referring veterinarians and clients who responded to the survey, approximately 6 of every 10 veterinarians were aware that the referral hospital operates a surveillance and infection control program, compared with approximately 4 of every 10 clients. This finding suggests that current communication channels (infection brochure and *Salmonella* fact sheet) between the study hospital and its clients with equine patients can be improved. One method of improving communication is to request that clinicians briefly describe the infection control services implemented by the hospital to optimize veterinary care as part of the clinician-client consultation at the time of admission of each patient. At the same time, the client would be given a brochure with information about the infection control program. In addition, from a broader perspective, communication strategies could include the participation of university extension agents statewide (the University of Florida has an extension office in each of the 67 counties in the state).

Almost all referring veterinarians (54/56 [96%]) and clients (570/586 [97%]) considered it important to be informed by the hospital's attending clinician when their patient tested positive for *Salmonella* shedding at admission or during hospitalization. Referring veterinarians can use laboratory results to better manage a horse confirmed to shed *Salmonella* during hospitalization. Recommended biosecurity precautions to mitigate potential risk of disease transmission at the farm after the patient is discharged include isolation from other horses on the premises, controlling indirect transmission through segregation or disinfection of materials used for animal care, use of good hygiene practices for personnel, and safe disposal of feces and soiled bedding from horses.[14] The study results also indicate that clients want to be informed and possibly more engaged in the management of affected horses.

Most referring veterinarians and clients indicated that they found testing of horses for detection of *Salmonella* at admission and once during hospitalization to be justified and did not perceive it as expensive. These findings are an indication that veterinarians and clients recognize the value of these surveillance and infection control practices to reduce the risk of hospital-acquired infections and that the current cost is reasonable. The mean cost of hospitalization for an equine inpatient with colic at the University of Florida Large Animal Hospital ranges from approximately $2,500 to $7,000 for inpatients treated medically and surgically, respectively. The mean cost of surveillance testing (currently $56/equine inpatient) during hospitalization represents 2.2% of the hospital bill for a horse with colic treated medically and 0.8% of the cost for a horse with colic that requires surgical intervention. We consider this a relatively small amount to pay for high standards of hospital biosecurity that can affect both humans and animals.

More clients (144/572 [25%]) indicated that they found the cost of testing expensive, compared with referring veterinarians (5/57 [9%]). Among clients, no association was identified between the cost of testing and number of horses owned or main use of the horses. Differences in education or income, which were not assessed in this study, could explain why some clients considered the cost of testing expensive and others did not. Additionally, veterinarians who found the cost of testing expensive had been in practice for significantly less time (median, 11 years) than those who did not (median, 26 years). The reason for the observed difference is not known.

Both referring veterinarians and clients indicated that it was very important that a referral hospital operate an infection control program, and most veterinarians (51/57 [89%]) and clients (480/583 [82%]) responded that if the study hospital

were forced to close temporarily for cleaning and disinfection because of an outbreak of salmonellosis, they would consider referring horses to the hospital again after its reopening. The results indicate that veterinarians and clients that participated in this study were aware of the risk *Salmonella* infection poses to horses and the potential consequences of an outbreak at a referral hospital. In addition, they recognize surveillance and infection control practices are accepted measures to mitigate the risk of an outbreak at a referral hospital.

Results of our survey provided data and information that can be used to assist administrators of the hospital where the study was performed in making informed decisions based on data. Similar studies and larger studies may similarly provide useful data applicable to other populations.

a. Copies of the survey instruments are available from the corresponding author upon request.
b. Excel, Microsoft Corp, Redmond, Wash.
c. PROC SURVEYSELECT, SAS, version 9.2, SAS Institute Inc, Cary, NC.
d. PROC FREQ, SAS, version 9.2, SAS Institute Inc, Cary, NC.

References

1. Morley PS. Biosecurity of veterinary practices. *Vet Clin North Am Food Anim Pract* 2002;18:133–155.
2. Ewart SL, Schott HC, Robinson RL, et al. Identification of sources of *Salmonella* organisms in a veterinary teaching hospital and evaluation of the effects of disinfectants on detection of *Salmonella* organisms on surface materials. *J Am Vet Med Assoc* 2001;218:1145–1151.
3. Ward MP, Brady TH, Couetil LL, et al. Investigation and control an outbreak of *Salmonella typhimurium* in a population of hospitalized horses. *Vet Microbiol* 2005;107:233–240.
4. House JK, Mainar-Jaime RC, Smith BP, et al. Risk factors for nosocomial *Salmonella* infection among hospitalized horses. *J Am Vet Med Assoc* 1999;214:1511–1516.
5. Ekiri AB, MacKay RJ, Gaskin JM, et al. Epidemiologic analysis of nosocomial *Salmonella* infections in hospitalized horses. *J Am Vet Med Assoc* 2009;234:108–119.
6. Dallap Schaer BL, Aceto H, Rankin SC. Outbreak of salmonellosis caused by *Salmonella enterica* serovar Newport MDR-AmpC in a large animal veterinary teaching hospital. *J Vet Intern Med* 2010;24:1138–1146.
7. Ekiri AB, Morton AJ, Long MT, et al. Review of the epidemiology and infection control aspects of nosocomial *Salmonella* infections in hospitalized horses. *Equine Vet Educ* 2010;22:631–641.
8. Morley PS. Surveillance for nosocomial infections in veterinary hospitals. *Vet Clin North Am Equine Pract* 2004;20:561–576.
9. Smith BP. Evolution of equine infection control programs. *Vet Clin North Am Equine Pract* 2004;20:521–530.
10. Smith BP, House JK, Magdesian KG, et al. Principles of an infectious disease control program for preventing nosocomial gastrointestinal and respiratory tract diseases in large animal veterinary hospitals. *J Am Vet Med Assoc* 2004;225:1186–1195.
11. Traub-Dargatz JL, Dargatz DA, Morley PS, et al. An overview of infection control strategies for equine facilities, with an emphasis on veterinary hospitals. *Vet Clin North Am Equine Pract* 2004;20:507–520.
12. Steneroden KK, Van Metre DC, Jackson C, et al. Detection and control of a nosocomial outbreak caused by *Salmonella* Newport at a large animal hospital. *J Vet Intern Med* 2010;24:606–616.
13. United States Census Bureau. Florida counties map. Available at: www2.census.gov/geo/maps/general_ref/stco_outline/cen2k_pgsz/stco_FL.pdf. Accessed Dec 16, 2013.
14. Hartnack AK, Van Metre DC, Morley PS. *Salmonella enterica* shedding in hospitalized horses and associations with diarrhea occurrence among their stablemates and gastrointestinal-related illness or death following discharge. *J Am Vet Med Assoc* 2012;240:726–733.