Evolution of a Salmonella Biosecurity Program Over a 10-Year Period

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Control of nosocomial salmonellosis and implementation of effective biosecurity programs to limit the risk of this disease continue to be a challenge in equine hospitals. Monitoring programs for detection of fecal shedding of Salmonella serovars is an effective tool to identify both nosocomial infection and colonization and to determine when changes in biosecurity programs may be necessary. Authors’ address: Department of Large Animal Clinical Sciences, D-202 Veterinary Medical Center, Michigan State University, East Lansing, Michigan 48824-1314; e-mail: schott@cvm.msu.edu. © 2009 AAEP.

1. Introduction
There have been numerous reports detailing outbreaks of nosocomial salmonellosis in large animal hospitals.1–3 Morbidity and mortality rates in these outbreaks have varied with the offending Salmonella serovar, species of patients affected, and facility size and design. Prevalence of and risk factors for fecal shedding of Salmonella spp. by hospitalized horses as well as hospital practices that may contribute to spread of disease (e.g., lack of proper isolation facilities, common use of stomach tubes, inadequate disinfection protocols) have also been documented.3–5 In the face of an outbreak, containment efforts have included depopulation with or without closure coupled with a thorough hospital cleaning and disinfection.1–3,6

In response to each outbreak, biosecurity protocols are reviewed, and often more detailed and costly infection control practices are implemented. These typically include establishing traffic flow patterns, detailing specific indications for isolation of patients, cohort housing of patients at various risk levels, using barrier precautions, screening patients for fecal shedding of Salmonella spp., monitoring efficacy of disinfection practices with environmental cultures, and encouraging staff to practice good hygiene.6 Although these general practices can be established in all large animal hospitals, specific details of each hospital’s biosecurity program necessarily vary with facility design (and limitations) and resources dedicated to the effort. Thus, specific protocols differ among institutions and, as a result, comparison of the efficacy of biosecurity programs between different hospitals is challenging.

To evaluate efficacy of biosecurity programs in human hospitals, nosocomial infection rates are compared before and after program implementation or modification. Nosocomial infection rates with organisms acquired from the hospital environment or personnel (e.g., Clostridium difficile, multidrug-resistant enterococci, and methicillin-resistant Staphylococcus aureus) have been documented to
decrease after establishing biosecurity protocols or altering existing practices.7–8 However, nosocomial salmonellosis tends to occur as sporadic outbreaks lasting weeks to months after introduction of an animal shedding a pathogenic Salmonella serovar. Thus, most large animal hospitals have a “zero tolerance” goal for nosocomial salmonellosis, and efficacy of biosecurity programs can only be assessed by a decrease in frequency and severity of outbreaks over a period of years compared with a historical incidence of disease. This type of evaluation of biosecurity programs for nosocomial salmonellosis has not been reported for large animal hospitals.

This report describes the biosecurity program implemented after the 1996 nosocomial outbreak of Salmonella typhimurium involving equine patients at Michigan State University’s Veterinary Teaching Hospital (MSUVTH). This outbreak has been described in detail in a previous report.9 The apparent efficacy of the biosecurity program was assessed by evaluating nosocomial epizootics of equine salmonellosis over the subsequent decade and associated modifications of the biosecurity program.

2. Materials and Methods

All fecal culture results collected from equine patients admitted to the MSUVTH for evaluation of gastrointestinal (GI) disease from January 1, 1997 through December 31, 2006 were compiled. In addition, for the years in which the prevalence of positive results for Salmonella spp. was >3%, fecal culture results were further reviewed for serovars of Salmonella isolated, antimicrobial susceptibility profiles, and pulsed-field gel electrophoresis (PFGE) analysis, when performed, to identify potential nosocomial outbreaks. When nosocomial outbreaks were recognized, the biosecurity program was reviewed and modified, if deemed appropriate.

After the 1996 Salmonella outbreak, biosecurity protocols were extensively revised. A surveillance program for detection of fecal Salmonella shedding was implemented in which all equine patients admitted to the MSUVTH with a primary GI disorder were required to have a fecal sample submitted daily for detection of Salmonella for the initial 3 days of hospitalization. Next, all horses that presented with a primary complaint of diarrhea were admitted directly to an isolation area. Horses that did not present for diarrhea but subsequently developed diarrhea were also moved to the isolation facility. The isolation facility for adult (>6 mo) consisted of a cordoned off block of stalls at the end of a common hallway. The isolation area for foals (<6 mo of age) consisted of a cordoned off block of stalls at the end of the neonatal ward. Horses admitted to isolation areas were not removed from isolation until discharged from the hospital. Horses housed in isolation areas were required to have fecal cultures submitted daily for a minimum of 5 days. When working with isolated patients, personnel were required to wear a disposable impenetrable gown, a double layer of protective booties, gloves, and cap. In both the main hospital and the isolation areas, commonly used equipment (i.e., rectal thermometers, nasogastric tubes, buckets, and funnels) was purchased for individual use for each horse with GI disease.

3. Results

From January 1, 2000 to December 31, 2006, 17,742 equine patients were presented to the MSUVTH, with an average of 2535 horses/yr (range, 2380–2838 horses/yr). Inpatients constituted 48% of the patients (average, 1221/yr; range, 1171–1271/yr); the remainder were evaluated as outpatients. The total number of GI cases from January 1, 1997 to December 31, 2006 was 3350, with an average of 335 (range, 190–401) GI cases per year. The number of GI cases was determined by using the number of horses that had fecal cultures submitted for Salmonella isolation; thus, the number of GI cases was likely underestimated because fecal samples may not have been submitted for all GI cases.

A total of 9519 fecal cultures were submitted from January 1, 1997 to December 31, 2006, with an average of 951 cultures per year (range, 443-1335). The average number of fecal cultures per GI case over the 10-yr period was 2.8 and ranged from a low of 2.3 in 1998 to a high of 3.4 in 2003. A total of 128 fecal cultures were positive for Salmonella spp. over the 10-yr period (1.3% positive rate). The average was 12.7 positive cultures per year, with a range from 2 to 21. The annual prevalence of fecal samples positive for Salmonella ranged from 1% to 5.7%.

The prevalence was >3% for 6 of the 10 yr reviewed (1997, 1999, 2001, 2002, 2003, and 2006). In 1997, S. typhimurium constituted 33% (5/15) of the isolates. Three of these five isolates were cultured from horses in January and February, and PFGE analysis indicated that the S. typhimurium isolates were identical or very similar to isolates recovered during the 1996 outbreak. Antimicrobial susceptibility profiles provided further support, with two of the three isolates having identical profiles, and the third being similar. The remaining two S. typhimurium isolates recovered in 1997 had antimicrobial susceptibility profiles that were different from the three isolates occurring early in the year, indicating that they were different from the outbreak serovar. In 1999, S. typhimurium accounted for 56% (5/9) of the Salmonella isolates. Two of the five strains had identical susceptibility profiles (different from the 1996 outbreak isolate); however, no other similarities were identified. Fifty seven percent (12/21) of the isolates in 2001 were S. newport. The 12 S. newport isolates had indistinguishable PFGE patterns, and similar multidrug-resistant antimicrobial susceptibility profiles supported a nosocomial salmonellosis outbreak. Although 2002 had a Salmonella fecal positive rate of 3.3%, there was no single isolate that was of a higher prevalence.
than others. There were three *S. newport* isolates, two reported in January, with antimicrobial susceptibility profiles identical to the previous year’s outbreak serovar.

In 2003, 47% (9/19) of isolates were *S. thompson* isolates, with identical antimicrobial susceptibility profiles and PFGE results, supporting nosocomial salmonellosis. Of interest, only one of eight horses from which *S. thompson* was isolated during this outbreak (subsequent to the index case that had been admitted to an isolation unit) had clinical evidence of disease. The remaining seven horses seemed to have been colonized with *S. thompson* without exacerbation of their primary GI disease. In 2004, *S. newport* again accounted for 64% (9/14) of positive fecal culture isolates. Antimicrobial susceptibility profiles and PFGE patterns for seven isolates were similar to the serovar identified in the 2001 outbreak and subsequent detection of this *Salmonella* serovar in one of the isolation stall drains supported a reservoir for infection in the isolation facility. Once this reservoir was recognized, this stall was no longer used. In 2006, *S. typhimurium* accounted for 26% (5/19) of positive culture results. Antimicrobial susceptibility testing indicated that all of these isolates were susceptible to all antibiotics tested.

4. Discussion

All in all, four nosocomial salmonellosis episodes (1997, 2001, 2003, and 2006) were detected by the fecal culture monitoring program for GI cases. The 1997 *S. typhimurium* cases were considered a continuation of the 1996 outbreak. The 2001 *S. newport* outbreak was subsequently determined to be a consequence of environmental contamination of a referring veterinarian’s practice in which dairy calves with *S. newport* diarrhea were treated in crates adjacent to horse stalls. Five of the 12 horses affected in 2001 had been referred to MSU-VTH from this practice and had positive fecal culture results for the multidrug-resistant *S. newport* on admission (all were admitted directly into an isolation unit). This 2001 outbreak prompted modifications to the biosecurity program including further separation of GI cases from the remainder of hospitalized horses and increased use of barrier protection for GI cases.

In 2003, the *S. thompson* outbreak was notably different in the fact that only one horse developed clinical disease in association with nosocomial infection; the remaining horses seemed to have been colonized with the organism with no change in clinical course of their primary GI disease. However, a disconcerting fact about this outbreak was that the index case had been admitted directly into an isolation unit, but the subsequently infected or colonized horses were housed in multiple hospital wards. This finding strongly implicated personnel as a potential disease vector despite strict use of isolation protocols with the index case. In response to this outbreak, the biosecurity program was again modified. Once an isolation unit was entered to work with multiple cases, the protocol was changed such that personnel were required to completely re-gown between patients. Previously, an outer protective gown was worn over the impervious gown, and the outer gown, gloves, and booties were changed between patients. Complete re-gowning had only been required if there was visible contamination of the impervious gown. Next, in the main hospital, all medical cases had disposable gloves placed on the stall door for use when working with the patients. In the gastrointestinal ward, individual lead ropes and shovels were now placed on each stall door and used for that stall only.

The last outbreak in 2006 involved apparent colonization of several horses in the “colic” ward with a highly susceptible *S. typhimurium* isolate. No exacerbation of GI disease was noted with this minor outbreak, and no further changes in the biosecurity program were made at that time. However, the cumulative experience with both primary and nosocomial salmonellosis at the MSU-VTH had made it extremely clear that a better-designed isolation facility was essential for limiting further nosocomial salmonellosis outbreaks. Fortunately, resources had been identified for this need, allowing construction of a 10-stall isolation and critical care facility that was opened for service at MSU near the end of 2006.

In summary, control of nosocomial infections is important in any type of large animal hospital. Protocols must be developed and placed into practice to identify when an increasing number of infections are occurring, in order that a rapid and effective method of controlling outbreaks may be undertaken. As illustrated by our experiences, when surveillance for disease is implemented, the opportunity to detect outbreaks of both nosocomial disease and colonization is also increased.

Unfortunately, improved biosecurity programs are not always completely effective in limiting nosocomial infection rates. Thus, biosecurity remains an ongoing challenge that requires strict compliance to protocols coupled with effective communication to encourage all personnel to understand why such protocols are necessary. Furthermore, ongoing evaluation of the efficacy of biosecurity programs and regular re-evaluation of protocols used is critical in the effort to reduce *Salmonella* nosocomial infection rates in equine hospitals.

References


