A National Estimate of the Prevalence of 
Salmonella Fecal Shedding by Horses in the U.S.

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The National Animal Health Monitoring Systems (NAHMS) Equine '98 study represents the first national estimate of the prevalence of fecal shedding of Salmonella by horses in the general population. The prevalence of fecal shedding of Salmonella by horses in 28 states was estimated to be 0.8%, with 1.8% of operations having one or more horses shedding the organism. This information is of value to the equine practitioner from a comparative standpoint when performing fecal cultures on horses in their practice. Authors' addresses: Department of Clinical Sciences, College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Fort Collins, CO 80523 (Traub-Dargatz); US Dept of Agriculture: Animal Plant Inspection Service: Veterinary Services Centers for Epidemiology and Animal Health, 555 S. Hawes Street, Fort Collins, CO 80521 (Garber); USDA Agricultural Research Service, Richard Russell Research Center, 950 College Station Rd, Athens, GA 30605-2720 (Fedorka-Cray and Ladely). © 2000 AAEP.

Introduction

Establishing the prevalence of fecal shedding by the general horse population gives us a much better estimate of what percentage of horses might shed Salmonella on any given day than would estimates based on a hospital population of horses or a smaller sample of the population. The NAHMS Equine '98 study allowed for the selection of a representative sample of horses and horse operations in the U. S. to establish credible estimates of the characteristics of fecal shedding of Salmonella by horses.

Most of the previously reported information in the literature has focused on determining the infection status of the individual horse, not the prevalence of fecal shedding by the horse population. The infection status of an individual horse would best be established by culturing the feces of that horse on multiple occasions or by performing a culture of a rectal biopsy, because fecal shedding can be intermittent and in low numbers which may preclude identification by routine standard culture methods. Thus, prevalence of shedding of the horses in general would likely be less than the prevalence of infected horses. However, this estimate would be of value to a practitioner. For example, it would be useful for an equine practitioner who was asked to determine the cause of an outbreak of diarrhea in a herd of horses to know the fecal Salmonella shedding patterns of the general horse population.

One report demonstrated a larger percentage of hospitalized horses with gastrointestinal disease were positive for Salmonella on culture and polymerase chain reaction (PCR) testing of feces than were equine outpatients at the same hospital. Many of the previous estimates of the Salmonella status of horses has been established based on the population of horses in veterinary teaching hospitals.

One of the objectives of the NAHMS Equine '98 study was to estimate the prevalence of fecal shedding of Salmonella by horses in the U. S. The NAHMS program was in an ideal position to accomplish this goal with a field force in all of the 28 states included in the study and laboratory capabilities to culture a large number of samples (up to 500 fecal samples per wk) using previously validated techniques. Determination of the prevalence of enteric pathogens such as Salmonella has been a goal of previous NAHMS studies and there are estimates for fecal shedding by dairy and beef cattle.

Additional goals included describing the serotypes of Salmonella in horses in the general population. In previous NAHMS studies the serotype of Salmonella shed by the general population was different than those shed by ill cattle.

Materials and Methods

Twenty eight states (Fig. 1) were included in the NAHMS Equine '98 study. These states were se-
selected based on the size of the equine population in the state and for geographical location. A representative sample of equine operations was selected by the National Agricultural Statistics Service (NASS) in 28 states. From these equine operations a subset of operations was selected for participation in the biological sampling phase of the study. To qualify for inclusion in this phase of the study operations had to have 3 or more horses on the operation on January 1, 1998. This sample was estimated to represent 51.6% of the operations with horses and 83.9% of the horses in the 28 states on January 1, 1998. Participation by horse operations in the study was voluntary. For further details regarding the study methods see the NAHMS Equine '98 tabular reports.

A field force of Veterinary Medical Officers, Animal Health Technicians and personnel from the state veterinarian’s office were involved in administering questionnaires, assessing cleanliness of the operation, and collection of biologic samples. Fecal samples were collected from horses including foals on half of the operations in each state in the summer of 1998 and half of the operations in each state in the winter of 1998–1999. Each horse was sampled only once.

The number of horses having feces sampled per operation was based on a sliding scale. If there were 10 or less resident horses on the operation all horses were sampled; 10 horses were sampled if the operation had 11–19 horses; 15 were sampled if there were 20–49 horses; and 20 were sampled if there were 50 or more horses. The field staff was instructed that if all horses were not sampled on an operation, then a representative sample of ages, genders, breeds and uses should be sampled on each operation.

Feces were transported overnight and cultured for Salmonella at the Agricultural Research Service (ARS) in Athens, Georgia using a previously described technique. Serotyping of the Salmonella isolates was performed at the Diagnostic Bacteriology Laboratory of the National Veterinary Services Laboratories (NVSL) in Ames, Iowa. Population estimates were generated weighting the data by the inverse of probability of the operation being selected and adjusting for non-response using Sudaan software.

**Results**

A total of 972 operations participated in the fecal sampling phase of the study and 8417 fecal samples were cultured for Salmonella. There were 4643 samples collected in the summer sampling period (June 15 to Sept 11, 1998) and 3774 samples were collected in the winter sampling period (November 2, 1998 to March 3, 1999).

Prevalence results reported here represent weighted estimates of fecal Salmonella shedding by horses and for operations with one or more positive horse. Point estimates along with the 90% confidence interval (CI) of the estimate are provided. The 90% CI is calculated by multiplying the standard error of the estimate times 1.65 to estimate the upper and lower bounds of certainty.

From the NAHMS study it is estimated that 0.8% (90% CI = 0–1.6%) of horses shed Salmonella in their feces. Categorized by season the animal level prevalence of fecal shedding of salmonellae in summer was 1.1% of horses (90% CI = 0.3–1.9%) and the winter prevalence was 0.2% of horses (90% CI = 0–0.5%). The regional prevalence for the Southern region was 1.4% (90% CI = 0–3%) and the Northern region was 0.2% (90% CI = 0–0.5%). See Figure 1 for the states included in the Southern and Northern regions.

An operation was considered positive if it had one or more horses positive for Salmonella. The prevalence of positive operations was 1.8% (90% CI = 0.7–2.9%). Categorized by cleanliness of the operation, the prevalence of positive operations was 6.7% (90% CI = 0–14.3%) for operations ranked as poor for cleanliness and was 1.3% (90% CI = 0.5–2.1%) of operations ranked as adequate to good for cleanliness.

The Salmonella serotype most commonly identified in this study was S. muenchen (22% of isolates), followed by S. newport (11% of isolates), S. schwarzengrund (8% of isolates), S. thompson (8% of isolates), S. typhimurium var. copenhagen (8% of isolates), S. agona (5% of isolates), S. infantis (5% of isolates), S. rubislaw (5% of isolates), S. newbrunswick (5% of isolates), and S. uganda (5% of isolates). The remainder of serotypes identified (S. cerro, S. mississippi, S. worthington, untypeable and multiple serotypes in same sample) each represented less than 3% of the isolates.

**Discussion**

The equine hospital population likely varies from the general population of horses residing on their
home operation with regards to the frequency of fecal shedding of *Salmonella* and the serotypes of *Salmonella* shed. The results presented here represent the first national estimate of the prevalence of fecal shedding of *Salmonella* by the general population of horses in the U. S. The data from this study is unique because of the scope, sampling scheme, and type of population included in the study. It would be inappropriate to compare the results of this study with those of previous reports due to differences in sampling schemes (e.g., number of samples per horse), differences in culture methods, and especially differences in populations of horses sampled. The most commonly identified serotype of *Salmonella* identified in the NAHMS Equine '98 study was *S. muenchen.* The serotype most commonly identified in horses with clinical illness is *S. typhimurium* (annual data from the National Veterinary Services Laboratories).7

The results of this study can be applied by the equine practitioner faced with interpreting culture results from horses in their practice. For example, a practitioner on one summer day submits feces from 100 horses to the laboratory for culture. These horses reside on an equine operation which was experiencing an equine diarrhea problem. Based on the laboratory report 50% of these horses cultured positive for *Salmonella,* this practitioner would then need to decide if this prevalence of fecal shedding of *Salmonella* was different from the norm. Based on the Equine '98 study it would be clear that this prevalence of shedding was far in excess of that for the overall population which had a fecal shedding prevalence with an upper 90% CI of 1.6%. Since the samples for this herd were collected in the summer, the practitioner could look at the NAHMS Equine '98 upper confidence limit for the prevalence of fecal *Salmonella* shedding in the summer, which was 1.9%, and see that the herd tested far exceeded this estimate as well.

The serotype(s) of *Salmonella* identified should be taken into consideration along with the percentage of horses shedding the organism. In the example above if all 50 horses were found to be shedding an unusual serotype such as *S. infantis* it would be even more likely that this operation was experiencing an outbreak of salmonellosis.

The results of this study of *Salmonella* shedding by horses in the general population was published in the journal of the American Veterinary Medical Association.8

References and Notes


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