RISK FACTORS FOR CORYNEBACTERIUM PSEUDOTUBERCULOSIS INFECTION IN HORSES

Doherr M.G.[1], Carpenter T.E. [1], Hanson K.M.P.[1], Wilson W.D. [1], Gardner I.A.[1]

Les objectifs de cette étude étaient d'utiliser des dossiers médicaux et des données tirées d'une enquête par courrier pour évaluer les associations entre des facteurs de démographie équine, de pratiques d'élevage et l'infection à Corynebacterium pseudotuberculosis des chevaux de Californie dans une étude cas / témoins.

Les chevaux admis à l'hôpital de l'école vétérinaire UC Davis (VMTH) ont servi de base d'étude pour l'identification des cas et le choix des témoins. Une enquête par courrier a été réalisée pour collecter des données concernant la démographie des chevaux, la conduite d'élevage et leur état de santé. Une procédure pas à pas a été utilisée pour le modèle de régression logistique multivarié, avec les effets significatifs suivants : âge, niveau du travail d'extérieur, autres sites de Californie, mesures de prévention contre les insectes, contact avec d'autres chevaux, pâturage estival. Le modèle final a été ajusté pour les facteurs de confusion possibles comme le type d'admission, la fréquentation régulière de l'hôpital et la race. Les chevaux de 1 à 2 ans, de 3 à 5 ans ainsi que ceux ayant eu des contacts avec d'autres chevaux et ayant une saison de pâturage ont un risque de maladie significativement plus élevé (limite inférieure de IC95%>1.0).

Les résultats étayent les hypothèses suivantes : la maladie affecte surtout les jeunes chevaux adultes des deux sexes et de toute race, et les facteurs de conduite d'élevage jouent un rôle important dans l'apparition de la maladie. Sachant que le système actuel de test sérologique n'est pas fiable et que l'abattage des animaux infectés n'est pas envisageable, l'approche la plus logique pour prévenir la maladie consiste à identifier et isoler précocement les cas cliniques et à améliorer des pratiques d'élevage, comme l'hygiène des stalles, le contrôle des insectes ou à changer les habitudes de pâturage. D'autres études à partir d'enquêtes d'observation et des essais de recherche clinique appliquée sont nécessaires pour répondre aux questions encore posées.

INTRODUCTION

Corynebacterium pseudotuberculosis induced abscesses are one of the more common and economically important infectious diseases of horses in California. This specific form of the disease was first described in San Mateo County, CA (Hall & Fisher, 1915). Since then it has spread to affect horses in many parts of the Western United States. Several investigators have performed descriptive or clinical studies on cases; however, no formal observational study incorporating a comparison group of non-diseased animals to identify risk factors for the disease has been done (Knight, 1969; Aleman et al., 1996). The objective of this study was to use the equine medical records at the UC Davis Veterinary Medical Teaching Hospital (VMTH) and data derived through a mailed survey to estimate the strength of association between horse demographics and horse management factors, and C. pseudotuberculosis infection applying univariable and multivariable logistic regression techniques.

MATERIALS AND METHODS

Horse patients added to the VMTH medical (admission) record database between July 1, 1992 and June 30, 1994 were used as the study population. Cases of the disease were identified and controls randomly selected from the remaining population. A questionnaire was mailed to the owners to collect information on demographic characteristics of the owner and the horse, management factors and use of the horse, geographical information (location of the horse), and health-related and general questions. Potential risk factors were selected based on their statistically significant association with disease status ($p < 0.05$), previous knowledge and biological reasoning. In addition, possible confounding variables that were associated with disease status were identified. Univariable logistic regression analysis was performed to estimate stratum-specific odds ratios (OR) for each individual risk factor. Selection of the final main-effects logistic regression model was done in a stepwise procedure. To this multivariable model, previously identified potential confounders were individually added. All 2-factor interactions were tested for their statistical significance ($p = 0.05$).

RESULTS

Age, outdoor activity level, movement within California, owner-perceived insect problem, performed insect control, contact with other horses, housing/stabling practice during summer, admission type and regular VMTH patient status were significantly ($p \leq 0.05$) associated with the risk of having the disease. Gender, breed, color of the horse, movement outside of California, number of other contact horses, contact with other livestock, housing/stabling practice in fall, winter and spring, other diseases, and treatment by other (non-VMTH) veterinarians were not significantly associated with disease status. The final logistic regression model (Table I, last column) presents the adjusted OR for the main effects age, outdoor activity level, other locations within

[1] School of Veterinary Medicine, Dept. of Medicine and Epidemiology, University of California, Davis, CA 95616-8737, USA

California, insect control, horse contact, and summer pasture while controlling for the effects of the confounding variables admission type, regular VMTH patient and breed. Horses 1-<2 or 3-<5 years of age, horses with increased contact with other horses, and horses on summer pasture had significantly ($p < 0.05$) increased risk for disease. The disease risk was increased (though not statistically significant) for age categories 2-<3 years, medium and high outdoor activity level, and insect control measures, and decreased (but not statistically significant) for horses that had been at other locations in California. The model fit, based on the goodness-of-fit statistics, was acceptable. Not one of the 2-factor interactions between main effects was statistically significant ($p < 0.05$).

Table I
Logistic regression (risk factor) model for Corynebacterium pseudotuberculosis infection in horses. Adjusted odds ratios (OR) and 95% confidence intervals (CI) are specified. Baseline categories used for comparison: 'age' (<1&≥5 years), outdoor activity (low), 'other locations in CA' (no), 'insect control' (no), 'contact to other horses' (never/seldom), 'summer pasture' (no), 'admission type' (Hospital), 'regular VMTH patient' (no), 'breed' (all other breeds combined).

Parameter	Stratum-specific (univariable) OR (95% CI)	MODEL 1 main effects only OR (95% CI)	FINAL MODEL with confounders OR (95% CI)
Age 1-<2 years	3.06 (1.26; 7.42)	2.95 (0.46; 19.0)	5.92 (1.05; 33.3)
Age 2-<3 years	0.81 (0.23; 2.78)	2.24 (0.57; 8.83)	2.68 (0.59; 12.1)
Age 3-<5 years	2.37 (1.26; 4.48)	3.81 (1.61; 9.02)	4.47 (1.68; 11.9)
Medium outdoor activity	3.25 (1.29; 8.19)	2.63 (0.83; 8.33)	1.75 (0.47; 6.50)
High outdoor activity	1.85 (0.82; 4.15)	1.30 (0.47; 3.59)	1.28 (0.39; 4.20)
Other Locations in CA (yes)	0.48 (0.25; 0.93)	0.46 (0.21; 1.02)	0.45 (0.18; 1.12)
Insect control (yes)	2.49 (0.96; 6.41)	6.99 (1.44; 33.8)	3.51 (0.66; 18.6)
Horse contact (often)	4.25 (1.79; 10.1)	4.43 (1.58; 12.5)	4.36 (1.37; 13.9)
Summer pasture (yes)	2.03 (1.20; 3.44)	3.01 (1.49; 6.05)	2.83 (1.28; 6.26)
Admission type (Field Service)	6.64 (3.83; 11.5)	-	6.72 (3.02; 14.9)
Regular VMTH Patient (yes)	3.65 (2.15; 6.19)	-	2.43 (1.13; 5.22)
Breed Paint horse	1.59 (0.63; 4.04)	-	2.02 (0.52; 7.82)
Breed Quarter horse	0.63 (0.34; 1.19)	-	0.71 (0.29; 1.74)
Breed Standardbred and Thoroughbred horse	0.54 (0.27; 1.09)	-	0.56 (0.18; 1.77)
Overall model fit			
Model parameters		9	14
Log Likelihood		-119.05	-98.70
Goodness-of-fit χ^2 p-value		0.586	0.999
Hosmer-Lemeshow GOF χ^2 p-value		0.292	0.453
C.C. Brown GOF χ^2 p-value		0.163	0.671

DISCUSSION

The fact that breed and gender are no significant risk factors for the disease is in agreement with the current knowledge on the disease in sheep and goats. Our finding that certain age groups have an increased risk for disease is of considerable interest. It has been reported from sheep and goats that lambs and kids within their first 3-4 months of life have a decreased risk of infection, most likely due to protective maternal antibodies. Thereafter, the herd prevalence increases with age cohort, and reaches a peak at approximately 4 years of age. Proportionally larger increases in herd prevalence can be observed when susceptible age cohorts move through periods of increased risk, for example when sheep pass through the shearing season (Holstad, 1986; Serikawa et al., 1993). It is likely that since foals are born predominantly during late winter and in spring, they are either protected by maternal antibodies during the typical disease peak in summer/fall, or do not become exposed to infection during the first disease season. The following year these now 1-<2 year old still susceptible horses enter the high-risk season and have a significantly higher disease frequency than other age groups, as indicated by the increased disease risk calculated from our data. This trend continues until the birth cohort reaches five years of age. Horses older than 5 years do not a significantly elevated risk of disease when compared with foals, which could be a result of these horses permanently being kept in a low-risk environment or being to some extent protected by unspecific or disease-specific immunity.

Our results showed that increased contact with other horses significantly increased the risk of disease. This observed association might be attributable to similar management practices like keeping horses on pasture or in paddocks that result in increased contact with other horses. In addition, generally higher horse density in the geographic region where the cases have occurred. Horse pastures and paddocks tend to be occupied by the same or different horses on an almost constant basis, increasing the probability of horse-to-horse contact. Infected horses (with draining abscesses) could easily contaminate the pasture or soil, which could then act as a source of infection for other horses.

Insect control and owner-perceived insect problem were strongly associated with each other (χ^2 p-value < 0.0001), with horses with owner-reported insect problems having a fourfold increase in odds of having insect control measures in place. This counterintuitive association could be explained by the fact that insect control measures were started too recently to have an effect, that they don't have an effect at all, or that the owner, though explicitly asked to report the status at the time when the admission to the VMTH occurred, reported current activities (when the survey took place). The variable insect control entered the final model. The significant positive association between implemented insect control measures (as a proxy for insect exposure) and disease status seemingly supports the previously stated hypotheses that insects could be a (mechanical) vector for the disease, and that an increase in insect exposure would heighten the risk for disease. However, this observed association might be an indicator for successful (VMTH) education towards disease prevention, rather than a true risk factor for the disease. Case horse owners educated by VMTH clinicians about the hypothesized disease-insect association would be more likely to report perceived insect problems or implemented insect control measures.

The significant association between use of summer pasture and disease status, together with the previously reported seasonal occurrence of the disease could be an indication of increased contact with other horses during the time on pasture or increased exposure to the infectious agent from the environment (directly or through insect vectors). Other possibilities are the increased occurrence of minor wounds (cuts and abrasions) that possibly serve as a port of entry for the bacterium, a higher frequency of younger (1-5 year old) horses of higher-risk breeds on summer pasture, or any combination of the above. This association, however, could also be a proxy variable for common management practices (summer and fall pasture) coinciding with the age (cohort) specific increased susceptibility for the disease.

Results of this study support the hypothesis that the disease proportionally affects more young adult horses, and that use of the horse and management factors play important roles in the disease occurrence. In sheep and goats, a combination of management changes (stable hygiene, shearing practices etc.) and identification and culling of infected adult animals has proven necessary to eradicate the disease at the herd level (Dercksen et al., 1996). Implementation of such radical measures, however, might not be feasible for an equine population, and a diagnostic (antibody) test system with sufficiently high sensitivity and specificity has yet to be developed. Change of management (improved stable hygiene and insect control measures, pasture and paddock use) and early identification and isolation of clinically infected horses will continue to be the most logical approach for disease prevention. Further work, both through observational studies and applied clinical research, is necessary to gain additional insight into the disease.

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