



Original Research

Factors Associated With Nonsurvival in Foals Diagnosed With Perinatal Asphyxia Syndrome



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ABSTRACT

The objective of this retrospective study was to describe a population of foals with perinatal asphyxia syndrome (PAS) presenting to a veterinary teaching hospital and identify maternal and fetal factors associated with nonsurvival. Included in the study were 79 foals <5 days of age, with abnormal behavior, mentation, or other clinical signs consistent with PAS. Foals were excluded if they were diagnosed with meningitis. Medical records were examined, and data recorded for analysis. Descriptive statistics were calculated, and multivariable logistic regression was performed to investigate factors associated with foal nonsurvival. Of the 79 foals, 43 foals (54.4%; $n = 43/79$) were discharged, 9 died, and 27 foals were euthanized (45.6% nonsurvival rate; 36/79). Foals delivered from mares with an abnormal placenta had a 19 times greater odds of nonsurvival (odds ratio [OR] = 19.2; 95% confidence interval [CI] 1.29–431.64; $P = .07$). Foals delivered from mares with a history of illness during pregnancy had eight times greater odds of death (OR = 7.62; 95% CI 0.99–93.4; $P = .05$). Foals with serum IgG concentrations <400 mg/dL were eight times more likely to die (OR = 7.52; 95% CI 1.34–58.26; $P = .01$). Foals with seizures in the first 24 hours of hospitalization were 21 times more likely to die than foals without seizures (OR = 21.52; 95% CI 2.26–351.88; $P < .01$). Foals with complications during hospitalization were six times more likely to not survive (OR = 5.58%; 95% CI 1.18–37.39; $P < .03$). In conclusion, PAS is multifaceted. The mare's health weighed heavily on the outcome of the foal. A prospective study is needed to understand factors associated with foal nonsurvival.

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1. Introduction

Perinatal asphyxia syndrome (PAS) has known by many names including: hypoxic-ischemic encephalopathy (HIE), neonatal encephalopathy, neonatal maladjustment syndrome, neonatal multisystemic syndrome and been recognized for many years in neonatal foals with an estimated incidence of 2% [1]. Initially described as HIE, it is

now known that HIE can affect many organ systems beyond the neurologic system resulting in abnormal cardiopulmonary, endocrine, gastrointestinal, and renal function as well as behavioral disturbances [1–5]. These foals can be very difficult and costly to manage medically.

Unfortunately, to date, there has been limited progress made in determining the etiology or underlying pathophysiology of PAS in neonatal foals. Recent studies have shown that neurobiomarkers [6–9] may be useful indicators of neural tissue compromise in foals. Research also suggests that many factors can contribute to nonsurvival in neonatal foals including dystocia, premature placental separation, cesarean section, or being a twin [1–5].

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However, we still have limited knowledge of how many of these factors may contribute to nonsurvival of foals suspected of having PAS, increasing the difficulty of clinical decision making and determination of prognosis. Therefore, the objective of this study was to identify factors associated with nonsurvival of foals with clinically evident PAS.

2. Materials and Methods

2.1. Case Selection

Medical records were used to retrospectively evaluate foals presenting to Texas A&M University Teaching Hospital from January 1, 1998–January 1, 2009.

2.2. Inclusion Criteria

Foals were included in the study if: (1) they were admitted to the hospital at less than 5 days of age with abnormal behavior or mentation at admission. The age was chosen because this is the most common time frame in which PAS is observed [1–5]; (2) Foals were included if they developed abnormal behavior or mentation during hospitalization; (3) Or they were included if they showed other clinical signs of PAS, such as inability to stand, inability to nurse, and level of consciousness (normal, somnolent, obtunded, stuporous, or coma) comprised the foals in the study.

2.3. Exclusion Criteria

Foals were excluded from the study if: (1) they did not show abnormal behavior or mentation changes at admission or throughout hospitalization; (2) If the information could not be determined from the hospital records; (3) If they had severe electrolyte changes that could cause abnormal mentation; (4) If foals were diagnosed antemortem or postmortem with meningitis (as determined by clinical signs, cerebral spinal fluid analysis, or necropsy finding). Finally, foals were excluded from the study if they were euthanized due to financial constraints.

2.4. Medical Records Review

Independent and dependent variables regarding foals and their dams were extracted from data contained within the electronic medical records database maintained at the university teaching hospital including signalment, medical history, clinical findings, complete blood count and biochemistry profiles, patient treatment within the first 24 hours of hospitalization, complications/co-morbidities that developed during hospitalization (sepsis, colic, diarrhea, pneumonia, ruptured bladder, other), and treatments administered to the foal throughout hospitalization.

Variables related to foal signalment and medical history: Independent variables representing foal characteristics included age, breed (Quarter Horse, Thoroughbred, Other, Arabian, American Paint, and Warmblood), sex (male and female), age, weight at presentation, and gestational age (<320 days and >320 days). Variables representing the

foal's history included whether the foal stood before presentation (yes and no), suckled or stood within 2 hours of parturition (yes, no, and unknown), had seizures on farm (yes and no), and if treated medically on the farm (yes and no unknown).

Clinical variables during the first 24 hours of hospitalization: Independent variables describing the foals clinical course for the first 24 hours of hospitalization included ability to stand on presentation (yes, no, and unknown), ability to walk at presentation (yes, no, and unknown), rectal temperature (°F) heart and respiratory rates, weight at presentation (kg), mentation (normal or abnormal [included somnolent, obtunded, stuporous, comatose, or unknown]), capillary refill time, any abnormalities of the umbilicus (normal, infection, hemorrhage, patent urachus) and joints (normal, swollen, painful), seizures (yes and no), seizure type (partial, focal, generalized), medications administered for seizure management, and complications/comorbidities during hospitalization (sepsis, colic, diarrhea, pneumonia, ruptured bladder, other: modeled as a single variable, complications yes/no, due to the sparse nature of data). Sepsis was defined by a sepsis score of >12 and/or a positive blood culture [10]. Values for all clinical pathologic data and medical treatments were recorded including complete blood count, hematocrit, total protein, plasma fibrinogen concentrations, and biochemistry profile including, plasma l-lactate, and glucose concentrations. Immunoglobulin G concentrations were also included, and failure of passive transfer of immunity (FPTI) was defined as IgG concentrations <400 mg/dL [11–13]. Foal appearance as recorded as premature (<320 days gestation or less than the dam's normal gestation date and having signs of prematurity such as floppy ears and silky hair coat), dysmature (>320 days of gestation and the mare was known to have placentitis or a prolonged gestation), or normal (term gestation length).

Mare signalment, medical history, and parturition variables: Independent variables describing mare characteristics included age (<10 years of age and >10 years of age), breed (Quarter Horse Thoroughbred, Arabian, American Paint, Warmblood, and Other), whether illness was diagnosed during gestation (yes and no), whether there was a prepartum vaginal discharge (yes, no, and unknown), and if medications were administered during gestation. Variables pertaining to parturition included whether birth was normal with no assistance, assisted delivery (but not dystocia), dystocia (mal-positioned foal), cesarean section, premature placental separation, red bag, or unknown. Lastly, placental abnormalities were included (normal or abnormal [defined as placentitis, edematous, or premature separation, either chronic or acute]).

Outcome or dependent variable: Final foal outcome was recorded as discharged alive, died, or euthanized with categorization for the analysis being survival or non-survival. If the foal did not survive and a necropsy was performed, postmortem findings were recorded for descriptive purposes.

2.5. Statistical Analysis

Extracted data were entered into a spreadsheet, validated, and explored using descriptive statistics. All

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