

Prognosticating Survival of the Equine Neonate

Benjamin R Buchanan, Brazos Valley Equine Hospital, Navasota, TX

Introduction

In 1988 Drs. Koterba, Brewer, and Tarplee published one of the first scoring systems utilized in equine neonatal intensive care. Dubbed the sepsis score, they identified multiple laboratory, historical, and physical exam findings that predicted the presence of sepsis in their population. Subsequent studies have found the model to be valid in some hospital populations, but not in others. The use of the sepsis score persists today and is a good indicator of the degree of neonatal illness if not strictly sepsis. This presentation will focus on the sepsis score and subsequent studies that utilize easily accessible parameters.

Equine Vet J. 1984

The authors examined 38 foals to determine what factors were associated with survival. Septicemic foals had a survival rate of 26%. Low neutrophil count, toxic changes to the neutrophils, hypoglycemia, metabolic acidosis, and hypoxemia were significant.

JVIM 1992

The authors complete a retrospective study of 56 foals to develop a model that was tested prospectively in 48 foals. Anion gap and the venous PO₂ were identified as significant variables and formed a predictive equation. The PPV of the equation to predict survival was 62% and NPV was 100%.

JVIM 1997

The authors completed a prospective study to investigate 53 variables in 64 foals in two different hospitals. Overall survival was 74%. The final model included rectal temperature, heart rate, and neutrophil count.

Equine Vet J. 2005

The authors completed a retrospective study to investigate the association of blood lactate with survival and markers of cardiovascular status. 72 foals were included in the study. Lactate alterations were significantly associated with survival, blood pressure, creatinine concentrations, bacteremia, anion gap, and evidence of SIRS. Use of anion gap, base excess, strong ion gap, and bicarbonate did not correctly classify hyperlactemia in over 20% of foals.

JVIM 2006

The authors completed a prospective study comparing septic foals and critically ill foals receiving different types of commercial plasma. Overall survival was 72%, although foals with sepsis score less than 11 had a survival rate over 95%. Bacteremic foals had a survival rate of 58% compared to 56% for non-bacteremic foals with sepsis score >11. Administration of hyperimmune plasma increased survival. Additional analysis identified high sepsis score, low IgG, high fibrinogen, low neutrophil count, and anemia were significant predictors of non-survival

JAVMA 2006

The authors completed a retrospective study of 910 foals, which was validated prospectively on 163 foals in a different population. Overall survival rate was 83%. A logistic regression model was developed from 34 variables including historical data, physical exam findings, and laboratory results. A final model included ability to stand, presence of a suckle reflex, WBC count, serum creatinine concentration, and anion gap. Accuracy of the model was 81% compared to initial prediction of the admitting clinician or 83%. Combining the clinician prediction improved the accuracy of the model by ~10%. Euthanized foals were excluded from all analysis. Foals who are ambulatory and have a suckle have a high likelihood of survival.

J S Afr Vet Assoc. 2007

The authors completed a prospective study of 62 neonates admitted to a NICU. Overall survival was 66%. White blood cell (WBC) count, TCO₂ and alkaline phosphatase were higher and the anion gap lower in survivors, although only anion gap was independently associated with survival.

JVIM 2008

The authors completed a retrospective study of 515 foals with blood glucose measured at within 60 hours of admission. 36.5% had high blood glucose, 34.4% had low glucose, and 29.1% had normal glucose values. Hypoglycemia was associated with non-survival, sepsis, SIRS, and positive blood cultures. Extreme hyperglycemia (>180 mg/dl) was associated with a non-statistical reduction in the prognosis to discharge. Foals with wide swings in glucose also had a reduced prognosis.

JVIM 2009

The authors completed a retrospective study of 225 consecutive foals <30 days of age admitted to the NICU with lactate measured at admission and again at 24 and 48 hours. Overall survival was 82%. At all time points lactate was higher in foals that did not survive. The authors suggested a cut point of 6.5 mmol/L for lactate values at admission, but found that the change in lactate over time (or lack of change) was important to outcome.

Equine Vet J Suppl 2012

The authors enrolled 643 foals over the 2008 foaling season. Overall survival was 79%. Lactate concentration was shown to be a useful prognostic tool. The higher the lactate the greater the risk of non-survival. Foals with history of placental problems or dystocia had higher lactate values. Increased lactate had increased odds of non-survival when the foal was diagnosed as septic, enterocolitis, colic, trauma, immune mediated, and respiratory.

Discussion

Over the last 30 years, veterinarians have struggled to counsel owners on the treatment of neonatal foals. In this time period the standard of care and understanding of disease process has improved. This has led to an improvement in the survival of very sick and septic foals to above 50% and overall survival rates approaching 90%. However the search for the single laboratory test or physical exam finding that will help identify that foal which will not survive has not been satisfied. The search is complicated by the reluctance of owners to invest in treatment, and the judgment call of clinicians that a case necessitates euthanasia. What is consistent in studies over the last 30 years is the consistent findings of markers associated with systemic inflammation (low WBC or neutrophil count) and markers of poor cardiovascular status and perfusion (high lactate, metabolic acidosis, low venous oxygen saturation) are associated with non-survival. Use of the “sepsis score” does not always correctly identify foals whom are septic, but rather foals who are severely affected and need the most intensive of care. Foals who do not survive typically have higher costs per day of therapy and being able to separate foals into severity categories will help clinicians prepare clients for anticipated expense. Two models will be discussed during the presentation include the Sepsis Score developed by Koterba, Brewer, et al in 1988 and the Tennessee model developed by Rohrbach, Buchanan, et al in 2006.

Sepsis Score

PARAMETER	4	3	2	1	0
Neutrophil		<2,000	2,000-4,000 or >12,000	8,000 – 12,000	Normal
Bands		>200	50 - 200		<50
Toxic Change	Marked	Moderate	Slight		None
Fibrinogen			>600	500-600	<400
IgG	<200	200 – 400	400 – 800		>800
Blood Glucose			<50	50 – 80	>80
Petechia, sclera injection		Marked	Moderate	Mild	None

Fever			>102	<100	Normal
Hypotonia, depression, seizure			Marked	Mild	Normal
Uveitis, diarrhea, swollen joint, wound, respiratory distress	Yes				No
Placentitis, Dystocia	Yes				No
Gestation		<300	300-310	310-330	>330
				TOTAL	

Tennessee Foal Model

1. WBC cells/ul		
a. <2,000	=	1.0
b. 2,000 to 4,400	=	2.0
c. > 4,400	=	3.0
2. Anion Gap meq/L		
a. >23.6	=	0.3
b. 17 – 16.3	=	0.5
c. 15.7 – 17	=	0.8
d. <15.7	=	1.1
3. Creatinine mg/dl		
a. >1.9	=	0.0
b. <1.9	=	1.1
4. Rectal Temp F		
a. <96.2	=	0.2
b. 96.2 – 99.3	=	0.4
c. >99.3	=	0.5
5. Recumbency		
a. Yes	=	0.0
b. No	=	2.2
6. Suckle		
a. Yes	=	0.9
b. No	=	0.0

Model Prediction of Survival	
Score	Percentage
1.5	9.70%
2.0	15.05%
2.5	22.60%
3.0	32.50%
3.5	44.26%
4.0	56.69%
4.5	68.33%
5.0	78.06%
5.5	85.44%
6.0	90.63%
6.5	94.10%
7.0	96.34%
7.5	97.74%
8.0	98.62%
8.5	99.16%
8.8	99.38%

TOTAL = _____

ADJUSTED PROBABILITY OF SURVIVAL

Model Score	Clinician Estimate								
	10.00%	20.00%	30.00%	40.00%	50.00%	60.00%	70.00%	80.00%	90.00%
8.5 - 8.8	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
7.5 - 8.5	64.96%	80.66%	87.73%	91.75%	94.35%	96.16%	97.50%	98.52%	99.34%
7.0 - 7.5	41.39%	61.38%	73.15%	80.91%	86.41%	90.51%	93.68%	96.22%	98.28%
6.5 - 7.0	30.62%	49.83%	63.00%	72.59%	79.89%	85.63%	90.26%	94.08%	97.28%
5.5 - 6.5	12.97%	25.10%	36.49%	47.20%	57.28%	66.79%	75.78%	84.28%	92.35%
4.5 - 5.5	8.51%	17.31%	26.40%	35.82%	45.57%	55.67%	66.14%	77.00%	88.28%
3.5 - 4.5	1.91%	4.21%	7.00%	10.49%	14.94%	20.86%	29.08%	41.27%	61.26%
1.5 - 3.5	0.98%	2.17%	3.67%	5.60%	8.16%	11.77%	17.18%	26.23%	44.45%

