Two Novel Clinical Scoring Systems for Bovine Respiratory Disease in Pre-Weaned Dairy Calves

William Love
PhD Candidate

Sharif Aly
Assistant Professor

Philip Kass
Professor

Christiana Drake
Professor

Thomas Farver
Professor

Hugh Crockford
Resident

Jessica Davis
Resident

Alison Van Eenennaam
Cooperative Ext. Spec.

Terry Lehenbauer
Director, Professor

Introduction

Bovine Respiratory Disease (BRD) which includes pneumonia, is a multi-factorial disease of cattle and a leading cause of productivity loss in North American beef and dairy herds. Identification and treatment of BRD in pre-weaned dairy heifers is of particular interest since these calves may experience a life-long reduction in productivity. However, accurate diagnosis and control of BRD in production settings have proven challenging for a number of reasons, including inaccurate and costly diagnostic criteria and variable clinical presentation. This may lead to inappropriate administration of antibiotics to healthy calves or production loss from untreated cases.

Standardized clinical scoring systems have been applied in several fields to diagnose and predict clinical outcomes in a repeatable, reliable manner. A standardized and validated scoring system for BRD would be a useful tool to improve BRD diagnosis, treatment, and control. While at least one previous scoring method has been proposed, no BRD clinical score or validation has been published in peer-reviewed literature.

Study Aim

The aim of this research is to develop and validate a standardized clinical scoring system to diagnose BRD in pre-weaned dairy calves.

This project is the first phase of our proposed research plan to develop a BRD risk assessment tool for California dairy producers. The validation of this scoring system is the subject of a spring 2013 research project. In addition, a 2013 questionnaire on California calf management practices will be used to identify practices associated with increased BRD prevalence. The final study in our research plan will be to design a risk assessment tool using both the management questionnaire and the validated and standardized BRD scoring system.

This research is being performed in conjunction with the Bovine Respiratory Disease Complex Coordinated Agricultural Project, led by Dr. Womack at Texas A&M.

Bovine Respiratory Disease Complex
Coordinated Agricultural Project

Method

Population & Sampling

- 1,996 pre-weaned Holstein calves were sampled from a large calf ranch in the San Joaquin valley. Calves were between 23 and 86 days old.
- Calves were categorized as clinically ill or healthy based on a previously described clinical score from the University of Wisconsin, Madison ("WI Score"). Clinically ill calves (WI Score ≥ 5) were pair-matched to healthy calves (WI Score ≤ 3) housed nearby and sampled on the same day.
- The following clinical signs were recorded for each calf:
  - Cough* (5 levels)
  - Nasal discharge* (4 Levels)
  - Ocular discharge* (4 Levels)
  - Ear & Head position* (4 levels)
  - Rectal temp/Fever* (5 levels)
  - Dyspnea (+/-)
  - Tachypnea (+/-)
  - Emaciation (+/-)
  - Depression (+/-)
  - Anorexia (+/-)
  - Diarrhea (+/-)

  *Indicates clinical signs used in the WI score
- Deep pharyngeal and mid-nasal culture swabs were collected from each calf. Aerobic bacterial & mycoplasmal culture were performed on all swabs. Deep pharyngeal swabs were also submitted for PCR to detect bovine respiratory syncytial virus (BRSV), bovine corona virus, bovine herpesvirus-1, and bovine viral diarrhea virus.

Analysis & Score Development

- Calves were considered BRD positive if they had a WI Score ≥ 5 **and** were PCR/culture positive for any of the following BRD pathogens: BRSV, *Mycoplasma bovis, Histophilus somnus*, *Mannheimia haemolytica*, *Pasteurella multocida*, or *Bibersteinia trehalosi.*
- Conditional logistic regression was used to estimate clinical sign effect measures. Models were compared using Akaike's Information Criterion (AIC).
- Levels with similar effect measures and those which converged poorly were collapsed into adjacent levels.
- Scores for each specific clinical sign were weighted by their associated regression coefficient, rounded to the nearest integer.
- Total score S_{total}, was calculated by summing the component scores: S_{Cough}, S_{Nasal}, S_{Eye}, S_{Ears}, S_{fever}.
- Two scores were developed. Score #1 allowed all of the WI score's clinical sign levels to be considered in the model. Score #2 removed cough induction to reduce calf handling and possible inter-observer variation.
- Score cut-offs were selected to maximize sensitivity and specificity.

Results

Model Selection & Performance

Comparison of the 3 scoring systems are presented in table 1. After inclusion of the clinical signs from the WI scoring system, no other clinical signs significantly improved model fit. Test Cut-offs for scores #1 & #2 were set to classify calves as BRD positive if $S_{total} \geq 6$. The diagnostic performance of all 3 scoring systems are presented in table 2. The specificity of scores #1 & 2 (44.7% & 43.8%, respectively) to detect calves infected with BRD-associated pathogens were slightly lower than that of the WI score (48.0%), while their specificities (69.4% & 68.9%) were slightly higher than the WI score (64.9%). Overall, the performance among the 3 scores is very similar, but the simpler scoring criteria of the new scores may make them more appealing. Evaluation of all three scores in independent samples of calves across multiple ranches remains necessary for further validation.

Table 1. Score values associated with specific clinical signs in WI BRD clinical score, and two scores generated by different standardized BRD scoring systems.

Clinical Signs	Specific Signs	Scores WI	Scores #1	Scores #2
Cough (S_{Cough})	Normal	0	0	0
	Single induced	1	4	0
	Multiple induced	2	4	0
	Single Spontaneous	2	4	5
	Multiple Spontaneous	3	4	5
Nasal (S_{Nasal})	Normal	0	0	0
	Unilateral, serous	1	2	2
	Bilateral, cloudy	2	2	6
	Mucopurulent	3	2	6
Ocular (S_{Eye})	Normal	0	0	0
	Small amount	1	2	2
	Moderate, bilateral	2	2	2
	Heavy	3	2	2
Ears & Head (S_{Ears})	Normal	0	0	0
	Ear twitch	1	0	0
	Unilateral ear droop	2	4	6
	Bilateral ear droop or head tilt	3	4	6
Rectal Temp (S_{Fever})	< 100.9 F	0	0	0
	101.0-101.9	1	0	0
	102.0-102.4	2	0	0
	102.5-102.9	2	2	3
	>103.0	3	2	3

Table 2. Diagnostic performance of Wisconsin and 2 new BRD scoring systems to accurately classify calves as BRD positive based on microbiological testing alone and in combination with clinical signs. AUC: Area under curve, Se : Sensitivity, Sp: Specificity

Score	Outcome	Cut-Off	AUC (95%CI)	Se (%)	Sp (%)
WI Score	Clin + Micro	≥5	0.954 (0.944, 0.963)	100.0	90.0
	Micro only	≥5	0.564 (0.533, 0.595)	48.0	64.9
Score #1	Clin + Micro	≥6	0.950 (0.940, 0.960)	91.5	90.2
	Micro only	≥6	0.571 (0.541, 0.601)	44.7	69.4
Score #2	Clin + Micro	≥6	0.951 (0.941, 0.960)	89.7	90.1
	Micro only	≥6	0.578 (0.549, 0.608)	43.8	68.9

Example Calves

Two calves were selected from the study to demonstrate score calculation.

Calf #2555 37 day-old heifer

Clinical signs: Unilateral serous nasal discharge, mild ocular discharge, unilateral ear droop, 103.9℉ rectal temperature

Culture: *P multocida* (light growth)

Score	S_{Cough}	S_{Nasal}	S_{Eye}	S_{Ears}	S_{Fever}	S_{Total}	Result
WI	0	1	(1	2)*	3	6	BRD +
#1	0	2	2	4	2	10	BRD +
#2	0	2	2	6	3	13	BRD +

Calf #4456 46 day-old bull

Clinical signs: Moderate bilateral cloudy nasal discharge, mild ocular discharge, unilateral ear droop, 100.9℉ rectal temperature

Culture: BRSV +

Score	S_{Cough}	S_{Nasal}	S_{Eye}	S_{Ears}	S_{Fever}	S_{Total}	Result
WI	0	2	(1	2)*	0	4	Suspect
#1	0	2	2	4	0	8	BRD +
#2	0	6	2	6	0	14	BRD +

*WI score uses the only the higher of S_{Eye} & S_{Ears} to calculate S_{Total}.

UCDAVIS VETERINARY MEDICINE
Veterinary Medicine Teaching and Research Center

University of California
Agriculture and Natural Resources

HEALTHY FOOD SYSTEMS | *HEALTHY* ENVIRONMENTS | *HEALTHY* COMMUNITIES | *HEALTHY* CALIFORNIANS