Bovine Respiratory Disease, Interstitial Pneumonia, and Heart Disease: timing, risk factors, and pathology

Brad White, DVM, MS
Beef Cattle Institute
Kansas State University

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BCI Funding disclosure

- Foundation for Food and Agricultural Research
- USDA National Institute for Food and Agriculture
- USDA Higher Education Challenge Grants
- USDA Veterinary Services Grant Program
- National Science Foundation
- KS Beef Council
- KS Dept. of Agriculture
- National Cattlemen's Beef Association
- American Angus Association
- American Association of Bovine Practitioners
- Alberta Veterinary Labs
- Elanco
- Boehringer-Ingleheim

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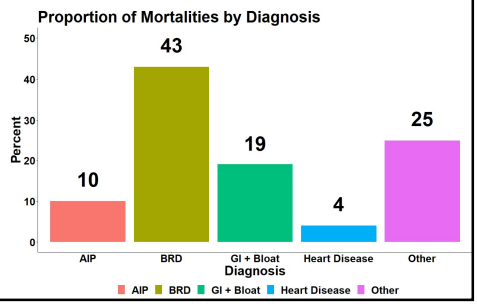
BRD Research

- BCI Feedlot database
  - ~50 feedyards (various projects)
  - Represent ~ 2 million head on feed



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- BRD Timing
- BRD Diagnosis
- Post-treatment outcomes
- Heart disease
- Pen management and BRD

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- BRD Timing
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- Pen management and BRD

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BRD Timing

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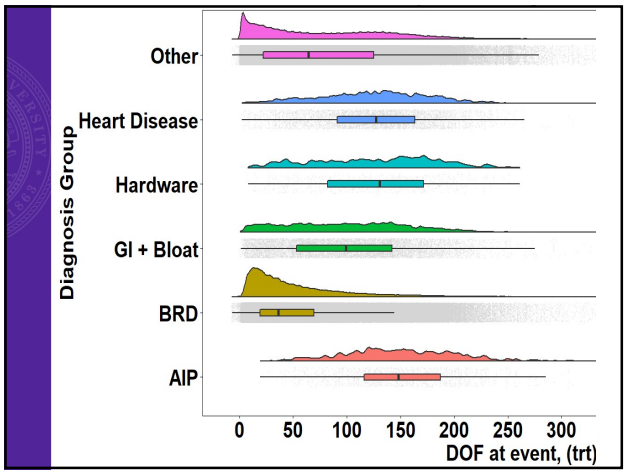

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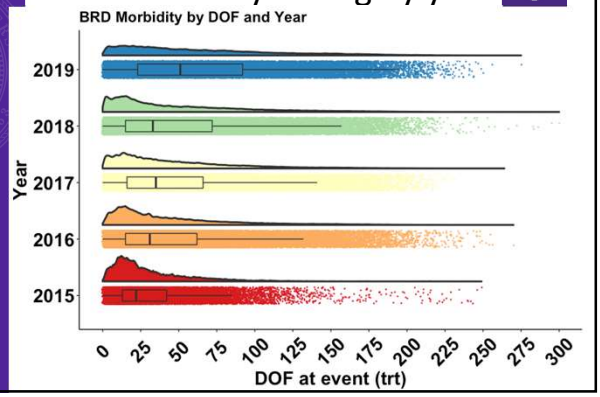
BRD Morbidity timing by year



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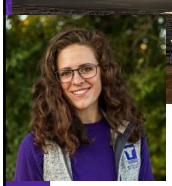
Determining Relevant Risk Factors Associated with Mid-day and Late-day BRD Morbidity



Objectives:

- Case definitions for middle and late day BRD: ***cohort level***
- Determine risk factors for middle- and late-day BRD: ***individual animal***

Smith et al. Applied Anim Sci 2022 38(4): 373-379

Smith et al. Applied Anim Sci 2022 38(4): 360-372

Funding provided by FFAR grant

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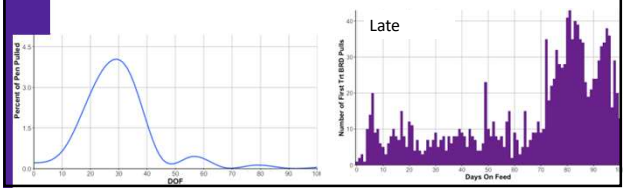
Cohort case Definition: combination of consultant and timing

Consultant Classification

- Consultant survey: all clusters
- 13 respondents

Timing classification

- Majority of morbidity occurred:
  - Early DOF 0-42
  - Middle DOF 42 – 71
  - Late DOF 72-100



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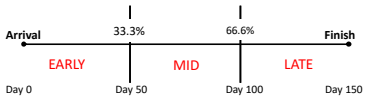
Individual Defining timing of disease (Morbidity)

- No well-defined case definition of BRD timing
- Only included first Tx with diagnosis BRD
- Timing determined by (DOF at first treatment for BRD / cohort total DOF)*100

Early: 0-33.3%
Mid: 33.4-66.6%
Late: 66.7-100%



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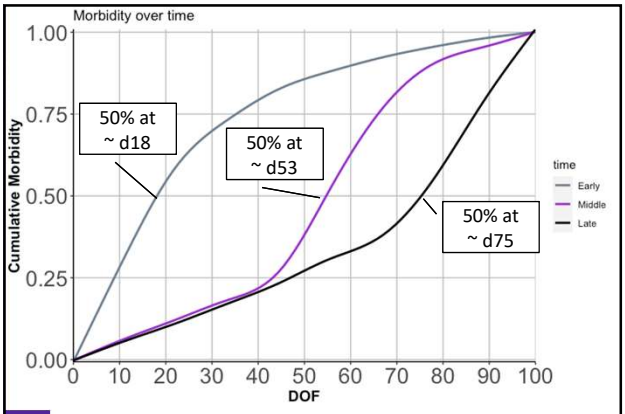

Cohort Patterns

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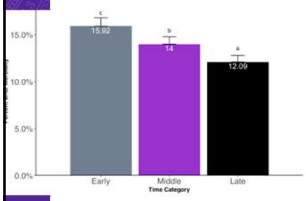
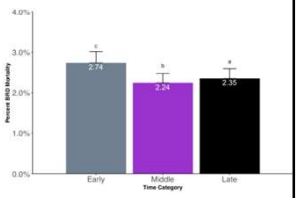
Cohort Health

Morbidity



Mortality



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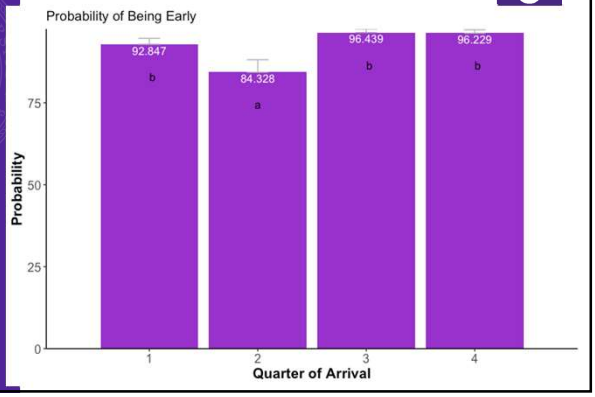
Cohort Results



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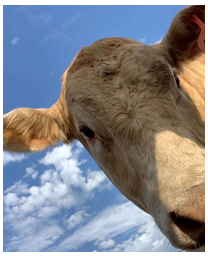
Conclusions

- **Cohorts** classified as:
  - Early (93.6%)
  - Middle (4.1%)
  - Late (2.3%)
- **Cohorts** arriving in Q2 more likely to be:
  - Middle (5.5%)
  - Late (10.1%)
- **Individual** risk factors
  - Heifers more likely to be mid-late (modified by arrival quarter and weight)



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An Evaluation of Temporal Distributions of High, Low, and Zero Cohort Morbidity of Cumulative First Treatment Bovine Respiratory Disease and Their Associations with Demographic, Health, and Performance Outcomes in US Feedlot Cattle

B. Johnson,
B. White,
P. Lancaster,
R. Larson

Objectives:

- *Cluster analysis on temporal distributions of first Tx BRD:*
  - HIGH (≥15%)
  - LOW (>0% - 15%)
- *Determine associations among clusters*
  - demographic risk factors
  - health outcomes
  - Performance
- 10 feedlots; ~1.0 million head

2023 Johnson et al. Vet Sci

FFAR Late Day BRD Grant

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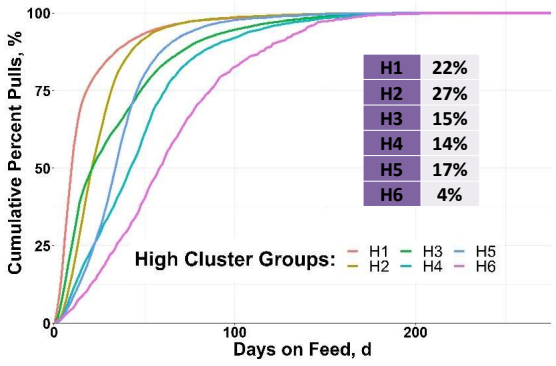
HIGH (>15%) clusters (n=6)



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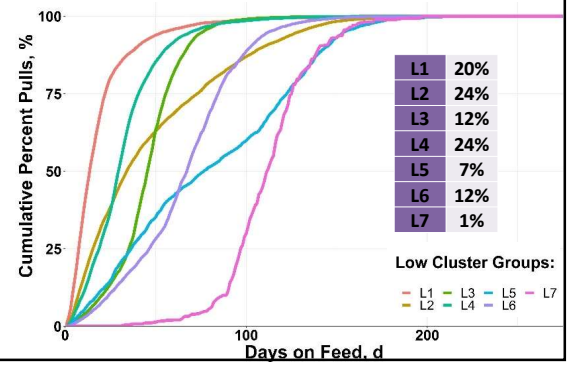
Low (>0-15%) Clusters (n=7)



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Results

- Demographic
  - Cattle in ZERO had lowest (n=93) avg hd received
  - LOW smaller shrink compared to HIGH
    - ZERO had lowest shrink; 1.24%
- Performance
  - Minimal differences in ADG
    - Several in HIGH group lower ADG compared to LOW
- Health
  - Higher morbidity and mortality with earlier disease

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BRD Timing

BRD Diagnosis

Post-treatment outcomes

Heart disease

Pen management and BRD

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Clinical v. Gross Diagnosis

Objective: Characterize the epidemiology factors associated with four gross lung diagnoses (AIP, BP, BIP, and normal) observed during feedlot cattle necropsies and describe the agreement between treatment diagnosis and necropsy diagnosis.

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Descriptive Statistics

- 357 animals enrolled in the study (had to have a lung diagnosis that was either AIP, BIP, BP or normal lung tissue, and retrospective data from feedyards)
- Sex:
  - Heifers: 70.6% (252)
  - Steers: 29.4% (105)
- Treatment pulls:
  - None = 27.2% (97)
  - Once = 29.4% (105)
  - Twice = 24.5% (88)
  - Three or more = 18.9% (67)

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Necropsy Gross Diagnoses

Feedlot diagnosis	AIP	BIP	BP	Normal	Total
AIP	9	22	14	2	47
BIP	2				
BP	9				
BP/AIP + OTHER	3				
OTHER	17				
Total	40				

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Necropsy Gross Diagnoses

Feedlot diagnosis	AIP	BIP	BP	Normal	Total
AIP	9	22	14	2	47
BIP	2	9	7		18
BP	9	68	40	6	123
BP/AIP + OTHER	3	15	17	3	38
OTHER	17	28	67	19	131
Total	40	142	145	30	**357**

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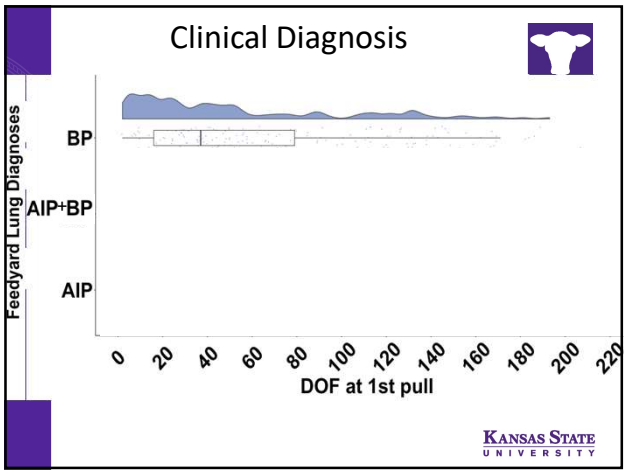
Clinical Diagnosis
Feedyard Lung Diagnoses
BP
AIP+BP
AIP
0 20 40 60 80 100 120 140 160 180 200 220
DOF at 1st pull
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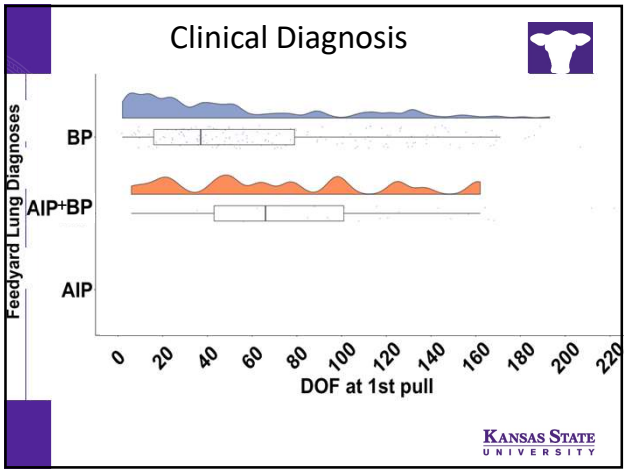
Clinical Diagnosis
Feedyard Lung Diagnoses
BP
AIP+BP
AIP
0 20 40 60 80 100 120 140 160 180 200 220
DOF at 1st pull
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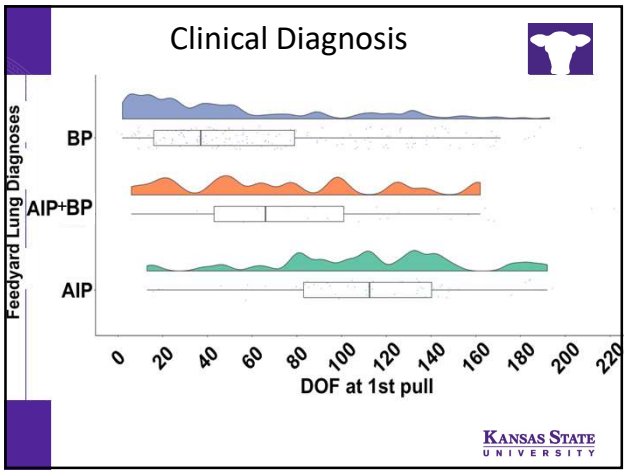
Clinical Diagnosis
Feedyard Lung Diagnoses
BP
AIP+BP
AIP
0 20 40 60 80 100 120 140 160 180 200 220
DOF at 1st pull
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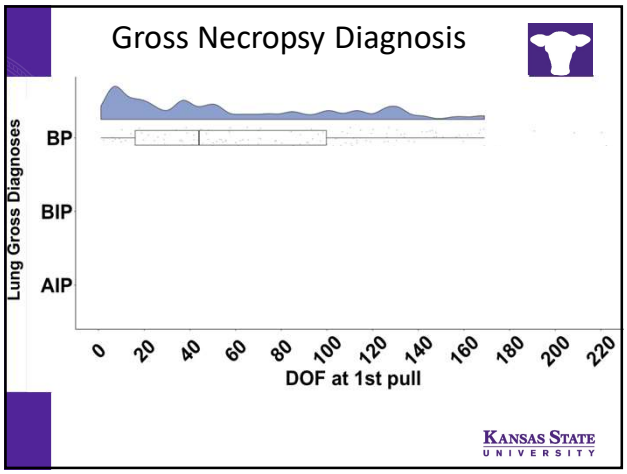
Gross Necropsy Diagnosis
Lung Gross Diagnoses
BP
BIP
AIP
0 20 40 60 80 100 120 140 160 180 200 220
DOF at 1st pull
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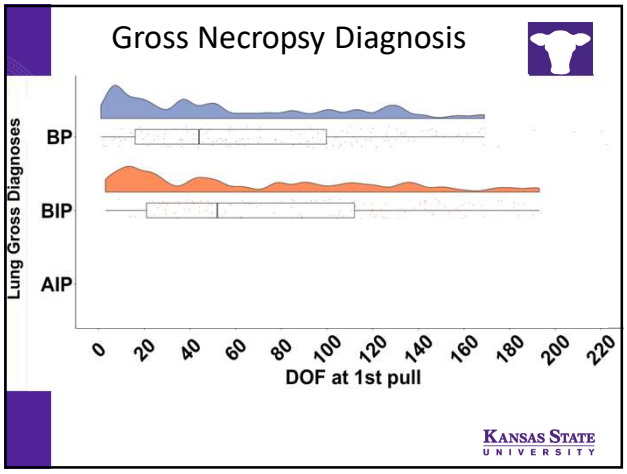
Gross Necropsy Diagnosis
Lung Gross Diagnoses
BP
BIP
AIP
0 20 40 60 80 100 120 140 160 180 200 220
DOF at 1st pull
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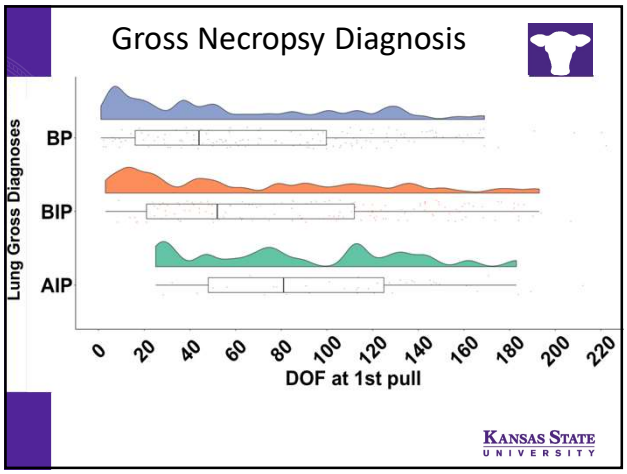
Gross Necropsy Diagnosis
Lung Gross Diagnoses
BP
BIP
AIP
0 20 40 60 80 100 120 140 160 180 200 220
DOF at 1st pull
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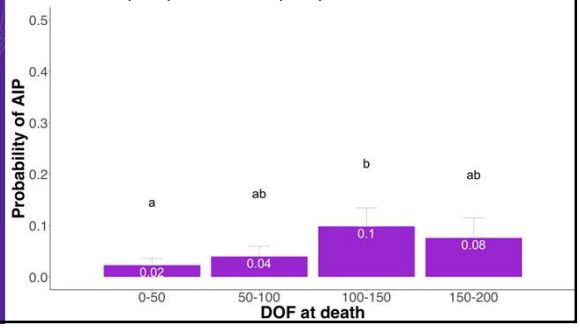
Risk factors for AIP

- Heifers (9%) > Steers (3%)



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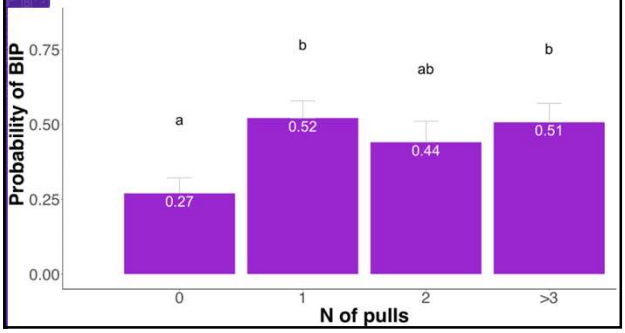
Risk factors for BIP

- More likely at 150-200 DOF than 0-50



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Clinical v. Gross Conclusions

- Further understanding of interstitial pneumonia to determine its impact on animal health
- Bias to diagnose AIP later in the feeding phase and BP in the beginning
- Evaluated potential risk factors for respiratory lesions

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- BRD Timing
- BRD Diagnosis
- **Post-treatment outcomes**
- Heart disease
- Pen management and BRD

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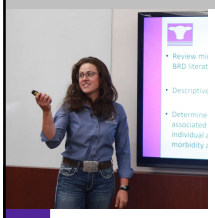
Evaluation of first treatment timing, fatal disease onset, and days from first treatment to death associated with bovine respiratory disease in feedlot cattle



Objectives:

Evaluate BRD temporal patterns for cattle in U.S. feedyard systems

K.J. Smith, D.E. Amrine, R.L. Larson, J.I. Szaz, J.W. Waggoner, B.J. White, M.E. Theurer

Smith et al. Vet Sci 2023 10:204

Funding provided by FFAR grant

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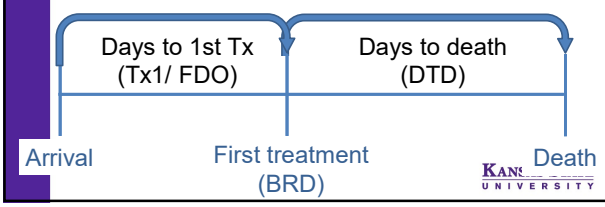
Materials and Methods:

- **Timing of:**
  - Days to first treat BRD morbidity (Tx1)
  - Days to fatal disease onset (FDO)
  - Days to death (DTD) (days from first pull for BRD till death attributed to BRD



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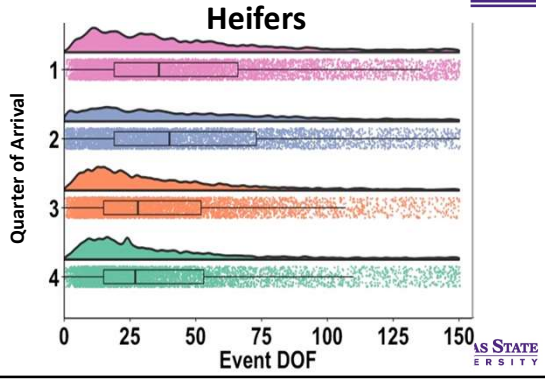
DOF: Arrival to BRD Treatment



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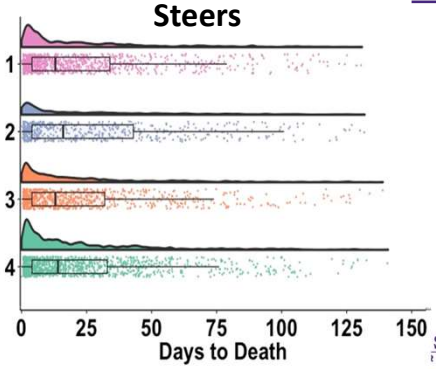
Days to death (DTD)



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Evaluation of predictive models to determine final outcome for feedlot cattle based on information available at first treatment for bovine respiratory disease

Lilli Heinen

L. Heinen, B.J. White, D.E. Amrine, R.L. Larson

Objective:
- Evaluate predictive model ability to determine probability of an animal finishing feeding phase after first treatment for BRD

Data:
- 12 feedyards, 5 year
- 96,382 BRD cases
  - 14.2% did not finish; DNF

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Results

- Baseline model:

Model	AUC	Sn(%)	Sp(%)	Acc(%)	PPV	NPV
Base Dec Tree	0.74	57%	76%	74%	0.28	0.91

- Models did not approve appreciably with sampling technique
- Adding weather data did not improve models

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Risk factors associated with case fatality and treatment success following initial bovine respiratory disease treatment in feedyard cattle

Kyndall Neal

Objective:
- identify relationships between risk factors at initial BRD treatment with:
  - first treatment success
  - non-cause specific case fatality risk
  - cause-specific case fatality risk

Data:
- 14 feedyards, 3 years
- 132,521 initial BRD Tx

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Results

- Treatments early in the feeding phase (DOF 0-10, 11-20) resulted in:
  - lower FTS (49.2% ± 0.8; 55.3% ± 0.8)
  - higher CFRALL (12.5% ± 1.3; 12.6% ± 1.4)
  - higher CFRBRD (6.3% ± 1.1; 6.1% ± 1.0) compared to cattle treated days 21-70
- Rectal temperature in 39.4-40.0°C category had higher CFRALL (15.3% ± 1.5) and CFRBRD (9.2% ± 1.5) compared to other rectal temperature categories

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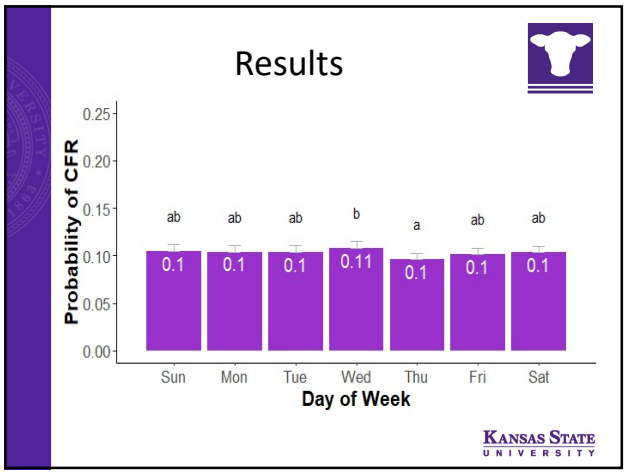
Results
Probability of CFR
0.25
0.20
0.15
0.10
0.05
0.00
ab
ab
ab
b
a
ab
ab
0.1
0.1
0.1
0.11
0.1
0.1
0.1
Sun
Mon
Tue
Wed
Thu
Fri
Sat
Day of Week
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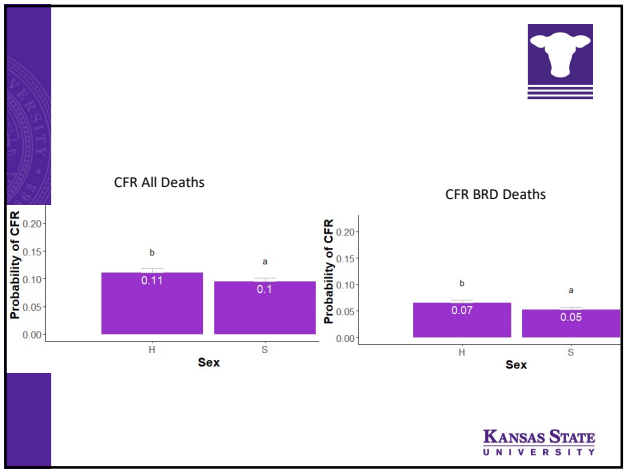
CFR All Deaths
Probability of CFR
b
a
0.11
0.1
H
S
Sex
CFR BRD Deaths
Probability of CFR
b
a
0.07
0.05
H
S
Sex
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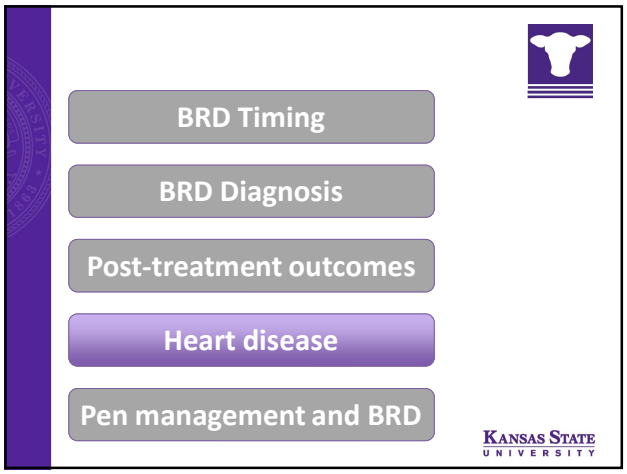
BRD Timing
BRD Diagnosis
Post-treatment outcomes
Heart disease
Pen management and BRD
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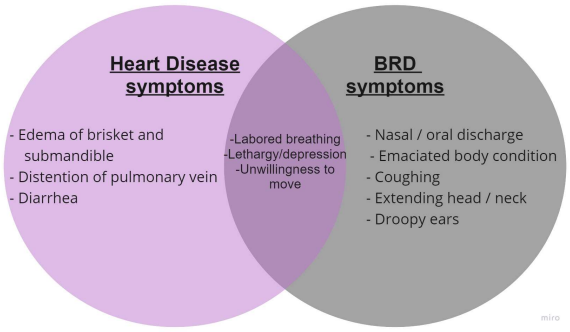
Similarities Between Heart Disease Symptoms vs. BRD Symptoms



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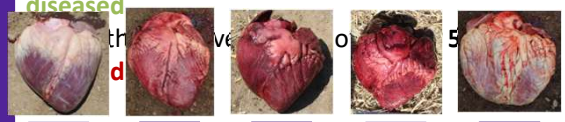
Heart Scoring Method

- We used a 1-5 heart scoring system based on current scoring standards (Hefferenan et. al, 2020).
- Hearts that received scores of **1** or **2** = **non-diseased**



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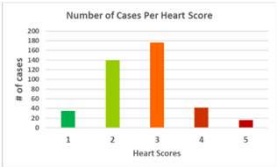
Heart Data Descriptives

- Ended the summer with 517 total cases, 414 heart cases
- 175 non-diseased hearts (scored 1-2)
- 239 diseased hearts (scored 3-5)



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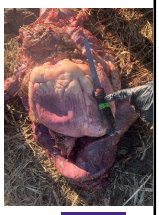
Retrospective analysis of associations between risk factors and probability of a non-infectious heart disease death

Blaine Johnson

B. Johnson,
D. Amrine,
R. Larson,
R. Weaber,
B. White

Objective:

- Determine associations of cohort factors and risk of at least one non-infectious heart disease death.



Funding provided by American Angus Association Foundation

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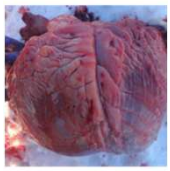
Introduction

- Non-infectious Heart Diseases (CHF, Right-Heart Failure, Cor Pulmonale, and Brisket Disease) previously described
  - Few associations of cohort demographics on heart disease risk and timing.



Photos courtesy of Feedlot Health Management Services Ltd, 2020

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Working Data Set

Steers/Heifers
Cohorts > 39 hd
2016-2019
Arrival 400-1100
Closed lots 100-360 dof

28,950 Cohorts
- **4,596,205 hd**
  - **75,963 (1.65%) mortalities**

3,282 (~0.07%) Non-Infectious Heart Mortalities

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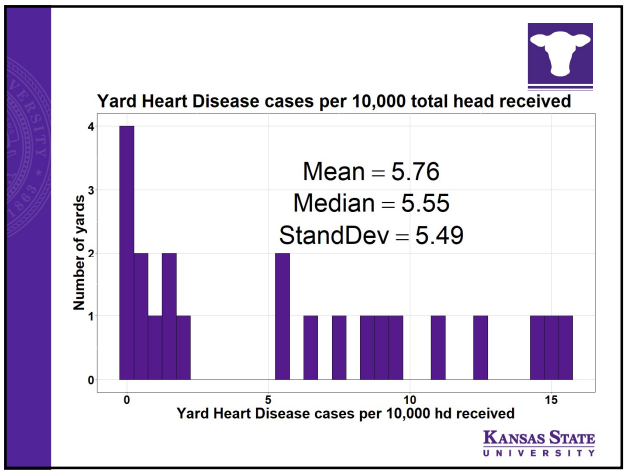
Yard Heart Disease cases per 10,000 total head received
Mean = 5.76
Median = 5.55
StandDev = 5.49
Number of yards
Yard Heart Disease cases per 10,000 hd received
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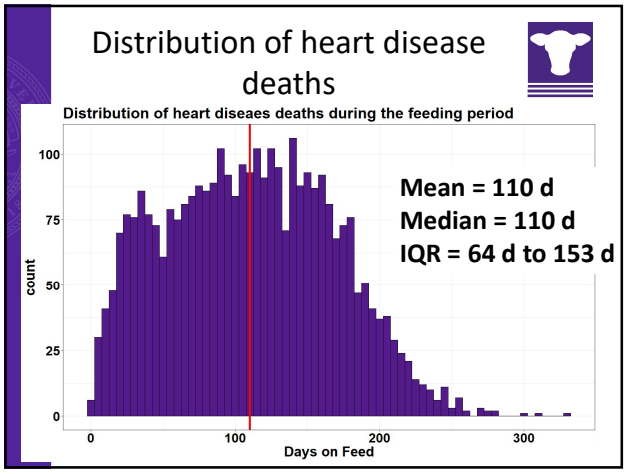
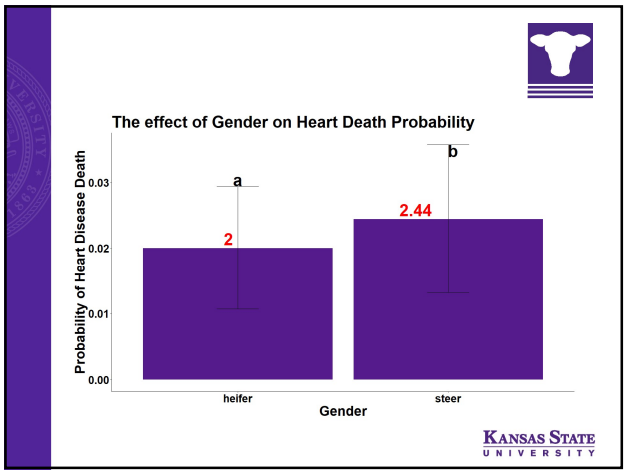

Distribution of heart disease deaths
Distribution of heart diseaes deaths during the feeding period
Mean = 110 d
Median = 110 d
IQR = 64 d to 153 d
count
Days on Feed

53


The effect of Gender on Heart Death Probability
Probability of Heart Disease Death
a
b
2
2.44
heifer
steer
Gender
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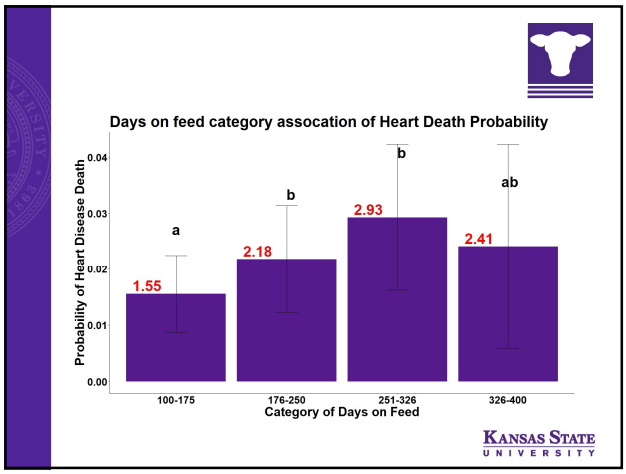
Days on feed category assocation of Heart Death Probability
Probability of Heart Disease Death
0.04
0.03
0.02
0.01
0.00
a
b
b
ab
1.55
2.18
2.93
2.41
100-175
176-250
251-326
326-400
Category of Days on Feed
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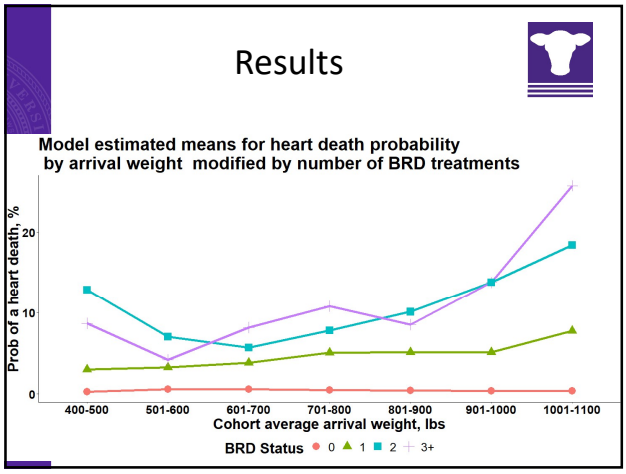
Results
Model estimated means for heart death probability
by arrival weight modified by number of BRD treatments
Prob of a heart death, %
20
10
0
400-500
501-600
601-700
701-800
801-900
901-1000
1001-1100
Cohort average arrival weight, lbs
BRD Status 0 1 2 3+

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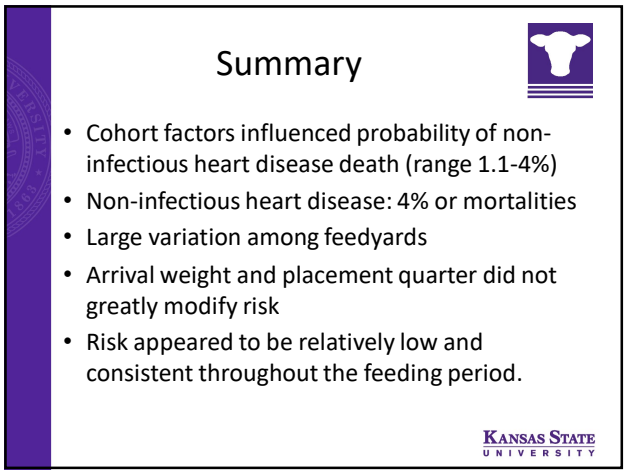
Summary
• Cohort factors influenced probability of non-infectious heart disease death (range 1.1-4%)
• Non-infectious heart disease: 4% or mortalities
• Large variation among feedyards
• Arrival weight and placement quarter did not greatly modify risk
• Risk appeared to be relatively low and consistent throughout the feeding period.
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BRD Timing

BRD Diagnosis

Post-treatment outcomes

Heart disease

Pen management and BRD

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Associations of pen management characteristics and cattle morbidity in the first 45 days after feedlot arrival

Hector Rojas

H. Rojas, D. Amrine, S. Capik, R. Larson, B. White

Objective:
- Determine associations between
  - Pen Density and bunk space per head

And
- BRD risk (1st 45 DOF)

Data:
- 1,733 cohorts (avg size~120 hd), multiple feedyards

USDA Funding: USDA National Institute of Food and Agriculture Grant no. 2019-67015-29845

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Covariates of Interest

- Categories created according to KSRE recommendations
  - Pen area: 250-350 square feet (sq. ft.)
  - Bunk space: 1.01-1.5 feet (ft.)

1,733 Cohorts of Cattle

	<	Recom-mendations	>
Pen area per head	≤250 sq. ft.	251-350 sq. ft.	≥351 sq. ft.
Bunk space per head	≤1 foot	1.01 – 1.5 feet	≥1.5 feet

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Results

- Pen density associated with BRD morbidity: when pen space/hd < 250 sq ft
  - Heavier cattle (900-1000 lbs) ↑ morbidity
  - Larger groups (> 175 hd) ↑ morbidity
- Bunk space lower than 1 ft/hd
  - Heavier cattle (900-1000) slightly ↓ morbidity

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- BRD Timing
- BRD Diagnosis
- Post-treatment outcomes
- Heart disease
- Pen management and BRD

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