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Thoracic Ultrasonography for IP Diagnosis and Prognosis of Feedlot Respiratory Disease

ARC Regional (West)
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Resource Collaborations

FFAR
Grant ID 22-000564

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ILS
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VETERINARY EDUCATION, RESEARCH, & OUTREACH

RowanUniversity
SHREIBER SCHOOL OF VETERINARY MEDICINE

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General Background & Objectives

- Bovine respiratory disease (BRD) is an important cause of morbidity and mortality in beef feedlot industry. BRD causes decreased feed efficiency and weight gain, increased cost, and death.
- Utilization of chute-side technologies to aid on Diagnosis and Prognosis.

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Terminology

- **BRD =** Bovine Respiratory Disease
- **BP =** Bronchopneumonia, often associated with bacteria and results in consolidation
- **IP =** Interstitial pneumonia, typically associated with viruses or incompletely characterized pneumotoxins
- **BIP =** Bronchopneumonia with interstitial pneumonia
- **POCUS** = Point-of-care (chuteside) Ultrasound of Lung and Pleura
- **Cranio-ventral** = Towards the head and belly / elbow area
- **Caudo-dorsal** = Towards the top and tail

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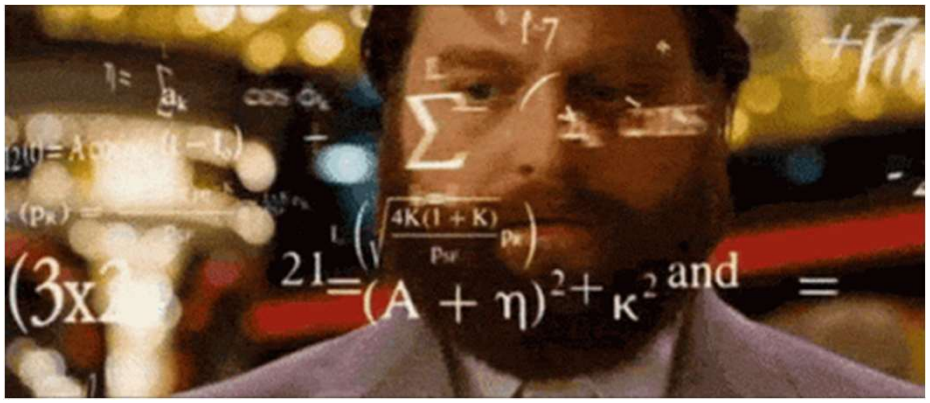
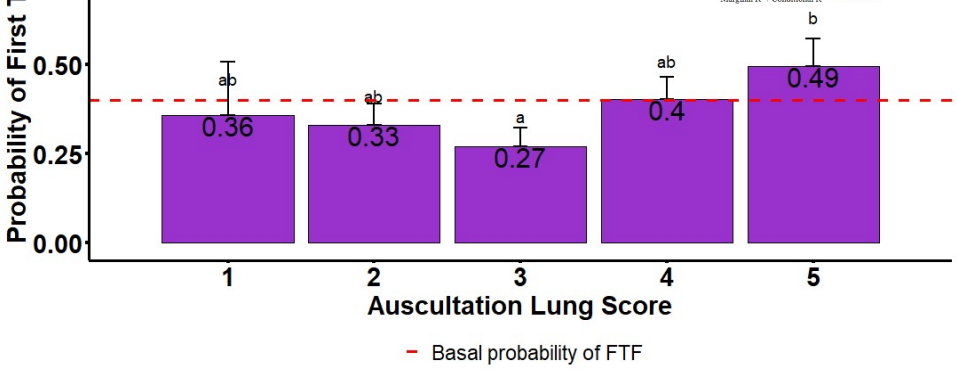


Respiratory disease and its complexity

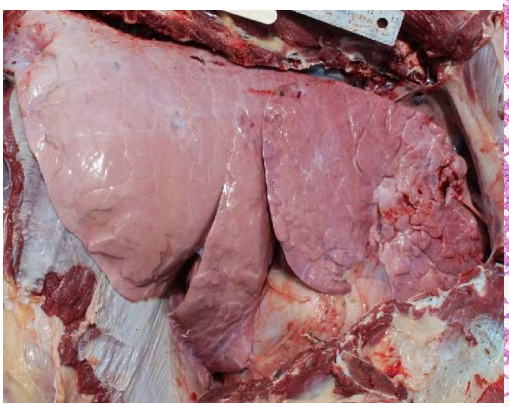
FTF: How about auscultation only

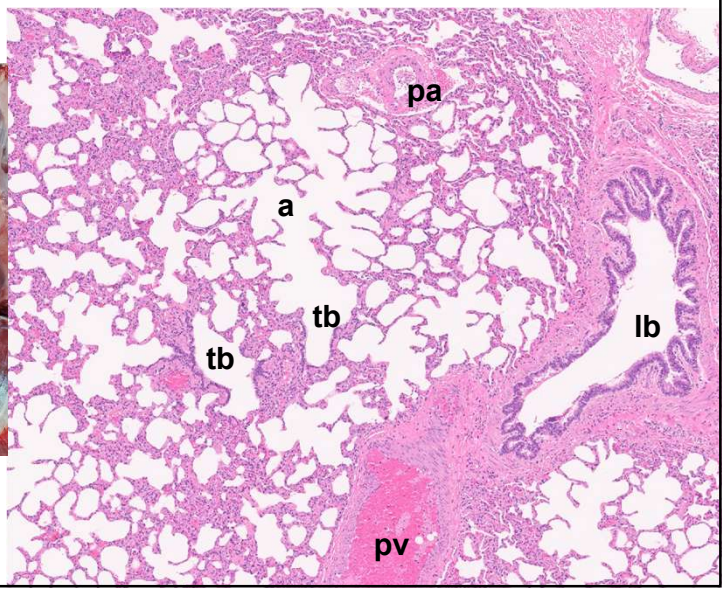
	Chisq	Df	Pr(>Chisq)	
(Intercept)	0.4517	1	0.50151	
Sex	0.0152	1	0.90191	
DOF_cat	1.3401	2	0.51168	
BW_cat	6.7787	3	0.07929	.
CV	8.7513	4	0.06762	.

	FTS		
Predictors	*Odds Ratios*	*CI*	*p*
(Intercept)	1.70	0.36 – 7.90	0.502
Sex [Steer]	1.03	0.60 – 1.77	0.902
DOF_cat43-71	0.94	0.40 – 2.21	0.890
DOF cat [>71]	0.65	0.30 – 1.41	0.274
BW_cat600-800	1.19	0.52 – 2.72	0.678
BW_cat800-1000	2.09	0.81 – 5.41	0.127
BW cat [>1000]	0.92	0.30 – 2.82	0.879
CV [2]	1.13	0.30 – 4.30	0.860
CV [3]	1.50	0.40 – 5.66	0.550
CV [4]	0.83	0.22 – 3.13	0.778
CV [5]	0.57	0.14 – 2.25	0.420
Random Effects			
σ^2	3.29		
$\tau_{00\ Lot}$	0.51		
ICC	0.13		
N_{Lot}	143		
Observations	443		
Marginal R^2 / Conditional R^2	0.068 / 0.193		



Normal Lung





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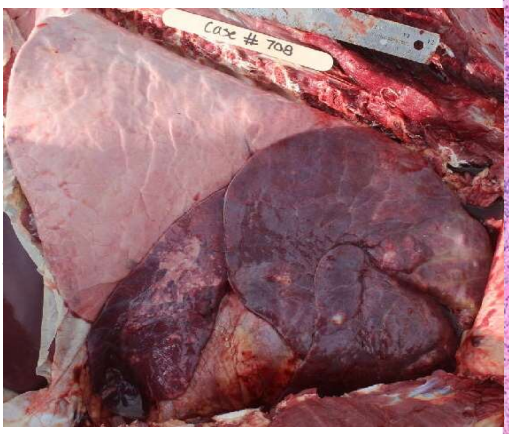
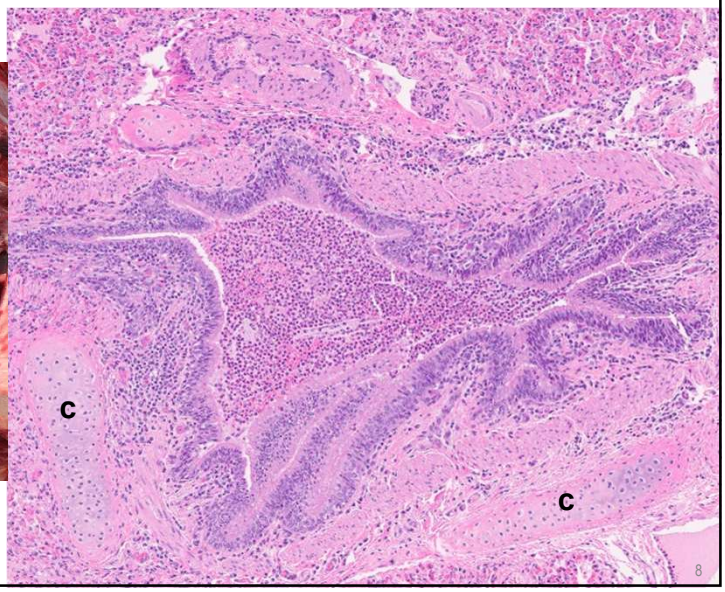
Acute BP





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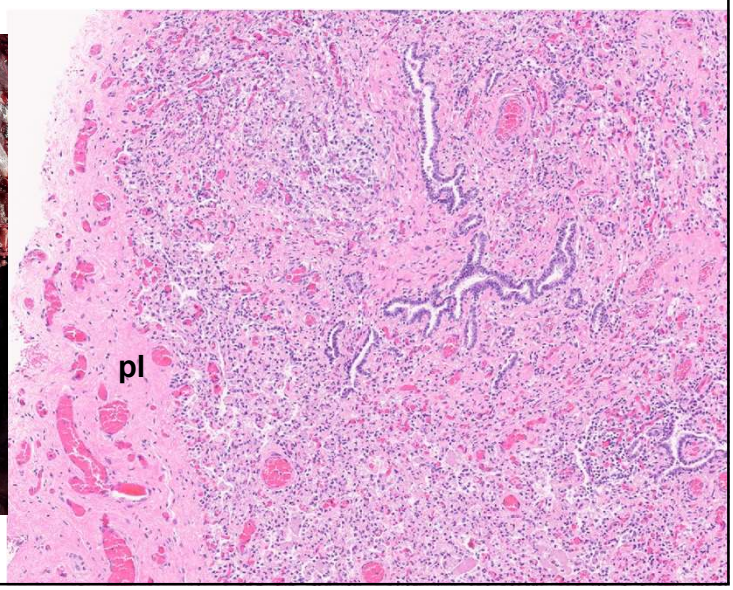
Chronic BP



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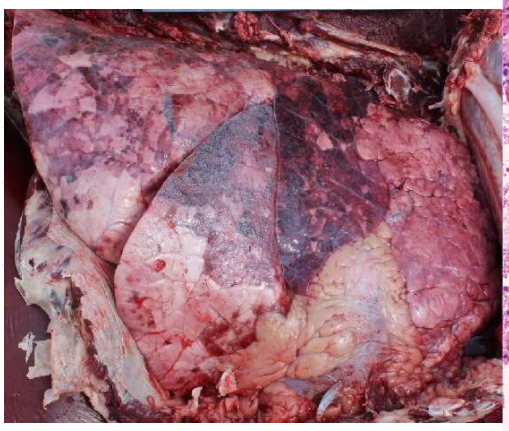
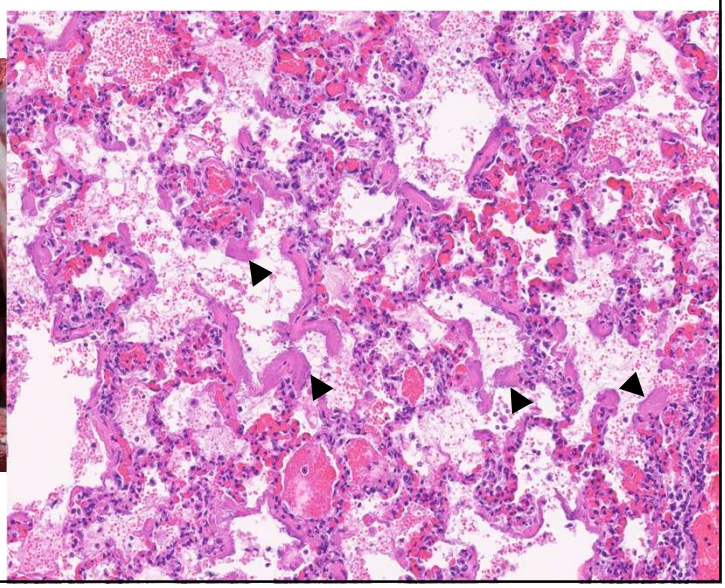
Acute IP





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Bronchopneunomia with Interstitial Pneumonia

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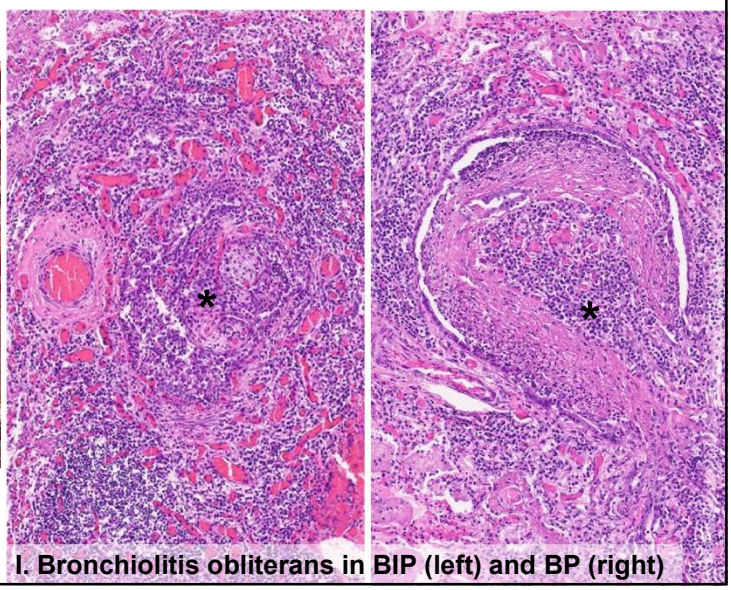
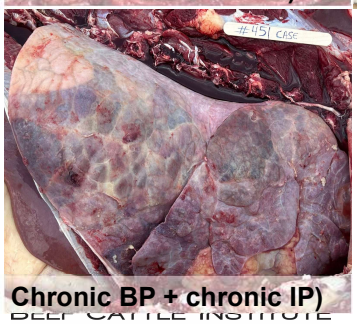


I. Bronchiolitis obliterans in BIP (left) and BP (right)

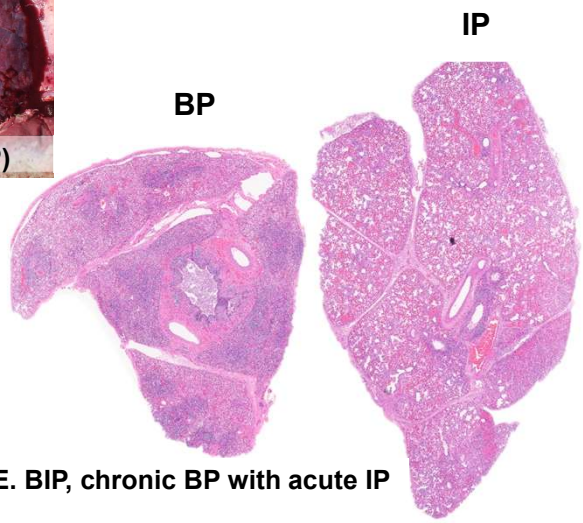
Bronchopneunomia with Interstitial Pneumonia

Chronic BP + acute IP)

Acute BP + chronic IP)



Chronic BP + chronic IP)



E. BIP, chronic BP with acute IP

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How did we learn about chute-side Dx/Px

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Variables collected at time of POCUS

1. Pleural Line
   1. Moth Sign,
   2. Effusion,
   3. Distance: Pleural Line to B-Line
2. Lung parenchyma
   1. Pixel Integrated Density,
   2. B-Line Area,
   3. B-line count,
   4. A- Line Count,
   5. POCUS Lung Score,
   6. Min/Mean/Max/Modal Gray Value
3. Animal Population
   1. Animal Body Weight,
   2. Interval from POCUS to Death,
   3. Days on Feed,
   4. Sex,
   5. Breed
4. Other measurements
   1. Back Fat Thickness,
   2. Rib Eye Area,
   3. Pulse,
   4. SPO2,
   5. Lung Auscultation (CV and CD)

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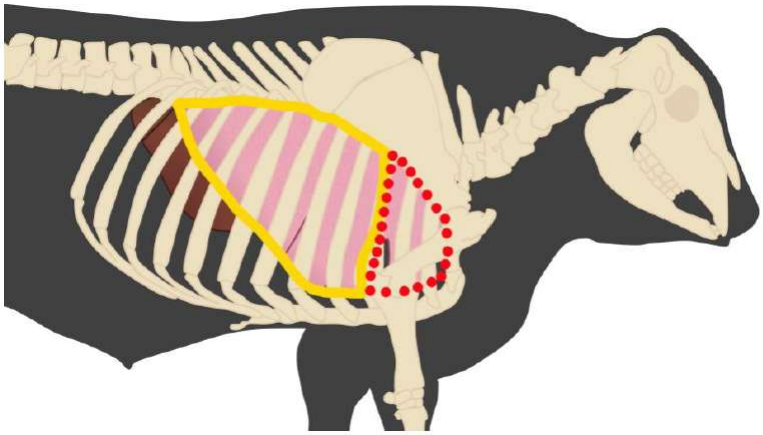
TT-POCUS



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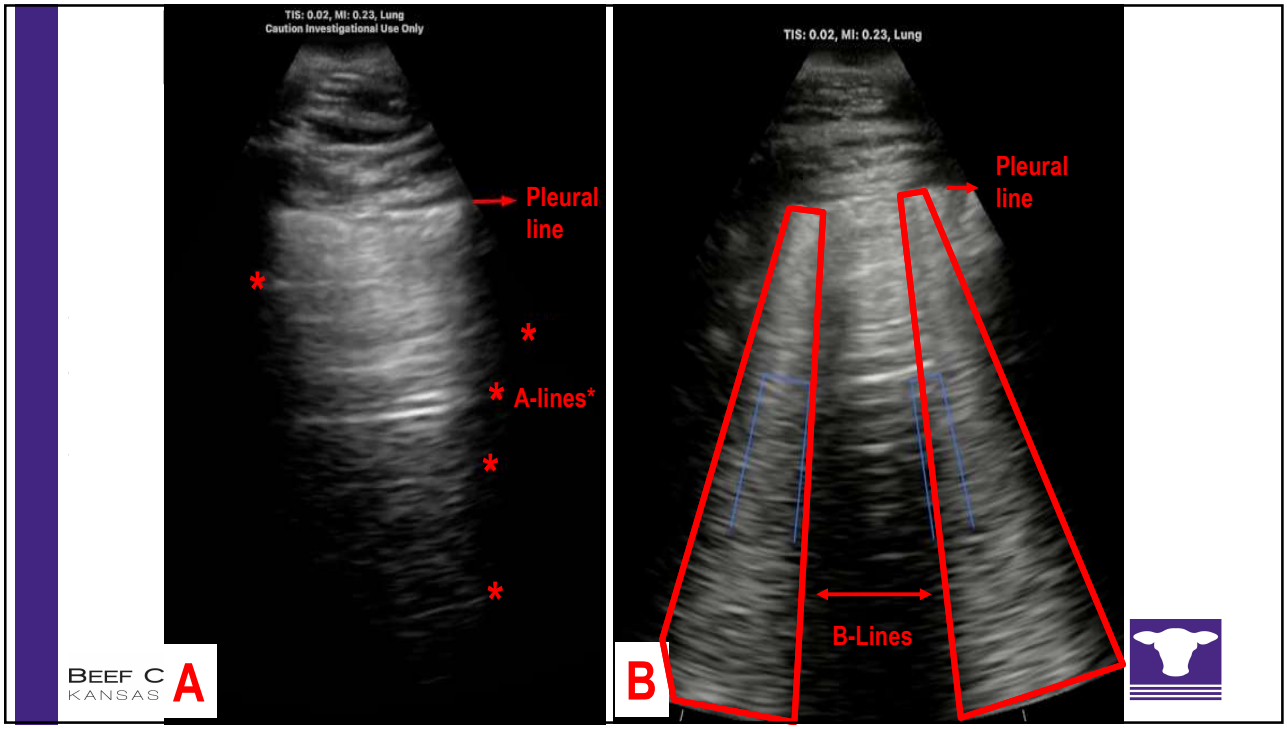

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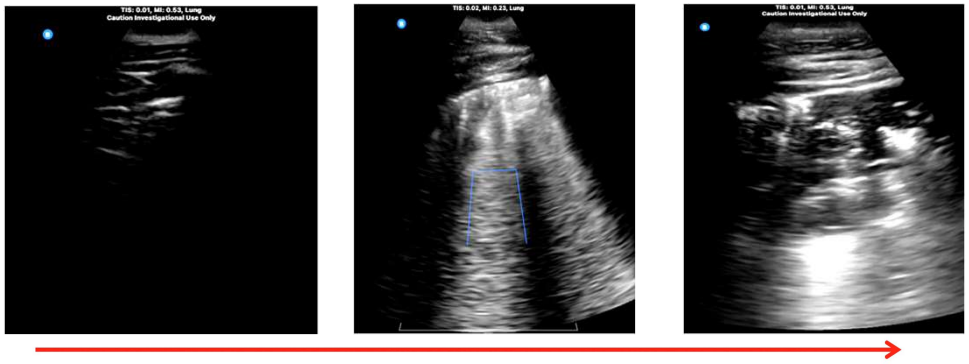

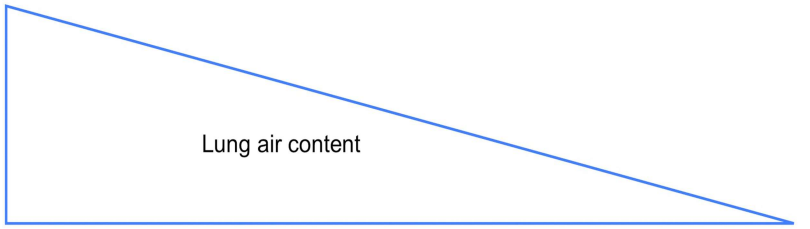

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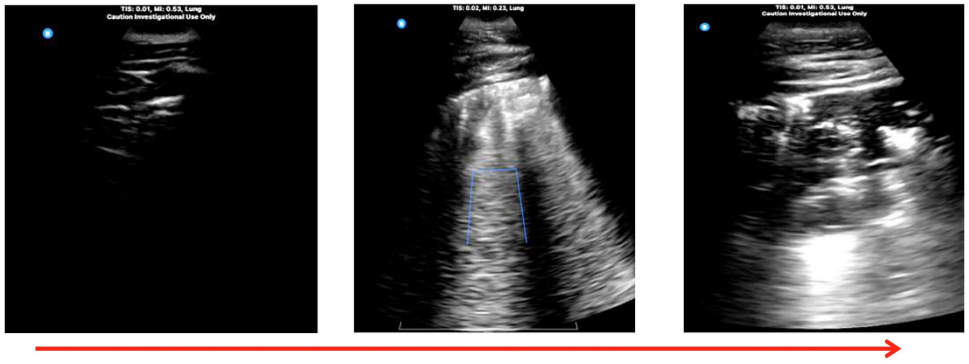
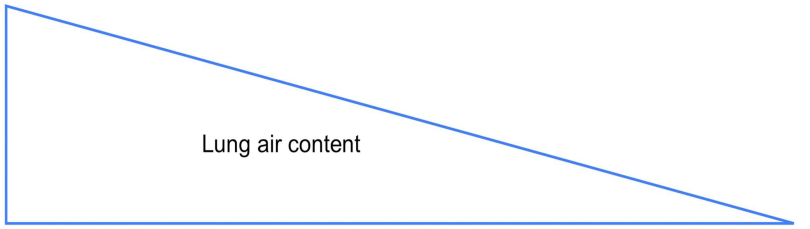
TT-POCUS





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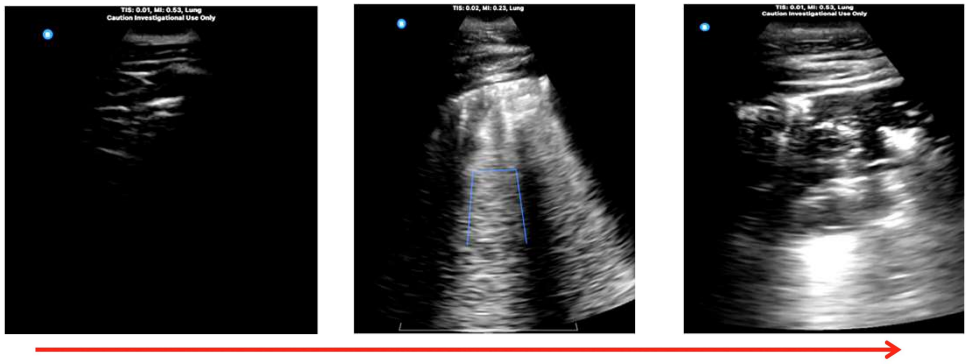
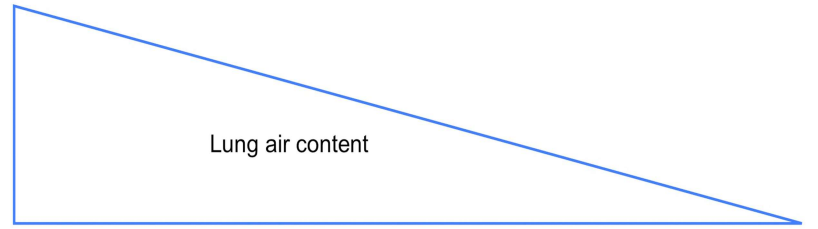
TT-POCUS





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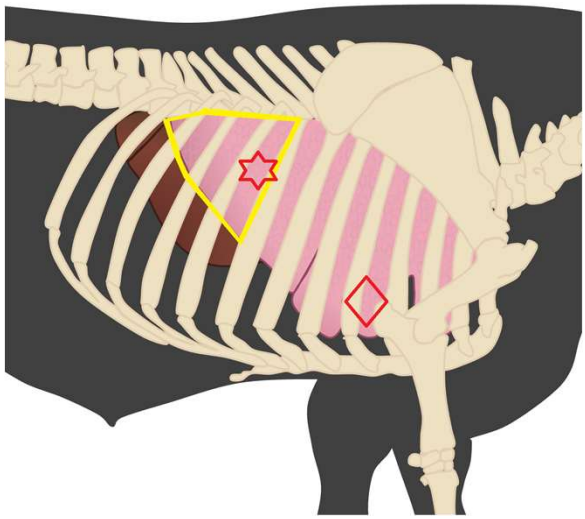
Lung Auscultation



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Pulse oximetry

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Evaluation of targeted thoracic point-of-care ultrasonography for identification of interstitial pneumonia in feedyard cattle

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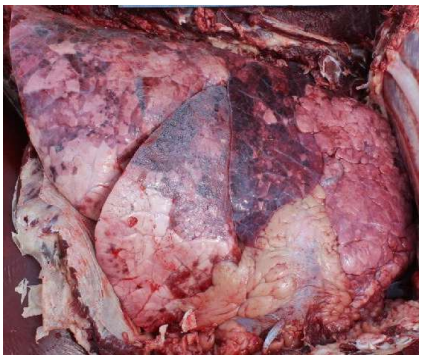
Hypothesis & Objective

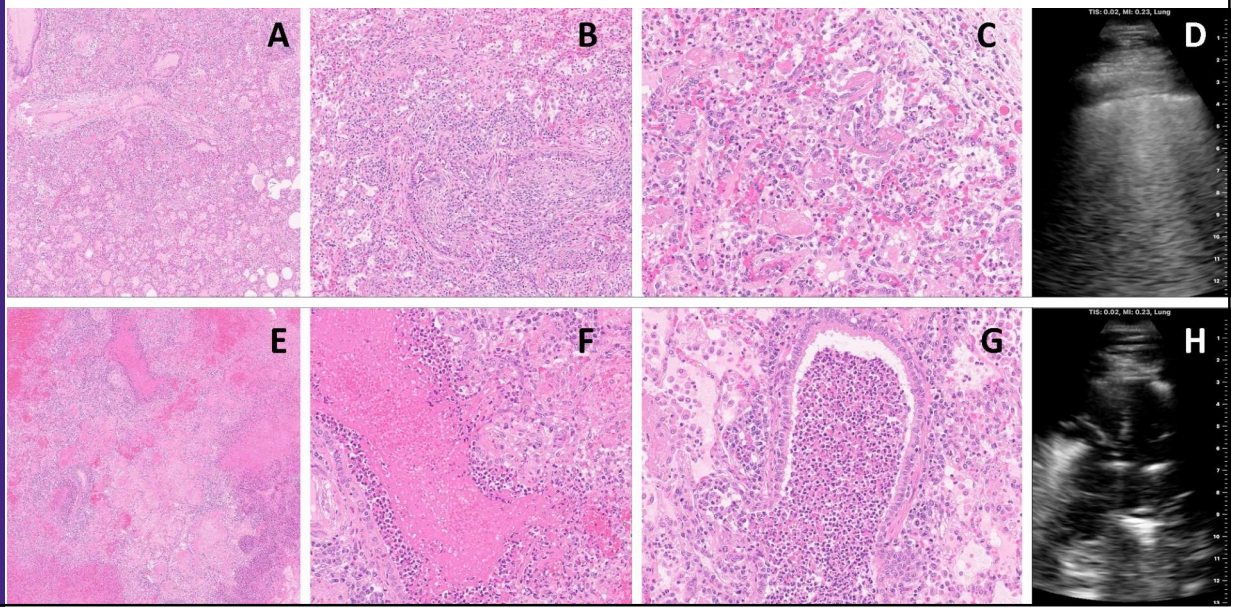
- **Targeted use of Ultrasound technology can decrease evaluation time, Dx respiratory diseases and differentiate Interstitial-pattern Pneumonia from other respiratory diseases**
- **Identify variables associated with interstitial pneumonia using Multivariate Logistic Regression.**

Inclusion criteria

- Individual animals POCUS'd at chute-side **AND** deceased



Outcome = Histopathology Dx



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Results & Discussion

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Multivariate Logistic Regression using GLM

Response outcome: Interstitial Pneumonia	VIF	LR χ^2	*P-value* (χ^2)
Sex	1.10	0.92	0.33
Days on Feed	**1.58**	**5.12**	**0.02**
B-Line Count	**1.90**	**4.92**	**0.03**
Lung Score	**2.70**	**12.4**	**0.002**
A-Line Count	**1.70**	**13.67**	**0.0003**

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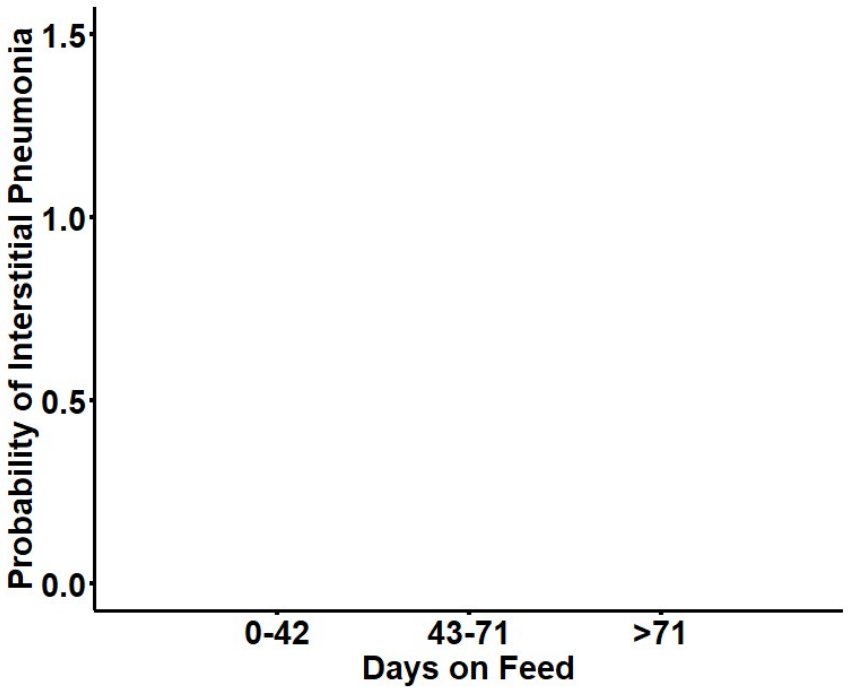

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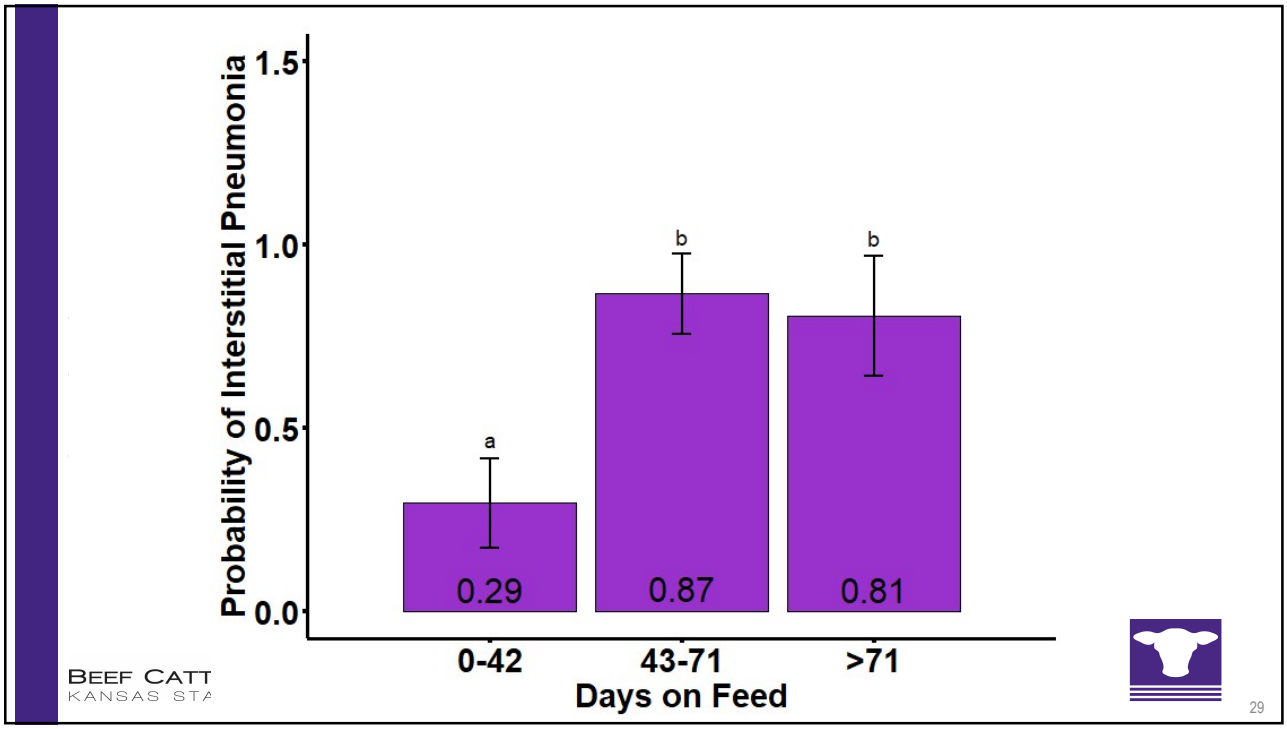
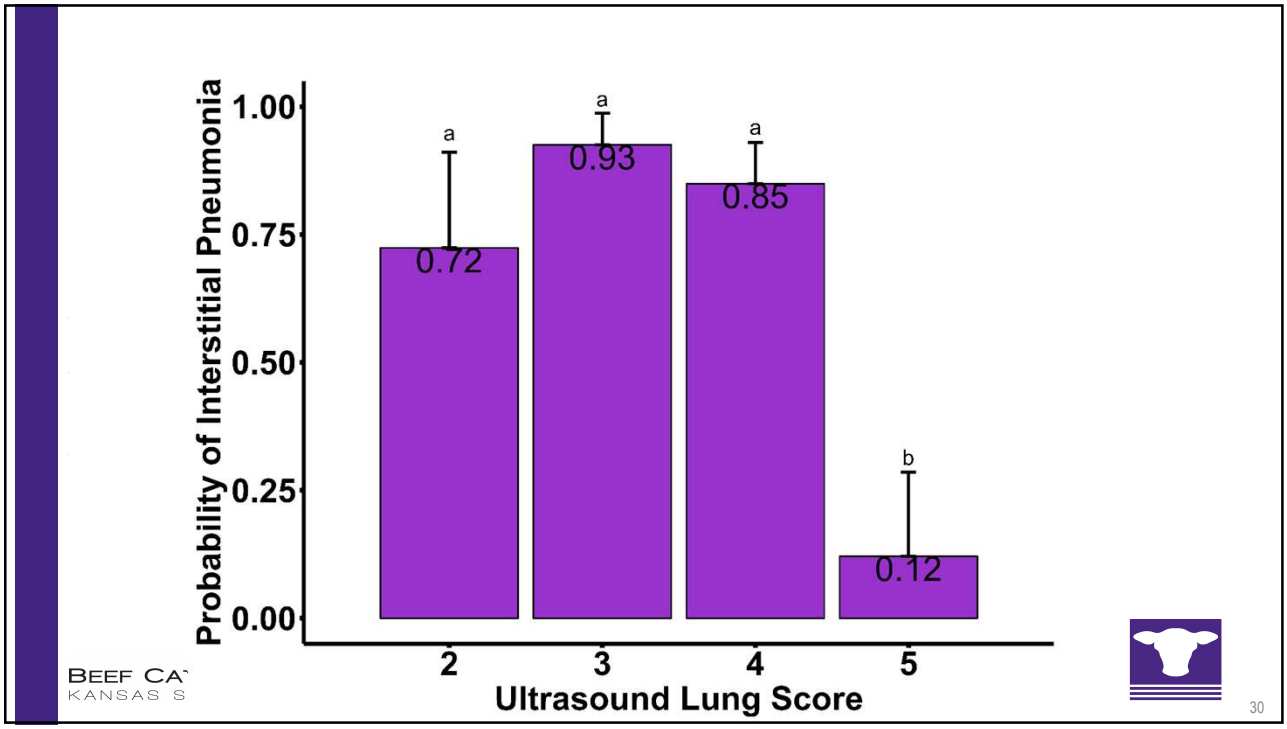
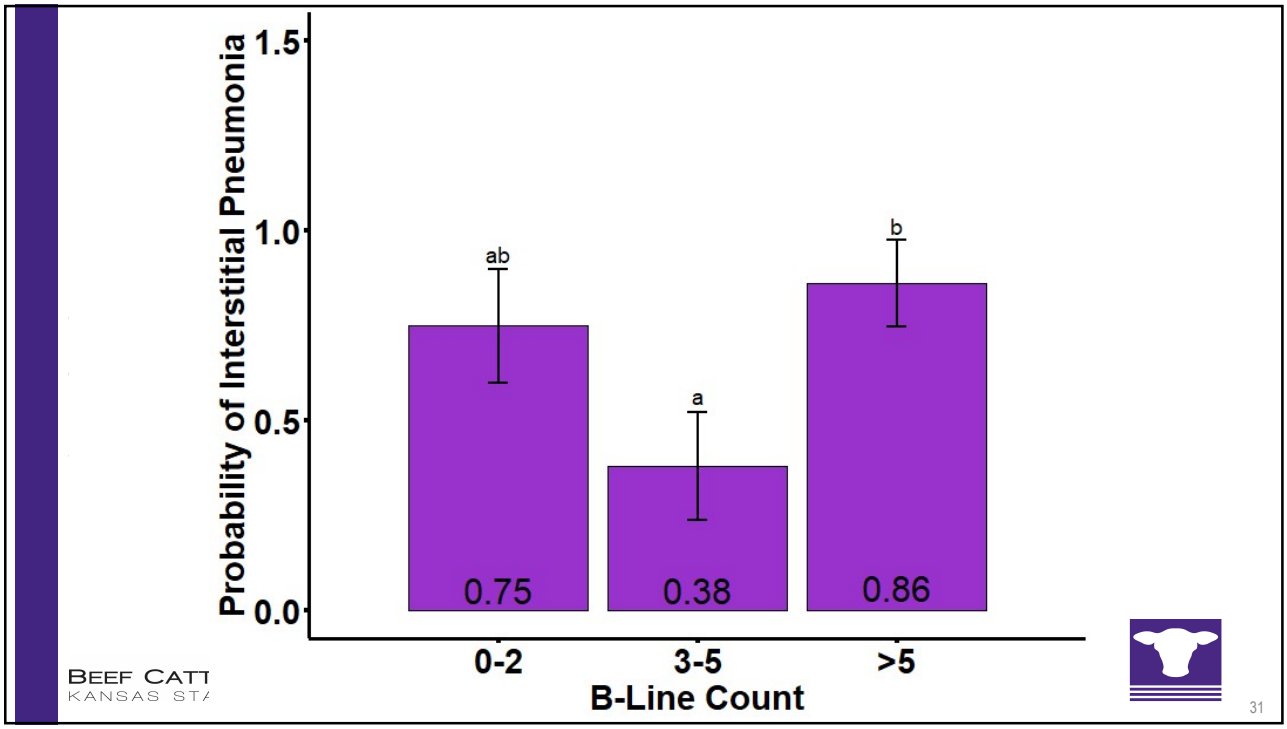
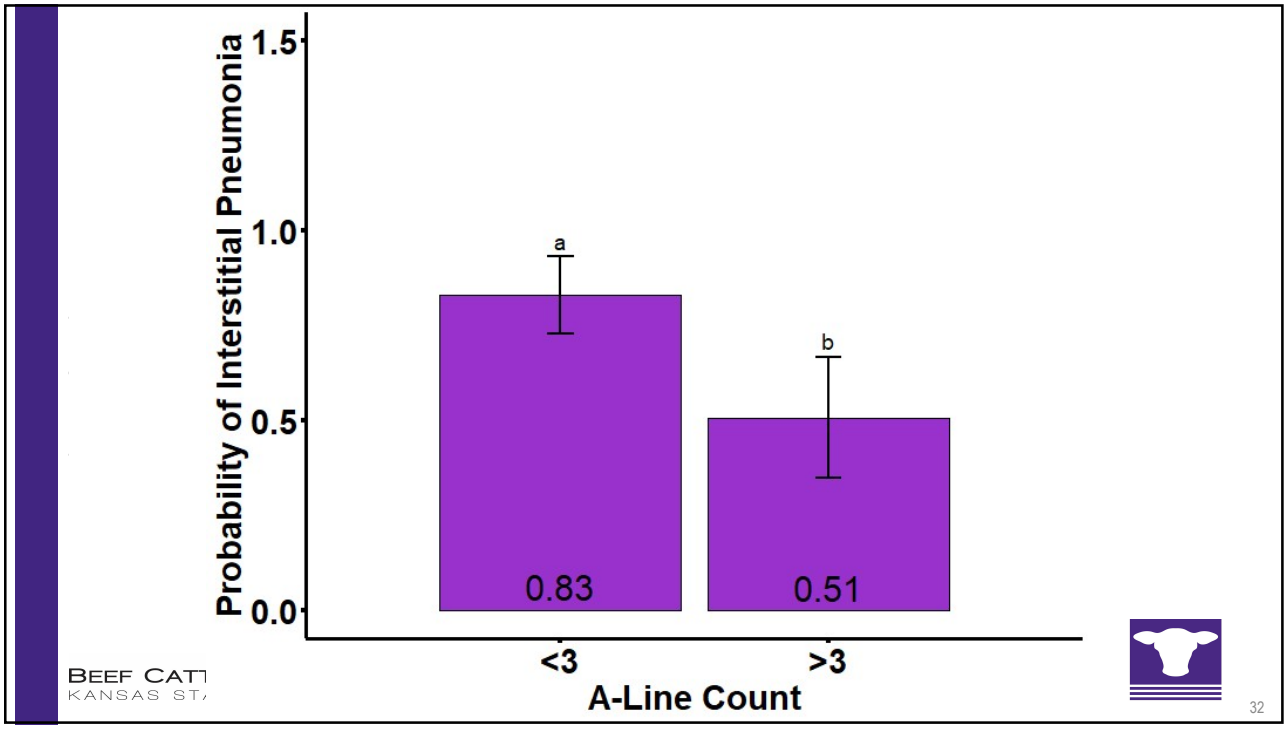

Probability of Interstitial Pneumonia
1.5
1.0
0.5
0.0
a
b
b
0.29
0.87
0.81
0-42
43-71
>71
Days on Feed
29


Probability of Interstitial Pneumonia
1.00
0.75
0.50
0.25
0.00
a
a
a
b
0.72
0.93
0.85
0.12
2
3
4
5
Ultrasound Lung Score
30


Probability of Interstitial Pneumonia
1.5
1.0
0.5
0.0
ab
a
b
0.75
0.38
0.86
0-2
3-5
>5
B-Line Count
31


Probability of Interstitial Pneumonia
1.5
1.0
0.5
0.0
a
b
0.83
0.51
<3
>3
A-Line Count
32

Conclusion

- Without disturbing commercial feedyard hospital pace, TT-POCUS at chute-side served to identify cases of respiratory diseases at caudo-dorsal level.
- This study identified imaging parameters that could be used to differentiate Interstitial-pattern pneumonias from other respiratory diseases in feedlot cattle.

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How about Prognosis

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Utilization of point-of-care evaluation to determine prognosis in feedyard cattle with multiple previous respiratory disease treatment

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Background

- Point-of-care chuteside diagnostics may be valuable to enhance **prognostic** accuracy for diseased cattle.

- Accurate prognosis for chronically ill cattle with pneumonia facilitates informed management practices.

Objective

- Identify associations between chuteside parameters at the time of ≥ 3 treatment with:
  - Mortality or culling (DNF)

Enrollment

- Animal's **≥ 3 treatment** for respiratory disease clinically diagnosed by feedyard and 60-day outcome data
- Feedyard doctor blinded to chuteside evaluation;

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Final Multivariate Logistic Regression

Response outcome: Did not finish	**LR χ^2**	***P-value*** **(χ^2)**
Sex	0.09	0.75
Days on Feed	3.13	0.20
B-line count category	**5.32**	**0.02**
Moth Sign	**4.53**	**0.03**
B-line area	**4.35**	**0.03**

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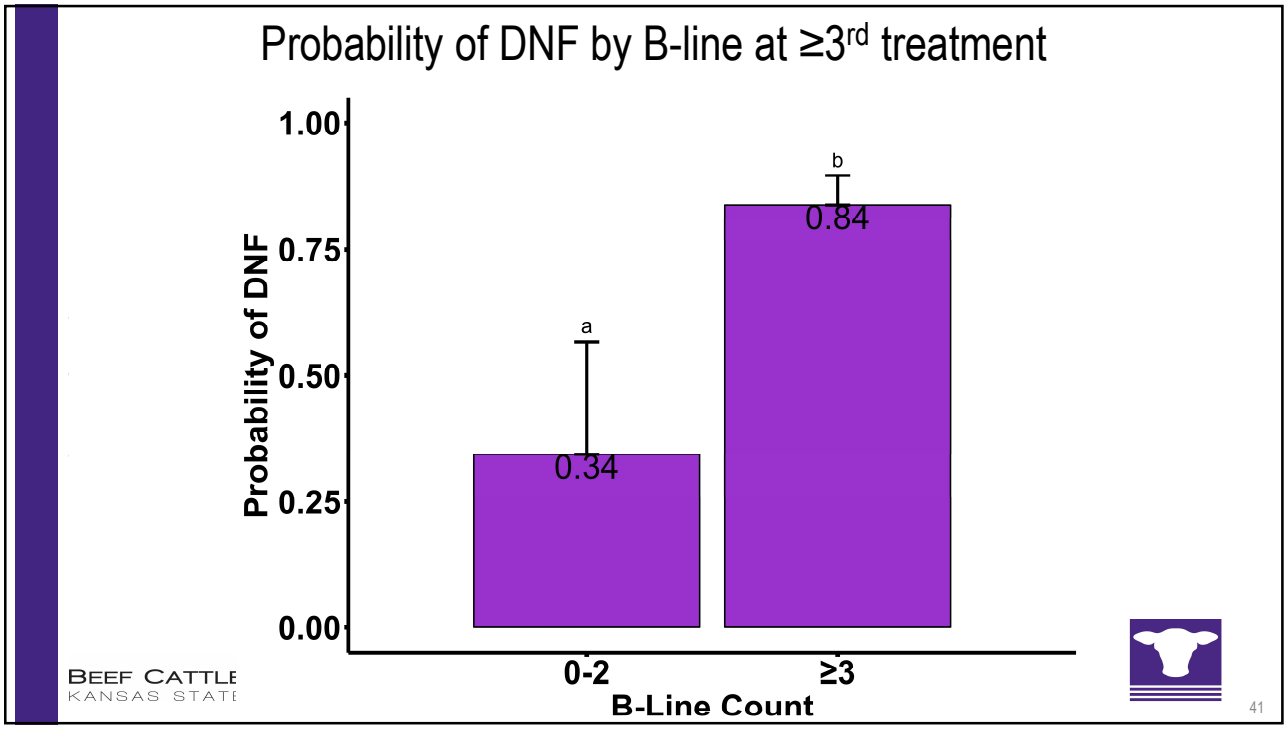
Probability of DNF by B-line at ≥3rd treatment
1.00
0.75
0.50
0.25
0.00
Probability of DNF
a
0.34
b
0.84
0-2
≥3
B-Line Count
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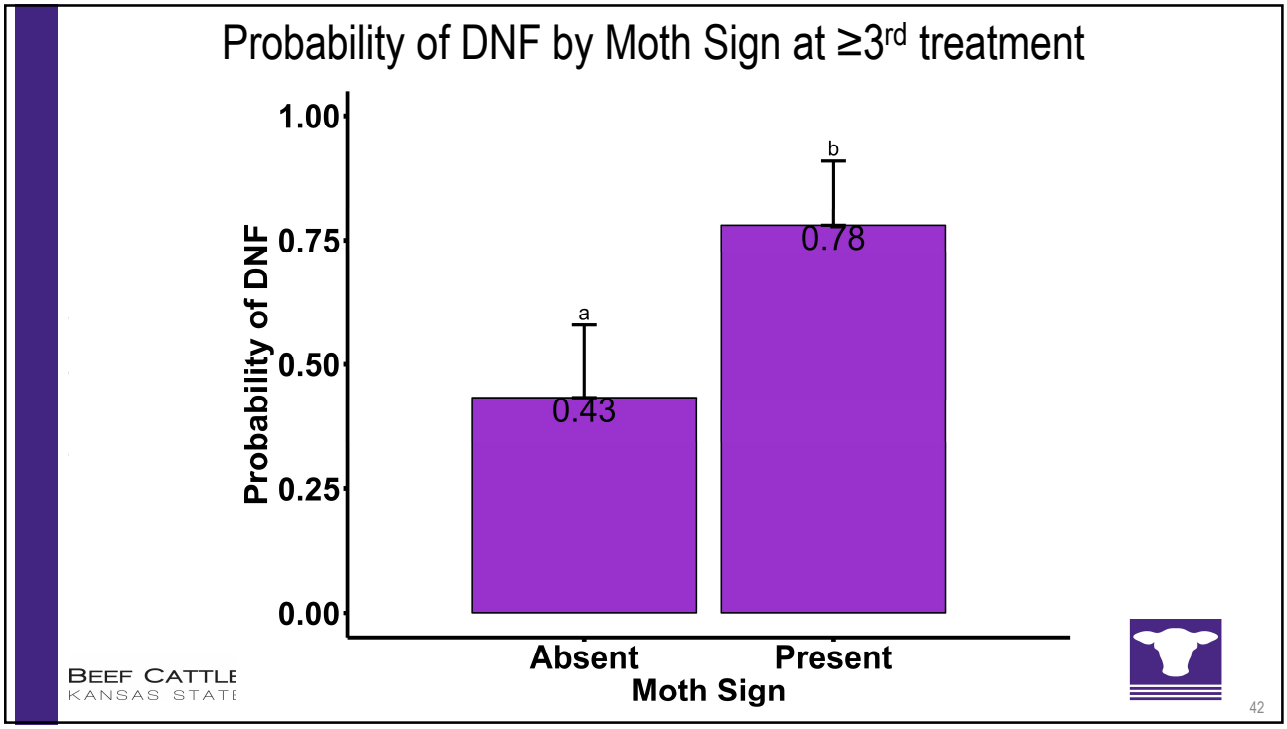
Probability of DNF by Moth Sign at ≥3rd treatment
1.00
0.75
0.50
0.25
0.00
Probability of DNF
a
0.43
b
0.78
Absent
Present
Moth Sign
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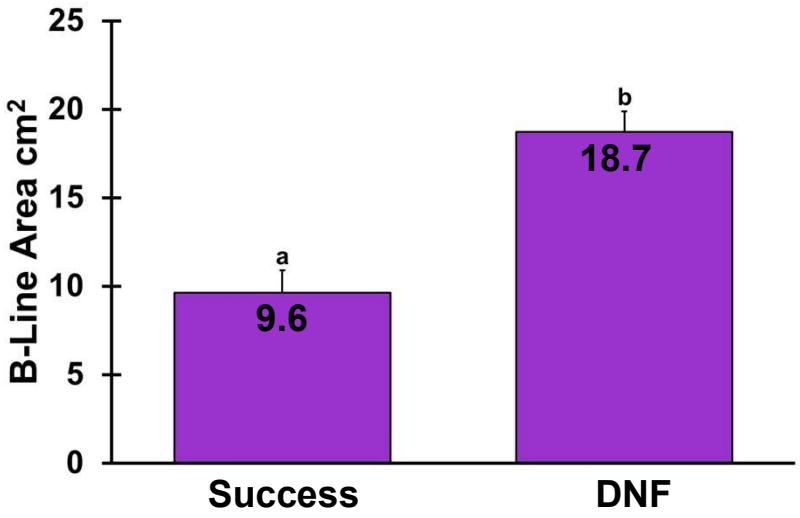
Average B-line area by 60-day outcome



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Conclusion

- Pulse, SPO2, lung auscultations, sex, DOF, BW and breed showed no evidence of association with the 60-day post treatment outcomes in these multivariate logistic regression ($P > 0.05$).
- **Target thoracic ultrasound measurements: B-line category, Moth Sign and B-line area** were valuable information at time of ≥ 3 treatment to prognose respiratory diseased feedyard cattle to inform decisions

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Associations Between Chuteside Evaluations and 60-day Outcomes in Feedyard Cattle at Time of First Treatment for Respiratory Disease

Background

- Point-of-care chuteside diagnostics may be valuable to enhance **prognostic** accuracy for diseased cattle.

- Accurate prognosis for cattle at time of **first treatment** with pneumonia facilitates informed management practices.

Objective

- Identify associations between chuteside parameters at the time of first treatment with:
  - Mortality or culling (DNF)
  - First treatment failure = Relapse+DNF (FTF)

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Materials & Methods

Enrollment

- Animal's **first-time treatment** for respiratory disease clinically diagnosed by feedyard and 60-day outcome data
- Feedyard doctor blinded to chuteside evaluation;

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Model: Did not finish (DNF)

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Final Multivariate Logistic Regression

Response outcome: Did not finish	χ^2	*P-value* (χ^2)
Sex	1.02	0.31
Days on Feed	**12.25**	**0.01**
Body Weight	**15.14**	**0.03**
Moth Sign	**18.58**	**0.0001**
B-line count	**32.96**	**0.0001**
Ultrasound Lung Score	**29.56**	**0.01**

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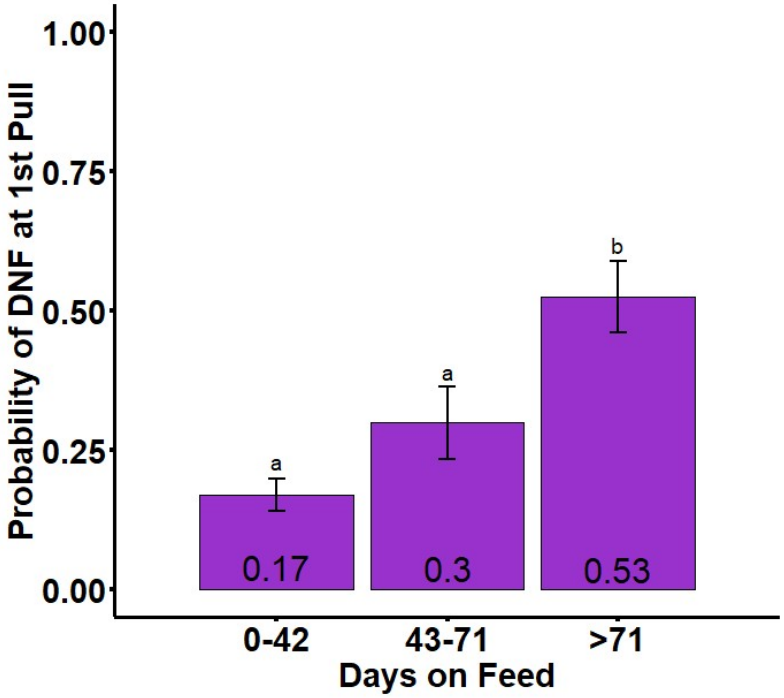

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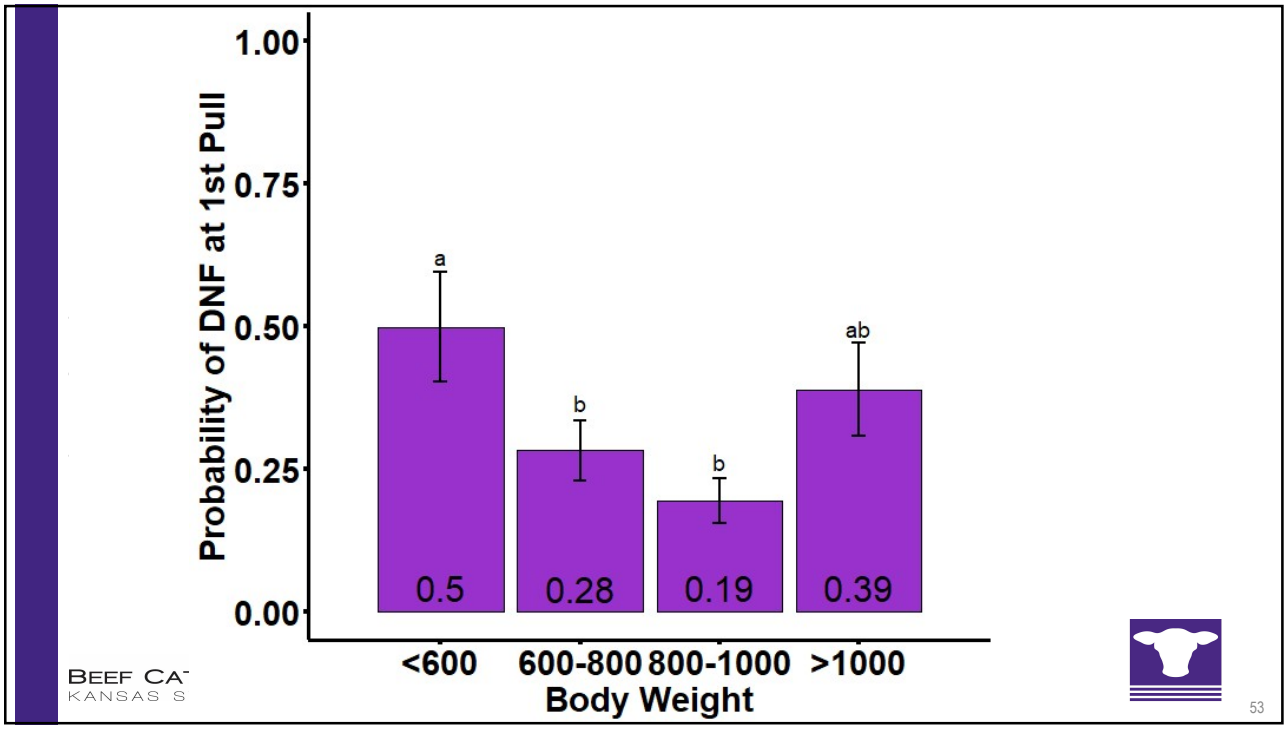
Probability of DNF at 1st Pull
1.00
0.75
0.50
0.25
0.00
a
b
b
ab
0.5
0.28
0.19
0.39
<600
600-800
800-1000
>1000
Body Weight
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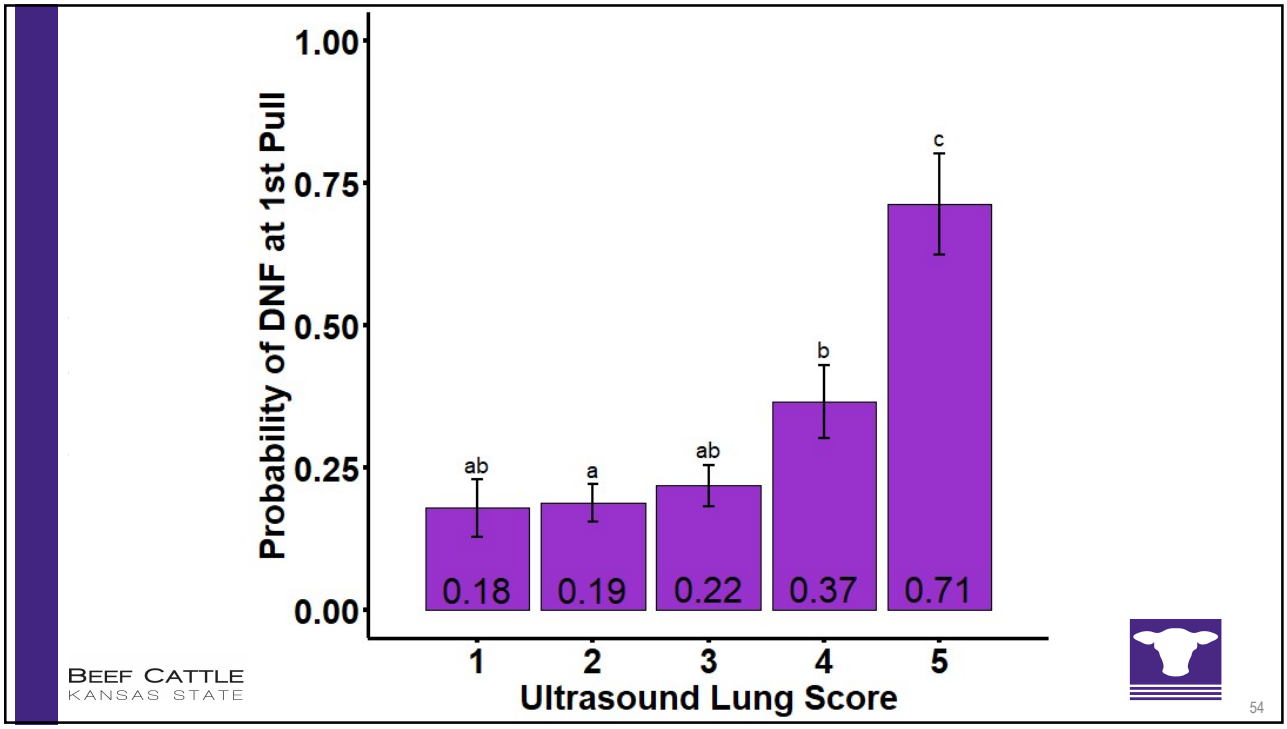
53


Probability of DNF at 1st Pull
1.00
0.75
0.50
0.25
0.00
ab
a
ab
b
c
0.18
0.19
0.22
0.37
0.71
1
2
3
4
5
Ultrasound Lung Score
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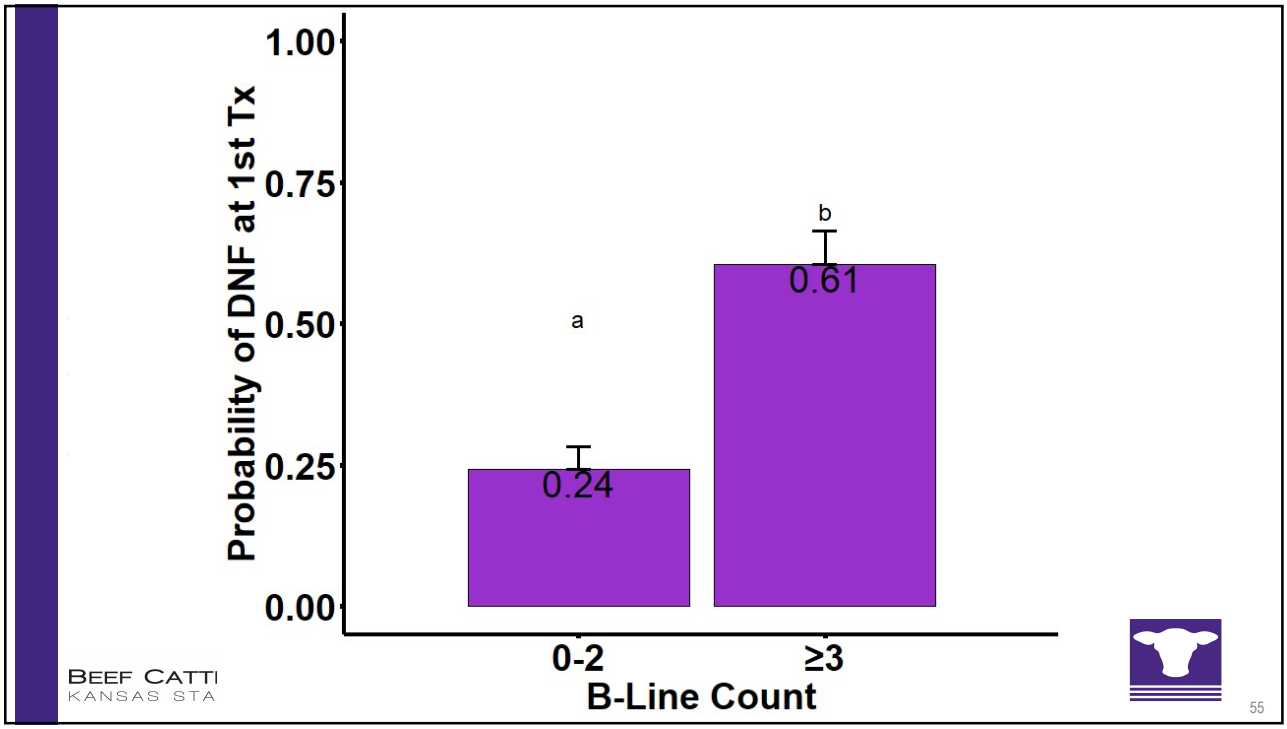

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Model: First treatment failure (FTF)

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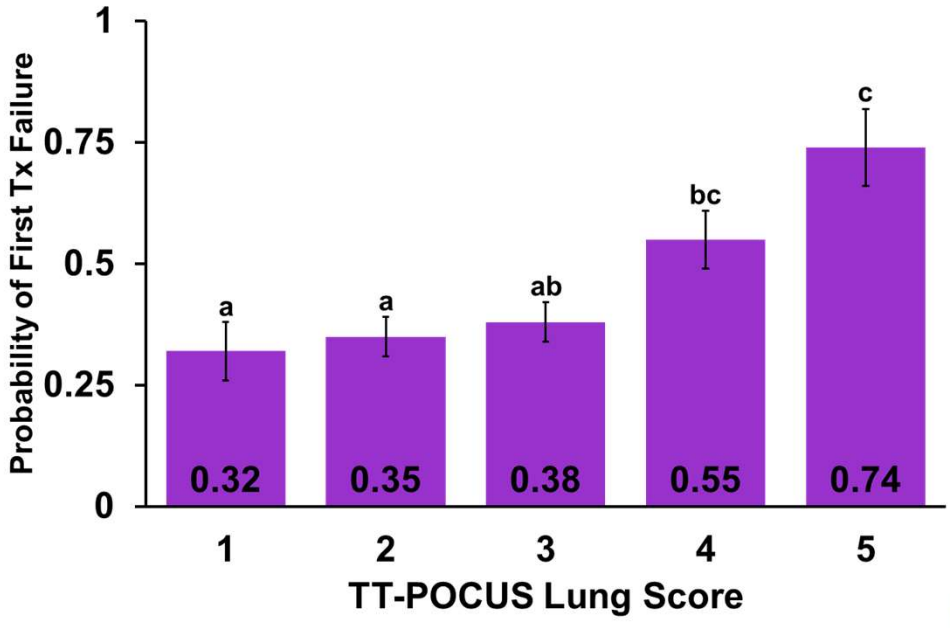
Final Multivariate Logistic Regression

Response outcome: First Treatment Failure	χ^2	*P-value* (χ^2)
Sex	0.74	0.38
Days on Feed	**3.51**	**0.007**
Body Weight	**12.10**	**0.01**
Moth Sign	**22.79**	**0.0001**
B-line count	**16.51**	**0.0001**
Ultrasound Lung Score	**24.41**	**0.038**



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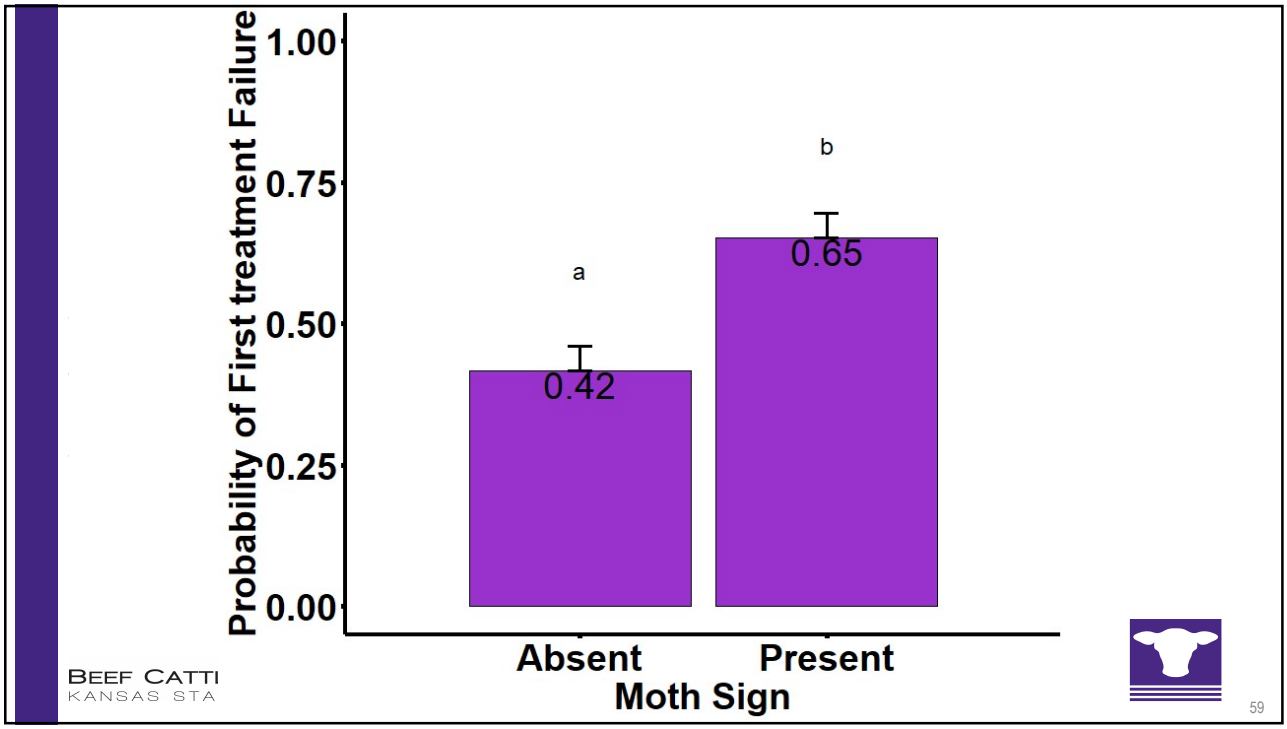
Probability of First treatment Failure
1.00
0.75
0.50
0.25
0.00
a
b
0.42
0.65
Absent
Present
Moth Sign
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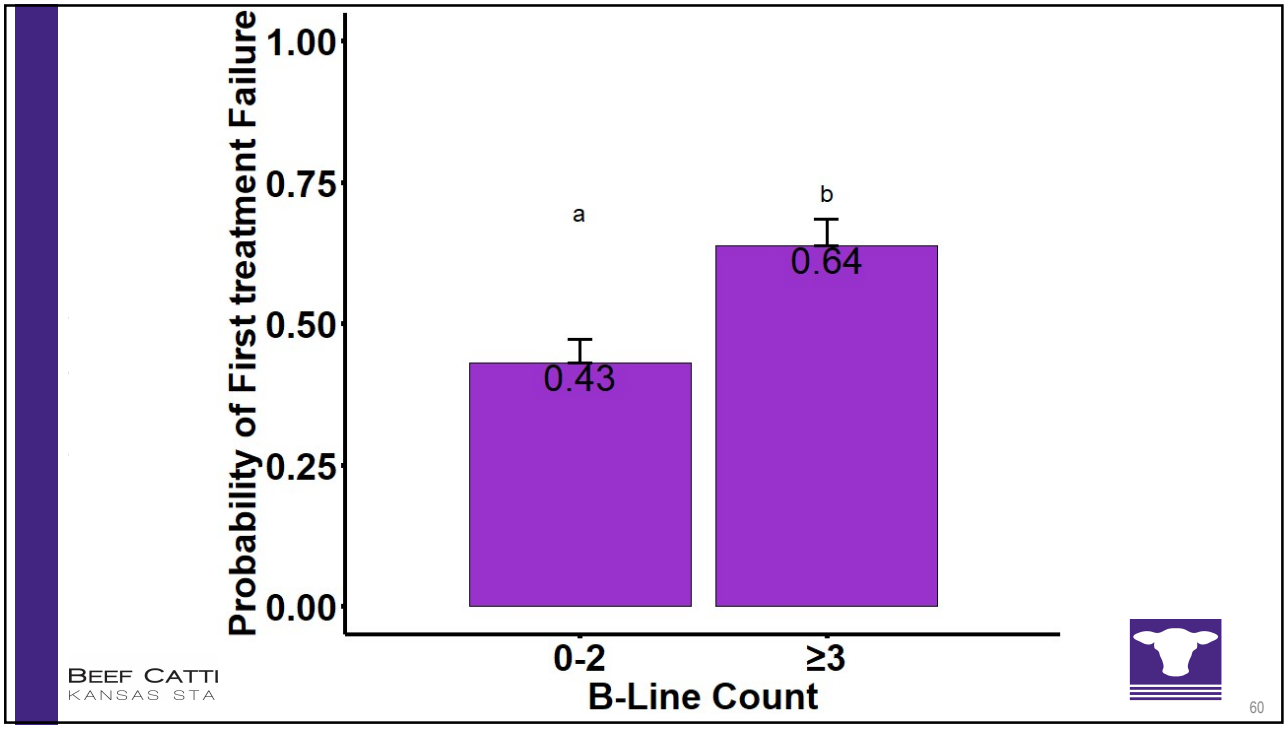
Probability of First treatment Failure
1.00
0.75
0.50
0.25
0.00
a
b
0.43
0.64
0-2
≥3
B-Line Count
BEEF CATTI
KANSAS STA
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Conclusion

- Pulse, SPO2, lung auscultations, sex, and breed showed no evidence of association with the 60-day post treatment outcomes in these multivariate logistic regression ($P > 0.05$).
- In addition to cattle BW class and DOF**, Ultrasound lung score, B-line count, moth sign** were also valuable information at time of first treatment to prognose respiratory diseased feedyard cattle.

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Training

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Overall conclusions

- Novel targeted thoracic ultrasound results indicated that certain ultrasound parameters were associated with disease differentiation and prognosis.
- The ability to differentiate interstitial pneumonia and predict disease outcomes using targeted thoracic ultrasonography can represent a significant advancement in the point-of-care diagnostics for feedyard cattle.

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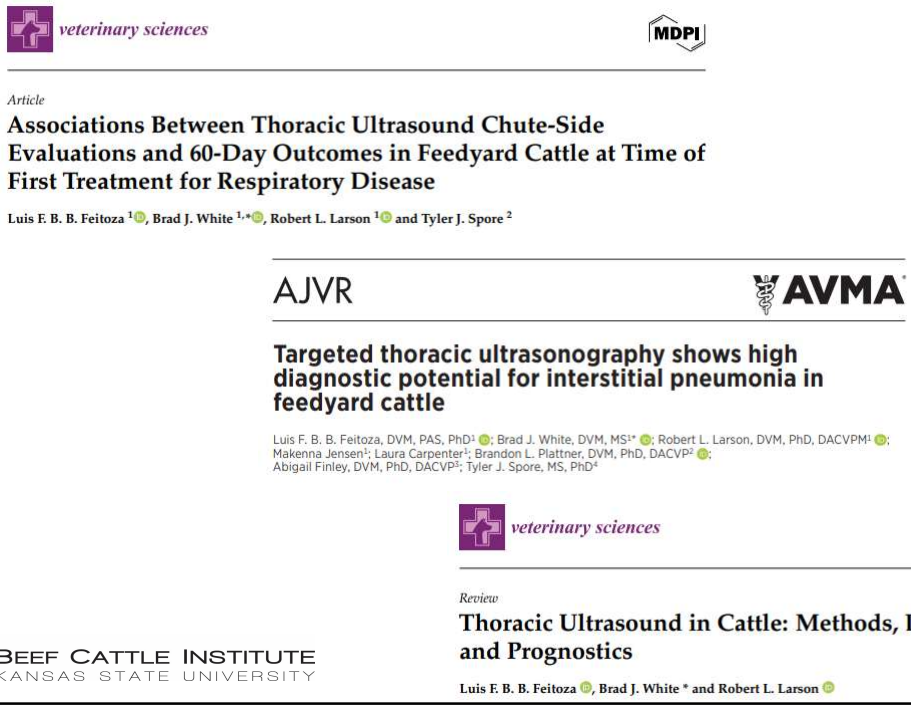

veterinary sciences — MDPI

Article

Associations Between Thoracic Ultrasound Chute-Side Evaluations and 60-Day Outcomes in Feedyard Cattle at Time of First Treatment for Respiratory Disease

Luis F. B. B. Feitoza [1], Brad J. White [1,*], Robert L. Larson [1] and Tyler J. Spore [2]

AJVR — AVMA

Targeted thoracic ultrasonography shows high diagnostic potential for interstitial pneumonia in feedyard cattle

Luis F. B. B. Feitoza, DVM, PAS, PhD[1]; Brad J. White, DVM, MS[1]*; Robert L. Larson, DVM, PhD, DACVPM[1]; Makenna Jensen[1]; Laura Carpenter[1]; Brandon L. Plattner, DVM, PhD, DACVP[2]; Abigail Finley, DVM, PhD, DACVP[3]; Tyler J. Spore, MS, PhD[4]

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Review

Thoracic Ultrasound in Cattle: Methods, Diagnostics, and Prognostics

Luis F. B. B. Feitoza, Brad J. White * and Robert L. Larson

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Questions?

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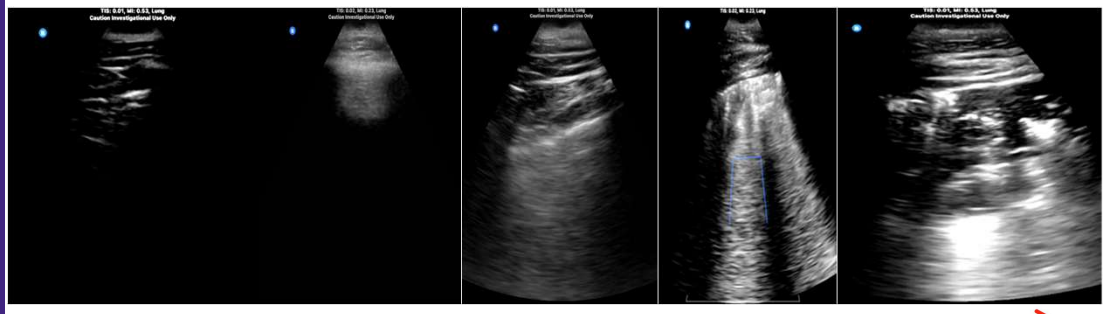
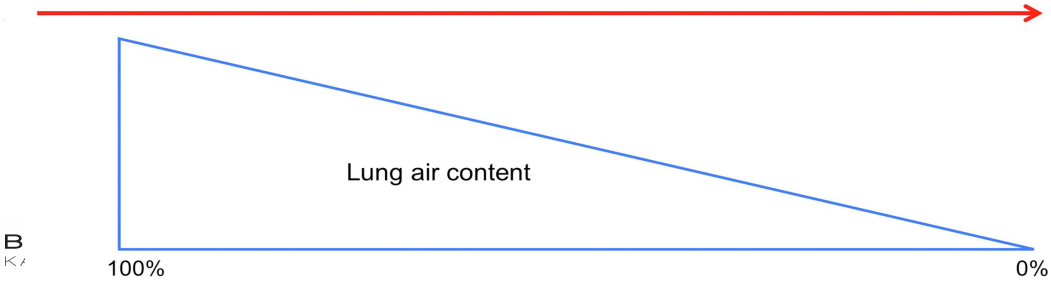
Ultrasound Lung Score

1 2 3 4 5





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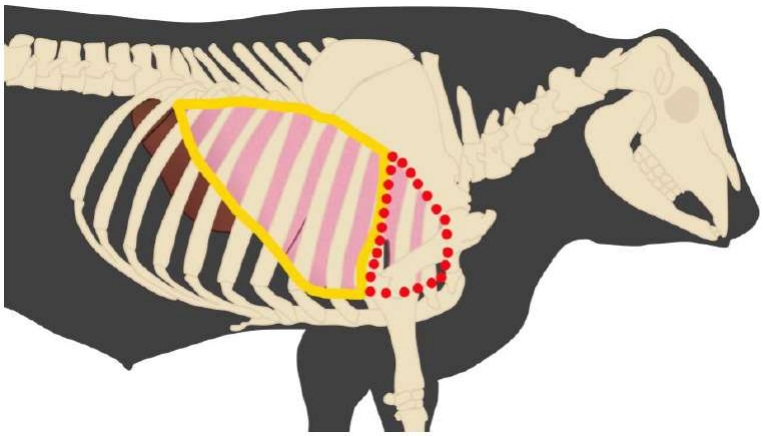

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