Thoracic ultrasound to monitor lung health and assist management decisions

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My journey

2014: Assistant Professor Outreach DVM UW-SVM

2011 – 2014: PhD Epidemiology

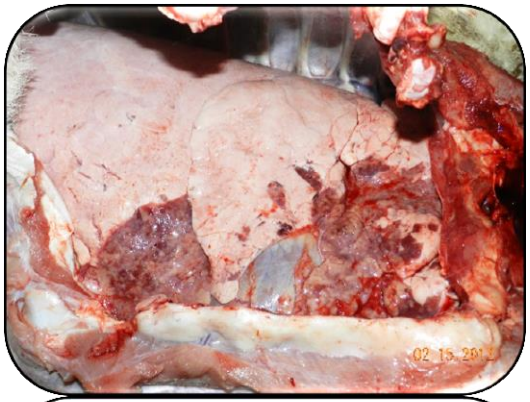
2004 – 2011: Practice, Specialized in Internal Medicine

Outline

- Why thoracic ultrasound?
- How TUS works
- How to implement TUS
  - Treatment decisions

TUS = thoracic ultrasound

Why do we need TUS?

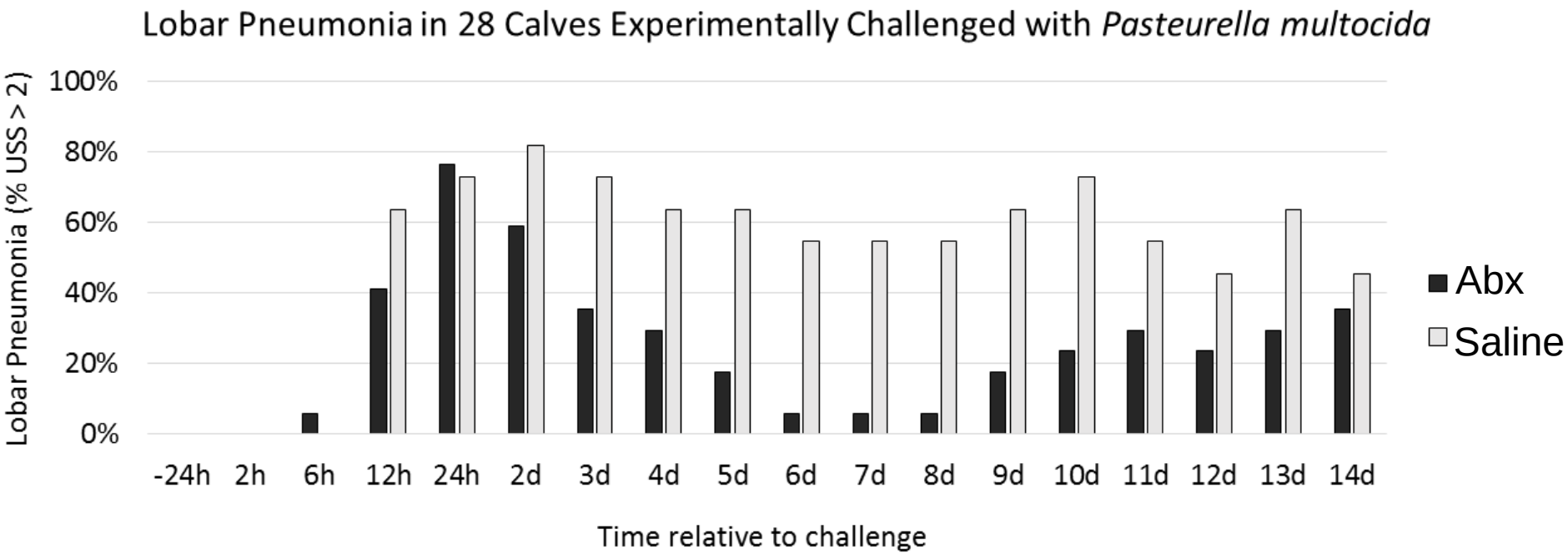


1/3 of **new** cases are **subclinical**

severity of **lung disease NOT well correlated** to severity of **clinical signs**

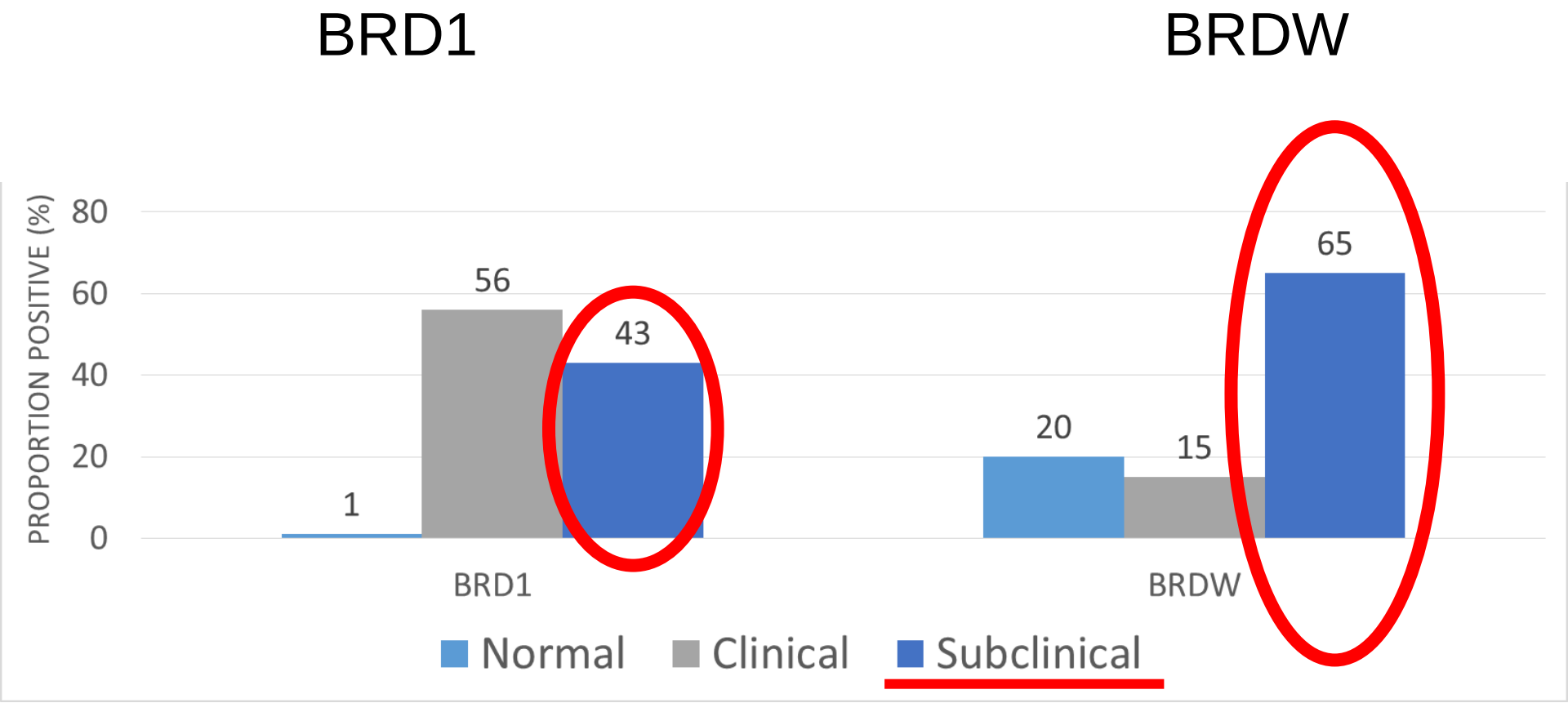
2 – 4 subclinicals for every **clinical case**

Response to early treatment

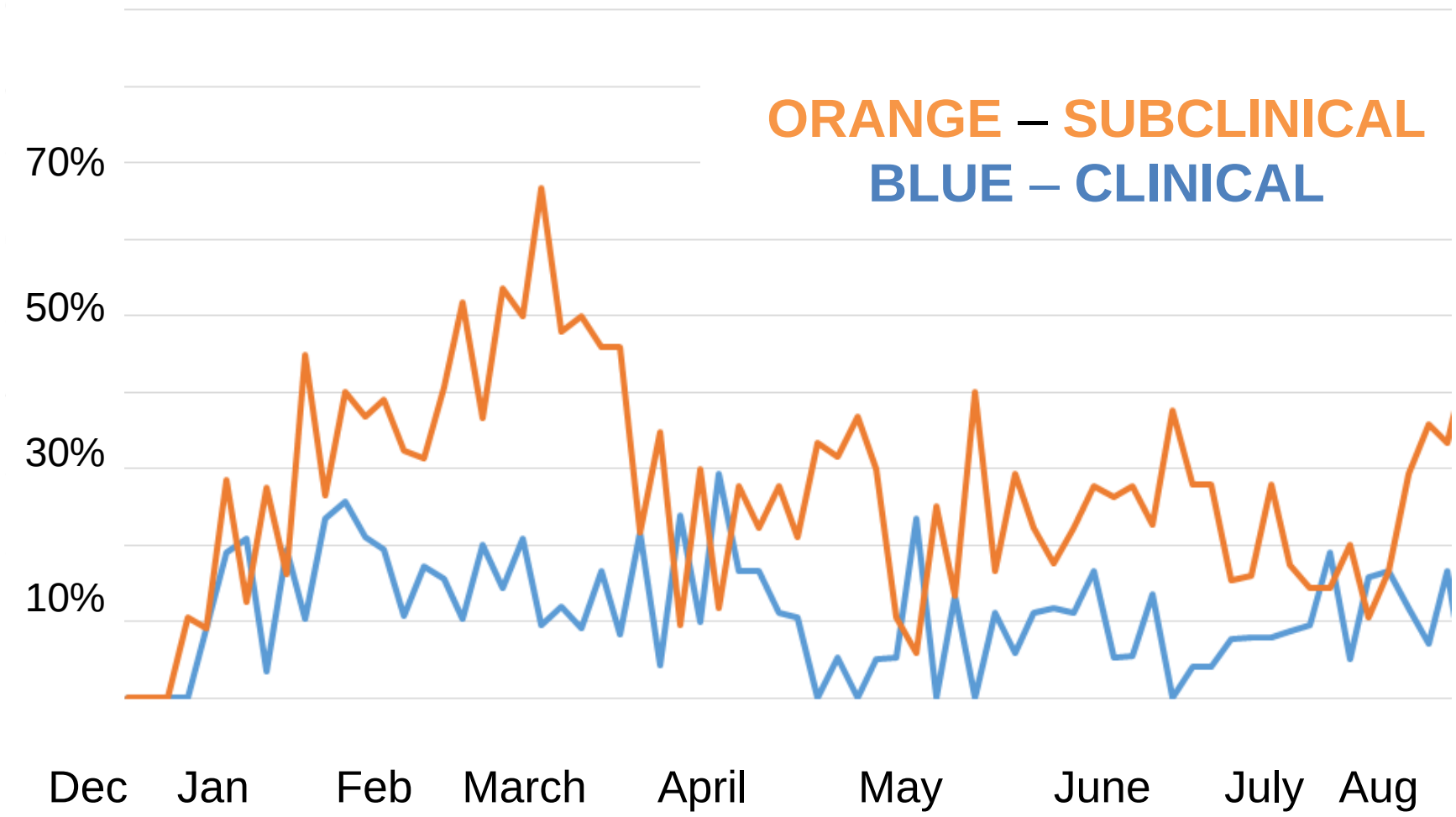


Early antibiotic treatment based on ultrasonographic lung lesions is beneficial
More research is needed to determine best duration of treatment

Clinical response to treatment is deceiving



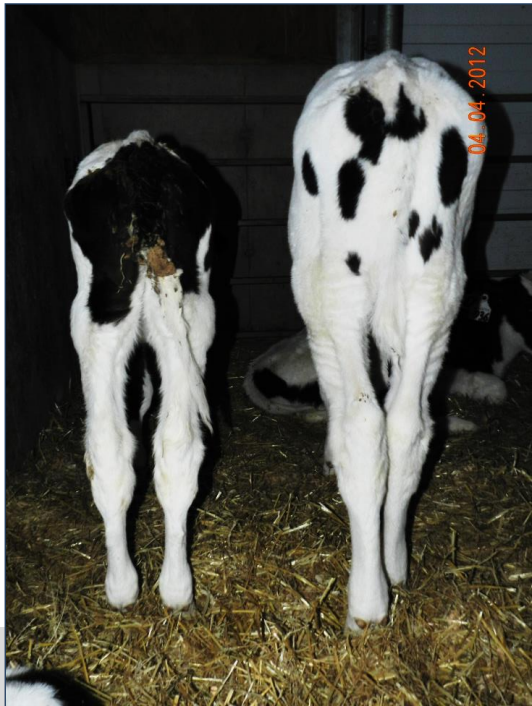
Subclinical disease independent of clinical disease



TUS in dairy calves

Use TUS for individual and herd level decisions

- Fast (less than 1 minute)
- Sensitive (>88%)
  - Better than clinical exam (~60%) or auscultation (<10%)
- Associated with short term outcomes
  - Growth
  - Vaccine, antibiotic response
- Associated with long term outcomes
  - Death
  - Removal
  - Decreased pregnancy risk
  - Decreased milk production (1200# L1)



Why do we need TUS?

1. You CANNOT fully understand the extent of the problem without **early detection** of sick animals, **consistent definitions**, and **accurate diagnoses**.

2. Therefore, you CANNOT fully **manage** lung health

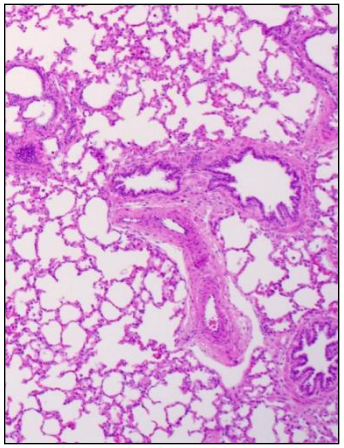
How TUS works…

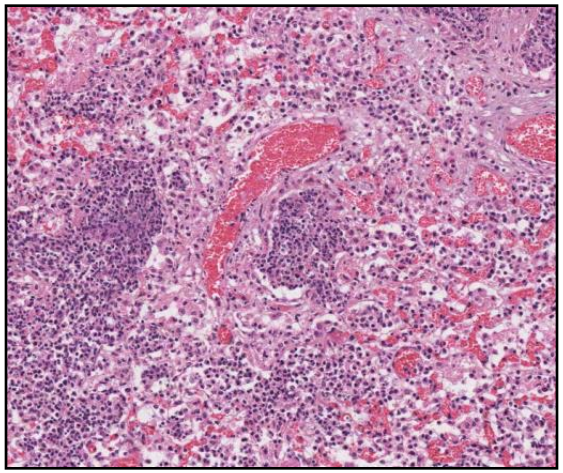
- Portable linear rectal transducer used for pregnancy
- Alcohol only
- No clipping hair

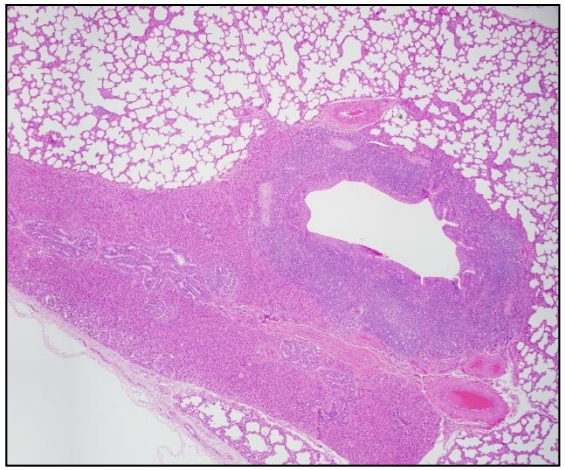
http://medicalimpo.com

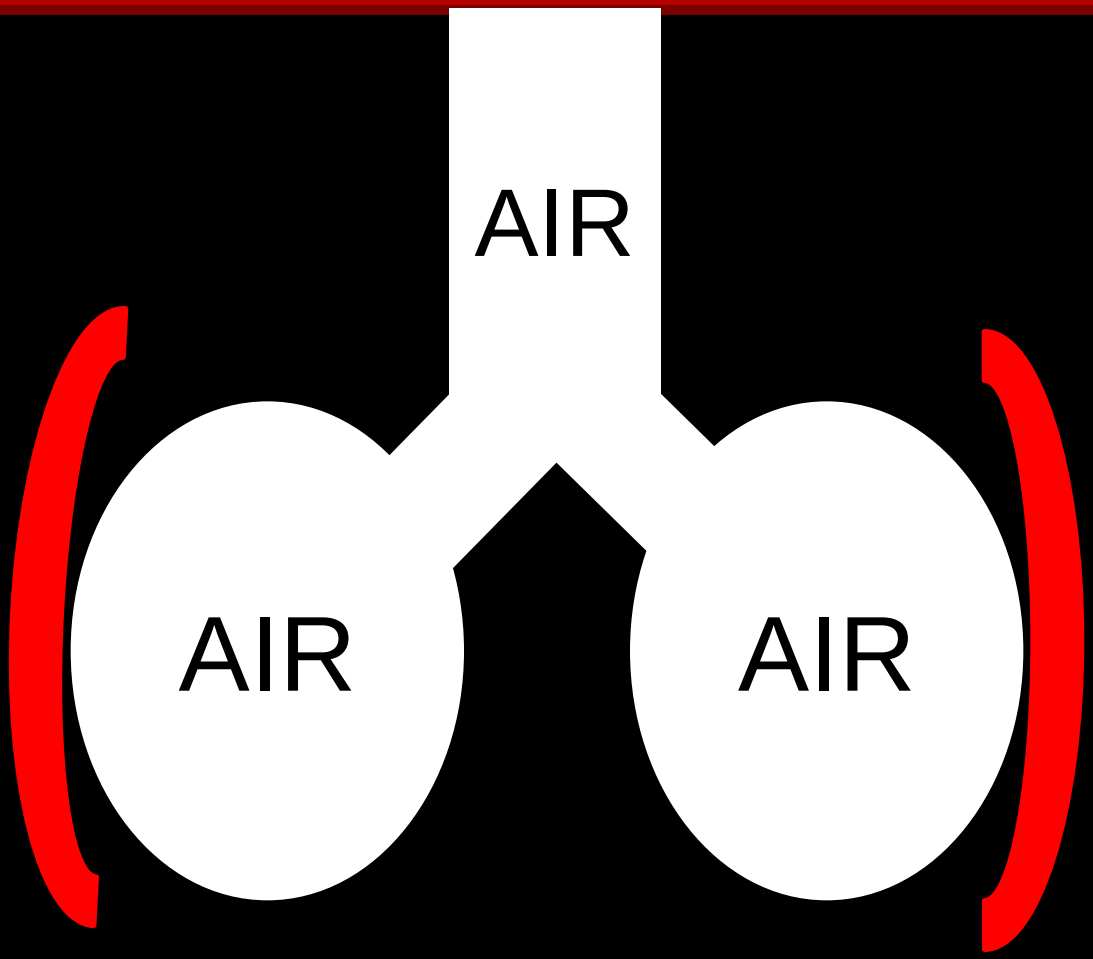
Lung lesion pathophysiology

- Bacterial infection
  - Bronchopneumonia
  - IN the airway
  - Rarely injures the airway
- Aspiration pneumonia
- Viral infection
  - AROUND the airway
  - Injured airway

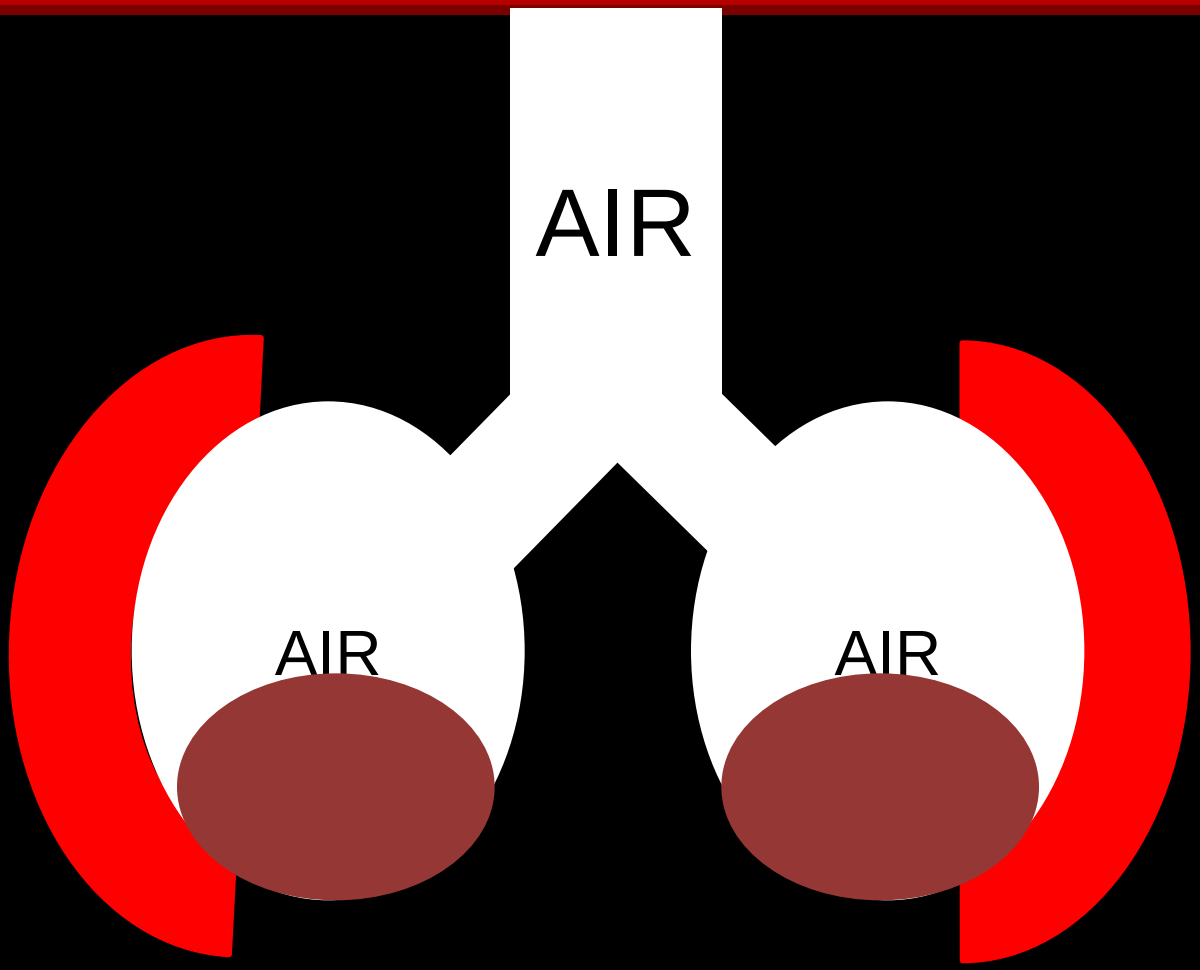








NORMAL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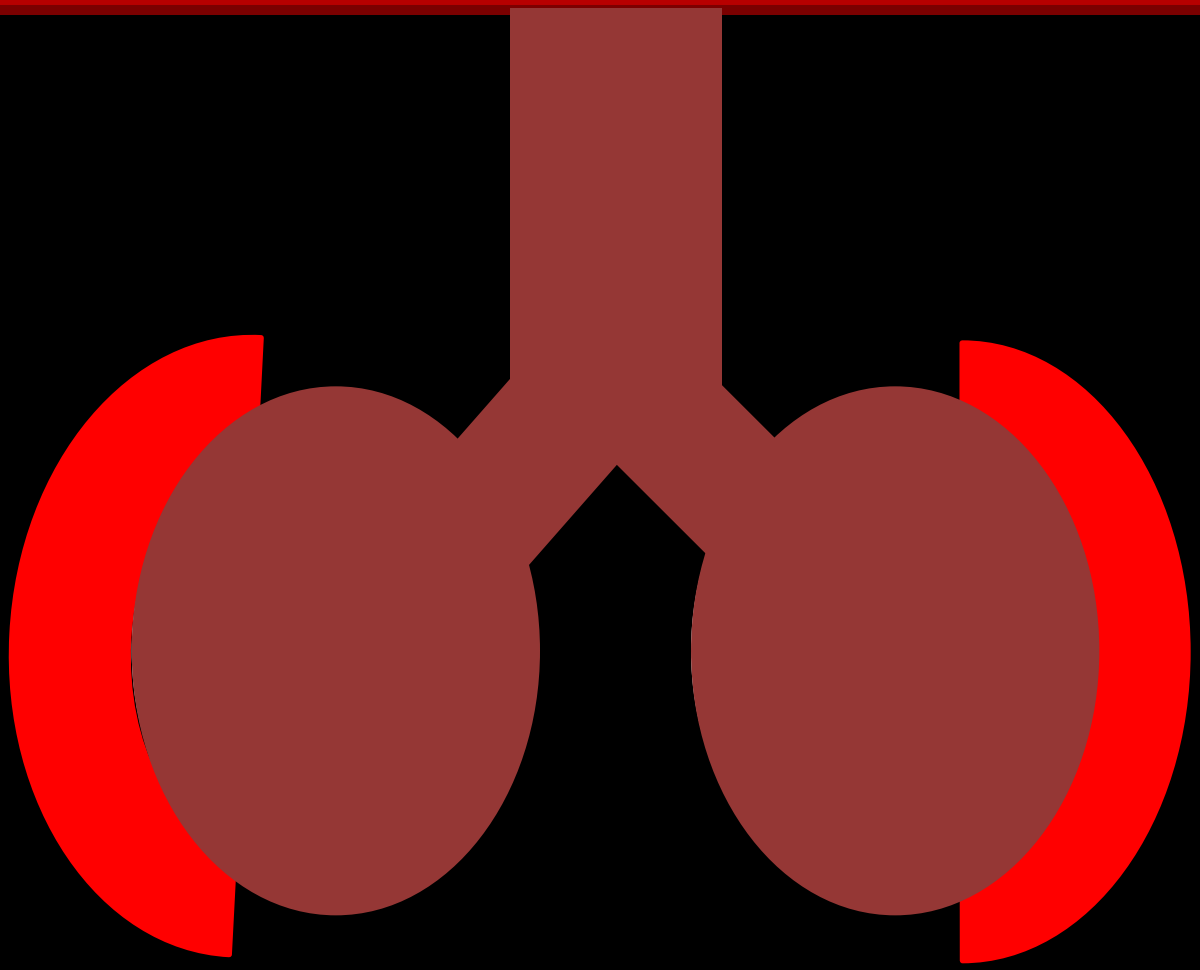
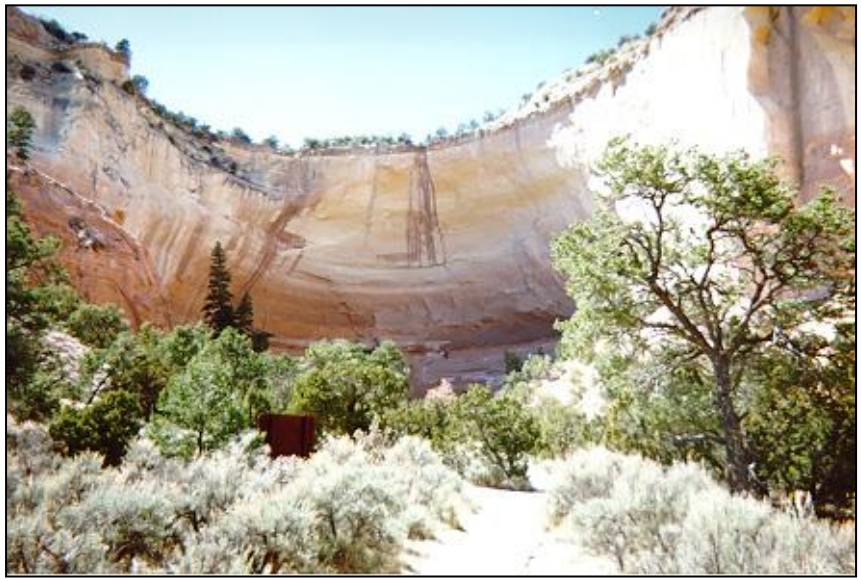


CONSOLIDATION

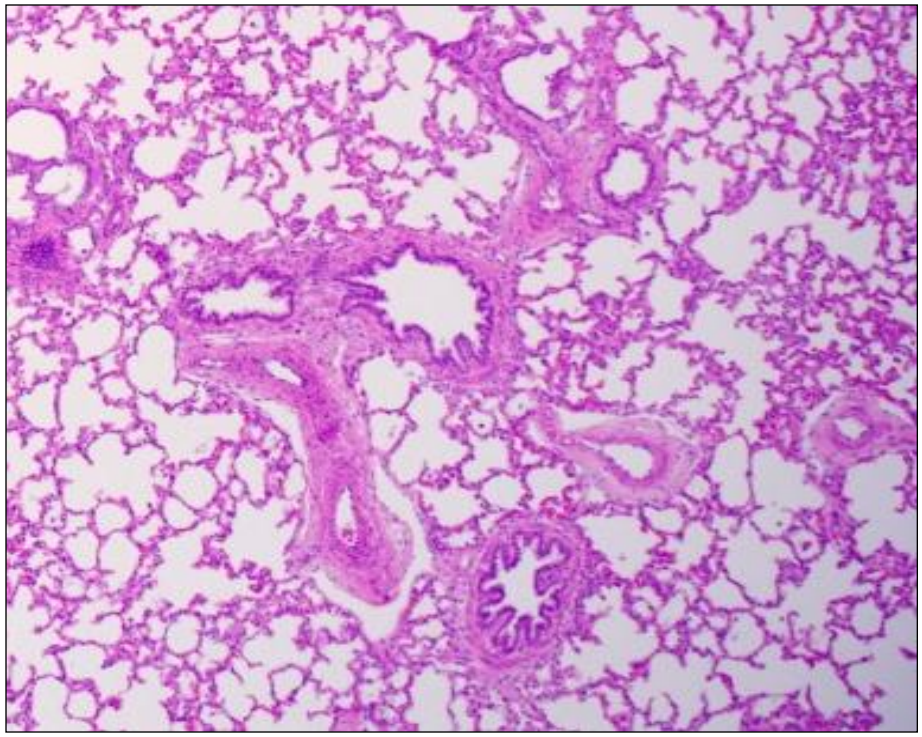
Ultrasonography – mechanism



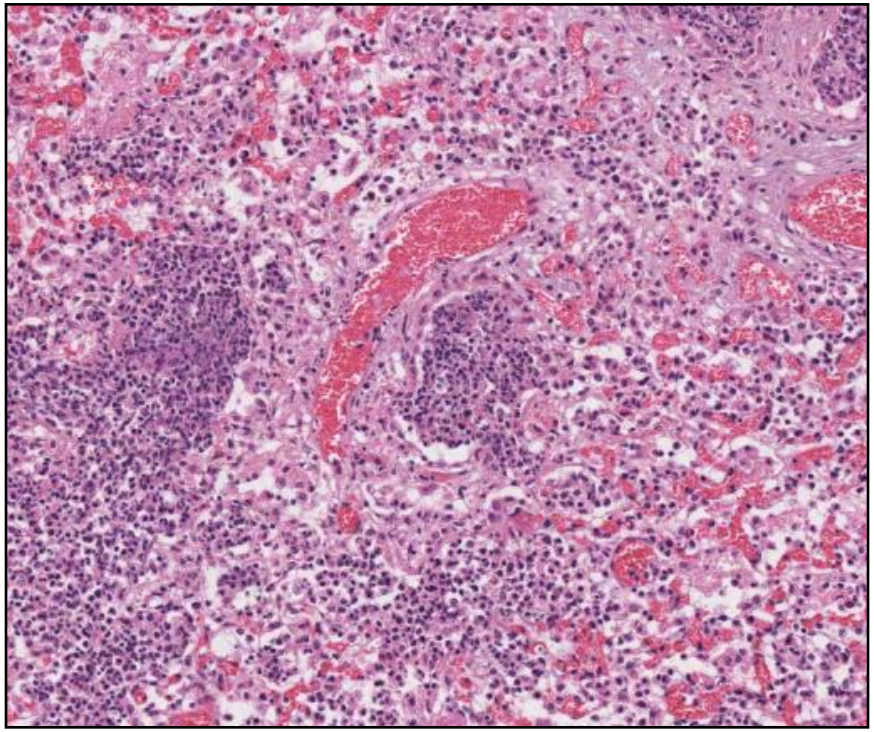
http://www.socalnurseryplants.com/

- Generation of ultrasound
  - Creation of echos

Lung lesions associated with infection



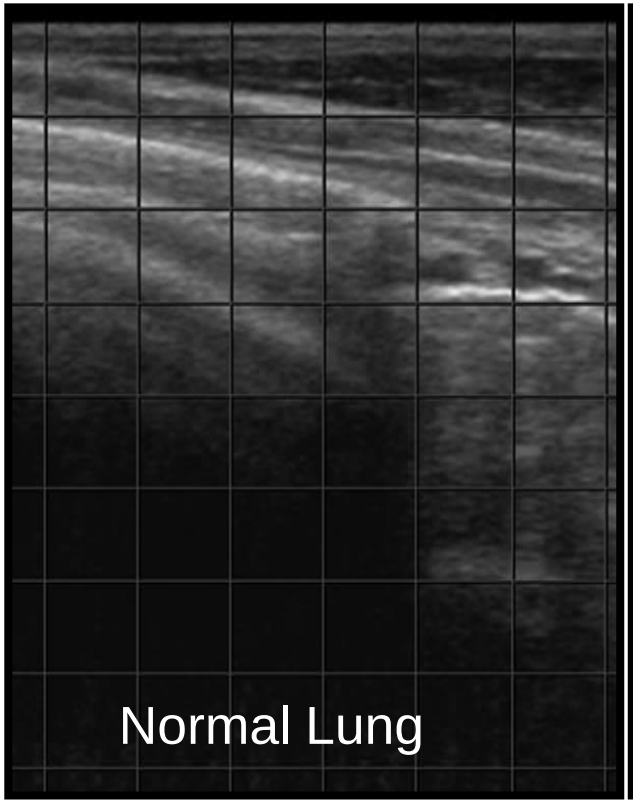
Normal



Abnormal - consolidation

Ultrasound terminology

- Hyperechoic
  - Bright white
    - Air
- Hypoechoic
  - Gray
    - Soft tissue
- Anechoic
  - Black
    - Fluid



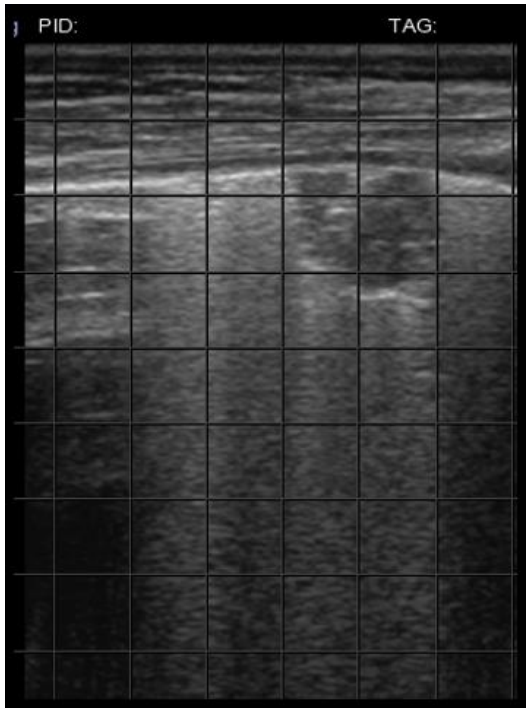
US diagnosis

Normal Lung

Bronchopneumonia

- Ultrasound scan lung scores

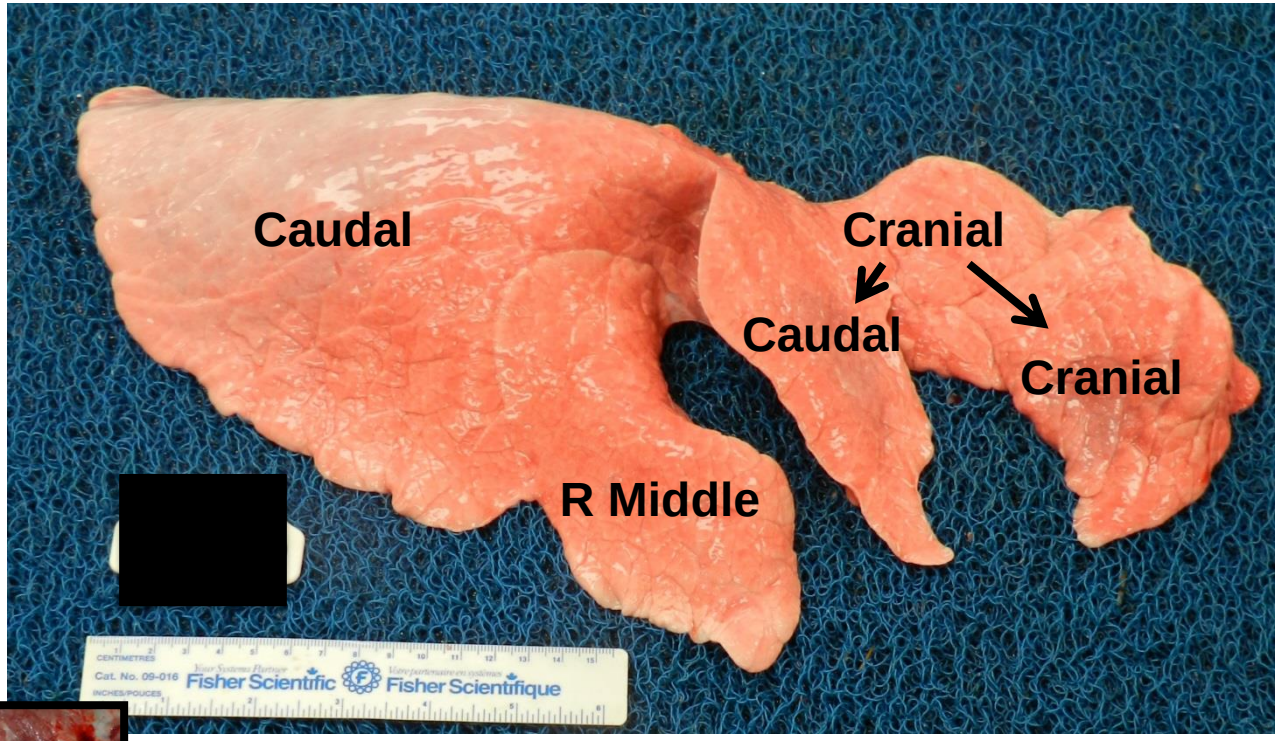
Normal lung

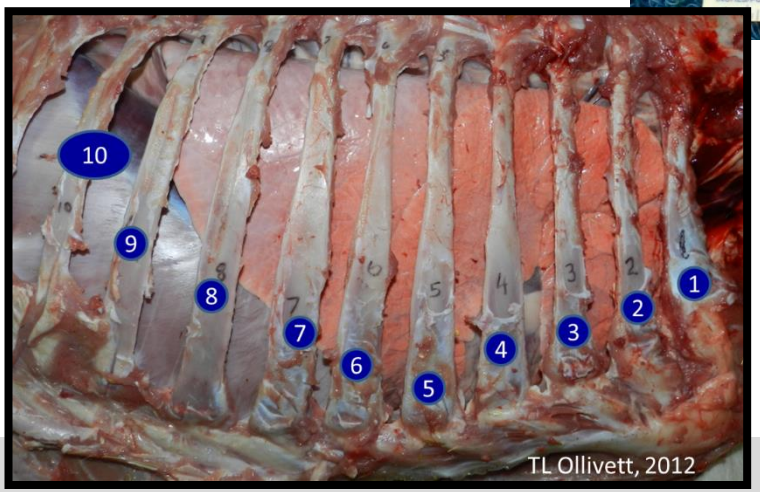


Lobular lesion

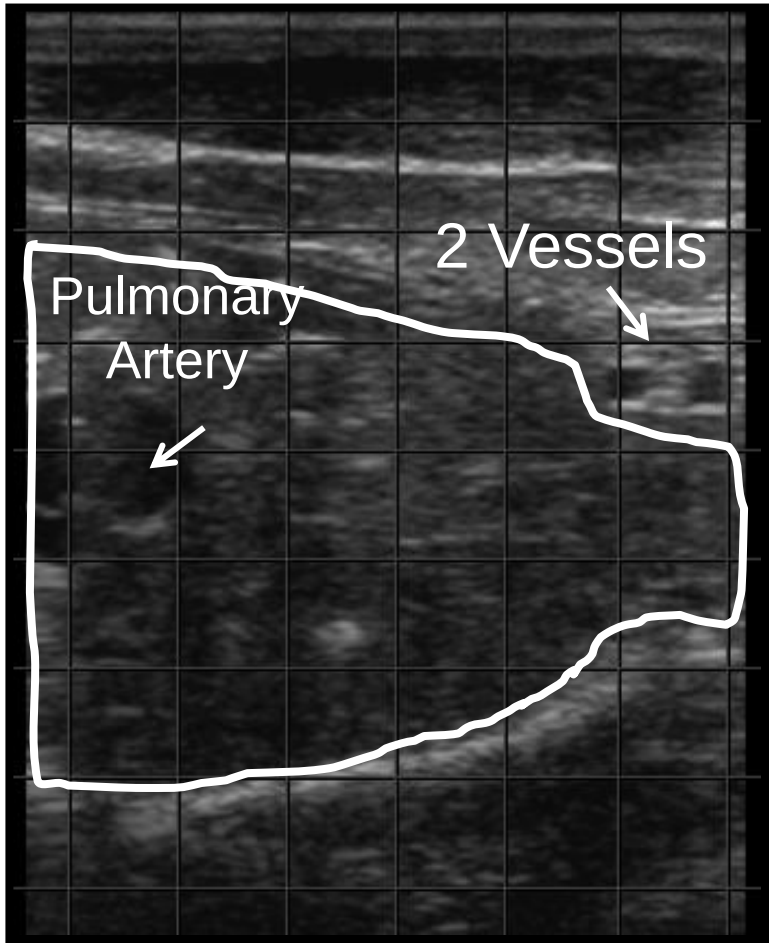
Lobar pneumonia

Lung Anatomy – Right Lung



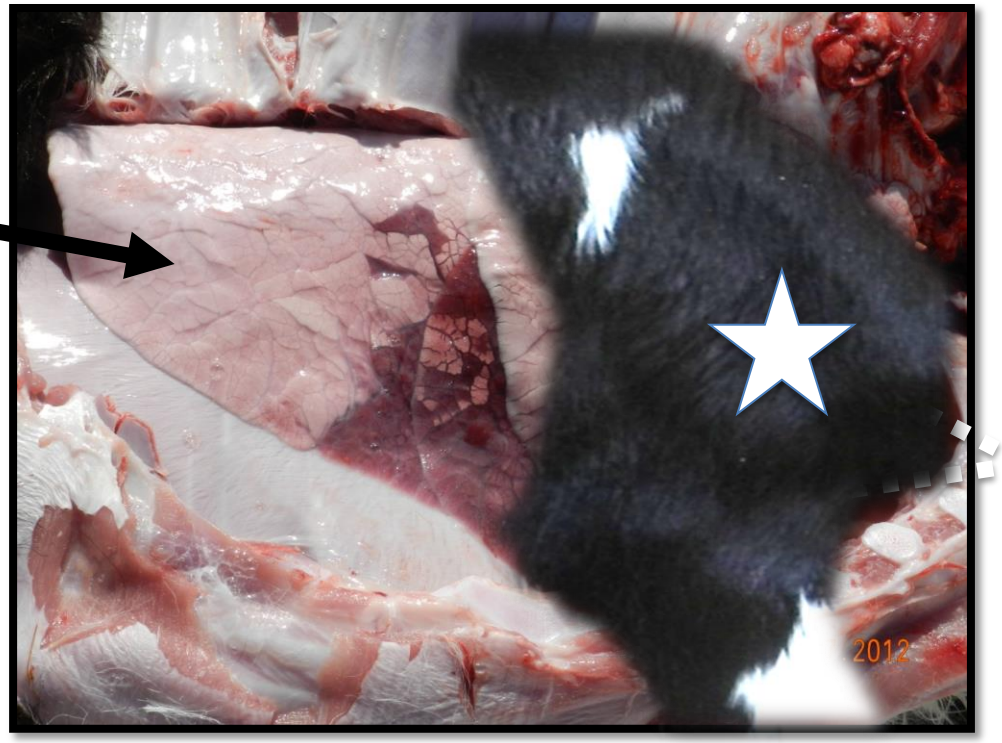


Lobar consolidation in 1st – 2nd ICS



Typical Pattern of Bacterial Bronchopneumonia in Young Dairy Calves

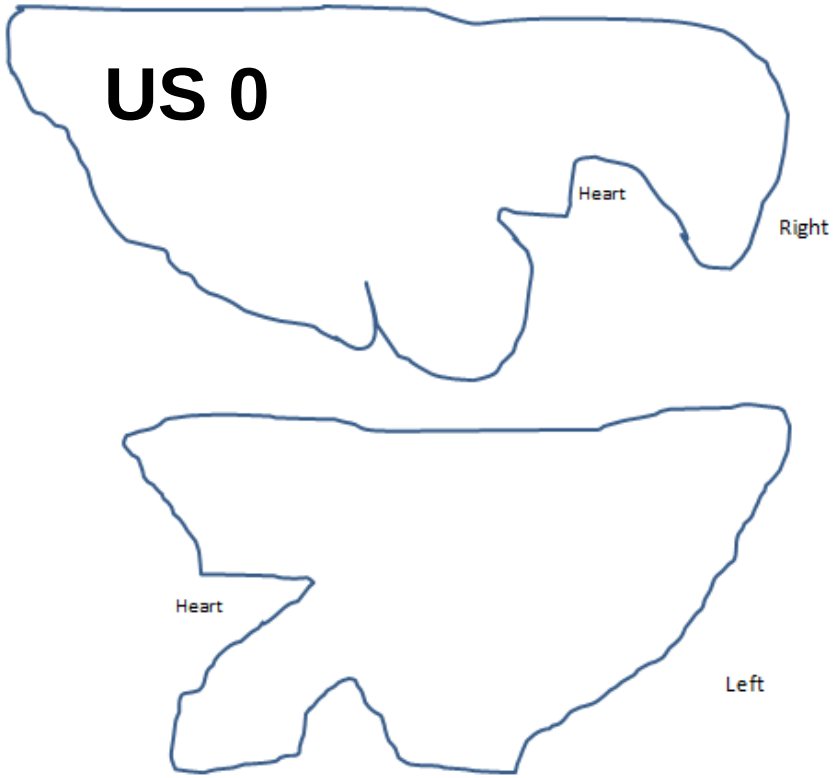
Normal Lung:
- Pale pink
- Spongy
- Air-filled

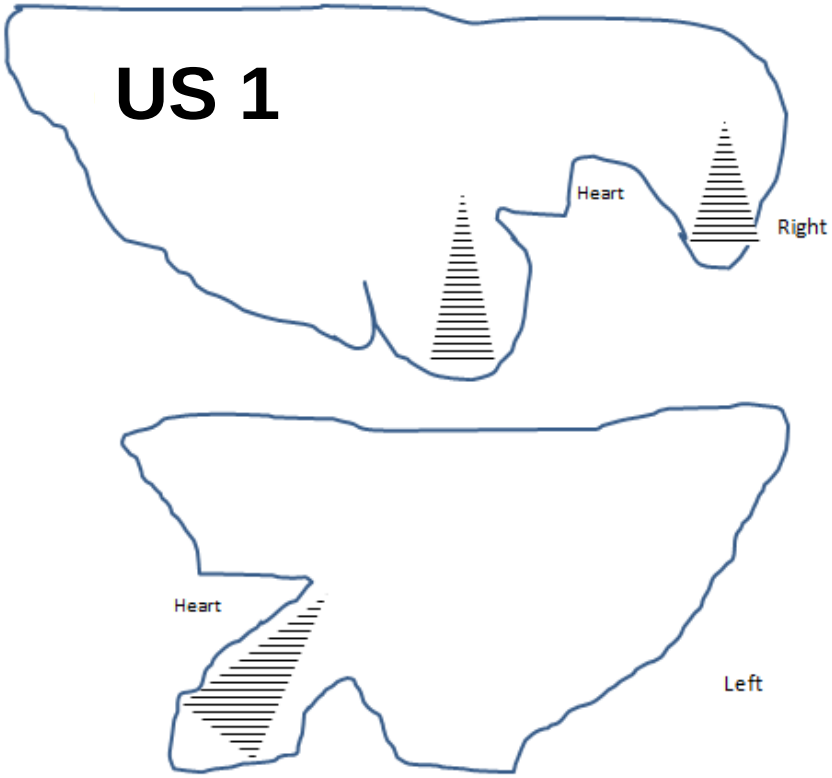


Consolidated Lung:
- Dark red, purple
- Firm
- Solid, lacks air-filling

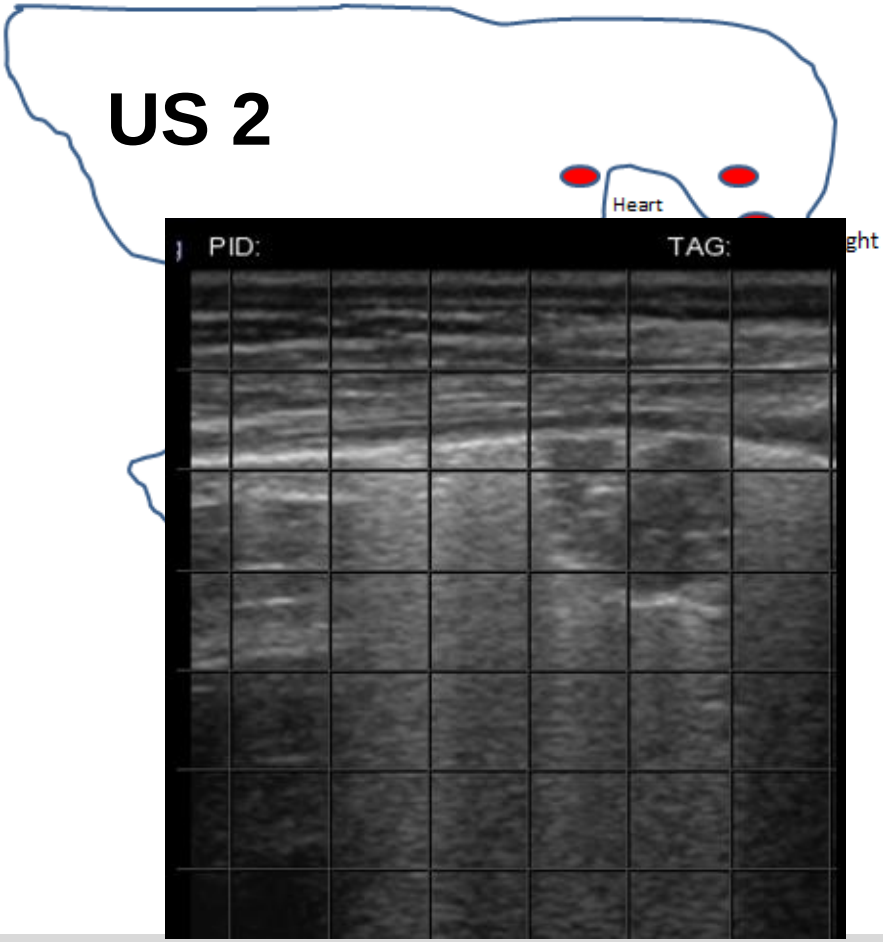
0 – 5 TUS scoring system

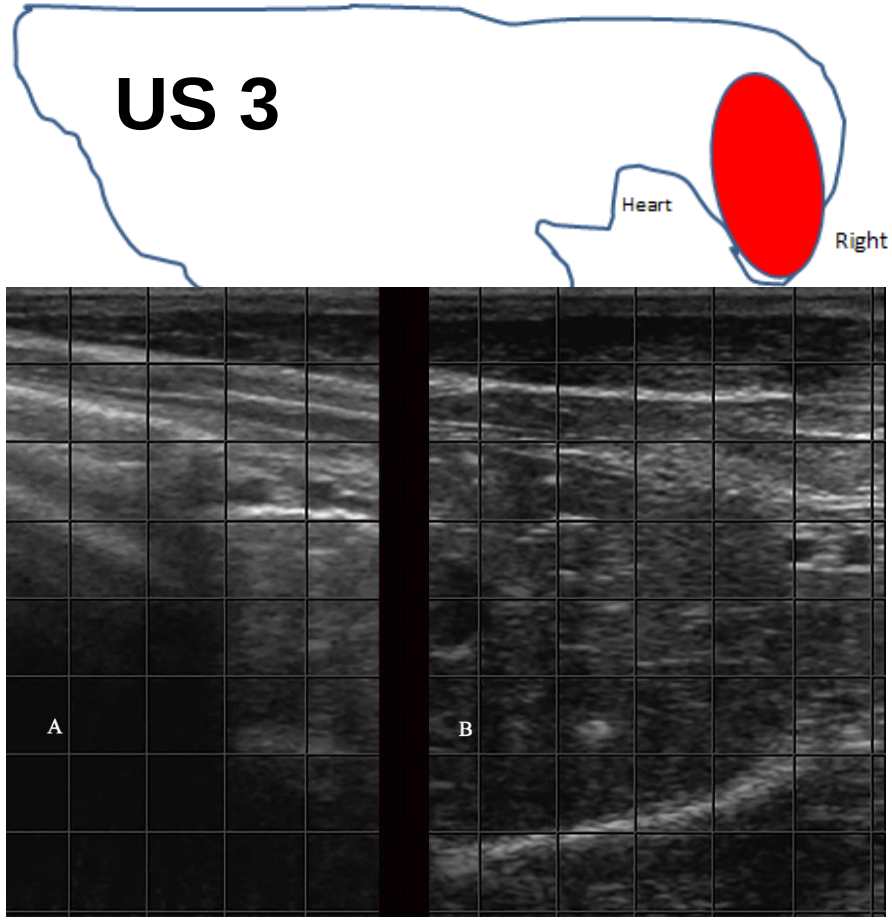
0 and 1 = normal



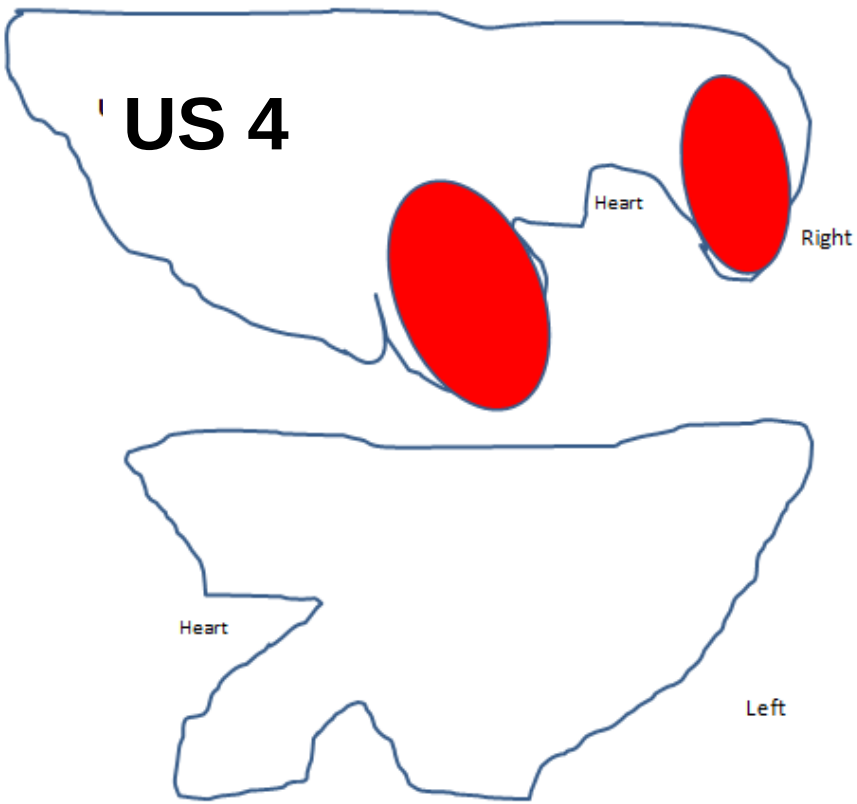


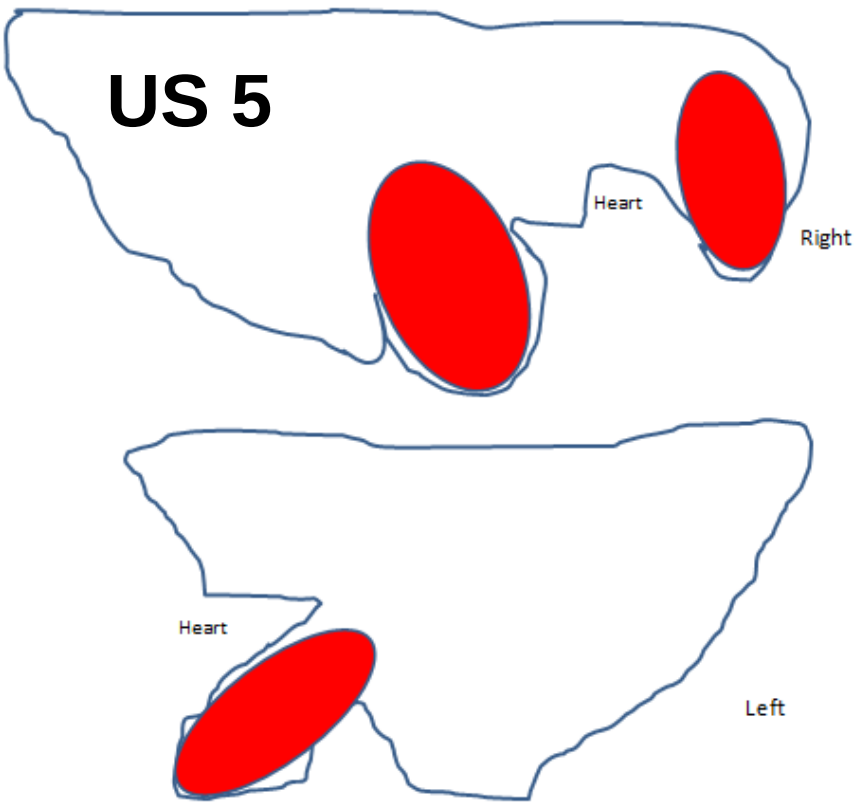
2 = **lobular** pneumonia
3 = **lobar** pneumonia 1 **lobe**

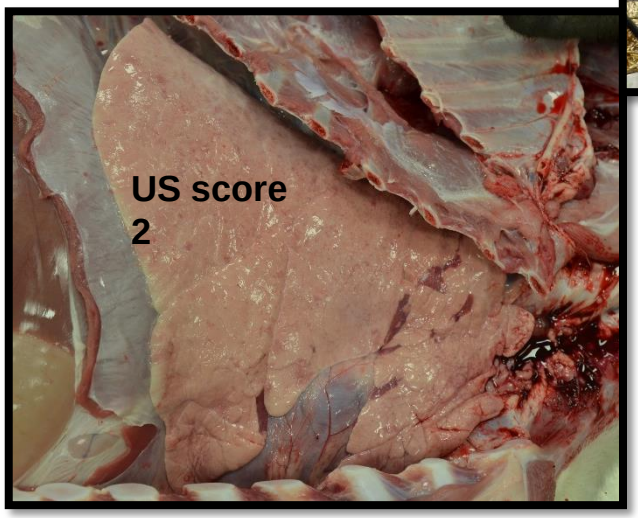


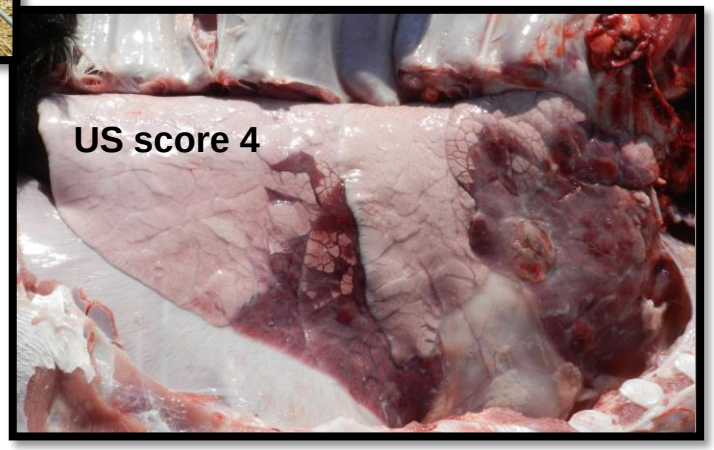


4 = **lobar** pneumonia 2 **lobes**
5 = **lobar** pneumonia 3 + **lobes**



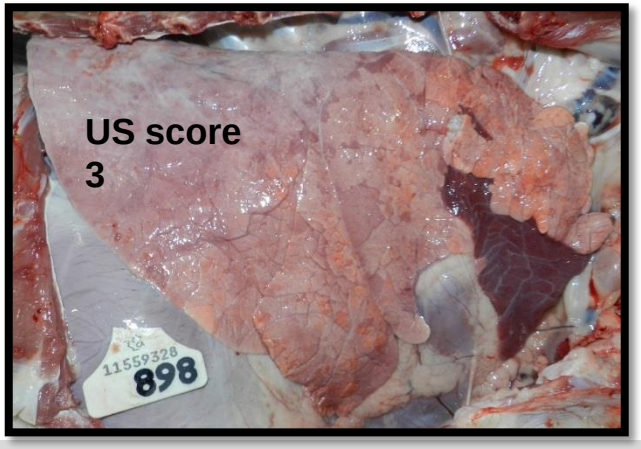






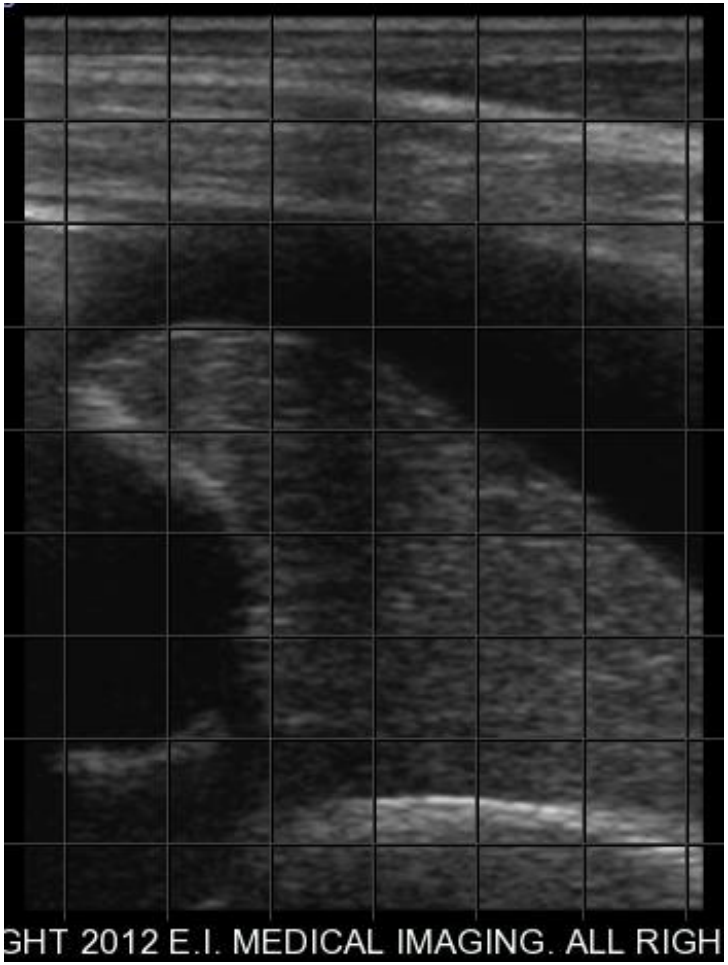
Are your calves getting treated early enough? Lung ultrasound can help you find out.

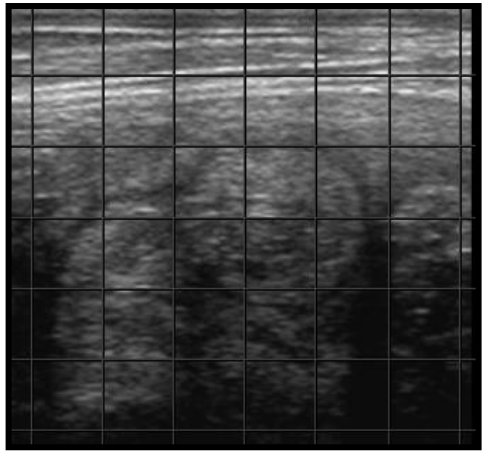
- If calves are scoring > 3 when they are first diagnosed, re-visit your detection system and definition of disease to improve early detection and treatment



"Extras"

Pleural Fluid

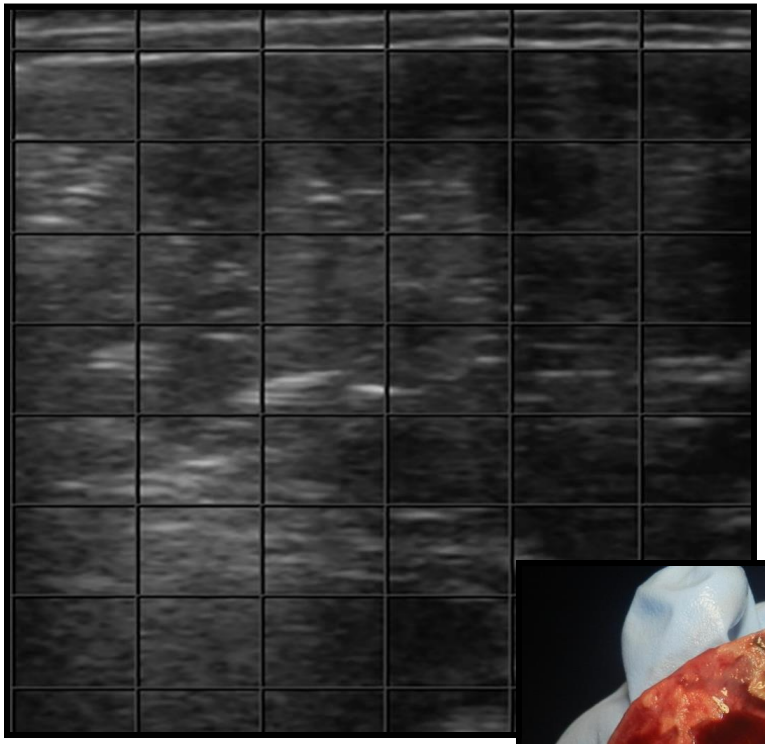


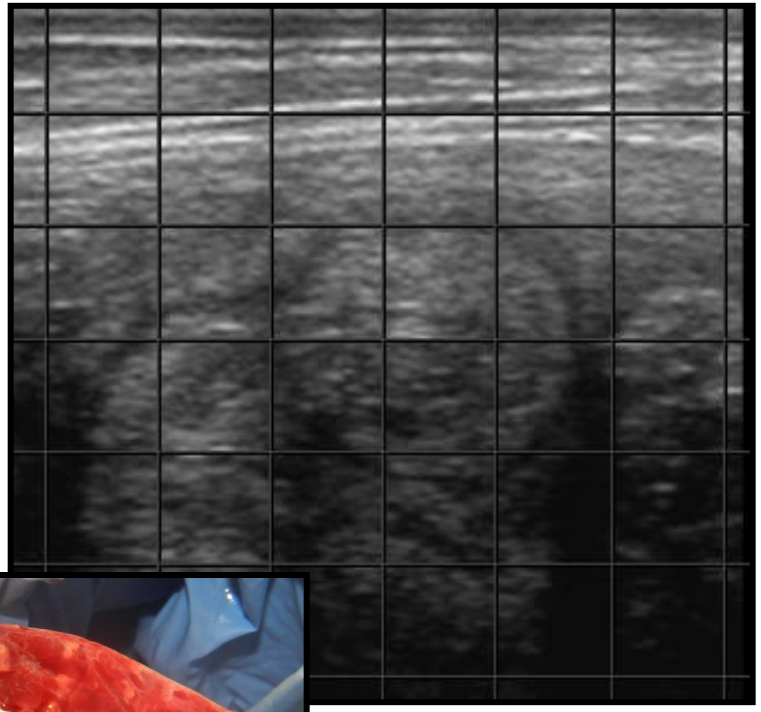


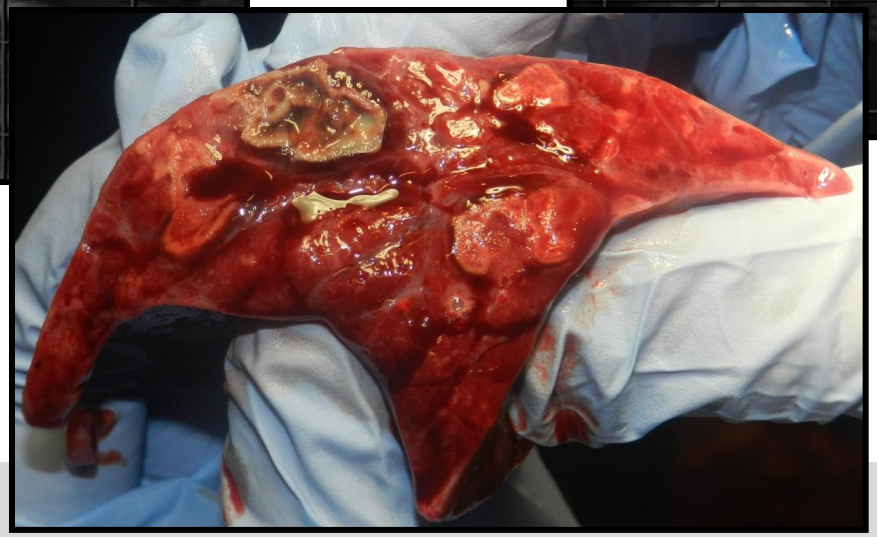
Necrosis

Abscess

Coagulation necrosis, suspect MH

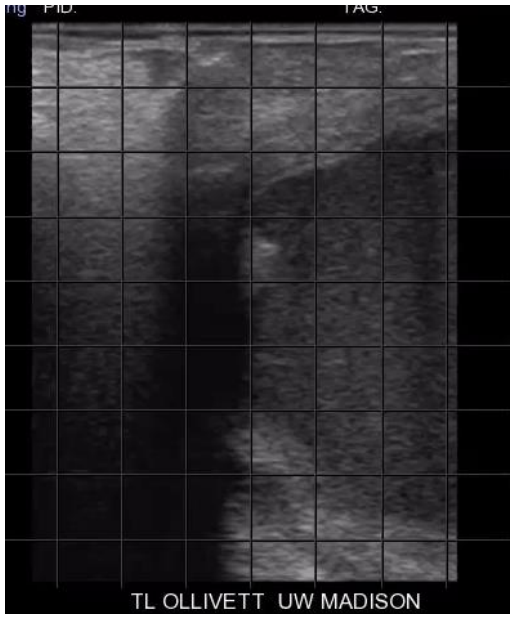


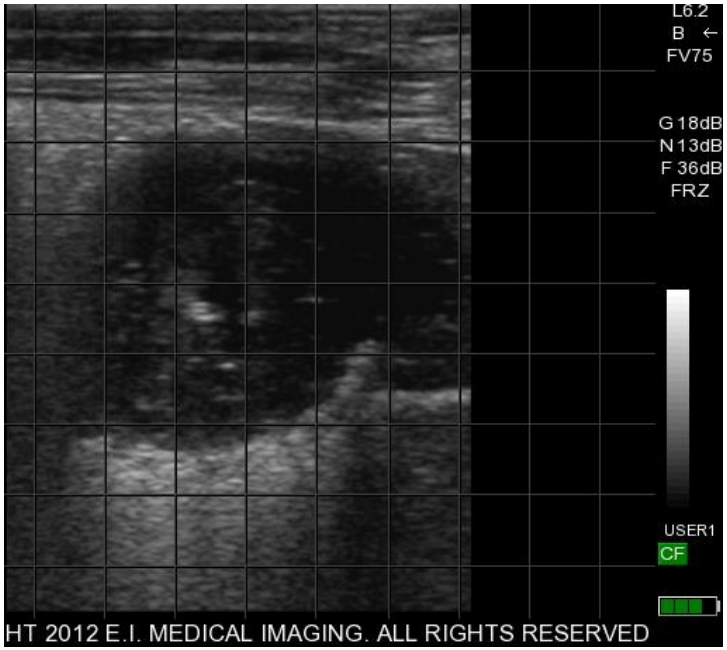




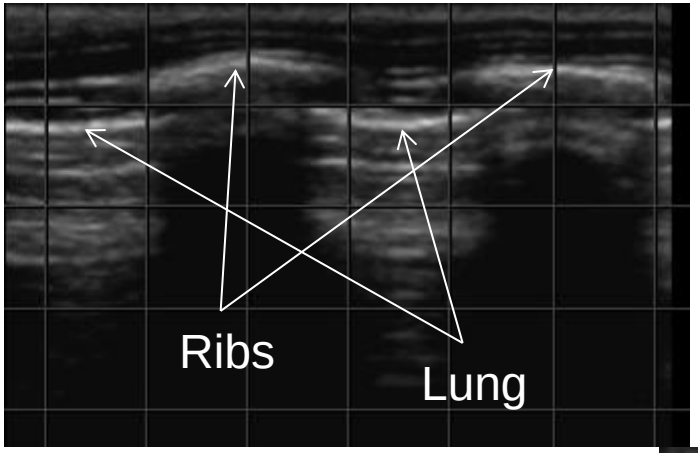
Abscesses…

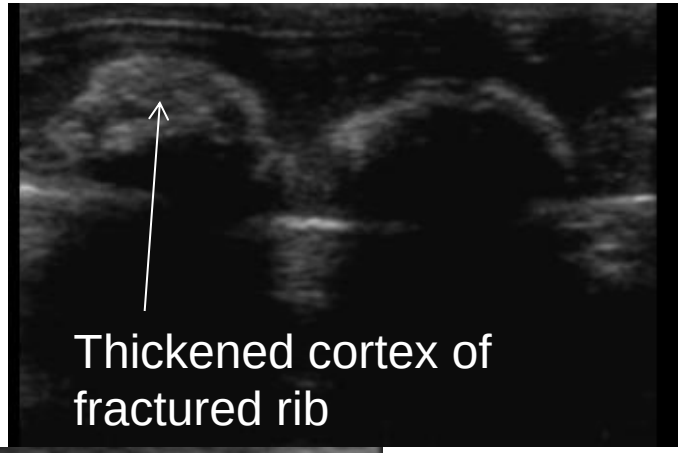
- Abscesses are mixed echogenicity with fluid, capsule, occasionally gas
- **Pics left to right:** yearling Holstein heifer cranial lobe abscess, 3 month old Jersey heifer caudal lobe abscess, Holstein bull caudal lobe abscess at 28 days of age.

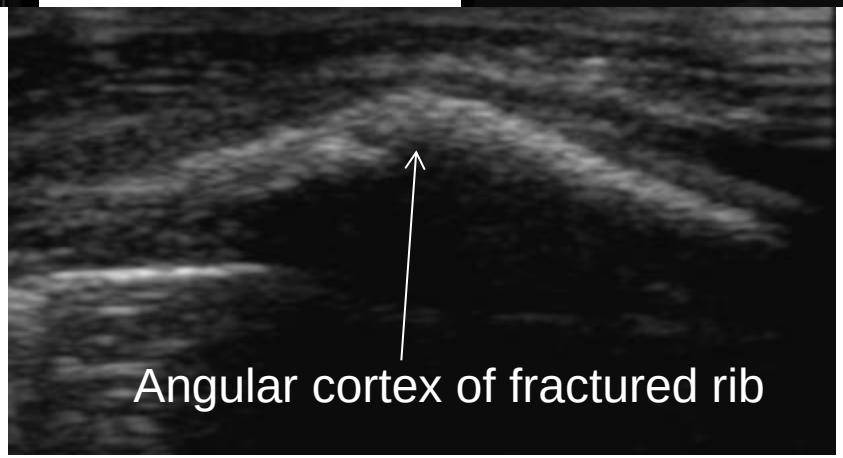




- Rib fractures should not exceed 5 – 10% of live births
- Check maternity management
- Ensure that interventions are not too aggressive and first lactation heifers are big enough







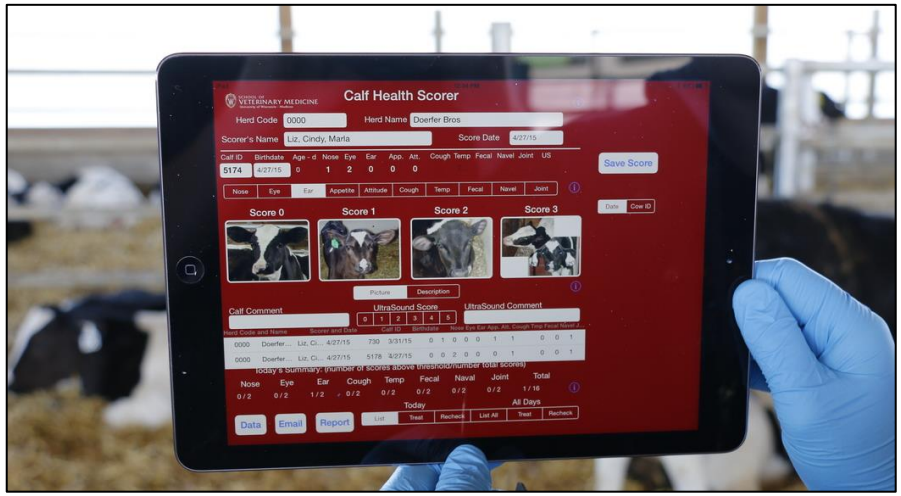
How to implement TUS?

- Improve your definition of disease
  - UW Calf Health Scorer
    - Define the clinical picture
  - Thoracic Ultrasonography
    - Define the lung involvement

Pick your clinical scoring system
UW – CA – DART

Clinical respiratory score

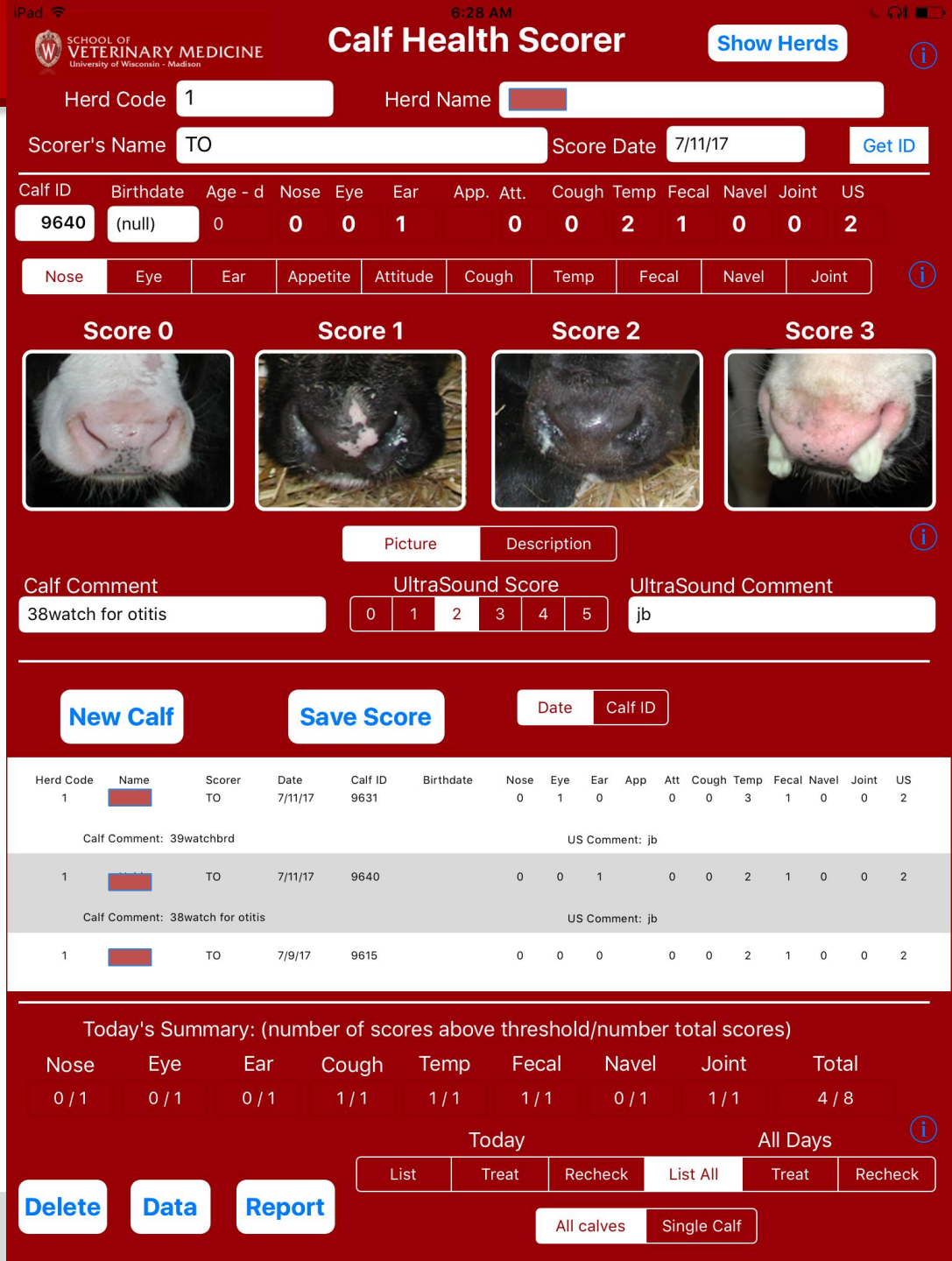
- University of Wisconsin Calf Health Scorer
- Parameters ranked by severity (0 – 3)
  - Rectal temperature
  - Cough
  - Nasal discharge
  - Eye discharge or ear position



- Score of ≥ 2 = abnormal
- At least 2 parameters ≥ 2 = clinical

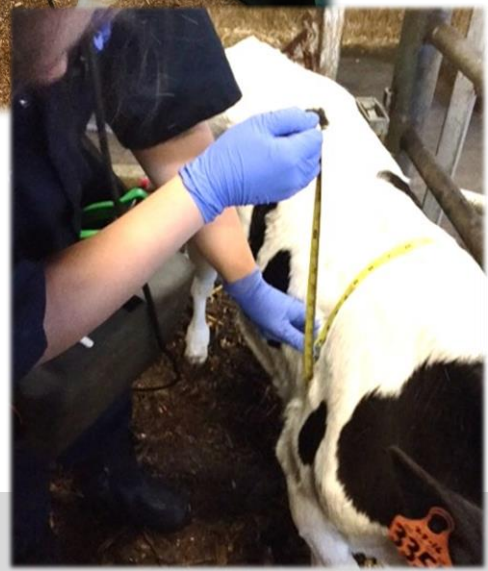
Photo: http://news.wisc.edu/story_images/10624/large/FAPM_app_close-up.JPG?1435331950

- Wand compatible
- Treat list
- Raw data
- Summary data
- Spanish
- German



Using TUS ± clinical score to monitor respiratory health

- Number of cases (%)
- Age of onset
- Metaphylaxis success
- Treatment success
- Staff competency
- Culling decisions
- Investigate poor growth
- Prepurchase exam



Where to start?

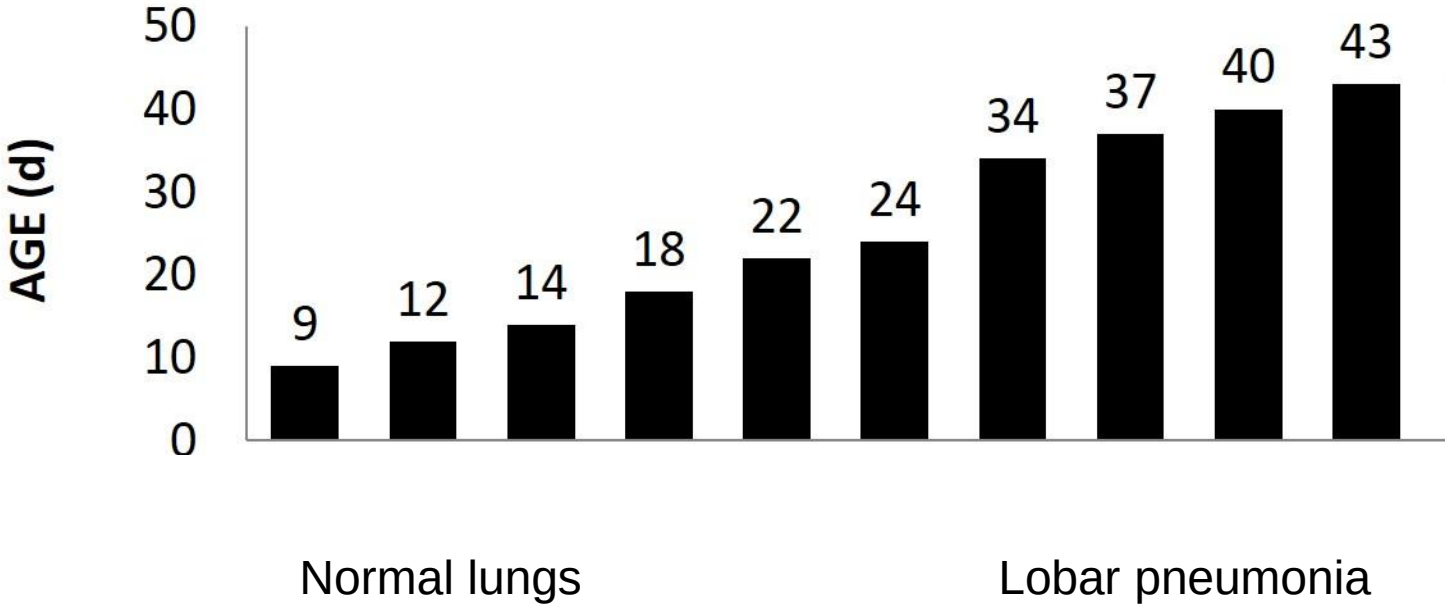
- Define your question

How many calves are affected?

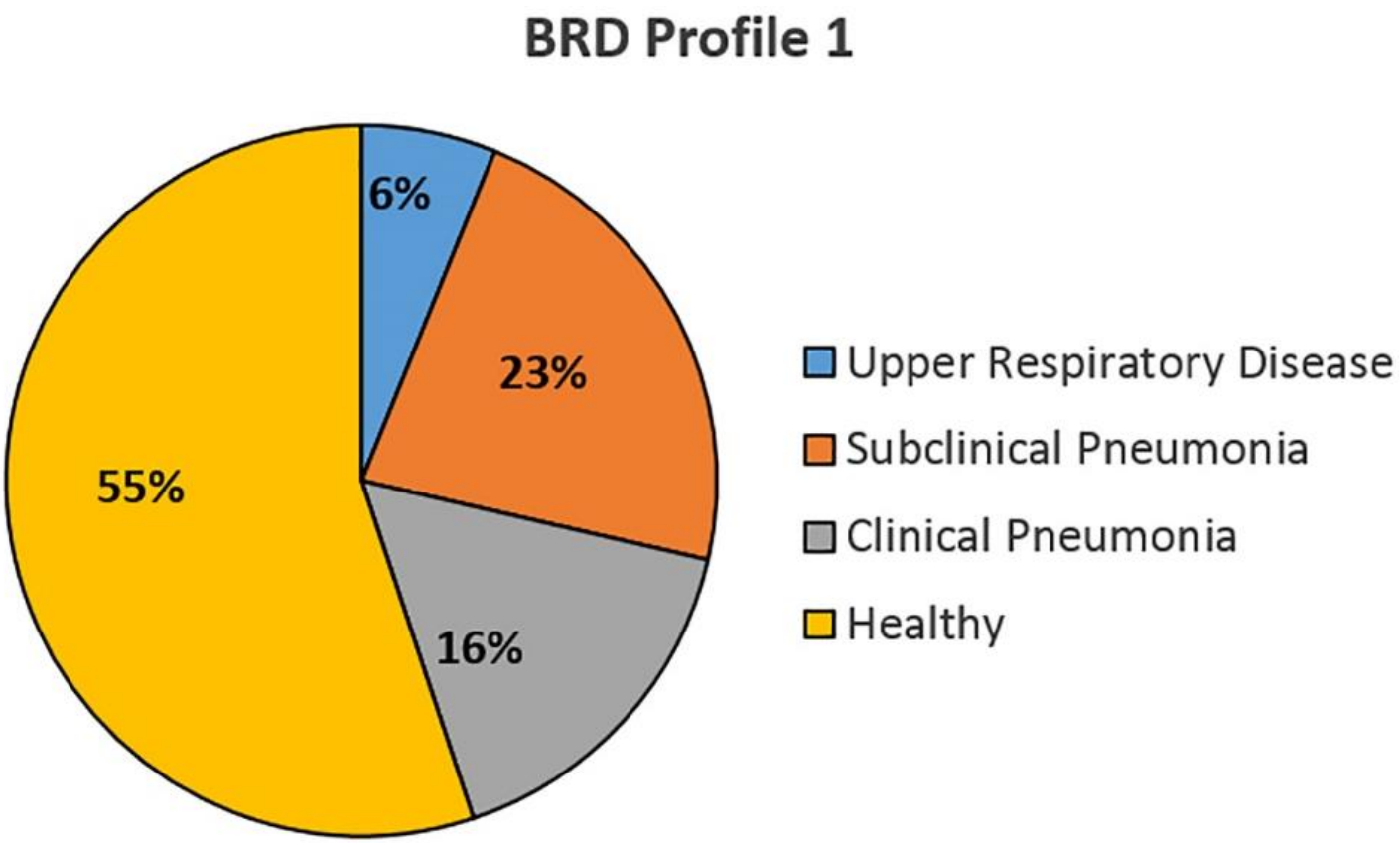
1. Get pre-intervention baseline at various ages
   - < 1 week
   - 2 weeks old
   - 4 weeks old
   - 6 weeks old
   - 8 weeks old (weaning)

2. Focus future evaluations at age of onset or peak age
   - Recheck every 1 – 2 months, quarterly, or Spring and Fall
   - Frequency depends on management system, severity of problem, and seasonality
   - Investigate significant increases in affected calves

Define who is affected

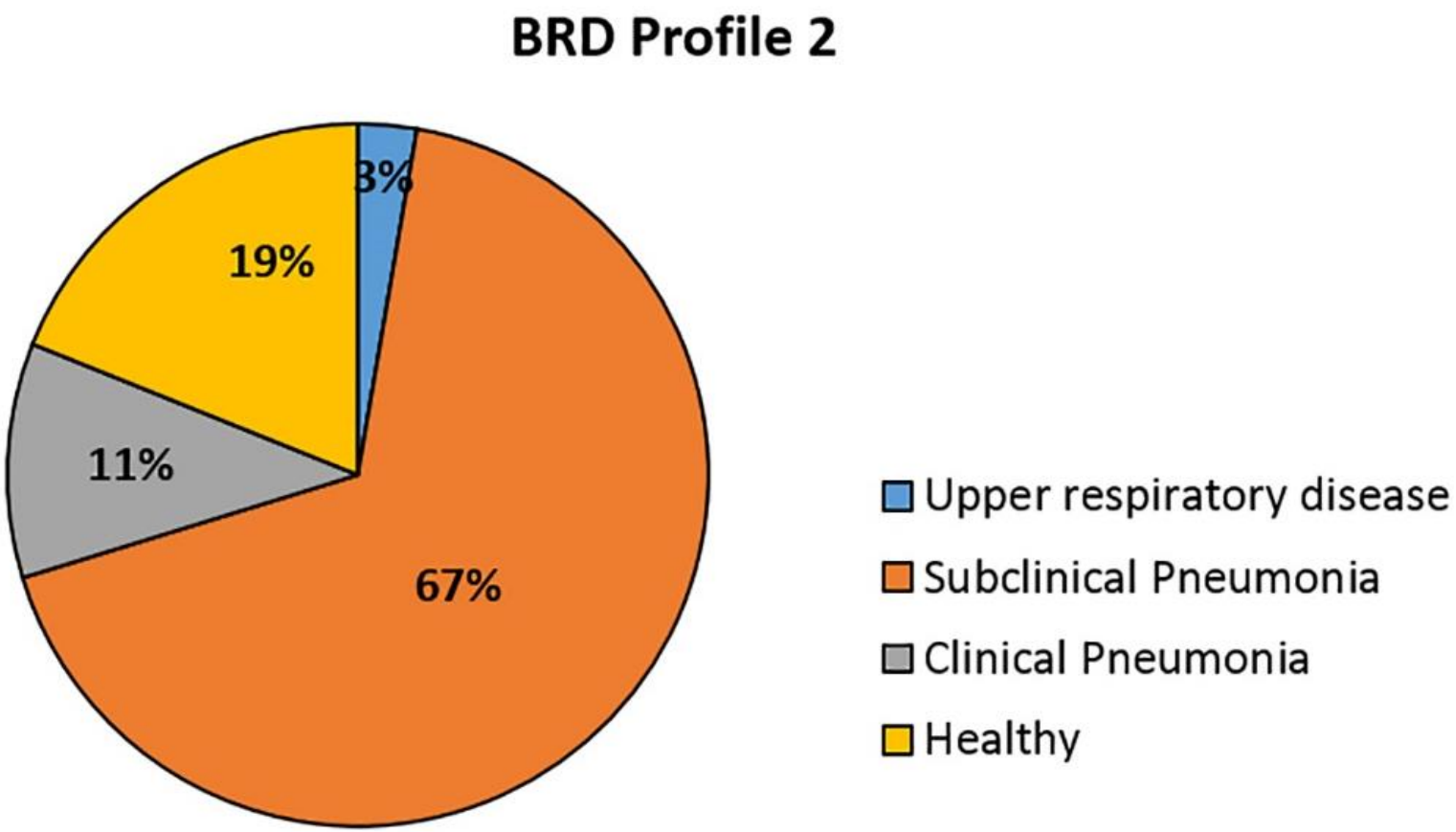


Cross-sectional disease prevalence



Average level of disease: indoor, individually housed calves

Cross-sectional disease prevalence



Excessive subclinical disease in indoor, group housed calves with poor definition of disease, subsequent late treatment, poor response to therapy, and poor ADG.

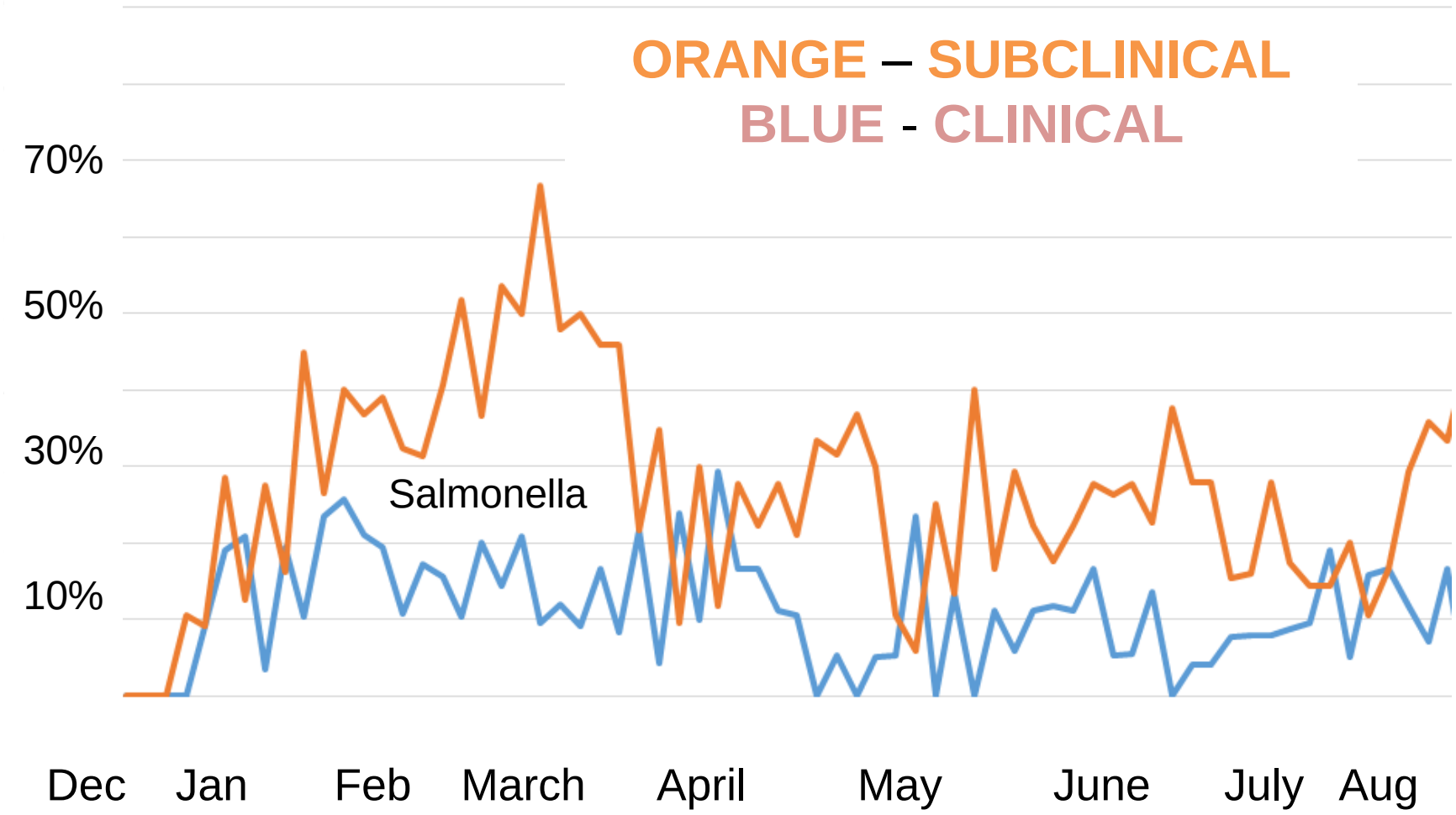
Did the intervention work?

1. Get pre-intervention baseline at various ages
   - < 1 week
   - 2 weeks old
   - 4 weeks old
   - 6 weeks old
   - 8 weeks old (weaning)

2. Recheck after enough time has elapsed to see the impact
   - Check calves that were born after the change was made
   - Wait until they are the age that was affected previously

3. Interventions to monitor
   - Fixing passive transfer or scours, PPV tubes, new vaccine
   - New staffing or training procedures
   - Metaphylaxis

Lobar pneumonia over time



Are my employees competent?

1. Obtain a list of calves treated for the first time within the past 24 – 48 hours
   - At herd check or every other herd check
   - Before cows are evaluated
   - Separate calf visit from herd health; after new employee starts

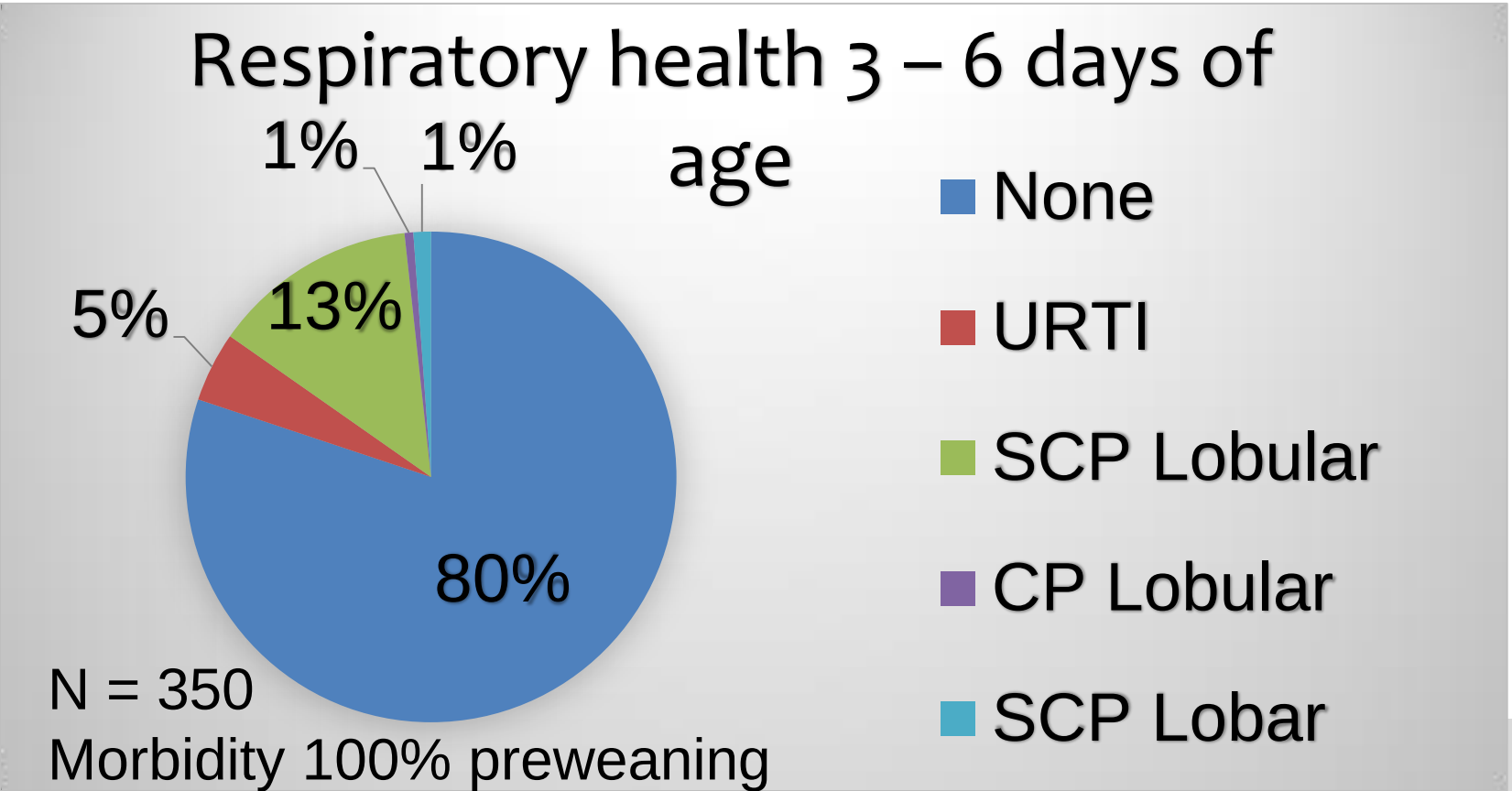
2. Scan calves
   - Majority of treated calves should score 2 – 3 on ultrasound.
     - Mostly 4 – 5: late detection
     - Mostly 0 – 1: too aggressive, misdiagnosing

   - Revisit definitions of disease and detection protocol
     - Twice daily observation for obviously sick calves
     - Twice weekly observation of high risk calves for subtle disease
     - Mark high risk calves (FPT, scours) for easier detection

3. Are treatment protocols effective? Re-scan 1 week later should see improvement

Are we causing aspiration by tube feeding colostrum?

- Scan week old calves. Very few should have lung lesions (>80% normal)
- Check new employees
- Check when very young calves are treated for BRD
- Check when changing nipple management strategies



Should I treat this calf?

It depends!

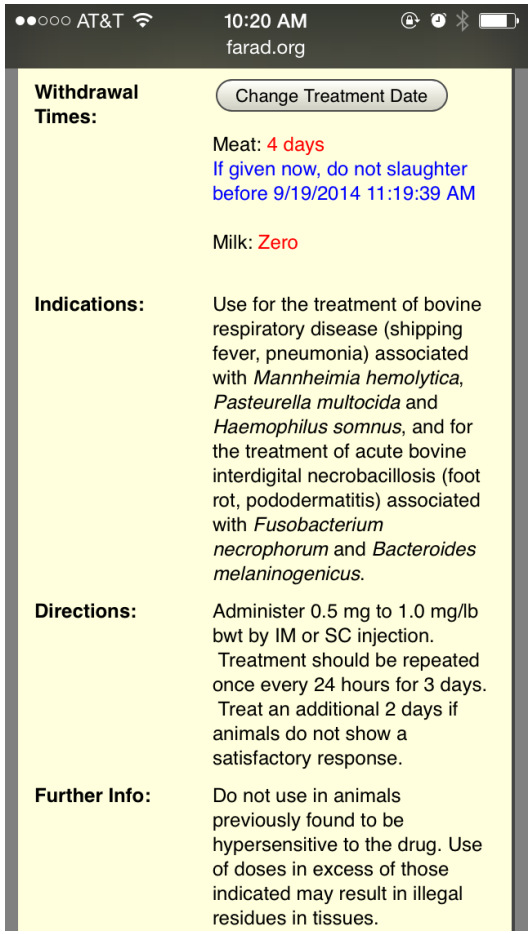
1. Is calf well grown?
2. How many times was calf treated previously?
3. Is there and abscess, necrosis, or caudal lung lobe disease?
4. Is she clinically stable?

Antibiotic treatment is NOT likely to help if calf has chronic disease

Chronic: thin top line, small stature, abscess, necrosis, caudal lung lobe
If chronic and NOT clinical stable – must consider euthanasia

No benign neglect or shipping if in respiratory distress, open mouth breathing, extremely thin

Appropriate Use of Antibiotics



- **AMDUCA**
  - Is there a drug approved for food animals that can be used on label?
    - Indication, formulation, clinically effective
  - Is there a drug approved for food animals that can be used off label?
    - Extend withholds, label/ recording requirements
  - Is there a drug approved for humans or non-food animals that can be used off label?
    - Extend withholds, label/ recording requirements
    - Need scientific evidence for withholding periods
- **FARAD**
  - App for iOS and Android users

Treatment strategies for BRD

- Antibiotics approved/labeled
  - Ampicillin
  - Ceftiofur
  - Danofloxacin (beef only)
  - Enrofloxacin
  - Florfenicol
  - Gamithromycin
  - Oxytetracycline
  - PPG
  - Spectinomycin
  - Sulfadimethoxine
  - Tildipirosin
  - Tulathromycin
  - Tylosin

Rarely will ELDU be necessary
- Chronics
- Abscessation

Use diagnostics to help make treatment protocols

- What is your typical bug?
- 6 affected untreated animals
- Deep nasopharyngeal swab
  - Complete Respiratory Panel
    - PCR for DNA of important bacterial, viral, mycoplasma bugs
    - Culture & sensitivity on positive bacterial samples

A couple rules of thumb…

- Treat 48 hrs after signs have abated
  - Typically 7 – 10 days for *M. bovis* otitis
- 72 hours before switching
  - Longer for long acting antimicrobials
- DVM involvement
  - Definitions and treatment protocols
  - Increase in morbidity/mortality
  - Failure to respond to treatments
  - Chronic cases
    - Weight loss, failure to grow
    - Labored breathing despite treatment

When things aren't working…

- Reasons for treatment failures
  - Failure to:
    - Reach MIC
    - Reach lesion
    - Penetrate abscess
    - Ineffective environment
  - Late timing
  - Wrong route
  - Wrong dose
  - Wrong duration
  - Extent of disease
  - Susceptibility of organism
  - In vitro ≠ in vivo activity

Adjunctive therapy for BRD

- Tissue injury and inflammation
- Endotoxin from G- pathogens
  - SIRS can be life threatening
- NSAIDs
  - Improve clinical signs
  - Mixed effect on long term outcomes
    - Improved lung lesions at slaughter
    - No effect on mortality

Supportive Care:

- Flunixin meglumine
  - Only NSAID labelled for fever reduction
  - Must go IV
    - IM/SQ = violative residue
  - Side-effects
    - GI ulceration
    - Nephrotoxicity

Corticosteroids
Use in life threatening situations
0.05 – 0.2 mg/kg IV or IM

- Supportive therapy
  - Shelter with good ventilation
  - Uncrowded housing
  - Easy access to quality feed and water and air

Should I buy this calf?

- Prepurchase exams reveal new or chronic lung disease

- 3 month old calf purchased
- Shipped east coast to WI in July
- Walked of trailer in distress with large abscess
- Died within 4 – 6 weeks of purchase

Quick mention on facilities and restraint

Group housing, minimal restraint
- No halters

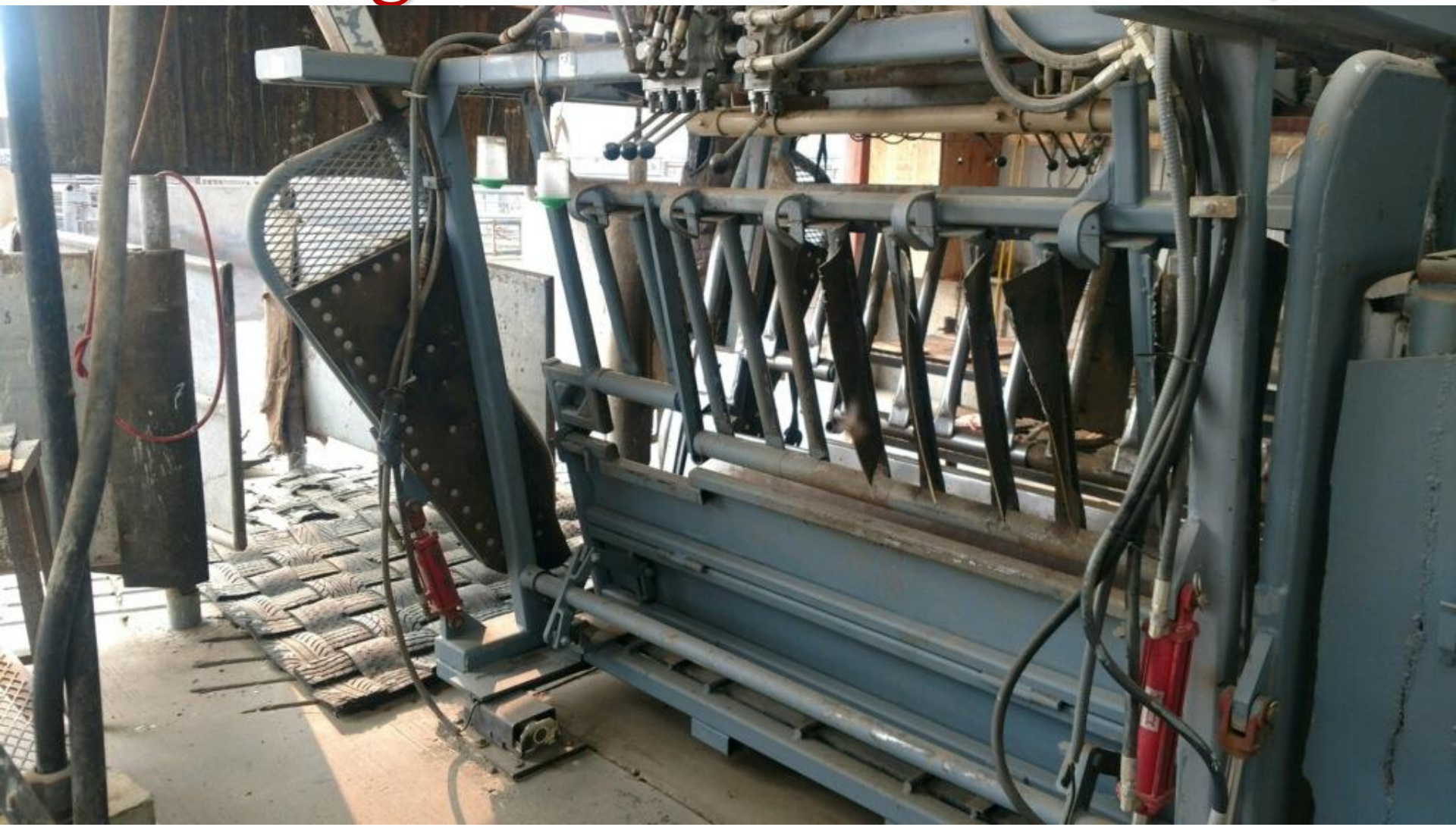
Pre-weaned headlocks

Headlocks on German slats

<u>What are your group housing restraint systems?</u>

- gates, head locks, chute?
- **Think ahead** when building your barn

Renovating chutes for older heifers/beef



Picture courtesy of Dr. Liz Cox, Merck

Picture courtesy of Dr. Liz Cox, Merck

Adult cows in stalls are possible

To conclude…

How are you detecting sick animals?

How are you monitoring lung health?

Are your employees & interventions effective?

How much future potential you are losing?

2016 Thoracic Ultrasound Rotation

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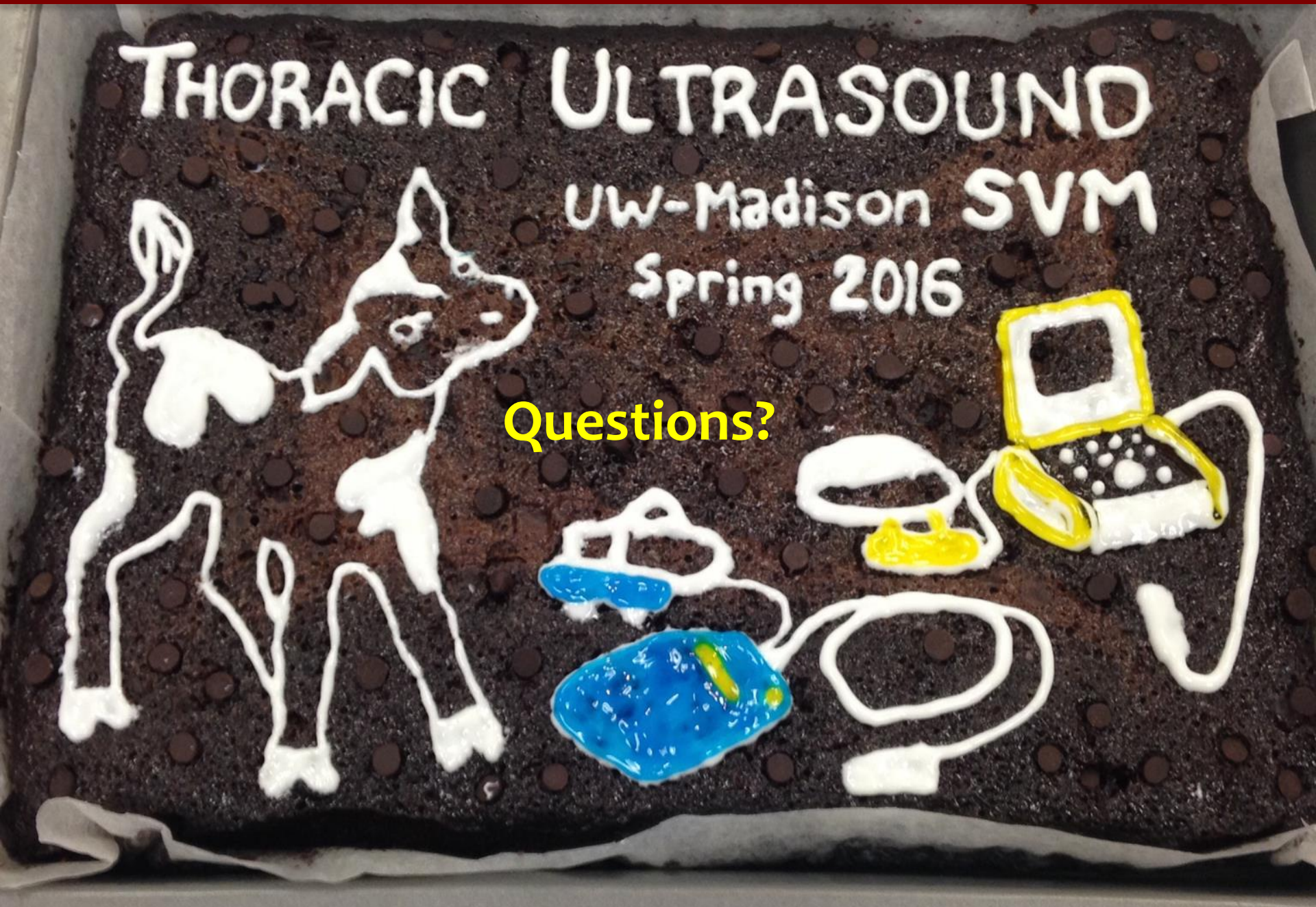

Questions?