What’s your diagnosis?

Hint: Notice the lump on the jaw.

This cow has:

- A. Botryomycosis
- B. Lumpy jaw
- C. Tooth ache
- D. Wooden tongue

What is the cause of lumpy jaw in cattle?

- A. *Arcanobacterium pyogenes*
- B. *Rhodococcus bovis*
- C. *Mycobacterium paratuberculosis*
- D. Iodine toxicosis
- E. *Actinomyces bovis*

*Actinomyces bovis* is a fungus.

- A. True
- B. False

Sequence of events

- Normal oral flora
- Injury or bad teeth
- Adhere → invade → infection → inflammation.
- Acute & cell-mediated immune response
- Pyogranulomatous inflammation
  - Mixed inflammation: PMNs + Macs & Lymphs
- Dramatic remodeling of bone

Diagnosis

- Novel clinical signs
- Sulfur granules in exudate
  - Clusters of bacteria surrounded by inflammatory debris
- Branching Gram-positive rods
Abscess under the skin of a cow. Tiny bacterial colonies that are Gram-positive small rods. What is the most probable etiologic agent?

- A. *Streptococcus pyogenes*
- B. *Arcanobacterium pyogenes*
- C. *Staphylococcus pyogenes*
- D. *Listeria pyogenes*

**Next case**

**Lucky's Lump**

This one is REALLY hard
Abscess
*Arcanobacterium pyogenes*

**Diagnostic Information**
- BAP culture at 24 hours
- Gram stain of colony

**What's Your Diagnosis?**
- Abscess
- *Arcanobacterium pyogenes*

**Key Elements of the Story**
- Source = environment / normal flora
- Predisposing factor = injury or other disease
- Inflammatory response – acute / PMNs = pus
- Antibiotic resistance NOT a problem
- However, getting the drug to the bug can be difficult for large abscesses – need to drain the abscess and treat both topically and systemically.

**Pyogenic**

**Next Case**
- Bovine vaginal exudate
- Pyogenic

**Necropsy**
- Uterine horns
- Pyogenic
- Name of this condition?
Pyometra
*Arcanobacterium pyogenes*

**The Buck Stops Here**
- White-tailed buck
- Walking in circles
- Disoriented
- No fear of people
- Pus exuding from base of antlers

**Cranial Abscess Syndrome (CAS)**
*Arcanobacterium pyogenes*

**Key Elements of the Story**
- Source = environment / normal flora
- Predisposing factor = injury – fighting
- Inflammatory response – acute / PMNs = pus
- Infection migrates from antlers to brain
- Brain abscess results in neurologic disease – abnormal behavior

**Pyogenic**

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“...CAS may account for up to 6% of the natural mortality in bucks.”

Early detection of emerging wildlife diseases protects the health of deer, livestock — and humans.
Any abscess in cattle – think *Arcanobacterium pyogenes*

Bovine penile abscess:
“...I assume *A. pyogenes* in every bovine abscess.”
Harry Momont, DVM, PhD, Univ. Wis., SVM, October 2001.

Rumenitis-Liver Abscess Complex

1. Diet high in grain
2. Fermentation in rumen forming organic acids
3. Rumen acidosis → rumenitis
4. Damage to rumen epithelium
5. Invasion of blood stream by
   - *Arcanobacterium pyogenes*
   - *Fusobacterium necrophorum*
6. Filtration of bacterial emboli by liver → damage → abscess

Microbial Synergism

<table>
<thead>
<tr>
<th>Factor</th>
<th><em>F. necrophorum</em> (Fn)</th>
<th><em>A. pyogenes</em> (Ap)</th>
<th>Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>Anaerobic</td>
<td>Facultative</td>
<td>Ap uses up O₂; creates anaerobic environment for Fn</td>
</tr>
<tr>
<td>Toxins</td>
<td>Leukotoxin</td>
<td>Hemolysin</td>
<td>RBC lysis provides iron to Fn &amp; creates anaerobicosis; leukotoxin protects Ap from PMNs</td>
</tr>
<tr>
<td>Nutrition</td>
<td>Lactate utilizer</td>
<td>Lactate producer</td>
<td>Ap provides energy source, lactate, for Fn</td>
</tr>
</tbody>
</table>

Economic impact

- Reduced feed intake
- Reduced weight gain
- Decreased carcass yield
- Liver condemnation

Prevention

- Nutrition management
- Tylosin in feed

Stories to Practice

- Lung abscess in a pig
- Chronic poor-doing ewe with clinical signs of pneumonia
- Mastitis in a 5 year old Holstein
- Liver abscess found in a slaughter in a Hereford steer
- Pleuritis secondary to traumatic reticulitis
Did you listen to read Vet Micro?

What is the source of *R. equi* infection for foals on most horse farms?

- A. Soil/dust
- B. Water
- C. Mare
- D. Owner

What is the primary virulence factor of *R. equi*?

- A. Enterotoxin
- B. Lipopolysaccharide (endotoxin)
- C. Intracellular survival
- D. M protein

What is most important in determining the outcome of the encounter between the foal and *R. equi*?

- A. Vaccination status
- B. Presence or absence of antibody to *R. equi*
- C. Level of complement in serum
- D. Dose of exposure

The Case of Clyde the Coughing Clydesdale
Clyde the Coughing Clydesdale

- Clydesdale foal
- Fever
- Cough
- No nasal discharge
- No swollen lymph nodes
- Off feed

The mother is Dale – so the foal is…….. Dale’s Clyde

Transtracheal Culture

Gram stain of colony

What Is Your Diagnosis?

Bronchopneumonia

*Rhodococcus equi*

What is the Story?

- Where did it come from?
- How are animals exposed?
- How does it cause disease?
- Why does the animal have these signs?
- How do you diagnose this disease?
- Will infection spread to other animals?
- How do I treat this infection?
- What is the prognosis?
- How can this be prevented?
- Is it contagious for humans?

Key Elements of the Story

- Source
  - Primary: horses – feces
- Secondary: dry dusty environment
- Transmission: inhalation
- Predisposing factor:
  - Age / immunologically naïve / virus
  - *R. equi*
  - Facultative intracellular pathogen
  - Inflammatory response mixed
  - T-cell-mediated & pyogenic
- Treatment
  - Rifampin + erythromycin x 2 months
  - Hyperimmune serum
Host Response; Mixed

1. Cell-mediated
   - Macrophages → giant cells
   - Lymphocytes

2. Dead PMNs & macrophages → Pus = pyogenic infection

Pathologists says: pyogranulomatous
Clinician says: suppurative bronchopneumonia

**Rhodococcus equi** and Foals

- Multiplies in foal intestine up to 12 weeks old
- Progressive build-up of infection of virulent isolates on farms over time
- Virulent & non-virulent isolates present on farms
- Foal virulent isolates all have a plasmid-encoded, highly antigenic surface protein, VapA

**Virulence Plasmid**

- All virulent isolates have 80.6 kb plasmid
- Plasmid is required for persistence in mouse and horse macrophages
- Plasmid is required for virulence in foals and immunocompromised mice (SCID, nude)
- Two plasmids have been fully sequenced from unrelated strains; both identical

**Evidence Plasmid Controls Virulence**

- Up-regulation IL-10, immunomodulatory cytokine, which down-regulates Th1 progression
- Down-regulation of interferon-gamma release

Proposed Mechanism: Immunomodulation by Virulence Plasmid
Antibody Is Protective

- **No Antibody**
  - *R. equi* is bound to macrophages via complement receptors (CR3) and phagocytized but phagosome-lysosome fusion is blocked and so *R. equi* survives and replicates.

- **With Antibody**
  - *R. equi* is opsonized by antibody, bound to macrophage by Ig Fc-receptors, phagocytized, and phagosome-lysosome fusion readily occurs and *R. equi* cells are killed.

Therefore, the mode of entry of *R. equi* into cells determines its fate and that of its host.

Current Approaches to Control of *R. equi* in Foals

- **Early recognition and treatment**
  - Expensive & prolonged
  - Erythromycin & Rifampin x 2 months

- **Use of hyperimmune plasma**
  - Expensive & only partially effective

- **Reduction of challenge dose**: Environmental management
  - Do not over-graze pastures
  - Keep environment moist to prevent dust

- **There is a need for an effective vaccine**
  - However, primarily for a subset of horse breeding farms with very expensive animals and recurring *R. equi* problem.