Emerging Infectious Diseases

Erin Goodrich DVM, DACVPM

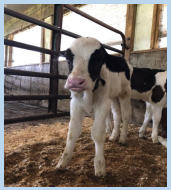
College of Veterinary Medicine

Cornell Animal Health Diagnostic Center

1

Scenario 1: Farm History

- Buys heifers from auction to sell as bred heifers
- Range from 1-6 months old currently
- 4/12 died in past 10 days
- Severe respiratory disease



College of Veterinary Medicine

Cornell Animal Health Diagnostic Center

2

AHDC submission

- 3 mo Holstein calf submitted for necropsy
- Had severe lung consolidation on thoracic U/S
- Received 1 injection of Draxxin, Banamine and Bo-Se
- Previous calves treated with Draxxin or Nuflor
- Housed in 2 groups sharing a fence line
- No vaccine history

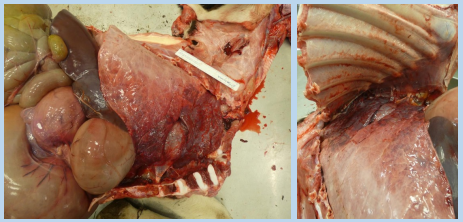
College of Veterinary Medicine

Cornell Animal Health Diagnostic Center

3

College of Veterinary Medicine
Cornell Animal Health Diagnostic Center

4



College of Veterinary Medicine
Cornell Animal Health Diagnostic Center

5

Differential Diagnoses

- *Mannheimia haemolytica*
- *Pasteurella multocida*
- *Histophilus somni*
- *Trueperella pyogenes*
- *Bibersteinia trehalosi*
- *Mycoplasma* spp.
- *Salmonella* Dublin sepsis
- BVD
- BRSV
- BHV1
- Coronavirus
- PI3
- Lungworm
- Selenium deficiency

College of Veterinary Medicine
Cornell Animal Health Diagnostic Center

6

Samples/Tests

- Lung
- Feces
- Liver
- Fixed tissues (esp. lung, heart, liver, spleen, kidney, GI)
- Aerobic culture
- Mycoplasma culture
- PCR or FA for each virus (intestine preferred sample for BVD)
- Fecal float (lungworm)
- Selenium
- Histopathology

College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

7

Results

1 **Calf** - Bovine Holstein Female

Lung	
Aerobic Culture Isolate Result	Many Salmonella species, Group D1
Liver	
Aerobic Culture Isolate Result	Many Salmonella species, Group D1
Lung	
Bovine Herpesvirus-1 PCR	Not Detected
Bovine Respiratory Syncytial Virus PCR	Not Detected
Intestine	
Bovine Viral Diarrhea Virus PCR	Not Detected

College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

8

Results

Calf - Bovine Holstein Female

Lung

Salmonella species, Group D1

AMPICILLIN	RESISTANT (>16)
CEFTIOFUR	NO INTERP (>8)
CLINDAMYCIN	RESISTANT (>16)
DANOFLOXACIN	NO INTERP (<=0.12)
SPECTINOMYCIN	RESISTANT (64)
SULPHADIMETHOXINE	RESISTANT (>256)
TETRACYCLINE	RESISTANT (>8)
TIAMULIN	RESISTANT (>32)
TILDIPIROSIN	NO INTERP (>16)
TILMICOSIN	RESISTANT (>16)
TRIMISULFA	SUSCEPTIBLE (<=2)
TULATHROMYCIN	NO INTERP (16)
TYLOSIN	NO INTERP (>32)

Ref: Salmonella, serotyping NC

Item	Result
1 Calf - Bovine Holstein Female Lung	Salmonella Culture: Salmonella Dublin
1 Calf - Bovine Holstein Female Liver	Salmonella Culture: Salmonella Dublin

College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

9

Salmonella enterica subsp. enterica Serotype Dublin

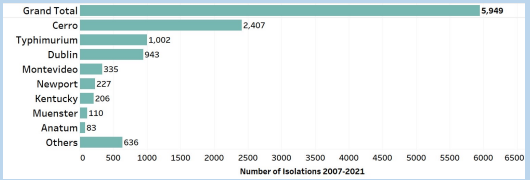
- Gram (-), facultative anaerobe
- Genus: *Salmonella*
- Species: *enterica*
- Subspecies: *enterica*
- **Serogroup** (based on cell wall (O) antigens only): **D1**
- **Serotype** (based on cell wall (O) and flagellar (H) antigens): **Dublin**
- Reported as *Salmonella* group D1 or *Salmonella* Dublin

Serogroup	Serotype
B	Typhimurium, Heidelberg, Agona
C	Newport, Montevideo, Kentucky
D	Dublin, Enteritidis
E	Anatum, Muenster, Give
K	Cerro

College of Veterinary Medicine
Cornell Animal Health Diagnostic Center

10

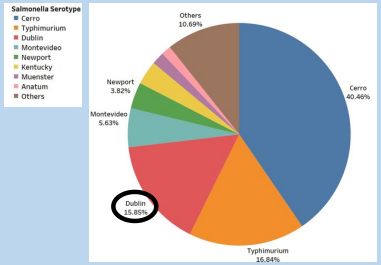
Cornell AHDC *Salmonella* isolates 2006-21



Courtesy of Missy Aprea

College of Veterinary Medicine
Cornell Animal Health Diagnostic Center

11



College of Veterinary Medicine
Cornell Animal Health Diagnostic Center

12

Salmonella Dublin

- Host-adapted strain in cattle
  - Healthy appearing carriers
- Sustained losses in infected herds
- Prevention more successful than treatment
- Calves <1yr shed ~9 weeks
- Heifers/cows shed ~3 weeks
- Clinical cases:
  - 18% become carriers
- Subclinical cases:
  - 1.5% become carriers

College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

13

Salmonella Dublin: Transmission

- Shed in feces, milk, colostrum
- Contaminated feed, water, housing
- Maternity pen
- Group calf housing
- Aerosolization?

College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

14

Salmonella Dublin: Human health concerns

- Zoonotic (multidrug resistant, high case fatality rate)
- Food safety
- 2019 outbrеak in US
  - Linked to ground beef in CA
  - 13 infected, 8 states, 9 hospitalized, 1 died
  - 6 were bacteremic

College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

15

Salmonella Dublin: Clinical presentation

- Acute respiratory disease in calves (5 days-8 months) most common
- High mortality
- High fever (≥ 104)
- Septicemia
- Abortion in naïve herds
- Diarrhea RARE in adults or calves

College of Veterinary Medicine

Cornell Animal Health Diagnostic Center

16

Salmonella Dublin: Antemortem diagnosis

- Blood culture
  - 2-3 ml
- NOT FECES
  - Salmonella Dublin only cultured 6-14% of the time from feces in carriers
  - 25-50% from feces in sick animals

College of Veterinary Medicine

Cornell Animal Health Diagnostic Center

17

Courtesy of Dr. Kaitlyn Kremer

College of Veterinary Medicine

Cornell Animal Health Diagnostic Center

18

19

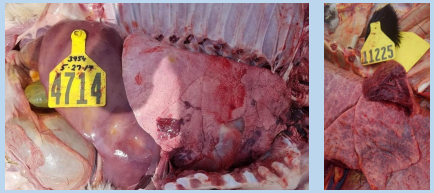
20

Salmonella Dublin: Antemortem diagnosis

- Blood culture $34
- Bottle $3, ~1yr shelf life
- Store/ship at room temp
- Overnight delivery to lab

21

Salmonella Dublin: Post-mortem



College of Veterinary Medicine
Cornell Animal Health Diagnostic Center

22

Salmonella Dublin: Post-mortem

Images courtesy of Dr. Michael Capel

College of Veterinary Medicine
Cornell Animal Health Diagnostic Center

23

Salmonella Dublin: Post-mortem

Courtesy of Dr. Lila Knowlton-Grallert

College of Veterinary Medicine
Cornell Animal Health Diagnostic Center

24

Salmonella Dublin: Post-mortem

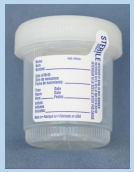
College of Veterinary Medicine

Cornell Animal Health Diagnostic Center

25

Salmonella Dublin: Post-mortem

- Aerobic culture of tissue
  - Collect 3 cm piece of lung, lymph node, spleen, kidney, or liver
  - Individual sterile containers
  - OR sear, stab, swab → Amies transport media
- Histology on formalin fixed tissue aids in diagnosis

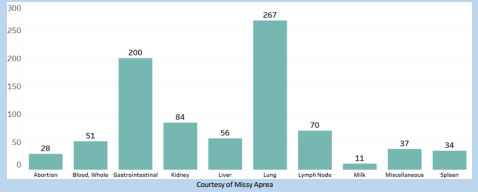


College of Veterinary Medicine

Cornell Animal Health Diagnostic Center

26

Salmonella Dublin culture by site 2006-21



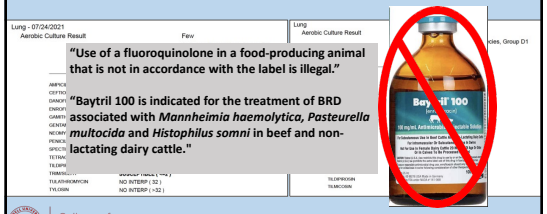
Courtesy of Missy Aprea

College of Veterinary Medicine

Cornell Animal Health Diagnostic Center

27

Salmonella Dublin: Multidrug resistant



"Use of a fluoroquinolone in a food-producing animal that is not in accordance with the label is illegal."

"Baytril 100 is indicated for the treatment of BRD associated with *Mannheimia haemolytica, Pasteurella multocida* and *Histophilus somni* in beef and non-lactating dairy cattle."

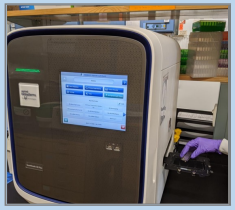
College of Veterinary Medicine

Cornell Animal Health Diagnostic Center

28

Salmonella: "Why can't you just do a PCR?"

- No isolate for SENSITIVITY
- No isolate for SEROTYPING
- Enrichment step required before fecal PCR and fecal culture = PCR not faster



College of Veterinary Medicine

Cornell Animal Health Diagnostic Center

29

S. Dublin: Surveillance & Monitoring

- *Salmonella* Dublin ELISA antibody titer $12.50
  - Milk, bulk tank milk, or serum
- ≤ 7 weeks to seroconvert
- Cross reacts with *S.* Typhimurium
- Detects EnterVene®-d & colostral antibodies
- Does not detect SRP® *Salmonella* Newport vaccine
- "Carrier" = + 3 times over 8 month period

College of Veterinary Medicine

Cornell Animal Health Diagnostic Center

30

S. Dublin: Surveillance & Monitoring

Table 3.1 Herd sensitivity (HSe) for different herd testing procedures (Veling et al., 2002; Warnick et al., 2006)

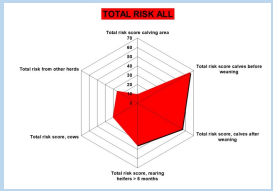
Herd testing procedure	HSe
Bulk tank milk LPS ELISA at cut-off OD=0.4	38%
Culture of dung-pits	45%
Drinking water cultures	5%
Bulk tank milk filter cultures	7%
Faecal culture of animals with current or earlier signs of salmonellosis	38%
Serology of all young stock	100%
Serology of all young stock between 4 to 6 months	91%
Serology of animals with current or previous signs of salmonellosis	80%
Combination of bulk tank milk ELISA and serology of animals with current or previous signs of salmonellosis	91%
Combination of bulk tank milk ELISA and serology of all young stock between 4 to 6 months	99%
Combination of bulk tank milk ELISA in four samples collected over 5 to 12 months	95%

College of Veterinary Medicine
Cornell Animal Health Diagnostic Center

31

S. Dublin: Risk Assessment Tool

- Series of housing/management questions:
  - Calving area
  - Calves before weaning
  - Calves after weaning, up to 6mo
  - Rearing heifers >6mo
  - Cows
  - Interactions with other herds



College of Veterinary Medicine
Cornell Animal Health Diagnostic Center

32

Scenario 2: Herd background

- 1,100 milking dairy herd in NY
- Milking in 2 different barns
  - 800 milking with 4 Lely robots
  - 300 milking in parlor – this houses the lower producing and older cows
- Diet:
  - Started feeding 2022 1st cut haylage 3 wks ago
  - Parlor cows on low forage and DNB cows
  - Drinking water is town water
    - waterers scrubbed weekly
- Herd production steady
- Sprinklers are well water
- No rumination collars

College of Veterinary Medicine
Cornell Animal Health Diagnostic Center

33

Relevant herd history

- Standard vaccine protocol
- Not testing for BVD
- Herd treated with Ultraboss recently
- Shared needles for vaccines and oxytocin administration
- Send heifers to heifer grower that also purchases and raises other calves from other states

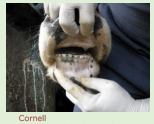
College of Veterinary Medicine

Cornell Animal Health Diagnostic Center

34

Initial clinical findings

- July 2022: late lactation cows from only low group affected
  - Affected group is milked in parlor (not by robots)
  - 6 cows died from 7/1-7/5/2022
  - Approx. 30 cows with similar clinical signs over 2–3 week period
- Signs:
  - Severe weakness
  - Anemia
  - Icterus
  - Death



College of Veterinary Medicine

Cornell Animal Health Diagnostic Center

35

7/5/22: Two necropsies performed

- Cow 1: 5th LACT, 7 yrs old, 359 DIM, BCS 1/5
- Cow 2: 2nd LACT, 4 yrs old, 281 DIM
- Necropsy findings on both:
  - Severe icterus
  - Enlarged liver and spleen
  - Liver grainy texture
  - Petechial hemorrhages on heart
  - GI tract empty, poor rumen fill

College of Veterinary Medicine

Cornell Animal Health Diagnostic Center

36

Cow 3: Antemortem serum chemistry

- 2nd LACT, 3 yrs old, 140 DIM, 100 lbs/day
  - Chemistry:
  - Elevated:
    - Alkaline phosphatase (ALP) ↑
    - Aspartate aminotransferase (AST) ↑↑↑
    - Calcium ↑
    - GGT ↑↑↑
    - BUN ↑
    - Ict 1+

VetScan VS2
Large Animal Profile

05 Jul 2022			13:25
Sample Type:			Cow
Patient ID:			Norton
Alternate ID:			Norton
Sample ID:			8715
Doctor ID:			Keith
Operator ID:			Kristen
Rotor Lot Number:			1499840
Serial Number:			00XXY22377
ALB	3.5	2.3-3.9	g/dL
ALP	185 *	23-138	U/L
AST	841 *	86-211	U/L
CA	10.8 *	7.8-9.8	mg/dL
GGT	217 *	12-48	U/L
TP	8.1	6.6-9.3	g/dL
GLOB	4.6	3.5-5.2	g/dL
BUN	30 *	8-20	mg/dL
CK	520	24-900	U/L
PHOS	4.8	4.1-9.2	mg/dL
MG	2.8	1.7-2.9	mg/dL
QC	OK		
HEM 0	LIP 0	ICT 1+	

College of Veterinary Medicine — Cornell Animal Health Diagnostic Center

37

Differential Diagnoses (hepatopathy/death)

- Infectious
  - Bacterial
    - Clostridial—always a ddx for sudden death
    - Anaplasma marginale/other tick-borne
    - Leptospirosis
  - Viral?
- Toxins
  - Blue-green algae
  - Cyanogenic plants (Sorghum, Sudan grass, etc.)
  - Urea/Fertilizer
  - Nitrites/nitrates
  - Dicoumarol (Rodenticide)
  - Iron (injectable)
  - Heavy metals (lead, arsenic, cadmium, etc)
  - Mycotoxins

College of Veterinary Medicine — Cornell Animal Health Diagnostic Center

38

Necropsy samples: formalin fixed

- FIX EVERYTHING
  - Histo $160 for field necropsy regardless of # of tissues
  - Always fix the lesion / organ system involved

- Fixed tissue set:
  - Lung (section from each lobe)
  - Liver (section from each lobe)
  - Spleen
  - Kidney
  - Lymph nodes
  - Forestomachs
  - Jejunum, ileum, cecum and colon
  - Skin
  - Skeletal muscle
  - Heart
  - Brain
  - Uterus
  - Mammary tissue

College of Veterinary Medicine — Cornell Animal Health Diagnostic Center

39

Necropsy samples: fresh (chilled or frozen)

- Fresh tissue set in individual containers
- Freeze until shipment

- Lung
- Liver
- Kidney
- Spleen
- estine
- ated)
- nph node
- art muscle
- letal muscle
- es/colon
- ntents
- ueous humor
- men contents
- art blood (serology!)
- Urine
- Brain

College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

40

Diagnostic Tests

- Heavy metal testing on liver
- Clostridial testing liver, kidney
- Bacterial cultures multiple organs
- Lepto PCRs

Arsenic:	<0.025 ppm
Cadmium:	<0.025 ppm
Lead:	<0.025 ppm
Thallium:	<0.025 ppm
Mercury:	0.06 ppm
Selenium:	0.11 ppm

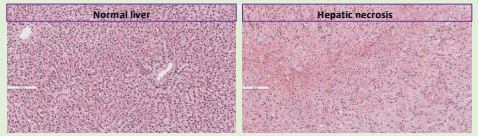
Liver - 07/05/2022

Anaerobic Bacterial Culture	No growth
Clostridium chauvoei FA	Negative
Clostridium novyii FA	Negative
Clostridium septicum FA	Negative
Clostridium sordellii FA	Negative

College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

41

Histopathology: Massive hepatic necrosis

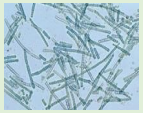


College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

42

More diagnostics…all negative

- Mycotoxin testing on feed negative
- Blue green algae?
  - Town water, waterers cleaned weekly
  - Sent rumen contents to K State for microcystin ELISA – negative


College of Veterinary Medicine — Cornell Animal Health Diagnostic Center

43

7/11/22: Cow 4 (3rd necropsy)

- 5th LACT, 6 yr old, 90 DIM, 120 lbs, BCS 1/5
  - No rumen movement
  - Tachycardic, pale mm
- Collected EDTA whole blood and serum antemortem
  - Blood watery and dark
- Necropsy findings:
  - Icteric
  - Spleen large and friable
  - Liver enlarged
  - Dilated heart with large ventricles

College of Veterinary Medicine — Cornell Animal Health Diagnostic Center

44

CBC results from cow 4

Test Name	Result	
Blood, Whole, EDTA		
Hematocrit	9	(L)
Hemoglobin	3.0	(L)
RBC	1.6	(L)
MCV	57	(H)
MCH	18	
MCHC	32	(L)
RDW	28.2	(H)
Nucleated Red Blood Cells	12	(H)

Many *Anaplasma marginale* on blood smear!

College of Veterinary Medicine — Cornell Animal Health Diagnostic Center

45

PCRs for hemoprotozoa

- Cows 1 and 2 were *Anaplasma marginale* PCR positive on spleen
- Cow 4 was coinfected with *Anaplasma marginale* and *Theileria orientalis* (both PCR positive on spleen)

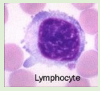
Tissue, Fresh	
Anaplasma marginale PCR	**HIGH POSITIVE**
Theileria orientalis PCR	**LOW POSITIVE**

College of Veterinary Medicine — Cornell Animal Health Diagnostic Center

46

Outcome

- 15 cows died
- *Theileria orientalis* → VA Tech for genotyping = **Ikeda**
- Pathogenicity: Ikeda>Chitose>Buffeli
- Many reactive lymphocytes on blood smears
- 17/18 additional herdmates BLV Positive (ELISA)



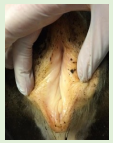
Result
POSITIVE 91%
POSITIVE 93%
POSITIVE 94%
POSITIVE 92%
POSITIVE 95%
POSITIVE 95%
POSITIVE 95%
Negative 0%
POSITIVE 94%
POSITIVE 94%
POSITIVE 93%
POSITIVE 94%
POSITIVE 95%
POSITIVE 95%
POSITIVE 95%

College of Veterinary Medicine — Cornell Animal Health Diagnostic Center

47

Anaplasma marginale

- Intracellular rickettsial bacteria
- Transmission:
  - Ticks (*Ixodes, Dermacentor, Rhipicephalus* spp.)
  - Mechanical: Needle sharing, blood contaminated equipment
  - Vertical (rare)
- Incubation periods: 7-60 days
- Clinical signs:
  - Fever, regenerative anemia, icterus, weakness, mortality up to 50%



College of Veterinary Medicine — Cornell Animal Health Diagnostic Center

48

Anaplasma marginale

- **Unlikely to cause clinical disease in cattle <1yr of age**
  - Persistent infection – recovered animals can become carriers
  - Older cattle = severe disease
- Diagnosis
  - Blood smear – during acute phase
  - PCR – EDTA or spleen
  - ELISA – serum; can detect carriers, herd screening
- Treatment
  - Oxytetracycline (extended therapy for clearance)
  - Cleared cattle = susceptible

College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

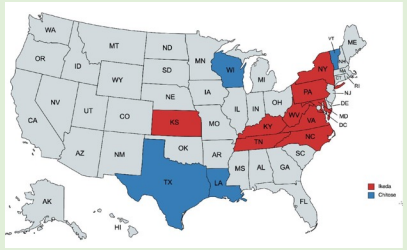
49

Theileria orientalis

- Bovine piroplasmosis
- Protozoan erythroparasite
- Transmission:
  - *Haemophysalis longicornis* (Asian Longhorned Tick)
  - Mechanical: Needle sharing, blood contaminated equipment
  - Vertical may be possible
- Australia, NZ, Japan…then USin 2017 (VA)
  - Now endemic in southeast (85% Ikeda)
  - This is first incursion in NY (found Chitose in VT in 2020)

College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

50



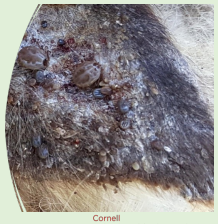
Map image from Dr. Kevin Lahmer's presentation to NCBA 8/23/22

College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

51

Asian Longhorned Tick (ALT)

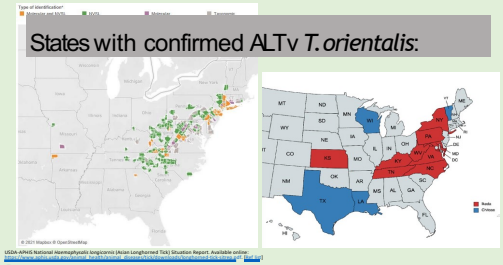
- ALT found on sheep in NJ in Aug 2017
- Detected in 17 more states (Feb 2023)
  - Back dated to 2010
- Parthenogenic
  - Explosive populations/exanguination
- Confirmed that VA *T. orientalis* strain was transmitted by ALT in 2021



College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

52

States with confirmed ALTv *T. orientalis*:

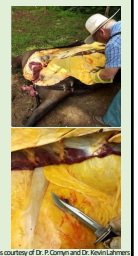


College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

53

T. orientalis

- Incubation period: 1-8 weeks
- Clinical signs: **Calves are susceptible**
  - Weakness
  - Regenerative anemia
  - Fever
  - Late term abortion
  - 'Banana cows'



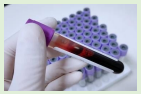
Photos courtesy of Dr. P. Comyn and Dr. Kevin Lahmers

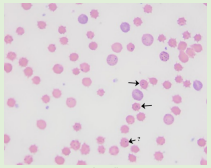
College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

54

T. orientalis

- 1-5% death loss with Ikeda
  - Beef herds 80-90% infected
  - Dairy 30-40% infected
- Deaths during stress
- Persistent infection, carrier state
- Diagnosis: Blood smear exam, PCR of EDTA, spleen
- No treatment





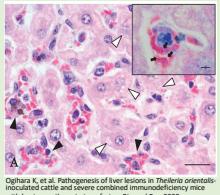
College of Veterinary Medicine

Cornell Animal Health Diagnostic Center

55

What caused the icterus and deaths?

- *T. orientalis* on RBC - massive hemolysis - severe anemia - macrophages phagocytose infected RBC, and inflammatory cytokines- go to liver.
- Severe anemia causes oxygen deprivation affecting liver
- Hepatotoxin we never found?
- other …?



Ogihara K, et al. Pathogenesis of liver lesions in *Theileria orientalis*-inoculated cattle and severe combined immunodeficiency mice with bovine erythrocyte transfusion. Biomed Res. 2020

College of Veterinary Medicine

Cornell Animal Health Diagnostic Center

56

A. marginale vs. *T. orientalis*

	Anaplasma	Theileria
Etiology	Rickettsial (bacteria)	Protozoal
Clinical signs	Transient fever	Continuous fever; disease may be less aggressive; spleens less distended versus anaplasmosis; may have ventral edema
Presentation	Cattle usually >1 year old	Calves and pregnant heifers more common
Tick vector	NOT ALT; Dermacentor, Ixodes and Rhipicephalus	Ixodid tick spp. H. longicornis (ALT)
Diagnosis	Blood smear, PCR, ELISA	Blood smear, PCR
Treatment	Extended therapy with tetracyclines	None available in US

College of Veterinary Medicine

Cornell Animal Health Diagnostic Center

57

Scenario 3 (Oct 2021): Herd history

- Jersey dairy; milking 25
- Recently turned out to pasture
- 7 affected
- Not eating hay, still grazing & eating grain
- Drooling; oral erosions (5 of 7)
- Lame; swollen coronary bands (all 7)

College of Veterinary Medicine

Cornell Animal Health Diagnostic Center

58

59

60

61

Differential Diagnoses

- Bovine viral diarrhea virus (BVD)
- Epizootic hemorrhagic disease virus (EHD)
- Bluetongue (BT)
- Malignant catarrhal fever (MCF)
- Bovine popular stomatitis virus (BPS)
- **Vesicular stomatitis virus (VSV)**
- **Foot and Mouth disease! (FMD)**
- Trauma
- Exposure to caustic substance

62

Oral erosions…Stop!

- Don't leave the farm
- Call your SAHO or AVIC
- In this case, an FAD investigation was initiated
- Samples to Foreign Animal Disease Diagnostic Lab (FADDL) on Plum Island
- Typically, duplicate samples also sent to NAHLN lab (AHDC)

63

Samples/Tests on 4 cows

- Swab of oral erosion
- EDTA blood
- Serum

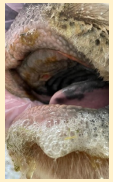
- FMD PCR
- VSV PCR
- MCF PCR
- EHD PCR
- BT PCR
- FMD ELISA
- VSV ELSA

College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

64

Results

- All negative for FMD, VSV, BT, MCF
- All 4 **EHD PCR positive** on EDTA blood at NVSL/FADDL
- All recovered
- 2 were pregnant and carried to term



College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

65

Epizootic Hemorrhagic Disease (EHD)

- *Orbivirus* from the Reoviridae family, *Culicoides* vector
  - Other *Orbivirus* diseases: African horse sickness, Bluetongue
- 7 serotypes worldwide (3 in US)
- White tailed deer most common host in North America (severe dz)
  - Mule deer, moose, reindeer, elk, other ruminants

College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

66

EHD: Deer

- Late summer/fall
- High mortality
- Incubation—36 hours
- Found near water

- Acute:
  - Sudden death
  - brusing,
  - Edema of head/neck
  - Swollen tongue
  - Respiratory distress
  - Bleeding from nose/mouth
- Chronic—hoof lesions, ruminal erosions, emaciation

College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

67

EHD: Deer

- Pathology
  - Tissue hemorrhage
  - Epistaxis
  - Scleral hemorrhage
- Histo
  - Vascular necrosis, inflammation

College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

68

EHD: Cattle

- Clinical signs in cattle
  - Low morbidity/mortality
  - Mostly subclinical or transient fevers
  - Occasional cases of inappetence, oral erosions, hypersalivation, ↓ milk, coronitis/lameness, fever, dysphagia (esophagitis, upper GI erosions)
  - Often triggers investigation for FMD/VSV
  - Direct contact transmission possible, high-density herds
- Diagnosis
  - PCR (EDTA blood, spleen, liver, hoof; serology)

Noronha, L.E., Cohnstaedt, L.W., Richt, J.A., Wilson, W.C. Perspectives on the Changing Landscape of Epizootic Hemorrhagic Disease Virus Control. *Viruses* **2021**, *13*, 2268. https://doi.org/10.3390/v13112268

College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

69

EHDin captive bison (Oct/Nov 2021 and Jan/Feb 2022)

- Multiple animals affected
- Various clinical signs noted:
  - Facial swelling
  - Bloody or mucopurulent nasal d/c
  - Conjunctivitis
  - Ocular swelling
  - Lameness/hoof sloughing in one

College of Veterinary Medicine
Cornell Animal Health Diagnostic Center

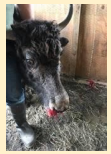
70

EHDin VT cow (Nov 2021)

College of Veterinary Medicine
Cornell Animal Health Diagnostic Center

71

EHDin NJ Yak (Sept 2021)



College of Veterinary Medicine
Photos courtesy of Dr. Todd Johnson
Cornell Animal Health Diagnostic Center

72

EHD

- Treatment/Control
  - Supportive care
  - Limit need for walking
  - Clean/dry/well-bedded to rest
  - Insect control

College of Veterinary Medicine

Cornell Animal Health Diagnostic Center

73

Scenario 4: Sudden death in 2 western NY dairies

Farm A:
- Sudden deaths calves 3-4 months old
- Late summer 2017 and 2018
- 2 week period each summer (mortality 33% and 17%, respectively)
- 1 had ↑ HR, ↑RR, vocalization, convulsions for minutes preceding death
- In 2018, all dead and 20% cohorts had mammary gland

Farm B:
- Sudden deaths calves 4 months old
- Late summer 2019
- 2% mortality
- Mammary gland enlargement

Cornell Animal Health Diagnostic Center

74

Farm A

- Milking 1500 Holsteins/1500 youngstock
- Fed raw colostrum, then pasteurized whole milk
- Housed in hutches, then group housing on wood shavings (at capacity)
- Pens stripped/replaced once weekly
- High temps, high humidity, increased rainfall preceded outbreak

College of Veterinary Medicine

Cornell Animal Health Diagnostic Center

75

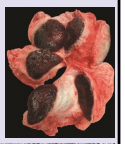
Farm B

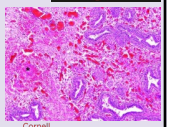
- ~60 miles from Farm A
- Milking 3600/2000 youngstock
- Also fed raw colostrum, then pasteurized whole milk
- Weaned calves in groups of 4-6 per pen, 3 barns, bedded with wood shavings
- High temps, high humidity preceded outbreak

76

Diagnostics on Farm A: 2017

- CBC/Chemistries
- Ionophore quantification of feed
- Selenium on EDTA and liver; Vit E on serum
- Heavy metal screening/liver mineral panels
- Serum troponin
- 9 necropsies → 6 with precocious udders (histo=vascular congestion, edema, hemorrhage, ductular hyperplasia)
- Cardiomyocyte degeneration in 5

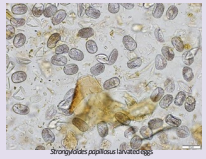




77

Diagnostics on Farm A: 2018

- 5 more necropsies → similar findings to 2017
- Fecal sample collected from 1 calf at post-mortem → 18,800 eggs/g of the nematode parasite ***Strongyloides papillosus***
- Confirmed with PCR of larval cultures
- Subsequently found in feces from 2 other calves



Strongyloides papillosus larvated eggs

78

Presumptive *Strongyloides papillosus* cardiotoxicity as cause of calf mortality

Sudden death in calves associated with *Strongyloides papillosus* infection

N. Taira* and S. Ura*

Sudden death of calves by experimental infection with *Strongyloides papillosus*. I. Parasitological observations

N. Taira*, Y. Nakamura*, N. Tsuji*, M. Kubo* and S. Ura*

Sudden death of calves by experimental infection with *Strongyloides papillosus*. II. Clinical observations and analysis of critical moments of the disease recorded on videotape

S. Ura*, Y. Nakamura*, N. Tsuji* and N. Taira*

Sudden Cardiac Death in Calves with Experimental Heavy Infection of *Strongyloides papillosus*

Naotoshi TSUJI, Tomoo ITABISASHI, Yoshio NAKAMURA, Noriyuki TAIRA, Masanori KUBO, Shigeyoshi URA[1], and Akira GENNO[1]

Sudden death of calves by experimental infection with *Strongyloides papillosus*. III. Hematological, biochemical and histological examinations

N. Nakanishi*, Y. Nakamura*, S. Ura*, N. Tsuji*, N. Taira*, N. Tanimura* and M. Kubo*

College of Veterinary Medicine

Cornell Animal Health Diagnostic Center

79

Diagnostics on Farm B: 2019

- 2 necropsies with similar results
  - No mammary tissue submitted for histo
  - Mild pulmonary hemorrhage in 1
  - Enteritis: neutrophilic cryptitis with intraluminal nematodes in 1
- Cultures/ viral testing/ selenium within normal limits
- *S. papillosus* larvae and eggs present in feces (25 larvae/g in 1; 13,300 and 12,705 eggs per gram in each)
- Subsequent fecal floats: 53% prevalence in age group

College of Veterinary Medicine

Cornell Animal Health Diagnostic Center

80

Strongyloides papillosus

- Nematode parasite with worldwide distribution
- Predilection for small intestine of ruminants (cattle, goats, sheep, deer)
- Juvenile ruminants most susceptible
- Known to cause ill thrift/diarrhea in young ruminants
- Associated with sudden death in weaned calves and lambs
  - Fatal arrhythmias
- May rarely see tachypnea, vocalization, collapse, convulsions prior to death

College of Veterinary Medicine

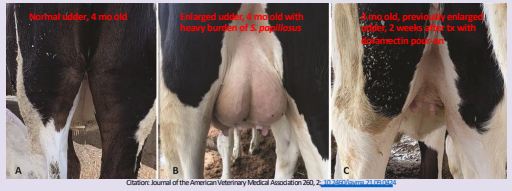
Cornell Animal Health Diagnostic Center

81

Strongyloides papillosus

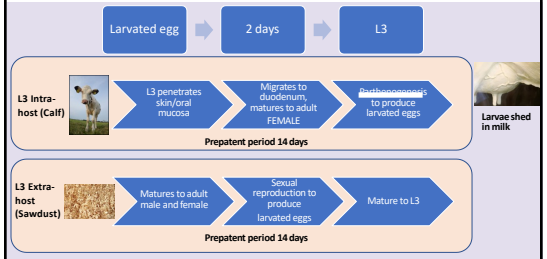
- Hypothesis: sudden death associated with *S. papillosus* hyperinfection, secondary to parasite-associated cardiac toxin from adult female nematodes in proximal small intestine (experimental infections)
- No mammary enlargement noted in experimental studies
- No consistent bloodwork abnormalities

82



Citation: Journal of the American Veterinary Medical Association 260, 2...

83



84

Strongyloides papillosus: Transmission

- Generally, via percutaneous or oral mucosal penetration by L3
- Transmammary transmission of *Strongyloides* spp. in some hosts
- Pre-natal infections demonstrated in pigs, cervids
- Why the congested mammary glands? Larval migration? (none seen in tissues)
- Wood shavings provide humid substrate for development
- Standing water in pens; promoted percutaneous migration of L3

College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

85

Strongyloides papillosus

- Consider as differential for sudden death (mammary enlargement) in weaned calves and lambs during late summer/fall
- Diagnosis:
  - Feces/colon contents for fecal floatation (not 100% sensitive; consider testing cohorts too)
- Prevention:
  - Clean, dry bedding
  - Monitor fecal egg counts in weaned calves during summer/fall
  - Monitor for udder enlargement
- Treatment:
  - Effective anthelmintics: doramectin (deaths stopped in 24 hours in NY outbreaks), fenbendazole, moxidectin, thiabendazole

College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

86

References

- Nielsen, L.R., Toft, N. and Ersbøll, A.K. (2004), Evaluation of an indirect serum ELISA and a bacteriological faecal culture test for diagnosis of *Salmonella* serotype Dublin in cattle using latent class models. Journal of Applied Microbiology, 96: 311-319. https://doi.org/10.1046/j.1365-2672.2004.02151.x
- Nielsen, Kudahl, and Østergaard, (2012), Age-Structured Dynamic, Stochastic and Mechanistic Simulation Model of Salmonella Dublin Infection within Dairy Herds. Prev Vet Med, 105: 59-74.
- https://www.cdc.gov/salmonella/dublin-11-19/index.html
- Nielsen LR, van den Borne B, van Schaik G. Salmonella Dublin infection in young dairy calves: transmission parameters estimated from field data and an SIR-model. Prev Vet Med. 2007 Apr 16;79(1):46-58. doi: 10.1016/j.prevetmed.2006.11.006. Epub 2006 Dec 18. PMID: 17175050.
- Nielsen, LR. Overview of the pathogenesis, epidemiology and diagnostic tools necessary for successful surveillance and eradication of *Salmonella* Dublin from the Danish cattle population.: Prize assignment "Professor Dr.med.h.c. C.O. Jensens Mindefond". Department of Large Animal Sciences, University of Copenhagen. 2009. p70
- Dinkel, K.D., Herndon, D.R., Noh, S.M. *et al.* A U.S. isolate of *Theileria orientalis*, Ikeda genotype, is transmitted to cattle by the invasive Asian longhorned tick, *Haemaphysalis longicornis*. *Parasites Vectors* **14**, 157 (2021). https://doi.org/10.1186/s13071-021-04659-9
- Hammer JF, Jenkins C, Bogema D, Emery D. Mechanical transfer of *Theileria orientalis*: possible roles of biting arthropods, colostrum and husbandry practices in disease transmission. Parasit Vectors. 2016;9:34. https ://doi.org/10.1186/s1307 1-016-1323-x.
- https://www.aphis.usda.gov/aphis/maps/animal-health/asian-longhorned-tick
- https://www.nj.gov/agriculture/divisions/ah/pdf/TickInfosheet.pdf
- Kocan, K. M., de la Fuente, J., Step, D. L., Blouin, E. F., Coetzee, J. F., Simpson, K. M., Genova, S. G., & Boileau, M. J. (2010). Current challenges of the management and epidemiology of bovine anaplasmosis. *The Bovine Practitioner*, *44*(2), 93–102. https://doi.org/10.21423/bovine-vol44no2p93-102
- Kocan, K. M., Coetzee, J. F., Step, D. L., de la Fuente, J., Blouin, E. F., Reppert, E., Simpson, K. M., & Boileau, M. J. (2012). Current challenges in the diagnosis and control of bovine anaplasmosis. *The Bovine Practitioner*, *46*(2), 67–77. https://doi.org/10.21423/bovine-vol46no2p67-77
- Oakes VJ, Todd SM, Carbonello AA, Michalak P, Lahmers KK. Coinfection of cattle in Virginia with Theileria orientalis Ikeda genotype and Anaplasma marginale. Journal of Veterinary Diagnostic Investigation. 2022;34(1):36-41. doi:10.1177/10406387211057627
- Ogihara K, Naya Y, Kurotori M, Tsurumaru T, Ishizawa K, Itoga S, Sogawa K, Shimada A. Pathogenesis of liver lesions in Theileria orientalis-inoculated cattle and severe combined immunodeficiency mice with bovine erythrocyte transfusion. Biomed Res. 2020;41(4):169-178. doi: 10.2220/biomedres.41.169. PMID: 32801266.
- Perera, P.K., Gasser, R.B., Firestone, S.M. *et al.* Oriental theileriosis in dairy cows causes a significant milk production loss. *Parasites Vectors* **7**, 73 (2014). https://doi.org/10.1186/1756-3305-7-73

College of Veterinary Medicine | Cornell Animal Health Diagnostic Center

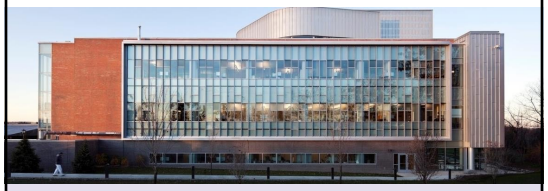
87

More References

- Rivera, N.A., Varga, C., Ruder, M.G., Dorsik, S.J., Roca, A.L., Novakofski, J.E., Mateus-Pinilla, N.E. Bluetongue and Epizootic Hemorrhagic Disease in the United States of America at the Wildlife–Livestock Interface. *Pathogens* **2021**, *10*, 915. https://doi.org/10.3390/pathogens10080915
- Pauline Noé, Cecilia Kato, Will K. Reeves, Jack Rhyan, Terry Spraker, Thomas Gidlewski, Kurt VerCauteren, and Mo Salman. "Epizootic Hemorrhagic Disease Outbreak in a Captive Facility Housing White-Tailed Deer (Odocoileus Virginianus), Bison (Bison Bison), Elk (Cervus Elaphus), Cattle (Bos Taurus), and Goats (Capra Hircus) in Colorado, USA." *Journal of Zoo and Wildlife Medicine* 41, no. 3 (September 1, 2010): 510–15. https://doi.org/10.1638/2009-0164.1.
- Pinn, T. L., Forrestal, A. M., Duhamel, G. E., Crouch, S. K., Thompson, B. S., & Lejeune, M. (2022). Strongyloides papillosus causes sudden death in weaned calves on New York dairies. *Journal of the American Veterinary Medical Association*, *260*(2), 244-250. Retrieved May 25, 2023, from https://doi.org/10.2460/javma.21.08.0364
- Tsuji N, Itabisashi T, Nakamura Y, Taira N, Kubo M, Ura S, Genno A. Sudden cardiac death in calves with experimental heavy infection of Strongyloides papillosus. J Vet Med Sci. 1992 Dec;54(6):1137-43. doi: 10.1292/jvms.54.1137. PMID: 1477164.
- Taira, N., and S Ura. "Sudden Death in Calves Associated with Strongyloides Papillosus Infection." *Veterinary Parasitology* 39, no. 3 (1991): 313–19. https://doi.org/10.1016/0304-4017(91)90067-j.
- Taira N, Nakamura Y, Tsuji N, Kubo M, Ura S. Sudden death of calves by experimental infection with *Strongyloides papillosus*. I. Parasitological observations. *Vet Parasitol*. 1992;42(3-4): 247–256. doi: 10.1016/0304-4017(92)90066-I
- Nakanishi N, Nakamura Y, Ura S, et al. Sudden death of calves by experimental infection with *Strongyloides papillosus*. III. Hematological, biochemical and histological examinations. *Vet Parasitol*. 1993;47(1-2):67–76. doi: 10.1016/0304-4017(93)90174-n
- Ura S, Nakamura Y, Tsuji N, Taira N. Sudden death of calves by experimental infection with *Strongyloides papillosus*. II. Clinical observations and analysis of critical moments ofthe disease recorded on videotape. *Vet Parasitol*. 1992;44(1-2): 107–110. doi: 10.1016/0304-4017(92)90148-2
- Tabor, Alicja e. Anaplasmosis in ruminants. The Merck veterinary manual. Whitehouse Station, NJ :Merck & Co., Inc. https://www.merckvetmanual.com/circulatory-system/anaplasmosis/anaplasmosis-in-ruminants. Retrieved
- Tebaldo A, Lahmers K, Todd M, Carbonello A, Broadbus CC, Bissett CJ, Hungerford LL. Distribution of *Theileria orientalis* in Virginia Market Cattle, 2018-2020. Pathogens. 2022 Nov 15;11(11):1353. doi: 10.3390/pathogens11111353. PMID: 36422604; PMCID: PMC9695988.

College of Veterinary Medicine — Cornell Animal Health Diagnostic Center

88



Questions?

ele25@cornell.edu
607-253-3972

College of Veterinary Medicine — Cornell Animal Health Diagnostic Center

89