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Viral and Bacterial Arthritis- A tale of two pains

Poultry Innovation Partnership – Innovation
Showcase – 06Mar24

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A tale of two pains

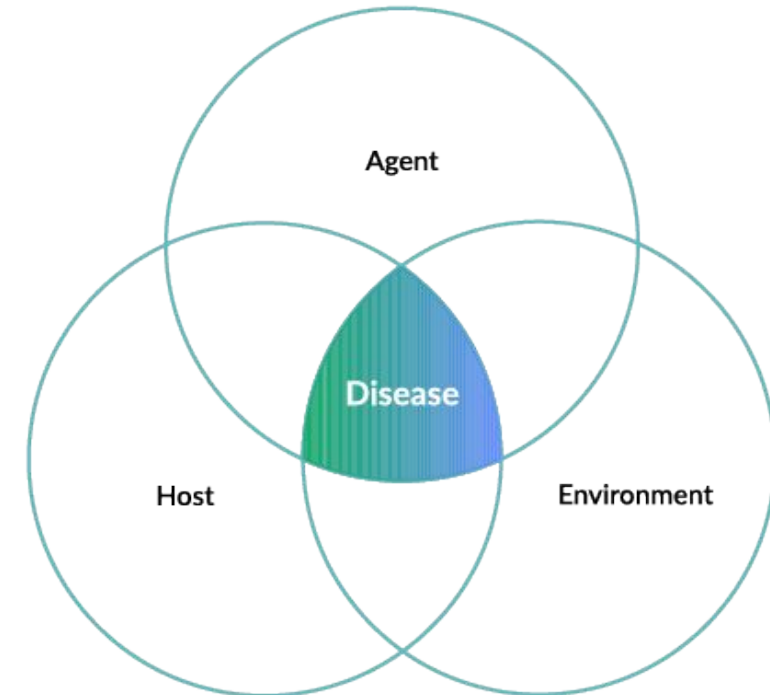


- 1 Lameness – Viral and Bacterial Arthritis
- 2 Viral Arthritis
- 3 Bacterial Arthritis
- 4 Field factors
- 5 Take home messages

Lameness

- Growing problem in modern poultry production that decreases bird performance, operation profitability, and is an animal welfare concern.
- Lameness can be caused by:
 - Developmental (Valgus-Varus, TD, etc).
 - Nutritional (Rickets, Osteoporosis/Cage layer fatigue, Perosis)
 - **Infectious (Viral)**
 - **Infectious (Bacterial)**
 - Infectious (Mycoplasma- Infectious synovitis)
 - Toxicity (ionophore, insecticides)

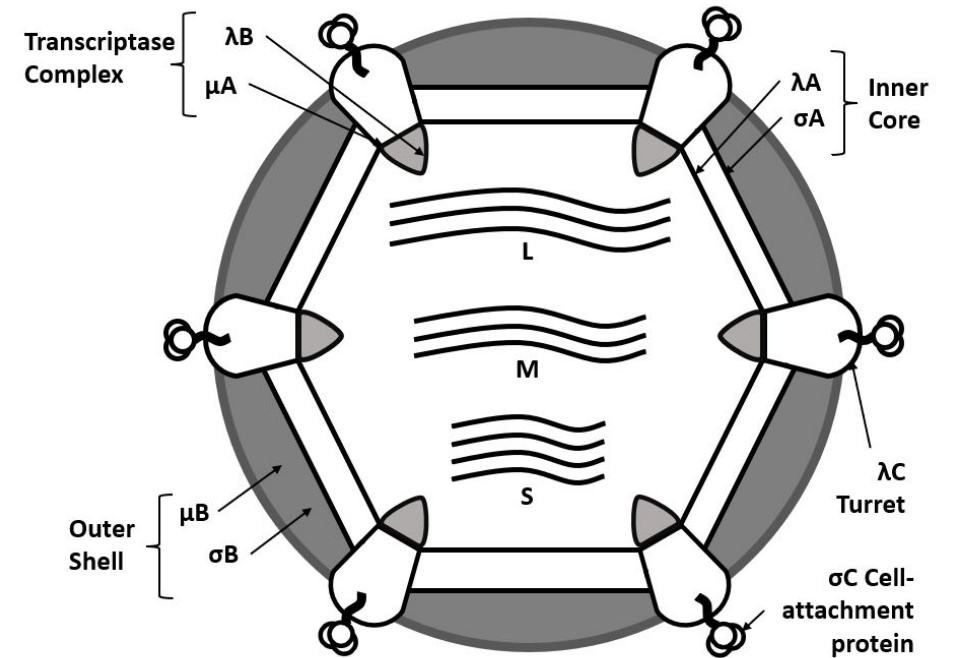
The Epidemiological Triad



<https://www.amstewardship.ca/faast-reviews/poultry-industry/clinical-signs-and-risk-factors/>

Viral Arthritis – Introduction (1)

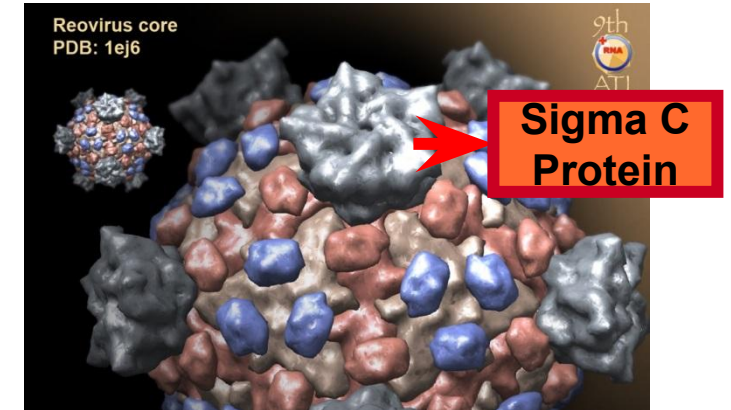
- Wide range of virulence - ~80% non-pathogenic (Jones, 2008);
 - Pathogenic ARVs have wide range of virulence
- ARV infection has been associated to multiple conditions/diseases in chickens and turkeys:
 - Viral Arthritis (VA)
 - Runting-Stunting / Malabsorption syndrome (RSS/MAS)
 - Neurologic Disease
 - Myocarditis
 - Hepatitis
 - Hydropericardium
 - Bacterial chondronecrosis with Osteomyelitis (BCO)
 - Immunosuppression (lesions/dep in bursa and thymus)
- The most important with the most evidence between viral infection and disease is **Viral Arthritis**.



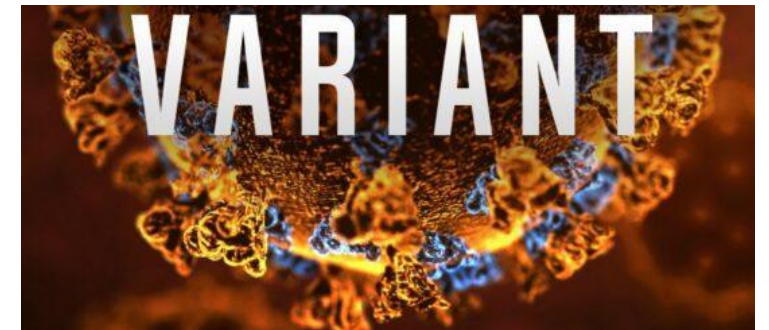
Palomino-Tapia, 2022

Viral Arthritis – Introduction (2)

- Sigma C Protein, is the most important viral protein – confers protection.
 - First ARV vaccine approved in 1980s (Classic)
 - ARVs with Sigma C different from the classical vaccines are called “Variants”
- “Variants” are causing arthritis and other issues in chickens & turkeys since 2011-
 - “Classic” vaccines only protect against classic challenge (CI 1 still circulating)
- “Variant” ARVs need to be monitored for tailoring control strategies



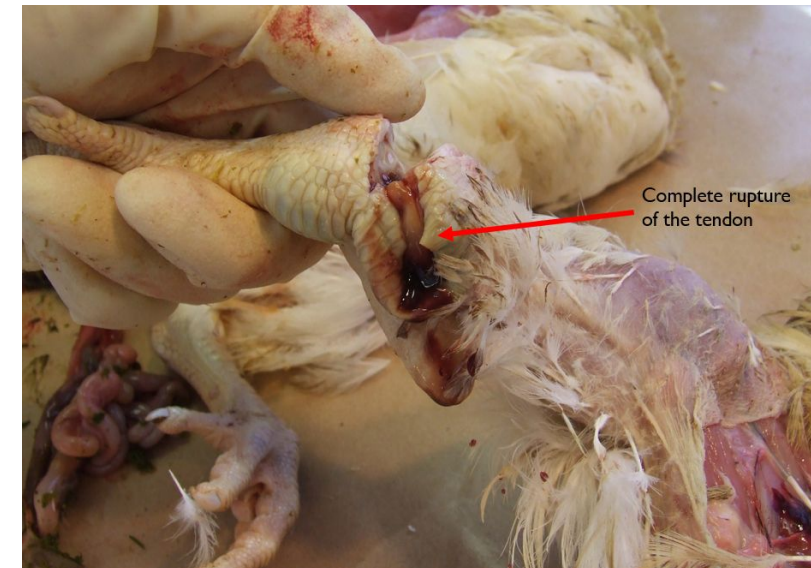
http://www.virology.wisc.edu/virusworld/PS10/reovirus_core_chimera_01.jpg



<https://waow.com/2021/01/28/virus-variant-from-south-africa-detected-in-us-for-1st-time-2/>

Viral Arthritis – Presentation in Broilers

- Viral arthritis (VA) –
 - Mainly in meat-type birds (Weight)
 - Susceptibility is age dependent
 - Infection occurs early in life (most susceptible) vertical/horizontal route
 - Clinical signs at later age
 - Lameness, rupture of tendons
 - Increased secondary infections □ culling, AMR, condemnation at proc. plant
 - Chickens break at 4-5 weeks, as early as 6 days, as late as 46, with an average of 22.6d
 - Cull rates ranging from 2%-50% (AHL Newsletter) to depopulation
 - Rule-outs: Secondary bacterial infection (e.g., Staphylococcus), perosis, footpad dermatitis, osteomyelitis, Infectious synovitis (Mycoplasma), etc.



Molecular characterization of emerging avian reovirus variants isolated from viral arthritis cases in Western Canada 2012–2017 based on partial sigma (σ)C gene

Victor Palomino-Tapia^a, Darko Mitevski^b, Tom Inglis^c, Frank van der Meer^a, Mohamed Faizal Abdul-Careem^{b,*}

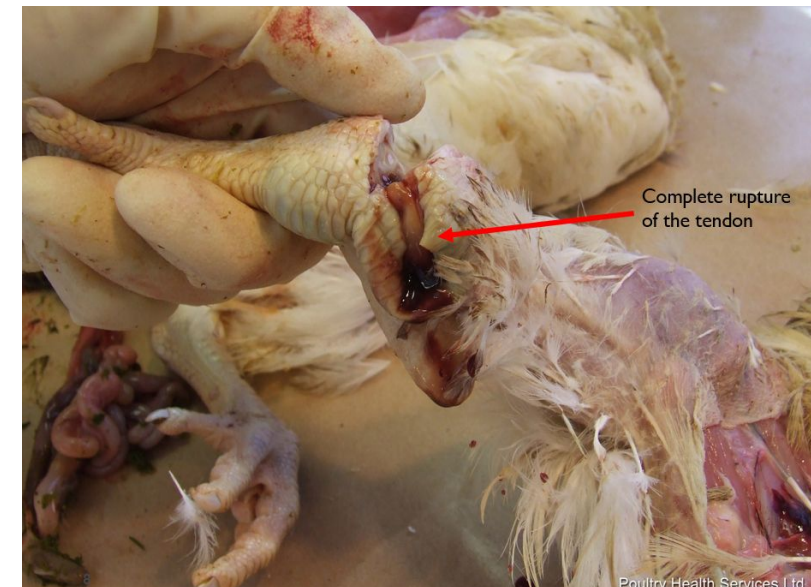
Viral Arthritis – Transmission

□ Horizontal transmission

- Respiratory tract
- Intestinal tract (fecal contamination)
- Reovirus can infect tissues through contact of broken skin and litter, replicate upwards to tendons and hock joint
- Age related resistance – Importance of Maternal antibodies (IgYs)

□ Vertical transmission

- Egg transmission is low and variable between strains (~<1.7%)
- Parent stock can be infected by oral, respiratory, skin inoculation and transmit reovirus to the progeny
 - Carrier birds may act as potential sources of infection. It can persist in birds for +250 days.
 - ARV found in eggs up to 19 days post infection
 - Contaminated feces may contaminate eggshells

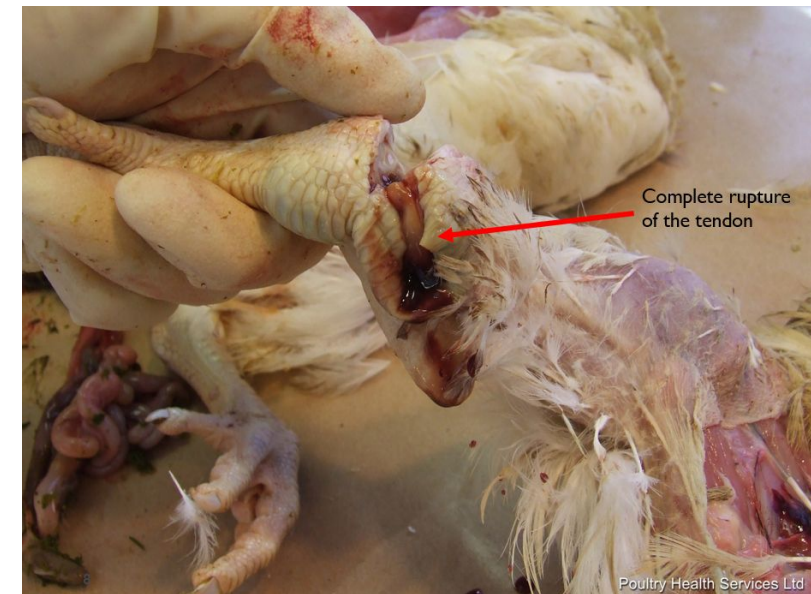


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Viral Arthritis – Transmission

- Not all ARVs are pathogenic.
 - Seroconversion \neq Disease. Need to be evaluated with clinical history & other factors
- A confirmed diagnosis of Viral Arthritis must consider all the following three:
 - Reference clinical signs of the disease
 - Rule-out other possible causes for field clinical signs
 - Bacteriology (Many ARV cases have bacterial contamination)
 - Histopathology (heart lesions more lasting than tendon lesions)
 - Serology (ARV Titer seroconversion Acute vs. convalescent)
 - Identification by PCR and/or isolation of a Reovirus from the joint / tendon
- Once the vet has checked two out of three, it would represent a “suspect” or “tentative” diagnosis

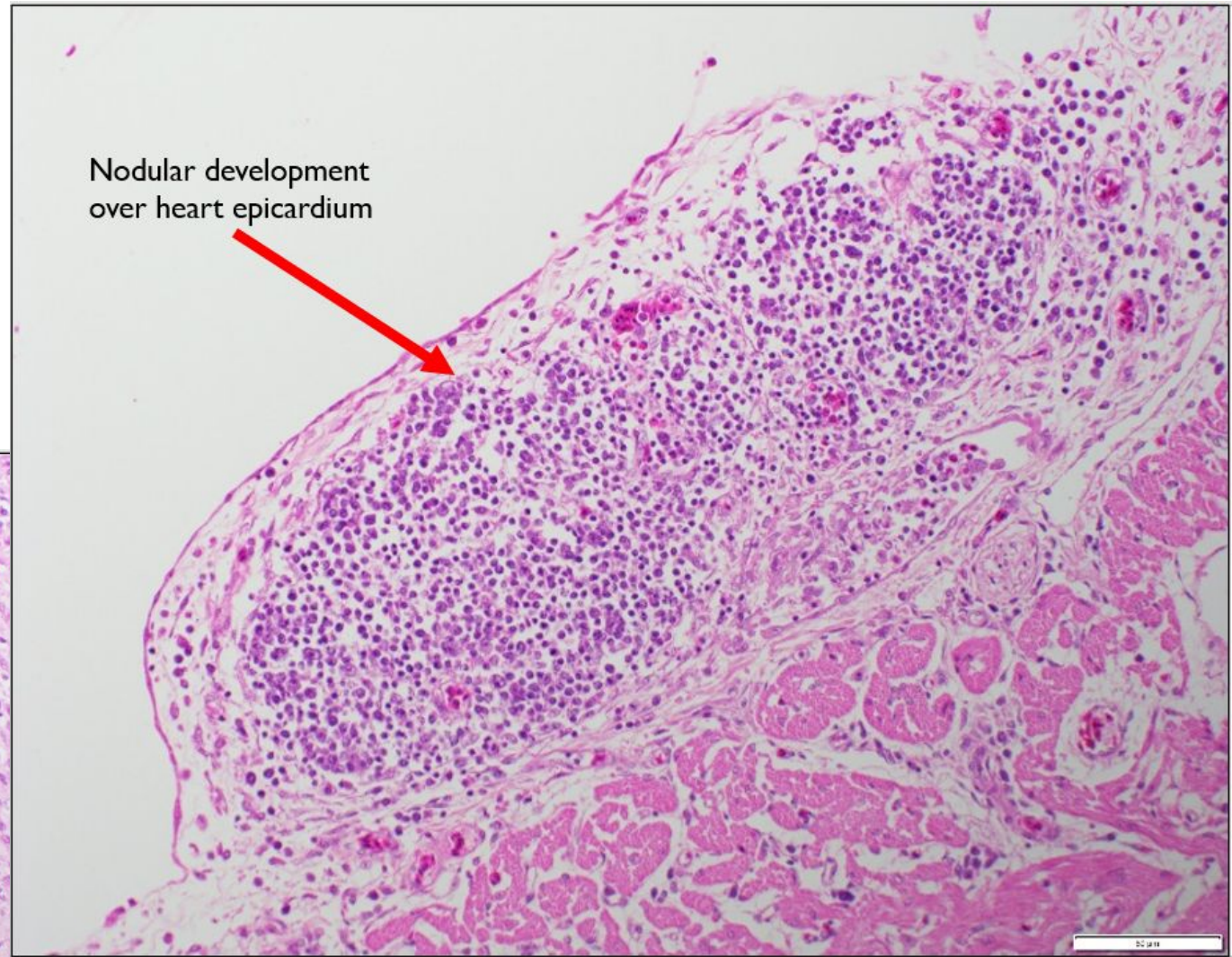
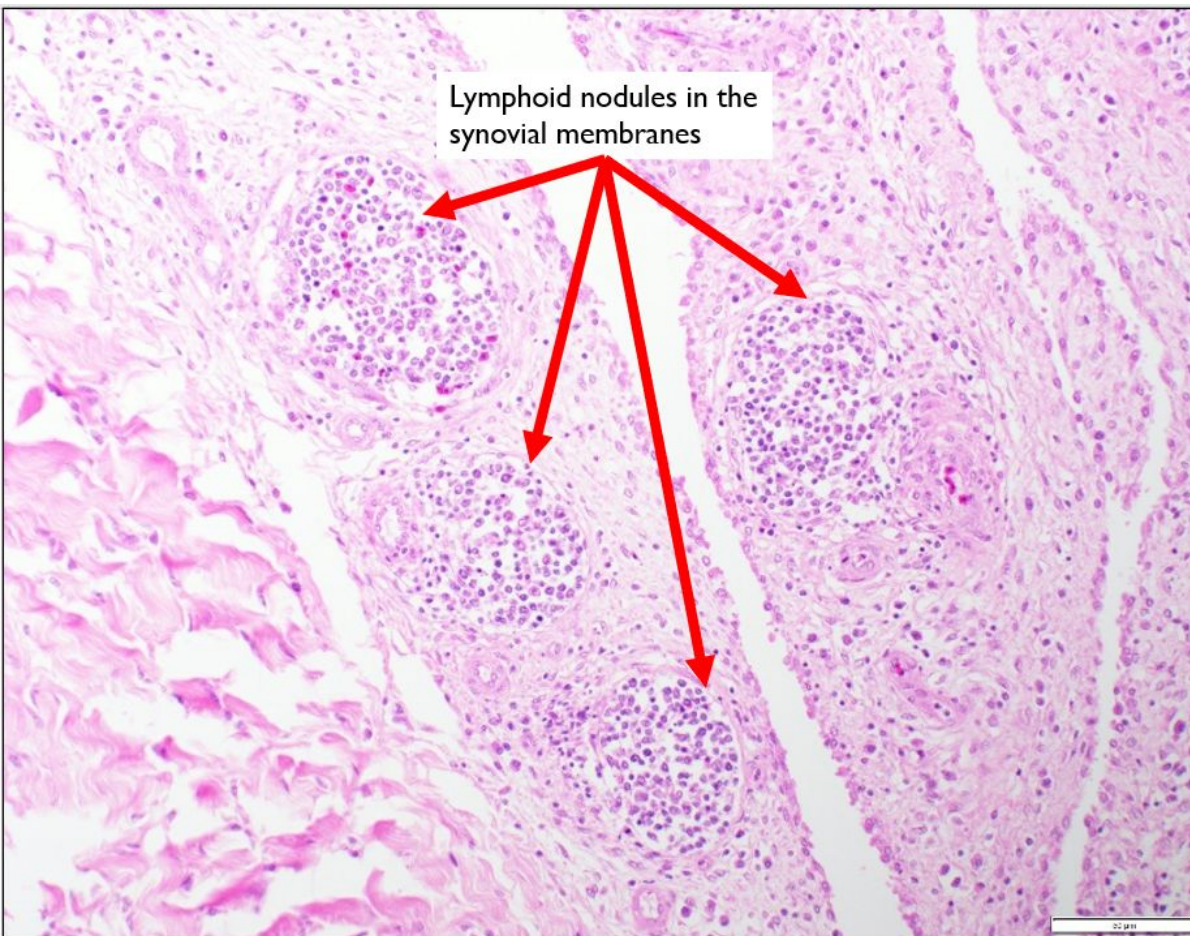


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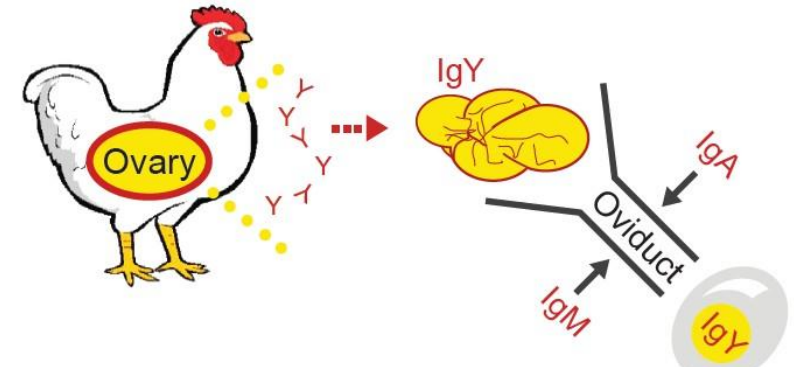
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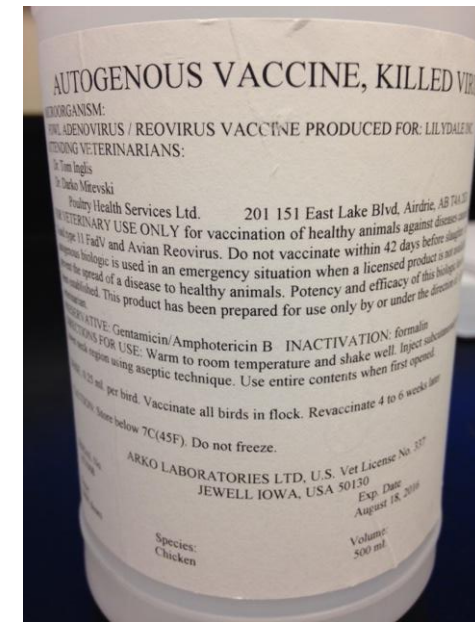


Viral Arthritis – Control (1)

- No treatment
- VA is controlled by :
 - Biosecurity: Strong biosecurity and cleaning & disinfection in between cycles will reduce environmental challenge load
 - Prevent introduction of new ARVs. Wildlife? (Choi et al 2022)
 - Parent stock vaccination will reduce the disease incidence:
 - Reducing the level of infection on the Breeders
 - Preventing egg transmission to progeny
 - Producing protective maternal antibodies for the progeny
- Types of vaccine available:
 - Commercial Live Modified vaccines – All Cluster 1.1
 - Commercial Inactivated vaccines – Most Cluster 1.1
 - Recently, one US vaccine containing Serotypes 1/4455; 2/4455; and 3.
 - Autogenous Inactivated vaccines (control variant ARV challenge).

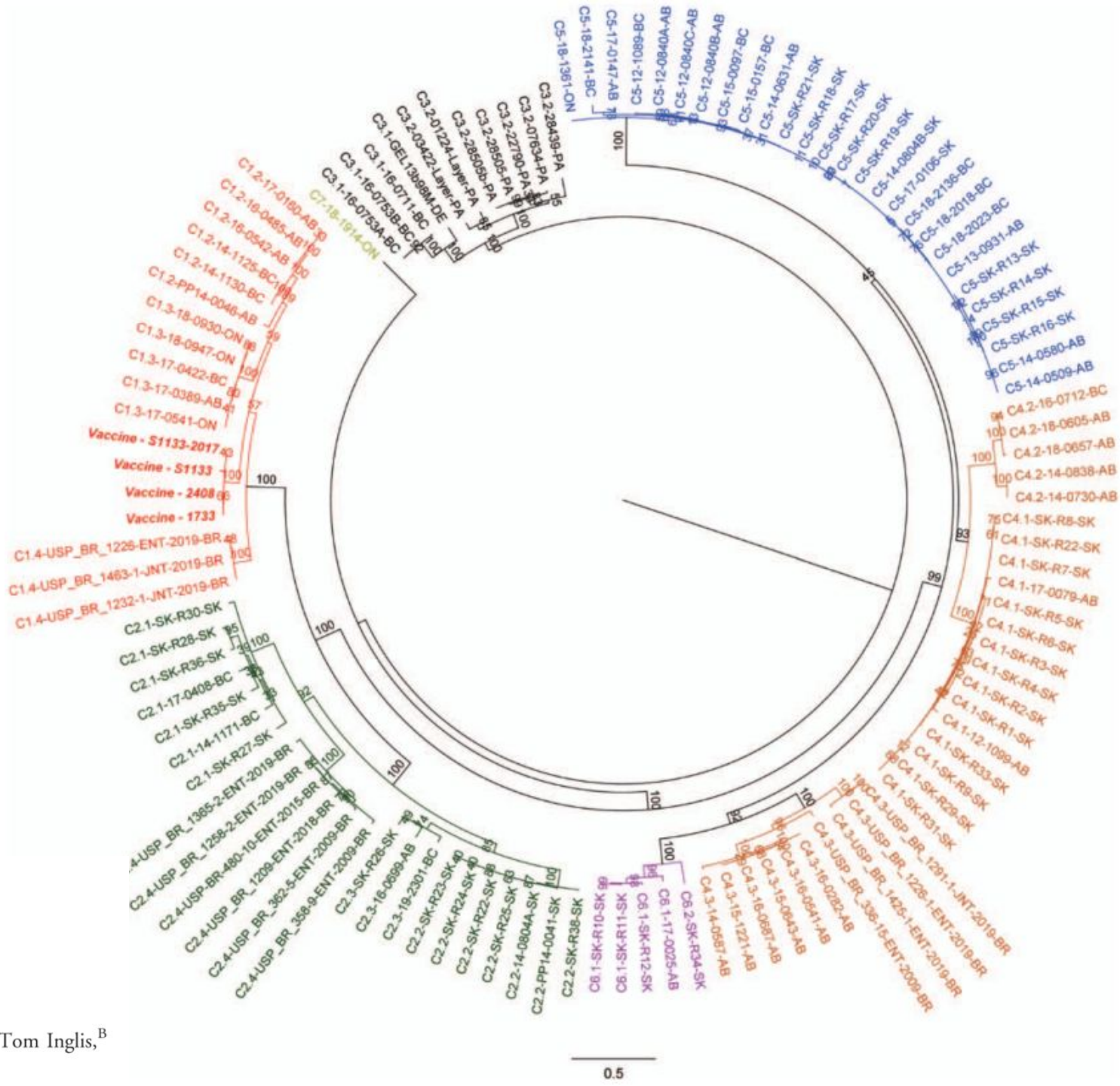


<https://www.viv.net/articles/news/what-is-igy-egg-yolk-antibody>



Viral Arthritis – Control (2)

- Each time a Canadian isolate is sequenced, it is “genotyped” and “grouped” in one of these seven clusters □
- Constant monitoring is paramount for developing an adequate program
- Program is not immediate – it takes several months to have it available.
- Up to two years to have it fully implemented in the system

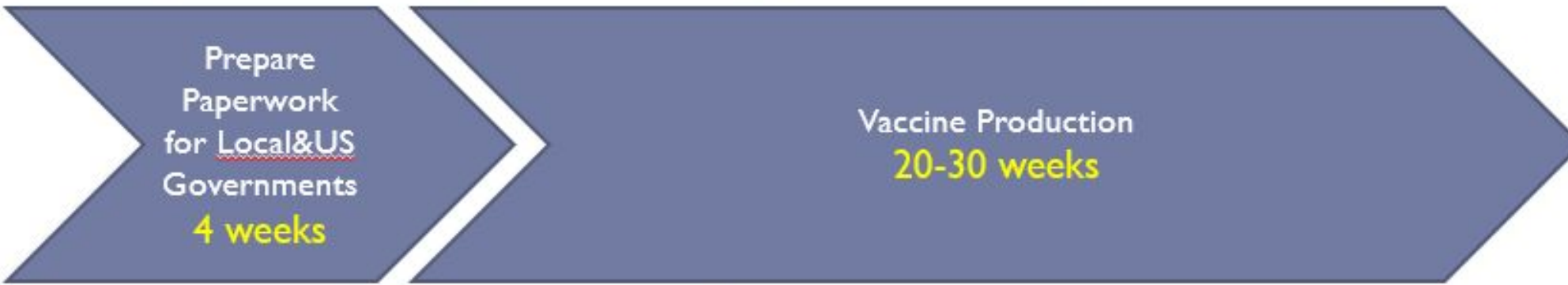


AVIAN DISEASES 66:000–000, 2022

Review Article—

Review of Viral Arthritis in Canada

Victor Palomino-Tapia,^{ABD} Luke Nickel,^A Ben Schlegel,^A Darko Mitevski,^A Tom Inglis,^B and Mohamed Faizal Abdul-Careem^C



Time from the First infected bird with variant REO to the first bird placed with Maternal antibodies → 77 Weeks

It can be up to 2 years from the first bird infected with variant REO until autogenous vaccine is implemented in 100% of the system

It is essential to get the right REOs!

Chapter

Autogenous Vaccines in the Poultry Industry: A Field Perspective

Palomino-Tapia Victor

Viral Arthritis – Economic impact, despite Autogenous vaccination

Bird Type	Disease	Houses affected (%)	Mort. and cull birds (%)	Estimation of bird numbers	Estimated value (CAD)
Broiler Pullets	Viral Arthritis(VA)	2.81	2.81	54,325	1,143,500
	MAS	5.10	0.23	8,071	170,000
Broiler Breeders	VA	5.87	3.91	157,920	1,662,500
	MAS	0.75	0	Negligible	Negligible
Broilers	VA	1.86	11.63	19,950,000	64,570,000
	MAS/RSS	5.57	5.05	16,541,000	53,536,000
Total					121,082,000
VA in turkeys – Increase cost of 0.075 CAD per pound					

- Culls and mortality alone in the US broiler industry is more than 121 million CAD (90 million USD) despite using autogenous vaccine programs.
- Not considering Malabsorption Syndrome (MAS)/Runting stunting (RSS) effects on feed conversion.

AVIAN DISEASES 66:432–434, 2022

Review Article—

Incidence and Economic Impact of Reovirus in the Poultry Industries in the United States

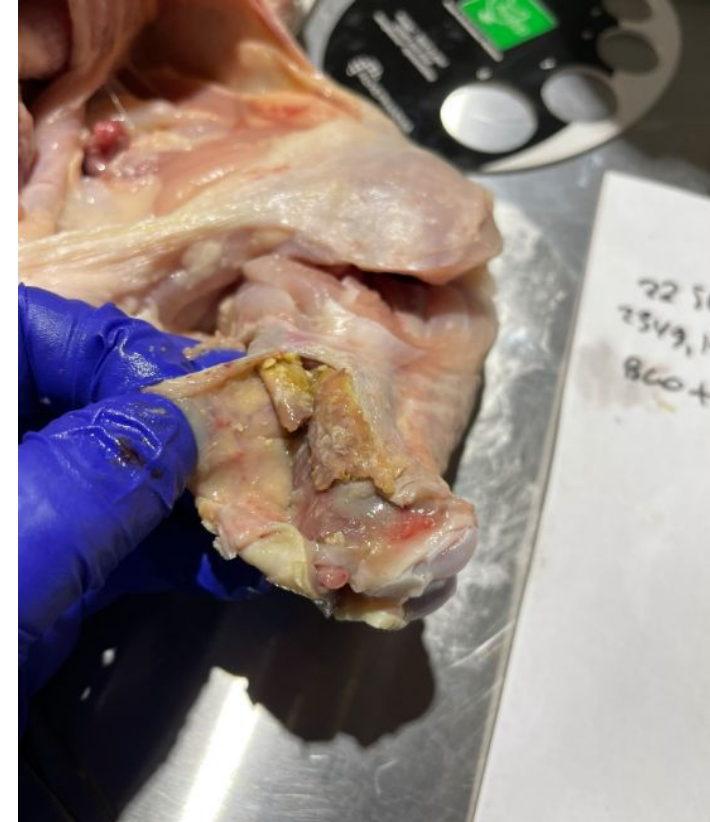
David French

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Bacterial Arthritis – Introduction (1)

- Significant cause of lameness in broiler breeders, broilers, and turkeys
 - Most often, a consequence of systemic bacterial spread from enteric or respiratory disease,
 - Also, infection of adjacent tissues.
 - Any joint, tendon sheath, synovial bursal can be affected. Most commonly hock joint.
 - Osteomyelitis is a sequel of septicemia – growth plate cartilage
- Most common causative agents (mixed infections are common)
 - *Staphylococcus aureus*
 - *Escherichia coli*
 - *Enterococcus spp.*
 - *Streptococcus spp.*
 - *Pseudomonas aureginosa*
 - *Salmonella spp*
 - *Pasteurella multocida*
 - *Mycoplasma synoviae*,
 - *Mycoplasma meleagridis*, etc.
- The most common in AB are ***Staphylococcus aureus*, *E. coli*, and *Enterococcus spp.***



Bacterial Arthritis – Introduction (2)

- Response to antimicrobial treatment is often poor
 - Low blood irrigation
 - Presence of caseous material.
 - Some infections are naturally refractory to some antibiotics (E. coli & Penicillins)
- Staphylococcus aureus
 - Experimentally reproduced by intravenous injection of pathogenic strains. Initially, affected tissues are acutely inflamed and contain white to yellow soft fibrinopurulent exudate. Later, the exudate becomes caseous. Fibrosis of affected tissues occurs late.
- Escherichia coli
 - Caseous exudate
- Enterococcus spp.
 - Caseous exudate, more chronic lesions might seem a bit reddish in color.
- The most common in AB are *Staphylococcus aureus*, *E. coli*, and *Enterococcus spp.*



Clinical Topics

HUMANS

First clinical use of penicillin

CHARLES FLETCHER

abscesses, sinuses, septic joints, and sometimes meningitis. Patients with staphylococcal infections would be ideal because sulphonamides had no effect on them and were inactivated by pus. In the septic ward at the Radcliffe Infirmary there was then an unfortunate policeman aged 43 who had had a sore on his lips four months previously from which he had developed a combined staphylococcal and streptococcal septicaemia. He had multiple abscesses on his face and his orbits (for which one eye had been removed): he also had osteomyelitis of his right humerus with discharging sinuses, and abscesses in his lungs. He was in great pain and was desperately and pathetically ill. There was all to gain for him in a trial of penicillin and nothing to lose.

He was eating well, and there was obvious resolution of the abscesses on his face and scalp and in his right orbit. But, alas, the supply of penicillin was exhausted: the poor man gradually deteriorated and died a month later. The total dose given over five days had been only 220 000 units, much too small a dose, as we now know, to have been able to overcome such extensive infection; but there was no doubt about the temporary clinical improvement, and, most importantly, there had been no sort of toxic effect during the five days of continuous administration of penicillin. This remarkable freedom from side effects, apart from allergy, has remained one of penicillin's most fortunate features.

Clinical Syndromes

HUMANS

1. Cutaneous Infections

- Folliculitis
- Boils/Furuncles
- Carbuncle
- Impetigo

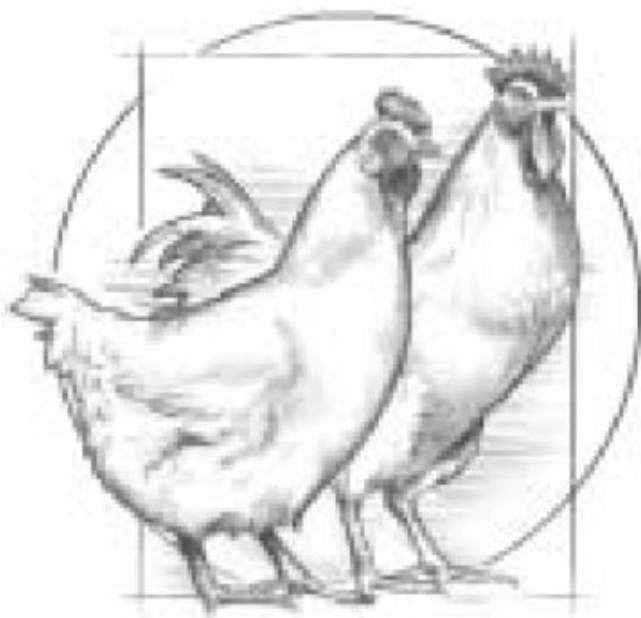
2. Deep Infections

1. Osteomyelitis
2. Endocarditis

3. Toxin Shock syndrome

4. Staphylococcal food Intoxication





AviaTe

Technical information

**Eric L. Jensen, DVM, MAM,
Diplomate ACPV**



Dr. Eric Jensen earned his Doctor of Veterinary Medicine and Master of Avian Medicine degrees from the University of Georgia. He is a diplomate of the American College of Poultry Veterinarians and

has more than 17 years of experience in technical support for the poultry industry. At Aviagen, Dr. Jensen is involved with preventive medicine, biosecurity, health monitoring and regulatory issues for the grandparent division.

**Carolyn L. Miller, DVM, MAM,
Diplomate ACPV**



Dr. Carolyn Miller earned her Doctor of Veterinary Medicine degree from the University of Missouri and her Master of Avian Medicine from the University of Georgia. She is a diplomate of the

American College of Poultry Veterinarians and has more than 15 years of experience in the poultry industry. At Aviagen, Dr. Miller is responsible for the health of the pedigree division, as well as the great grandparent division. Disease prevention by continuous evaluation of the biosecurity procedures and maintenance of health programs is a large part of her responsibilities.

Staphylococcus Infections in Broiler Breeders

Eric L. Jensen, DVM, MAM, Diplomate ACPV and Carolyn L. Miller, DVM, MAM, Diplomate ACPV • Aviagen North America • Huntsville, Alabama

Bacterial Arthritis – Introduction (3)

Staphylococcus infections tend to occur more frequently during the following four periods of a breeder's life:

0 - 2 weeks — Omphalitis and femoral head necrosis (or bacterial chondronecrosis) are often related to egg or hatchery contamination and minor surgeries.

4 - 6 weeks — Infected hock and stifle joints secondary to coccidiosis or harsh vaccine reactions (Figure 1).

10 - 20 weeks — Infected hock and stifle joints secondary to the stress of vaccination, feed restriction and sexual maturation. Overcrowding, poor feed distribution and insufficient feeder space exacerbate these problems.

24 - 30 weeks — Infected hock and stifle joints and "bumblefoot" (plantar abscess) secondary to the stress of moving, mating and onset of egg production. Male aggression and injuries associated with feed equipment, nest boxes and slats also contribute to the development of staphylococcal infections during this period.

The organism must enter the circulatory system to cause disease, thus the probability of infection is increased by any injury that provides the bacteria with a route of entry. The most obvious route of infection is through a break in the skin. This can be the result of a wound caused by injury, minor surgical procedures, such as beak trimming, toe trimming and dubbing, or needle injections. In addition, recent studies have shown that another

Bacterial Arthritis – Introduction (4)

cocci entry through the respiratory tract. It has been postulated that another portal of entry may be the gut. A repeatable experimental model has not been developed, but the frequent occurrence of staphylococcus and other bacterial infections following challenge with hemorrhagic enteritis virus in turkeys, as well as necrotic enteritis and coccidiosis in chickens, lends credence to this idea.

Once in circulation, staphylococci have a high affinity for collagen-rich surfaces, such as the articular surface of joints, and synovial sheaths located around joints and tendons. Staphylococci also tend to localize in the growth plate of actively growing bones. This explains the higher incidence of femoral head necrosis and osteomyelitis in young chickens versus more mature chickens.

Bacterial Arthritis – Introduction (5)

When the host immune system is impaired, the likelihood that staphylococci will cause disease increases. Viral agents such as infectious bursal disease (IBD) and chicken anemia virus (CAV) have been shown to suppress immune function and increase the incidence of such staphylococcal diseases as bacterial chondronecrosis and gangrenous dermatitis. Other agents that may cause similar immunosuppressive effects include Marek's Disease virus, reovirus and aflatoxins.

Stress has also been shown to impair immune function. Major sources of stress include overcrowding, insufficient access to feed and water, feed restriction, vaccination and other handling, onset of sexual maturity and egg production, inadequate clean out and biosecurity procedures, temperature extremes and poor air quality.

Bacterial Arthritis – Introduction (6)

- The most common causes:
 - *Injuries, scratches, pecking*
 - *Low gut integrity*
 - *Water quality.*
 - *Harsh Cocci cycling*
 - *Viral agents- IBDV, CAV*
 - *Stress*



Field factors – Water quality (1)

- Broiler Breeders
 - 9 Weeks with Lameness.
 - Staph aureus isolated from hock joints.
 - Susceptible to Penicillin
 - Flock treated with Penicillin
 - 13 Weeks with lameness.
 - Staph aureus isolated from hock joints.
 - Susceptible to Penicillin
 - City water.
 - Chlorine Dioxide at 0.5 ppm at end of line.
 - After results- recommendation to 3-5 ppm end of line. Consider acidification.



Barn with lameness issues.

Product - Description	Test Date	Culture	TSA_Count	TSA_Score
erLineSwab - Waterline Swab	02/13/24	Staphylococcus spp.	>30	3+
erLineSwab - Waterline Swab Left	02/13/24	Staphylococcus spp. & Unknown Bacteria	>30	3+

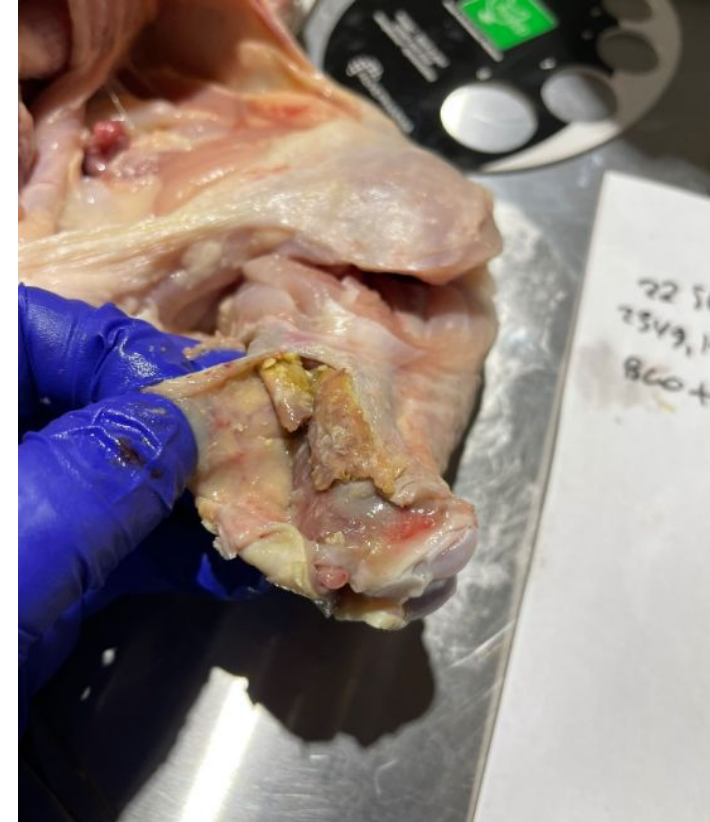
Barn next door.

Product - Description	Test Date	TSA_Count	TSA_Score
erLineSwab - Waterline Swab	02/13/24	1	0
erLineSwab - Waterline Swab Left	02/13/24	<1.0	0

Field factors – Water quality (2)

□ Broilers

- Some issues with lameness.
- High condemnns at processing plant
- High iron in water.
- Peroxide ~20-30 ppm
- IBDV + CAV positive.



Water sample

Sample #	Microbiological Analysis	Result (CFU/100 ml)
1	Total coliforms	5 CFUs
	<i>Escherichia coli</i>	<1
	<i>Pseudomonas aeruginosa</i>	<1

Biofilm sample

Product - Description	Test Date	Culture	TSA_Count
Agri-WaterLineSwab - B1-regulator	12/04/23	Coliform, NLFE & Staphylococcus spp.	3+
Agri-WaterLineSwab - B1-EOL #2	12/04/23	NLFE, Coliform & Staphylococcus spp	TNTC
Agri-WaterLineSwab - B3-EOL	12/04/23	Staphylococcus spp.	3+
Agri-WaterLineSwab - B6-EOL #2	12/04/23	NLFE & Staphylococcus spp.	TNTC

New



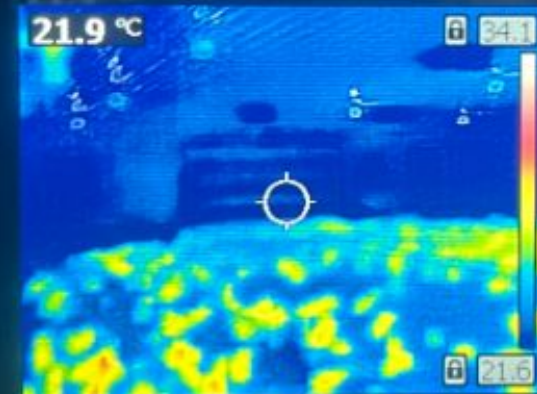
Old



Field factors – Stress factors (3)

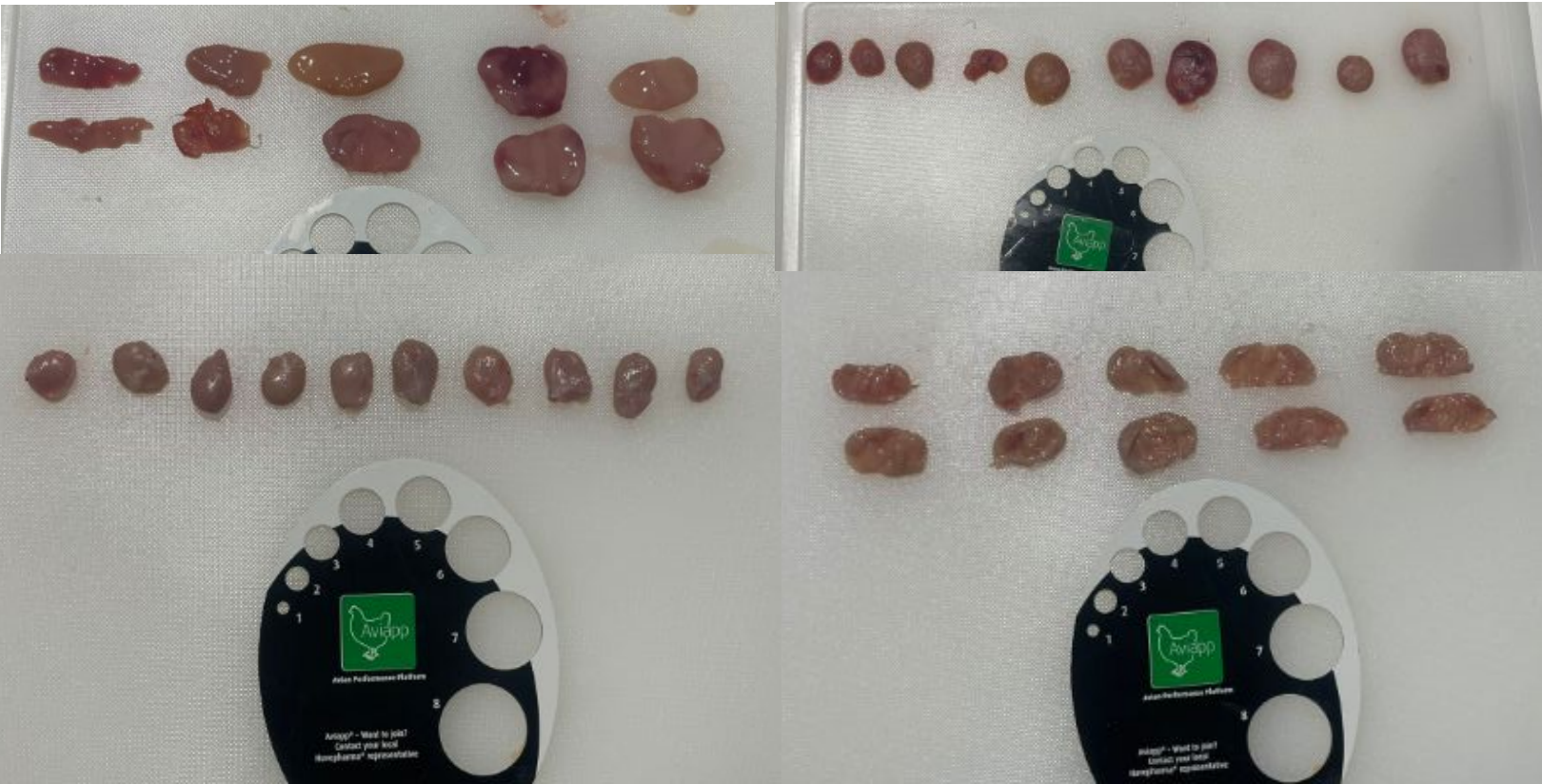
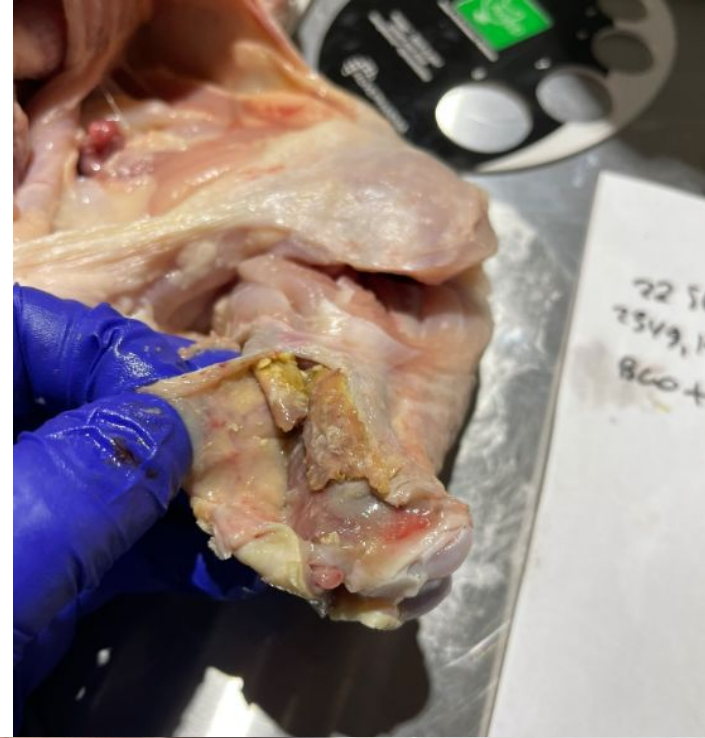
□ Environment

- Issues with lameness.
- Presence of osteomyelitis with no polyserositis–*Staphylococcus spp.* isolated
- Possible chilling of birds
 - Difference in temperature between one side and the other – 3.7C (21.9C to 25.6C)
 - Stress impacts immune function.



Field factors – IBDV & CAV (4)

- Broilers - Processing age
 - Issues with high condemnments and lameness issues.
 - Presence of IBDV and CAV in bursas and serology.



Field factors – IBDV & CAV

□ Broilers - Processing age

- Issues with high condemnns and lameness issues.
- Presence of IBDV and CAV in bursas and serology.
- Up to 5 IBDV variants circulating in the province, with and without CAV.
- Recommending changes in vaccination when pertinent.



Specimen Type Sampling Date / Time	Match	Compared To	Species Origin	Geographical Origin	Reference ID	Strain / Subtype
Scrolls 24-JAN-10 14:02	100%	Infectious bursal disease virus	Chicken	USA	86-Indiana-2014	field strain

Specimen Type Sampling Date / Time	Match	Compared To	Species Origin	Geographical Origin	Reference ID	Strain / Subtype
Tissue 2024-Feb-15	99.3%	Infectious bursal disease virus	chicken	British Columbia	15-062782	field strain

Specimen Type	Chicken anemia virus - PCR		Infectious bursal disease virus - PCR		Specimen Type Sampling Date / Time	Match	Compared To	Species Origin	Geographical Origin	Reference ID	Strain / Subtype
	Result (Ct)	Interpretation	Result (Ct)	Interpretation							
Bursa of Fabricius	33.08	Positive	30.14	Positive	Bursa of Fabricius 23-Dec-04	100%	Infectious bursal disease virus	chicken	Saskatchewan	09	field strain

Private and Confidential

Take home messages

- **Water sanitation & Acidification**
 - Review your level of disinfectant at the end of line.
 - Be aware that important differences in biofilm exist.
 - Consider acidification.
- **Biofilm**
 - Discuss with your service tech strategies to deal with biofilm.
 - Consider changing chemistries from time to time (6 months, 1 year?)
 - Microbes also want to live.
- **Check on proper distribution of heat on barn**
 - Check for condensation areas- corners of barn.
- **Attention to proper humidification first two weeks**
 - Proper cocci cycling
- **Consider thoroughly cleaning and disinfection**
 - After a cycle with high condemnns,
 - high number of birds left – low weights
- **Evaluate vaccination program suggestions based on current data.**



Take home messages

☐ Acknowledgements

☐ MLF Procurement team

- ☐ Frank Maenhout
- ☐ Rachelle Davidson
- ☐ Dallas Shenher
- ☐ Jesse Hunter
- ☐ Matthew Nordlund
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☐ MLF Processing Plant Team

☐ MLF Breeder & Broiler producers

- ☐ Deeply grateful for all your insights and support!

☐ UofCalgary – Dr. Faizal Careem

☐ UofGuelph – Dr. Davor Ojkic

☐ Poultry Health Services

☐ Please, wake up! Any questions? 😊





Thank you!

