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LIVERPOOL

Institute of Infection
and Global Health

Chicken respiratory infections: differential diagnoses and control strategies

Kannan **Ganapathy** DVM PhD DipECPVS MRCVS

Poultry Respiratory Infection & Immunobiology Group

RCVS Recognized Specialist in Poultry Medicine

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1966 - 2010

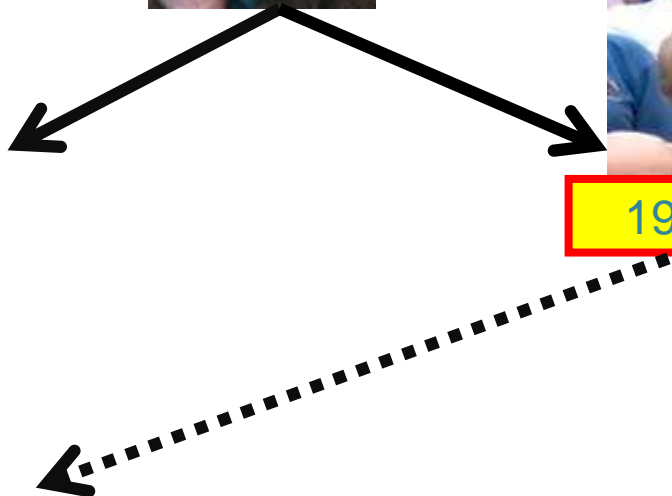


1964 - 2010



1993 -1997: PhD
2002 - present

1991 – DVM, Malaysia
2004 – MRCVS (UK)
2007 – RCVS specialist in poultry
2011 – European specialist in poultry



Main responsibilities

Kannan Ganapathy (@ Gana)

- **Research** [Focus: IBV, aMPV, H9N2, Mg/Ms, NDV, ILT]
- **Teaching (Year 1 to Year 5)**
 - Poultry management
 - Poultry infectious diseases
 - Poultry pathology and medicine
- **Postgraduate supervision**
- **Disease/problem investigations**
 - International and UK
- **Vet Poultry Consultations**
 - ~ 28 years of experience in poultry medicine & production
 - > 24 years of research in poultry diseases



Poultry Respiratory Infection & Immunobiology (2010 -)

IBV, aMPV, NDV, ILT, H9N2 & Mg+Ms

K Ganapathy (@ Gana) DVM PhD DipECPVS MRCVS
Senior Lecturer in infectious diseases (poultry)

Anne Forrester,
Technician

Dr Chris Ball
molecular biology & virology

Faez Awad, PhD - IBV and aMPV: immunopathogenesis, diagnosis, vaccination (2011-2014)
Thunai Al-Shekaili, PhD - AIV and NDV: epidemiology and control in the Middle East (2012-2015)
Rajesh Chhabra, PhD – IBV: host (cell, TOC, bird) response to variant IBVs (2012-2016)
Sally Hutton, MSc – Poultry respiratory diseases in Ethiopia (2012-2013)
Basim Manswr, PhD – IBV diagnosis and interactions (2014-2018)
Muhammed Al-Rasheed, PhD – IBV head-associated immunity and protection (2015-2020)

Epidemiology

Pathology

Immunology

Diagnosis

Control+Prevention
vaccine & vaccination

Content: Chicken respiratory diseases

- **Anatomy & physiology**
- **Factors leading to respiratory diseases**
- **Clinical signs and lesions**
- **Differential diagnoses**
- **Laboratory support**
- **Prevention strategies**



Farm - arrival

Brooding

Growers

Broiler

Layer

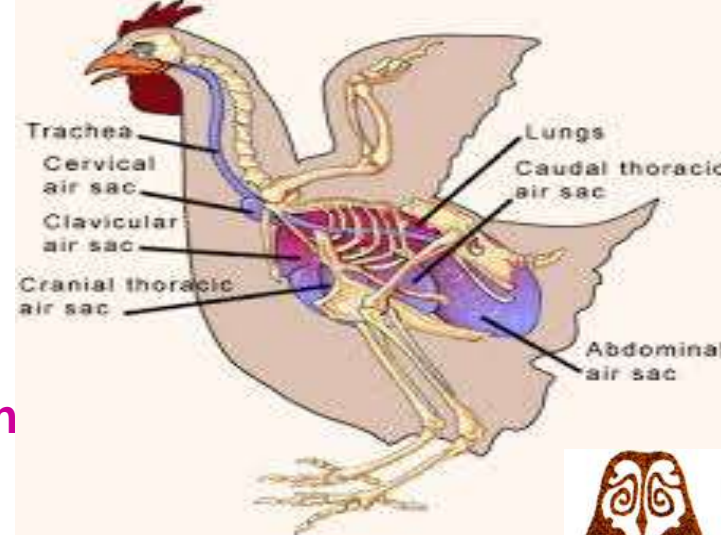
Breeder



Respiratory system

- Upper respiratory tract
 - Nares
 - Mechanical filters
 - Nasal cavity
 - conchae
 - Paranasal sinus
 - Infraorbital sinuses
- Lower respiratory tract
 - Air passes through the *Choanae* (palatopharyngeal) to larynx.
 - Larynx – not connected to sound creation.
 - Larynx to trachea (complete cartilaginous rings)
 - End of trachea, bifurcates onto bronchus

micro-filtration
warms
moisture





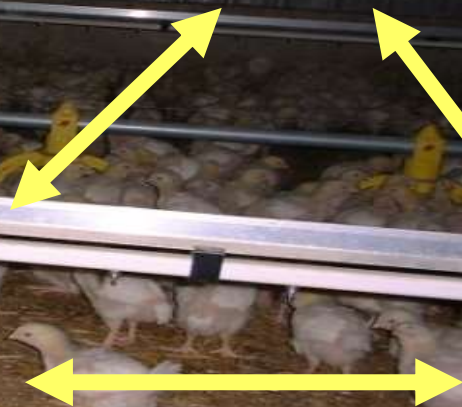
Interplay between AGENT, hosts and environment

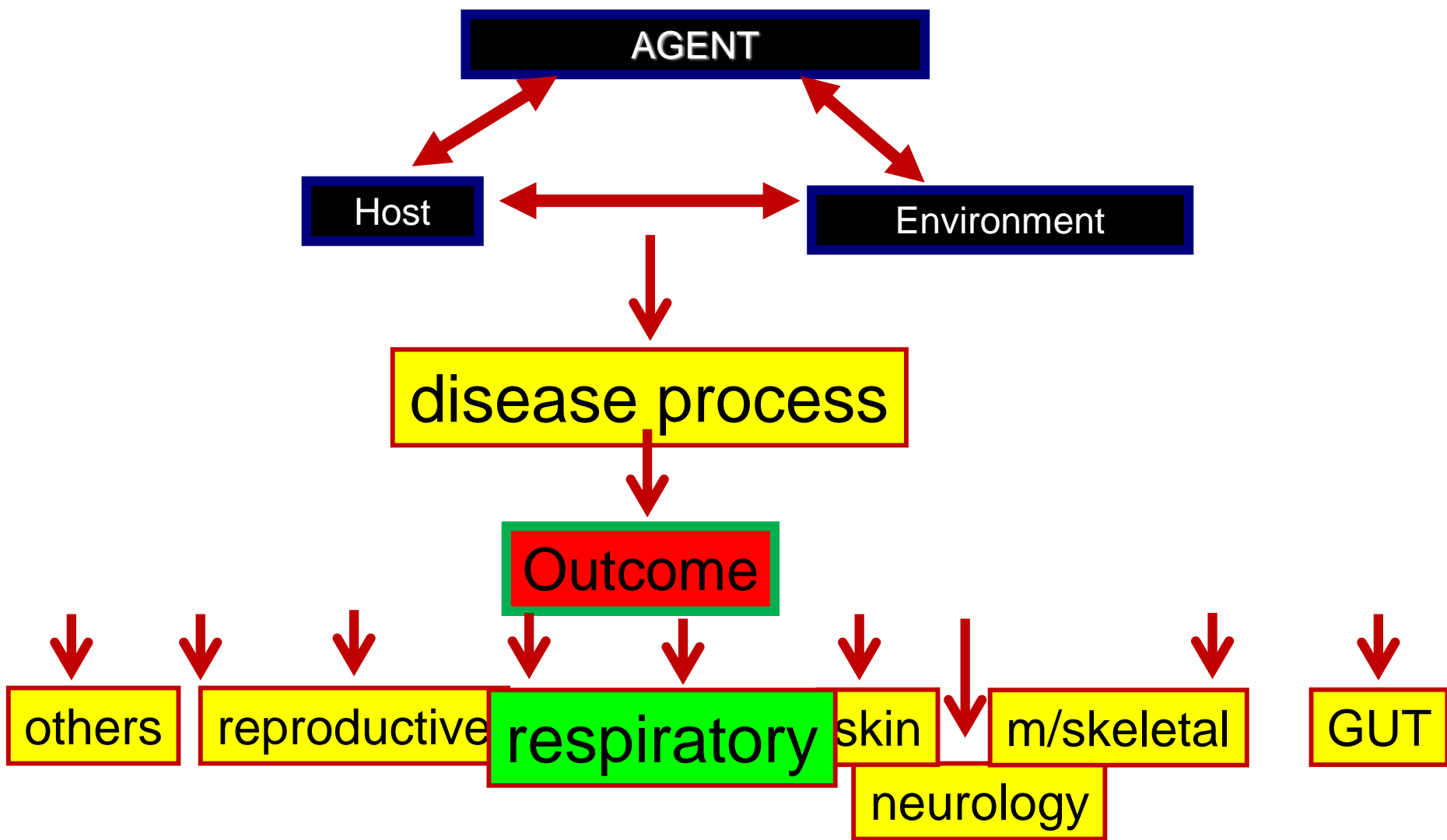
AGENT



Host

Environment

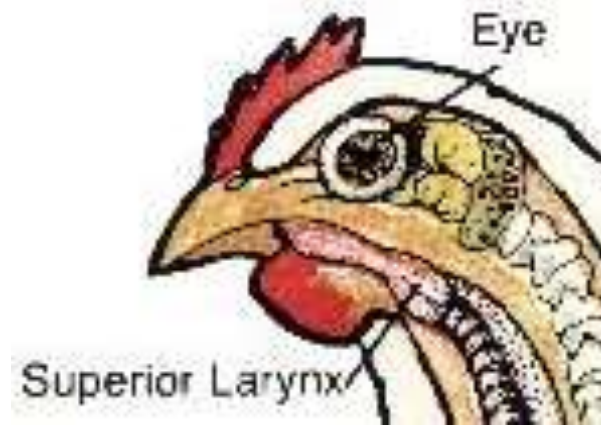




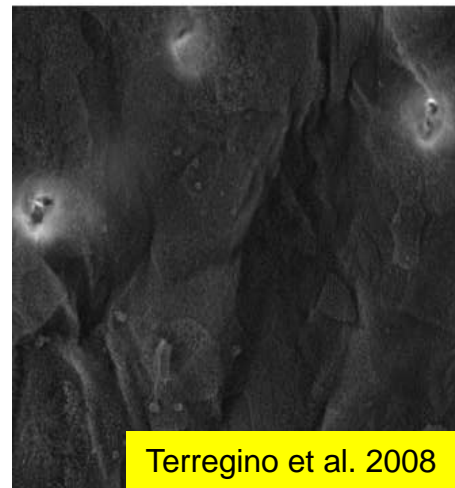
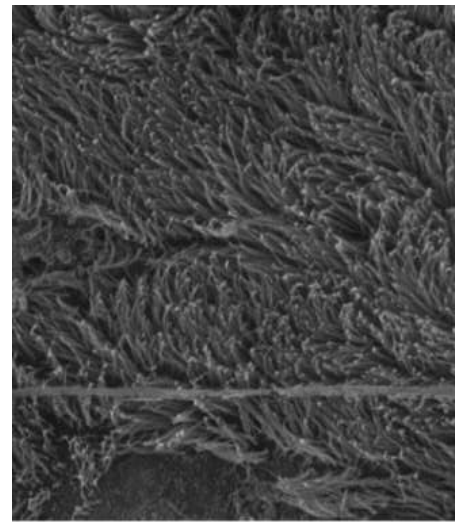
Chicken respiratory disease – clinical signs and lesions



- Nasal and ocular discharges
- Wheezing, rales
- Sneezing, Coughing
- Gasping
- Head-shaking/scratching
- Mortality and morbidity, variable



- Conjunctivitis
- Sinusitis
- Rhinitis
- Laryngitis
- Tracheitis

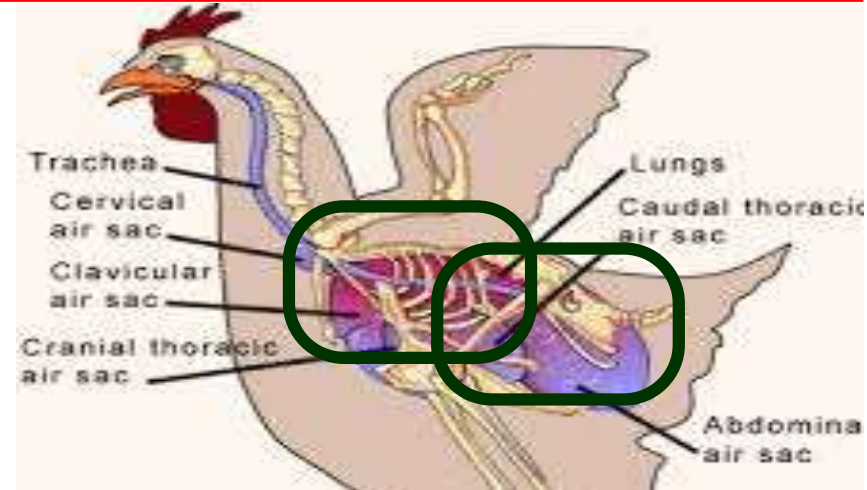


A Herrmann

Terregino et al. 2008

Chicken respiratory disease – clinical signs and lesions

- Abdominal breathing
- Wheezing
- Tracheal plug
- Pneumoniae
- Lung congestion
- Airsacculitis
 - Mild
 - Moderate
 - Severe
- Fibrinous airsacculitis
- Yellowish spots (fungi)



Chicken respiratory diseases

- ***Non-infectious***

Tumours

Behaviour

Nutrition

Management

Environment

Physical

Chemical

- ***Infectious***

Viruses

Bacteria

Chlamydia

Mycoplasmas

Protozoa

Fungi/yeasts

Internal parasites

External parasites

Chicken respiratory diseases

- ***Non-infectious***

Vitamin A deficiency

Tumours

Behaviour

Respiratory signs – ocular and nasal discharges, IOS swelling, cheesy exudate in eyes.

Nutrition

Management

Lesions – exudate in the IOS, mostly cheesy
- swelling of oesophageal glands

Environment

Physical

Other impact – integrity of respiratory epithelium affected.

Chemical

Chicken respiratory diseases

- ***Non-infectious***

Tumours

Behaviour

Nutrition

Management

Environment

Physical

Chemical

Excessive use of formalin
hatcheries

Respiratory signs – increased mortality week 1, sneezing, coughing, ocular-nasal discharge, gasping?

Lesions – those associated with CCRD including tracheal plugs

Other impact – disease and losses due to hatchery vaccination due to respiratory injuries

Chicken respiratory diseases

- ***Non-infectious***

Tumours

Behaviour

Nutrition

Management

Environment

Physical

Chemical

Feed – mycotoxins

- BF, thymus and others
- reduce feed intake

Adverse effects on respiratory tract health due to immunosuppression and loss of micronutrients.

- Increases susceptibility respiratory pathogens

Chicken respiratory diseases

- ***Non-infectious***

Tumours

Behaviour

Nutrition

Management

Environment

Physical

Chemical

Poor ventilation, enclosed building

Stuffy micro-environment

Ammonia building-up

Dust

Chicken respiratory infections...

Avian influenza– H5/H7
Newcastle disease

Infectious

Viruses

Tumours

Behaviour

Nutrition

Management

Environment

Physical

Chemical

Bacteria

Chlamydia

Mycoplasmas

- Infectious bronchitis virus (IB)
- LPAI – H9N2
- Infectious laryngotracheitis (ILT)
- Avian metapneumovirus (aMPV)
- Fowl pox (FP)

Chicken respiratory infections...

M. gallisepticum (Mg)
M. synoviae (Ms)

Infectious

Viruses

Bacteria

Chlamydia

Mycoplasmas

ngi/yeasts

asites

- protozoa

- worms

function

Tumours

Behaviour

Nutrition

- *E coli*
- *Pasteurella multocida* (F cholera)
- *Avibacterium paragallinarum* (IC)
- *Ornithobacterium rhinotracheale* (ORT)
- *Salmonella* sp
- Others

Chicken respiratory infections...

Aspergillus fumigatus

Physiological/malfunction

Tumours

Behaviour

Nutrition

Management

Environment

Physical

Chemical

Infectious

Viruses

Bacteria

Chlamydia

Mycoplasmas

Fungi/yeasts

Parasites

- protozoa

- worms

Chicken respiratory infections...

Syngamus trachea
Cryptosporidium baileyi

Infectious

Viruses

Bacteria

Chlamydia

Mycoplasmas

Fungi/yeasts

Parasites

- **protozoa**

- **worms**

Tumours

Behaviour

Nutrition

Management

Environment

Physical

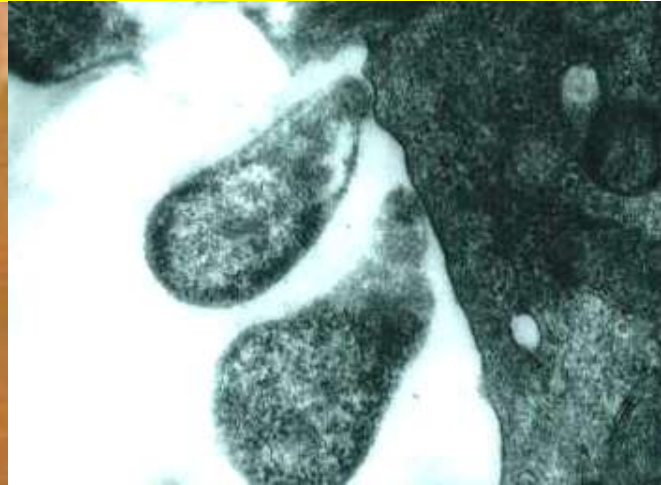
Chemical

Chicken respiratory infections– differential diagnoses

- ***Signs and lesions similar for the listed pathogens....***
- ***except:***
 - *HPAI, high sudden mortality, rapid morbidity*
 - *NDV, high sudden mortality, rapid morbidity**
 - *LPAI, variable mortality, rapid morbidity **
 - *IBV, variable mortality, rapid morbidity **
 - *aMPV, low mortality, low morbidity **
 - *ILT, variable mortality, low morbidity **
 - *Mycoplasmas and other bacterial infections, variable mortality and low morbidity **

Chicken respiratory diseases –differential diagnoses

For Mg + Ms, similar signs, often mild and prolonged, except exacerbation when complicated with other pathogens



Ms becoming as important as Mg - worldwide

	Mg	Ms
Year	1935/ 1960	1960/ 1964
Respiratory disease	+++	
Reproductive disease	+++	
Musculoskeletal	+	+++
Diagnostic priorities	+++	



	Mg	Ms
Year	1935/ 1960	1960/ 1964
Respiratory disease	+++	++
Reproductive disease	+++	+++
Musculoskeletal	+	+++
Diagnostic priorities	+++	+++



Feberwee, et al., 2009

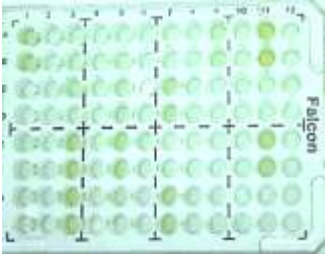
Beyond respiratory infection, pathology and losses

= respiratory + systems (normally)

Agent	Resp	GIT	Neu	Repr	Renal	M/S	etc
HPAI	√	√	√	√	√	√	
LPAI	√	√	√	√		√	
NDV	√	√	√	√	√	√	
IBV	√	?		√	√	√?	
ILTV	√						
aMPV	√			√		√	
FP	√	√				√	

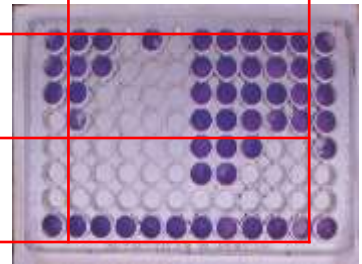
Respiratory infections

laboratory diagnosis - serology



- Availability
- Cost
- Speed
(delivering results)
- Assay
 - Convenience
 - User friendly
 - Sensitivity
 - Specificity

Agent	Serology			
	ELISA	HI	SNT	Pen-site
HPAI	✓	✓	✓	✓
LPAI	✓	✓	✓	
NDV	✓	✓	✓	
IBV	✓	✓	✓	
ILTV	✓		✓	
aMPV	✓		✓	



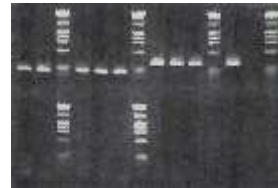
Virus isolation *versus* PCR

laboratory diagnosis - antigen detection

- Sample collection....
- Antigen detection
 - **Culture, isolation and identification**
 - Bacteria and fungal
 - Mycoplasmas
 - Viruses
 - Parasites (identification)
 - **Molecular detection**, genotyping, finger-printing
 - Conventional PCR
 - Real-time PCR

Direct demonstration

- EM
- Immunostaining



Aims

- To investigate the presence of Mg, Ms, IBV and aMPV in UK poultry flocks
 - Identify and differentiate the strains
- To compile percentage co-infections between the ...

- Mg
- Ms
- IBV
- aMPV



Contents lists available at ScienceDirect

Veterinary Microbiology

journal homepage: www.elsevier.com/locate/vetmic



Co-circulation of genetically diverse population of vaccine related and unrelated respiratory mycoplasmas and viruses in UK poultry flocks with health or production problems

Christopher Ball, Anne Forrester, Kannan Ganapathy*

University of Liverpool, Leahurst Campus, Neston, Cheshire, CH64 7TE, UK



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and Global Health



Based on Ricketts *et al.* (2017), **0 of 44**
TS-11(vaccine) found, all field strains
!!!!

Although based based on *mgc2*
 sequencing:
27 of 44 – TS-11-like

Based on *mgc2* sequencing:
 15 of 44 – **6/85-like**

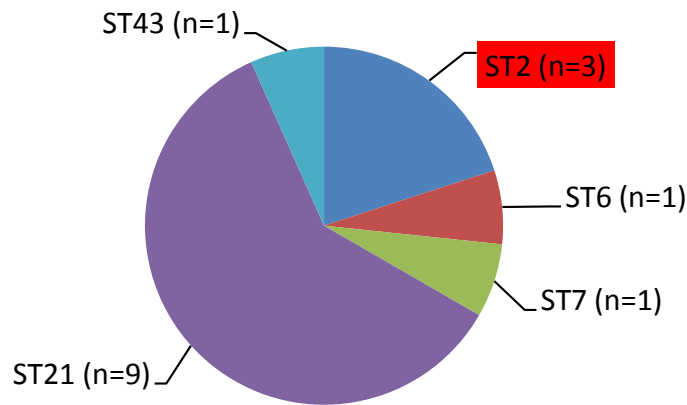
Sample	Gene	PCR Result	Outcome
TS-11 Vaccine	<i>mgc2</i>	+	Vaccine
	<i>vlha 3.04a</i>	+	
	<i>vlha 3.05</i>	+	
	<i>mg0359</i>	+	
LM16/63	<i>mgc2</i>	+	Field
	<i>vlha 3.04a</i>	-	
	<i>vlha 3.05</i>	-	
	<i>mg0359</i>	+	
LM16/66	<i>mgc2</i>	+	Field
	<i>vlha 3.04a</i>	-	
	<i>vlha 3.05</i>	-	
	<i>mg0359</i>	+	
LM16/79	<i>mgc2</i>	+	Field
	<i>vlha 3.04a</i>	-	
	<i>vlha 3.05</i>	-	
	<i>mg0359</i>	+	
LM16/80	<i>mgc2</i>	+	Field
	<i>vlha 3.04a</i>	-	
	<i>vlha 3.05</i>	-	
	<i>mg0359</i>	-	

M. Synoviae (n=16 positive by vlha) MLST

- 16 strains *M. synoviae* positive tested by MLST

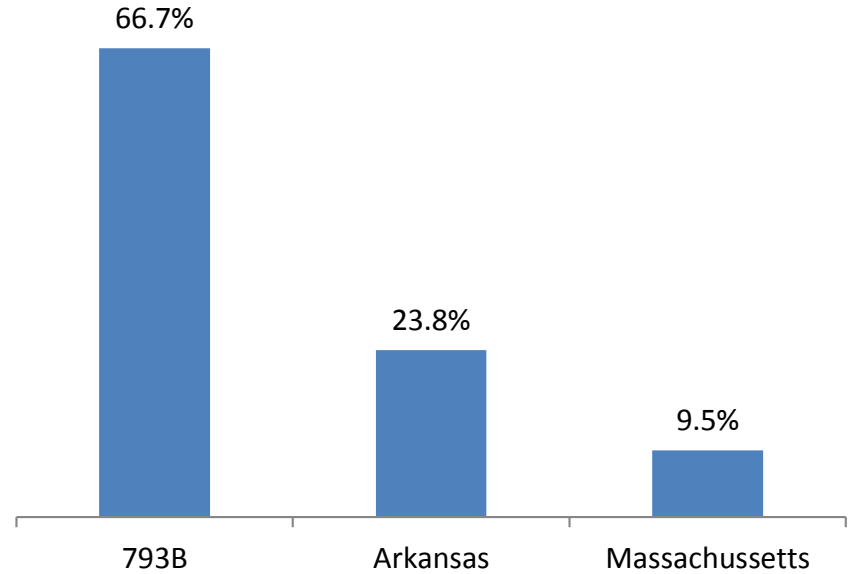
- (El-Gazzar et al., 2017) ; all 7 locii amplified and compared
– (<http://pubmlst.org/msynoviae/>)

- Only a single sample unable to type
- ST21 most common
 - Previously identified in the Netherlands
- **ST2, 6, 7 and 43 also identified**
 - **ST2 includes MS-H vaccine**



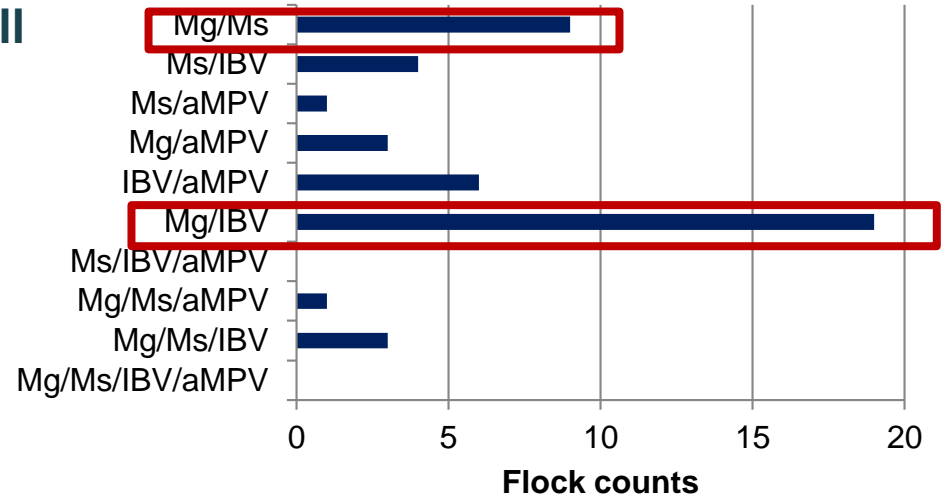
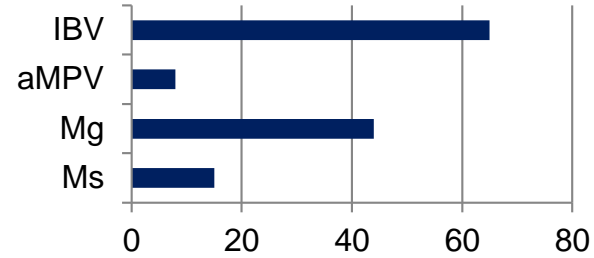
IBV detection

- IBV was detected in 65 flocks (49.6%)
 - **>99% (48% of strains)**
 - **96-99% (34% of strain)**
 - **85-96% field stain (18%!)**



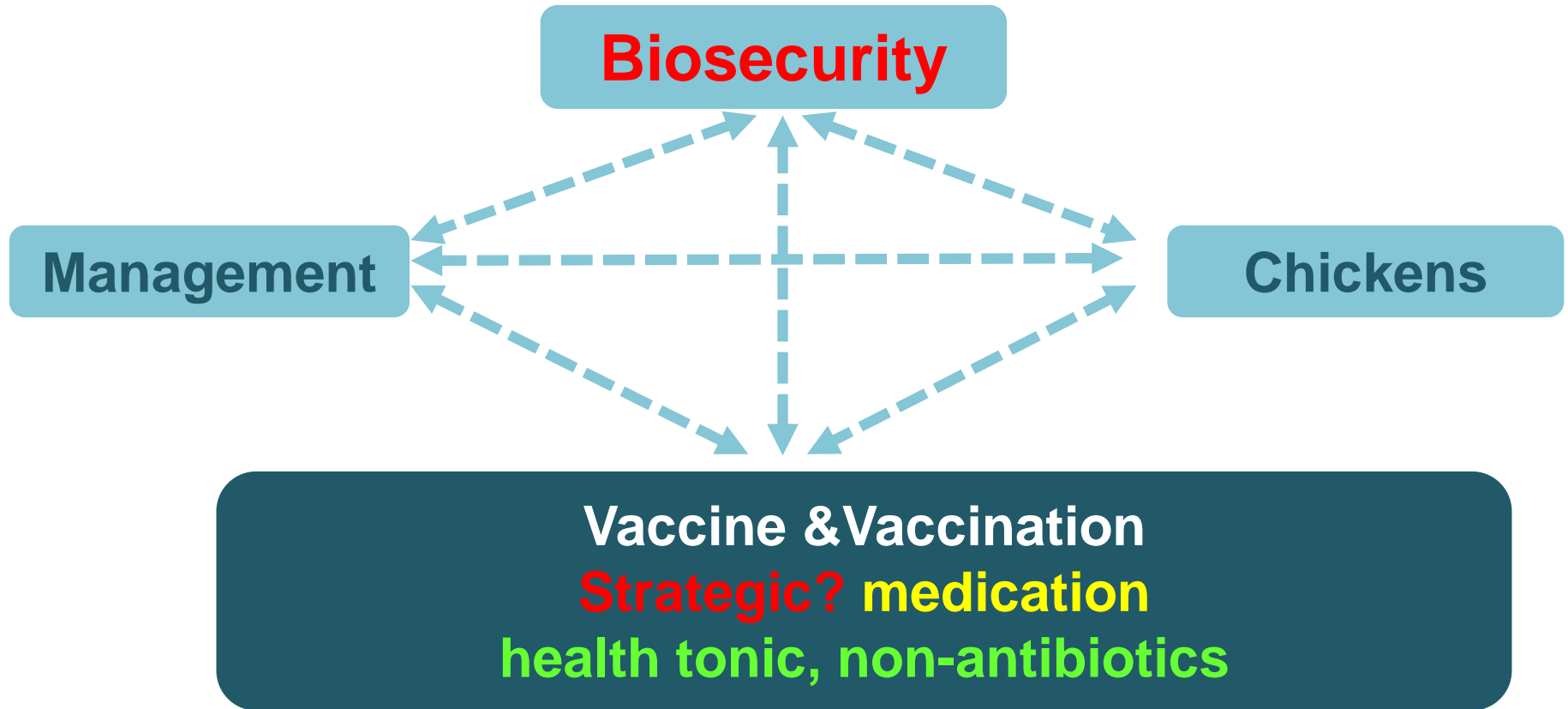
Co-infections

- Detected in 42 flocks
- Mg+IBV most prominent (19)
- Ms+aMPV least prominent (1)
- No flock found to contain all four



Prevention strategies: respiratory diseases

(outline)



Conclusions

- Consider non-infectious **prior** to the infectious causes
- Laboratory support **essential** for narrowing respiratory diagnoses
- Serology most preferred, however, best to complement with **antigen detection**
- Molecular detection preferred but should be accompanied with **culture, isolation and identification (differentiation)**

Poultry Respiratory Infection & Immunobiology (2010 -)

IBV, aMPV, NDV, ILT, H9N2 & Mg+Ms

Epidemiology

- ❖ IBV, NDV, AIV and aMPV surveillance in backyard flocks in Oman (Al Shekaili et al., 2015: *Research in Veterinary Science*)
- ❖ NDV and AIV epidemiology (Al Shaikaili et al., 2015: *Veterinary Preventive Medicine*)
- ❖ IBV epidemiology in the Middle East (Ganapathy et al., 2015: *Virus Research*)
- ❖ Detection of IBV793B, aMPV, Mg and Ms in poultry in Ethiopia.
Hutton et al., 2016: Journal of Tro. Ani. H & P).
- ❖ IBV epidemiology in Libya (Awad et al., *International Journal of Veterinary Science and Medicine*)
- ❖ IBV epidemiology in the Sri Lanka (Ball et al., 2016: *Archives of Virology*)
- ❖ IBV, aMV, Mg and Ms in UK flocks (Ball et al., 2018: *Veterinary Microbiology*)
 - ❖ Including differentiation of vaccine versus field strains: IBV, aMPV, Mg and Ms

Poultry Respiratory Infection & Immunobiology (2010 -)

IBV, aMPV, NDV, ILT, H9N2 & Mg+Ms

Immunopathogenesis & host-virus interactions

- ❖ IBV QX – proventriculus in UK (Ganapathy et al., 2012: *Veterinary record*)
- ❖ IBV IS/885/06 (Egyptian isolate), pathogenesis in broiler and SPF chickens (Awad et al., 2015: *Research in Veterinary Science*)
- ❖ IBV IS/1494/06 (Variant 2), pathogenesis in broiler and SPF (Awad, thesis, 2012)
- ❖ Pathogenesis of aMPV subtype A and subtype B in chickens, comparison) (Awad, thesis, 2012)
- ❖ Pathogenicity and tissue tropism of infectious bronchitis virus correlates to elevated apoptosis and innate immune responses. Chhabra et al., 2017: *Virology*.
- ❖ **Differential innate immune responses induced by classical and variant infectious bronchitis viruses in specific pathogen free chicks.** Chhabra et al., 2018: *Developmental Comparative Immunology*.

Poultry Respiratory Infection & Immunobiology (2010 -)

IBV, aMPV, NDV, ILT, H9N2 & Mg+Ms

Diagnosis

- ❖ Evaluation of FTA cards for storage and molecular detection of aMPV.
Awad et al., 2014: *Avian Pathology*)
- ❖ IBV - Partial *versus* full S1 sequencing, and impact of storage.
Manswr et al., 2018: *Avian Pathology*)

Poultry Respiratory Infection & Immunobiology (2010 -)

IBV, aMPV, NDV, ILT, H9N2 & Mg+Ms

Vaccine & vaccinology

❖ Vaccine interactions

(Ganapathy et al., 2006, 2007: *Avian Pathology*; Awad et al., 2015: *Avian Pathology*; Chhabra et al., 2015: *Clinical vaccine immunology*; Ball et al., in-preparation)

- ❖ NDV+IBV (H120)+aMPV, in SPF and broiler chickens
- ❖ NDV+IBV (H120+793B) in broiler chickens
- ❖ aMPV+IBV (H120+793B) in broiler chickens
- ❖ IBV H120+IBV 793B day-old vaccination.

IBV H120+IBV 793B + NDV

❖ Kinetics of live IB vaccine viral load, immune responses, and molecular changes in TOCs and in broiler birds

- ❖ Massachusetts + 793B vaccines in TOCs (Ball et al., 2017: *Journal of General Virology*)
- ❖ Massachusetts + 793B vaccines in birds
 - ❖ *Pathogenesis and viral distribution (Awad et al., 2017: Avian Pathology)*
 - ❖ *Molecular changes in the vaccine virus (Ball et al., 2017: Avian Pathology)*

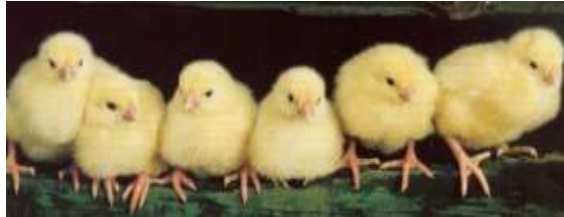
Acknowledgments



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ODA Seed Fund 4



education organization research

World's Poultry Science Association - Bangladesh Branch



Thanks for your kind attention...

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