Infektionserreger mit Einfluss auf die Darmgesundheit

- Pathogens influencing gut health -

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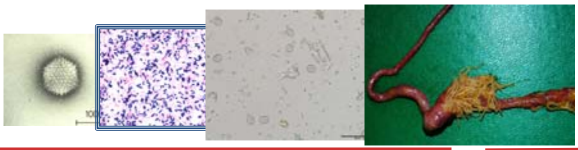
Gut – mucosal surface

- gut as the entrance gate for various microorganisms which target other organs

- number of pathogens which reside within the gut is limited

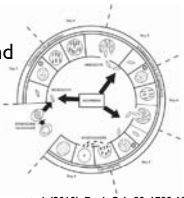


Pathogens

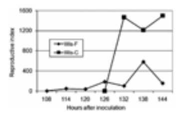
- **Impact on gut tissue**
  - **Inflammation – Motility – Physiology – Absorption – Growth – Health and Performance**
- **Specificity**
  - **for poultry species (chicken – turkey - waterfowl)**
  - **for certain age or production phases (layer – breeder – broiler)**

Eimeria spp.

- intracellular protozoan parasites
- high importance in all poultry species and production phases
- initial research by Tyzzer and Johnson in the 1920s and 1930s
- 1971 introduction of monensin, an ionophore, as coccidiostat in the market
- 1980s precocious lines as basis for vaccines
- 1990s vaccines introduced into the market, containing 3-8 *Eimeria* species
- last decade: molecular characterization and functional aspects of certain proteins



Chapmann et al. (2010), Poult.Sci., 89, 1788-1801



Jeffers (1975), J.Parasitol., 61, 1083-1090

Coccidiosis

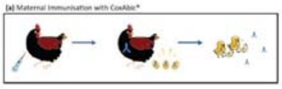
Eimeria: vaccination

Table 3. Coccidial lesions recorded in floor reared broilers after vaccination with different anticoccidial vaccines by various routes

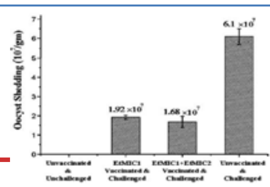
Vaccine	Coccivac®-B	Coccivac®-B	Coccivac®-D	Coccivac®-B	Paracox®	Paracox®	Paracox®	Paracox®	Nobilis® COX ATM
Trial type	Field	Field	Field	Field	Floor pen	Laboratory	Field	Field	Floor pen
Age at vaccination	1 day old	1 day old	1 day old	1 day old	7 days old	4 days old	3 days old	5 days old	1 day old
Administration route	Hatchery spray	Feed spray	Hatchery spray	Hatchery spray	Bell-drinkers	Gavage	Drip trays	Pipelines	Hatchery spray
Origin of lesions	Vaccinal/wild?	Vaccinal/wild?	Vaccinal/wild?	Vaccinal/wild?	Vaccinal	Vaccinal	None	None	Vaccinal
Days post-vaccination	14–28	12–19	16–28	14–28	26–40	5–21	None	None	7–21
Percentage of birds	35	?	?	?	4	24	0	0	?
Lesion scores[a]	1–2	?	?	?	1–2	1–3	None	None	<2
Species[b]	Ea, Emax, Emit, Et	Ea, Et	Ea, Et	?	Emax, Et	Ea, Emax, Et	None	None	Ea, Emax, Et
Reference	Newman (1999)	T.E. Cherry in Chapman et al. (2002)	T.E. Cherry in Chapman et al. (2002)	G.F. Mathis in Chapman et al. (2002)	Williams (1996)	Williams & Andrews (2001)	Williams et al. (1999)	Williams & Gobbi (2002)	Schetters et al. (1999)

[a]Johnson & Reid (1970)
[b]See Table 1 for key

Williams (2002), Avian Pathol., 31, 317-353



Sharman et al. (2010), Parasit.Imunol., 32, 590-598



Sathish et al. (2012), Vaccine, 30, 4460-4464

Coccidiosis – (alternative) strategies

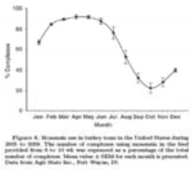
Protective effects of *Aloe vera*-based diets in *Eimeria maxima*-infected broiler chickens

Dongjean Yim, Sang S. Kang, Dong W. Kim, Sang H. Kim, Hyun S. Lillehoj, Wongi Min

Improved resistance to *Eimeria acervulina* infection in chickens due to dietary supplementation with garlic metabolites

Duk Kyung Kim, Hyun S. Lillehoj, Sung Hyen Lee, Erik P. Lillehoj and David Bravo

Coccidiosis Immunization: Effects of Mushroom and Herb Polysaccharides on Immune Responses of Chickens Infected with *Eimeria tenella*



Chapmann et al. (2010), Poult.Sci., 89, 1788-1801

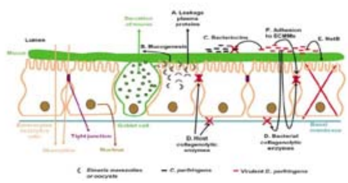
Assessment of dietary supplementation with probiotics on performance, intestinal morphology and microflora of chickens infected with *Eimeria tenella*

Enhanced Mucosal Immunity Against *Eimeria acervulina* in Broilers Fed a *Lactobacillus*-Based Probiotic

Necrotic enteritis (NE)

- *Clostridium perfringens* type A, widely distributed in the environment
- toxins as main virulence factors: alpha and NetB
- a single genetic strain during outbreaks
- risc components in the feed: texture, high energy, protein-rich, wheat, fishmeal, fat component
- immunosuppression and stress promote NE

NE: pathogenesis and prevention



Timbermont et al. (2011), Avian Pathol., 40, 341-347

Table 4. Numbers of birds examined for the presence of NE gut lesions per week.

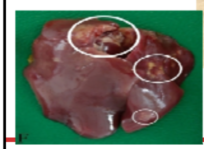
	Site 1						Site 2			
	Week 30 hatch		Week 35 hatch		Week 45 hatch		Week 27 hatch		Week 32 hatch	
Week	C	V	C	V	C	V	C	V	C	V
1	31	34	25	36	18	11	22	20	25	15
2	10	6	28	29	14	4	13	16	21	16
3	7	4	5	5	1	4	11	14	22	18
4	1	1	1	1	**18**[a]	3	**34**[b]	20	**33**[c]	19
5	1	0	6	1	8	3	12	11	10	11
6	1	0	0	1	6	1	13	10	16	17
7	8	6	1	2	4	5	12	11	15	20
8	0	0	5	5	2	1	11	9	11	12

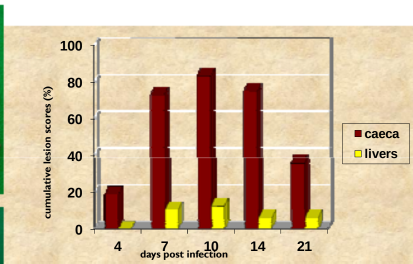
V, vaccinated; C, control. Bold text denotes when specific lesions were observed. [a]4/6 birds examined on day 26 were diagnosed as having NE (mean lesion score = 1.5). [b]12/13 birds examined on day 25 (mean lesion score = 1.15) and 11/12 birds examined on day 26 (mean lesion score = 0.92) were diagnosed as having NE. [c]12/12 birds examined on day 25 (mean lesion score = 1.50) and 6/30 birds examined on day 26 (mean lesion score = 0.7) were diagnosed as having NE.

Crouch et al. (2010), Avian Pathol., 39, 489-497

Histomonosis in layers: typhlo(-hepatitis)

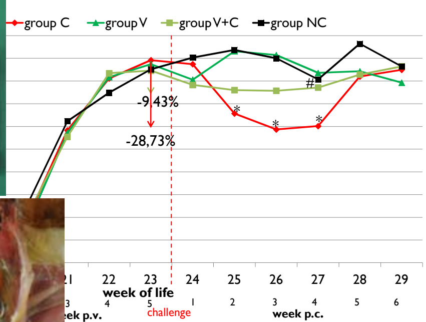
Experimental histomonosis in chickens





Zahoor et al. (2011), Avian Dis., 55, 29-34

Experimental histomonosis in layers

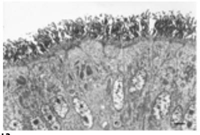


* significant difference between control and challenged group (P≤0.05).

\# significant difference between vaccinated+ challenged and only challenged group (P≤0.05).

Avian intestinal spirochetosis

- *B. intermedia, B. pilosicoli, B. hyodysenteriae, B. alvinipulli,* in poultry often mixed infections
- important in layers and breeders
- *B. alvinipulli* in in geese with fibrinonecrotic typhlitis (Nemes et al.,Avian Pathol., 2006, 35, 4-11)
- preference for alternative housing systems
- vaccination with inactivated bacterin not successful (Amin et al.,Vet.Microbiol. 2009, 133, 372-376)
- good susceptibility to antibiotics in a population with low level exposure to antibiotics (Jansson et al., Avian Pathol., 2011, 40, 387-393)



Shivaprasad & Duhamel (2005), Avian Dis., 49, 609-613

Runting-stunting syndrome (RSS)

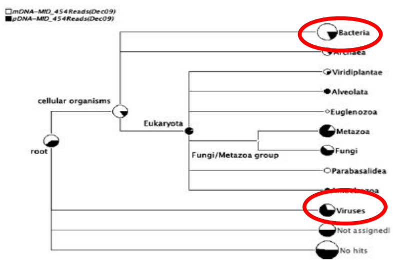
- Definition or synonyms
  - infectious runting and stunting syndrome
  - pale bird syndrome
  - malabsorption syndrome
  - helicopter disease
  - poult enteritis complex (PEC)
  - poult enteritis and mortality syndrome (PEMS)
- different nomenclature indicates a less well defined aetiology or multifactorial character of the syndrome

Runting – Stunting (RSS)

Consequences of RSS

Aetiolgy of RSS: Metagenome analysis

RSS-infiziert ●
versus
nicht-infiziert ○



Kim & Mundt, Methods Mol Biol. (2011), 733, 185-194

Aetiology of RSS

Bacteria-free intestinal and pancreatic homogenates from chickens of different ages, taken from flocks which developed RSS, regularly induced a lower mean live-weight in treated birds. Of these, only intestinal homogenates prepared from 5-day-old birds induced intestinal lesions, lowered mean live-weight and increased the incidence of both elevated plasma amylase activity and pancreatic atrophy. These changes were more marked in birds exposed to short periods of sub-optimal temperatures during the first week post-inoculation. An ultracentrifuged pellet prepared from this intestinal homogenate, was also found to induce an increased incidence of pancreatic atrophy in treated birds.

These studies suggest that the causative agent(s) of RSS is an as yet unidentified virus, and that the effects of this infection are greater in birds subjected to stress, such as sub-optimal temperature exposure, within the first week of hatch.

Smart et al., Avian Pathol. (1988), 17, 617-627

Table 1. Bacteria isolated from ground intestines of broiler chicks experiencing a runting/stunting-type syndrome.

Aerobes	Gram positive	*Enterococcus faecium* (5 347 510)[a]
		Enterococcus faecium (7 117 510)
		Staphylococcus cohnii[b]
		Bacillus licheniformis[b]
	Gram negative	*Escherichia coli* (5 144 552[a])
		Escherichia coli (5 044 502[a])
		Escherichia coli (5 044 552[a])
		Escherichia coli (5 144 572[a])
		Escherichia coli (1 044 552[a])
		Escherichia coli (1 144 552[a])
		Proteus mirabilis (0 732 000[a])
		Unidentified (7 044 452[a])/*Escherichia coli*[b]
Anaerobes	Gram positive	*Clostridium perfringens*[b]
	Gram negative	*Bacteroides fragilis*[b]

[a]Numbers in parentheses are biotypes derived from commercial identification systems: a = API 20 Strep (bioMérieux Vitek, Inc.), b = API 20E (bioMérieux Vitek, Inc.).
[b]Identified by NVSL.

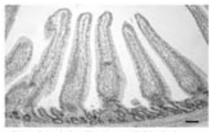
Montgomery et al., Avian Dis. (1997), 41, 399-406

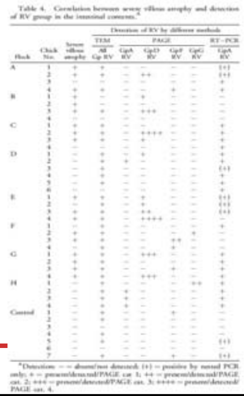
Viral aetiology of RSS

- **Astrovirus**
  - Turkeys: TAstV-1 and TAstV-2
  - Chickens: CAstV and Avian Nephritis Virus (ANV1,2,3)
  - Ducks: DAstV-1 and DAstV-2
  - Guinea Fowl (GFAstV)
- **Parvovirus**
  - Turkeys: (TuPV)
  - Chicken: (ChPV)
- **Rotavirus**
  - AvRV-A and –D, -F and -G
- **Coronavirus**
  - TCoV

- Adenovirus
- Reovirus
- Entero-like viruses

Rotaviruses: natural infection





Otto et al., Avian Dis. (2006) 50, 411-418

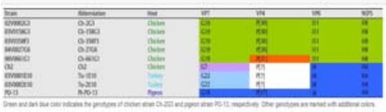
Epidemiology of Rotaviruses

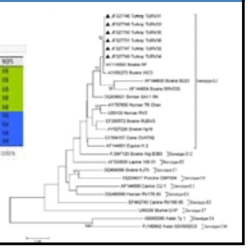
Table 2
Origin data of chickens and turkeys which were included in Study B.

Serial No.	Year	Country	Host	Age	Number of animals	Number of flocks	Clinical signs	% Positive for AvRV-A	% Positive for AvRV-D	% Positive for AvRV-A +AVRV-D
12	2009	Italy	Chicken	3-11 days	41	2	RSS	26.8	17.1	14.6
13	2009	Germany	Chicken	15 days	243	13	RSS	61.7	91.4	52.7
14	2009	Germany	Chicken	15 days	10	2	None	0.0	40.0	0.0
15	2010	Bangladesh	Chicken	15 days	30	3	RSS	76.7	3.3	3.3
16	2010	Germany	Turkey	3-12 weeks	14	6	Diarrhoea	64.3	7.1	7.1
17	2010	Germany	Chicken	9-21 days	7	4	RSS	85.8	14.3	14.3
18	2010	Netherlands	Chicken	1-35 days	44	7	RSS, diarrhoea	72.8	61.3	36.7
19	2010	Netherlands	Turkey	6 weeks	4	2	Diarrhoea	0.0	0.0	0.0
Total	–	–	–	–	393	39	–	58.8	65.9	38.9

Otto et al. (2012), Vet. Microbiol., 156, 8-15

Schumann et al., Virology, (2009) 386, 334-343





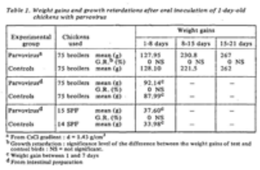
Asano et al., Avian Dis., (2011) 55, 697-700

RSS: Parvovirus

Table 1. Mean body weight (g) of broilers infected orally with chicken parvovirus strain ABU at 1 day of age.

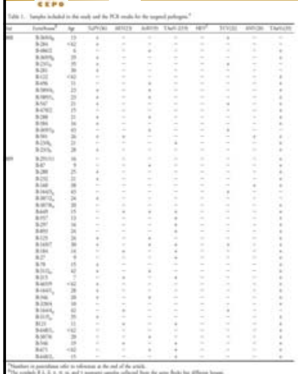
Age in days	Uninfected		Infected		Retardation in growth (%)
	Weight	Growth rate	Weight	Growth rate	
1	34.1	–	34.1	–	0
7	84.1	2.46	80.1	2.34	4.77
14	204.5	2.43	185.1	2.31	9.50
21	398.0	1.94	298.7	1.61	24.96
28	586.0	1.47	369.1	1.23	37.02

Kisary (1985), Avian Pathol., 14, 1-7

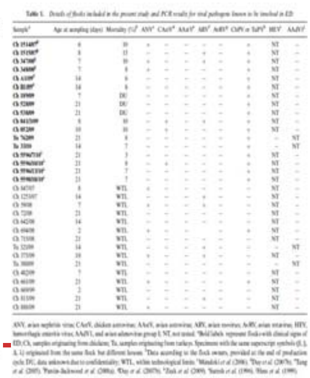


Decaesstecker et al. (1986), Avian Pathol., 15, 769-782

Parvoviruses in Hungarian poultry flocks



Palade et al., Avian Dis., (2011) 55, 468-475



Palade et al., Avian Pathol., (2011) 40, 191-197

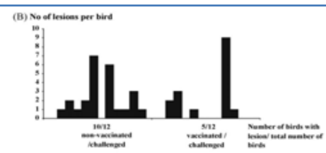
Astrovirus: functional aspects - prevention

Table 1
Values are mean ± SE. Jejunal tissue was stripped off seromuscular layer (A) or not (B) before mounting on Ussing chambers. Na^+ and Cl^- fluxes (J) and short-circuit current (I_{sc}) are given in μeq/cm²/h, and tissue conductance (G_t) is given in mS/cm². $J_{m\to s}$, mucosal-to-serosal flux; $J_{s\to m}$, Serosal-to-mucosal flux; J_{net}, net flux. n = 6 for each experiment.

	Na^+ flux			Cl^- flux				
	$J_{m\to s}$	$J_{s\to m}$	J_{net}	$J_{m\to s}$	$J_{s\to m}$	J_{net}	I_{sc}	G_t
(A) Unidirectional Na^+ and Cl^- fluxes across stripped jejunum of control and TAstV-2-infected poults								
Control	4.53 ± 0.31	3.58 ± 0.38	0.96 ± 0.38	2.67 ± 0.22	3.23 ± 0.38	−0.56 ± 0.40	9.40 ± 0.9	9.33 ± 0.9
TAstV-2	2.03 ± 0.36*	4.13 ± 0.42	−2.10 ± 0.43*	2.70 ± 0.40	2.26 ± 0.39	0.44 ± 0.37	4.00 ± 1.7*	15.50 ± 1.3*
(B) Unidirectional Na^+ and Cl^- fluxes across intact jejunum of control and TAstV-2-infected poults								
Control	4.36 ± 0.48	3.80 ± 0.29	0.57 ± 0.53	1.72 ± 0.44	2.14 ± 0.38	−0.42 ± 0.21	6.60 ± 0.9	9.83 ± 1.7
TAstV-2	2.91 ± 0.27*	4.04 ± 0.61	−1.13 ± 0.54*	2.54 ± 0.61	1.88 ± 0.54	0.66 ± 0.44	3.30 ± 1.1*	17.50 ± 1.4*

* $P < 0.05$ infected vs. control tissues (t-test).

Nighot et al. (2010), Virology, 401, 146-154



Sellers et al. (2010), Vaccine, 28, 1253-1263

RSS: Aetiology???

Table 2. Enteric virus detection in commercial chicken and turkey flocks by age.

Age (wk-days)	Astrovirus	Coronavirus	Rotavirus	Reovirus
Chickens				
Hatch to 1-0	12/14[A]	12/14	8/14	10/14
1-1 to 2-0	22/24	16/24	9/24	14/24
2-1 to 3-0	1/1	1/1	1/1	1/1
Unknown	2/2	2/2	2/2	2/2
Turkeys				
Hatch to 1-0	2/2	0/2	1/2	0/2
1-1 to 2-0	21/21	0/21	18/21	8/21
2-1 to 3-0	4/4	0/4	1/4	4/4
3-1 to 4-0	3/3	0/3	2/3	2/3
4-1 to 5-0	NA[B]	NA	NA	NA
5-1 to 6-0	1/1	0/1	0/1	1/1
Unknown	2/2	0/2	2/2	0/2

[A]Number positive/total tested.
[B]NA = not applicable, no flocks in this age range were included.

Pantin-Jackwood et al. (2008), Avian Dis., 52, 235-244

Table 2. Distribution and severity of histological lesions in poults inoculated with turkey astrovirus type-2 (TAstV-2), turkey rotavirus (TRotV), or turkey reovirus (TReoV) and all combinations at 4 days postinoculation.

	TRotV	TRotV + TAstV-2	TAstV-2	TRotV + Reo	Reo	TAstV-2 + Reo	TRotV + Reo + TAstV-2
Duodenum	+[A]	+	−	+	−	+/−	+
Jejunum	+	+	+/−	+	+/−	+/−	+
Ileum	+	+/−	−	+/−	−	−	+/−
Bursa	+/−	+	++	++	++	+++	+++

[A]Microscopic lesions: − = no or sporadic lesions; +/− = minimal; + = mild; ++ = moderate; +++ = severe.

Spackman et al. (2010), Avian Dis., 54, 16-21

Digestive tract: proventriculus and gizzard

INFECTIOUS PROVENTRICULITIS CAUSING RUNTING IN BROILERS

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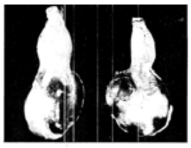
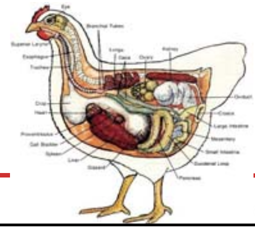
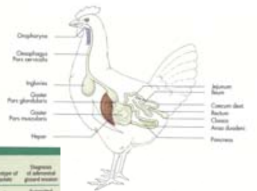
[2] *Department of Poultry Diseases, State University of Utrecht, P.O.B. 43, Doorn, The Netherlands*

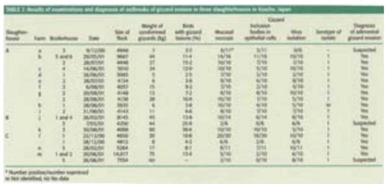




Kouwenhoven et al. (1978), Avian Pathol., 7, 183-187

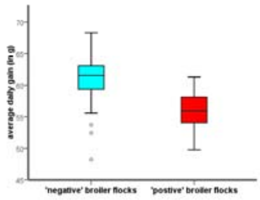
Gizzard Erosion (GE)

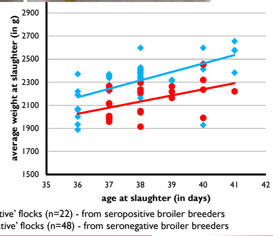




Ono et al., Vet. Rec., (2003), 153, 775-779

Gizzard Erosion (GE): field data





Grafl et al. (2012), Avian Pathol., in press

Summary

- various pathogens infect birds via the gut
- from all type of organisms – protozoa, bacteria and viruses – some specifically target the digestive tract
- coccidiosis is the most important disease of bird's gut
- in recent years PCR technology helped to elucidate the aetiology of RSS; however there is a need for functional studies
- various diseases with multifactorial aetiology
- new diseases of the digestive tract (e.g. GE) underline the need for precise diagnostics
- a wide range of plant substances are discussed to improve gut integrity
- efforts to combat gut diseases via vaccination have increased in recent years but numerous problems remain

Thanks!