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HYPOGLYCAEMIA-SPIKING MORTALITY LIKE SYNDROME (SMS) IN BROILERS

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SUMMARY

Mortalities in 10-14 day-old broilers showing characteristic spiking mortality syndrome in October 1994 are reported. The mortality rate exceeded 0.3% per day for at least 3 consecutive days involving 2 houses comprising 12,000 birds per house in a multiage broiler complex. The mortalities were accompanied by fine head tremors, apparent blindness, ataxia, coma and death. Between 5-10% of the birds appeared lethargic with backward extension of the legs. An orange-coloured, mashed papaya consistency faecal dropping was observed. No significant post-mortem lesion was observed. Subsequently, the frequency and severity of the disease syndrome were found to increase since 1995. In 1997, the disease was observed in 37 consecutive flocks with a total of 4.8 million birds resulted in mortality rate of 0.8% per day. The disease was also observed in the 3-4 and 4-6 week-old birds. Clinically affected birds were hypoglycaemic (71.0 mg/dl - range 52-92 mg/dl). Broiler performance worsened by 90-120 g bodyweight at slaughter but showed an increased feed/gain by 0.22-0.24. Enhancing management procedures in cleaning, disinfection, vector control and reducing bird stress were effective in reducing the severity of the syndrome.

Keywords: Hypoglycaemia-spiking mortality syndrome, broilers, tremors, ataxia

INTRODUCTION

A new syndrome called spiking mortality syndrome or hypoglycaemia-spiking mortality syndrome (HSMS) has been observed in broiler chickens between 6 to 21 day-old and up to 42 day-old in the United States since 1986 (Brown *et al.*, 1991; Davies *et al.*, 1995a; 1997) and in the Netherlands (Anon, 1996). It is a disease of infectious aetiology characterised by low morbidity and abrupt spikes in mortality of up to 0.3-0.5% per day for at least 3 consecutive days. The clinical signs include fine head tremors, apparent blindness, ataxia and coma. Recovery often occurs spontaneously but enteritis, rickets, runting/stunting and air sacculitis frequently developed in survivors (Davis *et al.*, 1995a,b,c). The affected chicks become severely hypoglycaemic acutely, with plasma glucose levels as low as 17 mg/dl. Hypoglycaemia is the apparent physiological basis for the central nervous system (CNS) signs because chicks with CNS signs are histologically normal.

The role of agents in affecting pancreatic glucagon and its correlation with plasma glucose levels has been demonstrated in affected birds (Davies *et al.*, 1995a). HSMS has been experimentally reproduced using filtered (0.45 micron) homogenised intestines, pancreas, faeces, darkling beetles and brains derived from field cases of HSMS (Davies *et al.*, 1993; 95a,b,c,d; 96; 97). Various viral agents such as arenavirus (Anon, 1995; Davies *et al.*, 1995a; 1997), serotype-12 adenovirus, inclusion body hepatitis adenovirus (Pilkington *et al.*, 1997), avian encephalomyclitis (Davies *et. al.*, 1997), herpesvirus and reovirus-like particles (Goodwin *et al.*, 1995) have been associated with this syndrome.

This report describes the disease syndrome in a multi-age broiler complex in Malaysia for the first time in 1994, but with increasing frequency and higher mortality rate in 1997. The prevention and control strategies are also discussed.

MATERIALS AND METHODS

Farms

A retrospective study was carried out in a multi-age broiler complex comprising 10 all-in-all-out farms located in an area of 250 hectares. Each farm consisted of 8 to 12 houses with a capacity of between 10,000 to 18,000 Cobb-500 birds per house. Each farm was operated on a 6 to 7 week rearing cycle and with a 2 to 4 weeks cleaning-disinfecting-resting period before the next intake of chicks. The interval of chick intake from one farm to another was spaced out at one to two-week intervals.

The broiler farm complex had all activities of the broiler production cycle simultaneously taking place, which included intake of chicks, rearing, sale of broilers, waste accumulation and disposal, cleaning and disinfecting as well as significant movements of personnel and vehicles.

Each farm had its own set of workers with a rotating set of supplementary workers for supervisory services, vaccination, bird catching, cleaning and disinfecting farms. Each farm was individually fenced, had its own changing and shower rooms for personnel and vehicles. Individual farm houses were raised floor type (1.5 to 2 m) with wooden slatted flooring and open sided equipped with automatic feeders and drinkers. The broiler chicks were housed at a stocking density of about 9-10 bird/m^2. The vaccination programmes included the combinations against Newcastle disease (B1B1 strain) - Infectious Bronchitis (H120 strain) coarse spray vaccination at day 1 of age, Infectious Bursal Disease (IBD) intermediate strain in drinking water at day 7, IBD intermediate-hot strain in drinking water at day 14 and Newcastle disease (Lasota strain) in drinking water at day 2 1.

Sample submission and tests

Live birds and fresh organs collected during the outbreaks as well as during the weekly flock health, assessed either as normal or non-healthy broilers in each age group (Kiers *et al.*, 1991) were submitted to the Veterinary Research Institute and the Faculty of Veterinary Medicine, University Putra Malaysia. Organ samples included liver, pancreas, proventriculus, spleen, gizzard, lungs in 10% formalin as well as sciatic nerves and brain in 40% formalin. Feed samples were screened for mycotoxins and subjected to mould and yeast counts whilst water samples were screened for colifonns and *Salmonella*.

Serum samples taken at Day- 1, 3 weeks and 6 weeks of age were screened for Newcastle Disease (ND), Infectious Bronchitis (IB), Infectious Bursal Disease (IBD), *Mycoplasma gallisepticum (Mg), Mycoplasma synoviae* (MS) and Avian Encephalomyelitis (AE) using ELISA (Proflok; Kirkeland Perry and Guard) and AE-Agar Gel Immunodiffusion Test (AGID). Blood glucose level was determined using the Elite Glucometer test strips (Bayer). Five blood samples each from the clinically normal and affected birds in breeder flocks of various ages, which had good AE vaccination titres, were tested. The blood was collected at a fixed time between 2-4 p.m.

RESULTS

Disease prevalence

In October 1994, spiking mortality of over 0.3% per day for 3 consecutive days was observed in the 10 to 14-day old chicks in 2 houses with capacities of 12,000 birds per house. The mortality rate was subsequently returned to normal levels of 0.02 to 0.04% per day. Clinical signs included weakness in 5 - 10% of the birds, dehydrated, ruffled feather or moribund, on sternal or lateral recumbency with a characteristic backward prostration of legs. Some birds showed apparent blindness, fine head tremors and ataxia. Diarrhoea was not consistent but an orange-coloured, mashed papaya consistency faeces was observed. Necropsy revealed liver congestion and enlargement with multiple foci of darkened areas, empty crops, partially filled gizzards with evidence of darkling beetles and larvae and orange-coloured mashed papaya consistency intestinal contents. The differential diagnoses included Avian Encephalomyelitis, mycotoxicosis, insecticide poisoning, vitamin deficiencies (thiamine or vitamin E), Inclusion Body Hepatitis and Spiking Mortality Syndrome.

A similar pattern of spiking mortality and clinical signs without specific temporal or spatial trends were intermittently observed in 1996 involving 1 - 2 houses per farm. Little investigative attention was given to these high mortality as the disease appeared to be self limiting and did not appear to significantly affect production efficiency while necropsy, bacteriology, virology and pathology findings failed to attribute significant findings.

However, in the period from January to March 1997 (Period I), the syndrome was observed again in eight flocks comprising a total of about 1 million broilers, affecting 37% of the houses in the broiler complex (Fig. 1; Tables 1 and 2). Seven of the eight affected flocks (88%) demonstrated spiking mortality (at least 3 consecutive days of high mortality of at least 0.3%) in 2-3 week-old chicks. Peak mortality spikes were observed at 0.4% per day, which was significantly above the expected mortality of 0.03-0.04% per day at this age group.

From April to July 1997 (Period II), 71% of the houses were affected with spiking mortality averaging 0.8% per day for at least 3 days involving 16 consecutive flocks with about 2 million heads of broilers. Approximately 94% involved 2-3 week-old broilers. In addition, the spiking mortality episode was no longer limited to a single spike of mortality in 2-3 week-old broilers but was observed to occur for a second and third time in 6 flocks and 1 flock respectively in the lifespan of a broiler cycle (Table 1). About 44% and 25% of the 16 flocks showed spiking mortality at 3-4 and 4-6 weeks respectively. One flock, however, had a sustained mortality from day 15 to finish with a maximum of 0.7% mortality a day and an average mortality of 0.25% per day.

The disease prevalence in the other 13 flocks with 1.8 million broilers between July to October 1997 (Period III) was significantly reduced. Only 4.5% of the houses were affected with 54% of flocks showed mild incidence of fine head tremors in 2-3-week old birds. Peak mortality was reduced to 0.03% per day. Multiple spikes in mortality exceeding 0.3% per day for 3 consecutive days were no longer observed.

Table 1: Disease prevalence and characteristic of head tremor in farms with 3 to 4 successive grow-outs

Farm	Cycle 1		Cycle 2		Cycle 3		Cycle 4	
	Age (day) SMS was observed	Degree of head tremor observed	Age (day) SMS was observed	Degree of head tremor observed	Age (day) SMS was observed	Degree of head tremor observed	Age (day) SMS was observed	Degree of head tremor observed
C2	12-18	mild	14-19	mild	14-21	mild	*None	-
			25-28	mild	25-28	mild		
B1	11-16	severe	13-18	severe	12-15	severe	*None	-
					20-25	severe		
					28-32	Severe		
A4	7-16	none	15-20	severe	14-19	severe	*None	-
			28-35	severe	21-28	severe		
B2	10-15	moderate	15-end	severe	14-21	severe	*None	-
A3	16-24	moderate	17-22	moderate	*None	-	None	-
A1	28-40	moderate	14-21	severe	*None	-		
C4	10-19	mild	19-27	mild	14-21	mild	*14-21	mild
C3	14,21	mild	14-21	mild	*None	-	None	-
A5	14-18	severe	14-21	severe	*None	-	-	-
	25-30	severe	27-32	severe				
A2	-	-	12-16	mild	14-21	mild	-	-

*Initiation of enhanced disinfection and vector control programme

Table 2: Percentage of the affected house, peak mortality, age of occurrence and degree of fine head tremor in broilers affected by SMS

Period	Date of chick Intake	% house affected	Peak mortality (%/day)	% occurrence of SMS Week 2-3	Week 3-4	Week 4-6	% degree of tremor None	Mild	Moderate	Severe
I	01/97-03/97	36.5	0.39	88	-	13	12.5	37.5	37.5	12.5
II	04/97-07/97	70.6	0.79	94	44	25	0	37.5	6.3	56.3
III	07/97-10/97	4.5	0.03	38	-	-	46.0	53.8	-	-

Clinical signs

Fine head tremors were observed in 87.5% and in 100% of the broiler houses in Periods I and II respectively. The fine head tremor could be classified into 3 categories; the mild (<5%), moderate (5 - 10%) and severe (>10%). Mild head tremor was observed in 38% of houses in Periods I and II. Severe head tremor was observed in 12.5 and 56% of the houses in Periods I and II respectively. Houses, which had history of spiking mortality, had a recurrence of the disease in the following cycle with either equal or greater severity in the rate of mortality and head tremors (Table 1).

Histological findings

Histopathological examinations of the brain, proventriculus, pancreas and gizzard ruled out AE. Although fluorescent antibody technique (FAT) and AGID detected AE virus in one of the samples, no histological lesions consistent with AE were observed. Histopathological examination was also used to rule out Inclusion Body Hepatitis (IBH), nutritional deficiencies and insecticide toxicity. Meningitis was diagnosed in one case whilst tymphoid infiltration of the proventriculus was reported in another one case.

Of the 6 samples submitted in October 1997, necrosis of the cerebral cortex and cerebellar Purkinje cell (3/6), mild non-suppurative encephalitis (4/6), non-suppurative iridocyclitis (2/6) and non-suppurative retinitis (1/6) were diagnosed. Bursal cells atrophy (6/6) was a consistent finding, which was expected as intermediate hot vaccines were used in the farm. Other histopathological findings included dilatation of the jejunal wall with oedema of the villi and cellular infiltration in the lamina propria, and liver necrosis.

Microbiological findings

Bacteriological and parasitological findings included isolations of *Pasteurella multocida, Staphylococcus aureus, Escherichia coli* and the presence of *Leucocytozoon* spp. in a few cases. Reovirus was isolated in a bird. A filterable (<50 nm) non-enveloped virus particle and the chicken anaemia agent virus were also isolated.

Disease impact on performance

The impact of the disease syndrome on flock performance including body weight, feed conversion ratio (FCR), percent depletion and European production efficiency factor (EPEF) were evaluated over the three periods (Table 3). Broiler birds at a market weight of 1.8 to 2.0 kg live weight were between 90 and 120 grams lighter and with lower feed/gain ratio of between 0.22 and 0.24 points. Percent depletion was between 3.7 and 4.3% lower and the overall EPEF performance was between 30 and 45 points lower.

Blood analysis

A glucose profile of 10 clinically affected 14-day-old broilers in June 1996 showed a mean glucose level of 139±138 mg/dL). Approximately 70% of the chicks sampled in the initial outbreak were considered hypoglycaemic (<150mg/dL).

Blood glucose, determined during Period II showed unaffected broilers at days 10 to 30 had glucose levels ranging from 204 to 277 mg/dL (mean 229 mg/dL). Affected birds were hypoglycaemic with glucose levels ranging from 52 to 92 mg/dL (mean 71 mg/dL) (Table 4). Blood glucose level in unaffected chicks during Period III (August 1997) showed an average glucose level of 258 mg/dL (Table 4).

Control measures

Unidentified infectious agent(s) were postulated to have attributed to this syndrome. The agent(s) were not eliminated despite cleaning and disinfecting the houses. The presence of black darkling beetles and their larvae *(Alphitobius diaperinus)* in the crops and gizzards and in the brooding litter of wood shavings, especially under the feeder trays and bell drinkers as well as under the water drinking nipples, were a suspected link to the disease syndrome. From late June 1997, modifications were made on the management practices, which included tight supervision of cleaning and washing of houses, disinfecting and insecticidal spray (synthetic pyrethroids) on the interior and exterior of the houses. The cleaned houses were also partially fumigated with formalin, followed by final disinfection of brooding area prior to chick intake. The darkling beetle and larvae populations were markedly reduced after the use of insecticides.

Table 3: Impact of SMS on performance of broiler at market

Period	Depression in bodyweight (kg)	Depression in FCR	% depletion	EPEF depression
I	0.09±0.12	0.22±0.18	3.7±2.6	30.4±22.5
II	0.12±0.09	0.24±0.24	4.3±4.0	44.7±20.6
III	0.05±0.08	0.05±0.07	0.8±1.6	11.3±17.8

Table 4: Average glucose levels (mg/dL) in chicks of uninfected house and in the clinically normal and affected chicks of affected house

Age of birds (days)	Unaffected house	Affected house	
		Clinically normal	Clinically affected
10	384.6±129		
14		276.8±31	54.8±7
15	239±90.5	217.4±24	66.0±35
18		235.7±30	54.1±2
19		155.0±43	88.0±83
20	202.2±29		
25	231.0±28		
30	231.0±11	208.0±21	76.4±53
Mean	257.7	228.8	71.0

Brooding practices that could contribute to the health of chicks, such as stress, underfeeding and chilling of young birds, were reviewed. The role of vaccination stress was also considered as a predisposing factor to the disease syndrome as the birds had to endure 4 vaccinations over a period of 21 days. Management measures undertaken to alleviate stress included delaying the removal of brooding material by 2 to 3 days, improving ventilation (brooding curtains control) and additional glucose and vitamin supplementation between 14 and 21 days of age.

DISCUSSION

Davies *et. al.* (1997) reported that a diagnosis of SMS can be made when high mortality (>0.5% per day) for 3 consecutive days with concurrent fine head tremor and hypoglycaemia are observed. The retrospective study in this broiler complex revealed the 'hypoglycaemic-spiking mortality syndrome' episodes over a three-year period. This syndrome did not appear to cause much economic damage initially but as time progressed, the increased prevalence and intensity of economic damage and depression in performance warranted serious action. Poor farm sanitation, high litter beetle *(Alphitobius diaperinus)* and rodent population in poultry houses had also been implicated and played a role in maintaining infection in the houses (Davies *et. al.,* 1995a, 97). The impact of this syndrome was shown to be moderated by intensified vector, sanitation and disinfection practices.

The disease syndrome observed in this study was in agreement with the studies of Davies *et al.,* (1995a). The two forms of the disease reported by Davies *et al.* 1995a) were also observed in this study. Type A form is a more severe but of shorter duration than Type B, which is a milder form occurring over a longer period. Davies *et al.,* (1995a) reported that hypoglycaemia is the apparent physiological basis for the development of the central nervous system (CNS) signs because chicks with CNS signs are histologically normal. The significance of brain lesions, however, is in contrast with Davies *et al.* (1995 a, b, c) who reported that no lesions were observed in chicks with the syndrome.

The normal and fasting glucose levels in 2-week old broiler birds were reported to be in the range of 241-265 mg/dL (180 - 240 mg/dL fasting) in broilers and broiler breeders (Davies *et. al.,* 1995a). Ross (1978), however, reported that the 95% percentile of glucose levels in broilers is between 110 and 228 mg/dl with a lower mean of 167 mg/dl.

The cause of hypoglycaemia is related to pancreatic dysfunction, as it is unable to produce sufficient glucagon to maintain the glucose level when the birds are fasted or stressed. Death occurs due to hypoglycaemia. Studies have also shown that the disease cannot be replicated in controlled-kept broiler chicks exposed to cold stress and starvation in the absence of the artificial gavage of suspected infected material.

Other factors believed to contribute to the syndrome include rancid feed and diets that contain high levels of products that are labile to oxidation, insufficient vitamins, particularly thiamine or vitamin E (Davies *et al.,* 1995a, 97). Lighting programmes have been shown to reduce the incidence of the syndrome (Davies and Vasilatos-Younken, 1995).

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RINGKASAN

SINDROM KEMATIAN HIPOGLISEMIA-RUNCING (SMS) DALAM AYAM PEDAGING

Satu kajian retrospektif yang dijalankan dalam sebuah kompleks terdiri daripada 10 buah ladang semua-masuk-semua-keluar menunjukkan kematian pada ayam pedaging berumur 10-14 hari yang memaparkan sindrom kematian runcing cirian pada bulan Oktober 1994. Kadar kematian ini melebihi 0.3% selama sekurang-kurangnya 3 hari berturutan dengan melibatkan 2 rumah ayam yang mengandungi 12,000 ekor ayam per rumah. Kematian ini diiringi oleh gigil kepala halus, buta nyata, ataksia, koma dan maut. Di antara 5-10% daripada ayam ini nampak lemah dengan kakinya melunjur ke belakang. Tinja berwarna oren berkonsistensi betik lenyet telah dicerap. Tanda lesi post-mortem tererti dicerapkan. Berikutannya, bermula pada tahun 1995, kekerapan dan keterukan sindrom ini didapati meningkat. Pada tahun 1997, penyakit ini dicerapkan berlaku pada 37 kumpulan pusingan berturut dengan melibatkan 4.8 juta ekor ayam yang menunjukkan kadar kematian setinggi 0.8% per hari. Penyakit ini juga berlaku dalam ayam berumur 3-4 dan 4-6 minggu. Ayam berkesan klinikal adalah berhipoglisemia (glukosa darah 71.0 mg/dL; julat normal ialah 52-92 mg/dL). Prestasi ayam pedaging ini merosot sekadar 90-120 g berat badan pada masa sembelih tetapi menunjukkan peningkatan nisbah makanan/tambah berat badan sekadar 0.22-0.24. Prosedur pengurusan penokok melalui pembersihan, penyahjangkitan, kawalan vektor dan pengurangan tekanan pada ayam adalah berkesan dalam mengurangkan keterukan sindrom ini.