

# Necrotic Enteritis in Broiler Chickens

## I. A Review of the Literature and the Prevalence of the Disease in Ontario

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### ABSTRACT

The available literature on necrotic enteritis in broiler chickens is reviewed.

The records of three poultry diagnostic laboratories in Ontario were examined for the years 1969, 1970 and 1971. During this period 855 (7.7%) of 11,076 consignments of broiler chickens examined were diagnosed as necrotic enteritis. The condition was most common in broilers at three weeks of age, with 66% of all cases occurring in chickens between two and four and one half weeks. The disease occurred throughout the year but it was most common during July, August, September and October. Necrotic enteritis often occurred more than once per year on a farm.

### RÉSUMÉ

L'auteur présente une revue de la littérature actuellement disponible sur l'entérite nécrotique des poulets de grill, ainsi qu'un aperçu des statistiques de trois laboratoires de diagnostic des maladies aviaires de l'Ontario, pour les années 1969, 1970 et 1971. Au cours de cette période, on examina 11,076 envois de poulets de grill et on diagnostiqua l'entérite nécrotique dans 855 d'entre eux (7.7%). La condition affectait surtout les oiseaux âgés d'environ trois semaines; on diagnostiqua 66% des cas chez des sujets dont l'âge variait de deux à quatre semaines et demie. La maladie sévissait tout au long de l'année, mais surtout en juillet, août, septembre et octobre. On l'observa souvent plus qu'une fois par année, sur une même ferme.

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### INTRODUCTION

Since necrotic enteritis (NE) was first reported in 1961 (12), it has become an important disease of broiler chickens in several countries of the world. Although the condition can be controlled with appropriate antibiotics, its etiology has not been established nor has the disease been satisfactorily reproduced.

This paper consists of two parts: a review of the literature on NE and a compilation of the prevalence of NE using the records of the three largest poultry diagnostic laboratories in Ontario over a period of three years.

### REVIEW OF LITERATURE

Necrotic enteritis was first reported in 1961 by Parish from a flock of six to seven week old cockerels in England (12). He considered the disease an enterotoxemia due to *Clostridium welchii* (*C. perfringens*). Since then the condition has been reported from Australia (1, 6, 10), Canada (3, 8), United States (4, 7) and Sweden (11).

### CLINICAL OBSERVATIONS

The condition occurs almost exclusively in broiler chickens. Several authors report the disease to be most common from two to six weeks of age (1, 3, 6, 8), but Nairn and Bamford (10) found the condition in broilers seven weeks of age and Helmboldt and Bryant found NE in birds up to 11 weeks of age (7). Data on morbidity are not available. Since sick birds die very quickly, limited clinical information has been recorded. Sick birds are depressed with ruffled feathers and are often huddled close to a heat

source. In a more advanced stage they are limp, lying in lateral recumbency. When picked up fluid frequently runs from the mouth and the crop is often distended with gas and fluid. At this stage the birds usually die within a few hours (7).

The daily mortality rate in an outbreak rises suddenly. Julian (8) studied several cases of NE and lists mortality at 0.1% to 0.5% per day. Connecticut workers, (7), reporting data from 75 field outbreaks in Maine and Connecticut, noted that deaths occurred for about a week with the mortality rate rarely exceeding 1% per day. Mortality is usually restricted to one floor in a barn and the condition can occur more than once on a farm.

#### ROLE OF *C. PERFRINGENS* IN NE

Parish isolated *Clostridium welchii* from the small intestine in 27 of 34 birds studied (12) and these isolates were considered to be *C. welchii* type F (13). Organisms were not seen in smears or isolated from any other body tissue. Isolates originally considered type F are now included in type C (18). No other significant organisms were found on aerobic culture from any body tissue. Filtered saline extracts from intestinal contents of diseased birds killed chickens and mice when inoculated intravenously and these extracts were neutralized by *C. welchii* type B or C antitoxin (12).

Nairn and Bamford (10) studied six isolates of *C. perfringens* from field cases but were unable to type them because of insufficient toxin production. Filtrates from diseased chicken intestines did not kill mice when injected intravenously. *C. perfringens* is considered to be the only bacterium of significance isolated from lesions of necrotic enteritis or seen in smears from intestinal lesions (1, 6, 8, 12). Six isolates collected from field cases were found to be *C. perfringens* type A (8) but the role of this type in NE is unclear, since *C. perfringens* type A is ubiquitous (20). However Smith (16) states, "*C. welchii* has an important association with necrotic enteritis of chickens".

When present in the intestine of normal chickens *C. perfringens* is recorded only in low numbers (2, 19).

There are no reports of pathogenic virus being isolated from this disease, although isolation from feces was attempted (12).

#### THE ROLE OF NUTRITION AND MANAGEMENT IN NE

Certain physiological factors are considered by some poultry workers to play a role in the etiology of NE. Although often considered, there are no data to suggest that necrotic enteritis is more common in broilers of any particular genetic composition. The high energy-high protein ration fed to broilers has often been suspected of playing a role in this disease. In Australia, Nairn and Bamford (10) studied several outbreaks of NE associated with one brand of commercial feed, but its composition was not made available. However, when Barnes *et al* (2) fed diets containing either 9% or 25% fish meal they saw no intestinal lesions; changes in the intestinal bacterial flora of the birds from two to six and one half weeks of age were not related to diet.

Coccidia are considered, by some avian pathologists, to be associated with the etiology of this disease, but at present, there is no experimental evidence to support this suggestion. In field cases oocysts are not always seen, and when present in the tissue or on scrapings they are usually found only in low numbers, a finding common in most broilers submitted for examination (8, 10). Oocysts of *Eimeria maxima* and *Eimeria brunetti* were seen in intestinal tissue sections (7), but the severity of the protozoan infection was not stated.

Coccidiostats are often considered significant in the etiology of NE, presumably because most, if not all, broiler chickens consume coccidiostats in their diet throughout life. However, there is no published evidence to support this role. It has been shown (9) that the common coccidiostats do not suppress intestinal motility, a fact that could be important in the etiology of NE.

#### ATTEMPTED REPRODUCTION OF NE

There are only a few publications on the attempted reproduction of NE, but the results are not overly convincing. Parish dosed birds orally with a broth culture of his isolates of *C. welchii*, but failed to produce the disease by this method. He did produce lesions in two of five birds (14) dosed with *C. welchii* type F and given opium, calcium carbonate and sodium bicarbonate for seven days. In two experiments Nairn and Bamford produced intestinal lesions in seven of 79 three week

old birds by oral administration of *C. perfringens* from field cases to birds on a commercial diet associated with NE (10). The organism was recovered in pure culture from the experimental intestinal lesions but intestinal filtrates failed to kill mice. One report (3) stated that necrotic enteritis was reproduced experimentally when chickens were inoculated intravenously with broth cultures of *C. perfringens*, probably type A.

seen in the tissue sections (12). On histopathological examination, intestinal lesions (7) consisted of necrotic and diphtheritic enteritis and in the lumen of the small intestine a mixture of dead epithelial cells was trapped in fibrin; bacterial colonies, chiefly gram positive, were common. Villos tips were absent and the lamina propria contained a moderate number of non-granulocytic phagocytic cells (7).

**PATHOLOGY**

The gross and microscopic lesions of necrotic enteritis have been described (7, 12). Helmboldt and Bryant observed gross lesions only in the small intestine (7). In the outbreak examined by Parish (12) intestinal lesions were confined to that area of the small intestine caudal to the duodenum, and one large or several small lesions could be present. Each necrotic area was sharply demarkated from the adjacent normal mucosa. The small intestine was distended with gas and a brown coloured fluid and the walls were usually friable. Liver necrosis was observed but bacteria were not

**TREATMENT**

In field cases the disease normally responds well in 24 to 48 hours to oral treatment with a nitrofurantoin or one of a variety of antibiotics. Several workers (3, 6, 10, 13) have reported the results of *in vitro* sensitivity tests on *C. perfringens* isolates. With rare exception (10), isolates were sensitive to penicillin, bacitracin and chloramphenicol. Not all isolates were sensitive to the tetracyclines. Smith (17) dosed day-old chicks orally with *C. perfringens* isolates from cases of necrotic enteritis and conducted *in vivo* sensitivity tests. He found that a number of antimicrobial agents

**TABLE I. The Occurrence of Necrotic Enteritis from all Veterinary Diagnostic Laboratories in Ontario During a Three Year Period\***

| Year | Total chicken consignments | No of consignments diagnosed as NE | Percent |
|------|----------------------------|------------------------------------|---------|
| 1969 | 9,247                      | 375                                | 4.0     |
| 1970 | 10,084                     | 326                                | 3.2     |
| 1971 | 9,105                      | 338                                | 3.7     |
|      | 28,436                     | 1,039                              |         |

\*These data were calculated from yearly reports compiled by Dr. R. C. Topp

**TABLE II. Total Broiler Consignments for Three Laboratories and Number of Consignments Diagnosed as NE and Percentage for a Three Year Period**

| Laboratory | Year | No of broiler consignments | No consignments diagnosed NE | Percent |
|------------|------|----------------------------|------------------------------|---------|
| A          | 1969 | 321                        | 43                           | 13.4    |
|            | 1970 | 471                        | 23                           | 4.8     |
|            | 1971 | 506                        | 14                           | 2.4     |
| B          | 1969 | 2,082                      | 90                           | 4.3     |
|            | 1970 | 905                        | 59                           | 6.5     |
|            | 1971 | 725                        | 68                           | 9.3     |
| C          | 1969 | 1,513                      | 107                          | 7.1     |
|            | 1970 | 2,029                      | 212                          | 10.4    |
|            | 1971 | 2,524                      | 239                          | 9.4     |
|            |      | 11,076                     | 855                          |         |

when added to the ration decreased the clostridial count in the feces of birds after they consumed the medicated feed for one day. In some areas, at the present time, an antibiotic is added to the feed of broiler chickens for the first month of life to prevent necrotic enteritis.

**COMPARISON OF NECROTIC AND  
ULCERATIVE ENTERITIS**

Ulcerative enteritis (Quail disease) in contrast to NE, occurs in chickens, turkeys, and a variety of upland birds of which quail are extremely susceptible (15). Peckham (15) had isolated a gram positive spore-forming bacillus from the blood, liver and intestines of birds with this disease. The disease can be reproduced by feeding feces or ground up intestines and by feeding or injecting yolk sac cultures. Using quail as biological indicators, Davis, Brown and Dawe (4) were able to reproduce ulcerative enteritis in quail by feeding them intestines from cases of ulcerative enteritis, but were unable to reproduce necrotic enteritis when they fed quail intestines from chicken with necrotic enteritis. Ulcerative enteritis is confined to the ileum and cecum where it causes focal lesions, usually ulcers, which frequently penetrate the intestinal wall causing focal peritonitis (7). Helmboldt

and Bryant (7) were prompted to conclude that these two conditions (ulcerative enteritis and necrotic enteritis) are far more similar in nomenclature than in lesions.

**PREVALENCE OF NECROTIC  
ENTERITIS IN ONTARIO**

**COLLECTION OF DATA**

The data presented here were collected from the records of the three largest poultry diagnostic laboratories in Ontario and cover a three year period from 1969-1971. Laboratories A and B are operated by the Veterinary Services Branch of the Ontario Ministry of Agriculture and Food. Laboratory C is a commercial laboratory operated by a drug company. Only those diagnostic records covering broiler chickens were utilized and for each consignment the date, age of birds, number of birds, results of coccidia examination, diagnosis and owner's name and address were recorded. The number of dead and living birds submitted per consignment averaged approximately six. Often more than one diagnosis was made per consignment. The broiler population in the areas served by the three laboratories is not known.

**TABLE III. Age of Broiler Chicken Consignments Diagnosed as NE from Three Laboratories over Three Years**

| Lab         | Year | Number of consignments diagnosed as NE |    |     |    |     |    |                |                |    |    |    |   | Total |     |     |
|-------------|------|--|----|-----|----|-----|----|----------------|----------------|----|----|----|---|-------|-----|-----|
|             |      | Age of broilers in half-weeks          |    |     |    |     |    |                |                |    |    |    |   |       |     |     |
|             |      | 2                                      | 3  | 4   | 5  | 6   | 7  | 8 <sup>a</sup> | N <sup>b</sup> |    |    |    |   |       |     |     |
| A.....      | 1969 | 1                                      | 2  | 12  | 10 | 4   | 1  | 2              | 0              | 4  | 0  | 3  | 1 | 3     | 43  |     |
|             | 1970 | 0                                      | 2  | 5   | 3  | 4   | 0  | 2              | 1              | 5  | 0  | 0  | 0 | 1     |     | 23  |
|             | 1971 | 0                                      | 1  | 6   | 3  | 2   | 1  | 0              | 0              | 1  | 0  | 0  | 0 | 0     |     |     |
|             |      | 1                                      | 5  | 23  | 16 | 10  | 2  | 4              | 1              | 10 | 0  | 3  | 1 | 4     | 80  |     |
| B.....      | 1969 | 10                                     | 2  | 24  | 4  | 21  | 0  | 8              | 4              | 7  | 0  | 6  | 1 | 2     | 90  |     |
|             | 1970 | 2                                      | 2  | 26  | 8  | 9   | 1  | 4              | 3              | 2  | 1  | 1  | 0 | 0     |     | 59  |
|             | 1971 | 4                                      | 11 | 19  | 6  | 7   | 5  | 3              | 0              | 8  | 0  | 1  | 0 | 0     |     |     |
|             |      | 16                                     | 15 | 69  | 18 | 37  | 6  | 15             | 7              | 17 | 1  | 8  | 1 | 2     | 5   | 217 |
| C.....      | 1969 | 6                                      | 5  | 18  | 9  | 17  | 5  | 11             | 4              | 4  | 0  | 6  | 2 | 19    | 107 |     |
|             | 1970 | 9                                      | 11 | 43  | 12 | 35  | 6  | 26             | 4              | 15 | 6  | 18 | 2 | 23    |     | 2   |
|             | 1971 | 14                                     | 13 | 57  | 30 | 41  | 18 | 14             | 10             | 14 | 3  | 10 | 2 | 5     |     |     |
|             |      | 29                                     | 29 | 118 | 51 | 93  | 29 | 51             | 18             | 33 | 9  | 34 | 6 | 47    | 11  | 558 |
| Totals..... |      | 46                                     | 49 | 210 | 85 | 140 | 37 | 70             | 26             | 60 | 10 | 45 | 8 | 53    | 16  | 855 |

<sup>a</sup>Eight weeks of age and older  
<sup>b</sup>Age not given

In laboratories A and B the gross diagnosis of NE was confirmed by histopathology and the examination of gram-stained smears and anaerobic bacteriological culture. In laboratory C the gross diagnosis was less frequently supported by histopathology and bacteriology. In each laboratory smears were made from intestinal scrapings of one or more birds of many consignments and examined for the presence of coccidia. There were two vet-

erinarians in each laboratory who were responsible for all diagnostic reports.

#### INTERPRETATION OF DATA

During each of the years 1969, 1970 and 1971, three to four percent of all chicken consignments in the province of Ontario were diagnosed as necrotic enteritis (Table I). These results do not reflect the true prevalence of NE since the total chicken

**TABLE IV. The Percentage of 855 Broiler Consignments of Various Ages Diagnosed as NE and the Cumulative Percentage from Three Laboratories over Three Years**

| Age (half-weeks) | Consignments of each age diagnosed as NE | Percentage of total NE consignments | Cumulative percentage |
|------------------|--|-------------------------------------|-----------------------|
| 2                | 46                                       | 5.3                                 | 5.3                   |
|                  | 49                                       | 5.7                                 | 11.0                  |
| 3                | 210                                      | 24.5                                | 35.5                  |
|                  | 85                                       | 9.9                                 | 45.4                  |
| 4                | 140                                      | 16.3                                | 61.7                  |
|                  | 37                                       | 4.3                                 | 66.0                  |
| 5                | 70                                       | 8.1                                 | 74.1                  |
|                  | 26                                       | 3.0                                 | 77.1                  |
| 6                | 60                                       | 7.0                                 | 84.1                  |
|                  | 10                                       | 1.1                                 | 85.2                  |
| 7                | 45                                       | 5.2                                 | 90.4                  |
|                  | 8  | 0.9                                 | 91.3                  |
| 8 <sup>a</sup>   | 53                                       | 6.2                                 | 97.5                  |
| N <sup>b</sup>   | 16                                       | 1.8                                 | 99.3                  |
|                  | 855                                      | 99.3                                | 99.3                  |

<sup>a</sup>Eight weeks of age and older

<sup>b</sup>Age not given

**TABLE V. Month of Submission of 855 Consignments of Broilers Diagnosed as NE from Three Laboratories during 1969, 1970 and 1971**

| Lab    | Year | Month of submission |    |    |    |    |    |     |     |    |    |    | Total |     |
|--------|------|---------------------|----|----|----|----|----|-----|-----|----|----|----|-------|-----|
|        |      | J                   | F  | M  | A  | M  | J  | J   | A   | S  | O  | N  |       | D   |
| A      | 1969 | 2                   | 1  | 6  | 2  | 6  | 0  | 6   | 2   | 5  | 7  | 4  | 2     | 43  |
|        | 1970 | 4                   | 1  | 4  | 1  | 0  | 4  | 1   | 1   | 3  | 0  | 0  | 4     | 23  |
|        | 1971 | 0                   | 1  | 1  | 0  | 0  | 1  | 0   | 2   | 4  | 0  | 4  | 1     | 14  |
|        |      | 6                   | 3  | 11 | 3  | 6  | 5  | 7   | 5   | 12 | 7  | 8  | 7     | 80  |
| B      | 1969 | — <sup>a</sup>      | —  | —  | —  | 2  | 4  | 17  | 23  | 16 | 16 | 1  | 11    | 90  |
|        | 1970 | 9                   | 4  | 12 | 2  | 5  | 8  | 0   | 6   | 4  | 3  | 3  | 3     | 59  |
|        | 1971 | 3                   | 4  | 2  | 4  | 6  | 4  | 7   | 14  | 7  | 5  | 4  | 8     | 68  |
|        |      | 12                  | 8  | 14 | 6  | 13 | 16 | 24  | 43  | 27 | 24 | 8  | 22    | 217 |
| C      | 1969 | 0                   | 3  | 5  | 5  | 6  | 6  | 15  | 14  | 8  | 10 | 22 | 13    | 107 |
|        | 1970 | 14                  | 14 | 11 | 16 | 16 | 28 | 26  | 26  | 18 | 14 | 11 | 18    | 212 |
|        | 1971 | 12                  | 9  | 24 | 21 | 19 | 17 | 28  | 23  | 25 | 30 | 14 | 17    | 239 |
|        |      | 26                  | 26 | 40 | 42 | 41 | 51 | 69  | 63  | 51 | 54 | 47 | 48    | 558 |
| Totals |      | 44                  | 37 | 65 | 51 | 60 | 72 | 100 | 111 | 90 | 85 | 63 | 77    | 855 |

In 1969, NE first recorded in May

consignments are included rather than only meat-type birds (broilers) which are the ones at risk.

In the three laboratories 855 of 11,076 broiler chicken consignments (7.7%) were diagnosed as NE (Table II). There is considerable variation from year to year and this is especially true for laboratory A where the percentage dropped from 13.4 in 1969 to 2.7 in 1971. In each laboratory NE was most common in birds three weeks of age (Table III). The cumulative percentage shows that two-thirds of all cases of NE occurred in broilers between two and four and one half weeks of age (Table IV). Totals from the three laboratories show a noticeable increase of cases in late summer and early fall (Table V). This is less noticeable for laboratory A than for the other two.

The 855 consignments diagnosed as NE involved 755 "outbreaks" and 541 "farms" (Table VI). Thus during some outbreaks more than one consignment was submitted. NE can occur more than once per year on a farm, since 541 farms yielded 855 consignments giving an average ratio of 1.6 consignments per farm (Table VI). From available records it was impossible to learn whether NE when it occurred more than once on a farm, occurred in the same broiler house or even on the same floor as previously.

Sixty-one percent (522) of all positive cases of NE (855) were examined for coccidia, of these one-quarter (130) were negative and the remainder were positive

for oocysts. Most of these were designated as 1+ or 2+, indicating that coccidial oocysts were present in intestinal smears only in small numbers. A few smears were designated 3+ or 4+ indicating a more severe infection. In most cases the coccidia were not identified as to species.

The etiology of necrotic enteritis in broiler chicks is not, at present, understood nor can the condition be satisfactorily reproduced (10, 14), although the anaerobic bacterium *Clostridium perfringens* is associated with the intestinal lesions (8, 13, 16). The fact that rapidly growing birds die so quickly is highly suggestive of an enterotoxemia. It is well known that the condition responds readily to antibiotics such as penicillin or bacitracin to which virtually all isolates of *C. perfringens* are susceptible *in vitro*.

It is often suggested by broiler growers and avian pathologists that coccidia and/or coccidiostats may play a role in the etiology of NE. Helmboldt and Bryant (7) suggest that coccidia may slow intestinal motility but they did not have experimental evidence to prove it. Julian (8) did not find oocysts in every case of NE and a quarter of the examined cases of NE in this study were negative. It has been shown that several of the commonly used coccidiostats do not reduce intestinal motility (9).

It is possible that the heavy consumption of a high energy-high protein ration may impair intestinal motility in some birds. It is well known that factors reducing intestinal flow in mammals can allow rapid mul-

**TABLE VI. Consignments of Broilers from Three Laboratories Diagnosed as NE and Expressed in Terms of Outbreaks and Farms of Origin over a Three Year Period**

| Laboratory | Year | Number of consignments diagnosed as NE <sup>a</sup> | Number of outbreaks <sup>b</sup> | Number of farms <sup>c</sup> | Ratio: consignments/farms |
|------------|------|---|----------------------------------|------------------------------|---------------------------|
| A.....     | 1969 | 43  | 30                               | 22                           | 1.9                       |
|            | 1970 | 23  | 23                               | 18                           | 1.2                       |
|            | 1971 | 14  | 14                               | 13                           | 1.0                       |
| B.....     | 1969 | 90  | 82                               | 69                           | 1.3                       |
|            | 1970 | 59  | 54                               | 45                           | 1.3                       |
|            | 1971 | 68  | 56                               | 42                           | 1.6                       |
| C.....     | 1969 | 107   | 100                              | 67                           | 1.5                       |
|            | 1970 | 212   | 184                              | 121                          | 1.7                       |
|            | 1971 | 239   | 212                              | 144                          | 1.6                       |
|            |      | 855   | 755                              | 541                          |                           |

<sup>a</sup>Each entry in the laboratory records diagnosed as NE is a consignment

<sup>b</sup>All consignments from a farm during a two week period constitutes one outbreak unless the age of the birds or the history indicate otherwise

<sup>c</sup>Each different owner's name in the laboratory records indicates a farm

tiplication of intestinal bacteria along with toxin production (5). One would expect similar findings in birds.

Why the disease is most common at three weeks of age (24.5%) is unclear. There is no specific change in management at this age. Also, there is no obvious reason why the disease appears most often in July, August, September and October, especially since the environment in modern broiler houses should change little throughout the year.

The fact that NE may occur on a farm more than once a year deserves consideration. In the author's experience NE often occurs only on one floor or in one pen of a broiler house while birds in the remainder of the house are unaffected. If the condition occurs in more than one crop of broilers per year on a farm, it would be important to know if it always occurred in the same section of the housing area. If it recurs in a specific housing area this would tend to rule out breeding and nutrition and suggest something specific in the environment.

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