

Systemic Consequences of Gut Health Problems and Barrier Failure

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SUMMARY

One common consequence of enteritis, regardless of its cause, is a breakdown in the intestinal barrier function that normally protects the animal against invasion by commensal and pathogenic gut microbiota. The objective of this poster is to discuss possible systemic consequences of the resulting bacterial translocation.

INTRODUCTION

Subclinical enteritis is an increasing problem in the poultry industry. It inevitably causes damage to the intestinal villi. Enteritis can be caused by a number of factors, including any of a variety of relatively mild parasitic, bacterial and viral infections as well as transient toxic challenges. The resulting oxidative stress can damage intestinal villus epithelial cells, resulting in the potential for systemic invasion by members of the gut microflora (Figure 1). Thus, studying the consequences of intestinal inflammation is to some extent independent of the causative factors. This poster will focus on enteritis and resulting systemic effects.

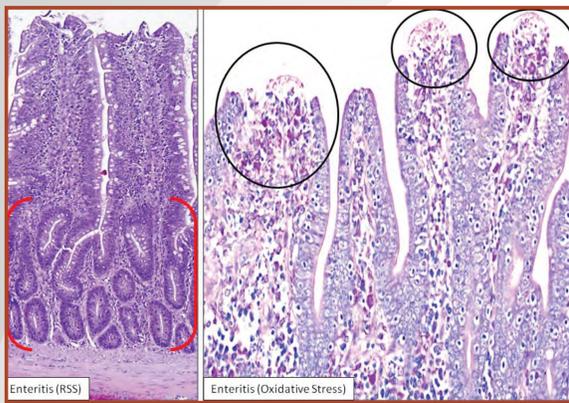


Figure 1: Villus and crypt damage in enteritis showing crypt hyperplasia (bracket) and villus tip damage (circles). 100x

DYSBACTERIOSIS

The gut of poultry has been demonstrated to undergo retrograde peristalsis (1, 2), carrying digesta, including the resident microbiota, from the colon or cecum into the ileum at any time. The cecal microbiota of poultry typically includes facultative anaerobes such as Clostridia that can enter a more rapid rate of growth in response to the nutrients available in the ileum. The ileum ideally has a relatively low availability of the amino acids required for *Clostridium perfringens* (CP) growth. However, feeding poorly digestible ingredients leads to a higher concentration of amino acids in the ileum and is one way to induce overgrowth of CP, referred to as dysbacteriosis, potentially resulting in gangrenous dermatitis (Figure 2). Figure 3 shows the pathology of the gut from the animal in Figure 2. In fact, the dysbacteriosis in this instance reached all the way up into the duodenum, showing necrotic enteritis with heavy submucosal contamination by Gram positive bacteria.

SYSTEMIC CONSEQUENCES

Intestinal barrier failure, particularly during an episode of dysbacteriosis can have disastrous effects on distant organs. The bacteremia results in contamination of many tissues by opportunistic pathogens in a state of abnormal proliferation and these can take advantage of the permissive conditions of distant sites. The resulting pathology can be life threatening to the animal. One example of this is the gangrenous dermatitis (3) shown in Figures 2 and 3.

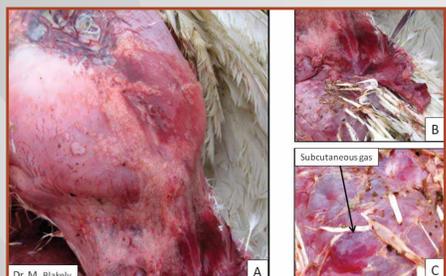


Figure 2: Gangrenous Dermatitis gross lesions showing (A) subcutaneous liquification of breast and (B) wing muscle and (C) subcutaneous emphysema typical of *Clostridium perfringens* under the skin on the ventral side.

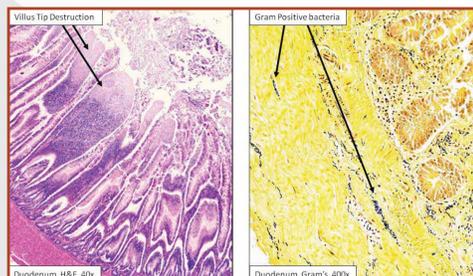


Figure 3: Duodenum from the animal in Figure 2 showing villus necrosis and Gram positive bacterial growth in the submucosa.

Another potential systemic effect of intestinal barrier failure is the lameness that is becoming a common problem in rapidly growing poultry such as broilers and turkeys. In fact, numerous investigators have reported isolating *Enterococcus cecorum* from spinal and leg lesions of lame birds or birds paralyzed by spondylitis (4, 5). Dr. Robert Wideman and his group have developed a wire model for the Bacterial Condroncrosis with Osteomyelitis (BCO)-associated is lameness (6) and connected it with intestinal barrier failure during dysbacteriosis by demonstrating that the lameness can be prevented significantly through the use of a stabilizing probiotic in the diet (7). Work done at Novus using a model system based on Wideman's also causes a high incidence of severe lameness (Figure 4). The gross and histopathology of those lesions is consistent with bacterial growth by Gram positive organisms like *Enterococcus* spp. The incidence and severity of the lameness is also ameliorated by including a probiotic, in this case SPORULIN®, a probiotic consisting of live *Bacillus subtilis* spores that are resistant to feed pelleting conditions (8). In this study, SPORULIN decreased the lesion severity of femoral and tibial heads by 14% and 25% respectively, in all necropsied birds including non-lame and lame birds. SPORULIN also increased the percentage of normal tibial heads by 40% in non-lame birds (8).

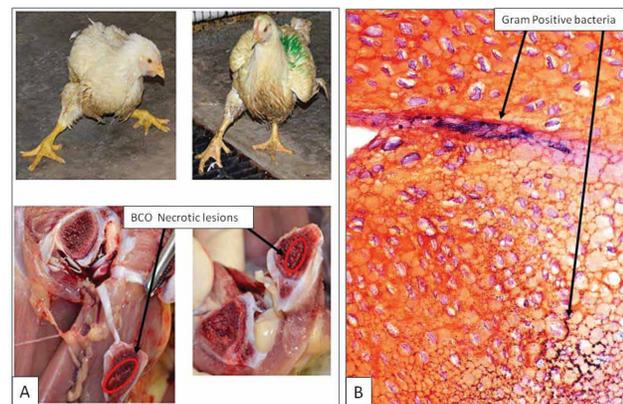


Figure 4: A. Lameness in birds under on wire flooring and under oxidative stress with associated Bacterial Condroncrosis with Osteomyelitis (BCO) lesions below the tibial growth plate (red circles). B. Gram's stain of tibial cartilage from lame birds showing Gram Positive bacteria that have colonized a cartilage crack and spread into the growth plate cartilage below. 400x

CONCLUSIONS

Intestinal barrier failure has numerous causes, but oxidative stress associated with dysbacteriosis should not be among them because it can be managed nutritionally. There are two very important ways to reduce the likelihood of systemic disease associated with bacterial translocation. First is the control of gut oxidative stress. The association between it and barrier failure means that antioxidant supplementation should always be a part of the formulation, even in diets supplemented with stabilized or fresh fat sources. The second way is to reduce the likelihood that when barrier failures occur, for example during the inevitable subclinical coccidiosis cycling, they will not result in translocation of such potentially deadly anaerobes as CP due to dysbacteriosis. This means that homeostasis of the normal gut microbial populations needs to be protected. Addition of antimicrobial organic acids or enzymes that improve nutrient availability and the inclusion of a probiotic to stabilize the normal gut microflora can have benefits beyond performance; it can eliminate rapid proliferation of CP and *Enterococcus* populations, reducing the likelihood that these will be disseminated by gut barrier failure from any cause, including subclinical enteritis.

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