DIAGNOSIS AND CONTROL OF COLITIS IN GROW-FINISH PIGS

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INTRODUCTION

Diarrhoea in growing pigs due to colitis is a major cause of financial loss to pig farmers and can lead to delays of 14 - 21 days in pigs reaching finishing weight. There are many causes of enteric disease in pigs from weaning to finishing, as shown in Table 1. These include infectious and non-infectious (or diet-associated) conditions. Some of the infectious causes for example Classical swine fever and African swine fever are highly virulent pathogens that are notifiable in many countries and controlled by slaughter policies. Others, for example salmonellosis are important zoonotic infections. However the common endemic infections are recognised as having the most significant economic impact on farms as they effect successive batches of pigs and their subclinical influence extends well beyond the obvious clinical effects observed by the farmer and his veterinarian.

Table 1. Summary of the major enteric infections in pigs from weaning to finishing

Agent	Diseases
Bacterial (endemic)	*E.coli* – K88 *Spirochaetes – Brachyspira hyodysenteriae, Brachyspira pilosicoli* *Lawsonia intracellularis* *Salmonella* species *Yersinia enterocolitica, Yersinia pseudotuberculosis* *Clostridium perfringens* type A *E. coli* - F18
Viral (endemic)	Rotavirus, Transmissible gastroenteritis virus (TGE), Porcine epidemic diarrhoea virus (PED), Bovine virus diarrhoea virus (BVD)
Parasitic	Trichuris suis, Oesophagostomum *species, coccidia*
Viral (notifiable)	Classical swine fever, African swine fever
Nutritional causes	Niacin deficiency, Diets high in non-starch polysaccharides - wheat based rations, (barley occasionally)

Surveillance studies that provide national incidence or prevalence data on infectious causes of diarrhoea are valuable to field veterinarians. They also provide information on changes in prevalence that might occur naturally or in response to local or national disease control polices. There is little published information on the prevalence of infectious causes of diarrhoea in grow-finish pigs in South American countries. In a study in Southern Brazil, David Barcellos and colleagues identified *B. hyodysenteriae* in 6/17 units with diarrhoea problems and *B. pilosicoli* in 7/17 of those units (Barcellos et al. 2000). An example of surveillance data from our lab in the UK shows that *B. pilosicoli* continues to be the most prevalent cause of diarrhoea, with *B. hyodysenteriae, Lawsonia intracellularis, Salmonella* and *Yersinia* spp also playing an important role (Table 2). Mixed infections involving two or more pathogens are common and result in more severe enteric pathology, poorer growth rates and lower economic returns. Dual infections might not be susceptible to the same antimicrobial agents leading to difficulties with the therapeutic management of disease outbreaks.

Table 2. Example of national diagnostic prevalence data
(Causes of Entero-colitis in a survey of 98 affected pig units in the UK – 2005)

Infection(s)/ diseases identified	Primary infection (%)*	Mixed infection (%)^	Overall incidence (%)[#]
Brachyspira pilosicoli	18	24	42
Brachyspira hyodysenteriae	13	16	29
Lawsonia intracellularis	10	15	25
Salmonella spp	6	12 (9)	18 (9)
Yersinia pseudotuberculosis	4	10	14
Trichuris suis	2	0	2
Oesophagostomum sp	1	0	1
'Atypical' *Brachyspira spp*	8	4	12
Others	1	7	8
No diagnosis	7	-	7

*Agent regarded as the primary cause of the enteritis/colitis outbreak.
^ Agent involved as part of mixed enteric infections in the outbreak.
[#]Total exceeds 100% on account of mixed infections.
( )*Salmonella spp.* isolated on enrichment culture only.

DIAGNOSIS

The diagnosis of porcine entero-colitis in grow-finish pigs and identification of the aetiological agents requires a combination of traditional methods and modern technologies.

Traditional methods:

- herd history
- clinical findings
- post mortem examination and histopathology
- microbiology
- parasitiology
- virus isolation

Modern technologies:

- polymerase chain reaction (PCR) testing
- immuno-histochemistry
- *in situ* hybridisation
- DNA-chip diagnostics is something for the future

The veterinary surgeon's approach to the diagnosis depends on a number of factors such as:

- How serious the problem is – mortality rate or suspected notifiable disease
- Cost to the producer
- Availability of diagnostic tests and facilities
- National control policies

HERD HISTORY AND CLINICAL SIGNS

The herd history and clinical signs are very important as they frame the diagnostic picture.

Important information relating to the health status of the unit (eg, swine dysentery-free or not), the level of biosecurity in place, routine control measures used eg TGE vaccination, clinical signs and duration of the problem, information from herd records, eg, effects on the cost of production.

It is important to establish which pigs or stages of production are affected and approximately what proportion of pigs have diarrhoea. This can be a difficult where pigs are housed in large groups on slatted floor or in a deep-straw system. Examination of the dunging areas should provide evidence of the type of diarrhoea (pasty, watery, bloody, mucus) but finding typically affected pigs can be difficult. Pre-identification of affected pigs by farm staff in advance of the veterinary surgeon arriving increases the rate of diagnostic success considerably. Pigs are less likely to show clinical signs when disturbed by unfamiliar people entering pens. Having pigs pre-selected means that they can be readily separated out for examination and testing.

SAMPLING

What samples? How many? What tests? These are questions that we get asked regularly.

Samples available for testing during an outbreak are faeces, blood samples, dead pigs and live pigs. All pigs sampled for pathogen detection must be unmedicated and sampling should be planned so the material reaches the diagnostic laboratory fresh and on a 'good day'.

FAECES

Faecal samples are valuable if collected fresh from pre-identified affected pigs. Faeces that are 'pasty' in consistency can be collected from freshly passed piles using plastic disposable spatulas. Samples of old (cold) faeces from the corners of the pen, or slurry samples from the dunging areas will seldom yield useful results so should be avoided. Pigs with runny or watery diarrhoea must be collected direct from the anus as floor contamination is unavoidable with material of this consistency. The ideal number of samples from an affected batch is between 10 – 15 pre-selected affected pigs. Samples can be pooled in batches of up to 5 samples per pool for most tests if cost is an issue. If you want to determine the prevalence of infections among diarrhoeic pigs, it is best to test samples individually. Any samples that have a different character from the rest should be marked and tested separately. Highly mucoid or haemorrhagic samples suspicious of swine dysentery should be marked for spirochaete microscopy to give a rapid indication of spirochaetal disease.

TRACING SOURCES OF INFECTION BY FAECAL SCREENING

Isowean systems involving pigs sourced from multiple farms have led to problems with swine dysentery for some farming groups. With this arrangement, it is difficult to trace the infected farm of origin, but we have approached this by repeated screening of incoming or outgoing batches of pigs by PCR test. It is difficult to trace infected breeding farms, when all piglets leave the units at 3 weeks of age, as there is usually no evidence of clinical illness on these farms. We have tackled this by obtaining rectal swabs from piglets at weaning and performing PCR on pools of swabs from different litters. Alternatively, a batch of weaners has to be held back at the breeding unit for up to 8 weeks to see if they develop clinical signs.

Faecal samples can be collected from weaners or growers as they arrive on farms, off the lorry. It is best to select pigs that are diarrhoeic on arrival, and collect the samples from the anus rather than the lorry floor. Although lorries should be washed out thoroughly and disinfected before loading pigs, sometimes this is not done, or not done properly and this could lead to the wrong conclusions being drawn. Screening of representative numbers of litters of piglets at weaning, or older pigs on arrival at farms, might have to be done repeatedly before the source of infection is detected.

Screening clinically-normal breeding sows by PCR involves sampling a representative number of sows (suggest 40) and pooling samples in batches of 5 for testing to reduce the cost. Repeat samplings (up to 5 times) may be needed before infection is detected. |In adult stock the bacteria are shed intermittently and in very low numbers which makes detection especially difficult. Any diarrhoeic gilts or sows should be marked for sampling.

BLOOD SAMPLES

Serological testing can be used for evidence of seroconversion and for screening in relation to herd health certification. Paired serology on individual pigs is seldom carried out as it requires individual identification of animals. More often, 'serum profiling' is carried out by testing between 6 – 12 pigs at specified ages eg, at 6, 10, 14, 18 and 22 weeks to detect when seroconversion to a pathogen is occurring in the unit. This is used for *Lawsonia intracellularis* infection (ELISA testing) in order to determine the optimal stage for use of the oral vaccine or medication. Similar serum profiling for Salmonella species (mix-ELISA for Group B and group C organisms) indicates the stage that pigs are initially exposed. This helps with management control of Salmonella infection. Serology screening for certification can be used for TGE, PED and notifiable diseases.

DEAD PIGS

There are limitations attached to examining pigs that have been dead more than 1 – 2 hours. However there is still very useful information to be gained from looking at them. For example, it is possible to assess the macroscopic lesions and look for consistency in findings across as many pigs as available. Certain tests can be undertaken on these pigs such as bacterial cultures, examination for parasites, PCR tests and histopathology for major changes provided the pigs are still reasonably fresh and not left in hot conditions. Limitations are histopathology requiring the surface epithelium to make a diagnosis (eg, attaching *E. coli,* Clostridial diseases, viral enteropathies and porcine colonic spirochaetosis). Brachyspira cultures may also be unsuccessful as the organisms autolyse quite soon after death.

Table 3. Suggested diagnostic pathways for enteric post mortem lesions in grow-finish pigs.

Lesion	Enteritis/ Enteropathy	Ileitis (PPE)	Typhlitis & colitis
Potential pathogens	Salmonella Yersinia TGE PED	Lawsonia intracellularis	Brachyspira hyodysenteriae Brachyspira pilosicoli Lawsonia intracellularis Salmonella, Yersinia Parasites, (CSF/ASF)
Laboratory tests to consider	Cultures Salmonella, Yersinia, (E.coli, Clostridia) Histopathology Bacterial-type lesions Viral-type lesions (Coccidia) IHC TGE, PED	Microscopic examination MZN for L.intracellularis-type intracellular organisms (mucosal smears) PCR test L.intracellularis Histopathology PPE-type lesions, special staining (silver-staining or IHC for L.intracellularis)	Microscopic examination Spirochaetes, parasites Cultures Brachyspira, Salmonella, Yersinia PCR test B.hyodysenteriae, B.pilosicoli L.intracellularis Histopathology Bacterial-type lesions Viral-type lesions Parasitic-type lesions Non-specific colitis (silver-staining for spirochaetes, L.intracellularis. IHC for B.hyodysenteriae, B.pilosicoli, L.intracellularis. IHC or ISH for CSF/ASF)

Depending on the findings and the size of the operation and problem, live pigs should also be selected for euthanasia and immediate post mortem examination for tests requiring very fresh material. The number of pigs selected should be proportionate to the size of the unit and the problem. Four – six pigs are ideal from large units. Do not rely completely on the findings from a single pig in the hospital pen. It is unlikely to be representative.

LABORATORY TESTS

Faeces

In the laboratory, smears made from each faecal sample should undergo direct microscopic for large spirochaetes and be examined for worm eggs by a flotation technique. Spirochaetes can be visualised using eosin and nigrosin counter staining or by staining fixed smears with dilute carbol fuchsin or Giemsa. Bacterial cultures for *Salmonella, Yersinia* and *Brachyspira* species require selective media and specific culture conditions, with confirmation by culture characteristics, biochemical reactions and slide agglutination. Other means of bacterial detection, most notably polymerase chain reaction (PCR) can be used to provide rapid and accurate evidence of *B. hyodysenteriae, B. pilosicoli* and *L. intracellularis* in faeces.

Pigs/post mortem examinations

Pigs submitted for necropsy should undergo a thorough examination of both small and large intestine with samples collected for histopathology from a minimum of three levels of the small intestine including ileum, the caecum and three levels of the large intestine, including the apex of the spiral colon. Gut samples should be placed in 10% buffered formal saline with minimum tissue handling. Loose ingesta should be removed gently from the large intestine but any adherent material should be left in place and the tissue wafted in a large volume of formal saline to aid fixation. Lymphoid tissues (intestinal lymph nodes, spleen and one or two carcase lymph nodes) should be collected for PMWS assessment. Samples of fresh tissue taken for microbiological examination should be processed as for faecal samples using material scraped from the mucosal surface by means of a sterilised spatula or glass slide. In addition to routine histopathological examination, sections of gut tissue should be stained by Gram and Warthin and Starry methods to look at the type of bacteria which are colonising the surface, crypt epithelium and lumens. Immunohistochemistry or *in situ* DNA hybridisation can be used for detection of specific pathogens.

The emergence of PMWS has given increased problems with diagnosis of enteric diseases as the pattern generally alters during the extended outbreaks. Agents like K88 E. coli and rotavirus continue to affect pigs until

6 – 8 weeks of age. There are also more mixed pathogen infections. Sometimes there are no detectable pathogens but histopathology shows marked lymphoid depletion in intestinal lymph nodes and Peyer's patches and apparent 'bacterial overgrowth' in the ileum and colon. In these cases there are mixed bacterial forms in the intestinal crypts and neutrophil inflammatory infiltrates. Presumably the pigs are severely immunocompromised and unable to control the balance of commensal organisms in the intestine. In increased numbers they might cause enteritis and colitis resulting in diarrhoea problems.

FINISH PIGS

Control of colitis

Factors that predispose to infectious forms of colitis are: farmers obtaining pigs from multiple sources, inadequate biosecurity on farms, continuous throughput of buildings and pens, solid floors in grower accommodation, 'scrape-through' slurry passages, poor hygiene, staff shortages, overstocking, moving and mixing of pigs and the presence of vermin on farms. Economic crises in the pig industry lead to many farmers cutting back on staffing levels and this has an adverse effect on hygiene and disease control systems on farms.

General control measures.

1. Management and hygiene.

- Keep a clean and well-managed unit, provide clean overalls for staff, wash boots
- Use disinfectant footbaths at strategic points
- Apply all-in, all-out batch management with cleaning pens and disinfecting between batches
- Use the best disinfectant in particular circumstances (viruses – approved virucidal agents, Lawsonia, Brachyspira – phenolic or quaterary ammonium compounds, parasites – agents like Oocide)
- Avoid scrape-through systems
- Adhere to acceptable stocking rates
- Avoid moving/mixing batches as far as possible
- Avoid 'holding back' poor pigs and re-mixing them with smaller pigs
- Control of vermin and birds

2. Vaccination

- Lawsonia intracellularis, TGE, Salmonella – use vaccines as required.

3. Medication

- in feed / in water as required
- 'welcome' medication in ration eg ZnO2 for control of E. coli in weaners.
- For disease control, apply 'medicate and move' strategy to try and break the cycle of infections.
- Use best medication for the problem. Diagnostics important! Many possible agents – OTC, CTC, tylosin, tiamulin, valnemulin, lincomycin, aivlosin, carbadox.

4. Antimicrobial resistance

- investigate suggested resistance problems.
- Use antimicrobial agents with care to avoid resistance development
- Educate farmers to understand issues to do with resistance and the importance of targeted use of antimicrobials in combination with good management.

5. Eradicate infections

- Eradication programmes for swine dysentery can be very cost-effective long term
- Programmes have to be thoroughly planned with good understanding by all concerned.

6. Herd biosecurity

- vital in order to avoid introducing serious enteric diseases.
- Every aspect must be examined, control measures identified and used.

As all enteric infections involve faecal-oral infection, control requires good hygiene and stockmanship, cleaning and disinfection between batches. Rodent and bird control should be undertaken, and dogs should not be allowed into piggery buildings. Additional comments on control of separate diseases are given below.

Control of *E. coli* infections in weaners requires antibiotic treatment during outbreaks of clinical disease. Alternatively, in units with regular problems of post-weaning colibacillosis especially when affected with PMWS, the use of a high concentration of dietary zinc (2500 – 3000ppm) for two weeks after weaning is beneficial (Holm and Poulsen, 1996). It controls *E. coli* by reducing microbiological proliferation in the gut. Studies have shown that fewer organisms are cultured from the mesenteric lymph nodes of pigs receiving zinc oxide suggesting that it reduces the spread of *E. coli* from small intestine to the mesenteric lymph nodes.

Table 4. Differential Diagnosis of the Common Intestinal Disorders of Grow-

Disease	Ileum	Colon	Ileocaecal nodes	Extra-intestinal lesions
Salmonellosis	Mild inflammation	Focal to severe deep necrosis	Always enlarged (2-5 times normal). Colonic nodes may be enlarged	Often generalised infarction Interstitial pneumonitis. Haemorrhages with *S.choleraesuis*
Swine dysentery	-	Superficial diffuse, moderate-to-severe colitis, blood leakage, mucus, diptheresis	Normal, possibly slightly enlarged. Colonic nodes enlarged.	None
Colonic spirochaetosis	-	Superficial diffuse, mild-to-moderate colitis, mucus, multifocal erosions, maybe diptheresis	Normal, possibly slightly enlarged. Colonic nodes may be enlarged.	None
Porcine Proliferative Enteropathy	Proliferation, may be necrosis. Haemorrhagic in PHE	Milder than in the ileum, diffuse. Usually the proximal spiral colon	Variable with stage of disease, usually enlarged.	None
Yersiniosis	Mild enteritis	Mild-to-moderate granulomatous colitis	Variable with stage of disease, usually slightly enlarged.	None
Whipworms (Trichuris)	-	Mild-to-moderate colitis, mucus. Parasites visible.	Normal, possibly slightly enlarged. Colonic nodes may be enlarged.	None
TGE/PED	Pale, thin intestines, villus atrophy	Watery content in colon	Usually normal	Dehydrated carcase
Non-specific colitis	-	Mild colitis. Greyish watery faeces.	Usually normal	None
ASF/CSF	Serosal and mucosal haemorrhages	Mucosal infarcts, 'button ulcers', haemorrhages	Haemorrhages	Haemorrhages, 'turkey egg' kidneys

For control of rotavirus infection, peroxygen disinfectant (Virkon S) is effective. Provision of electrolyte solutions to combat dehydration will minimise the impact of the diarrhoea. Drinkers should be kept clean and electrolytes refreshed twice daily whilst pigs have diarrhoea.

Occasionally coccidiosis affects weaner pigs during PMWS outbreaks. The disinfectant of choice is Oocide (Antec International). When outbreaks of coccidiosis occur, pigs can be treated with toltrazuril (Baycox, Bayer) orally or by injection. Repeat treatment might be required 4 – 5 days later. Alternatively sulpha-based antimicrobial agents can be given in feed or in water where large numbers of pigs are involved.

B. pilosicoli is susceptible to a number of antimicrobial agents including tiamulin, valnemulin, lincomycin, carbadox and salinomycin. Clinical trails using the first four agents have demonstrated efficacy *in vivo.* Zinc bacitracin at an inclusion rate of 250 ppm is also reported to be effective. The antimicrobials licensed for use in pigs vary from country to country. Prophylactic medication should be used strategically in the age group of pigs most at risk, and timed to combine with management practices aimed to create a break in the exposure to infection. For example, pigs could receive antimicrobial medication for 7 days before and after being moved to the next stage of accommodation. Combined with all-in all-out, cleaning and disinfection, this should create a break in exposure to infection. Periodic minimum inhibitory concentration (MIC) studies on recently-isolated field strains should help to monitor for any trends of developing resistance to the commonly-used antimicrobial agents.

Herds that are free from swine dysentery adopt rigorous biosecurity measures and buy breeding stock from SPF or Minimal Disease multipliers. In herds with swine dysentery, the disease is controlled by good management (all-in, all-out), cleaning and disinfecting buildings between batches and strategic medication of pigs before being moved into clean buildings. Antibiotics of choice are the same as those recommended for *B. pilosicoli* control. In addition a new macrolide product Aivlosin is also reported to be effective against swine dysentery. Although it has been suggested that the disease can be controlled by dietary means, the experiments have not been reproducible and no commercially available diet has been effective in preventing the disease.

Eradication of the disease can be done in several ways; 1) complete depopulation of the herd with thorough cleaning and disinfecting plus a minimum of three weeks vacant, re-stock with SPF pigs 2) depopulation of the growing herd (all pigs from weaning to finishing), sows moved off-site for a minimum of two weeks and medicated in feed (tiamulin 10mg/kg bodyweight or the equivalent dose of valnemulin), thorough cleaning and disinfecting of empty buildings, sows moved back to farm, pigs weaned thereafter remain on the farm 3) depopulation of the growing herd (all pigs from weaning to finishing), sows stay on farm and receive in feed medication as in (2), thorough cleaning and disinfecting of empty buildings and sow accommodation as best possible.

There are reports of resistance developing to some of the antimicrobial agents used to treat and control swine dysentery. This is a worrying situation as the number of products available is very limited. This highlights the need for careful use of therapeutic agents in all circumstances. No effective vaccine for swine dysentery has been developed as yet although work is in progress, especially in Australia.

L. intracellularis is susceptible to a wide range of antimicrobial agents including chlortetracycline, oxytetracycline, tylosin, tiamulin, valnemulin, lincomycin, olaquindox, carbadox and aivlosin. No resistance to antibiotics has been recorded as yet. The antimicrobial agent of choice depends on the availability, cost etc.. An important recent development is the production of the oral vaccine for ileitis (Enterisol® Ileitis, Boehringer) (Kroll et al, 2004). This is administered in water, with milk added to avoid inhibitors such as chlorine having an adverse effect on the organisms. As this is a live vaccine, pigs must not be receiving antibiotics in feed or in water at any dose as they will kill the vaccine organisms and no benefit will be achieved. This vaccine is being marketed in many countries.

Prevention and control of TGE depends on strict biosecurity. Breeding stock should be bought from uninfected sources. Controls should be placed on visitors and vehicles entering the unit. Where possible birds should be kept out of piggery buildings as they can be important vectors of infection. Feeders should be covered to prevent birds feeding from hoppers and soiling the feed. In the event of a suspected outbreak, rapid confirmation of the diagnosis is required and measures should be put in place to prevent spread to other units. Ample water provision is vital to the survival of affected pigs. Electrolyte solutions should be given to young piglets to maximise survival rates.

Control of salmonellosis depends on hygiene and management measures primarily. The use of antibiotics is not recommended unless pigs are clinically ill, on account of concerns of increasing resistance to antimicrobial agents. The use of killed salmonella vaccines in breeding-age animals has been found to reduce the prevalence of infection. The use of salmonella surveillance schemes based on ‘meat juice’ serology from slaughtered pigs has been introduced in several European countries, following the lead set by Denmark. This scheme detects herds that have high salmonella prevalence, then hygiene measures are introduced to combat infection. Care is taken to prevent the introduction of salmonella from any source, including feed. The benefits of the scheme in reducing

salmonella carriage by pigs and carcase contamination has been widely publicised by the Danish Slaughterhouses Association.

Non-specific colitis associated with pelleted diets high in nonstarch polysaccharides can be partially controlled by inclusion of arabinoxylanase enzyme to the diet alone or in combination with beta-gluconase. Changing to meal feeding (non heat processed feed) is another option. Although this is a mild form of colitis, the colon mucosa develops multifocal erosions that can readily be colonised by infectious agents. Therefore nonspecific colitis can serve as an important 'starter mechanism' for infectious colitis and result in more severe pathology than in the case of the disease alone.

CONCLUSIONS

There are many potential causes of diarrhoea in pigs; not all are infectious in nature. Effective control of problems depend on achieving the correct diagnosis. Pathology and histopathology on freshly-fixed representative intestinal samples is essential to reach a morphological diagnosis and suggest the aetiological diagnosis. Culture and other means of pathogen detection confirms the aetiology. Mixed pathogenic infections can occur in all age-groups and this can be a complicating factor in deciding on the treatment of choice. Sometimes, an apparently poor response to treatment has been attributable to a second or third pathogenic agent that is not susceptible to the antibiotic being used. The importance of hygiene and good management in the prevention and control of enteric infections is paramount. Maintaining these standards poses a real challenge for pig farmers in the future, in view of the tightening economics of pig production and the drain of experienced pigmen from the industry.

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