

# Clinical Signs are an Interaction of Host, Agent and the Environment

John C. Harding

Swine Production Medicine, Western College of Veterinary Medicine, University of Saskatchewan, 52 Campus Drive, Saskatoon, SK S5N 5B4; **Email:** john.harding@usask.ca

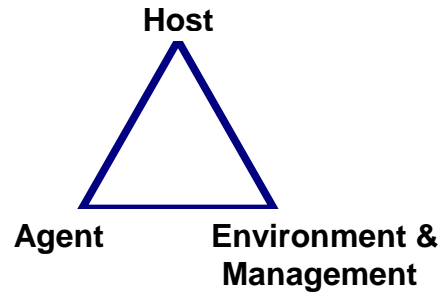
## ■ Introduction

The clinical signs of any disease, whether endemic or epidemic, are the result of an intricate relationship between the infectious agent (virus, bacteria, or other), the host's immune response, the management and environmental factors imposed on the host. In this afternoon's session, we will expound on these factors, and equip producers with the vision and knowledge to better control clinical disease in their operations.

## ■ Epidemiology and the Disease Triad

Epidemiology is the study of the relationships of various factors determining the characteristics of diseases in populations. Professional epidemiologists devote their careers to investigating the factors associated with the distribution, frequency, transmission and risk factors of diseases in populations. Recent and populous examples include the Canadian Food Inspection Agency's investigation of Alberta's May 2003 BSE case, and the World Health Organization's 2003 investigation of the spread of SARS in Toronto, Hong Kong, and other SE Asian countries. Swine veterinarians are trained in epidemiology prior to graduation, and many become very skilled and influential on the prevention, control, and transmission of swine diseases. In fact, the generally accepted rules of biosecurity employed in the present industry, have fundamentals that are deeply-rooted in the science of epidemiology. Also entrenched, is the notion of the disease triad:

- Agent
- Host
- Environment and Management



**Figure 1. The Disease Triad**

### ■ The Influence of the Agent on Disease Expression

There are many viruses, bacteria and parasites (collectively referred to as pathogens) that have the potential to cause disease in swine. Unlike humans and some ruminants, the causative agent of the transmissible spongiform encephalopathies such as BSE, CJD, CWD have never caused disease naturally in pigs. While bacteria and parasites can generally survive and replicate in the environment, viruses are unique in that they require cellular DNA to replicate. Therefore, viruses must infect cells to propagate. Over the years, pathogens have evolved and changed to more efficiently infect and dodge the host's immune defenses. While some pathogens evolve slowly, some viruses such as PRRS, due to their genetic structure, evolve more quickly by mutation (a single nucleic acid change in the genome), or by recombination (swapping of larger sections of genetic material between 2 virus particles). However, the evolutionary specialists are the influenza viruses, as they can mutate and jump the species barrier (i.e. from poultry to humans) and infect a new host that has little or no immunity. If this "new" virus infects a host that is already infected with another influenza virus, the genomes of the two viruses can mix or "re-assort" to create highly contagious variants. The pig is significant in this process, because it is susceptible to porcine, human and avian strains, resulting in high risk of re-assortment and the development of highly contagious and deadly global pandemic strains. Mutation also assists some bacteria such as *E. coli* and *Salmonella* develop antibiotic resistance, by passing portions of their genetic material to other similar bacterium in the local area.

All pathogens contain or produce unique factors and/or toxins that are essential for infecting cells and causing disease. These are call "virulence factors". For example, the strains of *E. coli* that cause piglet diarrhea produce toxins (i.e. Sta, STb, LT), and have finger like projections (fimbria such as F4, F5, F18) that allow the bacteria to attach to the intestinal wall. Bacteria of the same

species that are non-pathogenic generally do not display such factors. This is of practical significance. For example, if *E. coli* is cultured from a scouring piglet, but is tested and found not to produce the enterotoxins (such as Sta, STb, LT), it is unlikely to be the cause of the scours, and is very likely an incidental finding. Autochthonous vaccines would therefore be ineffective.

Finally, some of the pathogens are host adapted and only infect swine (i.e. *Mycoplasma hyopneumoniae*), while others are able to infect more than one mammal (i.e. *Salmonella*, *Leptospirosis*) and therefore pose a greater biosecurity risk. Pathogens that infect humans and mammals are termed “zoonotic”, and are of considerable public safety concern. In swine, there is a long list of zoonotic diseases, including salmonella, *E. coli*, erysipelas, influenza etc.

## ■ The Influence of the Host on Disease Expression

The host is the animal that is exposed and infected by the pathogen. In our case this is the pig, but more specifically the age group within a population is a particular concern. “Age” is a very important determinant of clinical expression because most diseases are noted in a specific age group. This is most often due to age-dependent changes in the level of immunity, or the availability and susceptibility of specific target cells of the pathogen. For example, parvovirus only infects rapidly dividing cells, and only fetuses are susceptible, resulting in embryonic death and fetal mummification. Older animals do not display any clinical signs. By contrast, respiratory diseases such as *Mycoplasma* can infect all ages of swine, but are most commonly noted in grower hogs because they are the largest susceptible population on most farms.

The host’s immune system protects against disease, and it is another very important determinant of clinical disease expression on most farms. The larger the susceptible population is, the greater the risk of a disease “outbreak” occurring in a given population of animals. The immune system is very complex, and involves many different cell types and organs. The primary systemic immune organs are the spleen, thymus, bone marrow and lymph nodes. However, the mucosal surfaces of the respiratory, gastrointestinal and urogenital system are essential defence barriers in themselves. Some of the components of the immune system are non-specific and are directed at all pathogens (termed the innate immune system), and others very specific and react only to a single pathogen (termed the acquired immune system). Activation of the acquired immune system can result in the production of antibodies (humoral immunity), or the production of specific cells to fight infection (cell mediated immunity). The acquired immune system also has memory, and initial exposure to specific pathogens (active immunity) results in an ability of the acquired immune system to react quickly upon repeated

exposure. Immunologic memory is the principle behind booster vaccinations. Neonatal piglets are born with a functional immune system, but no memory, and the immune system is slow to respond several weeks after birth. For protection after birth, the newborn consumes colostrum, which contains maternal antibodies (passive immunity) and some immune cells. In some species, like humans, antibodies pass to the fetus prior to birth, but this is not so in the pig, because the pig's placenta has more layers than the human, and each layer is an impediment to the transfer of antibodies. Finally, stress-induced hormone, cortisol has a suppressive effect on the immune system, before and after birth, and the control of stress is significant from the point of view of management, the environment and animal care.

### ■ **The Influence of Management and the Environment on Disease Expression**

"Management" has a substantial impact on the expression of clinical disease, and for this reason, two papers, devoted to this subject, follow in these proceedings (*How Management Promotes Disease Prevention/Control and Staff Success*, pg 227; *Implementing a Systematic Approach to Disease Control and Prevention*, pg. 231). Because the influence of "management and the environment" can be divided into two categories: systems and operations, and each will be addressed by our speakers this afternoon. It goes without saying that people control both systems and operations and, therefore, have a substantial impact on the expression and control of diseases on all hog farms.

### ■ **Conclusions**

Disease expression varies on swine farms, due to the varied and integral relationship between the host, agent and the environment and management. Personnel at all levels of management have a direct impact on disease control and the ultimate success of their operations.