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What do we know about food-borne pathogens in pigs and slaughterhouses?

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Introduction

While the safety of the US food supply relative to that of other countries is debated, food safety improvements are clearly warranted. Several arguments can be presented in support of this statement.

Food-borne disease remains a significant cause of mortality and economic burden in the US, and due to continual exposure to media reports of food-borne disease outbreaks and food product recalls, consumers are increasingly demanding higher quality and safer foods.

Expanded global trade links the US to food safety developments in other countries. Countries that develop systems to produce foods guaranteed with lower health risks will use this for market advantage, and food safety and quality is likely to become a barrier to market access.

Recent identification of emerging pathogens and development of antimicrobic resistance in food-borne pathogens indicate a failure of current methods of monitoring and control to deal with these problems, especially those resulting from healthy-appearing animals.

Improving food safety in the US is a multi-dimensional problem and has many potential solutions. Overall, a "multiple barriers" approach to food safety has been proposed, partly in recognition that total control at any single phase of the "farm to fork" food chain is not possible. This implies that each segment of the food chain—including the production level—has food safety responsibilities. In the pork industry, increased size and complexity of production enterprises increases the potential dimensions of human food-borne disease outbreaks. At the same time, the creation of vertical production chains increases the accountability of each component of the chain as well as the monitoring capability.

The FoodNet monitoring system, part of the Centers for Disease Control's Emerging Infections Program, has identified the most important human food-borne pathogens by order of incidence (**Table 1**). These human food-borne illnesses originate from a variety of sources, and it is not currently possible to estimate the proportion of human food-borne disease due to foods of swine origin.

Human pathogens of swine origin

Important human pathogens of swine origin have been ranked in decreasing order (Blaha, 1997):

1. Salmonella
2. Campylobacter
3. *Toxoplasma gondii*
4. *E. coli* O157
5. *Listeria monocytogenes*
6. *Yersinia enterocolitica*
7. *Trichinella spiralis*

What can we learn from monitoring systems in swine production?

Salmonella

Initial results from the USDA Food Safety and Inspection Service HACCP post-implementation study have shown a baseline swine carcass prevalence of 6.5% (FSIS, 1999). The NAHMS Swine 95 Study (Bush, 1997) provided estimates of fecal shedding prevalence at the farm (38%) and pen level (18%). These estimates varied markedly by region and herd size. Since the mid-1990s, research on Salmonella in pork has been intensified in the US and many other pork-producing countries. Summarizing information learned from these more recent studies from recent International Symposia on the Epidemiology and Control of Salmonella in Pork, there is a comparable prevalence in US slaughter hogs to most other countries, with the exceptions of Sweden and Finland. Despite the high proportion of positive herds, very few Salmonella-positive herds have high within-herd prevalence, one indication that prevalence is amenable to change with management. Identifying these high prevalence herds and demonstrating effective, practical, and affordable control programs are clear objectives for the future.

Campylobacter

Most human cases of campylobacteriosis are due to *Campylobacter jejuni*, which is mostly from poultry, cattle, and other animals. The most prevalent

Campylobacter sp. in swine is *C. coli*, though precise estimates of prevalence are not yet available. From a subset of fecal samples from the NAHMS national swine study, 69% of over 1000 swine fecal samples tested positive using PCR testing (Wesley, personal communication). Unfortunately, there is limited data available from targeted studies on herd prevalence and the distributions of shedding. Control measures are largely unknown at this time.

Toxoplasma gondii

Regional studies have estimated the prevalence of *Toxoplasma gondii* from 2–5% of finishing pigs in Illinois and Iowa (Zimmerman, 1990; Dubey and Weigel, 1995; Weigel, 1995). Higher prevalences have been observed in breeding swine (10–20%). Control measures are largely understood, including eliminating the definitive host (cats) from farms (through use of total confinement). When these measures are adopted, *T. gondii* prevalence is much lower (0.06% of finishing pigs raised in total confinement systems in North Carolina (Davies, 1998)).

E. coli O157

No human health risks from *E. coli* O157:H7 have been linked to pork to date, and this pathogen was not identified in the last NAHMS national swine study (NAHMS, 1996). Nonetheless, verotoxigenic *E. coli* should remain on the list for monitoring, due to the seriousness of human disease caused by this pathogen.

Yersinia enterocolitica

Swine are considered a major reservoir of pathogenic strains of *Yersinia enterocolitica*, and pork is considered the major mode of transmission (Bottone, 1997). This pathogen, like *Listeria monocytogenes*, can multiply at refrigeration temperatures which creates added public health risks when foods are contaminated. From an Illinois study, 28% of herds had pathogenic strains (Funk, 1998). Currently, preharvest control measures are poorly understood.

Table 1: Major food-borne pathogens by incidence (Shallow et al., 1999) and cost of human illness (Buzby et al., 1996) in US

Pathogen	Incidence of human illness (per 100,000 population)	Annual cost of illness
Campylobacter	21.7	$0.6-1.0 bil
Salmonella	12.4	$0.6-3.5 bil
Shigella	8.5	Unknown
E. coli O157	2.8	$0.2-0.6 bil
Cryptosporidia	2.5	Unknown
Yersinia	1.0	Unknown
Listeria	0.5	$0.2-0.3 bil
Vibrio	0.3	Unknown

Trichinella spiralis

Trichinella spiralis is currently at very low prevalence in the US. The pig prevalence (from the NAHMS Swine 95 Study) was 0.01% of finishing pigs and lactating sows tested (Gamble, 1999). A North Carolina study of finishing pigs raised in total confinement showed a prevalence of 0.05% (Davies, 1998). Because of preharvest controls (including no feeding of garbage, rodent control, total confinement, and rapid removal of dead animals), this agent is largely controlled in the US. However, because of no trichinoscopy in the US, the implementation of trichina certification programs are essential for international trade.

Conclusion

In summary, data available from monitoring of US pigs and slaughterhouses shows very low human health risks from *T. spiralis* and low risks from *T. gondii* in pigs raised in total confinement. The other human pathogen receiving a great deal of emphasis is Salmonella, and monitoring data suggests this is a primary pathogen for control efforts. Some information is available about the prevalence of *Campylobacter coli*, Yersinia, Listeria, and other pathogens, though even less about potential pre-harvest control. This points to the necessity and importance of well-founded research directed toward pre-harvest control of these pathogens. Only through a combined effort (pre-harvest and post-harvest), can human foodborne disease risks be reduced to the lowest possible level.

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