Understanding the Public Health Significance of Salmonella

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The first half of 2012 has been an eventful time for the meat and poultry industry. Six additional Shiga toxin-producing *Escherichia coli* (STEC) were determined to be adulterants by the Food Safety and Inspection Service (FSIS or the agency). A media storm surrounding lean finely textured beef has shown the food industry the power of social media as well as having every reporter looking for the next big controversy. The fourth case of bovine spongiform encephalopathy (BSE) was found in the U.S., which was the third case that was determined to be atypical (BSE) not the classic BSE found in the UK in the 1990s. Studies have made headlines regarding red meat consumption and mortality, arsenic in the poultry industry, among others. All this activity has left the industry wondering what is next? The likely next issue is a familiar one – *Salmonella*.

Since the beginning of 2011, the Centers for Disease Control and Prevention (CDC) reports 15 *Salmonella* outbreaks (CDC, 2012b). The outbreaks were not limited to food sources like ground beef, turkey, tuna, pine nuts, sprouts or papayas but also included frogs, dog food, and turtles. This ubiquitous microorganism will likely garner additional regulatory focus as *Salmonella* illnesses have not declined in 15 years; *Salmonella* infections cause more hospitalizations and deaths than any other food pathogen; and over one million Americans are estimated to contract salmonellosis every year from consuming contaminated food (CDC, 2011b)

In January 2011, CDC revised their decade old foodborne illness, hospitalizations, and death estimates. Utilizing public health data acquired during the last 11 years, the CDC estimates 47.8 million illnesses, 127,839 hospitalizations, and 3,037 deaths are attributed to foodborne illness, which includes both known and unspecified agent estimates (Scallan *et al.*, 2011). While these numbers are not directly comparable, they are lower than the 1999 estimates of 76 million, 325,000, and 5,000, respectively (Mead *et al.*, 1999). CDC can only estimate the causative agent for approximately 20% of the foodborne illnesses: 9.4 million foodborne illnesses, 55, 961 hospitalizations and 1,351 deaths are estimated to be attributed from known foodborne pathogens (Scallan *et al.,* 2011). From that 9.4 million foodborne illnesses estimate, Scallan *et al.* (2011) projected that 1,027,561 illnesses, 19,336 hospitalizations and 378 deaths are caused by *Salmonella* spp. nontyphodial. The only other foodborne pathogen that is estimated to cause more illnesses than *Salmonella* is Norovirus with 5,461,731 illnesses (Scallan *et al.,* 2011). For comparison purposes, currently FSIS estimates the total number of illnesses from all FSIS regulated products to be 405,178 in 2012 and 394,770 in 2013 (FSIS, 2012).

Scallan *et al*. (2011) estimate that 59% of illnesses of known foodborne pathogens are attributable to viruses with 2% attributable to parasites and the remaining 39% estimated to be bacteria based. *Salmonella* is estimated to contribute 11% of all known foodborne illnesses (Scallan *et al.,* 2011). Within the 39% of illnesses estimated to be caused by known bacteria, *Salmonella* contributes 28% to those illnesses, followed by *Clostridium botulinum* at 26% and *Campylobacter* at 23% (Scallan *et al.,* 2011). *Salmonella* is also estimated to contribute 35% of hospitalizations caused by known foodborne pathogens with Norovirus at 26% *Campylobacter* at 9% as well as parasites at 9% (Scallan *et al.,* 2011). A similar trend is estimated for the deaths attributed to known foodborne pathogens with *Salmonella* attributing 28%, parasites 25% and *L. monocytogenes* 19% (Scallan *et al.,* 2011).

Although the accuracy of modeling techniques and improved data do not allow for a comparison between the 1999 and 2011 foodborne illness estimates, one could speculate that improvements by the public health agencies, regulatory groups, and the meat and poultry industry have all contributed in making the food supply safer, particularly in reducing *E. coli* O157:H7 and *Listeria monocytogenes* contamination (CDC, 2011b). Some success has been made in reducing *Campylobacter* illnesses by 12% between 2000 and 2010. Unfortunately, the incidence of salmonellosis has not improved over the last 15 years and the illness rate has actually increased by 24% between 2000 and 2010 (CDC, 2011b). The lack

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of improvement was the primary reason why the *Healthy People 2020* objective for *Salmonella* illnesses was raised from 6.8 – the *Healthy People 2010* goal - to 11.4 illnesses per 100,000 people (CDC, 2011b). *Salmonella* was the only foodborne illness pathogen those *Healthy People 2020* objective was increased and not decreased.

CDC outbreak data when analyzed for *Salmonella*, *Listeria*, STEC, and *Campylobacter*, the primary pathogens of interest for the meat and poultry industry, indicate between the years 1998 and 2008, *Salmonella* was responsible for 72.7% of the food outbreaks (CDC, 2011a). *Listeria* caused 1.3% of the outbreaks, STEC 15.1% of the outbreaks, and *Campylobacter* 10.9%. When accounting for *Salmonella* outbreaks that did not have a food vehicle or were mixed foods, poultry and eggs were responsible 13% and 11% of the outbreaks, respectively (CDC, 2012a). Pork, beef and fruit were considered food vehicles for 12% of the outbreaks, each contributing 4% (CDC, 2012a). Mixed meat foods, seafood, cheese, milk, miscellaneous dairy foods, vegetables, leafy greens, sprouts and miscellaneous salads also were identified as the food vehicle in *Salmonella* during 1998-2009 (CDC, 2012a).

CDC has maintains an enteric disease laboratory-based surveillance system that collects laboratory information for state public health laboratories. One of the systems, National *Salmonella* Surveillance System has been collecting data since the 1960s and provides annual summaries, which are the only national source of subtyping information. In 2009, the top five serotypes from human *Salmonella* isolates were Enteritidis, Typhimurium, Newport, Javianna, and Heidelberg (CDC, 2012c). Interestingly, the top four laboratory-confirmed *Salmonella* serotypes human sources between the years 1970 to 2009 were Enteritidis, Typhimurium, Newport, and Heidelberg (CDC, 2012c).

The National *Salmonella* Surveillance System also tracks nonhuman sources as well. In 2009, the top 5 clinical serotypes from nonhuman *Salmonella* isolates were Typhimurium, Newport, Dublin, Cerro and Derby (CDC, 2012c). Whereas the nonclinical serotypes from nonhuman *Salmonella* isolates were Kentucky, Enteritidis, Heidelberg, Typhimurium and Senftenberg (CDC, 2012c). While there are some similarities between the human and nonhuman top serotypes in 2009, striking differences due exist as well as differences between clinical and nonclinical serotypes from nonhuman sources. What impact does that have on public health? How does that impact decisions of regulators? Very interesting questions that will likely be need to be answered in the future, especially as the regulators consider *Salmonella* positive regulatory samples taken over the last 12 years.

On July 25, 1996, FSIS issued its landmark rule, Pathogen Reduction; Hazard Analysis and Critical Control Point (HACCP) Systems. The rule addressed foodborne illnesses associated with meat and poultry products by focusing more attention on the prevention and reduction of microbial pathogens on raw products that can cause illness. One component of the HACCP rule was establishing pathogen reduction performance standards for *Salmonella* that slaughter plants and plants producing raw ground products must meet, specifically in the following commodities: broilers, market hogs, cows/bulls, steers/heifers, ground beef, ground chicken, ground turkey and turkeys. Examination of the 1998-2010 *Salmonella* performance data adds an interesting component to the *Salmonella* public health data as positive rates have decreased since 1998 as well as being below the performance standard (FSIS, 2011). Effective July 1, 2012, FSIS implemented new performance standards for broilers and turkeys to 7.5% and 1.7%, respectively.

So what is the public health significance of *Salmonella*? Undeniably, a greater understanding of salmonellosis is needed as illnesses have remained unchanged for 15 years and actually increased since 2000. This is even more disturbing as the FSIS scientific regulatory data indicate deceases in *Salmonella* positives. The pathogenic *Salmonella* serotypes are significant and CDC, FSIS, and the meat industry will not dispute that. But how does one improve the public health risk, especially as so many *Salmonella* serotypes do not cause illness? That question needs to be answered yet the solution will not be simple, especially as the meat and poultry food production continuum is made up of four groups: the meat and poultry industry, regulatory agencies, public health agencies, and consumers. Each group has a vital and critical role in food safety, but likely the least understood is the role public health agencies have and their impact on food safety policy.

Public health agencies need to provide more accurate and timely foodborne illness attribution data. This objective data allows food safety stakeholders to allocate resources and scientifically justify the decisions made in their food safety systems. By having timely, credible food attribution data, regulators and the meat industry can accurately identify and improve any food safety gaps that may exist. These data also may help to identify emerging foodborne risks, especially when such risks have not been previously associated with specific foods. This rapid adjustment to improve food safety can only occur if accurate data is made available as soon as possible to all food safety stakeholders.

To complement public health data, FSIS and the Food and Drug Administration (FDA) should consider and evaluate how public health would be improved by if new regulatory paths are needed and implemented, and if needed determine if alternative regulatory paths could be could be more effective. A "one-size fits all" regulatory approach is not appropriate as differences in *Salmonella* spp. exist across products regulated by FSIS and FDA. The meat and poultry industry should also utilize a process management system that addresses all *Salmonella* spp. not specific serotypes. Finally, consumers should bet-

ter understand the risks associated with raw agricultural products in order to make the best purchasing and handling decisions for their lifestyle.

Additional research is needed to better mitigate the risk of *Salmonella* in food, specifically:

- examine the human acquisition factors of *Salmonella* and examine the causative species that cause illness;
- if causative species are commodity specific;
- how to better attribute *Salmonella* to specific food illnesses;
- address what is the role of competitive exclusion in preventing illness, among others.

The last decade has shown the important role cooperation and communication between public health officials, regulators, the meat industry, and other allied stakeholders have had on improving food safety. This collaborative success story, lessons learned, and the need for additional research can develop the blueprint in mitigating the *Salmonella* risk in meat and poultry products.

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