Proactive Use of Supply Chain Data in Foodborne Illness Outbreak Investigation**

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Summary

Unfortunately, traditional epidemiological foodborne outbreak investigations are generally forensic. They allow us to know what went wrong so that preventive controls can be put in place for the future and we know where to assign blame for the outbreak. However, these investigations do not allow us to intervene and help those who will become ill because, with episodic contamination, the majority of the contaminated food is usually consumed before the epidemiologic investigation has identified the vehicle. Traditional epidemiological investigations are only really a mitigation strategy (i.e., interventional) for systemic contamination events in which there is low-level contamination over an extended period of time. Part of the challenge of the traditional epidemiologic approach is that we need outbreaks to be recognized *before* epidemiologists can carry out a case control study (i.e., identifying possible causal factors by comparing ill individuals to nonsick individuals). However, our primary detection system is currently the emergency room. When the investigation begins, the epidemiologist has to do extensive interviews to find out which foods to consider in the case control study. The more foods included, the longer the study takes — an inherent conflict. There is an opportunity to dramatically simplify these investigations by utilizing private sector supply chain data, but this requires strong public-private partnerships. In essence, by comparing the illness pattern with the specific product distribution patterns, one could identify which products are possible contamination vehicles. Using that data in a meaningful way, however, requires near real-time analysis of vast amounts of information. New approaches on how data from competitors could be combined without compromising proprietary business information or exposing companies to additional regulatory risk must be identified.

Current realities

Investigations of foodborne illness outbreaks that follow a "church picnic" scenario are relatively straightforward. If half of the picnic attendees ate the potato salad and the majority of them became ill, it is a fairly easy epidemiological investigation and the outbreak is over. However, this does not help those who became ill. Outbreaks such as the *E. coli* O104:H4 associated with sprouts in Germany, *E. coli* O157:H7 associated with spinach in the United States, *Salmonella* Saintpaul associated with peppers in the U.S., and many others, illustrate how the "church picnic" style investigation fails as a real mitigation strategy. In both *E. coli* cases, the epidemiological curve followed the basic trend as depicted in Figure 1; the consumption and illness presentation curves had already peaked before the vehicle was identified. In the case of *Salmonella* Saintpaul, some disease cases might have been prevented by the announcement to avoid peppers, yet it took months from the first illnesses to identify them as the vehicle. Thus, while the systemic nature of the contamination provided an opportunity to mitigate the consequences, the difficulty in identifying the source resulted in illnesses that could have been prevented by a more timely identification of peppers as the vehicle.

Supply chain data (i.e., information on how products move from pre-farm inputs, through primary production, harvest, and further processing, and to consumer purchase) were used in each case. However, the investigation and mitigation of the outbreak could have been accelerated if supply chain data had been more proactively and thoroughly utilized. As a normal part of the product traceback to try to identify the source, federal and local authorities obtained data on the products that they thought were most likely associated with the outbreak. However, real-time analysis of food supply chain data, as new illnesses become associated with an outbreak, was not and is currently not conducted. Real-time analysis would allow the list of foods and sources to be narrowed down, even before a clear association

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is identified or a traditional case control study is completed. The challenge is that the data would have to be collected and analyzed on a continual basis to be useful. For example, a single entity would have to receive data from all major retailers and mine these data as illnesses are identified.

In the *Salmonella* Saintpaul outbreak, initial inclusion of private sector data would have immediately indicated that the Florida tomatoes were likely not the source because the illness distribution exceeded the probable distribution of the Florida tomato harvest at that stage in the season. This investigation was the first time that import data available to U.S. federal agencies were significantly utilized prior to the identification of the probable vehicle, albeit in the final stages of the investigation, to narrow the number of possible sources from the more than 500 manufacturers and thousands of shipments during the outbreak. While in the *Salmonella* Saintpaul case investigators were looking at a limited segment of the food industry, for the U.S., there are more than 300,000 food producers who supply approximately 55,000 items for sale in roughly 900,000 retail outlets. Therefore, the brute force approach of manually reviewing each line entry would not be a realistic option.

Import data are the only type of real-time supply chain data currently available to federal officials. These data comprise only a small fraction of the existing supply chain data and are not usually shared with local officials or automatically analyzed to identify potential vehicles. Due to probable cost, it is not realistic for regulatory agencies to collect all available private sector data in real-time and on a continual basis. Also, companies are not likely to want their regulators to hold their proprietary data. Supply chain structure, for example, is part of how firms manage their cost structure. In some cases, businesses will not share company information on their suppliers with their customers, demonstrating how sensitive the food industry can be about basic supply chain structure.

Scientific opportunities and challenges

Import and supplier/customer data for each firm in the supply chain already exist, usually in electronic form. For most foods, however, these data are not held in one central database, even from supplier to retail outlet. Enterprise Resource Planning (ERP) systems or similar systems are widely deployed to manage, among other things, manufacturing systems, order fulfillment, and raw material/supplies acquisition. Import data are also available electronically. The scientific challenge is how to rapidly merge data from different sources, given that unfortunately there is no single, unifying, information structure standard. The need to integrate disparate data is a challenge shared in many other contexts, from medical research to financial markets. As a result, the basic tools to analyze large, disparate datasets exist. The development of a system to acquire basic data on suppliers and production facilities of individual foods to retail outlets, down to the stock-keeping unit level, is therefore achievable. That alone would be a significant step forward as it would make it much easier to confirm that foods distributed in areas with no associated outbreak cases are not related to the specific outbreak. If the distribution pattern of a product matches some unique attribute of the illness distribution, it would conversely suggest that the product has a higher likelihood of being a source. In the *Salmonella* Saintpaul outbreak, there were higher incidences of illness in states where the implicated importer had distribution centers or more distribution than in other states. If that information had been available and/or considered during the investigation, produce items moving through those distribution centers could have been investigated as potential sources. Identifying this association becomes more difficult when the contaminated product is a widely used ingredient. It is at that point that trying to capture the sourcing data for the production facility, repacking house, or distribution center is important. Such investigations would drive a significant increase in data management complexity, but are still achievable. Imported ingredients dramatically increase complexity; while import data is available, there may be challenges with language barriers, limited electronic data capture/sharing capabilities, and compliance. If investigators want to trace all the way back to the farm, many products would be, at least for now, out of reach.

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Policy issues

The core technology exists to utilize supply chain data to accelerate outbreak investigations, and even at its simplest implementation, this would be a tremendous asset. There are a number of policy issues that must be addressed to ensure that supply chain data are effectively employed.

- It is necessary to accelerate outbreak investigation and source attribution without creating new regulatory enforcement or litigation hazards for the private sector. The requisite management and data needs of government agencies associated with the food system must also be defined.

- The reason for the food industry to share data in real-time must be justified, especially since there are associated costs (i.e., either direct and/or opportunity costs).

- The legal and regulatory framework for establishing an independent third party that can create a single unifying information structure and data standards — and should then become the clearinghouse for sharing supply chain data in the event of an outbreak — must be established.

- The private sector should fund a public supply chain surveillance system as part of the outbreak clearinghouse or as a separate entity, because it is the private sector that financially benefits from reducing the impact of unintentional food contamination and intentional food system events.

- A modest investment by the private sector to increase local public health capabilities for foodborne illness investigation would, according to the Council to Improve Foodborne Outbreak Response (CIFOR, 2009), significantly improve outbreak detection and response.

- The economic justification for the public sector enabling, and the private sector funding, these significant efforts is the reduction in losses to the public and the industry that would stem from accelerating outbreak source attribution. Beyond consumers, communities that would benefit economically from reducing consumer exposure in an outbreak include:
  - food businesses (especially retailers, finished food processors, and produce suppliers) who bear the direct cost of delayed or incorrect source identification
  - insurers of food businesses, as it reduces their overall exposure risk
  - health insurers, given that estimated U.S. direct health care related costs of foodborne illness are US$152 billion per year (Scharff, 2010)

Developing the standards and protocols will not be easy, but the technology exists and the algorithms could be made. Only the will to collaborate in unconventional approaches to reduce the burden of foodborne illness is needed. The private sector investing in public infrastructure is a very different paradigm, but one that will protect the public and the private sectors. It is, however, somewhat of a misnomer to say that the private sector is paying, as in the end, it is always the consumer who pays.

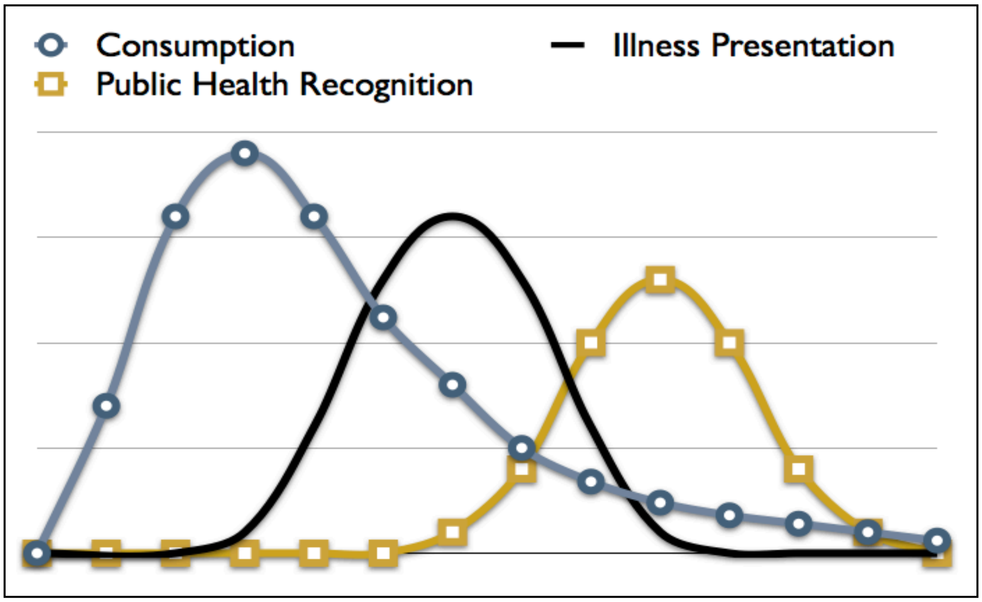
References

Council to Improve Foodborne Outbreak Response (CIFOR). (2009). *Guidelines for foodborne disease outbreak response.* Retrieved September 19, 2011, from http://www.cifor.us/documents/CIFORGuidelinesFrontMatter_000.pdf

Scharff, R. L. (2010). *Health-related costs from foodborne illness in the United States.* Retrieved September 19, 2011, from http://www.producesafetyproject.org/media?id=0009

*** A policy position paper prepared for presentation at the conference on Emerging and Persistent Infectious Diseases (EPID): Focus on Mitigation, convened by the Institute on Science for Global Policy (ISGP) October 23–26, 2011, at the University of Edinburgh, Edinburgh, Scotland.*

Figure 1.



Consumption
Public Health Recognition
Illness Presentation