Intentional and Inadvertent Chemical Contamination of Food, Water, and Medication

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KEYWORDS

• Chemical terrorism • Food contamination • Water contamination
• Medication contamination • Risk communication • Supply chain

KEY POINTS

- Food, water, and medication production, processing, and distribution involve multiple potential points of entry for chemical contamination.
- Developing a clinical case definition based on toxidrome recognition is the most important epidemiologic step early in a chemical contamination event.
- Laboratory investigation and identification of a chemical compound as the cause can be time and labor intensive, expensive, and frustrating, with attendant problems of confounding or associated noncausal substances.
- The number and location of affected individuals can facilitate identification of the likely point of entry of a chemical contaminant through the use of bow-tie modeling.
- Risk communication is an important aspect of the response to potential chemical contamination of food, water, or medication.
- The resources of a regional poison control center or medical toxicologist can be used as an entry to the public health system and considerations regarding tracking potential contamination of food, water, or medication.
- Following large-scale contamination events, the public health impact associated with an outbreak of mass epidemic illness must also be addressed, especially in the absence of an available biological marker to differentiate stress response from toxic injury.

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INTRODUCTION

The delivery of toxins or contaminants via food supply, water, or medications has a long history, particularly as a means of altering political futures. In 585 BC, the city of Kirra in modern-day Greece was besieged by attacking clans in the First Sacred War. The attackers discovered a buried pipe bringing fresh water to Kirra and reportedly poisoned it with hellebore, weakening the city occupants by inducing vomiting and diarrhea.[1] Recordings of other targeted terroristic poisonings at feasts or other gatherings date back several millennia.[2,3] Technological, legislative, and regulatory efforts to forestall terrorist goals of targeted or widespread poisoning by contamination of food, water, or medication supplies continue. This article uses examples of contamination of these critical supply chains to highlight the production and distribution components that provide common points of vulnerability for attack, and the resources and measures to counter such attempts.

Production and Distribution Systems as a Framework

Most modern societies have developed highly specialized production and distribution methods to deliver large quantities of goods such as medications to populations that are both congregated in large cities and more widely dispersed, while maintaining standards of uniform composition and potency. The same is true for food and water. Separation of the many steps and multiple components required to produce, package, and widely distribute these critical entities affords numerous opportunities for inadvertent or intentional contamination; this complexity can also create barriers and delays in identification of, and notification about, contamination. Production and distribution systems can be depicted as a bow-tie model, as shown in **Fig. 1**. Many raw materials or tributaries combine to make a processed or finished product, which is then collected, stored, and distributed via a series of outlets until eventually reaching a large number of consumers. This simple unidirectional flow example of network theory has been used to model the impact of introduction of a small amount of the potent botulinum toxin into the milk supply.[4]

Using Bow-tie Analysis to Identify the Point of Introduction of Chemical Contaminant

From an epidemiologic point of view, the in-flow/out-flow concept is critically important in determining the need and location for investigations, recalls, testing, and communications. These same issues need to be addressed in individual patient encounters. For

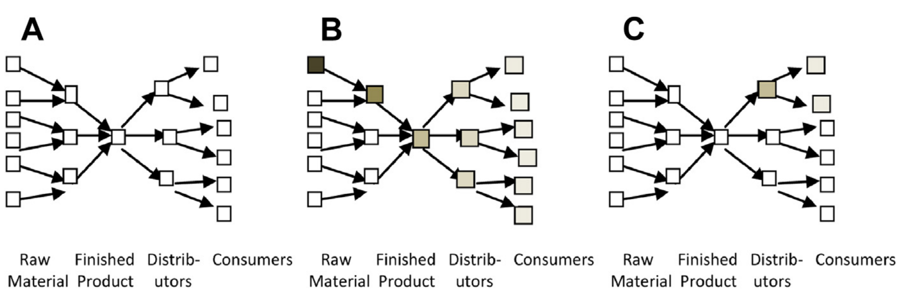

Fig. 1. (*A*) Bow-tie production and distribution. (*B*) Insertion of a large amount of a compound early in the production can have a widespread but diluted effect for many consumers. (*C*) Insertion of a smaller amount of a compound late in the distribution process requires less substance for effect, but affects fewer individuals. (*From* Centers for Disease Control. CDC estimates of foodborne illness in the United States: overview of attribution of foodborne illness. Available at: www.cdc.gov/foodborneburden/attribution/overview.html.)