PART

I

Outbreak Investigations

CHAPTER 1

An Overview of Outbreak Investigation

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An outbreak (or epidemic) is a unique public health event and poses many challenges and opportunities to those tasked with the response. It occurs when more cases of a disease are recognized than would normally be expected at a given time among a specific group of people, whether it is a dozen persons with gastroenteritis that attended a church supper or the occurrence of a marked rise in cases of a disease among the population of an entire country. Unlike a research experiment where you try to control many things, such as precisely how the study subjects are exposed to some health-related variable, the responder to an outbreak has had no control over the exposure and may not even know what the exposure was. Rather, the focus is on investigating and describing this natural experiment that nature or man (intentionally or unintentionally) has caused with the hope of mitigating its consequences. The investigator might only be confronted with a syndrome (such as an outbreak of diarrheal illness) without knowing which agent has specifically caused this outbreak. They may even be challenged with the cause of the outbreak being a novel organism that has not previously been described. In the case of the many thousands of public health employees working in health departments in units or sections that are responsible for more than one disease (such as those dealing with communicable or immunization preventable diseases), they never know what will be the next outbreak, and are challenged to master the information about each of what can be 40, 60, or more reportable conditions. And regardless of whether the disease is named on the list of reportable conditions, usually if it causes an outbreak it is automatically reportable.

In an outbreak, there is typically an urgent need to control the public health outcome and minimize its impact, especially through prevention of further cases. One of the first things that is needed by the public health responder is some familiarity with what is already known about how to deal with the problem. For example, when one is confronted with a Salmonella outbreak, it is useful to have had experience investigating previous outbreaks of salmonellosis and to have read the literature of Salmonella outbreaks to gain familiarity with methods of investigation and issues that can arise. The scientific literature has many publications of outbreak investigations. Some of these are descriptive and others focus on one or more aspects of the outbreak, such as laboratory issues or infection control. These publications are won-

derful resources, but may be less accessible to those not trained in epidemiology, the laboratory science, or biostatistics. Such reports are also limited by journal word count and scientific writing requirements that may make them less accessible to some public health employees and students.

Outbreaks are fascinating stories. They are real-life events that sometimes weave together all the drama any Hollywood producer could wish for in a blockbuster: the baker vomiting in the kitchen sink and then resuming his work duties; a casual or even celebratory meal out at a restaurant followed days later by hospitalization and death, only because the deceased decided that he would have the Caesar salad with the entrée for a small additional price; or perhaps a family reunion at a hotel followed by a family cluster of illnesses with fever because the whirlpool they enjoyed may have been aerosolizing *Legionella* species. Some outbreaks, including several in this book, are even more dramatic, making national headlines, as when previously unrecognized organisms hospitalize and kill, or when massively large numbers of persons are sickened, or when a relatively small number of persons is sickened or killed but an entire nation is fearful for their own safety. Some outbreaks are fascinating puzzles for the epidemiologist to solve. How do Orthodox Jews who never eat pork become sick from the pork tapeworm? Why do children in a Ukrainian town go bald?

A pessimist that studies outbreaks finds reason not to drink, swim, relax in, or even shower in water, and not to eat shellfish, meat, chicken, pork, fried rice, home canned vegetables, fresh spinach, tomatoes, alfalfa sprouts, peanut butter, apple cider, and even pasteurized milk! Beware hotels, any banquet (especially at a wedding), any catered meal, and flying on an airplane or taking a cruise. Heaven forbid your child goes to a daycare, plays on an athletic team, visits a petting zoo, or just plain goes to school at all. Just when you thought it might be good to get away, you had better avoid beaver dams and rivers, caves, well water, and rustic cabins where ticks are hiding to bite you and your friends or family painlessly in the night. Don't get sick with anything so you won't need any medicine or sleeping aids and so you can avoid the hospitals and surgicenters. And don't even think of having sex!

But the optimist recognizes the incredible potential to learn and apply public health skills while performing useful and rewarding work. It is no coincidence that some of the most important outbreak investigations have had lead investigators who lacked subspecialty knowledge of the disease that they were investigating (before they began the investigation). However, the reason that they were so suitable for the investigation was due in large part to their epidemiologic skill set. They brought their "epidemiologic tool kit" with them to the outbreak and, in the midst of investigating, attempted to master relevant knowledge of the disease and, whenever possible, to partner with others who had disease-specific knowledge. I have seen many successful epidemiologists move their careers from one area of study to a seemingly unrelated area of study. How can someone who worked on AIDS for 8 years transfer to work on cancer or air pollution or smoking cessation, and then some years later transfer to work on influenza? Why do such programs hire that person? The answer is that these individuals have a highly valuable "epidemiologic tool kit," and those that hire them understand the value of this. A well-rounded epidemiologist has been involved in a diversity of epidemiologic analyses; a great way to develop and polish these epidemiologic skills is through outbreak investigation.

An outbreak is both a negative public health event and an opportunity. Although people are ill, there are many benefits to outbreak investigation. Outbreak investigations identify populations at risk for a disease, allow for modes of disease transmission to be characterized, and provide information that can be used to control the outbreak (thus preventing further disease transmission) as well as to prevent similar occurrences in the future. Outbreak investigations also provide the opportunity to evaluate public health programs or policies (such as a requirement for universal immunization against a particular disease) and whether they have been effective. In the course of an outbreak investigation, laboratory methods might reveal if there is something new about the causative organism (such as a strain that is novel and not well covered by the current vaccine), or if the strain is usual and therefore immunity from the vaccine may be less long lasting than hoped or believed. These investigations allow for the evaluation of new control measures that might be introduced in the course of the outbreak and are derived from the data analysis. They also allow for an improved understanding of the disease, especially when the disease is relatively uncommon. Whereas a disease might occur only sporadically throughout the country and get reported occasionally as a case report, the outbreak creates a series of cases under the thoughtful observation of an investigator or team of investigators who may recognize epidemiological, clinical, or laboratory features not previously observed. The outbreak also generates what can be relatively large numbers of samples (such

as stool or blood) or isolates of an organism that can allow for advancement of the scientific knowledge related to that disease or organism.

Outbreak investigations are also an opportunity for public health staff training. It is common for outbreaks to occur where staff have little to no experience dealing with them (such as outside of a city or county with a very large population). As a result, the administrative staff may wisely request assistance from the state or federal health department. The arrival of experienced staff under real-world conditions can lead to training that advances the skills of the staff in the jurisdiction requesting the help and the individual(s) who provide assistance to them. The Centers for Disease Control and Prevention's Epidemic Intelligence Service (EIS) is a wonderful example of this benefit. There have been numerous deployments of the EIS officers into outbreaks of all kinds throughout the United States, its territories, and to other countries. Many of the chapters in this book derive from EIS officer experiences. I have heard numerous former EIS officers describe their time in the EIS as the best 2 years of their career.

Outbreak investigations also allow for the fulfillment of legal obligations and duty of care for the public. State legislatures have passed rules and regulations establishing what should happen under certain circumstances, such as the reporting of a disease or outbreak. Outbreaks allow for the fulfillment of these legally mandated control measures, such as removing a food handler from food preparation activities while they have diarrheal illness or are shedding *Salmonella* species in their stool despite recovery from diarrhea. Other legislative mandates, such as the authority to close down a business (such as a restaurant) or to isolate or quarantine a patient may be fulfilled as the public health authority responding to the outbreak carries out its control efforts.

An outbreak investigation offers a unique opportunity to educate the public about disease prevention. Although the media is sometimes an investigative watchdog and can be overzealous or less than scientific in its approach to a public health problem, it can also be a terrific partner of the health department with the mutual goal of informing the public with what they need to know. As a result, while information about hand washing, covering your cough, receiving immunizations, or cooking meat or chicken to a certain temperature might not be news on any given day, during an outbreak it might be a critical control measure and can even become front page news. Contact with the media can also be very useful to calming fears, combating rumors, directing the public to where they can access special assistance (such as antibiotics, immunizations, or information) and promoting the single overriding communication objective (SOCO). The SOCO is very important, because while a thoughtful investigator can talk about many features of the outbreak that may be of interest, the journalist is limited by the space and focus of their article. Therefore, it is helpful to be concise and focused with what is being shared with the journalist, even to the point of being redundant, such as saying "We really want to emphasize that thorough hand washing after using the bathroom is an essential way to prevent the spread of this disease", "Parents need to help their children wash their hands thoroughly to minimize risk of spread of this disease", and "The public does not need to be afraid of this disease. Something as simple as hand washing can protect themselves and others from getting it".

Public health departments often go unnoticed by many in the community. The public might be aware of influenza or other immunization services offered by them, but a lot of the very important functions of the local public health department are performed quietly and without fanfare. As a result, when there is an outbreak investigation, it is an opportunity for the public health department to improve and promote its credibility in dealing with a health emergency. As mentioned previously, while not every health department can take an active lead in such an investigation due to the heterogeneous distribution of epidemiologic skills from health department to health department, even inexperienced staff can provide vital support roles to those invited in to take the lead. A public health department can be praised for calling in needed assistance, just as it can be condemned for not realizing when it has delayed getting help, to the detriment of the community. It is a difficult balance that should be kept in mind, as it impacts the credibility of the health department to its stakeholders, including the community it serves.

An outbreak also provides an opportunity to intelligently direct laboratory resources. I have heard laboratory workers on more than one occasion in my career recoil or ridicule the outbreak investigator who, when asked "What do you want us to test for?" about food or environmental samples, replies "Test for everything". While testing for everything might eventually find the pathogen, it is an unrealistic use of laboratory personnel and financial resources, and can create a great deal of unfocussed busy work for the laboratory. Laboratory testing should

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ideally follow epidemiologic information and test a hypothesis. However, there are circumstances where less targeted testing is reasonable, such as when mortality is high, time is of the essence, and the laboratory results might inform hypothesis generation.

Finally, an outbreak is an opportunity for sharing information with other health professionals, scientists, the public, and many others (such as our elected leaders). In addition to a written report that might sit for years in a file drawer, some outbreaks are published. These published outbreaks may be disseminated worldwide as their journals circulate to subscribers, including libraries where many persons gain access to them. With the Internet, some of these outbreak investigations are available for study without any subscription through free access or access granted through academic institutions. There is great value in many of these publications, as they can provide useful background information about the disease, summaries of methods used to perform part or all of the investigation, ways to display and interpret the results, and references to other publications that might be useful to future outbreak investigators.

Outbreak investigation would be considered beneficial even if only one or two of the above mentioned reasons applied. However, the benefits of outbreak investigation are many and substantial. Outbreak investigation is a vital public health duty and, as this book demonstrates, can also be a fascinating and instructive drama.

LEARNING QUESTIONS

1. Make a list of the benefits of outbreak investigation and consider who is the beneficiary with each one.
2. Define the acronym "SOCO" and explain its purpose.