
Outbreak Investigations Around the World: Case Studies in Infectious Disease Field Epidemiology

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Dedication

This book is dedicated to my wife, Renee, and daughters, Josie and Julieanne, whose love and support have made it possible for me to pursue the unusual infectious diseases career that has been my life for the past 16 years. I also dedicate it to my parents, Edward and Una Dworkin, who nurtured my curiosity and sacrificed to ensure that I would have the best education that they could provide.

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Preface

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 (where the term outbreak is most suitable) or the occurrence of a marked rise in cases of a disease among the population of an entire country (where the term epidemic may be better applied). Unlike a research experiment in which 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. The investigator might only be confronted with a syndrome (such as an outbreak of diarrheal illness) without even 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 local or state 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. 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 wonderful 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 of 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 when previously unrecognized organisms hospitalize and kill, massively large numbers of persons are sickened, or a relatively small number of persons are sickened or killed but an entire nation is fearful for their own safety. An outbreak might be heartbreaking when it ruins a family business as its reputation is tainted by a *Salmonella*-contaminated chicken or egg-containing dish or is responsible for the death of a student from an immunization preventable disease such as measles.

A pessimist who 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 don't even think of flying on an airplane or taking a cruise. Heaven forbid that 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 the 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 that you can avoid the hospitals and surgicenters, and don't even think of having sex!

The optimist recognizes, however, 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 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 "epidemiology tool kit," and those that hire them understand its value. 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.

This book attempts to reach out to the experienced and the less experienced outbreak investigator, as well as anyone interested in the study of epidemics, by presenting extraordinary and illustrative outbreaks. It is the hope of the editor and the chapter authors that these outbreak descriptions will clarify what was involved in the outbreak investigation beyond what is found in published scientific articles and illustrate the kind of issues that can arise. The first person style of these chapters is intended to create a reader-friendly format that is more like a story in that it can entertain while instructing. They also provide a context for the outbreaks by introducing the reader to where the author was in his or her career at the time, with whom he or she was working, as well as the real world conditions that he or she had to face while practicing field epidemiology. In an article written

for the *New York Times*, Lawrence K. Altman recalled the Legionnaires' disease outbreak of 1976. He described an interview with a patient that left the epidemiologic team unable to explain why that patient developed the disease but not four other Legionnaires with whom he spent a great deal of time. He goes on to recognize that dead ends such as these in epidemiologic investigations are not what scientific journals publish. The concise and focused scientific article that becomes what most persons know of the outbreak investigation (along with other factors) "creates a false impression that investigations and discoveries are simpler than they really are" (*New York Times*, August 1, 2006). These investigations are typically very complex and bring together many challenges, including recalling and applying epidemiologic knowledge, making numerous decisions quickly and under stressful conditions, working as a team including team members with whom one has never worked before, working in an environment away from the office where most of one's resources are located, and many more.

A special feature of this book is that it includes some of the most historically important outbreaks of the past 40 years, including an outbreak of cholera in Portugal, an outbreak of toxic shock syndrome linked to tampons, the outbreak of Legionnaires' diseases that led to the discovery of the bacterium *Legionella pneumophila*, the early investigation of what would become recognized as a global AIDS epidemic, the massive outbreak of cryptosporidiosis in Milwaukee, and the New York City experience with the intentional outbreak of anthrax. Other outbreaks presented here illustrate a variety of problems, modes of transmission, populations, and control measures, including Ebola virus in Gabon, hepatitis A among injection drug users in Iowa, hepatitis B among Israeli hospital patients, community outbreaks of shigellosis and whooping cough, and syphilis among men who have sex with men after meeting in Internet chat rooms. Importantly, there is also a chapter illustrating the discovery of a pseudo-outbreak.

Each of the authors was asked to describe his or her personal experience within an outbreak investigation while describing the methods that were employed. As a result, the chapters are not uniform in their presentation, and one chapter actually has more than one perspective. This informality with style was intentional, and it is hoped that it makes these investigations more accessible to some readers.

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 prevent similar occurrences in the future. Outbreak investigations also provide the opportunity to evaluate public health programs or policy (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 whether there is something new about the causative organism (such as a strain that is novel and not well covered by the current vaccine) or whether 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 also the individual(s) who provide assistance to them. The Centers for Disease Control and Prevention's (CDC) 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. In certain

countries such as Kenya, India, and Thailand, the CDC has created the Field Epidemiology Training Program (FETP) to provide a similar EIS-like experience in collaboration with the country's ministry of health.

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. These 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 their approach to a public health problem, they can also be a terrific partner of the health department with the mutual goal of informing the public of what they need to know. As a result, although 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 for calming fears, combating rumors, directing the public to where it can access special assistance (such as antibiotics, immunizations, or information), and promoting the single overriding communication objective. The single overriding communication objective is very important because although 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 his or her 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: "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." "The public does not need to be afraid of this disease. Something as simple as hand washing can protect them and others from getting it."

Public health departments often go unnoticed by many in the community. They 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, 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, although 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 members 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 on 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, replied “test for everything.” Although 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 unfocused busy work for the laboratory. Laboratory testing should ideally follow epidemiologic information and test a hypothesis.

Finally, an outbreak is an opportunity for sharing of 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 information on 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 if only one or two of the previously 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.

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About the Author

Dr. Mark S. Dworkin is a medical epidemiologist and is board certified in internal medicine and infectious diseases. After receiving his medical degree from Rush Medical College (Chicago), he trained in Internal Medicine at Rush Presbyterian St. Luke's Medical Center and in Infectious Diseases at Tulane University Medical Center, he also obtained a Master's Degree in Public Health and Tropical Medicine from the Tulane University School of Tropical Medicine and Public Health in New Orleans. He then served for 2 years in the Centers for Disease Control and Prevention's (CDC) Epidemic Intelligence Service stationed at the Washington State Department of Health where he investigated many outbreaks including those due to pertussis, Salmonella, Cryptosporidium, Trichinella, and measles. Dr. Dworkin worked at the CDC in Atlanta for 4 years in the Division of HIV/AIDS Prevention and performed many epidemiologic analyses related to opportunistic infections. During 2000 to 2006, he was the Illinois Department of Public Health State Epidemiologist in the Division of Infectious Diseases and team leader for the rapid response team (an outbreak investigation team). He is now an associate professor in the Division of Epidemiology and Biostatistics at the University of Illinois at Chicago School of Public Health and an attending physician at the HIV outpatient Core Center of the John H. Stroger Jr. Hospital of Cook County (formerly Cook County Hospital) and provides on-call coverage to a private practice infectious disease group in the Chicago area. Dr. Dworkin lectures at Northwestern University and the University of Chicago. He has authored or co-authored many scientific publications on various topics including outbreak investigations, surveillance, HIV/AIDS opportunistic infections, salmonellosis, tick-borne illnesses, and vaccine-preventable infections. He has been awarded both the Commendation Medal and the Achievement Medal by the United States Public Health Service.

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