

# What's in Your Food?

## A Case for the Disease Detectives

by

Bwalya Lungu

Department of Food Science and Technology

University of California, Davis



### Part I – What's Happening to Me?

It was raining heavily in Sacramento. Dan had just returned to his apartment after attending classes at the University of California, Davis where he was getting a degree in computer science. He couldn't figure out why he was feeling so tired and nauseated. His day had been predictable; calculus followed by American history in the morning, and then it was the dreaded three-hour general microbiology lab to round out his afternoon. It was during lab that he started to feel ill. His stomach hurt, but he couldn't leave because Professor Kunda always gave quizzes at the end of her classes. He was just glad when lab was finally over as he had now started to sweat. He felt as though he had a slight fever. His skin was warm when he touched it with his forearm. He decided he would take a hot steamy shower as soon as he could. Maybe that would make him feel better.

When he got home, he took his temperature and, sure enough, it was 101 °F (38.3 °C). His head was now pounding, so he took an Advil with his rice and chicken dinner and went to sleep. He woke up suddenly at midnight with the urge to vomit. He ran to the bathroom and bent over the toilet seat just in time to throw up all his dinner. His stomach rumbled. He felt like it was being twisted in knots and ripped apart at the same time. He had never felt this way before and wondered if it was something he had eaten. He thought for a moment about going to see a doctor then quickly changed his mind because he figured he would feel better in a few hours. He drank a glass of water and went back to sleep.

The next morning, he was exhausted because he had barely slept, so he decided to skip class and rest. As the day wore on, he grew weaker, felt even more tired, and began to experience violent diarrhea. He tried to eat to keep up his strength, but his appetite had vanished. Later that night around 10 PM, his phone rang; it was his girlfriend Michelle calling to check up on him since he had told her that he had not been feeling well. After he updated her on his condition, she told him she was coming over immediately.

Michelle arrived, took one look at Dan, and told him he needed to go to the emergency room (ER). He insisted that he would be fine and was rather irritated because he hated hospitals and dreaded going to the ER. He recalled an incident in which he had once waited almost eight hours before being seen by a doctor and he didn't want to go through that again. As far as he was concerned, he didn't need a doctor for an upset stomach. He argued with Michelle for a few minutes, then fell silent, realizing she was just concerned for him. Michelle then went to the kitchen to make him some soup because he was weak and complaining that he was unable to keep any solid food down. But halfway through eating his soup, he got up and ran to the bathroom and threw up again. This time he observed that not only was his poop still watery, but it also had blood in it; a lot of blood. Now he was scared. He asked Michelle to take him to the ER at the regional hospital a few miles away from where he lived.

Later at the hospital, he barely remembered having met Dr. Campbell or anything else that happened during his three-hour wait in the ER. He felt totally drained and exhausted. He found himself lying in a hospital bed hooked to

an IV machine. Nurse Lin reminded him of his mother. She was kind and gentle as she propped up his bed so that she could take his blood pressure and heart rate. She seemed efficient and he felt calm as she quietly told him she needed to collect his blood, urine, and stool. He vaguely remembered smiling at her and asking her why she was taking all those samples. She said they wanted to check for microorganisms and chemical toxins, and to monitor his kidney function to ensure he didn't experience kidney failure. Dan's symptoms appeared to be getting severe so she also checked his body for bruising and made sure he was not bleeding from his nose or mouth. She said he looked quite pale and checked his eyelids to see if they were pale too. When she saw the alarmed look on his face, she assured him that this was standard procedure for someone in his condition. The nurse explained that they needed to make sure he avoided dehydration. His kidneys were deteriorating, and they would have to closely monitor those organs for the next 48 hours.

### *Questions*

1. List the symptoms of disease that Dan showed.
2. Which of these symptoms would be considered severe?
3. Discuss Dan's reaction when he started feeling sick and how you would have reacted under the circumstances.
4. How would Dan's initial reaction to his illness (which included not going to the hospital) impact disease surveillance reports?

## Part II – The Disease Detectives

In his office, Dr. Campbell asked nurse Lin to run a complete urine and stool sample in order to determine if the patient had a bacterial, parasitic, or viral infection. Samples were sent to the local public health laboratory housed in the hospital complex. Within a few hours, Dr. Campbell was called by Nurse Lin who told him that three more patients had arrived at the hospital with symptoms that were very similar to Dan's. As the night wore on, a few more patients arrived complaining of stomach pain and bloody diarrhea. *It's going to be a long night*, Dr. Campbell thought to himself.

Blood, urine, and stool samples were collected from each patient in sterile disposable containers, labeled, and sent to the lab. Dr. Campbell requested that lab analysis include microscopic examination, chemical tests, and microbiological tests. He asked that the stool also be checked for color, consistency, amount, shape, odor, presence of blood, and presence of mucus.

Dr. Patel, who usually had quiet nights at the lab, was puzzled at the abnormally high number of stool samples that had come in within a short time frame. Such a high number coming all at once from people with similar symptoms could mean that there was a common agent that was causing the illness. She wondered, *If there was a common cause, was it microbial or chemical?* Dr. Patel set up samples to check for the presence of chemical toxins, which she was able to rule out within a few hours. At the same time she also set up presumptive microbiological tests on bacteriological media. She plated stool samples on various organism-specific agar media and also set up concurrent samples in various broth media specific for different bacteria species. She tested for the most common bacterial pathogens that cause foodborne illnesses, including *Salmonella*, *Shigella*, *Escherichia coli* (*E. coli*), and *Campylobacter*. Different types of agar and media specific to each organism were used to isolate and detect different bacteria species. The process of enrichment in broth media would increase the numbers of the causative agents if they were microbiological in nature and present in the stools in low numbers. Enriching samples would also separate the organism from the original sample matrix, reduce other variables within the sample matrix that might interfere with confirmatory test sensitivity, and also allow for growth of the target organism, thereby increasing the concentration of target organism in the enrichment broth sample. Enrichment would thus increase sensitivity, specificity, and reliability of results. Plating the stool samples on the agar would allow Dr. Patel to directly isolate the bacteria if they were present.

Dr. Patel knew that she would have to confirm the causative organism once her presumptive test results were in. Presumptive tests establish the possibility that an organism is present in a sample, however, it does not definitively and conclusively identify the organism. Confirmatory tests are needed to definitively identify the organism in a sample. Once she had presumptively identified the likely causative organism, she could set up confirmatory tests which included immunoassay and molecular tests such as PCR so that she could determine the specific causative agent that was responsible for this outbreak. She initially had her technicians prepare samples to run molecular tests for foodborne viruses including norovirus, but these came back negative for all viral pathogens.

Within a couple of days, bacteriological and molecular tests on all patient samples came back positive for *E. coli*. Her presumptive testing showed that her samples were positive for non-O157 serogroups. *E. coli* that produce Shiga toxins are referred to as Shiga toxin-producing *E. coli* (STEC). These *E. coli* are named based on their somatic (O) and flagellar (H) antigens. According to the CDC there are six non-O157 serogroups that account for the majority of infections in the United States. These are O26, O45, O103, O111, O121 and O145. Dr. Patel ran further confirmatory tests to determine the specific *E. coli* serotype isolated from the samples. Tests included antigen detection methods (enzyme immunoassay), *stx* PCR, and PFGE. Immunoassay and *stx* PCR confirmed that all the samples were Shiga toxin-producing *E. coli* O26 (STEC O26). Due to the unusually high number of cases, she also sent samples to the state lab requesting whole genome sequencing (WGS) be performed on all samples to get more detailed information about the DNA fingerprint of the isolates.

Dr. Patel then sent an urgent email to alert her colleague and friend Dr. Kumase at the California state public health laboratory and ask that her samples be prioritized as she had an unusually high number of patient samples that tested positive for STEC O26. She also asked Dr. Kumase if they had received any other samples that tested positive for STEC O26. Two days later Dr. Kumase called Dr. Patel and said he had his local health officers and state epidemiolo-

gist with him on the line to discuss the test results for the samples she had sent them and to let her know they had received more samples that tested positive for *E. coli* from around the state. They were extremely concerned as these samples were highly unusual in that they had all tested positive for the same strain of *E. coli* (STEC O26). Therefore, they had concluded that these were not isolated incidences of *E. coli* infections. It appeared that there were clusters of infections that could be traced back to different parts of the state; in fact, ten other samples had come back positive for *E. coli* (STEC O26) in the last eight days. WGS results showed that all the isolates were identical. Since STEC O26 was classified as a reportable disease, they had entered all the results into the California State Reportable Disease Information Exchange (CRDIE) network. CRDIE was also connected to PulseNet, a disease surveillance network run by the Centers for Disease Control and Prevention (CDC), so the CDC would now have the same information. In addition, Dr. Kumase had dispatched his disease detectives to begin speaking with the hospitalized patients in order to determine what and where they had eaten in the last couple of weeks since they now believed that these cases were not isolated incidents, but were part of an ongoing outbreak.

Dr. Kumase's lab received a call from the CDC later that day. WGS data had confirmed there was indeed a multi-state outbreak as there were STEC O26 cases in several other states. The CDC announced they would expand their investigation to involve all relevant agencies to determine the source of the outbreak. The investigation would involve various agencies tasked with ensuring America's food is kept safe, including the CDC, the Food and Drug Administration (FDA), and the USDA—Food Safety and Inspection Services (USDA—FSIS). They would work collaboratively with all local and state officials to determine the cause and extent of the outbreak so they could contain it. They also sent out a memorandum to all local and state hospitals around the country asking them to upload any STEC O26 data from their electronic case reporting systems, as this would assist in determining the extent of the outbreak. In addition, they wanted disease detectives to begin speaking with all the hospitalized patients and any other patients who had come in complaining of diarrhea, vomiting, and other similar symptoms associated with STEC O26 ingestion.

Identifying the source was going to be critical to containing the outbreak. The CDC knew that they would need to put more resources into assisting the states, so they sent some of their disease detectives to California. One of these detectives was now standing at Dan's bedside two weeks after Dan had first been admitted into hospital. Dan was feeling much better now, but he could barely walk and had been going through dialysis as the disease had affected his kidneys. The detective introduced himself as Lance and told Dan he was from the CDC. After briefly talking about the weather and the long plane ride from Atlanta, Lance asked if Dan could answer some routine questions about his disease. He explained that he was working with local and state public health officials to determine the cause of the outbreak. He mentioned that there were several patients who had presented with symptoms like his across the state so he was working with the California Department of Public Health (CDPH) to determine what was causing the disease.

Detective Lance then turned the conversation to how many farms Dan had visited in in the past three weeks. He also asked if Dan had come into contact with any farm animals, especially cows and goats. Dan said that he did not have time for farm visits and pretty much just went to school because he was taking 24 credits and needed to keep a GPA of 3.5 to keep his prestigious scholarship. Lance then asked him to tell him every single food item he had eaten prior to coming to the hospital as this was crucial to the investigators determining the source of the illness. Unfortunately, Dan said he could only remember the chicken and rice he had eaten the night he came to the ER with Michelle. He told Lance he threw that up, so maybe the chicken and rice was spoiled. Lance did not respond, but just kept taking notes on his iPad. After about 15 minutes, he asked Dan to think back to at least three to four weeks before his illness and tell him everything he had done during that period. Dan was starting to get annoyed. This investigator was asking all sorts of invasive and personal questions including where he had gone, eaten, and what activities he had done prior to getting sick. Dan just wanted to be left alone; after all, who remembers what they ate three weeks ago?

Detective Lance could see that Dan was becoming exasperated so he explained that he really needed his help to determine the source of the outbreak so that the authorities could prevent more people from falling sick or even dying. Lance patiently described how some microorganisms can contaminate different types of foods so his food list was really important. Realizing that he wouldn't wish this sickness on his worst enemy, Dan laughed sheepishly and said, "Well, I tend to eat ramen noodles most of the time, with sandwiches from Power Grocers, but occasionally I buy takeaway

to eat if I have a lot of work to do.” Lance asked him to try and remember the days he purchased sandwiches. Dan said he couldn’t remember as that was probably at least a month before his illness. He knew this because he usually purchased sandwiches when he was going to replenish his noodle supply, which he hadn’t replenished in over a month. Life had been busy lately, so he had started eating at GoGo Health Diner the week before his illness.

Dan’s friends had told him that GoGo served healthy fast food and also used fresh ingredients that were grown locally. He had grown to like the diner because he had read that they were also an environmentally conscious establishment. He, like many students, preferred to eat there because it also offered healthy, natural and organic options. After thinking carefully, Dan realized he had eaten at GoGo almost every day for a week prior to getting sick. In fact, he now remembered having eaten at GoGo the day before illness onset. *Surely it couldn’t be the GoGo food*, thought Dan to himself, *that restaurant was clean and they sold natural, fresh, organic food*. The investigator nodded, wrote some things in his iPad and then left to go and interview other patients. Investigators also went to Dan’s house and took samples of the food in his fridge.

Within a few weeks, more patients were admitted to hospitals in the state of California. Local, state and federal public health investigators learned that all the sick patients had eaten at a GoGo establishment at least one to three days prior to getting sick. The CDPH, CDC, FDA and the USDA—FSIS decided it was time to contact GoGo Health Diner and pay them an official visit. As they looked at all the data that was coming in through the surveillance systems, they realized that it was not just the state of California that had been affected, but that several other states were also reporting patients testing positive for STEC O26. Data from WGS showed that there were cases originating from 14 states in all. However, after looking at WGS data, investigators realized they were looking at two different strains, so it appeared that there were two outbreaks. The large outbreak was concentrated in eleven states with California and Oregon having the highest numbers (55 illnesses, 21 hospitalizations, 0 deaths). The smaller outbreak was concentrated in three states (5 illnesses, 1 hospitalization, 0 deaths).

### Questions

1. How long after eating at a GoGo Health Diner did patients start to exhibit disease symptoms?
2. What were some of the assumptions Dan made about his local GoGo Health Diner that have no bearing on whether food is contaminated or not?
3. Define and contrast the terms *outbreak* and *sporadic incident*. Based on your definitions, is an outbreak or a sporadic incident described in this story?
4. Define and contrast the terms *outbreak*, *epidemic*, and *pandemic*.
5. What kinds of tests were performed to determine the cause of disease? Which tests confirmed the presence of STEC O26? Why do you think these tests were performed?
6. Which method played a major role in determining the extent and scope of the outbreak described in the story and why was this technique robust?
7. Define the terms *presumptive test* and *confirmatory test*. Which testing method was used as a confirmatory test in this story?
8. Explain how the method in Question 6 played a crucial role in determining that there was indeed an outbreak.
9. List the various agencies that worked together to determine the cause of the outbreak and discuss the role of each in an outbreak.
10. Discuss the terms and conditions in which these agencies get involved in foodborne disease outbreaks.
11. What are the advantages of collaboration between state and federal agencies in an outbreak?
12. What are the methods disease detectives use to determine the cause and extent of an outbreak? How did they conclude that GoGo Health Diner was at the center of the outbreak?

## Part III – Investigation of GoGo Health Diner

Dr. Janet Michaels, the state public health officer, would serve as the liaison between the team of investigators from the CDC, FDA, USDA—FSIS, and the various state and local health departments. In addition, her team would also handle all communication between the investigators and the various GoGo Health Diner establishments in the affected states. She sprang into action immediately and called the GoGo Health Diner head office in Sacramento to alert them of the multi-state investigation. She told them that current information pointed to GoGo Health Diner as the source of the outbreak and that investigators needed to determine what food product was involved. She requested permission for investigators to have access to GoGo establishments in the affected states.

When investigators arrived at the various GoGo Health Diner establishments, they noted the menu consisted of a variety of foods both fresh and cooked, so this was going to be very challenging as pathogens can be associated with more than one food. The restaurant chain had suppliers who supplied food to all their establishments, therefore it was imperative to determine the exact source of the outbreak so that control measures could be put in place and the outbreak could be contained. When contaminated foods come into an establishment, they may become sources of contamination for food preparatory surfaces, equipment and other foods. Therefore, investigators would need to meticulously collect samples from food surfaces, equipment, and all foods. As they were collecting samples and talking to establishment personnel, investigators realized that there was a quick turnover of food in this establishment. This was a very popular restaurant especially among young people. Foods included vegetables, meats, and cereal grain products. They checked to see if raw vegetables such as tomatoes, lettuce, onions, olives, and jalapeno peppers were stored at the correct refrigeration temperatures and under sanitary conditions. They requested sanitation logs dating back three months. They looked at all freezer logs to determine whether frozen foods were being stored at the correct temperatures. They also asked for the logs for the holding trays for all cooked foods, especially ground beef, other meat and poultry products, rice, flour, and corn tortillas. They looked at what measures GoGo Health Diner was taking to keep food fresh and safe. Investigators also took samples of all the food products and swabbed equipment, holding trays, and any food preparation surface. Samples were sent to nearby federal labs for further testing.

Investigators requested records from all GoGo locations around the country. At one location, the manager took at least ten days before he was able to locate some records. In several instances, records were either unavailable, lost, confusing, or incomplete. When asked for a copy of their Food Safety Plan (FSP), GoGo Health Diner said they did not really have one. As the investigation progressed, GoGo Health Diner voluntarily shut down at least 47 locations across the country, threw out all food products, and implemented rigorous sanitary measures to clean up store equipment, utensils, and storage areas. In addition, GoGo Health Diner management released various public statements in which they stated that their goal was to serve fresh healthful foods with integrity. They also vowed to implement new food safety measures to establish themselves as a leader in food safety. These measures would include:

- Testing of all produce before shipment to restaurants, and testing to ensure quality throughout shelf life.
- Improved employee training for food safety and handling.
- Review of food safety measures.
- Employment of several regional full-time food safety managers.
- Implementation of a food safety plan for all GoGo establishments around the country.

A spokesman for GoGo Health Diner acknowledged that in spite of the company's commitment to food safety, it might not be possible for local produce suppliers to be able to meet the new standards.

### *Conclusion*

The outbreak that took place between October 2015 and February 2016 was over. Interestingly, the CDC, FDA, and FSIS were unable to determine which food product had caused the outbreak. GoGo Health Diner was unhappy with this assessment and conclusion and insisted the culprit was the Australian ground beef. However, they did not provide the agencies with any positive food product or any other evidence to corroborate that information. As a result of this

and other outbreaks, the CDC put out the following information on their website for companies and consumers about foodborne illness outbreaks.

People with higher chances for foodborne illness include pregnant women, adults over 65 years, children under 5, and people with weakened immune systems. Food industries and other eating establishments can play a major role in reducing or preventing foodborne illnesses by doing the following:

- *Keep records to trace foods from source to destination.*
- *Use store loyalty card and distribution records to help investigators identify what made people sick.*
- *Recall products linked to an outbreak and notify customers.*
- *Choose only suppliers that employ best practices in food safety.*
- *Share proven food safety solutions with others in industry.*
- *Make food safety a core part of company culture.*
- *Meet or exceed new food safety laws and regulations.*

Source: CDC. (2015). Safer food saves lives [webpage]. <<https://www.cdc.gov/vitalsigns/foodsafety-2015/index.html>>

Coordinating an investigation may prove to be challenging in the event of an outbreak, therefore the role of public health and environmental departments is important and must be clear. Each department needs to understand its responsibilities and communication lines must remain open at all times. Inspections conducted by these departments must also be consistent and thorough. These inspections must be performed by skilled investigators who understand microbial growth, survival, and persistence. Public health departments also have the authority to close down restaurants with poor food safety records. However, it is unclear whether public health departments have enough inspectors to frequently and consistently inspect all the establishments in their jurisdiction. In some counties and states, the public health department and environmental department are two independent departments that collaborate during outbreaks; in others, they are housed together under one public health department. Housing them under one department might allow for a more cohesive unit that is better able to coordinate an investigation during a disease outbreak.

### Questions

1. What are the responsibilities of investigators and/or the various agencies in an outbreak?
2. What did the investigators or agencies do when they arrived at the GoGo establishments?
3. Why do you think the CDC was unable to determine which food product was the source of the outbreak?
4. What are the responsibilities of the company during and after an outbreak?
5. How did GoGo attempt to restore customer confidence?
6. What did GoGo do that undermined their commitment to food safety?
7. What were some of the challenges faced by the investigators, GoGo Health Diners, and consumers during this particular outbreak?
8. Name the four main stakeholders in this story and describe their responsibilities or role in ensuring food safety.