An Investigation of a Mysterious Deadly Outbreak at Cedar Crest College
Tara Bruckler, Kathaleen Deane, Amber Green, Emily Haner, Sam Huey, Sam Korpics, Melody Nyoni, Shannon Ronca, Karen Sanchez, Erin Studer

Introduction
October 27, 2011. It was only a few days before Halloween. While most people were preparing their costumes and buying candy in bulk, the four EIS teams were preparing for an investigation at Cedar Crest College (CCC), where a few students were rapidly falling ill and claiming the life of one. The four teams were scheduled to begin the investigation starting October 31, 2011. Although the disease was unknown, the teams went into this case with the goal to determine the cause and stamp out the problem before the disease spread further.

The Beginning
Prior to our arrival, all we knew was that two students had fallen ill within a day of each other. The first student started experiencing a headache, fever, and overall weakness on October 26, 2011. The next day, another student displayed the same symptoms. On October 28, 2011 the students had died of shock. When we arrived on October 31, 2011 the only medical report available was for the second death, but the information was minimal. Even though the student was treated with penicillin, she still succumbed to the disease, indicating that the pathogen was resistant to penicillin.

On November 1, 2011, three more students were reported ill. Two went home to their families, and the third died in the hospital three days later. To protect its students, CCC had successfully vaccinated 95% of students, faculty, and staff with the flu vaccine by November 2, 2011. The severity and rapid onset of death following symptoms was too quick for a flu-like virus. Even the 1918 influenza pandemic took more than three days to kill its victims. Confirming our skepticism, five more students were reported ill even though they were vaccinated. With the accumulating number of cases in mind, the four EIS teams decided to combine forces.

The Survey
Our teams created a survey that we hoped would help us to understand what was causing this disease (Figure 1). We found that it was difficult to question the students that needed to be interviewed because of our limited access to the residence halls. We pooled the information from this survey and developed a basic flowchart of the initial cases (Figure 2). From this flowchart we were able to see connections between the soccer team residing in Steinbright Hall and the spread of the disease. The results allowed us to determine that the flu vaccine did not prevent the students from developing the disease. This survey allowed us to establish a case definition that stated: Anyone displaying at least three of the following symptoms: fever, headache, overall weakness, respiratory failure, and/or shock since October 26, 2011 who is a member of the Cedar Crest College campus community, especially those that have frequent contact with members of the soccer team and residents of Steinbright Hall.
By filling out this form, you are giving consent that your information will be seen and utilized by the Outbreak Investigation: Case Studies in Epidemiology class to solve the hypothetical campus outbreak. Your information will not be shared with others outside of this class.

If you do not know how to answer any question, please have I have and ask Dr. Nodel.

Name (first, last): __________________________
Date Completed: ____________________________
Age: _______ Class Year: _________
Gender: ☐ Male ☐ Female Phone: ____________________________
Email: ____________________________ Gender Affiliation: ____________________________

1. Are you:
   ☐ Resident Student ☐ Commuter Student
   If a Resident Student, please indicate your Building/Room:
   If a Commuter Student, please indicate the town in which you reside:

2. What is your academic major(s)/minor(s) of interest and minor(s)?

3. Please include your class schedule:
   (Example: Course 1, Class Name, Room 1, Professor)
   1. ____________________________
   2. ____________________________
   3. ____________________________
   4. ____________________________
   5. ____________________________
   6. ____________________________
   7. ____________________________

4. Are you involved in a campus varsity sport?
   ☐ No ☐ Yes
   If YES, please check all that apply:
   ☐ Basketball ☐ Cross Country ☐ Field Hockey
   ☐ Lacrosse ☐ Soccer ☐ Softball
   ☐ Tennis ☐ Volleyball

5. Are you involved in any of the following extra-curricular activities?
   ☐ ZUMBA ☐ Yoga ☐ Core and More
   ☐ Intramural Sports ☐ Other:
   Please list the clubs in which you are an active member and attend meetings:

6. Are you involved in any off campus activities?
   ☐ Employment ☐ Clubs ☐ Classes
   ☐ Religious Service ☐ Community Service

7. If YES, please indicate the date you received the shot: ____________________________

8. Have you traveled off campus from October 26 - Present?
   ☐ No ☐ Yes
   If YES, please indicate where you have traveled:

9. Have you traveled outside the country from October 26 - Present?
   ☐ No ☐ Yes
   If YES, please indicate the date you departed:
   If YES, please indicate the date you returned:

10. Have you come into contact with anyone displaying the following symptoms from October 26 - Present: Headache, fever, overall weakness, and/or shortness of breath?
    ☐ No ☐ Yes
    If YES, please indicate whom:

11. Please indicate all allergies:

12. Did you receive a flu shot through Cedar Crest College Health Services from October 26th - Present?
    ☐ No ☐ Yes
    If YES, please indicate the date you received the shot:
    If NO, did you receive a flu shot off campus?
    ☐ No ☐ Yes
    If YES, please indicate the location where you received the shot:

Thank you for your participation!
Figure 2: Original Flowchart of Infection as of 11/11/11.
The Cases Continue
Although our survey allowed us to determine which students were most at risk for contracting the disease, we were nowhere near the end of the battle. On November 4, 2011, we heard that similar cases were being reported in Allentown near the Lower Macungie Middle School and in Baltimore, MD. The Allentown hospital where Cedar Crest students were treated had found coccobacilli, bacteria shaped like a plump rod or an elongated circle, in the lung aspirate of one of the five students showing symptoms November 2. They administered chloramphenicol. The chloramphenicol worked, and she was the only of the five students reported on November 2 to survive. Her survival combined with the presence of coccobacilli gave us a place to start searching for the pathogen.

We decided to pursue pathogens that can cause fast-acting, deadly diseases. Some of us believed that the symptoms looked like meningitis, while others thought the disease was too focused on the lungs to be meningitis. Still, we decided not to rule anything out just yet. Using Bergey’s Manual, a scientific reference manual used for determining the species of bacteria isolated from sources, and the Centers for Disease Control and Prevention website, we were able to determine which coccobacilli were able to cause disease. Since many coccobacilli are opportunistic, meaning that the bacteria are only harmful to immunocompromised or patients suffering from other infections, we focused on Neisseria meningitidis, Yersinia pestis, and Haemophilus influenzae. We were hesitant to include Haemophilus, as it is one of the opportunistic pathogens. We were also hesitant to include Neisseria, since Cedar Crest College students are required to get the meningitis vaccine prior to their attendance at the college. However, we were also wary to confirm that the disease was caused by Yersinia pestis, as this is the organism that causes Plague and it could cause mass hysteria if we were wrong.

The Obstacle
At this point in the investigation, the team felt like we were at a standstill. Ten more students had died, with six more students displaying symptoms. It was very difficult to contact and interview the students that fell ill, as many of them chose to head home instead of to the hospital. We established that the outbreaks near Lower Macungie Middle School were likely due to a Cedar Crest College student who went home to recover, as that is very close to her hometown and only one family (most likely her family) was reported to suffer from the disease. However, we finally caught a break when we found a connection between the location of the Baltimore cases and the Cedar Crest College soccer team.

The Baltimore Connection
According to Johns Hopkins Medical School, the outbreak in Baltimore had occurred near the 4700 block of N. Charles Street where the Notre Dame University of Maryland is located. On October 23, 2011, only three days prior to the onset of the index case of Cedar Crest College, the Cedar Crest College soccer team played a make-up game at Notre Dame University of Maryland. Their original game, scheduled for September 24, 2011, had been postponed to October due to weather. This was the kind of break that the team needed, as the first students involved in the Cedar Crest outbreak were members of the soccer team. Our hunch was that the inflicted soccer team members had contracted the disease from the NDU soccer team members.

On November 17, Johns Hopkins revealed that no new cases were reported in Baltimore and that their international student from Uganda had recovered from the illness. Since the
original information did not involve the reports of an international student, we decided to dig deeper to get as much information about this student as possible. In the process of further investigating the Baltimore connection, the Allentown hospital provided us with updated symptoms related to the cases that continued to occur in Allentown, and informed us that the pathogen was nonmotile, facultatively anaerobic, and negative for the production of indole. With this information, we were able to consult Bergey’s manual once more to determine that the pathogen was none other than *Yersinia pestis*.

*Yersinia pestis*

Johns Hopkins Medical School confirmed our suspicions of *Yersinia pestis*. We immediately sent out recommendations that anyone experiencing symptoms that fall under the case definition or anyone that had had close and constant contact with confirmed cases should be treated with tetracyclines or sulfonamides for seven days. *Y. pestis*, like many bacteria, can be removed and prevented if proper handwashing techniques are put in place and if 0.5% household bleach solutions are used on surfaces, which were also part of our recommendations to the public.

*Y. pestis* is commonly associated with the Bubonic Plague, the disease that killed millions during the 14th century in Europe. However, there are three forms of the plague; bubonic plague, pneumonic plague, and septicemic plague. Bubonic plague is characterized by swollen lymph nodes called buboes on the skin and is usually transmitted via the bite of an infected flea, which was clearly not the case here. Septicemic plague is when the bacteria enters the bloodstream and can sometimes kill without any symptoms, which also does not fit our situation. These first two forms of plague are also not transmitted from person-to-person. Pneumonic plague, however, affects the lungs and can be spread person-to-person. The symptoms include fever, headache, chills, and rapid onset of pneumonia related symptoms, such as the shortness of breath, cough, chest pain, and bloody sputum. Pneumonic plague can occur after bubonic plague spreads to the lungs, or can be transmitted from animals infected with pneumonic plague to humans via aerosolized droplets of the bacteria. Our next step was to determine how the disease was contracted by the students.

**Back to Baltimore**

With the link between NDU and CCC soccer teams, we decided to try and determine more about the outbreak from Johns Hopkins and from NDU. We were informed that the student from Uganda had arrived in the States on August 15, 2011, but had left for her grandmother’s funeral in October and returned the week of October 16, 2011. According to the Director of Athletics at NDU, that student was a forward on the soccer team and had been the first to display symptoms. She had begun displaying symptoms the same day as the soccer game between NDU and CCC. There were six other students from the NDU soccer team reported to be infected and at least some of those students played in the soccer game on October 21, 2011. NDU refused to give any more information, as they feared bad publicity would result. Unfortunately, Johns Hopkins was in the process of handling a salmonella outbreak and was unable to supply us with additional information.

**Putting the Pieces Together**

Due to the lack of information provided from Johns Hopkins and NDU, we were unable to determine how the NDU students contracted the disease. Our most probable hypothesis was
that the disease originated from the international student’s travel to Uganda. Although we were informed that her grandmother died of tuberculosis, we do not know how this was diagnosed. Since tuberculosis is a disease of the lungs, it is possible that it could have been misdiagnosed. No outbreaks of pneumonic plague were seen on HealthMap or ProMed Mail anywhere in Uganda during the time of the grandmother’s funeral. It is also possible that the student was exposed to an infected animal during her travels. Without interviewing the student and having more detailed information, we cannot confidently say where the disease came from. However, we determined that the index case of Cedar Crest College contracted the disease from the members of the NDU soccer team (Figure 3).

Reflections and Lessons Learned

This outbreak served as a valuable experience that taught us, as new EIS officers, about how to handle many aspects involved with investigating outbreaks.

1. Communication. Only with effective communication between the departments (CCC, NDU, hospitals, etc.) were we able to successfully take all of the information and form a reasonable conclusion. We learned that no open communication, as well as lack of providing information, caused massive setbacks. For this reason, we were unable to determine the source of the outbreak. If we had access to NDU students and Johns Hopkins information, we could have determined the source of the outbreak with confidence. However, our communication with local hospitals, doctors, and patients allowed us to prevent more infections and save many lives.

2. Collective knowledge. In the beginning of this investigation, the four EIS teams conducted their investigations separately; however, we came to learn that uniting the teams allowed us to be more efficient. Because of the collective input of the members, we were able to thoroughly work through the ideas to determine a more accurate hypothesis. The fact that our team members come from different backgrounds, majors, minors, and experiences contributed to our better understanding of the problem at hand.

In the end, even though we learned so much, we were disappointed that we could not pinpoint the source of the outbreak. From this experience, some of us have been inspired to pursue a career in epidemiology; others simply view it as a valuable experience. One thing that all the EIS members agreed on was that although at times it was frustrating, we still enjoyed putting the puzzle pieces together.

References


Figure 3. Finalized flowchart representing the believed path of infection.