NATIONAL CENTER FOR CASE STUDY TEACHING IN SCIENCE

Holes in the Matter: A Case of Prion Disease

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Part I – Symptoms

When university president, George Caspase, hung up the phone, he had a very worried look on his face. Another alumnus had passed away. It was the second time that the Centers for Disease Control and Prevention (CDC) had called in the past week. Henry Proton, age 26, Emily Reticulum, age 25, and Frank Spongiform, age 26, had died in the past year. The loss of these young people was tragic enough, but it was the way they died that had the President's mind reeling and the CDC concerned.

Henry was a sportscaster, husband, and father of an infant son. He was outgoing, smart, and seemed to have a bright future. That spring he began to feel depressed. His wife talked him into seeing a psychologist. He was put on an antidepressant and for awhile it seemed to help, but in a couple of weeks the depression was back and he began hallucinating. Later that fall, Henry's movements became more rigid, and it became clear that the problem was more than psychological and that they had better see a neurologist. After months of testing and progressive deterioration of his physical movements, his doctors still did not have a diagnosis. Henry passed away one week before his son's first birthday. An autopsy was ordered; it was discovered that Henry's brain was filled with holes and a call was made to the CDC.

The stories were similar for Emily and Frank, and it did not take long for Dr. Annie Isomerase, an infectious disease specialist at the CDC, to determine that these cases were due to a transmissible prion disease. It also did not take long to determine that these cases had another connection: All of the affected individuals attended the same university at the same time.

Questions

1. Which prion disease was the most likely to have been contracted by the people in this story? Justify your choice.
2. Propose a mode of infection.
3. Are the family members of the affected individuals at risk? Why or why not?
4. If you were the university president, who would you inform and what would you tell them?
5. Would early intervention help any others who might be infected? If so, what possible treatments could be implemented?

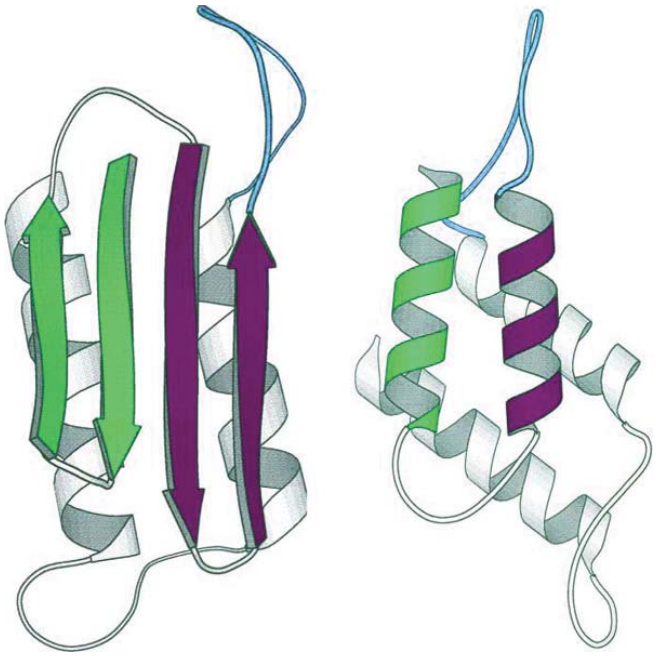
Image credit: USDA, Al Jenny, retrieved from http://en.wikipedia.org/wiki/File:Histology_bse.jpg. Micrograph of brain tissue cow infected with bovine spongiform encephalopathy (BSE). Note the presence of vacuoles, i.e. microscopic "holes" in the gray matter.

Part II – Transmission and Mechanism

Upon further investigation, the CDC determined that the graduates were likely afflicted with variant Creutzfeldt-Jacob disease (vCJD). While in college together, all three former students had studied abroad in Scotland, along with 30 other students and two professors. From personal accounts, the students had a wild time studying glaciation patterns during the day and drinking scotch ale and eating haggis and brawn each night. During that same year, Scotland had an outbreak of mad cow disease. Thousands of cows and 49 human deaths were recorded.

Mad cow disease, or bovine spongiform encephalopathy (BSE), is a type of transmissible spongiform encephalopathy (TSE) likely caused by an abnormal, misfolded, form of the prion protein (PrP). The function of normal PrP is unclear, but the structure of the protein is rich in alpha helices and it is expressed as a membrane-bound protein on neurons. In prion diseases, the PrP has fewer alpha helices and is rich in beta-pleated sheets. This abnormal structure causes the protein to clump together, ultimately causing neuronal cell death and sponge-like holes in brain tissue. Evidence suggests that the abnormal PrP converts the normally shaped protein to the disease-causing form; thus the protein, itself, is thought to act as the infectious agent.

Figure 1. Prion structure. Disease-causing PrP (left) and normal PrP (right).



Credit: By AJC1 at http://www.flickr.com/photos/ajc1/464066753/, used in accordance with CC BY-NC 2.0.

Given this new information, answer the following questions:

Questions

1. What was a likely mode of transmission of this prion disease?
2. Is it possible that other members of the study abroad trip could be infected? Why or why not?
3. Is it possible that other members of the university could be infected? Why or why not?
4. Disease-causing prions are a unique infectious agent. What makes this type of infection unique?

Part III – Comparison

Fill in the table below.

	Kuru	CJD	vCJD
Location/s of occurrences			
# of cases			
Average age of onset			
Symptoms			
Incubation period (time from acquisition to symptom onset)			
Duration of illness (symptom onset to death)			
Origin of disease			
Other			

Part IV – Essay

Imagine that this story took place at your institution and that the administration decided that they must announce the deaths to the community and their families. You get a call from your mom (or other worrisome guardian); she has just received the news and is frantic. She declares that you will need to withdraw immediately and return home! Write a letter (1 page or less) to your mother explaining the biology of vCJD in layman, but accurate, terms and justify whether you agree with her assessment or disagree. Use facts and logic (hint: the use of data/citations increases your credibility).