



# Dr. Collins and the Case of the Mysterious Infection

by

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## PART I

### Week 1, Day 1

Dr. Jenna Collins rounded the corner of the hospital hallway and entered her next patient's room. There she saw Kayla Starnes lying in the hospital bed in front of her with her mother standing nearby. Picking up Kayla's chart, Dr. Collins introduced herself to Kayla. "Hi, I'm Dr. Collins. I hear you're not feeling very well."

Kayla replied weakly, "Hi ... am I gonna have surgery?"

"I don't know, Kayla. Let's take a look at things." Dr. Collins estimated Kayla's age to be seven or eight. Picking up Kayla's chart, she began assessing the situation. It turned out Kayla was seven years old. She had suffered for a couple days with a temperature of 103°F/39.4°C and right groin pain. The emergency room diagnosis was an infected right hip joint.

"Let's take a look at that infection," said Dr. Collins.

Dr. Collins confirmed that the groin area was inflamed and observed abscess formation in the area. From all signs, the diagnosis seemed certain—infected hip joint caused by some type of bacteria. Surgical drainage of the fluid-filled area of infection would be required followed by antibiotic treatment.

Dr. Collins made some notes on Kayla's chart and then turned back to Kayla and her mother. "Well, Kayla, it looks like we will have to carry out a surgical procedure to take care of this problem after all." Dr. Collins explained the details of what would take place to Kayla's mother who sat listening intently to Dr. Collins. "We'll do the procedure today in order to prevent Kayla's condition from getting any more serious. But don't be alarmed. The procedure is routine, and we have several antibiotics in our arsenal that should take care of the infection."

As Dr. Collins walked away she thought to herself, "Hmm, this procedure is routine, but what antibiotic should I choose? The hospital microbiology lab will be able to tell me what type of bacteria Kayla is carrying, but that information may not be available for a couple of days. Kayla can't wait that long. I've got to decide now."



*Dr. Collins has gathered the facts and knows that she must begin Kayla's antibiotic treatment immediately. Based on what you know about Kayla's case and the information about antibiotics provided in your background reading, what antibiotic would you recommend that Dr. Collins prescribe? List the criteria that you used to make your selection.*

## Part II

### Day 3

Dr. Collins sat down at her desk. It was the time in her day designated to looking over laboratory test results. Among the pile of folders she found the report from the microbiology lab on Kayla Starnes. She had been waiting two days for this. Despite surgical drainage of the infected hip joint and administration of several doses of cefazolin, Kayla's condition was not improving. Her fever persisted and she was beginning to complain of difficulty in breathing.

Dr. Collins ran through the protocol for antibiotic prescription in her head. Administration of cefazolin was standard therapy for the type of infection Kayla was displaying. Only patients who have specific risk factors for a special type of *Staphylococcus aureus* infection—hospital-acquired MRSA (methicillin resistant *S. aureus*)—generally receive any other kind of treatment. These risk factors include recent hospitalization, living in a nursing home, or exposure to health care workers. Typically these patients are treated with vancomycin since MRSA tends to be resistant to all other antibiotics.

But Jenna had no risk factors for MRSA. Why wasn't she responding to cefazolin? Dr. Collins hurriedly opened the report and searched for an explanation. As she read over the lab results, her heart sank.



Examine the data from the Microbiology Lab Report below and consider the following questions:

1. Why has Kayla not responded to treatment with cefazolin?
2. What are the similarities and differences between the strain of bacteria that Kayla carries and the typical hospital-acquired version of MRSA?
3. What should Dr. Collins do now?

### Microbiology Lab Report

**Date:** July 15, 1997

**Patient Name:** Kayla Starnes                      **Doctor:** Jenna Collins

**Source of bacteria:**  
surgical drainage fluid - right hip joint. Obtained 7/13/97

**Species of bacteria:**  
*Staphylococcus aureus*

**Strain of bacteria:**  
Methicillin-resistant *Staphylococcus aureus*

**Pattern of antibiotic susceptibility:**  
Trimethoprim-Sulfamethoxazole - susceptible  
Tetracycline - susceptible  
Methicillin - resistant  
Cefazolin - resistant  
Vancomycin - susceptible

**Analysis of chromosomal DNA by PCR:**  
mecA positive

## Part III

### *Week 5, Day 1*

Dr. Collins sank into her chair. Breaking the news of a patient's death to the patient's family was the worst part of this job. She thought back over the past five weeks of Kayla's hospital stay. Despite the switch to vancomycin when she discovered that Kayla was carrying MRSA, Kayla's respiratory condition worsened, leading eventually to pneumonia. Things continued to escalate until early this morning when Kayla died of hemorrhaging from the lungs. "Some things," Dr. Collins mused aloud, "I'll just never understand."

She reached for the phone and dialed Dr. Kurt Blanton, one of her best friends from college and an up-and-coming researcher at the Centers for Disease Control in Atlanta. She recalled from their last conversation that Kurt was working on characterizing various MRSA isolates. Using a method known as pulsed-field gel electrophoresis, he could determine the genetic relatedness of each isolate. Perhaps he could characterize this strain and help to explain some of its oddities—similar to MRSA in its resistance to cefazolin-like antibiotics, most likely because of *mecA*, but dissimilar to MRSA in its susceptibility to multiple other common antibiotics and its presence in a person without any MRSA risk factors.

"So what do you think, Kurt?" Jenna asked after telling him Kayla's story.

"Sure, I'll characterize the strain. I'm always looking for new samples. This information adds to our database and helps us know how to advise doctors like you about prescribing antibiotics to your patients. I'll be in touch with your hospital's microbiology lab about the details and get back to you when our tests are complete."

### *Week 10, Day 1*

"Hello, Dr. Collins speaking."

"Hi, Jenna. It's Kurt. I'm emailing you an attachment with our pulsed-field gel electrophoresis results. I've included a description of things you need to know to understand what you're looking at. I think you'll find this interesting."

**Date:** Mon, 16 Jul 2001 12:56:15 -0700 (PDT)  
**From:** Kurt Blanton, kblanton@cdc.gov  
**To:** Jenna Collins, jcollins@stlukes.org  
**Subject:** Pulsed-field gel electrophoresis results

Jenna,

The important thing for you to look at in the figure I've attached is the pattern of bands. These are bands of DNA; each band represents a piece of DNA of a specific length (see my note in the P.S.). Compare the pattern obtained from your patient's sample with the other patterns on the gel. This will give you a clue about the genetic origin of this isolate. When comparing patterns use the following criteria: If the patterns are indistinguishable, the isolates are said to be genetically identical; if they differ by 2-3 bands they are said to be genetically closely related; if they differ by 4-5 bands they are said to be possibly genetically related; and if they differ by more than 5 bands they are genetically unrelated.

We compared the isolate from your patient to various MRSA isolates. I know you were puzzled about why your patient carried an MRSA strain yet had no risk factors for MRSA infection. Look below; I think our results will shed some light on this for you.

P.S. If you're interested in learning about pulsed-field gel electrophoresis, I've included a description of the technique and a diagram to help you understand on a separate page.



Examine the data in Figures 1 and 2. Come to consensus within your group about the following questions:

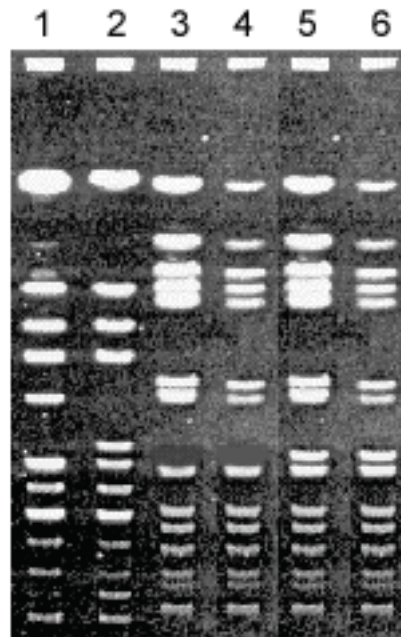
1. *What is the degree of genetic relatedness among each of the isolates in this experiment?*
2. *To which isolate is the isolate carried by Kayla most closely related?*
3. *Noting the differences in DNA banding patterns below, explain how these MRSA isolates can be susceptible to the same antibiotics? To different antibiotics?*

#### Figure 1. Description of Samples in Each Lane

Lanes 1 and 2—Hospital-acquired MRSA isolates; both patients had multiple previous hospitalizations. Both were susceptible only to vancomycin.

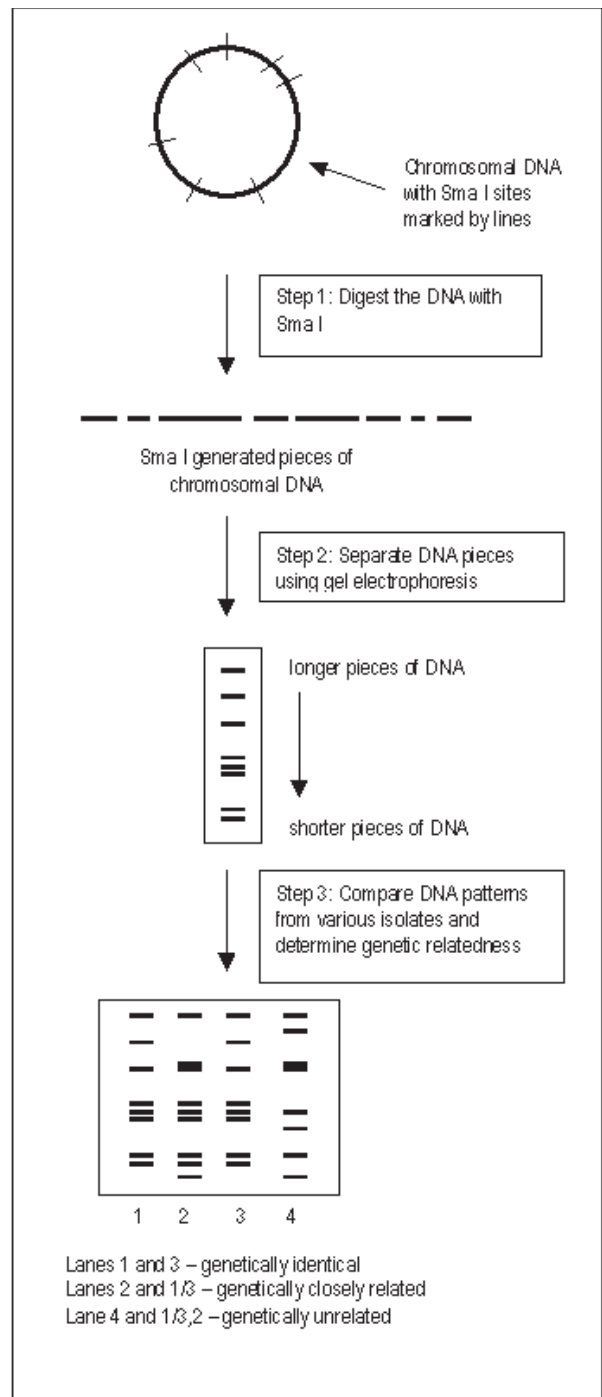
Lanes 3–5—MRSA isolates obtained from pediatric patients without any known risk factors for MRSA. Antibiotic susceptibility includes trimethoprim-sulfamethoxazole, tetracycline, and vancomycin.

Lane 6—Isolate from Dr. Collin's patient.



## Figure 2. Pulsed-field Gel Electrophoresis

In pulsed-field gel electrophoresis, the chromosomal DNA from bacterial isolates is treated with a restriction enzyme that cuts the DNA at random, infrequent locations, yielding pieces of DNA. In this example, the restriction enzyme is Sma I. Whenever Sma I encounters a CCCGGG sequence in the DNA, it makes a cut. The mixture of different size pieces of DNA are then embedded in a porous matrix—an agarose gel. The matrix is subjected to an electric current that switches direction according to a predetermined pattern. Since the DNA pieces are negatively charged they move through the matrix toward the positively charged end. The shorter pieces move further because they can get through the pores more easily. The longer pieces move more slowly because they migrate through the pores less easily. This process is referred to as pulsed-field gel electrophoresis. The result is a pattern of DNA bands on the gel, like you see in the figure, with shorter pieces of DNA represented by bands near the bottom of the gel and longer pieces of DNA represented by bands near the top of the gel. The DNA patterns of different isolates can be compared to determine their genetic relatedness.



## Part IV

### *Week 10, Day 2*

“Hi, Kurt. It’s Jenna. I looked at the results. The take-home message from all of this seems to be that there is a new strain of MRSA lurking—one that lacks any identifiable risk factors.”

“Exactly, Jenna. This new strain appears to be community-acquired. We had seen it in three pediatric patients before you called me. This case makes four. Interestingly, it seems to be occurring primarily in the midwest—two cases in North Dakota and two cases, including yours, in Minnesota.”

“This definitely changes my standard therapy for kids with severe infections of the bloodstream.”

“Yes! Fortunately, you have several options. Unlike hospital-acquired MRSA infections, this community-acquired version is susceptible to several antibiotics—excluding those in the cefazolin category. We’re getting ready to publish this information. One of our main recommendations to doctors is that they treat critically ill patients harboring invasive infections with vancomycin in addition to cefazolin—at least until a culture report can be obtained.”

“My concern is that we’ll end up with strains that are vancomycin resistant as well. You know that studies are showing strong positive correlations between antibiotic resistance and antibiotic consumption.”

“Yours is a valid concern, but I’ve got to run. Let’s talk more about that another day.”

“Sure, Kurt. Thanks!”



1. *Speculate about the selective pressures that could have led to the emergence and increased prevalence of a new and unique strain of MRSA.*
2. *Why might Dr. Collins be concerned that vancomycin resistant strains will emerge as well?*

## References for Further Reading

- This case study was based on: Four pediatric deaths from community-acquired methicillin-resistant *Staphylococcus aureus*—Minnesota and North Dakota, 1997–1999. *JAMA*. 1999;282:1123–1125. <http://jama.ama-assn.org/cgi/content/full/282/12/1123> (Last accessed May 15, 2007).
- Herold, B.C., Immergluck, L.C., Maranan, M.C., Lauderdale, D.S., Gaskin, R.E., Boyle-Vavra S., Leitch, C.D., and Daum, R.S. 1998. Community-acquired methicillin-resistant *Staphylococcus aureus* in children with no identified predisposing risk. *Journal of the American Medical Association* 279(8):593–598.
- Tenover, F.C., Arbeit, R.D., Goering, R.V., Mickelsen, P.A., Murray, B.E., Persing, D.H., and Swaminathan, B. 1995. Interpreting chromosomal DNA restriction patterns produced by pulsed-field gel electrophoresis: criteria for bacterial strain typing. *Journal of Clinical Microbiology* 33(9):2233–2239.

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