

Anyone Who Had a Heart: A Case Study in Physiology



Phil Stephens
Biology Department
Villanova University, Villanova, PA

Part I—Prenatal Visit

It had been a hectic day for the doctor, and his last patient was on time for her appointment.

“Hi. Sis.”

“Hi, Jim. How’s my kid brother?”

“Tired—how’s the first-time mom? Have you stopped work yet?”

“Come on, Jim, I’m a career woman. The chemical industry needs me. It’s tough to go cold turkey. When Dave and I decided to have a family, we agreed that I should work as long as I could.”

“You’re the size of a house, Jen. You’re 37 years old, you have twins that are 28 weeks, and I really would like you to carry them as long as you can.”

“Oh, oh, here comes the lecture again. I know you didn’t like the fertility procedure we did, but I just couldn’t get pregnant. Anyway, as you so tactfully pointed out, doctor, I am not getting any younger. Look at it this way; we’re having our family all at once.”

There was a knock at the door and the nurse entered.

“How did the ultrasound go?”

“It’s like Times Square,” replied the nurse. “Arms and legs everywhere—it’s almost impossible to see anything, and those kids are so active. I just hope they slow down after they’re born, otherwise you’ll get no rest until they go to college. It’s crazy in there, with two hearts beating. And with yours in the background, it’s tough to isolate one. As best as I can tell, the rates are around 130 to 160 beats a minute.”

“OK, well let’s see if the expert can hear anything.”

Both women glared at the doctor.

“Do you need the crane or can you get up on the table by yourself?”

Jen looked at the nurse and said, “Is he like to this to all his patients?”

“No comment; I need this job.”

They laughed and Jim went to work. Moving the head of his stethoscope to different locations, he tried to isolate the sounds from one heart. His expression changed as he listened intently. Jen began to worry as her brother took longer than usual with his stethoscope.

“Is everything OK?” she asked.

Jim looked concerned. He was reluctant to tell his sister that he thought he had heard a heart murmur. Like his nurse had said, it was difficult to hear just one heart. He didn't want to alarm his sister, so he made a joke of the situation.

"Must be a girl in there, she won't stop talking. I think she said something about not leaving the hospital in just any outfit."

Jen went to hit her brother, but he easily evaded the playful smack.

"It's tough to predict when the babies will arrive, so I think you should start coming to see me every week, Jen."

"Is there a problem? You did all of the tests, and you said that I'm not diabetic. The alpha-fetoprotein levels indicate no neural tube defects, and that horrible amniocentesis procedure showed no birth defects or Rhesus problems."

"It's OK, Sis. It's quite normal for women who are close to delivery to visit their OB-GYN every week. It's tough to predict delivery with multiple births, because they rarely go full term. So, to be on the safe side, let's get together every week from now on. In that way I can see your lovely smiling face more often."

Jen scowled at her brother.

"For once in your life, do what I ask," Jim said. "And bring Dave with you next time."

A little later, as Jim was finishing his paper work for the day, the nurse returned to his office.

"Everything OK with Jen?"

"I can't stop thinking about that vague sound I heard. It sounded like a heart murmur, but it's so tough to single out with two kids in there."

"I thought I heard it too. The babies seem active and are about the same size. No history of birth heart defects in either family, but I guess you never know with twins in an older mom."

"My thoughts exactly. I don't want to worry her because you know how hyper she can be. I guess we'll need to keep a close eye on her, and on my nephew and niece."

"Does Jen know the sexes?"

"She and Dave don't want to know. They want to be surprised."

Questions

1. Draw a diagram of the heart of a human adult. Show the circulation of the blood through the heart and to and from the body and the lungs.
2. Draw a diagram of the heart of a human fetus. Show the circulation of the blood through the heart and to and from the body and the lungs.
3. What are the major structural differences between the fetal and the adult human heart? Draw and label these differences on your diagram of the fetal heart. How do these structures alter the circulation of blood?
4. Why is the pulmonary circulation reduced in the human fetus?
5. Are heart rates of 130 to 160 normal in a human fetus?



Part II—The Arrival

The ambulance that carried Jen sped through the crowded streets with its sirens blasting and lights flashing. The traffic parted, and people watched as the vehicle made its way to the hospital.

“My water had to break right in the middle of a meeting.”

“Don’t worry, Jen. I’m sure they understand.”

Her husband, Dave, was trying to comfort her, but then, true to form, he said something wrong. “Anyway, it’ll give them something to talk about around the coffee machine.”

Jen thought how lucky she was that her husband worked in the same office, but she didn’t like the idea of being the topic of office gossip. She was beginning to feel motion sickness from lying on a stretcher in a moving vehicle. Just then the ambulance stopped, its doors opened, and she was being wheeled down a long corridor.

Finally, the stretcher turned a corner and she felt Dave leave her side as she entered a delivery room. She felt the sting of a needle in her left hand. Then she felt Dave’s hand slip into hers and saw his eyes like slits between the cap and the surgical mask he had put on.

Jen felt a needle go into her back and almost immediately the lower half of her body felt numb; the epidural had taken effect. She looked up into the mirror and saw the surgeon with a child in his hands. The noise of first one crying baby and then another filled the room.

Jen held the babies and everyone, except Dave and the nurse, left the room. The babies were passed between the two of them as the nurse performed various tests.

“I came as quickly as I could,” Jim said as he entered the room like a hurricane.

Jen thought that he had been late for almost everything in his life, but she would forgive him this time. Jim kissed his sister, smiled at his brother-in-law, and then went over to the nurse. Jen and Dave could hear them talking softly.

“No problem, doctor.”

Jim came over to the new parents. “So, one of each. Any names picked out?”

“Brianna and Christopher,” said Jen.

“OK, Doc.” Dave smiled because he knew that Jim hated being called Doc. “Why were they blue when they were born?”

“That’s quite normal, but they should have changed to pink a minute or so after they were born.”

“So why does Brianna still have blue finger tips and lips?” asked Jen.

“It’s called cyanosis; it’s not uncommon. Don’t worry. One advantage of being related to a doctor is that all three of you will get first-class treatment.”

“I hope so, because Chris has pink lips, and he’s breathing at a much slower rate than his sister.”

Questions

1. What vital signs or symptoms do the two babies exhibit?
2. What is cyanosis?

3. Would you be alarmed that Brianna has cyanosis and Christopher does not? Why?
4. Why would the cyanotic baby have a faster breathing rate?
5. What are the possible diagnoses for Brianna's condition at this time? For each diagnosis that you come up with, describe the signs or symptoms that relate to that diagnosis.



Part III—The Babies

A wave of exhaustion washed over Jen as a second nurse entered the delivery room.

“OK, it’s time for Mom to check into her room. The pediatric nurse will take the babies to the greenhouse where you can show them off to your family.”

“Don’t worry, they call it the greenhouse because of all of the windows where friends and relations can come and see the babies,” explained Jim. “You will be here a few days because of your surgery, Jen, and you’ll need to get some rest. Dave, why don’t you go up with Jen and settle her in? I’ll stay here with the nurse and make sure the kids don’t get lost. I’ll be up soon.”

The new parents smiled and left the delivery room.

“Nice job, Doc.”

At that moment, Dr. Penny Smothers entered the room with a fresh-faced medical student.

“No sense in worrying the new parents. Hi, Penny. I am afraid we may have problems with the new arrivals.”

“Hi, Jim, nurse, this is Sam Jones. He’s a medical student interested in becoming a pediatrician. He’ll be following me around for the next few weeks. Now, the babies, were there any prenatal indications of problems?”

“I thought I heard a heart murmur, as I told you when Jen selected you to be the kids’ doctor, but it was tough to get a clear handle with twins.”

“OK, Sam, you’re up. Go listen to each child’s heart and tell us what you think. Please remember your bedside manners. Their names are on the plastic ring around their ankle, so please remember how you upset the last set of parents with twins. Get into the habit of using their names rather than referring to them as that one!”

Sam listened to the heart of each child with a stethoscope.

“Christopher has a heart rate of about 120, his heart sounds normal, and his color is pink. Brianna is cyanotic. Her breathing is much faster and deeper than Christopher’s, and she is beginning to cough. She has a heart rate of 160 and a heart murmur—and there is a whirring sound between the lub and the dub.”

“Well, let’s hope that’s an exaggeration,” Penny whispered to Jim as they went over to examine the children.”

“Oh, my gosh, he’s right!” Penny exclaimed. “Nurse, get Brianna into the neonatal intensive care, stat. If there’s room, try to get Christopher in there too.”

She turned to her student.

“OK, Mr. Hotshot, what tests do you think we should do?”

Even though the tension was high and Jim had a personal interest in the health of his newly arrived nephew and niece, he couldn’t help but smile as Penny rewarded her student’s good work with more pressure.

Questions

1. What additional signs or symptoms do the two babies exhibit?
2. What creates the lub heart sound?
3. What creates the dub heart sound?

4. What is a heart murmur?
5. Do murmurs have different sounds and are they correlated with different problems?
6. What creates the whirring sound between the lub and the dub in Brianna's heart?
7. What are the possible diagnoses for Brianna's condition at this time? For each diagnosis that you come up with, describe the signs or symptoms that relate to that diagnosis.
8. If you were the pediatrician, what tests would you perform to help you narrow the possible diagnoses for Brianna's condition?



Part IV—Brianna

Here is a table of some of the children's vital signs soon after they arrived in the Intensive care Unit:

Color of finger tips and lips	Blue (Cyanotic)	Pink
Heart sounds	Lub whirrrrr dup	Normal
Arterial PO ₂	100	100
Breathing	Heavy, rapid, congested	Normal
Feeding	Disinterested	Normal

Brianna's congestion is becoming progressively worse and she is coughing. And, although she is lethargic, the coughing is keeping her awake.

Questions

1. What new signs or symptoms do the two babies exhibit?
2. What are the possible diagnoses for Brianna's condition at this time? For each diagnosis that you come up with, describe the signs or symptoms that relate to that diagnosis.
3. If you were the pediatrician, what tests would you perform to help you narrow the possible diagnoses for Brianna's condition?



Part V—Brianna: Follow-up

An echocardiogram reveals that Brianna’s heart valves are normal—neither incompetent nor stenotic.

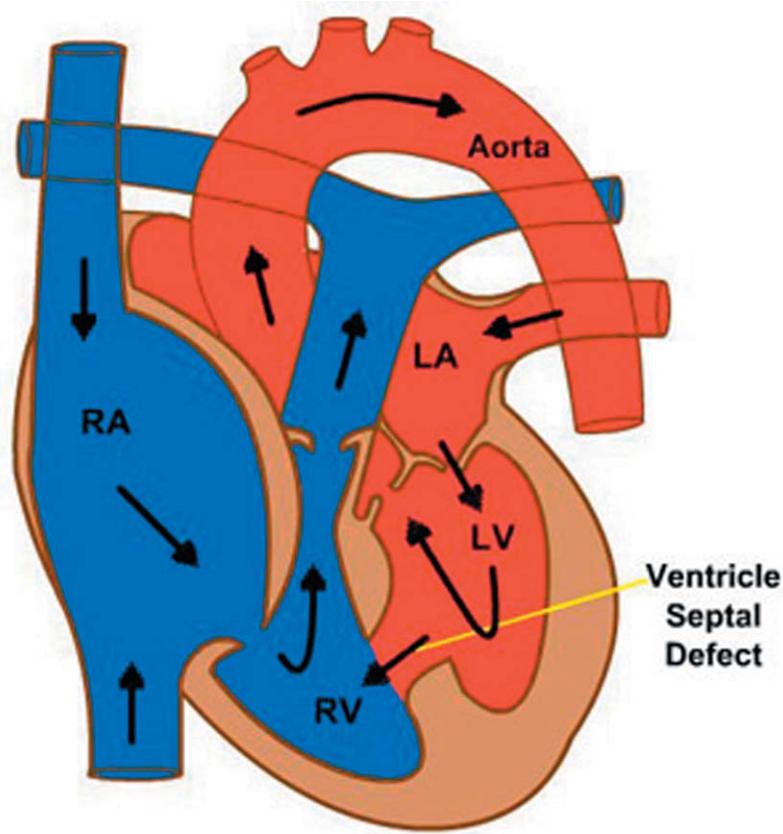
Questions

1. What are the possible diagnoses for Brianna’s condition at this time? For each diagnosis that you come up with, describe the signs or symptoms that relate to that diagnosis. Try to think logically—sometimes the line of reasoning and the correct questions are more important than the answer.
2. Does a heart murmur necessarily indicate a dysfunctional valve? What other defects could produce the murmur heard through the stethoscope?



Part VI—Brianna: Conclusion

The echocardiogram reveals that blood is flowing between Brianna's left and right ventricles due to a ventricle septal defect.



Questions

1. Does this diagnosis fit Brianna's vital signs?
2. What created Brianna's heart murmur?
3. Why is Brianna's blood pressure lower than Christopher's?
4. Is it reasonable that Brianna's arterial PO_2 is the same as Christopher's?
5. Why is Brianna breathing rapidly and deeply?
6. Do you think Brianna's blood pressure is normal? Explain your answer.
7. Why is Brianna congested?
8. What is the long-term treatment for Brianna's condition?

Copyright © 2004 by the National Center for Case Study Teaching in Science.

Originally published 12/04/04 at http://www.sciencecases.org/fetal_heart/fetal_heart.asp

Please see our [usage guidelines](#), which outline our policy concerning permissible reproduction of this work.