

Keeping up with the Joneses: A Case Study in Human Physiology

by

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Part I—The Accident

Suzie Jones felt her heart pounding and the sweat dripping from her forehead as she ran the last mile through her neighborhood. She had left home at noon and had run around the high school track for what seemed like hours. She felt tired when she started, but found it pleasurable to drive her body to a point of exhaustion, believing that she could run forever on that warm spring afternoon. As a child, she had hated exercising, but now she found it helped clear her head and get her thoughts into perspective. Suzie felt light-headed as she rounded the corner for home.

“Funny,” she thought. “Where’s Mom’s car?”

She saw a note taped to the garage door.

David’s had an accident, come to the hospital ASAP.

“This time next year I’ll be able to drive,” muttered Suzie as she started to run the mile to the hospital.

Suzie entered the Emergency Room and saw her mother sitting with her brother Dave’s baseball coach.

“What happened?” asked Suzie.

Mrs. Jones looked at the coach and he answered: “A freak accident. Dave rolled his ankle as he was rounding first base. He hit the ground and we all thought that his leg was broken, but the x-rays proved us wrong. It’s just a badly sprained ankle.”

Suzie nodded her head in response as she walked the short distance to the water fountain. Just then, Mrs. Jones noticed one of the nurses and said to Suzie, “Isn’t that your friend’s sister at the nurse’s station? Why don’t you ask her how your brother is and how much longer this will take?”

“Mom, I’ve been running for hours and I smell. I look a mess. If it hadn’t been for your note telling me to come right away, I would have showered and changed before coming here.”

“Fine, Susan. We’ll just wait then,” replied Mrs. Jones, making her daughter feel guilty.

After about 10 minutes, a nurse called Mrs. Jones into the examination room, and after another 15 minutes she appeared with Dave, who was sitting in a wheel chair, awkwardly holding crutches. Suzie and the coach rose to meet them.

“I’ve given you a prescription for a more powerful analgesic than your regular over-the-counter pain medicine,” said the doctor. Mrs. Jones held up the piece of paper and smiled at the young intern.

“Inflammation is caused by fluid moving from the blood and accumulating in the space between the cells. To minimize the inflammation of Dave’s ankle, just remember PRICE—Protect, Rest, Ice, Compression, and Elevation. Call your family physician if his pain becomes severe,” said the young doctor as he walked back to the examination rooms.



Questions

1. What two parameters are responsible for creating the movement (filtration and reabsorption) of fluid across the capillary wall?
2. Draw a diagram of a capillary and label *arteriole* at one end and *venule* at the other. With pressure on the vertical axis, draw two lines to show how the two parameters (see question 1 above) vary along the length of the capillary.
3. Under normal circumstances, what components of the blood cross the capillary wall?
4. Cytokines, like histamine and leukotrienes, are secreted by damaged cells in Dave's ankle. How do these cytokines cause inflammation?
5. How does the application of ice to the ankle affect blood flow through the capillaries?
6. How does the removal of ice from the ankle affect blood flow through the capillaries and the cytokines?
7. How does compression, which is provided by an elastic (Ace) bandage wrapped around the damaged ankle, decrease inflammation?
8. How does elevation of the damaged ankle decrease inflammation?

Part II—The Next Morning

Suzie joined her mother at the breakfast table while Dave sat in the den watching television.

“Cold, Suzie?” asked her mother.

“I am always cold these days,” replied Suzie.

“I was thinking,” said Mrs. Jones. “I didn’t trust that doctor in the hospital yesterday. He was so young I wonder whether he has a medical degree. I would feel more comfortable if we had gone to Dr. Fay. I called her office, but the earliest appointment we could get is tomorrow. This flu outbreak is keeping them busy. They said that David should take your scheduled appointment today; that they can fit you in tomorrow. Why don’t you have breakfast and you can come with us? You never know, they may be able to squeeze you in for your annual physical.”

“Okay mom. But I already ate breakfast,” said Suzie.

“When?” asked her mother.

“Oh, earlier,” said Suzie vaguely. “I’ll go get changed now.”

Suzie was feeling resentful as she got up from the table. Her mother doted on her brother. He had always been their parents’ favorite, no matter what Suzie did at school or with her ice skating. Her older brother always came first.

Just then they heard a moan from Dave in the den and the two women rose from the table. Suzie felt faint and passed out on the floor. Flustered over having to decide whether to tend to her son or to her daughter first, after a moment’s hesitation Mrs. Jones took Suzie’s feet and placed them on a chair, elevating her legs, and then went to her son to check on him.

Suzie slowly gained consciousness and cautiously sat on the chair. She sipped water from a glass on the table before standing up and walking to her room to change. In 10 minutes they were in the car and on their way to the doctor’s office.

Suzie was tired of listening to her brother complaining to their mother about his ankle. She was hungry and felt like she had no energy, but tried to convince herself that her hunger would soon pass. When they got to the doctor’s office, Suzie went to the nurse’s station, but everyone was busy. Bored, she decided to stand on the scale and weigh herself and check her height.

The nurse appeared just as Suzie stepped off the scale. “Hi Suzie. We’ve been busy today. Sorry you had to wait.”

“Just passing the time by checking my weight and height,” Suzie said as she pushed the metal sliders to their zero positions.

“So what was it?” asked Dr. Fay as she passed by the scale.

“Hi Dr. Fay, 5 foot 8 inches and 120,” Suzie replied.

“I thought you were coming in for your physical today,” said Dr. Fay.

“I was, but Mom said that Dave should see you because he hurt his ankle at practice yesterday. But I’ll be in tomorrow for my pre-season physical,” Suzie responded.

Some time later, Suzie’s mother and brother came back into the waiting room. Her mother seemed annoyed.

“These doctors stick together. She just repeated what that young hospital doctor said yesterday.”

Questions

1. What problems are there in Suzie’s life, and does she exhibit any peculiar signs and symptoms?
2. Why did Suzie pass out when she stood up?
3. Why did Suzie’s mother place Suzie’s feet on a chair?
4. Why did Suzie feel as if she had no energy at the doctor’s office?
5. Make an initial speculation about Suzie’s condition at this time. Assuming that your speculation is true, what do you think the doctor will find in the results of Suzie’s physical examination?

Part III— Suzie Sees the Doctor

Suzie sat in the kitchen listening to the rhythmic sound of one of her mother's exercise machines next door. The sound stopped and a few minutes later her mother came into the kitchen with a towel around her neck.

"Do you mind going to Dr. Fay's by yourself this morning?" she asked. "David's still not himself, and all I do is sit outside and wait for you anyway. I'll drive you there and you can walk back. It's a nice day and I know you will enjoy the exercise."

"No problem, mom," Suzie replied.

"Your father comes home tonight from his business trip and I can use the extra time to clean up, so that he doesn't come back to a dirty house."

Thirty minutes later Suzie began her physical examination.

"You're supposed to take off your shoes when we weigh you," said the nurse as Suzie stepped off the scale.

"Shouldn't make too much difference," replied Suzie.

The nurse looked closely at Suzie's face as she waited for her to remove her sneakers before getting back on the scale. The nurse adjusted the weights and the ruler.

"That's better. Now let's get your blood pressure," said the nurse.

Suzie sat on the chair and the nurse put the cuff around her right arm. Suzie felt the cuff squeeze around her arm and then a slow release as the cuff deflated. The nurse seemed puzzled, so she repeated the procedure and got the same values. She wrote the blood pressure on Suzie's chart.

Next Suzie felt the nurse repeatedly jab the inside of her right arm and then the sting as the nurse was finally able to draw blood.

"We meet again, young lady," said Doctor Fay as she entered the room. "So, an annual physical and a pre-season physical all rolled into one."

The doctor looked at the chart with only a few entries from the nurse, then said, "Okay, let's take a look."

When the physical was over Suzie looked in the mirror and caught Doctor Fay looking at her as she put on her sweats. Doctor Fay had a pained expression on her face and asked, "Is your Mom waiting for you outside?"

"No, she's looking after Dave," Suzie replied.

"Your brother has an appointment with me tomorrow morning at 11. Why don't all three of you come in and see me. We'll have the results from your blood work by then, so we can kill two birds with one stone," Dr. Fay suggested.

"Can you at least give me the physical form so that I can skate? The first practice is tomorrow morning," Suzie pleaded.

"Sorry; I can't do that until the blood work comes in. Do you think that missing one practice will hurt?"

"I guess not," replied Suzie. "I'll explain to the coach that my brother is sick and Mom switched our appointments. Maybe he'll let me practice."

Questions

1. What new signs and symptoms does Suzie exhibit that would concern you if you were the doctor?
2. Do you wish to make any further speculation about Suzie's condition at this time? Assuming that your speculation is true, what do you think the doctor will find in the results of Suzie's physical examination?

Part IV—Back to the Doctor’s Office

Here are some data from Suzie’s physical:

Table 1		
<i>Condition/test</i>	<i>Normal</i>	<i>Suzie</i>
Height		5 ft 8 in
Weight		105 lb
Blood pressure	120/80	88/56
Hematocrit	37–47	32
RBC		Pale & immature
Heart rate	72	65 ectopic beats
Cardiac output	4.5–5 L	3.6 L

After sending the nurse to the outer office to get the lab results on Suzie’s blood, Dr. Fay turned to Suzie and her mother and said, “Suzie, before we discuss the results, you say that you run a lot?”

“That’s right,” replied Suzie, “This is my time to shine. I start competitions soon, and they run through the end of the year. I have always dreamed of getting to the Olympics, and my big chance is next February. From there, I could get a scholarship and go to college without being a burden to my parents.”

“What do you drink after you exercise? Any sports drinks?” the doctor inquired.

“No, just water, I hate the taste of those drinks. They are too salty and I hate that sweet, sticky feeling it leaves in my mouth.” Suzie became quiet and sullen, almost introverted.

“Who needs all of that sugar?” her mother asked.

“In this case, I think Suzie does,” said Dr. Fay. “The results of her blood work will give us more information on that.”

Questions

1. Is Suzie’s weight reasonable for her height?
2. Calculate the stroke volume of Suzie’s heart, and compare it to that of a normal individual.
3. Why do you think her blood pressure is lower than normal? Does low blood pressure explain any of Suzie’s signs and symptoms that you may have noticed?
4. Why is Suzie’s hematocrit low, and why are her red blood cells pale and immature?
5. Compared with a normal, healthy person predict the level of the following in Suzie’s blood (higher, same, lower): sodium, potassium, calcium, glucose, iron, and protein.
6. Do you wish to make any further speculation about Suzie’s condition at this time?

Part V—Blood Results

Level	Normal	Suzie
Sodium	136–145mmol/L	126mmol/L
Potassium	3.6–5.1mmol/L	2.4mmol/L
Calcium	4.2–5.3mmol/L	2.9mmol/L
Fasting Glucose	65–95mg/mL	55mg/mL
Iron	50–140ug/dL	38ug/dL
Protein	6–7.8g/dL	3.9g/dL

The doctor continued, “There’s no need to worry about your son, Mrs. Jones, the nurse will help him if he has any problems with his ankle. Now Suzie, I can’t stress enough that the results of your physical examination show that you are in bad physical shape. I appreciate that you are driven to succeed, but as your doctor it’s my duty to tell you that you are going about this in the wrong way.”

“I feel great, doctor. I’m in the best shape I have ever been. I can run forever. So my blood pressure is a little low and I have had some fainting spells. Maybe I have been overdoing things lately and I’m a bit dehydrated. I am on the ice now, so I won’t be running as much as I concentrate on skating,” Suzie replied.

“I understand that, but I’m afraid that you’re heading down the wrong road. When did you last have your period?” Dr. Fay asked.

“I don’t remember. About a month ago,” replied Suzie, avoiding eye contact with the physician.

“Perhaps a little longer? We didn’t do a percent body fat test, but I would predict it is low. In fact, I would predict that your estrogen levels are too low to produce menses. Do you go to parties with your friends?” the doctor asked.

“She’s lost interest in boys,” replied Mrs. Jones. “She lives to skate.”

The doctor nodded and continued, “I bet you’re on a low-fat diet and your caloric intake is too low. It doesn’t take a medical degree to see that you’re under weight. You are starving yourself, Suzie, and your bones stick out. Sure, you have a nice sun tan because you’re outside a lot, but look at your tan lines; your skin is pale and flaky.”

“But I am almost there,” exclaimed Suzie. “I still have fat under my skin.”

“That’s not fat. You’re so malnourished that what you see as fat is, in fact, an edema; it’s fluid. Your blood protein levels confirm that.”

Questions

1. Assuming that the ion levels in the blood plasma are similar to those in the interstitial fluid, what is the effect of low potassium levels on the membrane potential of Suzie’s nerve and muscles?
2. Does this explain Suzie’s slow heart rate and ectopic beats?
3. How does low plasma calcium level account for her decreased stroke volume?
4. What is the role of blood proteins in the movement of fluid between the blood and the interstitial space?
5. What would be the effect of low blood protein levels on the colloidal pressure?
6. How do low plasma protein levels produce edema?

Part VI—Conclusion

“Suzie,” said Dr. Fay. “This is serious. You are suffering from what is known as the *female athlete’s triad*: a combination of disordered eating, loss of your period, and osteoporosis. Your rigid eating habits and strenuous training regimen have produced loss of menses, and if you keep going like this you are likely to develop osteoporosis. I assume that you’ve heard of *anorexia nervosa*? I think that you are anorexic and your extreme exercise regimen is making things worse. I appreciate that a girl of your age is very aware of her body, and I don’t think it’s your fault entirely. I think that you are striving to please your parents, who seem to be pulled in other directions.”

“We do our best, but it isn’t easy with Dave. You know, we almost lost him when he was a baby.” Mrs. Jones interrupted defensively.

“That must have been very hard on you at the time, but he’s going into his senior year and will be away at college next year. When was the last time you sat down to dinner as a family or the last time you went to one of Suzie’s competitions?” the doctor asked.

Mother and daughter looked at the floor.

Dr. Fay continued: “I am going to send you to a counselor, Suzie. I am also going to recommend that the entire family takes part so that all aspects of your problem can be addressed. You’re a fine young lady who needs to take care of herself. Continue like this and you’ll be in a hospital within a month. I already have enough data here in my hand to admit you to a hospital where they will monitor your food intake and feed you through a tube if necessary. However, I have known your family for years and believe that you’ll do what is necessary to make things come out right in the end. Now, when are you coming back to see me?”

Questions

1. What conditions make Suzie a candidate for anorexia?
2. Do you think the doctor’s treatment is appropriate, or would you have admitted her into hospital?
3. When do you think Suzie should schedule her next visit to the doctor?



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