

# Driving Can Be Dangerous to Your Health: An Interrupted Case Study in Physiology

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## Part I—The Grandparents Arrive

Dave pulled the cell phone out of his pocket, cursing himself for not putting it on vibrate. The children, Jason and Laura, were both asleep, and he knew that the rest of the day would not be fun if they were awakened from their naps.

“Hi, Dave. We’re just a few minutes away,” said his father.

“OK, see you soon.”

Dave looked at his wife Jen, who smiled. “Come now, Dave, you know your Mom and Dad. There’s no stopping them once they get going; driving 1200 miles in one day. I guess they’re impatient to see their granddaughter. Mom never got over the fact that her hip replacement was scheduled at the same time that Laura was born.”

“I know, Jen. She takes being the only grandmother very seriously.”

A car pulled into the driveway and Dave and Jen went out to greet their visitors. They all crept into the house and sat in the kitchen quietly drinking coffee. His mother was breathing heavily, which made Dave recall his childhood and what it had been like to grow up with an asthmatic mother.

“Hi Grandpa,” said Jason, as he ran into the kitchen in his pajamas.

“Hi, big guy. Wow, you’ve grown. How old are you, now?”

Jason smiled as he held up four fingers. He extended both arms so that his grandfather could lift him onto his lap. He stood on his grandfather’s legs and looked over his shoulder for presents.

Everything stopped when they heard crying from upstairs.

“Let’s wait and see if she goes back to sleep.”

They all sat quietly, but the crying got worse. Both women stood up.

“I’ll get her, Mom. She is beginning to recognize faces, and I don’t want to start you off on the wrong foot.”

“Come on, buddy, let’s go out to the car and see what we brought you from Florida.”

Dave watched his father and son walking hand-in-hand out the front door, as his wife and daughter come into the kitchen. His mother’s arms went out and he could see the pleasure in her eyes when she held her granddaughter. Laura was holding a stuffed toy bear in her arms.

“My goodness, is that your old bear, Dave?”

“Yes. We found it in one of the boxes you gave me, and Laura latched onto it. It’s a bit dusty, but we’ve been afraid to wash it because it may fall apart.”

Laura giggled as her grandmother cooed to her while carrying her around the kitchen.

“Should you be doing that?” Dave asked his mother. “With your hip and all.”

“I’m fine, just a little breathless. Guess I’m a little out of shape for babies.”

She gave Laura back to her mother and sat down. Her breathing was labored, and Dave recognized the signs of an oncoming asthma attack. He rushed to the door and shouted to his father to get the nebulizer.

Dave could hear his mother’s wheezing as she tried to breathe out. He never understood why it was more difficult for asthmatics to breathe out than breathe in, and why exhaling took so much longer than inhaling. His father calmly placed the liquid medicine into the nebulizer cup, plugged in the machine, and turned on the compressor. He helped his wife hold the mask to her face.

Soon, her breathing was regular; deeper than normal, but regular.

Jen noticed that Jason was alarmed, and she wondered whether he had forgotten that his grandmother had had some attacks during their last visit.

“It’s okay, Jason,” she said. “Grandma sometimes has a problem with her breathing. But you can see that her medicine makes her better quickly.”

Jason looked relieved and smiled.

### **Questions**

1. What factors can trigger an asthmatic episode?
2. What do you think triggered the asthmatic episode in this case?
3. Imagine that you are performing a lab in which you are monitoring breathing in a student volunteer. Draw a graph, with time on the horizontal axis and breathing movements on the vertical axis. Draw a line to show the results you would expect for a healthy student, assuming that inhaling produces an upward deflection of the line and exhaling produces a downward deflection of the line.
4. Draw a second line to show the results you would expect from someone having an asthmatic episode. Pay close attention to the slopes of the lines (the rate of air movement) and the amplitude of the waves (the amount of air flowing in and out of the lung during each breath).
5. Which of the airways (trachea, bronchi, and bronchioles) do not contain rings of cartilage, and are therefore more likely to collapse?
6. Why is air flow restricted during an asthmatic episode?
7. Why is wheezing usually worse when asthmatics exhale?

## Part II—That Night

“I’m glad they went to bed early,” said Dave. “They look really tired.”

“Yes,” agreed, Jen. “They really shouldn’t have done the entire trip in one day. Florida to New Jersey in 19 hours; must be a record.”

“Poor Muffy,” said Jen as she looked down at the old cat curled up in her lap. “He’s lost his favorite sleeping spot on the spare bed. He’ll have to camp out in our room while your parents are here.”

“He smells like tuna. I caught him in the recycling again, and I think he cut his nose on an aluminum can.”

Jen smiled. She had been given Muffy as a kitten, long before she knew her husband.

Upstairs, Dave’s parents, tired from the long day, were sleeping.

Hours later, Dave’s father woke from a deep sleep. His wife’s breathing was labored, and she was wheezing.

“Are you okay, Barb?” He knew that his wife was awake, but he did not wait for an answer. He opened the bedroom door and turned the light on in the bathroom. He set up the nebulizer, carried it into the bedroom, and gave the mask to his wife as he plugged it into the outlet. Her breathing became more regular, but it was fast; she was wheezing and seemed anxious. Even in the dim light, Barb looked pale.

“I have this pain in my chest and neck, John, and it’s making its way down my left arm.”

He reached for her hand and it felt cold and sticky. He placed his finger on the inside of her wrist and felt her pulse racing.

“I think we need to go to the hospital, Barb.”

“I know, but the pain gets worse when I move. It was just an ache before you went to the bathroom, but now it really hurts and I feel like I am going to pass out.”

Dave knocked on the open bedroom door and entered his parents’ room. His father was dressed and his mother was clearly distressed.

“I heard Mom coughing. Is everything okay?”

“I’m not sure. This is the worst attack she’s ever had. I think we need to get her to the hospital.”

Dave pulled on some clothes and in no time he and his father had his mother in the backseat of the car. The hospital was only a few miles away.

“Do you have any tissues, Dad?”

John passed a box of tissues to his son. He could hear Barbara coughing, and pushed down on the gas peddle.

### Questions

1. Do you think that this episode is simply a bad asthmatic attack?
2. What could have brought on this episode?
3. What symptoms indicate that this may be something else?
4. With the above symptoms in mind, do you wish to speculate about Barbara’s condition?

## Part III—The Hospital

John pulled up in front of the hospital and opened the back door of his car. He saw Dave holding a bloody tissue as they picked up his wife and carried her into the Emergency Room. The nurse saw the two men holding the older woman and the blood on the tissue, and ushered them into a cubicle.

The nurse put a clip on Barbara's finger and turned on the heart monitor. The two men could hear the fast beeping sounds and saw "95 bpm" appear in the lower right corner next to the heart icon. The nurse started an IV, and took Barbara's blood pressure (90/58). Finally, she put a plastic ring around Barbara's head and a tube up each nostril.

"What's that for?" asked John, concerned for his wife.

"It's called a nasal cannula. It's used to administer oxygen, should the doctor decide that it's necessary."

The nurse stepped back when the doctor entered the cubicle and she began to examine Barbara. John told her about the asthma attack that afternoon, and the second unusual attack that had happened in the last hour.

"Did your wife complain of chest pain?"

"Yes, she said that it was in her chest, neck and left arm. I thought that she was having a heart attack."

"That is possible," continued the doctor. "Are your wife's legs usually swollen?"

John explained that his wife's legs often swelled when they took road trips because they were in the habit of driving long distances without stopping. The doctor frowned at John.

"Did you notice that the swelling is worse in her right leg?"

"No doctor," replied John. "But her right hip was replaced about six months ago."

"Your wife had major surgery, and you drove how far?"

"That was my fault," said Barbara. "My granddaughter was born around the time I had my hip surgery, and I wanted so desperately to see her."

"If my initial prognosis is correct," the doctor continued, "you may be staying here for a few days." She reached down and turned on the flow of oxygen through the nasal cannula, and made notes on a chart.

"An orderly will take you to your room. I'll schedule you for some tests."

The bed was pushed out of the cubicle and John went to follow. The doctor turned to John and continued, "Perhaps you should go to Admissions while we get your wife settled in. I am afraid there's a mountain of paperwork waiting for you."

### Questions

1. Is Barbara's heart rate normal?
2. Is Barbara's blood pressure normal?
3. What can you conclude from these two observations?

4. What two parameters are responsible for creating the movement (filtration and reabsorption) of fluid across the capillary wall?
5. 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 (Question #4) vary along the length of the capillary?
6. Why does a lack of movement create swelling in Barbara's legs?
7. Why is swelling restricted to her legs? Why didn't her arms swell?
8. If you were the doctor, what tests would you perform?

## Part IV—Tests, Tests, and More Tests

John held his wife's hand. The hip replacement surgery had worried her, but at least she understood what was going on. Tests using computers and X-rays were something else because she did not understand them. He smiled as he remembered how she would spend hours on the Internet doing research before surgery.

"I didn't know that they could do another X-ray so soon after the ones I had for the surgery, but the technician said that it was necessary to rule out a lot of possibilities. Did you go on the Internet, as I asked you? What did you find out about the V/Q scan I had?" Barbara asked John.

"The Internet is a wonderful, thing, Barb. I think I may be your first convert," said John as he fumbled in his pocket. He put on his glasses and read his notes on the folder paper.

"Did they get you to inhale a powder and take pictures, and then take more pictures after they injected something into your vein?" asked John.

"Yes. The technician said that they were radioactive tracers, but the radiation was at such low levels that it was not dangerous."

"Well, that sounds right. This ventilation quantification scan, or V/Q scan as you called it, allows them to see air flow and blood flow through your lungs," said John.

"They seemed to get the results quick enough, because then they took me for a spiral CT scan, which apparently takes a bunch of x-rays and then uses a computer to make a 3-dimensional picture of me! It's really amazing what they can do these days."

"What I don't understand," Barbara continued, "is why they scanned my legs with the CT and then did an ultrasound. I know my legs are swollen, perhaps a little worse than usual, but they always swell up after long car trips."

John stood up and walked around the bed. He picked up the chart hanging on the bottom of the bed and glanced at the notes written when his wife was admitted.

Test	Barbara	Normal
ECG	Normal (fast)	Normal
Heart rate (b/m)	95	75
Blood pressure	90/58	110/65
Arterial PO <sub>2</sub>	78	100
Arterial PCO <sub>2</sub>	45	40
Blood pH	7.25	7.4
Blood creatine phosphokinase-2	2.7 nanograms/mL	3 nanograms/mL
Blood troponin-I	1.9 micrograms/L	<3 micrograms/L
Breathing rate	20; labored	12
Breathing sounds	Wheezing	—
Asthmatic	Yes	—

## **Questions**

1. What do the ECG and the blood levels of creatine phosphokinase-2 and troponin-I tell you about the likelihood that Barbara had a heart attack?
2. Why are Barbara's arterial  $PO_2$ ,  $PCO_2$ , and pH values different from normal?
3. Are your ideas consistent with her blood pressure and heart rate?
4. What conditions cause contraction of the bronchiole smooth muscle?
5. What conditions cause contraction of the (pulmonary) arteriole smooth muscle?
6. Why did the doctor ask for a CT scan and ultrasound of Barbara's legs?
7. With Barbara's symptoms in mind, and the tests that were performed, do you wish to speculate about her condition?

## Part V—A Few Days Later

After they returned from the hospital, Dave and Jen took the children to dinner and a movie in order to give the grandparents some peace and quiet. As they came into the house, John was coming down stairs carrying the cat.

“I found Muffy in our room,” said John.

“How’s Mom?” asked Jen taking the cat from her father-in-law.

“She’s asleep right now.”

“I called work and they’ve given me the rest of the week off,” Dave said to his father. “We’ve booked Mom and me on a flight to Orlando on Saturday.”

“That’s perfect, son, I’ll pick you up at the airport.”

“So, what did the doctors say?” asked Jen.

“Well, as you know, she had a pulmonary embolism,” replied her father-in-law. “That’s a blood clot in her lung. They found clots in the veins in her thighs, and think that one of them broke loose and traveled to her lung and blocked the blood circulation there.”

“So only part of her lung was functioning,” interrupted Jen. “I guess that, together with her asthma, gave her the breathing problems.”

“That’s what they said,” confirmed John. “They repeated the tests and found that the initial intravenous heparin treatment dissolved the embolism in the lung and the blood clots in the veins in her thighs. So there shouldn’t be any more embolism problems in the near future. The Warfarin tablets have stabilized her blood clotting. She needs to take the tablets as prescribed. She doesn’t need any more medication today. Oh, and she’s not supposed to take any aspirin or ibuprofen because they can affect blood clotting.”

Jen and Dave nodded.

“I called our doctor in Florida and Mom has an appointment on Monday,” said John. “In the meantime, all you need to do is look for signs of bleeding like bruises, purple toes and fingers, or if she tells you that she has blood in her urine, is feeling dizzy, weak, or has a headache. We must try to keep her moving around; apparently clots are more likely to form if she is sedentary. The doctor says that Mom will be on this anticoagulant medicine for months, and she should get periodic blood work to check that the Warfarin is keeping her blood clotting times within normal limits.”

Jen looked down at Muffy, who was squirming in her lap, and saw blood on her pants.

“That cut must have opened up again,” said Jen as she held a tissue to the cat’s nose. “You’d better get some sleep, Dad, if you are going to start driving to Florida tomorrow.”

Jen looked at Muffy’s nose, but the bleeding would not stop. After about ten minutes, she gave the cat to Dave and went quietly upstairs to the spare bathroom. Two minutes later she came downstairs.

I’m afraid that Muffy got into Mom’s medicine. I can see we’ll need more Warfarin, and I’d better call the vet.”



## Questions

You should consult the Internet for this last group of questions.

1. What would a V/Q scan tell the doctor about air flow through the affected part of the lung?
2. What would a V/Q scan tell the doctor about pulmonary blood flow to the affected part of the lung?
3. Why should Barbara not take aspirin or ibuprofen?
4. How does Warfarin control the clotting time of blood?
5. If Muffy the cat ate Warfarin, which is used as rat poison, what would be the vet's treatment?

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