The Hot Tub Mystery: The Story of a Very HOT Tub

Herbert House
Biology Department
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Part I—The Discovery

Cast of Characters

- Sam Garrison—Detective
- Roma and Clint Underhill—The *hot* couple
- Kavita Dickson and Larry Gonzales—EMT paramedics
- Renee Volenbach—Physiologist in the Biology Department at Noletown University

Friday, 7PM

Roma and Clint Underhill had both had a long day. They were the owners of a successful real estate company in Desert Palm. Each had several clients, and the strain of the current real estate market was getting to them. It had been an unusually cool day for January, with temperatures hovering around 60 degrees. On coming home they decided to relax in their hot tub with some wine. While Roma changed from her work clothes, Clint said that he would join her in the hot tub after he took his Lasix.

Saturday, 8AM

"911… Please state your emergency."

"Oh, Oh, I… I… "

"Ma'am, please calm down and tell me the address."

"I think…, yes, OK, it's… it's 2560 Oak Creek Drive."

"What is the problem, please?"

"I'm the maid for Mr. and Mrs. Underhill and… and I didn't find them in the house when I came in this morning, so I looked around outside. I just found them in their hot tub out back. They are under the water. Please come, please come now!"

"Yes, ma'am, I'm alerting the EMTs and an ambulance will be on the way. Please go out front and wait, so the paramedics can find the address quickly."

Saturday, 8:10AM

Paramedics Kavita Dickson and Larry Gonzales brought the ambulance to a stop at the end of a long driveway next to an impressive two-story mansion. The maid was on the front steps and quickly directed them to the back patio where the hot tub could be seen.

Empty bottles of wine were on the ledge surrounding the hot tub. Kavita quickly climbed up the steps and saw the bodies of the Underhills on the bottom of the hot tub. As she got into the water, she exclaimed, "This water seems really hot. Let's see if we can get them out." Larry climbed in after her and together they

dragged the bodies out of the hot tub and onto the patio. It was obvious that both had been dead for some time. Kavita called the dispatcher.

"Listen, Linda, this hot tub case is a DOA, but something is not right. How about sending the medical examiner and a detective out to look the situation over. Tell them to bring a thermometer!"

Questions

1. What observations did the paramedics make?
2. List the questions raised about this situation or that you think that the investigators should ask of the maid.
3. List any physiological effects that you think would be associated with this situation.
4. How might these physiological effects have contributed to the Underhills' death?
5. Make an initial speculation about the cause of the Underhills' death.

ANSWERS:

1)

- empty wine bottle, Hot Tub Water too hot, Bodies in hot tub

2)

- The investigators should ask the maid about:
  - the underhill's hot tub habits, their use of alcohol, and whether or not they are taking any medication
- the investigators should raise the following questions:
  - what is the cause of death?
  - if the cause was drowning, were the Underhill's conscious immediately prior to drowning?
  - Is there evidence of foul play?
  - What are the roles of alcohol, temperature, and heat on the body?

3)

- effect of temperature on peripheral resistance:
  - Vasolidation reduces peripheral resistance and decreases blood pressure
- effect of alcohol on the brain and body:
  - narcotizes the brain and prevents normal responses to decreased blood pressure
  - vasolidation due to decreased sympathetic stimulation
  - dehydration due to interference with ADH (anti-diuretic hormone) effect on the kidney
- effect of Lasix on the body:
  - Lasix is a class of drugs called loop diuretics (water pills). It decreases the amount of fluid in the body by increasing the amount of salt and water lost in the urine, and is primarily described to reduce swelling in the body caused by congestive heart failure, liver disease or kidney disease.
  - Serious side effects includes: allergic reaction, muscle cramps or weakness, irregular heart beat, abdominal pain or diarrhea; low BP (weakness, dizziness, fatigue) or decreased hearing
- Patients are advised to use alcohol cautiously when taking Lasix since alcohol may increase the side effects of the medication

4)

- All these effects results in a decreased blood pressure, which then leads to loss of consciousness

5)

- heat stroke?
- Alcohol induced death?
- Low Blood pressure?

** How might these relate to Blood pressure?

Part II—The Investigation

Saturday, 9:30AM

"115 degrees! What is this thing doing so hot?" Sam Garrison asked Kavita as he removed the thermometer from the water.

He was investigating the death of Roma and Clint Underhill, prominent real estate brokers in Desert Palm.

"This hot tub should be no more than 109 degrees."

He remembered reading a Consumer Product Safety Commission flyer on hot tubs and wondered if the tub was associated with the death. The bodies were being taken away for autopsy as he took in the scene.

"Hmm. What about these bottles of wine? It looks like they had a party—all by themselves! The medical examiner will check their blood alcohol level (BAL, or blood alcohol concentration—BAC) and we'll be able to see his complete report on Monday. We may even be able to determine their cause of death with that information. I'll ask the maid about any medications."

He went into the sunroom off of the patio to where the maid was being consoled by another officer.

"Ma'am, can you tell me if the Underhills were taking any medicine?"

"Well, sir, I know he was complaining about having to use the bathroom a lot since he returned from the doctor's office about two weeks ago. You might look in the cabinet over the sink where they keep aspirin and such."

Sam looked where she indicated and found a recently filled bottle of Lasix.

Monday Afternoon

Monday afternoon, the medical examiner phoned Sam with the following information:

- BAL of the couple was 0.20
- Roma weighed 120 lbs; Clint weighed 160 lbs
- Time of death estimated at 2AM Saturday morning
- There was a therapeutic level of Lasix in Mr. Underhill's blood, but none in Mrs. Underhill's blood

Questions

1. Do you think that the couple died before or as a result of going under the water of the hot tub? Explain your reasoning.
2. What is the effect of Lasix on Mr. Underhill?
3. What is meant by "blood alcohol level" (also know as "blood alcohol concentration")?
4. What are the general effects of alcohol on the brain? On other parts of the body?
5. How fast is alcohol metabolized?
6. What are the effects of a .20% BAL on a 160lb man and on a 120lb woman?

ANSWERS:

1)

- The couple became unconscious and due to low blood pressure and slipped under the water. Checking for water in the lungs would indicate whether they died before slipping under the water. Think about the side effects of alcohol and heat on vasolidation

2)

- Lasix is a diuretic that reduces blood pressure. It is primarily used to treat edema associated with heart failure or high blood pressure.

3)

- The amount of alcohol in the blood stream; usually measured in milligrams of alcohol per 100mL of blood, or milligrams percent. For example, a blood alcohol level of 0.10 means that 1/10 of 100% (or 1/1000) of your total blood content is alcohol

4)

- induces state of euphoria:
  - general effects on the brain include impaired behaviour, judgement, memory, concentration and coordination.
- Alcohol acts as a sedative on the CNS, depressing nerve cells in the brain
- Large doses cause sleep, respiratory failure, coma and death
- Alcohol consumption causes dilation of the peripheral blood vessels and inhibition of ADH action on kidney tubules resulting in dehydration.

5)

- About one drink per hour depending on several variables including weight and gender.

Approximate Blood Alcohol Content (BAC) In One Hour

Source: National Highway Traffic Safety Administration

Drinks	Body Weight In Pounds								Influenced
	100	120	140	160	180	200	220	240	
1	.04	.03	.03	.02	.02	.02	.02	.02	Possibly
2	.08	.06	.05	.05	.04	.04	.03	.03	
3	.11	.09	.08	.07	.06	.06	.05	.05	Impaired
4	.15	.12	.11	.09	.08	.08	.07	.06	
5	.19	.16	.13	.12	.11	.09	.09	.08	Legally Intoxicated
6	.23	.19	.16	.14	.13	.11	.10	.09	
7	.26	.22	.19	.16	.15	.13	.12	.11	
8	.30	.25	.21	.19	.17	.15	.14	.13	
9	.34	.28	.24	.21	.19	.17	.15	.14	
10	.38	.31	.27	.23	.21	.19	.17	.16	

6)

- Go back to the chart
- at such a high level, effects may include double vision, slurred speech, staggering, nausea, and drowsiness

Part III—The Final Report

Later Monday Afternoon

Detective Garrison returned to police headquarters and, after reading the medical examiner's complete report, began the process of writing his own explanation of what happened to the Underhills. As he wrote, he thought about all that had happened and began to wonder about the physiology associated with the couple's death. The level of alcohol found by the medical examiner was high but was not necessarily sufficient to cause their death, but was it a contributing factor? Sam knew that Lasix was used to treat high blood pressure and that both alcohol and heat will reduce blood pressure, but he was unsure of the mechanism. He decided to go to Noletown University and talk to Renee Volenbach, a physiologist in the biology department, in her office in the McWhirter Biology building. Renee patiently explained her answer to each of the following questions posed by the detective.

Questions

1. How does the body regulate blood pressure?
2. What were the specific effects of the Lasix, hot water, and alcohol on the couple's blood pressure?
3. What could the body have done to reverse the decreasing blood pressure, if it had been possible?
4. Identify several procedures that might have helped save the couple if they had been found unconscious but still above water and alive.

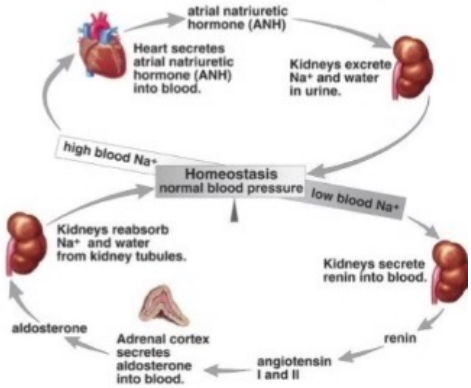
Essay

Put yourself in the role of Detective Garrison. You must now write a report explaining what Renee might have said with regard to the above questions. You should use all of your knowledge about blood pressure and the information from this case to explain each of the following aspects of blood pressure and discuss their relation to the above questions. Describe the role of the nervous system, adrenal glands, kidneys and pituitary as appropriate to the relation of each of the seven factors listed below:

1. Peripheral resistance
2. Heart rate
3. Venous return
4. Stroke volume
5. Cardiac output
6. End systolic and diastolic volumes
7. Blood viscosity

1)

- cardiovascular, nervous, endocrine, urinary systems all contribute to blood pressure regulation
- the kidneys provide a hormonal mechanism for the regulation of blood pressure by managing blood volume
- Neurological regulation of blood pressure and flow depends on the cardiovascular centres located in the medulla oblongata
  This cluster of neurons responds to changes in blood pressure as well as blood concentrations of oxygen, carbon dioxide and other factors such as pH



2)

- lasix leads to dehydration
- heat resulting in sweating
- alcohol resulting in ADH inhibition
- The heat and alcohol also resulted in decreased peripheral resistance from vessel dilation
- alcohol and heat were most likely to cause low blood pressure and unconsciousness before drowning

3)

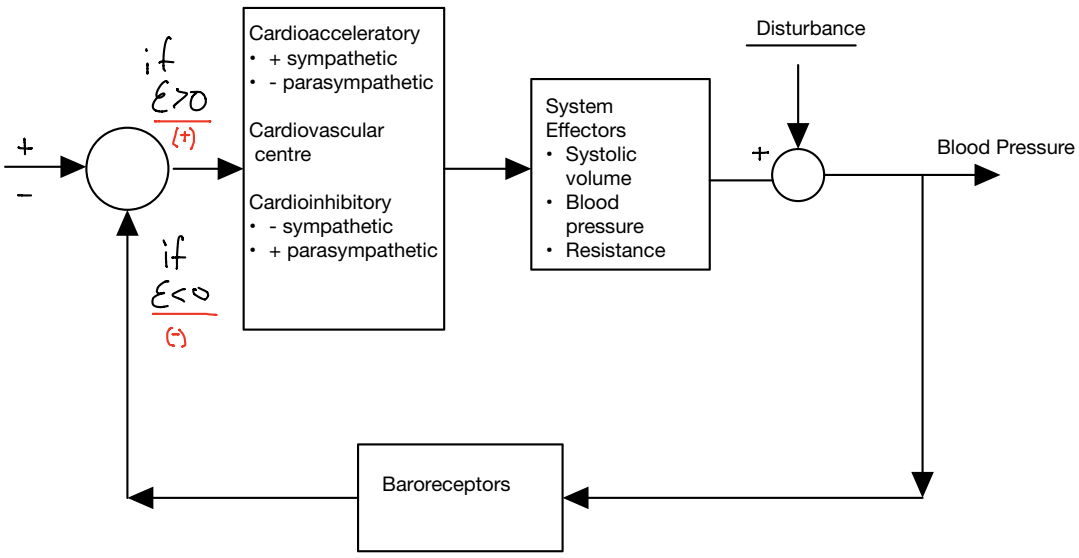
- A normal response would have included:
  - increased sympathetic and adrenal secretions to increase contractile force, vasoconstriction, and increased heart rate
  - a response by the renin-angiostatin mechanisms that release aldosterone and decreases urine output, thus conserving water
  - increased ADH secretion causing increased reabsorption of water

4)

- increasing the Blood pressure
- IV fluids

POP QUIZ:

THE DIAGRAM WAS ON LAST YEAR'S EXAM



- if ε is positive, then the blood pressure is low and the cardioacceleratory system will kick in (eg. sympathetic system will turn "on" and parasympathetic system will turn "off")
- if ε is negative, then the blood pressure is high and the cardioinhibitory system will kick in (eg. sympathetic system turn "off" and parasympathetic system will turn "on")
- If E = 0, then Blood pressure is ok and no response will occur

sensor ≈ MAP = ____ mmHg

Take home messages:

Sympathetic		**Parasympathetic**
↑HR ↑SV		↓HR ↓SV
↑R Vasoconstriction		↓R Vasodilation

High BP ⇩ Parasympathetic

Low BP ⇩ Sympathetic

Normal BP ⇩ No Response