

Osmosis Case Study

Liam was feeling slightly nervous as he arrived at the Saint John Regional Hospital for his first shift as a resident. The first few hours of his shift passed slowly as Liam mostly checked vital signs and listened to patients complain about various aches, pains, coughs, and sniffles. He realized that the attending physician, Dr. Greene, who was rather old school in general about how he interacted with his residents, wanted to start him out slowly.

Liam knew, though, that the paramedics could bring in a trauma patient at any time. After his lunch break, Liam didn't have long to wait before the paramedics burst in through the swinging double-doors of the ambulance bay wheeling in a young man on a gurney. Edward, a veteran EMT, recited the vital signs to Liam and Dr. Greene as they helped push the gurney into the trauma room, a 18 year old male, GSW to the right abdomen, heart rate 92, respiratory rate 22, blood pressure 95/65, no loss of consciousness. A gunshot wound! Liam knew that gunshot wounds were sometimes the most difficult traumas to handle.

Once inside the trauma room, Dr. Greene began his initial assessment of the patient while Liam got busy organizing the things he knew would be needed. He attached a pulse oximeter to the patient's index finger so Dr. Greene could keep an eye on the O₂ levels in the patient's blood and he inserted a Foley catheter so the patient's urine output could be monitored.

After finishing his initial duties, Liam heard Dr. Greene saying, "It looks like the bullet missed the liver and kidney, but it may have severed an artery. That's probably why his BP is a bit low. Liam, grab a liter of saline and start a fast IV drip. We need to increase his blood volume." Liam grabbed one of the fluid-filled bags from the nearby shelf, attached a 12-gauge IV needle to the plastic tubing, and gently slipped the needle into the patient's cephalic vein. He then hung the plastic bag on the IV stand and let the fluid quickly start to flow down the tubing and into the patient's vein. The reaction was quick and violent. The patient's heart rate began to skyrocket and Liam heard Dr. Greene shouting, "His O₂ saturation is falling! Pulse is quickening! What is going on with this guy?!" Liam stood frozen with fear. He heard Dr. Greene continuing, "Flatline! We've lost a pulse. Get a crash cart! We need to shock this guy to get his heart going again!" Liam broke free from his initial shock and did as Dr. Greene had ordered. He then started CPR as Dr. Greene readied the cardiac defibrillator to shock the patient. They continued to alternate between CPR and defibrillation for almost an hour, but to no avail. As Dr. Greene announced the time of death, Liam felt a sickening feeling in the pit of his stomach. He couldn't believe that he had lost his first trauma patient.

Looking around the room in continued disbelief, Liam noticed the fluid in the Foley catheter bag was bright red. "Dr. Greene, I think there's hemoglobin in the Foley bag," he said. "How could that be?" Dr. Greene snapped back. Liam began to retrace his steps in the trauma, trying to think of anything that could have caused the hemoglobinuria. His mounting fear turned to outright terror as he looked at the now empty bag on the IV stand. Its label read "Distilled Water," not "Saline." He looked at Dr. Greene, his heart quickly sinking, and said, "I think I may have killed this patient."

Questions

1. a) What problem did the distilled water in the patient's bloodstream create?
b) What happened to the patient's red blood cells as a result?
2. Considering the function of red blood cells, why did the patient's oxygen levels fall?
3. After Liam made his error, is there anything that could have been done to save the patient's life?
4. Draw a diagram of a section of a cell membrane that illustrates how it is able to regulate what crosses the membrane. Include some text to explain your diagram.
5. The bacterium *Vibrio cholerae* causes the disease cholera. Infected people have such severe diarrhea, they may lose as much as 20 L of fluid in a 24 hour period. The bacterium enters the body when a person drinks contaminated water, then attaches to the intestinal lining. During its metabolic activities, it secretes a compound that is toxic to cells of the lining, and they start secreting chloride ions. Sodium ions follow the chloride ions into the fluid in the intestines. Explain how this sequence of events causes the massive fluid losses.
6. In some crazy, bizarro world where "humans" are made up of plant cells (I'll pause so you can consider how awesome that would be . . .) why would this mistake have posed no problem at all for the patient?