

Osmosis Case Study

Tom 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 Tom 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.

Tom knew, though, that the paramedics could bring in a trauma patient at any time. After his lunch break, Tom 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 Tom and Dr. Greene as they helped push the gurney into the trauma room, “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! Tom 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 Tom got busy organizing the things he knew would be needed. He attached a pulse-ox monitor 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, Tom 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. Tom, grab a liter of saline and start a fast IV drip ... we need to increase his blood volume.” Tom 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 antecubital 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 Tom heard Dr. Greene shouting, “His O₂ saturation is falling! Pulse is quickening! What is going on with this guy?!” Tom stood frozen in place by the fear. He heard Dr. Greene continuing, “Flatline! We've lost a pulse ... Tom, get the crash cart, we need to shock this guy to get his heart going again!” Tom 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, Tom felt a sickening feeling in the pit of his stomach. He couldn't believe that he had lost his first trauma patient!

Then Tom noticed that the fluid in the Foley catheter bag was bright red. “Dr. Greene, there's hemoglobin in the Foley bag,” he said. “How could that be?” responded Dr. Greene. Tom began to trace back over 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 didn't read “Saline,” but rather “Distilled Water.” He looked at Dr. Greene, his heart quickly sinking, and said, “I think I may have killed the patient.”

Questions

1. What problem did the distilled water in the patient's bloodstream create?
2. What happened to the patient's blood cells as a result?
3. Considering the function of red blood cells, why did the patient's oxygen levels fall?
4. After Tom made his error, is there anything that could have been done to save the patient's life?
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 Tom?
7. When you have a long bath or spend some time in a swimming pool, the tips of your fingers turn wrinkled and white. Although babies develop in the uterus in a watery environment, their skin is not wrinkled at birth. Explain these phenomena, considering the differences in the two environments.