

Case Study: More Antibiotics?

Day 1. Hip Replacement Surgery

Mary Smith, a 73-year-old, arrives at the hospital with her husband Robert at 7:00 am on the day of her surgery. They go to the reception desk and she signs in with the staff. She is told to have a seat in the waiting area.

“How are you doing?” Robert asks.

“I’m nervous. What if something goes wrong?” Mary replies.

“Mary, please don’t worry. The surgeon met with us and she told us what to do to get our home ready for your recovery. She also gave us information about the surgery and the recovery so we know what to expect. Dr. Kline is very highly recommended.” Robert gave her hand a squeeze.

“Thanks! You always know what to say to make me feel better.” She replied and gave him a big smile.

“Mrs. Smith” a nurse calls out.

“That’s me” Mary answers. She follows the nurse to the pre-operative area with Robert assisting her, as walking has become very difficult.

When they get to the pre-operative area, Mary is asked to remove her shoes and clothing, and put on a hospital gown. She is asked to lie down on a hospital bed.

“I’m Nurse Jackie. I have some things to review with you before your hip replacement surgery today.”

The nurse goes over the procedure and what Mary should expect after the surgery. She reviews her medical chart and asks when the last time she ate was and what medications she is taking. Mary is in good health overall and fortunately does not take any prescription medication. She takes an extra strength Tylenol only when she is in a lot of discomfort. She is not a fan of taking medication, and avoids it whenever possible.

The nurse is pleased that Mary has followed all pre-operative instructions, including using an antibacterial soap called chlorhexidine the last 3 showers she took, to reduce the risk of bacterial infection. Her blood pressure, pulse and temperature are checked and the results are good. An intravenous (IV) drip is started in Mary’s arm. (1)

“It’s time to say good-bye” Nurse Jackie tells Robert.

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Robert gives Mary a peck on her cheek. “I will see you after your surgery. You’ll be running around this place in no time” he joked.

Laughing she said “I’ll settle for walking. See you soon. Love you.”

“Love you too” was his reply.

Mary is wheeled into the operating room. The operating room nurse ensures that her IV drip is okay and connects her to machines that will monitor her blood pressure and heart rate. The anesthesiologist sets up her spinal anesthesia which will “freeze” her nerves so that she has no movement or feeling in her hips or legs. Through the IV drip, she is given medication that relaxes her and sedates her (puts her into a light sleep). She will not see or feel anything that is taking place during her surgery. (1)

Dr. Kline and her team are ready to begin...

Day 1. Post-Operative Recovery

“Is it over?”

“Yes. Everything went well. I’m Nurse Tom. You are still a bit groggy which is normal. Dr. Kline will come by later to see how you are doing. How are you feeling? How would you rate your pain level out of 10, with 10 being the worst?”

“About a seven” she replies.

“Right now, your IV drip contains opioids that you can take whenever your pain is feeling unmanageable. Just press on this button when you need medication.” He shows her how to work her IV pump. “Ideally, over the next 24 hours, you will need less and less of it, and we will transition you to oral medications.” (1)

“I hate taking medication. I avoid it whenever possible.” Mary tells the nurse.

“Many patients tell us the same thing. However, you want to be mobile as soon as possible, so that you can recover more comfortably at home. Taking the pain medication will allow you to do the necessary exercises with the physiotherapist. If you are in constant pain, you won’t be able to achieve the mobility needed to be discharged, and there will be more risks to your health such as the possibility of blood clots. Also, the sooner you are up and about, the sooner we can remove your catheter (1). This time, you need to make an exception and take your pain medication when you need it.”

“Alright. That makes sense. I will do whatever it takes to get out of here. I hate hospitals! No offense.”

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Tom chuckles. “I get it. No offense taken. We’ll get you back on your feet and out of here as soon as possible. I’ll come to check on you in a little while.”

“Where’s my husband?” Mary asks.

“As I was coming into your room, he told me that he was going to go get a cup of coffee. He’ll be back soon. Get some rest.”

Day 2. Post-Operative Recovery

“That really wore me out! I need a nap after that.” Mary says as her and her husband come back to her room after going for a walk around her floor of the hospital.

“Not surprising but it’s necessary to keep moving. Are you in a lot of pain?” Robert asks her.

“I am in some pain but it’s not too bad.” She replies.

Later that evening...

“I feel very hot. I also have pain below my stomach. I am going to call for a nurse.” Mary presses the call button.

“Hi there, I’m Nurse Rhonda. I will be taking care of you overnight. Is everything alright?”

“I think I may have a fever. I also have pain right here.” Mary indicates her lower abdomen. (2)

The nurse checks her temperature. “You’re right. You do have a fever. Your temperature is 38.0°C. Have you been urinating frequently?” (2)

“More than usual but I also have been drinking more water than I normally do, so I didn’t think anything of it.” Mary responds.

“It sounds like you may have a urinary tract infection or UTI. They happen sometimes after a patient has had a catheter inserted for a surgical procedure. (2) I will bring over a urine specimen cup and an antiseptic wipe. Before urinating, use the wipe and collect mid-stream urine. Call me when you have the sample ready.” (3)

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Diagnosis and Treatment

Mary's urine sample is given to you, Dr. _____ for testing. The urine has tested positive for white blood cells, red blood cells and the presence of bacteria, suggesting the presence of a UTI, when combined with her symptoms. (3) Due to Mary's age, you want to start antibiotic treatment as soon as possible before symptoms get worse even though you do not know which bacteria is causing her infection.

You have two options of antibiotics:

- A. Prescribe the broad-spectrum antibiotic Nitrofurantoin, which is effective against numerous bacteria including E. coli, which is the most common causative agent of UTIs. It has fewer side effects than other antibiotics. Resistance to the drug is low; however, you need to ensure that it kills the type of bacteria causing Mary's infection, to not encourage resistant bacteria developing. (4, 5)

- B. Prescribe the broad-spectrum antibiotic Ciprofloxacin, which is effective against numerous bacteria including E. coli, which is the most common causative agent of UTIs. Although its effectiveness is quite high, pockets of resistance are beginning to emerge in some countries by E. coli UTIs. The recommendation is to only use this antibiotic for more serious infections and if other antibiotics are not a suitable option. (4, 6, 7)

1. List the pros and cons of each option. What option do you choose?

You send her urine sample to the lab for culturing to determine the exact cause of her UTI.

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Day 3. Post-Operative Recovery

Before examining Mary's culture results, you ask some bacteria review questions to Susan, the medical student assigned to you for the day.

2. What are the three main bacteria shapes?

3. What prefix is given for bacteria found in clusters?

4. What prefix is given for bacteria found in chains?

5. What is the purpose of gram staining?

6. What colour indicates gram positive bacteria?

7. What colour indicates gram negative bacteria?

8. What does aerobic mean?

9. What does anaerobic mean?

The culture results show that the culprit is *E. coli*. It is a gram-negative, rod-shaped bacterium (8). The antibiotic you prescribed is effective against it, and Mary should be feeling much better in the next couple of days. Recent research suggests that shorter prescription lengths of antibiotics are enough to fight most bacteria. Taking them for longer than needed may help bacteria become more resistant (9). You will re-test

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Mary's urine sample in a few days to ensure all the bacteria have been killed so she can stop her course of antibiotics.

Day 4. Post-Operative Recovery

Under normal circumstances, Mary would have been discharged by now since she is mobile. Given her age, and the fact that she is fighting an infection (UTI), you have kept her for further observation.

It seems that keeping her in the hospital was a good decision...

You visit Mary in her room to do a detailed examination of her vitals and of her wound. It is time to remove the bandage covering her incision and replace it with another one. Nurse Tom is helping you with this task. As he removes the bandage you notice swelling and redness, and the wound is warm when you touch it. You take Mary's temperature; it is 38.5°C (10). It appears that a UTI is not the only infection to have plagued Mary.

"Is everything okay doctor?" Mary asks.

"It looks like there is an infection at the site of your hip implant. I need to determine how serious it is. I will use a needle to remove fluid from your incision site to examine it for the presence of bacteria. In addition, Nurse Tom will remove some blood for analysis. I will also send you for an X-ray. (10)

"Oh no! A UTI and now this! Perhaps I should have just suffered with hip pain. Am I going to need another surgery?"

"Mary, I understand your concern. Please know that I will do everything I can to get you healthy and back home as soon as possible. On a positive note, it is good that this happened while you are still in the hospital so we can get on it ASAP. Hopefully, the infection is not too serious and we can treat it with antibiotics, and not something more invasive" you reassure her.

"More antibiotics?! I guess that is better than more surgery." Mary replies.

"As soon as I know something definitive, I will let you know. In the meantime, try to rest." You tell her.

Day 5. Post-Operative Recovery

You examine Mary's test results: the X-ray, along with her blood work and the examination of the fluid at her incision site. All things combined confirm an infection by the gram-positive bacterium *Staphylococcus epidermidis*. From what you can tell, the infection has not spread to the artificial joint itself and is still a 'superficial infection',

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that should be treatable with antibiotics. Treatment with antibiotics has a good success rate when the infection is caught early (10).

Staphylococcus epidermidis was previously regarded as a commensal microorganism on human skin that did not cause illness. However, nowadays, it is considered an important opportunistic pathogen. It is the most common cause of infections within hospitals and is the most common source of infections on indwelling medical devices. This is most likely due to the fact that it is a permanent colonizer on human skin and the device becomes contaminated as it is inserted, even though precautions to prevent infection are taken. What makes treatment of this bacteria difficult is the presence of antibiotic resistance genes and the formation of biofilms. Biofilms are multicellular, surface-attached groups of microorganisms that have an intrinsic resistance to many antibiotics and to human defense mechanisms. When in the biofilm mode of growth, these bacteria down-regulate (reduce) basic cell processes such as nucleic acid and protein synthesis, which may explain why antibiotics that work against actively growing cells are not very effective (11).

10. Using your knowledge of bacteria and resistance, why do you think biofilms are a smart survival mechanism for the bacteria that form them?

11. Imagine you are a bacterium that is part of a biofilm and you are found on the surface of that biofilm. What do you think may happen to you when exposed to the antibiotic? What about other bacteria that are found in the center of the biofilm? Do you think they will be affected by the antibiotic?

You decide to prescribe the antibiotic linezolid, since *Staphylococcus epidermidis* is very rarely resistant to it (11). It will be given intravenously (12). Recall that Mary is already taking an antibiotic for her UTI.

12. What negative effects do you think could occur due to Mary taking more than one antibiotic at once?

You deliver the 'good news' to Mary that it appears her infection has not yet affected her hip implant and should be remedied by taking an antibiotic.

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“Another antibiotic? Is that safe?” Mary asks.

“We will keep you in the hospital for a little while longer to ensure that everything is okay and the antibiotics are being effective. You are almost done your course of antibiotics for your UTI, so you will not be on overlapping antibiotics for very long. We will be starting you on some probiotic pills to ensure that you suffer no ill effects from taking two different antibiotics, especially since you will be on the second antibiotic for up to two weeks (12, 13).

“Two weeks?!” exclaims Robert.

“Mary shouldn’t have to be in the hospital for that long. We can arrange for her to have her antibiotics administered at our hospital’s outpatient clinic” you explain.

13. What are probiotics?

14. Why can’t Mary just increase her consumption of yogurt instead of taking probiotic pills?

Day 11. Post-Operative Recovery

Mary has been on the antibiotic linezolid for seven days. Her recovery has been promising. Her fever went down to normal in just over a day, and her incision site looks like it should after a week and a half. Her energy level is back to normal and she has been able to work with the physiotherapist while in hospital. Her mobility is quite good.

Yesterday, Mary was sent for another X-ray and had blood and fluid samples from the incision site analyzed. The results look good. She still has some bacteria present, but the levels are quite low. Continuing the antibiotic for another week should ensure that all the bacteria are dead, which will be confirmed with additional testing. It is very important that no bacteria remain, to avoid further infection and the possibility of surgery.

“It’s time to go home Mary. Everything is looking good. You will continue to get your antibiotic daily at our outpatient clinic. I will test you again at the end of your course of antibiotics to ensure that all the bacteria have been killed” you tell her and her husband.

“I’m so glad! This hospital stay has been much longer than anticipated” Mary says.

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“See you in just over a week. You have an appointment with me to go over your test results after you have finished your antibiotics. You will go to the lab on the first floor the day before to get samples taken, and I will have the results at your appointment. All of the information is on this piece of paper” you tell her as you hand her the paper.

“Thanks Dr. _____.”

Day 20. Post-Operative Recovery

“Hi Dr. _____.”

“Hi Mary. Everything looks great! The infection has cleared completely and your incision looks good” you tell her.

“Thank goodness! The only problem now is I think I have a cold. I must have gotten it from someone who visited me at home recently. Do I need an antibiotic? I hope not!” Mary says.

“Antibiotics are not effective against colds. Just rest and have lots of fluids and chicken noodle soup” you inform her.

“Okay. Thank you Dr. _____.”

“You’re welcome. Your next appointment will be with Dr. Kline, your surgeon. Book your appointment at the reception desk out front. They have your details. Take care.”

15. Why are antibiotics not effective against colds?

16. What are the dangers of using an antibiotic to treat a cold?

References

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