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The Impact of Drugs Used in Anaesthesia on Bacteria

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Abstract: ***This review paper delves into the impact of anesthesia on the human microbiota and the potential implications for patient care. It highlights how anesthesia drugs can directly and indirectly affect bacteria, either by inhibiting their growth or by altering the immune response. Volatile anesthetics like Isoflurane and Sevoflurane, for instance, have shown inhibitory effects on bacteria such as Staphylococcus aureus and Pseudomonas aeruginosa. Moreover, anesthesia can weaken the immune system, making it easier for infections to take hold post-surgery. The review also examines how the use of anesthesia alongside antibiotics can contribute to antibiotic resistance, a growing global health concern. Additionally, specific anesthetics like Propofol and opioids have varying effects on bacterial growth and immune response, sometimes supporting bacterial proliferation under certain conditions. The paper aims to bridge the knowledge gap regarding the interactions between anesthesia, antibiotics, and bacteria, thus improving patient outcomes and minimizing post-surgical complications.***

Keywords: anesthesia, bacteria, immune system, antibiotic resistance, microbiota

1. Introduction

Anaesthesia is essential for making surgery and medical procedure painless. But did you know that the drug used for anaesthesia might affect the tiny living things (bacteria) inside our bodies.

This review paper explores how Anaesthesia can influence these bacteria.

We now understand that our bodies are home to many different microorganisms called the human microbiota. These tiny creatures play a big role in keeping us healthy. Some of them live in our mouth and gut, which are exposed to anaesthesia during surgery, so, we need to figure out what happens to these microbes when we undergo anaesthesia.

Another important aspect is the use of antibiotics during surgery, often in combination with Anaesthesia. This raises concerns about bacteria becoming resistant bacteria are a serious global health problem. This review aims to connect the dots between Anaesthesia, antibiotic, and the development of antibiotic resistance, with implications for patient care.

Moreover, Anaesthesia might affect our body's ability to fight off bacterial infection, even after surgery. This review will explain how Anaesthesia can impact our immune system. Understanding these effects can help improve patient outcomes and reduce complications after surgery.

Direct effects of anaesthesia drugs on bacteria:
Anaesthesia drugs can have a direct effect on bacterial growth mortality and biofilm formation. For example, volatile anaesthesia such as Isoflurane and sevoflurane have been shown to inhibit the growth of some common bacterial pathogens such as *staphylococcus* aureus and *pseudomonads aeruginosa.*

Anaesthesia drugs can affect bacteria in the number of ways, including:

- Changing how bacteria move and from colonies:
- Anaesthesia drugs can make it harder for bacteria to move around and from colonies, which can make them easier for the body to fight off.
- Interfering with how bacteria works: Anaesthesia drugs can also mess up how bacteria works, such as by disrupting the proteins and enzymes that they need to survive.
- Stressing bacteria out: Anaesthesia drugs can also stress bacteria out which can make them move likely to cause infection. The effects of anaesthesia drug on bacteria can vary depending on the type of drug, the dose, and how long the patient is under anaesthesia. Different types of bacteria may also react differently to anaesthesia drugs. Fir example, volatile anaesthesia, intravenous anaesthesia, local anaesthesia etc.

Indirect effects of anaesthesia drugs on bacteria:
Anaesthesia drugs can also have an indirect effect on bacteria by suppressing the host immune system For example volatile anaesthesia have been shown to reduce the activity of white blood cells, which are essential for fighting off infection.

Other anaesthesia drugs, such as propofol and opioids, can also suppress the immune system. For example, Propofol has been shown to reduce the production of cytokines, which are signalling molecules the play an important role in the immune response. Opioids, have been shown to enhance bacterial growth and virulence.

The impact of agents used in anaesthesia on bacteria:

Propofol: Propofol is a drug that makes people fall asleep before surgery and other medical procedure. It is also a common drug used in hospitals to keep people unconscious. Propofol can also carry bacteria which can lead to infections. This is especially a risk fir people who are already sick or have weakened immune system. Propofol can also weaken the immune system, so it is easier for people to get sick. Propofol can cause infections in two ways:

Directly: Propofol can help bacteria grow and make it difficult for the body 's immune system to fight bacteria.

Indirectly: Propofol can weaken the immune system by preventing the body from releasing certain proteins that help fight infection.

Impact of Propofol used in anaesthesia on bacteria:
There were some concern about it because it could potentially become a breeding ground for harmful bacteria. The center for disease control in the USA even warned about it. In one case, four patients got very sick (developed sepsis) because the diprivan. They were given had been contaminated with a specific bacteria called *kiebsiella pneumoniae*. This happened because the medicine had been left out at room temperature for too long. Diprivan can help some bacteria, like *Escherichia coli* and *candida albicans*, to grow, but it seems to show down the growth of *staphylococcus aureus.* It might also have some effect on *pseudomonads aeruginosa*, but not all studies agree on this some studies found that Diprivan can even support the growth of *staphylococcus aureus* and *pseudomonas aeruginosa*, but these result might be different because they used different types of these bacteria

Different ways of preparing a substance can affect the risk of infection. They tested this on rabbits by injecting them with a bacteria called *s.aureus* when they used a substance called intralipid to prepare the bacteria, it affected which organs in the rabbits had the most bacteria. It seems that intralipid might hide the bacteria from the body's defence system. This could explain why using a drug called Diprivan and intravenous liquid might be risky.

However, when they tested Diprivan in a special type of oil emulsion, it supported bacterial growth, but pore 2,6 di-isopropylphenol killed bacteria, Also, adding a numbing drug called lignocaine to Diprivan reduce the number of bacteria, but a low concentration of lignocaine did not have much effect.

The chance of it getting contaminated during regular use are very low, between 0% and 6%.

Clinical studies also did not find any signs of infection from using it. However, it's still important to be vary careful about cleanliness when using Diprivan.

You should follow the instructions from the manufacture. At the very least, before opening the medicine, you should clean the ampoule with a disinfectant swab. If you have any Diprivan left in the ampoule after using it, you should throw it away and not store it, also it you put Diprivan into a syringe or connect it to an infusion line, you should use it within 6 hours.

Local anaesthesia
Doctor have been using either as a way to kill bacteria in infected wounds and abscesses since 1907. They found out that ether and it's vapour can kill bacteria. After 30 years, they also discovered that ether can kill a specific type of bacteria called enterobacteria. They even used chloroform vapour to clean and sterilize surface. So, basically, they found that these gases can help fight off bacteria and keep things clean. Certain gases used for anaesthesia affect the growth of bacteria. When they tested these gases at the concentrations used in medical procedure. They didn't seem to affect bacteria growth on solid surface. However, when they tested them on a material similar to contaminated anaesthesia equipment or in a liquid environment similar to the lungs, some of these gases did inhibit bacterial growth. One study by Mehta used two different methods to grow bacteria and found that one method to which simulated contaminated equipment, showed that clinical concentrations of these gases might help prevent infections. However, an interesting note is that nitrous oxide actually supported the growth of a bacteria called *s.aurcus.* They also mentioned that if bacteria contaminated an Anaesthesia vaporizer and get released into the anaesthesia system some of the anaesthesia can kill the bacteria, but they differ in how effectively they do so. Chloroform, ether and Halothane kill bacteria quickly, while Isoflurane, methoxyflurane and enflurane do so more slowly .Certain gases used for anaesthesia affect bacteria . They found that one gas called halothane can slow down some important functions in a bacteria called *E.coli*, and this effect gets stronger as the temperature rises. In the 1970, they discovered that some Anaesthesia gases could make glowing bacteria less bright, but one of these gases, ether, actually made them brighter at very low amount . This brightness has to do with a molecule called bacterial has to do with a molecule called bacterial luciferase. The gases seem to complete with another molecule for a spot on this luciferase, which affects how bright the bacteria glow. This discovery led some scientists to think that anaesthesia might work directly on proteins in our bodies, and this idea become a basic fir theories about how Anaesthesia works.

- Nitrous oxide stops bacteria from making their parts.
- When a bacterium called chlorobium vibrioforme makes a green pigment called *bacteriochlorophyll*, some molecules called *porphyrins* start building up inside the cell because of nitrous oxide.
- Pathogenic bacteria are harmful bacteria that can cause infection. These bacteria first stick to a surface and then attach to our body's cells which leads to an infection.
- In 1911, scientists found that a type of anaesthesia called ether did not affect how bacteria clump together.
- Years later, tests in a lab dish showed that some Anaesthesia drug could change certain part of our body's cells, making them less sticky fir bacteria.
- Halothane was the most effective at this, these findings are important because the stickiness of our cells is important for bacteria to cause infections.
- When researcher tested halothane on both our cells and bacteria in a dish, it reduced how will the bacteria stuck to our cells. This suggests that inhalation anaesthesia affects our cells, stickiness to bacteria rather than changing to bacteria themselves.

Opioids

Antimicrobial effects:
1) Morphine 2% and pethidine 0.6% can kill some bacteria.
2) Other drugs like levallophan, levorphanol, dextrorphan, and nalorphine also stop bacteria from growing.
3) A natural substance called (Met5)- enkephaline, which is like an opioid, can stop certain bacteria from growing.

4) Fentanyl 50 µg ml-1 and morphine 1% might or might not affect bacteria. It depends on factors like temperature and how long the bacteria are growing.
5) There's some evidence that fentanyl 50 µg ml-1 doesn't kill one type of bacteria called pseudomonas. There were cause where bacteria got into fentanyl during production or when it was stolen and replaced with water containing bacteria.
6) Only pethidine can stop bacteria from growth when used in a certain way (epidurally).
7) Fentanyl 20 µg ml-1 and sufentanil 0.3µg ml-1 doesn't seem to effect bacteria much.
8) Morphine 0.2% doesn't affect bacteria, and when tested with bupivacaine 0.5%, it doesn't make a different. However, there's a different report saying that morphine 0.1% can kill some types of bacteria.

In simple terms, some opioids can kill bacteria, while other might not, and the result can depend on various factors.

Opiates and Bacterial Growth:
What happens when bacterial interact with opiate drugs, like morphine and codeine bacteria can change these drug into different forms.For example, in 1975, they found that a bacterium called *p.testosteroni* could change morphine into something more powerful and a few years later , another bacterium was discovered that could use morphine or codeine as a food source and transform them. This is important because the new forms of the drugs can be stronger than the original. However, it's not clear if these changes also happen in the human body or if they only matter for making medicines. The bacteria in our gut can affect how our body handles morphine. Some bacteria seem to breakdown morphine in a way that allows it to be absorbed again, while other might not. This can be influenced by the types of bacteria living in our intestines. Fir example, taking certain antibiotics can reduce the breakdown of morphine in the gut. The research suggests that specific type of bacteria, like Bacteroids and Bifidobacteria, might be responsible for this.

Barbiturates
Thiopentone and methohexitone. These drugs can kill some types of bacteria, particularly the ones know as coagulase-negative staphylococci. Thiopentone is even more effective as it can also kill bacteria like *pseudomonas aeruginosa* and *Escherichia coli*. When these drugs are used in medical procedure, they are usually stored in containers, and these containers stay germ- free for quite sometime. But there's a question about why these drugs are good at killing bacteria. It's not clear whether it's because the solution they're in are very alkaline (basically, they have a high Ph level).

However, even though these drugs can kill bacteria, if people use them for a long time, especially in patients with brain swelling who need help breathing with a machine, it's seems to increase the chances of these patients getting respiratory tract infection like pneumonia in the hospital. So, while the drugs can fight bacteria, they might have some drawbacks when used for a long time in certain medical situation

Benzodiazepines: Midazolam 1% and Diazemuls (diazepam 0.5%) and how they affect different types of bacteria.

1) Midazolam 1%:
It can kill some bacteria called coagulase-negative staphylococcus, but it doesn't stop the growth of a bacteria called pseudomonas aeruginosa.

2) Diazemuls:
It doesn't stop the growth of coagulase-negative staphylococcus or pseudomonas aeruginosa, so these bacteria can still grow.
Benzodiazepines (a type of medication) might have some influence on bacteria like E.coli and Rhodobacter capsulatus . Some other medication might be changed by bacteria in our intestines.

Muscles relaxants
Some drugs can slow down bacterial growth (bacteriostatic) while others can actually kill bacteria (bactericidal). Tubocurarine, at a concentration of 3mg/ml slow down bacterial growth. Atracurium, vecuronium and Suxamethonium at various concentration, can kill bacteria. When you use partly used vials of Suxamethonium or tubocurarine for 3-7 days, on bacteria grow in them.

2. Conclusion

Many anesthtic drugs have been studied and some of them have been found to have properties that can kill bacteria. However, there are a few drugs like Propofol preparation, Diazemuls and calcium gluconate that actually support the growth of bacteria. The impact of opioids on bacteria is still not clear. Research on bacterial enzymes, functions, and receptors has shown that these systems can be affected by anesthtics. Recent studies suggest that anesthtics might interfere with how bacteria attach to surfaces, which is the first step in causing an infection. Currently, we have limited knowledge about how antibiotics and anesthtic drugs interact, but what we do know is promising. There's evidence that some combination of drugs, like promethazine and gentamicin in living organisms, and lignocaine and tetracaine with other antibiotics in lab settings, can work together effectively. In the review paper highlights the lesser-studied effects of anesthtics, which could help us better understand what causes postoperative infections and how to prevent them.

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