

Investigating The Transmission Of Infections Among Patients

Posted on September 19, 2019

Introduction

Pseudomonas aeruginosa is an infection-causing type of bacteria that is found in the environment. It is a gram-negative, rod-shaped bacterium, and it causes infections in both plants and animals. *P. aeruginosa* is an opportunistic disease-causing bacteria. In the majority of infection cases, the integrity of the physical barriers to infection, such as the skin and mucous membrane, is missing. There could also be an underlying immune deficiency condition, such as immunosuppression. (Behzadi et al., 2022)

The infections caused by these bacteria in humans are complicated and can cause death. Infections occur mostly in patients with compromised immune systems and those who are in the hospital. *Pseudomonas aeruginosa* is the commonly isolated bacteria from patients who are hospitalized for more than one week. According to Williams (9), the most common causing agent of nosocomial infections. Types of pseudomonas infections include pneumonia, gastrointestinal tract (GIT) infections, skin and soft tissue infections, skeletal infections, and eye infections. Other infections are meningitis, septicemia, endocarditis, bacteremia, and malignant otitis externa. (Qin et al., 2022)

People at high risk of *P. aeruginosa* infections are patients. Recent research (1) indicates that infections are especially common in patients with burn wounds, acute leukemia, drug addictions, organ transplants, and cystic fibrosis. It is rare but possible for healthy people to also get mild infections with *pseudomonas aeruginosa*, particularly after being exposed to water. Exposure to poorly treated water in hot tubs or swimming pools may result in ear infections and skin rashes, mostly in children. (Langton Hewer and Smyth, 2023)

Microbiological investigations on *P. aeruginosa* are important since pseudomonas infection is a major cause of morbidity and mortality among patients who have compromised immune systems. The reason why the investigations are done is to confirm the presence of an outbreak of pseudomonas infections. Outbreaks are common in a hospital setting where patients have been hospitalized for more than one week and among patients with compromised immune systems. Surgical, cystic fibrosis patients, and cancer and burn patients are susceptible to these outbreaks. (Jordana-Lluch et al., 2023)

Another reason is to identify the source or sources of the outbreak. This is useful so that the infection can be contained and prevent spread to other patients. The spread of pseudomonas infections inside the hospital can be prevented through thorough hand washing by both nurses and patients. Also, ensuring that the hospital equipment is always clean. Some bacteria can, however, become resistant

to detergents and sanitizers used in the hospital. Therefore, investigations and testing should be done often to determine if there is resistance so that the department can act appropriately. Outside the hospital use only the hot tubs and swimming pools that have been properly treated. After swimming, shower with soap and dry your ears to prevent infections.

Microbiological investigations are also done to explain the various ways that the infection is transmitted. Transmission of infections among patients could be through contaminated medical tools and apparatus and multi-vial drugs and through personnel such as nurses as they attend to many patients.

From all microbiological investigations, there are some outcomes that are expected. The outcomes include whether there is an infection and determining the presence of an infection-causing pathogen. We also expect to determine the type of bacteria that cause the infection example, *Pseudomonas aeruginosa*. From the investigations, we also expect to know which part has been affected by the infection. It could be GI tract, ear, and eye infection, or pneumonia, among others. Morbidity and mortality rates of pseudomonas infections can be determined from these investigations. These investigations are beneficial as they enable the medical personnel to take appropriate actions based on the results so as to deal with the identified condition.

The objective of this exercise is to investigate the presence of infection in a 22-year-old patient with cystic fibrosis. The patient attends the clinic for a routine sputum culture procedure. The procedure is done to identify the present disease-causing bacteria. CLSI tests were also conducted to determine the responses of the bacteria to different drugs.

Materials And Methods

The sputum sample was isolated from the patient. It was based on the patient's clinical history. The sample was also inoculated on three different media. The media include MacConkey Agar (MAC), hour's blood agar (HBA), and chocolate agar (CHA) which were incubated in an aerobic environment for 24 hours at 37°C. In addition, the gram staining method is the first test, and it was done to differentiate the bacterial groups and to observe numerous types of cells, such as epithelial cells, polymorphs, and normal flora. The materials and methods of gram stain were as explained in Medical Microbiology, Techniques Manual, Department of the School of Science, The RMIT University, (2016) page (8).

In addition, a number of biochemical tests were done to determine the family of this pathogen. Methods and materials were as referred to in the Medical Microbiology, Techniques Manual, Department of the School of Science, RMIT University. The biochemical tests are as follows:

1. Oxidase test (p 23)
2. Urease test (p 30)
3. Indole production test (p 16)

4. Gram stain test (p 8)
5. Nitrate reduction test (p 20)
6. Oxidation -fermentation test (p24)
7. Anti-microbial susceptibility test (p 39)

Results

Tests	Result
Gram stain	(-ve)
Oxidase	(+ve)
Urease	(-ve)
Indole production	(-ve)
Nitrate reduction	(+ve)
Oxidation-fermentation test	(+ve)
Growth anaerobically	(-ve)
Growth on MacConkey	(+ve)
Growth of Horse blood agar (HBA)	(+ve)
Growth in Chocolate agar (CHA)	(+ve)
Growth at 42	(+ve)
Fluorescent pigments (pyoverdins)	(+ve)

Table 1 examines the results of several tests that have been done to identify the pathogen

Antimicrobial drug	Zone size(mm)	Respond
Ceftazidime (CAZ)	0	Resistance
Imipenem (IPM)	9	Resistance
Ciprofloxacin (CIP)	25	susceptible
Gentamicin (CN)	0	Resistance

Table 2 displays the responses for different antimicrobials using the CLSI test:

The organism in case study 47 was clarified using a number of methods. The first method to be conducted was the gram stain test. The results showed that there were many gram-negative bacilli with some polymorph cells. As indicated in Table 1, the organism shows growth on both CHA agar and HBA agar with large creamy grey colonies. Furthermore, it indicates growth in both Nutrient agar and MCA agar with largely pink circular colonies. The pink circular colonies mean that the organism is not considered to be fastidious. However, no growth can be seen for the family of gram-negative rod bacteria on an anaerobic media.

A number of biochemical tests were conducted to find out the family to which this organism belongs. To illustrate, the results from the Nitrate reduction test and the Oxidase test are positive, while the results from the Indole production test are negative. From the results, it was possible to group the organism as a member of *Pseudomonas*.

To differentiate this organism from other members of *Pseudomonas*, there are two distinct methods were used. The first method was the Oxidation-fermentation test, which showed a positive result and also showed that the organisms' growth was at 42. The Fluorescent pigment experimented on MacConkey agar as well. Therefore, all the results from the number of tests done may confirm that the pathogen is considered to be *P. aeruginosa*.

Besides, the results of the CLSI susceptibility test showed different responses to the antibacterial drugs. For example, Ciprofloxacin (CIP) showed a significant effect on the pathogen. However, there is no effect seen from Ceftazidime (CAZ), Gentamicin (CN), and Imipenem (IPM) on the pathogen. This means that the pathogen has a resistance response to these antibacterial drugs.

Discussion

Cystic fibrosis is a common inherited disease among Caucasians in the United States. About 35000

people are currently living with the disease. It is important to understand the treatment of infections in cystic fibrosis. It is complicated and particular and is no longer restricted to the pediatrics department. Greater than 30% of the patients living with cystic fibrosis currently are over the age of 18 years.

In this study, tests were conducted to identify the organism to its genus and species level. The first test to be conducted was the gram stain test. From this test, the results showed that there were many gram-negative bacilli with some polymorph cells. The organism showed growth on both CHA agar and HBA agar with large creamy grey colonies. The organism also indicated growth on both Nutrient agar and MCA agar with largely pink circular colonies. The pink circular colonies mean that the organism is not considered to be fastidious. However, no growth can be seen for the family of gram-negative rod bacteria on an anaerobic media.

Biochemical tests were conducted to find out the family that this organism belongs to. The tests were nitrate reduction test, indole production test, and oxidase test. The results from the Nitrate reduction test and Oxidase test are positive, while the results from the Indole production test are negative. From the results, the organism in question was identified as a member of *Pseudomonas*.

To determine the species of the organism and to differentiate it from other members of *Pseudomonas*, two distinct procedures were done. The first procedure was the Oxidation-fermentation test. This test showed a positive result and also indicated that the organisms' growth was at 42. The second procedure was the Fluorescent pigment that was experimented on MacConkey agar as well. The results from all the tests confirmed that the pathogen present in the patient's sputum culture is *P. aeruginosa*.

A susceptibility test was conducted to test the response of the bacteria to the different antibiotic medications. The tested drugs included Ceftazidime (CAZ), Imipenem (IPM), Ciprofloxacin (CIP), and Gentamicin (CN). The results of the CLSI susceptibility test showed that there existed different responses of the drug to the antibacterial drugs. For example, Ciprofloxacin (CIP) showed a significant effect on the pathogen. No effect was seen from Ceftazidime (CAZ), Gentamicin (CN), and Imipenem (IPM) on the pathogen. The results mean that the pathogen has a resistance response to Ceftazidime (CAZ), Gentamicin (CN), and Imipenem (IPM) antibacterial drugs, and thus they are not the best drugs to treat the infection. The bacteria shows it is susceptible to Ciprofloxacin (CIP); thus, it is the most appropriate drug among the others to treat the infection.

Treatment of severe infections is commonplace in the treatment in adult medicine worldwide. *Pseudomonas aeruginosa* is the most common disease-causing bacterial that causes more severe deterioration in the pulmonary function in the lungs of patients with cystic fibrosis. Maintenance therapy on a daily basis is important for the control of severe infections with the use of antibiotics for the treatment of infections in patients with cystic fibrosis. Patients with Cystic fibrosis have complicated poly-microbial respiratory flora. According to Ahlgren (10), cystic fibrosis patients require routine checks that may show various species of bacteria that may cause complexity in the treatment

and prevention of infections in these patients. Among the main causes of infections in cystic fibrosis patients are *Staphylococcus aureus*, *Haemophilus influenza*, and *Pseudomonas aeruginosa*. In this case, a sputum test was conducted on a 22-year-old patient with cystic fibrosis. From the sputum test, we isolated mucoid pseudomonas aeruginosa.

1. *aeruginosa* is an opportunistic disease-causing bacteria. The bacteria is an oxidase-positive, gram-negative rod-shaped bacterium. It is commonly found in the environment, and it causes infections in both plants and animals such as humans. In humans, it is considered a common and severe disease-causing pathogen in patients with cystic fibrosis. In cases of chronic infections, *P. aeruginosa* is thought to have the ability to undergo a “mucoid switch.” A mucoid switch is where the bacteria have the ability to obtain mutations that result in the mucoid phenotype. The mucoid phenotype is impressive as excess polysaccharides will frequently drip onto the lid of the plate when it is placed upside down during incubation.

According to Gary (4), a key characteristic of mucoid strains of *P. aeruginosa* includes their ability to form biofilms. A biofilm consists of a matrix of polysaccharides, DNA and protein. The biofilms provide a protective barrier from antibiotics and the immune system. In addition, they may they may contribute to the growth of other bacteria within the environment. The presence of all the excess polysaccharides makes it hard to standardize the inoculum of mucoid isolates of *P. aeruginosa*. This is an important starting point for the micro broth dilution method of antimicrobial susceptibility testing. It is for this reason that susceptibility tests of isolated mucoids are often performed using the Kirby-Bauer (KB) diffusion method. The KB method is a test based on the zone of inhibition around the disks containing microbiological drugs. The type of bacteria isolated in this case was found to be susceptible to aztreonam, ceftazidime, and piperacillin.

Epidemiology

Severe respiratory tract infections are the most significant cause of morbidity and mortality in cystic fibrosis. *Pseudomonas aeruginosa* is the most common disease-causing bacteria. In a study done in 2007, the expectancy of patients with cystic fibrosis was 36- 40 years old. Patients with *P. aeruginosa* have a further decreased life expectancy of 30 years of age.

Signs And Symptoms

Pseudomonas infections affect certain parts of the body. The parts are as follows: the respiratory tract (for example, infections such as pneumonia), the bloodstream (example of infection is bacteremia), and the heart example of infection is endocarditis. In addition, the Central nervous system (CNS) (for example, brain abscess and meningitis), the ear (infections such as otitis externa and media), and gastrointestinal tract infections (for example, enteritis, diarrhea, enterocolitis). Other affected parts are the eyes (endophthalmitis, bacterial keratitis), skin infections (for example, ecthyma

gangrenosum), and lastly, the urinary tract. In severe cases, pseudomonas infections lead to death Williams (9).

Physical symptoms depend on the location and the type of infection. Symptoms are as follows:

1. Pneumonia: signs and symptoms include fever, malnutrition, rales, rhonchi, cyanosis, hypoxia, and retractions. Sometimes, shock with cystic fibrosis, clubbing, increase in anteroposterior (AP) diameter, cough, and difficulty in breathing.
2. Infections of the Skin and soft tissue: necrotic lesions, hemorrhagic infections, accompanied by erythema; subcutaneous nodules, cellulitis, and fasciitis, deep abscesses; in burns, there are black or violaceous discoloration or eschar.
3. Endocarditis: murmur, fever, and positive black culture results; exterior stigmata, for example, Roth spots, Janeway lesions, Osler nodes, splinter hemorrhages.
4. Gastrointestinal tract: diarrhea, dehydration, abdominal distention, signs of peritonitis, and results of Shanghai fever.
5. Eye infections: chronic mucopurulent discharge, lid swelling, conjunctival erythema, and chemosis; vision impairment; cellulitis: very fast change to panophthalmitis; sharp pain, erythema, photophobia, lacrimation, and impaired vision.
6. Central Nervous System (CNS) infections: listlessness, fever, irritation, tremor, shock, positive signs of Brudzinski and Kerning, and nuchal rigidity; Confusion, trauma, dejection, acute cranial nerve inadequacies, and changing levels of consciousness or focal neurological signs for brain abscess.
7. Urinary tract: signs and symptoms are catheter obstruction, fever, costovertebral angle (CVA) tenderness, and dysuria.
8. Ear infections: signs and symptoms include facial paralysis and vertigo; granulation tissue in the external ear canal.

Diagnosis

Severe disease-causing pathogens that cause infections in cystic fibrosis patients are mostly isolated from sputum cultures. Sputum cultures may be tested for antimicrobial susceptibility. Recent investigations on the polymerase chain reaction (PCR) do not show a better performance compared to cultures in the diagnosis of cystic fibrosis respiratory infections.

Chest x-rays may be done on the upper lobes because they are the places most involved in the respiratory system. They may indicate cavities or infiltrates in the upper lobes. Underlying cystic fibrosis, chronic illness, and resistance to drugs may cause a positive gram stain, leading to the identification of Pseudomonas in the respiratory tract.

Blood culture, blood count, and urine tests can be performed in the case of Pseudomonas infection in the blood system. Bacteremia may be indicated by the result of blood culture, leukocytosis with a left

shift by complete blood count, and a positive urine culture could indicate the source of the infection.

Meningitis is usually diagnosed by testing the cerebrospinal fluid (CSF) and gram stain. *Pseudomonas* infection may be indicated by pleocytosis with a predominance of neutrophils, a result of positive CSF gram stain, decreased glucose and protein levels, and growth of bacteria and positive culture.

A positive diagnosis of eye infection may be made by examining the eyes. Positive cultures of eye fluid and periorbital tissues may diagnose eye infections.

A *Pseudomonas* infection may be indicated by cultures of skin and soft tissue and positive tissue and gram stains.

Treatment

Treatment of *Pseudomonas* infections includes three major antibiotic classes. The drugs included are as follows:

1. Beta-lactam medications, for example, Ceftazidime (Caz).
2. Aminoglycoside, for example, Gentamicin and (CN)
3. Fluoroquinolone, for example, Ciprofloxacin (CIP).

Prevention

Avoiding contact with *Pseudomonas* bacteria is hard since the bacteria are common and are found in the environment. Hospital patients may avoid infections by washing their hands often. It is important for their care providers to frequently wash their hands. Hospital rooms and medical equipment should be cleaned and disinfected daily. Outside hospitals, use hot tubs and pools that are not correctly treated. After swimming, shower with soap and dry your ears thoroughly.

Conclusion

Pseudomonas aeruginosa is the primary pathogen that causes infections in patients with Cystic fibrosis. The infections are severe and lead to deteriorating pulmonary function. It is indicated in the sputum cultures obtained from the patients. In this case, the sputum culture shows that the *Pseudomonas* strain is resistant to Ceftazidime, Gentamicin, and Imipenem. The strain is susceptible to ciprofloxacin; thus, it is the appropriate drug among the available drugs for the treatment of infection.

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