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Research Article

Pseudomonas Aeruginosa an Opportunistic Bacterium Challenging Diagnosis and Management of Bacterial infection- India Case Epidemiology!

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Abstract

Pseudomonas aeruginosa is an opportunistic bacterium, causes extensive spectrum of infections ranging from ear infections, bacteraemia, urinary tract infections, burn infections, and respiratory tract infections with repaorted prevalence rate ranging from 3 to 16%.

Based on a laboratory-confirmed viral-bacterial co-infection, among all the bacterial species, Haemophilus influenzae 20.8%, Pseudomonas aeruginosa (16.6%) and Streptococcus pneumoniae (11.3%) were the three most common bacterial pathogens.

Infections with Pseudomonas aeruginosa have become a real concern in hospital-acquired infections, and some community-based infections among diabetics, critically ill and immunocompromised patients. Diverse strategies range from use of newer antibiotics based on culture and sensitivity tests and anti-virulence the pathogen. The mechanisms associated with resistance presenting a large genome, which can develop many factors associated with antibiotic resistance involving almost all classes of antibiotics. Clinical approaches to patients with bacteraemia, and Antibiotic combinations are being tried in the analysis of pharmacokinetic and pharmacodynamic parameters to optimize P. aeruginosa treatment.

Material and Methods: This is a case report based epidemiological analysis of P. Aeruginosa in India. Two cases managed by the author in 2023, is about not so common but multiple manifestations of a chronic infections mimicking and threatening some other common conditions like Tuberculosis and Peripheral artery disease or diabetes foot ulcers, requiring the bacterial culture and sensitivity of the organisms for getting rid of the infections. The case reports are complimented by literature search both national and global status of Pseudomonas aeruginosa infections.

Results: While our Respiratory infection case, threatened the patient with possible pulmonary tuberculosis due to family history and challenged the physician of differential diagnosis and demand bacterial culture and sensitivity test to clinch the diagnosis. The patient is doing well after 8 weeks of antibiotic therapy. Our second case of suspected peripheral artery disease or diabetic foot ulcer, a second episode after amputating one toe, turned out to be Pseudomonas aeruginosa infections, that was managed by wound cleaning and appropriate antibiotic therapy for 10 days, not only to get rid of infection, saving the toe and repenting for having not done similar efforts in the first episode.

Keywords: epidemiology; bacterial infections; gram negative bacteria; pseudomonas aeruginosa; bacterial culture of sputum or pus of the infected wound

Abbreviations:

PA= Pseudomonas aeruginosa

PAIs= Pseudomonas aeruginosa Infections

TB= Tuberculosis,

ESR= Erythrocyte Sedimentation Rate, WBC= White Blood Cells,

RBS= Random blood sugar, Hb1Ac= Glycosylated Haemoglobin

Introduction:

Epidemiology is the analysis of the spread and variables of health-related conditions, diseases, or incidents in special communities, as well as the interpretation of the findings to the management of medical issues. Common bacterial infections are the second-leading cause of death annually and are linked to one in eight deaths globally. E. coli, S. pneumoniae, K. pneumoniae, S. aureus and A. Baumanii cause nearly 700,000 deaths annually [1]. From June 1, 2015, to Sept 1, 2017, 2195 patients enrolled, and

it was observed that marked differences between India, Europe, and the USA. Patients in India were younger (median age 56 years vs the European and US registries; p<0·0001]) and more likely to be men (56·9%). Previous tuberculosis (35·5%) was the underlying cause of bronchiectasis and Pseudomonas aeruginosa was the most common organism in sputum culture (13·7%) in India Risk factors for exacerbations included male sex, P aeruginosa infection, a history of pulmonary TB, daily sputum production, and radiological severity of disease [2]. India, reports Tuberculosis (TB), Anthrax, Tetanus, Leptospirosis, Pneumonia, Cholera, Botulism & Pseudomonas Infection (PI) as deadly Bacterial Infections in order of priority [2,3].

Pseudomonas aeruginosa (P. aeruginosa/ PA) is an opportunistic bacterium which causes extensive spectrum of infections ranging from ear infections, bacteraemia, urinary tract infections, burn infections, bacteraemia, and respiratory tract infections and sometimes poses a challenge in diagnosis, though the treatment is easy. Prevalence rate of P aeruginosa infection ranges from 3 to 16%, in a multicentric study conducted by Ling J M et al [4,5,6].

Viral infections of the respiratory tract represent a major global health concern and Co-infection with bacteria contribute to severe disease and increased mortality in patients and their clinical outcomes have not been well characterized to date [3]. Based on a study of 15,906 patients with respiratory viral infection, there were nearly half (53%) clinically suspected and 1,087 (6.8%) laboratory-confirmed viral-bacterial co-infection. Among all the bacterial species, Haemophilus influenzae (226/1,087, 20.8%), Pseudomonas aeruginosa (180/1087, 16.6%) and Streptococcus pneumoniae (123/1087, 11.3%) were the three most common bacterial pathogens in the laboratory-confirmed co-infection group [6]

Common signs and symptoms of a Pseudomonas aeruginosa infection (PAI) include Chills, Fatigue, Fever, Joint pain, hypotension, and Muscle pain. Pseudomonas aeruginosa has a relatively large genome and possesses a great genetic versatility which enables it to grow in several different environments, to produce a variety of virulence factors and antibiotic resistance to most antibiotics. PAI causes community acquired as well as hospital borne infections. People exposed to healthcare settings like hospitals or nursing homes, dirty environmental occupations like sewage cleaners, and cooks who are exposed to higher risk in temporary kitchens with no proper drainage or hygiene and cultural compulsions of cookingbearfoot [4,5].

Antimicrobial Susceptibility Test Result

Antimicrobial Agent	Zone Size (mm)	Interpretation
Amikacin	24	Sensitive
Cefepime	16	Resistant
Ceftazidime	16	Resistant
Ciprofloxacin	30	Sensitive
Gentamicin	25	Sensitive
Levofloxacin	29	Sensitive
Meropenem	28	Sensitive
Piperacillin / Tazobactam	28	Sensitive
Tobramycin	25	Sensitive

Based on the test report the patient was put on 500 mg Ciprofloxacin (PM Jana Aushadhalaya), being the cheapest costing about INR 20 per day for 8 weeks & Cowyn Forte (Dextromethorphan Hydrochloride & Chlorphenamine Maleate) cough syrup for 2 weeks.

Repeat Test on 18/01/2024.

TWBC=14100/Cu.mm, Ab.NC= Repeat test = 6.7K/cu mm, Lymphocyte's count= 6200/cu mm, ESR= 87mm/@ 1Hr. **Sputum Culture=** *Oral Commensal Isolated*

Status as of 1 February 2024: A repeat Blood test and Sputum culture done on 18 January 2024 cleared the infection, Ciprofloxacin was stopped after 2 months. She is doing fine now.

This case report based epidemiological analysis of P. Aeruginosa in India is about not so common but multiple manifestations of a chronic infections mimicking some other common conditions, needing the culture and sensitivity of the organisms for getting rid of the infections and saving amputations in diabetic foot ulcers.

Case Reports:

1. A case of Pulmonary Infection mimicking TB:

Purnima, a 45-year female, a cook by profession sought the consultation of a physician in Hubballi, Karnataka in the first week of October 2023 with complaints of cough, copious sputum, fatigue after a course of antibiotics given by a general practitioner. History of significance was she had suffered bilateral lower limbs cellulitis in April 2022. Her profession exposed her to unhygienic environment and barefoot cooking, and she had cracks and fissures in her both soles.

General physical examination did not indicate much.

CBC indicated figures in parentheses are normal ranges i) *Total WBCs*= 13400 ((normal range 4-11K cells /cu.mm), ii) *Absolute Neutrophil* count of 8800 (2-7K)/cu mm, *Lymphocytes* 3900 (9103k) / cu.mm, iv) *ESR*= 68 mm (0-20)/ @1 hour all other parameters within normal limits. **Random Blood sugar**= 110mg/dl ((80-160), repeat on 18/1/26= 124mm/dl. **Renal Function Biomarkers:** (Blood Urea =19mg/dl, Serum Creatinine=0.86mg/dl, Serum Uric acids 3.7 mg) in normal ranges. **Routine Urine examination** *revealed no significant infection.* **Sputum examination for AFB-** Negative, Repeated on 18/1/24= Negative. **Chest Xray- NAD**

Sputum Culture & Sensitivity:

Specimen: Sputum Types of Culture: Bacterial Aerobic Culture.

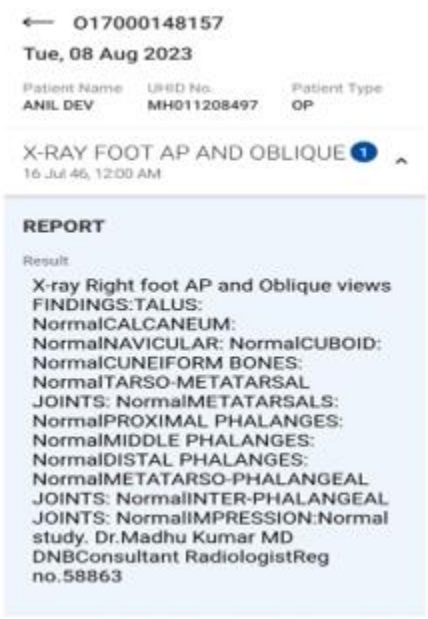
Gram stain:> 25 pus cells / lpf, < 10 epithelial cells / lpf, few Gram-positive cocci in pairs, and few Gram-negative bacilli seen.

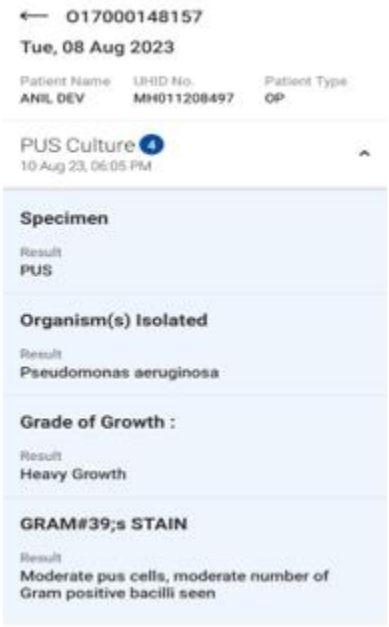
Final Report: Heavy growth of Pseudomonas aeruginosa in culture.

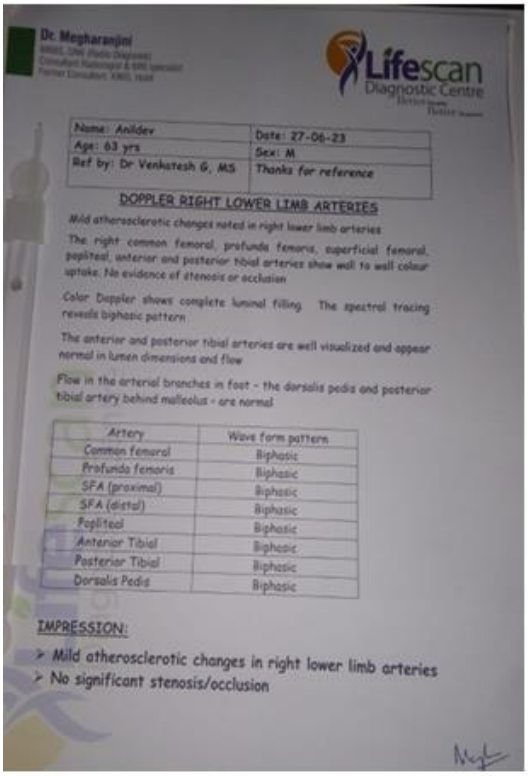
Methodology: Kirby Bauer disc diffusion method, Test done as per CLSI guidelines.

2 A case of Retrospective Repentance of PA Infection?

Anil Dev aged 62 years male, a known case of borderline diabetes and hypertension complained of a wound on the Same individual notice similar ulcer on the right middle toe, in June 2023, Blood sugar levels indicated border line Diabetes (PP=150mg/dl), Hb1Ac= 6.8. Local surgeon suspected Peripheral Artery Disease (PDA) and wanted a Doppler of the peripheral arteries of right leg, which showed no significant stenosis or Occlusion.







Dr. Megharanjini

Lifescan Diagnostic Centre

Name: Anildev	Date: 27-06-23
Age: 63 yrs	Sex: M
Ref by: Dr Venkatesh G, MS	Thanks for reference

DOPPLER RIGHT LOWER LIMB ARTERIES

Mild atherosclerotic changes noted in right lower limb arteries

The right common femoral, profunda femoris, superficial femoral, popliteal, anterior and posterior tibial arteries show wall to wall colour uptake. No evidence of stenosis or occlusion

Color Doppler shows complete luminal filling. The spectral tracing reveals biphasic pattern

The anterior and posterior tibial arteries are well visualized and appear normal in lumen dimensions and flow

Flow in the arterial branches in foot – the dorsalis pedis and posterior tibial artery behind malleolus – are normal

Artery	Wave form pattern
Common femoral	Biphasic
Profunda femoris	Biphasic
SFA (proximal)	Biphasic
SFA (distal)	Biphasic
Popliteal	Biphasic
Anterior Tibial	Biphasic
Posterior Tibial	Biphasic
Dorsalis Pedis	Biphasic

IMPRESSION:

- Mild atherosclerotic changes in right lower limb arteries
- No significant stenosis/occlusion

The case was referred to a private Tertiary care hospital, in Bengaluru in August 2023. The private tertiary care hospital ruled out PDA and Bone infection (Osteomyelitis) were excluded, and culture of the pus showed growth of Pseudomonas Aeruginosa infection.

The patient was advised home level cleaning and dressing of the wound on alternate days. He was taught to debride the wound cutting painless dead tissue using a sterile tissue forceps and scissors Thorough wound cleaning with Hydrogen peroxide and application of Betadine lotion, Tobramycin, for about 3 weeks. After 2 weeks the infective tissue disappeared, and pink granulation tissue was observed. In September the dressing was advised twice a week applying Silverx ointment. Silverex Ionic Gel is an inorganic chemical with antiseptic activity, used for the prevention of infections in burns and wounds. On application, it releases silver ions into the skin which kills and prevents the growth of infectious microorganisms. The wound healed, after 6 weeks, saving the agony of losing another toe as he had experience just 6 months ago.

Immediate Past episode leading to amputation of proximal phalanx of left little toe:

He had sought the consultation of aa local practitioner with the complaint of a blister on the left little toe in September 2022. The general practitioner treated with antibiotics and cleaning the wound, that did not help much. He then went to a local surgeon in October 2022, who did a debridement, and changed the antibiotic. As the wound did not respond and started expanding, the surgeon advised and finally amputated the toe in December.

Retrospectively, we now feel that a culture and sensitivity test and appropriate antibiotic Therapy could have save this toe.

First site of wound in September 2022

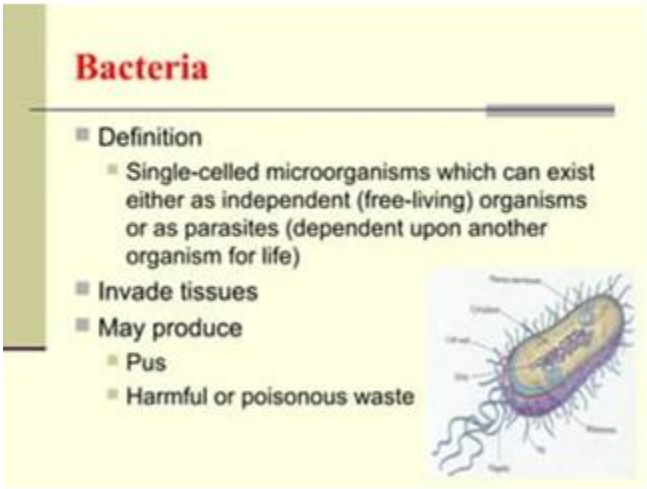
After Debridement October 2022

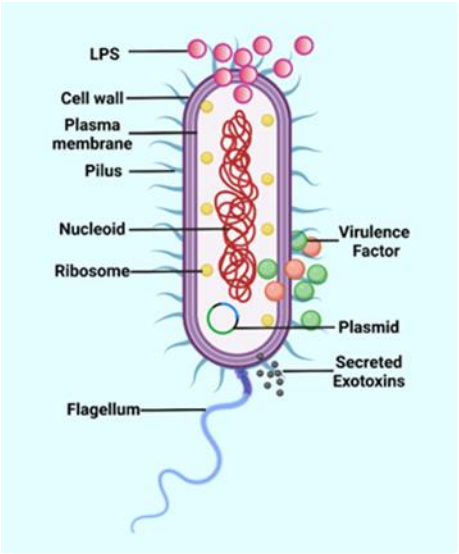
After Debridement October 2022

The healed wound December 2023

Discussions:

Pseudomonas aeruginosa is a bacterium that's commonly found in the environment, for example in soil and water. It can be spread to people through contaminated surfaces, hands, and equipment. It can cause serious infections in certain people. Some healthy people even have strains of it growing on their skin in moist parts of their body, like their armpits or genital area called a Pseudomonas infection. Pseudomonas aeruginosa can be found in- Drains and plumbing parts, Household cleaning products, Hospital or clinic equipment, Water and Soil. In India Pseudomonas infection is not uncommon in health care settings, Professional cooks etc. due to contaminated surfaces, hands, and equipment or utensils.



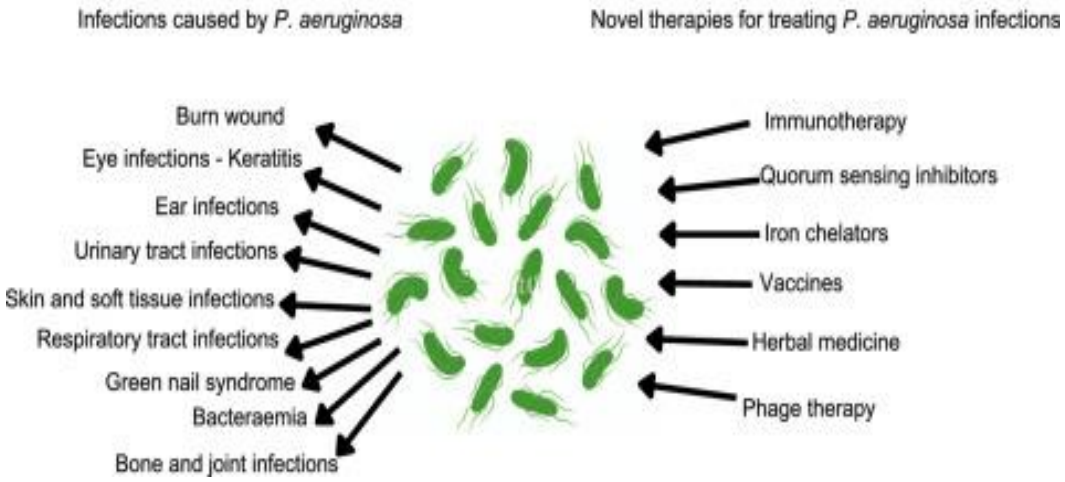


Schematic diagram showing the structure of the Pseudomonas

Pseudomonas aeruginosa is a non-capsulate and non-sporing gram-negative bacillus that most commonly affects the lower respiratory system in humans. The ability of P. aeruginosa to persist and multiply in moist environments and equipment, such as humidifiers in hospital wards, bathrooms, sinks and kitchens, temporary kitchens for social & Religious functions in India are of importance in cross-infection.

Many people in good health do not get sick from PA. Some get a mild skin rash or an ear or eye infection. But among people with weakened immune systems, pseudomonas can cause a severe infection. In people with cystic fibrosis, cancer, or burns, it can be life-threatening. One can get pseudomonas infections from eating contaminated food as it can grow on fruits and vegetables, in moist areas like pools, hot tubs, bathrooms, kitchens, and sinks as the organism thrives in such places. It is one of the top causes of infections people get from being in hospitals as Pseudomonas aeruginosa easily grows in humidifiers, catheters, etc. if that aren't properly cleaned. If health care workers don't wash their hands well, they can also transfer the bacteria from an infected patient to another person.

Infections caused by P. aeruginosa and novel therapies for treatment



The risk of pseudomonas infection goes up if health care provider gets a wound from surgery are being treated for burns, use a breathing machine, catheter, or other medical device, have diabetes or cystic fibrosis, and have any disorder that weakens your immune system, such as HIV, Cancer, or Chemotherapy for Cancers etc.

P. Aeruginosa isolated from tertiary care hospitals in India reported 47.7% were drug resistant, 50% MDR and 2.3% were extensively drug resistant (XDR) strains with a high level (80%) of carbapenems resistance. P. aeruginosa was identified in 6% of COVID-19 patients in the recent Pandemic [8,9]

Physiopathology: The bacterium is commonly isolated from natural resources like soil and surfaces in aqueous environments. P. aeruginosa is also found on the skin of healthy people and has also been isolated from the throat (5%) and stools (3%) of nonhospitalized patients. PAI cause nosocomial infections like pneumonia, infections of the urinary tract (UTIs), wounds, bones and joints, and the bloodstream. The bacterium also thrives when the epithelial barrier is damaged, neutrophil production is depleted, mucociliary clearance is altered and in the presence of medical devices. PAI causes community-acquired infections such as gastrointestinal, skin, and soft tissue infections, and otitis externa and is associated with lower respiratory tract infections in patients with cystic fibrosis. Community-acquired pneumonia is rarely caused by P. aeruginosa.

Pseudomonas infections can infect any part of our body, such as our blood, throat, lungs, stomach, urinary tract, or tendons. Pressure sores, wounds, and burns can also become infected. The signs and symptoms depend upon the places where infection occurs signs include: Ears: pain and discharge,

Throat-Chronic Sore throat, Skin: rash, which can include pimples filled with pus, Eyes: pain, redness, swelling, Bones or joints: joint pain and swelling; neck or back pain that lasts weeks, Wounds: -green pus or discharge that may have a fruity smell, Digestive tract: headache, diarrhea, Lungs: pneumonia; severe coughing & congestion, Urinary: urinary tract infections. Fever is a sign of a severe pseudomonas infection.

Literature Review:

PA &LR Infections: P. aeruginosa infections of the lower respiratory tract can range in severity from colonisation (without an immunological response) to a severe necrotising bronchopneumonia. There is no significant clinical advantage of any combination regimen over another. The emergence of resistance continues to be a concern. Pipericillin, piperacillin/tazobactam and meropenem have good but equivalent antibacterial activity against P. aeruginosa. Nebulised delivery of antipseudomonal antibiotics is thought to prevent recurrent exacerbations, reduce antibiotic usage, and maintain lung function, particularly in patients with CF. Colistin, tobramycin and gentamicin are currently the most prescribed nebulised antibiotics. A chronic infection is seldom if ever eradicated when first established. Therefore, early intensive treatment and prevention are preferable to maintain pulmonary function & postpone the onset of chronic PAI [2,3,9].

PAIs of Burn wounds: Around 7 million people in India suffer from burn injuries every year, resulting in 140,000 deaths. The burn wound surfaces are sterile immediately following thermal injury, but in the next 48 hours microorganisms colonize the wound surface, as it is rich in proteins and avascular necrotic tissue, facilitated by the thermal destruction of the skin and concomitant depression of the local and systemic host cellular immune response. Wounds first become colonized by Gram-positive organisms such as Staphylococcus aureus and Streptococcus pyogenes before infection by P. aeruginosa. Eventually other bacteria and yeasts along with P. aeruginosa colonize wounds from patients' endogenous flora of the gastrointestinal and or upper respiratory tract. P. aeruginosa causes serious burn infections and sepsis is a major cause of deaths in patients, with mortality as high as 75%. Recent studies with the burn patients demonstrated that thermal injury results in impaired production of host defence peptides (β-defensins) in tissues surrounding the burn wound, and these peptides play a primary role in defence against P. aeruginosa. The impairment of host immunity and loss of skin integrity allows opportunistic pathogens to enter the body and cause infection. Burn wound infection by P. aeruginosa manifests as a green pigment in subcutaneous fat, which is erythematous and later turns into a black, necrotic, nodular lesion. A study conducted in India found P. aeruginosa in 54.9% of burn patients with high-level (76.8%) of multidrug resistance. An intracellular signalling molecule such as 4-hydroxy-2alkylquinolines (HAQs) are involved in iron chelation governs and dictate the infection course, as in humans they produce and excrete detectable levels of HAQs [3,8].

Bacterial keratitis: P. aeruginosa causes keratitis in patients with ocular disease, postocular surgery and in individuals who use contact lenses. Most of the contact lens-associated P. aeruginosa infections are due to contamination of the lens or extended lens use—resulting in disruption of the epithelial surface of the cornea that further leads to corneal abrasions. When epithelial barrier function is impaired by using contact lenses for long periods, P. aeruginosa causes an opportunistic infection. P. aeruginosa becomes rapidly internalized by binding to toll-like receptors (TLR5) on the surface of the cornea. Keratitis due to Pseudomonas is characterized by sudden onset, rapid progression of ocular pain, redness, tearing, photophobia, and blurred vision. Clinically, this infection causes corneal epithelial defect and a stromal infiltration that further leads to stromal necrosis and progressive thinning. P. aeruginosa is responsible for causing bacterial keratitis in 8% to 21% in south India [3].

Ear infections: Inflammation or infection of the external auditory canal, referred to as otitis externa or "swimmers' ear", is caused by P. aeruginosa, due to contamination of water by P. aeruginosa, prolonged exposure to moisture, and insertion of foreign objects. P. aeruginosa is one of the major organisms to cause chronic suppurative otitis media (CSOM) in Indi. Mittal et al. using human, and animal cell-based assays demonstrated that Otopathogenic P. aeruginosa can enter and survive inside macrophages. A Tertiary care centre in Uttarakhand, India, indicated P. aeruginosa as a major cause of CSOM (32.1%) with substantial number of MDR strains. More than 700 million cases of CSOM are reported globally and about 42 million cases in India per annum, among children below age 15, who are found to be more vulnerable to P. aeruginosa. Pooled estimated prevalence of ear diseases of 11.66% in children of India (which works out to be 350 million in 2024) is substantial to lead to high disease burden. The point prevalence of CSOM in urban school children was 2.32%, while for rural children, it was 5.11%. Nearly 42% of cases of CSOM belonged to upper-lower socioeconomic group followed by lower middle group (32%). It's common for small children to have several ear infections in one year, as often as once every month [8].

Skin and soft tissue infections (SSTI): Folliculitis starts with sudden onset of numerous, large, monomorphic, painful papules, and pustules that develop approximately 24 hours after prolonged immersion in contaminated hot tubs or spa pools, whirlpools, and swimming pools or after leg waxing. The lesions often congregate on body parts in contact with contaminated water and usually appear 8–48 hours after exposure. In immunosuppressed patients, folliculitis can further progress to ecthyma gangrenosum. In AIDS patients, P. aeruginosa infection may cause subcutaneous nodules or progressive folliculitis with cellulitis. Another complication found in children is a "hot foot" syndrome, characterized by painful plantar nodules [8].

SSTI – Gangrenous cellulitis and necrotizing fasciitis: P. aeruginosa infection of the skin and fascial layers is a rare but serious medical condition, characterized by rapid and progressive destruction and inflammation that further results in fulminant skin necrosis and death. The spread of necrotizing fasciitis is directly proportional to the thickness of the subcutaneous layer as it moves along the fascial plane.

Green nail syndrome / chromonychia /Fox-Goldman syndrome: Green nail syndrome is commonly restricted to one or two nails with partial or complete involvement of the nail plate. The infection is characterized by painless nail plate with erythematous or tender skin around the nail. An infected individual can autologously disseminate the bacterium by scratching or rubbing his or her skin, especially when cutaneous surface is damaged. A retrospective study conducted to investigate fungal coinfection with P. aeruginosa during the period of 2015–2018 reported green nail syndrome commonly affected great toenail (69.9%) and high prevalence of fungi.

Bacteraemia: Blood stream infections (BSI) caused by P. aeruginosa are often fatal. The bacterium is responsible for 3%–7% of blood stream infection cases with high morbidity and mortality rates (27%–48%) in critically ill patients. Systemic P. aeruginosa infections cause subcutaneous nodules, ecthyma gangrenosum and gangrenous cellulitis. Patients with burns and AIDs are more vulnerable to systemic infection by P. aeruginosa.

Urinary tract infections (UTIs): UTI is the second most common type of infection in the body. P. aeruginosa was found to be the third most common Gram-negative pathogen causing 7.1% of all nosocomial urinary tract infections in surveillance studies from the Asia-Pacific region in 2009 to 2010. It is an important uropathogen, associated with catheterization or surgery. Shobha et al. [131] collected 107 urine samples from microbiology laboratory during 2015–2016 reported 84.11% P. aeruginosa UTIs. Results of this study indicated majority of UTIs with Pseudomonas species are found in males aged more than 60 yrs. P. aeruginosa causes 1%–4% UTIs after flexible cystoscopy.

Respiratory tract infections:

Pneumonia: Pneumonia is caused by P. aeruginosa and is divided into four categories: (1) Hospital-acquired pneumonia, which occurs 48 hours or more after hospitalization; (2) Ventilator-associated pneumonia that develops more than 48 to 72 hours after endotracheal intubation; (3) Health care-associated pneumonia occurs among nonhospitalized patients, who live in a nursing home or long-term care facility, those received intravenous antimicrobial therapy or chemotherapy or wound care, and those who attended a hospital or dialysis clinic in the previous 30 days of the current infection and (4) Community acquired pneumonia. P. aeruginosa is a rare cause of community-acquired pneumonia, but it does nearly always isolate from elderly patients with concomitant diseases, most notably COPD, rather than from community-dwelling patients. An increase in P. aeruginosa infections in nursing home residents and cooking professional who work in unhygienic conditions without any footwears in India as was seen out case of Purnima. There are case reports of CAP in healthy people.

Bronchiectasis: Chronic bronchial dilatation is referred to as bronchiectasis. As a result, there is inadequate mucus drainage and increased risk of bacterial infection. The findings imply that P. aeruginosa is a marker of disease severity but does not hasten a decline in pulmonary function. P. aeruginosa is one of the most prevalent bacteria that colonize bronchiectasis in people without cystic fibrosis. These patients have larger sputum volumes, higher FEV1 and FVC, more than three lobes were impacted in 66% of cases, 24% of patients needed hospitalisation, and 18% required long-term macrolide therapy.

Bone and joint infections: Our bones and joints are sterile areas, but bacteria can reach them by haematogenous spread or exogenous and endogenous contiguous focus of infection. P. aeruginosa is accountable for about in 10% of all cases of sternoclavicular septic arthritis, with common risk factors like intravenous drug use, diabetes mellitus, trauma, and infected central venous lines. Septic arthritis of wrist joint due to P. aeruginosa is a rare condition in children, characterized by acute onset of fever, swelling and pain.

Diagnosis: Pseudomonas aeruginosa can be detected from a sample of your blood or sputum, or another body fluid by culture and sensitivity tests in the laboratories. The results also help them decide which types of antibiotics will work best to cure the infection.

Treatment: Treatment is determined by the site of the pseudomonas infection and its severity. For a mild infection, a course of antibiotics helps. Depending on the site of the infection it could be in the form of a cream, eye drops or ear drops, or pills you take by mouth. A severe infection may need the antibiotic given through an IV. In most case the treatment requires weeks of antibiotics therapy. Laboratory research in India shows that Ceftizoxime-tazobactam, Ceftazidime-Avibactam, Imipenem-relebactam, Cefepime-Taniborbactam, Cefepime-Zidebactam, Cefepime-beta-lactams inhibitor (BLI) combinations and Meropenem-Nacubactam are sensitive to such organisms. Globally, Majority (>85%) of gram-negative isolates causing blood stream infections were sensitive to Amikacin, Cetohexazine-Sulbactam, Piperaciln-Tazobactam, Meropenem and Colistin [1].

A study from Mumbai reported that severe CAP (SCAP) reached 19 per cent of all patients and Streptococcus pneumoniae and Gram-negative bacteria (Pseudomonas aeruginosa and Klebsiella pneumoniae) had increased occurrence in severe pneumonia [10].

(All values are in percentages & are mutually not exclusive)

Antibiotic	Amikacin	Cefipime	Cefaperazone + Sulbactum	Cipro	Meropenem	Pipera-cillin+ Tazo	Colistin
Pseudomonas aeruginosa							
2005 n= 33	30	12	12	15	36	15	48
2006 n=8	25	12	50	12	50	62	62
2008-9 n=33	76	15	85	9	100	85	100

Table 1: Frequency of Isolation and sensitivity patterns of gram-negative blood stream isolates

The most used are the extended-spectrum Penicillin's, aminoglycosides, cephalosporins, fluoroquinolones, polymyxins and the monobactams. An aminoglycoside with a beta-lactam penicillin is usually considered to be the first line treatment. For wounds on the skin irritation with a 1% acetic acid solution for otitis externa together with topical polymyxin B, or fluoroquinolones in cases of a more severe infection. Two antipseudomonal drug combination therapy (e.g., a beta-lactam antibiotic with an aminoglycoside) is usually recommended for the initial empiric treatment of a pseudomonal infection, especially for patients with neutropenia, sepsis, bacteraemia, severe upper respiratory infections (URIs), abscess or wound infections in legs especially among diabetics. In the last decade PAI's are becoming more difficult to treat empirically due to increasing antibiotic resistance and treatment needs to be based on Bacterial culture sensitivity tests. PAI's bacteraemia or LRI is a severe infection, often treated with long-course (14-60 days) antibiotics [4, 5,6,8].

Novel approaches to treat Pseudomonas infections:

The antimicrobial resistance in P. aeruginosa is increasing steadily; as a result, the treatment of infections caused by P. aeruginosa is extremely challenging [8]. Novel therapeutic options for treating P. aeruginosa infections are shown in the Table below:

Novel therapies for treating Pseudomonas aeruginosa infections.

Novel therapeutic agents	Mode of action/target Reference
Quorum sensing inhibitors	Signal molecule degradation, preventing accumulation of signal molecules and antagonism of the signals- Chamomile, carrot, garlic, salicylic acid, furanones.
Immunotherapy	PcrV protein, flagellin, LPS KB001-A, Immunoglobulin Y, Panobacumab.
Iron chelators	Chelation of the environmental iron- Gallium.
Vaccines	Polysaccharide, PcrV, OprI, Hcp1, FlgE, fructose bisphosphate aldolase, OprH gene productPcrV-OprI-Hcp1-Trivalent vaccine, Polyvalent vaccine
Herbal medicine	Exopolysaccharide production, phenazine pyocyanin, rhamnolipids, elastase and alkaline protease Tanreqing, Herba patriniae
Phage therapy	Lysis of cell membrane and wall, Pf3R, genetically engineered synthetic phage's

Prevention of Pseudomonas Infection:

Medical grade manuka honeys are well known to be efficacious against P. aeruginosa being bactericidal and inhibiting the development of biofilms. moreover, manuka honey effectively kills P. aeruginosa embedded within an established biofilm. All the isolates of P. aeruginosa tested were killed in 12-24 h depending on the dilutions of the honey tested. Honey prevents the growth of P. aeruginosa even if it is diluted by deionized water by five folds in vitro [8].

One can lower your risk of getting sick by trying to avoid these nasty germs by:

o Wash hands often, the best-known way to avoid getting pseudomonas.

o Doctors, nurses & other workers must clean their hands before touching next patient

o Rinse fruits & vegetables (even salad greens) must be given a good wash.

o Clean the water bottles. Sterilize with boiling water between each use.

o Avoid unclean pools and hot tubs or make sure they're cleaned often, and the chlorine and pH are well-controlled, as Pseudomonas thrive in them.

o After any surgery, burns, diabetic foot ulcers, be on the lookout for signs of infection. Like a fever, pain, or see redness or discharge at the site, seek care.

Conclusion:

Pseudomonas aeruginosa (P. aeruginosa/ PA) is an opportunistic bacterium which causes extensive spectrum of infections ranging from ear infections, bacteraemia, urinary tract infections, burn infections, bacteraemia, and respiratory tract infections. A scoping report on antimicrobial resistance in India reported a high prevalence of carbapenem resistance among P. aeruginosa and more than 50% of isolates were also reported resistant to broad spectrum antibiotics such as fluoroquinolones and third generation cephalosporins. P. Aeruginosa in India is about not so common infections but can manifest as multiple chronic infections mimicking some other common conditions like Tuberculosis and Peripheral artery disease or diabetes foot ulcers, inducing fear and anxiety among patient and challenging the primary care Physicians and requiring the bacterial culture and sensitivity of the organisms to clinch the diagnosis for getting rid of the infections.

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