

Overview of Opportunistic Bacteria

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Abstract

The receptive patient and the bacterium serve as the two defining criteria for opportunistic bacteria. Theoretically, no saprophytic or typical commensal microbes can infiltrate a healthy receptive person. Only specific "undesirable" commensal species, "such as Vargues' Specific Pathogenic Bacteria", can infect this person. Several species from the typical commensal flora, or opportunistic bacteria in the wide meaning of the word, "may infiltrate an otherwise healthy host if their immune defences temporarily deteriorate". Even species that were previously thought to be non-virulent may assault an immunosuppressed patient with a significant and protracted immune system depression, "including various saprophytic and commensal microbes". Several bacteria that are typically found in water, food, and the air have recently become opportunistic pathogens in both people and animals. The issue is made more difficult by the introduction of many antibiotic-resistant strains of these opportunistic pathogens, which make hospital-acquired infections in susceptible hosts challenging to treat in the setting of illness.



نظرة عامة على البكتيريا الانتهازية

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الخلاصة

يعتبر المريض المستجيب والبكتيريا المعايير المحددة للبكتيريا الانتهازية. من الناحية النظرية، لا يمكن لأي ميكروبات رمية أو تكافلية نموذجية أن تتسلل إلى شخص صحي مستجيب. فقط أنواع معينة من الأنواع التكافلية "غير المرغوب فيها"، مثل "البكتيريا الممرضة المحددة لفارجس"، يمكنها إصابة هذا الشخص. يمكن لعدة أنواع من الفلورا التكافلية النموذجية، أو البكتيريا الانتهازية بالمعنى الواسع للكلمة، "أن تتسلل إلى مضيف صحي إذا تدهورت دفاعاته المناعية مؤقتاً". حتى الأنواع التي كانت تُعتبر سابقاً غير ممرضة قد تهاجم مريضاً مثبط المناعة يعاني من اكتئاب مناعي كبير وطويل الأمد، "بما في ذلك مختلف الميكروبات الرمية والتكافلية". عدة بكتيريا توجد عادة في الماء والطعام والهواء أصبحت مؤخراً ممرضة انتهازية في كل من البشر والحيوانات. تتعقد المشكلة بإدخال العديد من السلالات المقاومة للمضادات الحيوية من هذه الممرضات الانتهازية، مما يجعل العدوى المكتسبة في المستشفيات لدى المضيفين المستجيبين صعبة العلاج في سياق المرض.

1. Introduction

Opportunistic pathogens (OPs) are often defined as organisms in the medical literature that can become harmful after being perturbed by their host (such as sickness, wound, medicine, past infection, immunodeficiency, and aging). “These opportunists can appear among symbionts” that are typically commensal “such as *Streptococcus pneumoniae* and *Staphylococcus aureus*.” or from bacteria that have been acquired by environmental exposure “such as *Pseudomonas aeruginosa* and *Burkholderia cepacia*”. Many additional diseases are recognized as opportunists in that, in addition to often infecting healthy people, they are also zoonotic and prey on a variety of other hosts (such as the rabies virus and *Bacillus anthracis*) (Brown et al., 2012). Most pathogens fail to meet these assumptions, with many coexisting relatively peacefully with their human host (i.e., they are not obligately pathogenic) or even exploiting an entirely different environment outside of human hosts (Woolhouse et al., 2001).

Opportunist organisms have three main traits: (1) they typically have low pathogenicity; (2) they typically cause serious infections when the host's defence mechanisms against infection are compromised; and (3) they can act like typical pathogens but may also cause unusual symptoms when given the right circumstances (Fan *et al.*, 2019).

Those Hospital settings are the ones where infections brought on by microorganisms resistant to antibiotics are most common, in large part because of comorbidities and problems brought on by medical interventions (Hassan *et al.*, 2015). Patients in particular with weakened immune systems are more prone to infections, which allows opportunistic microorganisms to enter and spread unchecked (Moradali *et al.*, 2017). This can happen in individuals who are using immunosuppressants for autoimmune illnesses and other inflammatory problems (Riccardi *et al.*, 2019), as well as other ailments (Kirchgesner *et al.*, 2018). Patients with human immunodeficiency virus infections (Buchacz *et al.*, 2016). or as host-parasite interactions are affected by climate in ways that result in greater rates of death (Rohr *et al.*, 2013). Those bacterial commensals that transform into fatal pathogens under specific circumstances seem particularly probable candidates for an expanding involvement in illness and death in light of fast world change and increases in environmental stresses. These organisms are opportunists that may live in hosts for extended periods seemingly unaffected until developing clinical illness when host immunity is weakened or in response to changes in the pathogen. There is proof that commensals can act as opportunistic pathogens. Saiga antelopes had a particularly spectacular case in 2015, which was related to *Pasteurella multocida* serotype B in conjunction with environmental factors (Kock *et al.*, 2018).

2. Opportunistic bacteria Predisposing Factors

2.1 Long-term use of antibiotic According to research (José *et al.*, 2020), prolonged use of antibiotics may cause changes in the oral microbiota of the body's natural inhabitants and may lead to a rise in the prevalence of opportunistic microorganisms such as enteric bacilli, *Pseudomonas*, *Staphylococcus*, and yeasts. As a commensal fungus, *Candida* spp. is found in the oral cavity. According to Komiyama *et al.*, (2004), *Candida albicans*, which makes up 60 to 70% of all isolations, is the prevalent species. *Candida tropicalis* and *Candida glabrata* are the next most common isolates. Despite not being considered pathogenic in healthy humans, bacteria from the families Enterobacteriaceae and

Pseudomonas spp. have undergone extensive study. However, the oral cavity may act as a reservoir for these microorganisms, endangering the lives of people with disabilities (Kaklamanos *et al.*, 2005). “Staphylococci bacteria” are not regarded to be a normal component of the human oral microbiota, but they can behave as opportunistic pathogens in patients receiving long-term systemic antibiotics or immunosuppressive therapy (Zaatout, 2021).

When administered properly, antibiotics lower all-cause mortality and save children's lives from serious infectious infections (Keenan *et al.*, 2019). Despite this, they are routinely administered improperly (Fink *et al.*, 2020) and have a variety of unintended consequences in human hosts, in particular. The short- and long-term maturation of the gut microbiome in children is considerably altered by antibiotic exposure (D'Souza *et al.*, 2020). It is unclear how these modifications vary by antibiotic class and how they affect various populations' clinical outcomes and illness risks. It is well known that antibiotics can modify the microbiota, decreasing colonization resistance and increasing vulnerability to some opportunistic (entero-) infections including *Salmonella* and *Clostridium difficile* (Wu *et al.*, 2020). On the other hand, it has been demonstrated that mass azithromycin treatment considerably lowers pediatric mortality, maybe because of a decrease in enteropathogenic load (Keenan *et al.*, 2019). Asthma (Marra *et al.*, 2009), diabetes (Chen *et al.*, 2021) and obesity (Block *et al.*, 2019) are only a few of the children's disorders that have been linked to antibiotic-driven changes in early microbiome colonization in high-income environments.

2.2 Weakness of Immune System

According to Wasef *et al.* (2014), immunocompromised people are particularly susceptible to opportunistic parasite infections. Tekle *et al.*, (2008), found that immunosuppression creates an environment that allows opportunistic parasites to thrive against the host system and cause clinical illnesses. Various disease conditions, including cancer, AIDS, organ transplants, corticosteroid chemotherapy, autoimmune and metabolic diseases, irradiation, malnutrition, environmental factors, as well as in the elderly and young children, are associated with impaired host immune systems (Hassanein and Fanaky, 2021).

A-Human Immunodeficiency Virus (HIV) and Other Virus

Opportunistic infections are illnesses that affect patients with compromised immune systems, most often those infected with the Human Immunodeficiency Virus (Podlekareva *et al.*, 2006). Although the prevalence and incidence of HIV-associated opportunistic infections (OIs) varies significantly (Low *et al.*, 2016), all patients with HIV are prone to developing a variety of opportunistic illnesses. Opportunistic infections continued to be a key source of considerable morbidity and death among HIV/AIDS patients in low and medium-income countries (LMIC) despite improvements in HIV diagnosis and therapy (IeDEA, 2014). “HIV impairs immune function and increases the risk of contracting opportunistic infections, which can accelerate the progression of the disease and its transmission” (Edwards,2015). Low-income and industrialized nations have different rates of the most common opportunistic infection (OI); TB and recurring bacterial infections are more frequently seen in the former than in the latter (Seyler *et al.*, 2007). The virion binds to CD4+ and chemokine receptors to begin the HIV life cycle. Following the fusion of the HIV membrane with the cell membrane, the viral DNA enters the cytoplasm. Reverse transcriptase facilitates proviral DNA synthesis, which results in provirus integration into the cell genome. The cell is then activated by cytokines, the HIV genome is transcribed, and spliced and unspliced RNAs are transported to the cytoplasm. HIV protein synthesis

and assembly then occur, followed by gp120/gp41 expression on the cell surface and mature virion budding. The infectious cycle is accelerated by an infected cell's abundance of virions, which can attack CD4+ cells, macrophages, and neurons. HIV is characterized by a steady decline in CD4+ T cells, which destroys both cell-mediated and antibody-mediated immune systems (Vaillant & Naik, 2023).

However, a primary infection caused by the Varicella-Zoster Virus (VZV) in a patient (most often a child) receiving immunosuppressive medications for rheumatoid arthritis should not be considered an OI because that infection would have likely developed regardless of the immune suppression, even in the absence of a severe clinical picture or complications related to the VZV. For primary TB, similar factors might be taken into account. The common cold, conjunctivitis, or upper respiratory infection caused by an adenovirus, for instance, can strike both immunocompetent children and previously healthy people. However, these infections may be classified as opportunistic infections if they become persistently localized and/or widespread. (Ison & Hayden, 2016).

B- Immunocompromised Patients

According to (Riccardi *et al.*, 2019), opportunistic infections (OIs) are illnesses caused by bacteria, fungi, viruses, or parasites that ordinarily do not cause disease but become harmful when the body's defensive system is compromised. Additionally, iatrogenic immune suppression of various types, grades, and timings as well as genetic host patterns might influence the risk as well as the clinical characteristics of opportunistic infections (Polvi *et al.*, 2015). In the context of epidemiological studies in a specific patient group with a congenital or acquired condition (such as HIV illness, antineoplastic treatment, transplant, etc.), Opportunistic infections frequently make the news of immune system dysfunction. Unfortunately, pre-defined categories of opportunistic infections are generally not used, but any infections encountered may be recorded as opportunistic infections, especially in clinical trials with the administration of immunosuppressive or cytotoxic medications (B-Lajoie *et al.*, 2016).

2.3 Climate Changing

The natural environment and constructed environment, especially the aquatic ecosystems found in towns and cities, are projected to be significantly impacted by climate change. In-built infrastructure, opportunistic pathogens like Legionella, Mycobacteria, and Pseudomonas spp. can live in water distribution lines, premises plumbing, pools, spas, and green infrastructure, which can lead to serious infections and disease outbreaks in exposed, susceptible people. Ponds, ditches, and even roadside puddles can serve as reservoirs for the growth and eventual dispersal of these species. Only legionellosis, which includes Pontiac fever and Legionnaires' disease (LD), is a notifiable OP-related illness in Canada. Numerous terms are used to describe waterborne pathogens that colonize building water systems and infect exposed susceptible people. Legionellosis cases in Canada have increased from an average of 0.29 per 100,000 people before 2010 to over 1.7 in 2018 and 2019 (Government of Canada, 2021). These are also known as drinking water-associated microorganisms that cause illness, "opportunistic premise plumbing pathogens." (Proctor *et al.*, 2022). The opportunistic pathogens naturally occur in soils, surface waters, and groundwater but thrive in the built environment in distribution and premise plumbing systems (Schwake *et al.*, 2021). Opportunistic organisms frequently prefer warm water (e.g., 25–40 °C), have limited tolerance for disinfection and increased temperatures (e.g., 50–60 °C), and have the capacity to develop or join biofilms inside pipes and plumbing fittings (Hayward *et al.*, 2022).

Opportunistic diseases can colonize plumbing thanks to biofilms, which are collections of microbial cells, polysaccharides, minerals, nutrients, detritus, and silt (Donlan, 2002). Opportunistic pathogens (OPs) may also reside inside free-living amoeba, which gives them mobility while protecting them from disinfection (Atanasova *et al.*, 2018). When growth conditions are poor, certain opportunistic infections can transition into a viable but uncultivable form, enabling bacteria to endure challenging circumstances and avoid detection (Hayward *et al.*, 2022).

3. Foodborne Opportunistic Bacteria

The endospheres and rhizospheres of plants have been reported as the significant reservoirs for emerging opportunistic pathogens like *Escherichia coli* pathotypes, Enterobacter, Burkholderia, Ralstonia, Pseudomonas, Staphylococcus, Serratia, Stenotrophomonas, the multi-drug resistant multi-resistant species of Pseudomonas and Stenotrophomonas, resulting in disease outbreaks (Zope *et al.*, 2014). It should be emphasized that if plants serve as a natural reservoir for Enterobacteriaceae, then these bacteria may appear to be a natural part of the human diet. "Opportunistic infections with a broad evolutionary background" commonly conquer natural habitats or are connected with eukaryotic hosts maintaining an endophytic existence, which is extremely helpful for immunocompetent hosts.; Opportunistic pathogens can cause serious infections such as pneumonia, bloodstream infections, urinary tract infections, surgical site infections, and diarrhoea in immunocompromised persons (Berg *et al.*, 2014). A study using whole genome sequencing (WGS) discovered a link between *Cronobacter sakazakii* (a member of the Enterobacteriaceae family) and food-borne acute gastroenteritis (AGE) in neonates, infants, and adults with Cronobacter spp. (McCusker & Warrington, 2011). However, the toxicity and epidemiology of this species are still poorly understood. Probiotics are an intriguing field of investigation for opportunistic bacteria. The Lactobacillus genus complex (LGC), which is commonly found in fermented foods (or as a supplement), is known to colonize the mouth, gastrointestinal (GI) tract, and female genitourinary system of humans due to its numerous positive effects. Surprisingly, food-borne lactobacilli illnesses such as bacteremia, endocarditis and pleuropneumonia have lately been observed. (Rossi *et al.*, 2019).

4. Waterborne Opportunistic Bacteria

Opportunistic bacteria and other microbes identified from man-made and natural recreational water reservoirs pose the risk of infection or disease transmission. The harm to human health from non-potable water, particularly from natural sources, is currently unknown. Surface water quality is prone to rapid, dramatic, and even deadly changes in microbiological quality as a result of several human and animal activities. These changes are induced by the discharge of urban wastewater and precipitation runoff, as well as pollution from farmlands and animal husbandry into bodies of water such as rivers and lakes (Edokpayi *et al.*, 2017). Non-fecal pathogens such as *Legionella pneumophila*, *Mycobacterium avium* complex, and *Pseudomonas aeruginosa* can be spread through water (DeFlorio-Barker *et al.*, 2016). According to (José *et al.*, 2020) the infections stated above should be referred to as "water-based" rather than "waterborne," because diseases of fecal origin are referred to as "waterborne" Waterborne microbes" are sometimes known as "opportunistic pathogens." Pathogens that live in water usually flourish and thrive in both natural and manmade water systems (Salvat *et al.*, 2020).

5. Airborne Opportunistic Bacteria

Bioaerosols are abundant in human living and natural settings, and they mostly consist of bacteria, fungi, archaea, viruses, pollen, and endotoxins (Zhai *et al.*, 2018). Bioaerosols have an essential function in atmospheric chemistry and climate change as a key component of atmospheric particulate matter (Dong *et al.*, 2016). Bacteria are the major component of bioaerosols, accounting for 80% of the microbial components in the atmosphere (Zhai *et al.*, 2018). High concentrations of airborne bacteria, particularly pathogenic bacteria, "can cause a variety of ailments, including respiratory, digestive, and cardiovascular problems. (Riggs *et al.*, 2018). As a result, the influence of microorganisms in the environment on human health is progressively becoming recognized. Pathogenic bacteria are frequently found in airborne germs, posing a substantial hazard to human health. For example, *Acinetobacter baumannii* airborne transmission in hospitals can cause respiratory infections, bacteremia, and meningitis, among other disorders (Gao *et al.*, 2014). *Staphylococcus aureus*, an important human pathogen, is extensively prevalent in wastewater treatment plant bioaerosols and can cause bacteremia and skin infections in people (Talepour *et al.*, 2020). Several investigations have revealed the detection of a substantial number of harmful bacteria in the outdoor air environment (Fan *et al.*, 2019). Pathogenic bacteria with antibiotic resistance can make treating bacterial infections more difficult and extend hospital stays, as well as raise treatment costs (French, 2005). "Micrococcus, Sphingomonas, Enterococcus, Rhodococcus, and Stenotrophomonas have also been found as bioaerosol threats to human health " (Yan *et al.*, 2021)

6. Conclusion

Opportunistic microorganisms are non-pathogenic germs that act as pathogens under particular conditions. "They remain latent for extended periods until the host's immune system is weakened, at which point they become active "Several microorganisms found in foods, water, and air have evolved as opportunistic pathogens in people and animals.

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