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Virulence factors in *Pseudomonas aeruginosa*: The arms race between bacteria and humans

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Pseudomonas aeruginosa (*P. aeruginosa*) is a Gram-negative, motile bacillus that can grow at 42°C as well as 37°C in aerobic circumstances. It also tests positive for oxidase and catalase enzymes [1-2]. The bacteria may be found in a variety of habitats, including water and soil [3,4]. It is also considered an opportunistic human pathogen which has the capacity to causes infection especially in individuals with immunocompromised system [5,6] and also can be present in hospital climate [7,8].

Pseudomonas aeruginosa has a number of virulence factors that play a role in pathogenesis in the host, including type IV pili, which are found near the cell pole [9] and flagella [10,11]. It also releases exopolysaccharide alginate [12], which is utilized to build biofilm [13]. Lipases and phospholipases, which target lipids in the surfactant and host cell membranes, are further pathogenic agents of the bacteria [14]. As well as exoenzymes S, T, U, and Y

[15]. *Pseudomonas aeruginosa* also produces extracellular virulence factors such as elastase, toxin A, rhamnolipids, lipopolysaccharide (LPS), and protease [16]. These factors may be shared by other pathogens and may contribute directly or indirectly in resistance to multiple antibacterial agents [17-21].

Pseudomonas aeruginosa has a potential to develop biofilms on the surface of urinary catheters in addition to elaborating virulence factors. As a result, the most significant pathogenic characteristic of *P. aeruginosa* is the development of biofilms [22], which allows this bacterium to cause recurrent and chronic UTIs by evading host immune defense systems also biofilms contribute to the drug resistance and facilitate bacterial spreading.

Another virulence factor produced by *P. aeruginosa* is pyocyanin (PCN), a blue water-soluble pigment [23]. *Pseudomonas aeruginosa* may also produce pigments such as yellow-green, fluorescent pigments (pyoverdin), reddish pigment (pyorubin), and dark brown pigment (pyomelanin).

Pseudomonas aeruginosa may grow anaerobically and does not ferment, instead receive energy from sugar oxidation. This low nutritional requirement allows it to thrive in harsh environments like hospital operating rooms, hospital rooms, clinics, and medical equipment, as well as sinks, showers, and even contaminated distilled water [24], and has thus been identified as a significant source of nosocomial infection [25-28].

In conclusions: *Pseudomonas aeruginosa* has the ability to secrete several virulence factors that can use in their pathogenicity leading to invade and

damage cells as well as high rate of antibiotic resistance. More knowledge regarding these virulence factors is crucial to develop new strategies against growing challenges made by this bacterium. *P. aeruginosa* is an important infection in all populations, and it has been linked to an increase in morbidity and death among patients. The arms race between *P. aeruginosa* and humans is continuous and very long way that requires more efforts and researches.

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