



## The menace of the green monster on the postoperative diabetic foot wounds

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### Abstract

No complication in diabetes is as devastating as diabetic foot. A slight negligence and the patient may end up in an amputation. Various type 1 diabetic foot complications like abscess, gangrene, necrotizing fasciitis, etc requires emergency surgical management often leading to either amputation or large wounds. This would in fact result in prolonged hospital stay, add burden to the economic condition of the patient and impaired quality of life. Adding to the misery of these to the patients is the postoperative wound infection with pseudomonas, a nosocomial infection. This article briefly reviews about the characteristics of pseudomonas aeruginosa and way to prevent and treat this condition in diabetic foot wounds.

**Keywords:** Diabetic foot, pseudomonas, acetic acid

### Introduction

Pseudomonas is considered to be one of the major organisms that are known to cause severe tissue damage in diabetic foot infections and it is known to exhibit a high degree of antibiotic resistance [1]. This organism is also a common cause of hospital acquired infections.

### Bacteriology

Pseudomonas aeruginosa is a gram negative aerobic rod shaped non fermenting bacteria with unipolar motility with a pearlescent appearance and a grape like or tortilla like odour in vitro [2]. It is also known as pseudomonas pyocyanea or bacillus pyocyanous [3]. Pseudomonas aeruginosa produces a number of pigments, the 2 best known being the pyocyanin and the pyoverdine [3].

Pyocyanin is a bluish green pigment soluble in water and chloroform and is produced only by pseudomonas aeruginosa whereas pyoverdine (Fluorescein) is a greenish yellow pigment soluble in water but not in chloroform. It is believed that the pyocyanin secreted by pseudomonas inhibits the growth of many other bacteria and are therefore contribute to pseudomonas aeruginosa emerging as the dominant bacteria in mixed infection [3].

The mucoid strain of the pseudomonas have an abundance of extracellular polysaccharides composed of alginate

polymers which form loose capsules called glycocalyx in which the micro colonies of the bacillus are enmeshed and protected from the host defences [3].

Pseudomonas is sometimes also referred to as a green monster by few in view of its green colour production[4]. Blue pus was known as a surgical entity long before Gessard (1880) isolated pseudomonas from such cases [3,5]. Both the specific name of the bacillus refers to its capacity to cause blue pus, the term aeruginosa meaning Verdigris which is bluish green in colour and pyocyanea, being a literal translation of blue pus [3,5].

The following words are commonly used in practice [6,7]. Contamination means presence of bacteria in wound that are not multiplying. In It, the wound healing is not delayed. Colonization refers to bacteria which are growing within the wound but not causing tissue damage or initiate infection. When the bacteria causes tissue damage, multiplies or invades into the host tissue, it is called infected wound. Here wound healing is impaired. Critical colonisation means bacteria are multiplying in wounds, though not causing classical symptoms of infection, they are known to delay or affect healing [6,7].

### Clinical Scenario

Gram negative infections are three times more frequent in the diabetic than in non-diabetic individuals [1]. In some studies, pseudomonas aeruginosa was one of the most common pathogen and one among the top 3 common species associated with diabetic foot ulcers [8,9]. It is well known that bacterial isolates are known to differ in different countries, hospitals as well as geographical locations [9].

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*Pseudomonas* infection in burns patients is quite common and known to cause significant morbidity [10]. Postoperative wound infections simply means wounds infected after surgery [11]. In a study by Masaadeh and colleague's, it was seen that *pseudomonas aeruginosa* was the most common organism causing postoperative wound infections in general [11]. Wound infection is costly to both patients and health care services [6]. If the wounds especially the diabetic foot wounds get infected by *pseudomonas*, then it causes delayed wound healing in both acute and chronic wounds [12] and can sometimes lead to spread of the infection.

We, as diabetic foot specialist, have often encountered postoperative diabetic foot wounds that were initially clean and healthy, suddenly getting infected with *pseudomonas* during the course of regular dressing. This is very obvious when one can see the bluish discoloration [Figure 1] or greenish discoloration of the dressings externally [Figure 2]. Many a times, we may not see green colour from outside on dressing. but once you open a dressing, we can see high exudates that are green in colour often soaking the entire dressing and producing un pleasant look as well as smell [Figure 3 and 4] or bluish colour around the wound [Figure 5 and 6]. One needs to be careful in cases where some physicians use copper sulphate, for over granulating wounds, which is blue in colour [Figure 7].

Moisture as such is necessary for the wound healing but highly exudating wounds often require moisture removal. Occlusive dressings can promote the growth of pathogens. Ironically, *pseudomonas* is considered to be a water loving bug [13]. It has the ability to grow and multiply easily in water and is mainly found in water and soil [13]. *Pseudomonas* species have been frequently isolated from wounds that have been soaked or treated with wet dressings or hydrotherapy [14]. Hydrotherapy debridement may cause periwound maceration, traumatizes wound and puts the wounds to waterborne infections like *pseudomonas aeruginosa* [15].

*Pseudomonas aeruginosa* has been found to contaminate the floors, bedside rails, solutions used for wound care and it has also been cultured from hands of the nurses [16]. *Pseudomonas* contaminates the health care professional's hands and solutions for wound care if barrier nursing is violated [Figure 8]. It is present on bedside rails especially when the patients contaminated dressing is in constant touch with the ends of the bed which further can be transmitted to the health care professionals like doctors and nurses who holds these bed railings with bare hand. The *pseudomonas* can also be found on floors frequently due to the bad habit of throwing the contaminated dressings on the floor especially by interns and postgraduates and also by the consultants who pays least attention in barrier nursing. It is obvious that *pseudomonas* will automatically cross contaminates other patients and can reach to different wings of the entire hospital.



**Figure 1.** Showing bluish discoloration on dressing suggestive of *pseudomonas* infection.



**Figure 2.** Showing the *pseudomonas* infection where the entire dressing is green.



**Figure 3.** Showing greenish exudate from an ulcer over leg.



**Figure 4.** Showing excessive greenish exudate which was foul smelling in a patient with an ulcer over left forefoot.



**Figure 6.** Showing bluish discoloration in the 1st web space. The ulcer also looks unhealthy.



**Figure 5.** Showing bluish discoloration of the skin around the heel ulcer. Here the ulcer has healthy granulation.



**Figure 7.** Showing a wound over foot. It appears as if it is infected with pseudomonas in view of bluish green colour. This patient had copper sulphate applied over the over granulated tissue and since it is blue in colour. It gives a false alarm that there is pseudomonas.



**Figure 8.** Showing the solution bottles getting contaminated due to breach in protocols which can be carrier transmitting infection to other patients.

One interesting thing the author observed over years of diabetic foot practice is that when postoperative wound get infected with pseudomonas especially the granulating wounds, a characteristic blue or green colour is often seen on the dressings but in case of deep seated infections like plantar abscess, necrotizing fasciitis or diabetic foot osteomyelitis caused by pseudomonas aeruginosa, the blue or green pus was not seen during surgery till date in the authors practice over a decade. The author wasn't able to find the reason as to why plantar abscesses or necrotizing fasciitis that grows pseudomonas never have these colours.

### Prevention

Barrier nursing is one of the most important prevention methods that should be employed strictly in the clinical practice by all doctors and nurses. Often said easily, the author observed over years of his work experience in different setups, the breach in this policy [Figure 8] by all professionals including the junior doctors, the senior doctors and the nurses in various different hospitals. It seems to be an unsolved problems in most hospitals where wound care is not given due importance and there are no strict protocols that can lead to stringent actions against those who routinely breach these protocols. This obviously leads to spread of pseudomonas infection in the entire hospital including the intensive care sections. Prevention of pseudomonas cross infection in hospitals thus require constant vigilance and strict attention to asepsis [3, 5].

It thus goes without saying that as far as possible sterile technique has to be followed when one deals with diabetic foot wounds or any other wounds. Sterile technique means free from microorganisms whereas clean technique means free from dirt or stains [7].

Sterile technique involves meticulous hand washing, using a sterile field, sterile gloves and use of sterile instruments. In clean technique, you have meticulous hand washing, maintaining a clean environment, using clean gloves and sterile instruments. Clean technique is considered most appropriate for long term care, home care and in some clinical settings and in patients with chronic wounds requiring routine dressings [7]. In the no touch technique, there is changing the surface dressings without directly touching the wound or any surface [7].

### Management

Pseudomonas is sensitive to cefotaxim, ciprofloxacin, gentamycin and carbenicillin. Recently, there is emerging resistance to ciprofloxacin [fluoroquinolones].

Pseudomonas also exhibits a high degree of resistance to chemical agents, though not heat resistant, being killed at 55°C in one hour. It is also resistant to common antibiotics. Acquired resistance has been reported with pseudomonas in chlorhexidine [17].

It has been proved that effective topical antimicrobial agent substantially reduces the microbial load in open wounds and reduces the risk of infection. Silver sulfadiazine has excellent broad spectrum activity against pseudomonas aeruginosa [16]. Even Mafenide acetate had broad spectrum activity against pseudomonas. It is widely used as a cream or 5 % solution applied to gauze dressing [16].

For postoperative wound infection with the pseudomonas, acetic acid is believed to be effective. Nagoba et al [18], used 3% to 5% acetic acid topically on the wounds for 2 to 12 times to successfully eliminate pseudomonas from the wound. It lowers the PH and makes environment unsuitable for growth and multiplication of pseudomonas. It is nontoxic and inexpensive [18]. In salati et al series [19], 5% acetic acid was used prospectively in whom wounds were infected with pseudomonas and they obtained good results, the pseudomonas got eradicated after periods varying from 4 to 16 days [19].

It is also shown that PH level of linger lactate solution inhibits growth of pseudomonas. It can be used as a wound cleanser [17].

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