The Pharma Innovation Journal 2018; 7(1): 295-298

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2018; 7(1): 295-298

www.thepharmajournal.com
Received: 14-11-2017
Accepted: 15-12-2017

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Fungal wound infections: Mini review

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Abstract
Fungal infection is one of the major concerns for burns, natural disaster/ agricultural wounds and combat related injuries. These infections can induce local or systemic inflammatory response and cause serious substantial damage to the patient. Proper management of these injuries with local or systemic antifungals, wound debridement and dressings will reduce the associated morbidity and mortality.

Keywords: wound, fungi, debridement, burns, antifungals

1. Introduction
Wound infections are one of the common hospital acquired infections associated with increased morbidity and mortality, prolonged hospital stay and increase in treatment costs. Indiscriminate and extensive use of local and systemic antibiotics has increased predisposition for fungal and yeast wound infections. Geographical areas with warm and humid climate are also seeing an increase in the susceptibility for fungal wound infection. The review discusses fungal wound infections acquired through burns, natural disasters and agricultural/ industrial accidents and combat acquired wound infections.

2. Fungal wound infections
2.1 Fungal infections in burn wounds
Burn wound infections are chiefly caused by bacterial organisms albeit isolates of fungi, yeasts and viruses have also been reported [1-3]. Burn injuries provide a desirable environment for microbial growth with harbors colonization from organisms of nosocomial origin or from a comorbid condition. Coeval or subsequent immune suppression, various hospital related invasive and non-invasive diagnostic and therapeutic procedures contribute to the further contamination of the wounds [4-14]. An estimated 75% of mortalities in patients with burn injuries are due to infection, with extent of burned total body surface area (TBSA) and impaired immune system being the paramount risk factors associated proportional to the extent of infection [15-20].

Burn patients are comparatively more susceptible to fungal infections, with *Aspergillus* spp and *Candida* spp preponderating in the burn wounds [21-25].Indiscriminate use of broad-spectrum antibiotics is one of the paramount reasons in exacerbating the colonization of wounds with fungi and yeasts [23, 26, 27], with warm and moist environment further exacerbating this situation [16]. The principal sources of fungal infection are most often strictly from the hospital niche only from walls, beds, mattresses, and dressing instruments [16]. The method of dressing opted, open or occlusive, for burn wounds also has first-hand role to play in colonization and subsequent fungal infection. With the open wound dressing it was seen that there was more frequent fungal infection primarily due to the nature of the dressing with increased vulnerability to air-borne fungi. On the other hand the occlusive method of dressing due to the wet environment it fosters, yeast infection was predominantly encountered [2, 22]. Principally fungi and yeasts localize on the wounds with no systemic involvement but in cases of severe burns, they tend to invade blood stream and develop systemic infections. Per se are a prominent cause of late onset morbidity and high mortality in such patients [28-30].

Preventive measures to mitigate fungal infection in burn wounds include proper disinfection and eradication of molds and spores in the hospitals broadly and around the burn wards strictly. Proper air conditioning and ventilation helps reduce humidity and proportionately the chances of fungal spread. Kosher and balanced use of antibiotics should be advocated for Burned patients [31]. In contempt of such measures regular proper diagnostic measures like cultures, histology,

Candida and aspergillus antigen test and Real-time polymerase chain reach are of paramount importance for identification of such organisms and treatment thereof [32-39].Treatment of fungal infections must involve proper cleansing of the wounds by removal of dead tissue from the wounds.

Antimycotic therapy, whether topical or systemic, should be directed depending upon the condition of the patient, extent of the injury, fungal species and fungemia [40]. Topical antifungal agents include nystatin, amphomoronal, and silver containing agents which tend to be effective in treating local fungal infection. Systemic antifungals include polyenes, imidazole-based azoles, triazoles and echinocandins which provide a higher specificity, but due to their nature of being hepatotoxic and nephrotoxic, should be used only after due confirmation of fungemia. Surgical therapy may be advocated in severely invasive fungal infections to limit their extension and may include amputation of variable lengths of extremities [41-43].

2.2 Fungal wound infections after disasters and agricultural/industrial accidents

The implications of fungal wound infection after disaster are either direct or indirect, with direct effects on wounds with contaminated waters and soil, and indirect effects transpiring from damage to health-care infrastructures [44]. Fungi belonging to the order mucorales are the most common post-disaster fungal wound infection. They are primarily associated with the disease Necrotizing fasciitis which have case fatality rates of over 30% [45].Volcanic eruption in Armero, Colombia in 1985 is the first documented instance of disaster-associated mucormycosis which caused an estimated 23,000 deaths and ≈4,500 injuries. Rhizopus arrhizus (oryzae), a mucormycete, was isolated from several patients with necrotizing lesions [46, 47]. Similarly post-tornado in Joplin, Missouri, United States in the year 2011, mucormycosis caused by Apophysomyces trapeziformis occurred among 13 severely injured persons [48]. Many similar incidents of fungal wound infections were reported from several areas post-disaster [49-51]. Damage to Health Care can also expedite in outbreaks, as was seen after 2004 Indian Ocean tsunami where syringes were seen to be contaminated with A. fumigatus causing outbreak of Aspergillus meningitis [52]. Trauma related invasive fungal infections post natural disasters, agricultural and industrial accidents, as well as isolated cases are a reason of substantial morbidity and mortality as high as 38% in the civilian population [48,52-58].

2.3 Combat related fungal wound infections

Military personnel who suffer injuries in the battlefield are predisposed to a higher risk for infectious complications [59-62]. Although the infectious outcomes of combat related traumatic injuries are primarily bacterial, however fungal infections have also risen to significant levels particularly with personnel sustaining severe injuries typically when soldier on foot patrol sustains blast injuries (from improvised explosive devices) which causes extensive damage to the body especially limbs [63-69]. It was validated from a study that during the recent war in Afghanistan, between 2001 and 2011, the percentage of major limb injuries which resulted in amputation was 3.6% with an substantial increase from 3.5% in 2010 to 14% in 2011 [70]. The subsequent trauma-related invasive fungal infection generally develops as a complication after such deep/penetrating wounds have been introduced to fungal/mould spores from soil-contaminated environment in the battle fields. The most common fungal organism to be isolated from wound happened to be from the order Mucorales. Aspergillus spp. And Fusarium spp. have also been reported to cause wound infections [55, 56]. In a separate study between 2009 and 2011 trauma related IFIs had an incidence of 6.8% among US military personnel injured in Afghanistan [71]. The basic mechanism of IFI to cause such substantial morbidity and mortality happens to be angio-invasion; as such microvascular thrombosis occurs, leading to necrosis of the adjacent tissues and dissemination [55, 56].

As with burn wounds, proper antisepsis of the wound with surgical debridement of debris and necrosed area is paramount, with systemic antimycotic only adopted after confirmation of fungemia or when there is a strong suspicion for IFI. Mucorales being the most frequently isolated organism from such wounds use of liposomal amphotericin B (LFAB), polyenes, amphotericin B deoxycholate should be advocated. Voriconazole is inefficient against mucormycosis but happens to be highly effective against aspergillosis and molds like Aspergillus terreus and Scedosporium prolificans, which are resistant to amphotericin [72-74].

3. Conclusion

Proper management of wound through local debridement, judicious use of antibiotics on the basis of culture and sensitivity, hospital disinfection and bandaging will reduce the introduction of fungi in wounds. Development of bedside diagnostic kits for fungal infection diagnosis will help in appropriate use of antifungals and thus reduce fungal drug resistance.

4. Conflict of interest

Author has no conflict of interest with any individual or organization.

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