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Brief communication (Original)

The prevalence of fungal infections in a level I Iranian burn hospital

Mohammad Ali Bahar[a], Mohammad Reza Pakyari[b], Mazaher Gholipourmalekabadi[c], Ali Samadikuchaksaraei[d]
[a]Department of Immunology and Burn Research Center, Iran University of Medical Sciences, Tehran, Iran, [b]Shiraz University of Medical Sciences, Tehran, Iran, [c]Biotechnology Department, Faculty of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran, [d]Department of Medical Biotechnology, Cellular and Molecular Research Center, Faculty of Allied Medicine, Iran University of Medical Sciences, Tehran, Iran

Background: With significant increase in incidence of fungal infections in burn victims, determination of pattern of fungal infections and colonization is required to allow medical staff to begin proper empirical antibiotic therapy in early stages of septic episodes.
Objective: To determine the current infection profile (especially fungal profile) of burn wounds in a level I burn care center in Tehran.
Methods: A cross-sectional survey was conducted from January 2008 to September 2009 on burn wound patients admitted in Shahid Motahari Burn Hospital, Tehran, Iran. Wound swab cultures and tissue specimens from 869 patients (634 male and 235 female) out 4083 were taken and cultured in Sabouraud dextrose agar. The fungal organisms were then identified with macroscopic and microscopic structures.
Results: The incidence of fungal infection (not colonization) among the patients of this study was 13%. *Candida albicans* was identified as the dominant fungal agent (45%) followed by *Aspergillus fumigatus* (35%), *Penicillium* (8%), *Aspergillus niger* (5%), and other fungal organisms (7%).
Conclusion: With such high mortality rate and an increasing incidence of fungal wound infections, fungal infections should be a top infectious complication of burn patients and should be managed immediately and aggressively.

Keywords: Burn wound, *Candida albicans*, colonization, fungal infection, incidence

Because of high mortality and several physical and mental complications, every aspect of burn injuries should be considered seriously compared with the other forms of traumas. Bacterial and fungal infections are major causes of high mortality in burn wound injuries. Although a considerable decline in bacterial infection has been reported in many studies during recent decades, the incidence of fungal infections in burn wound patients seems to remain a rising threat [1, 2]. Some studies suggest that sufficient management of fungal infections, especially at TBSA (total body surface area) of 30%–60%, decreases the mortality rate [3, 4]. The extensive presence of fungi, in addition to recent suppression of bacterial infections with effective systemic and topical antibiotics promotes fungal infections of burn wound enormously [5]. During recent decades, advances in management of burn patients have extended survival of these patients. However, loss of a natural barrier, the presence of coagulated proteins as microbial nutrients and avascularity of the burn wounds lead the patients toward a suppressed immunity [6]. These patients are highly susceptible to opportunistic infections such as fungal and bacterial infections. The rate of fungal infections in burn patients has been reported as between 6.3% and 25% [3, 4]. Several studies reported different mortality rates of infections caused by mycoses. For *Candida* species, mortality ranges from 50 to 60%. For *Fusarium* species, *Aspergillus* species and *Mucormycosis* the mortality rates are considered 60%–70%, 80%–95%, and 100%, respectively [5, 7]. Nonetheless, fungal infections should be diagnosed and treated at an early stage; otherwise, the mortality will be very high.

Correspondence to: Ali Samadikuchaksaraei, MD, PhD, DIC, FRSPH , Department of Medical Biotechnology, Cellular and Molecular Research Center, Faculty of Allied Medicine, Iran University of Medical Sciences, Tehran, Iran.
E-mail: samadikuchaksaraei@yahoo.com

Numerous studies have been designed and conducted to determine the causes of such an increase in fungal infections of burn wounds. Several risk factors, such as age, total body surface area (TBSA), and inhalation injuries, have been associated with fungal infections in burn patients [3]. It is generally accepted that the infective agent spectrum alters from time-to-time and varies from place-to-place. Therefore, in every institute, intermittent reviews should be performed to study these periodic changes in bacterial and fungal flora of burn wounds. The results of such surveys could be used to modify preventive strategies for being more efficient and allow medical staff to start proper empirical antibiotic therapy in early stages of septic episodes, without wasting time in waiting for culture results and thus improving the overall outcome of burn patients.

In current study, we aimed to determine the current infection profile (especially fungal profile) of burn wounds in Tehran, Iran, during January 2008 to September 2009.

Materials and methods

This cross-sectional study was performed in Shahid Motahari Burn Hospital, a level I burn care center in Tehran to determine the prevalence and most related risk factors of fungal infections in burn patients who were admitted during January 2008 to September 2009.The study was approved by our institutional ethics committee. The committee ensures that all procedures follow the Declaration of Helsinki and the national protocols for human experimentation. Written informed consent was obtained for participation in the study. Where patients who were not able to give consent themselves, the consent was obtained from their legal representatives.

Patients

From 4083 patients admitted during the time of study, 869 patients (even with the slightest clinical suspicion for having bacterial or fungal infection) were included for collection of specimens (634 male and 235 female).

Sampling and specimen evaluation

After taking written informed consent, samples were obtained from the depth of burn wounds by sterile swaps. We included the patients who were admitted for at least one week, regardless of degree or cause of their burn wound injuries. The specimens were evaluated microscopically after being stained with Gimsa and Gram staining. Biopsy specimens from the depth of the wounds (living tissue with the size of 1 cm × 1 cm) were obtained on the second week of admission. The specimens then were divided into two parts; one part was sent to mycology laboratory in sterile plates filled with normal saline. These samples were then studied by 10% potassium hydroxide for mycelium (as the indicator of saprophytic fungi). The other part was sent to pathology laboratory for being processed by a Tissue Processor Machine regarding size, weight and color of the samples. It was followed by blocking and cutting the samples for hematoxylin and eosin (H&E) and Periodic Acid Shift (PAS) staining to be studied by a pathologist.

The specimens for culture were obtained and set in sterile plates filled with Sabouraud dextrose agar with chloramphenicol, incubated in 25°C (room temperature). Samples were cultured in blood agar and brain heart infusion agar (BHI agar) and incubated for 3 weeks at 37°C. Afterward, the size, shape, and color of colonies were observed microscopically. Round or oval cells were diagnosed as yeast (production of germ tubes).

After purifying the colonies, samples were put in corn meal agar with Tween 80 for deep culture and incubated at 25°C for 3 weeks. The samples were then studied under the low power field of a microscope. In the presence of mycelium, the fungi might have been labeled as blastoconidia and chlamydoconidia or *Candida albicans*. If there were any mycelium or blastoconidia, another kind of *Candida* was the diagnosis. In the presence of round or oval shaped cells with or without budding or cells as a mass, the colony was identified as yeast. In the presence of the germ tubes, *Candida albicans* was the diagnosis.

The biopsy specimens were then cultured in normal saline in Sabouraud dextrose agar with chloramphenicol and brain heart infusion agar in sterile plates. After 3 weeks of incubation in 22°C, the colonies were evaluated grossly and microscopically regarding to their size, shape, and color.

Fungal infection or colonization status category of each patient was defined according to the level, invaded by organisms. Fungal wound infection was defined as viable tissue penetration of fungal elements. Fungal wound colonization was defined as fungal elements within nonviable burnt area of the skin.

Results

Six hundred thirty-four from 869 patients of this survey were male (73%), and the rest (235) were female (27%). About 5% of the subjects were younger than 5 years old and 60% of the patients were living in cities. The mean age was 32.88 years and the mean age of expired patients was 38.6 years, (in the expired female group, mean age was 30 years and in the expired male group, it was 51.5 years).

The mean TBSA (total body surface area) was 31.87%. About 75% of overall burn wounds were a combination of second and third degree, but this rate was more than 90% in expired group. Thirty-three percent of patients were in the 21–30-year-old age group. Flame burn was the most predominant cause (74%) of burn injuries in this study; 85% of burn injuries happened accidentally, and about 15% occurred by self-immolation, which was much more frequent in female group (70%). The rate of self-burning was much more in the 20–40-year-old age group.

In cases in which causative organisms were identified, either by morphologic features on microscopic evaluation or by culture results, the fungal organisms had the total frequency of 13% (fungal wound infection) and each species of fungi had the following percentages, as shown in **Table 1**. The frequencies of organisms other than fungal agents have been listed in **Table 2**.

The mean age of patients with fungal wound infection was 32.8 years and with a mean size of 61.3% of TBSA. The overall mortality rate in patients with confirmed fungal wound infections was 64.3%. The mortality rate among the burn patients infected by *Candida albicans* was almost 55% and for *Aspergillus* spices, it was 87.1% (for *Aspergillus niger*, it was 100%).

Table 1. Percentage of fungal organisms isolated from wound cultures

Fungal organisms	Frequency (%)
Candida albicans	45
Aspergillus fumigatus	35
Penicillium	8
Aspergillus niger	5
Non-albicans *Candida*	5
Yeasts other than *Candida* species	2

Table 2. Percentage of fungal and bacteriological organisms isolated from wound cultures

Isolated organism	Frequency (%)
Pseudomonas aeruginosa	59
Fungi	13
Enterobacter spp.	9.8
Escherichia coli	6.8
Staphylococcus aureus	4.3
Klebsiella spp.	2.8
Coagulase-negative staphylococci	1.3
Other organisms	3

Discussion

The results of this survey have further suggested that fungal infections in burns patients should not be underestimated, especially when they have concomitant bacterial infections. We found fungi were responsible for 13% of burn wound infections (not colonization) in our center. Compared with some previous reviews on fungal burn wound infections, our results showed a significantly higher rate of fungal infection (not colonization). For instance, according to a survey performed by Horvath et al. 54 patients out of 2,651 (2.03%) were diagnosed as having fungal wound infections [4]. In another review by Mayhall, the incidence of *C. albicans* was 1.3% and the incidence of other fungal species <1% [6]. Despite being routinely cleaned by antiseptic agents, fungal and bacterial colonization in major burns is almost inevitable [8]. Recent changes in bacterial flora caused by topical and systemic antibiotics might be a major cause of such a surge in the incidence of fungal infections. In addition, lack of clinical suspicion, having clinical presentations similar to bacterial infections, and difficulty in diagnosis are other causes of such increase in the rate of fungal infections [5]. *Candida albicans* was the most predominant fungal organism in burn wound infections (45%) with a significant morbidity and mortality. Many risk factors have been identified for the development of Candidemia, but inappropriate empirical antibiotic therapy is a major cause of susceptibility to *Candida* infection in burn patients [3, 9]. Nonalbicans *Candida* species were much less frequent (5%) than *C. albicans*. However, since they have a low susceptibility to azoles, this might cause them to be a serious forthcoming threat. *Candida parapsilosis* was identified as the most frequent *Candida* after *C. albicans* in our study and in some other surveys [10, 11], although, some other studies have found *C. tropicalis* as the most frequent nonalbicans *Candida* especially in immuno-compromised patients [8, 12]. In recent years, a significant increase in the incidence of *Aspergillus* was seen in burn patients especially in thermally injured children and other immunocompromised patients [7, 13]. Although NNIS system (National Nosocomial Infection Surveillance) pointed out that only 1.3% of hospital nosocomial infections were caused by *Aspergillus* spp. [14], the incidence seems to be much higher in burn patients and other immunocompromised wards [15]. We found *Aspergillus fumigatus* was responsible for 4.6% of infections occurred in burn patients of this study. The mortality rate has been estimated to be as high as 95% and even higher in immunocompromised patients [16]. *Aspergillus* spps. are omnipresent, commonly exist in water, soil and decaying foods. Several places could be named as the hospitals reservoirs of *Aspergillus*, places such as, ventilation system, exhausted water pipe system, air exposed to dust from wards under construction [16]. Nosocomial *Aspergillus* outbreaks are commonly connected to environmental disturbances, such as, burns hospital being near highways, streets, or even other hospitals, patient overload in burns wards, unsterility of patient contacts [7, 16].

Conclusion

Fungal burn wound infections appear to be the second most common infectious complication amongst the burn infections at our burn center. According to our results, fungal wound infections have a high mortality rate especially in patients with extensive burn wounds. This issue makes it crucial for every institution to determine the pattern of fungal infection and colonization, the antifungal sensitivity profile, and the time related alterations in dominant flora. In the presence of clinical suspicion, confirmation with cultures and biopsy specimen should be taken. Then, topical and systemic antifungal agents should be administered in the early stages of fungal infections to reduce mortality.

The authors have no conflicts of interest to declare.

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