NOSOCOMIAL INFECTIONS AMONG BURN PATIENTS IN TEHERAN, IRAN: A DECADE LATER

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SUMMARY. The aim of this study was to determine the epidemiology of nosocomial infections among burn patients in a tertiary burn care centre in Tehran, Iran. A cross-sectional study was carried out during a 6-month period from August 2010 to January 2011 at Motahari Burn and Reconstruction Center in Tehran. Of 155 patients, 677 samples of wound and blood were taken for culture during the course of hospitalization. The rate of positive culture during the 1st, 2nd, 3rd, and 4th week of hospitalization were 76.3%, 99.3%, 100%, and 100%, respectively. On the 2nd, 3rd, and 4th week of hospitalization, *Pseudomonas aeruginosa* was the most common pathogen followed by *Acinetobacter*, while the culture positive rate for *Staphylococcus* spp., *Enterobacteriaceae*, and *Enterococcus* spp. significantly decreased ($P < 0.001$). In this study, 70 patients out of 155 (45.2%) had at least one *Acinetobacter* positive culture. Our results showed that *P. aeruginosa* is still the leading cause of nosocomial infections. Additionally, *Acinetobacter* has appeared as an emerging nosocomial pathogen, and should be considered as a serious risk. We believe that changes in burn wounds' bacterial colonization over time require consistent assessment and monitoring of these changes in any burn center.

Keywords: nosocomial infections, epidemiology, burns, Iran

Introduction

Numerous studies in the past couple of decades have well documented that burn injury is an increasing and growing public health problem in developing economies such as Iran.[1-5] Infection is known as the most common cause of death following burn injuries. It is obvious that burn patients are at greater risk for infections in general, and nosocomial infections in particular. This is mainly due to the immunocompromising effects of burns, prolonged hospital stays, and intensive diagnostic and therapeutic procedures.[6] Nosocomial infections contribute significantly to morbidity as well as to excess cost for hospitalized patients.

Pseudomonas aeruginosa has remained a significant cause of nosocomial infection among burn patients worldwide. In many burn centers across the globe, this gram-negative bacillus is the most frequently cultured organism from infected burn wounds.[6-10] With often lengthy hospital stays, burn patients can be repeatedly exposed to hospital-acquired organisms such as *P. aeruginosa*. Nosocomial infections, whether transmitted by patient-to-patient, staff-to-patient, or environment-to-patient contact, can be especially difficult to eradicate because of multidrug resistance. *P. aeruginosa* infection is a typical example in this regard.

Approximately a decade ago, the authors conducted a study examining the epidemiologic characteristics of nosocomial infections among burn patients in Iran's largest burn care facility (located in Tehran).[6] The study showed that *P. aeruginosa* was the leading cause of nosocomial infections among burn patients.

The current study was undertaken to revisit the status of nosocomial infections among burn patients in Tehran, Iran, a decade later. It is important to note that during the past decade, infection control policies have changed, with new antimicrobial agents being introduced into the market. Thus the findings of this study will hopefully shed light on the epidemiology of nosocomial infections among burn patients as an evolving public health challenge in Iran.

Materials and methods

We performed a cross-sectional study during a 6-month period, from August 2010 to January 2011, at Motahari

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Burn and Reconstruction Center, the tertiary burn care centre in Tehran, Iran. Motahari Burn and Reconstruction Center is one of the few large highly equipped tertiary burn centers in Iran, providing care to severely burned patients from the province of Tehran and to complicated cases referred from other centers across the country. All patients were admitted immediately after burn injuries except for referral cases. The policy of Motahari Burn and Reconstruction Center is to admit: 1) any patient with ≥ 20% total body surface area (TBSA) burns, 2) electrical and chemical burns with any degree of TBSA, and 3) any degree of burn among immunocompromised subjects, state such as diabetic patients.

At direct patient contact a protective gown and disposable gloves were used. Hands were washed with conventional soap when necessary, and disinfected with 70% ethanol/glycerol before and after patient contact. Fluid replacement was given according to Parkland formula. Central venous catheters were placed (i.e., subclavian or other appropriate sites) at the discretion of the clinician. The catheters were removed on clinical grounds such as no need for further treatment, mechanical failure or suspected catheter infections. Early excision and skin grafting were performed in full thickness burns when the patient's condition permitted.

Silver sulfadiazine was used topically and the dressings were changed daily. Prophylactic antimicrobial therapy was given per clinical situation. Any infections manifested during the management of a burn victim were followed carefully. Only burn wound infections already present on admission were excluded in this study. The diagnosis of infection in burn patients was based on clinical and laboratory parameters. Infection and septicemia were suspected when a patient showed signs of disorientation, hyperpyrexia or hypothermia, circulatory embarrassment, petechial hemorrhages, black and dark discoloration in a previously clean appearing burn wound, early and rapid eschar separation, bleeding into the subcutaneous tissues, and increasing edema in surrounding areas or leukocytosis in WBC counts. On suspicion of blood stream infection, blood cultures were drawn from a peripheral vein and one culture from any suspected focus of infection.

In the present study, a total of 677 samples of swabs and blood were processed from 155 hospitalized burn patients. The culture swabs from the burn wounds were taken at the time of admission for all patients, and for some during the course of hospitalization, based on clinical judgment of infection (i.e. approximately on day 4 during the first week of hospitalization). Microbial cultures were processed according to current methods. The bacteriological isolation was carried out in the microbiology laboratory of Motahari Burn and Reconstruction Center affiliated to Tehran University of Medical Sciences. The swabs were plated on blood agar, chocolate agar, MacConkey, and Sabouraud´s dextrose agar media (Difco). After incubation for approximately 24-48 hrs. at 37 ºC, the isolates were identified using conventional protocol. For the isolation of *P. aeruginosa*, sheep blood agar and EMB (eosin methylene blue) were used. Subsequently growth at 42 °C in brain heart infusion, the oxidative test and the oxidative-fermentation (OF) test for carbohydrate utilization were used for identification of *P. aeruginosa*.[6] Isolated *Staphylococcus aureus*, *Acinetobacter* and *P. aeruginosa* were confirmed by disc, by agar diffusion method according to the rules established by NCCLS.[11]

Medical records for all patients in this study were reviewed by one of the authors (L.A.) and pertinent information was obtained and collected using a data collection form for age, sex, method of burning, dates of admission and discharge, total body surface area (TBSA) burned, degree of burn injury, length of stay, and patient outcome. The data collection form was first piloted on a small sample of cases and necessary revisions were made before being used in the study. The Statistical Package for the Social Sciences (SPSS) version 15.0 was used to conduct the analysis.[12] The chi square test was used to compare categorical data. The level of significance was set at 0.05. The study was approved by the Ethics Committee of Tehran University of Medical Sciences in Tehran, Iran.

Results

During the study period, a total number of 155 severely burn patients were hospitalized and treated at Motahari Burn and Reconstruction Center, of whom 105 were males (67.7%). The mean (±SD) and the median age of the patients were 32.5 (± 19.5) and 30 yr (range, 1-88 yr), respectively. The most common cause of burns was flammable materials/liquids (e.g. kerosene, gasoline, etc.) (64/155, 41.3%) followed by explosions (47/155, 30.3%). The percentage TBSA ranged from 3-85%, with a mean and median of 32.5% and 30.0%, respectively. The duration of hospital stay ranged from 4-61 days with mean and median values of 20.2 and 18.0 days, respectively. The case fatality rate in this study was 10.3% (16/155).

During the study period, 677 specimens were obtained for microbiological examination, of which 576 (85.1%) were positive. The rate of positive culture during the 1st, 2nd, 3rd, and 4th week of hospitalization were 76.3%, 99.3%, 100% and 100%, respectively. Burn wound samples were taken from all hospitalized patients on admission day and they all showed negative culture results. *Table 1* presents frequency of positive various bacteriological cultures in the 1st, 2nd, 3rd and 4th week of hospitalization. During the first week of admission, Staphylococcus spp. were the most common isolated pathogens. Of 155 patients 42 had a blood culture, of whom 29 were negative and 13 were positive (10 patients had Pseudomonas and 3 Acinetobacter).

Table I - Frequency of various bacteriological species isolated during the course of hospitalization in burn patients

	Week 1	Week 2	Week 3	Week 4
Pseudomonas	54 (34.8%)	99 (66%)	57 (55.3%)	34 (68%)
Staphylococcus	106 (68.4%)	43 (28.7%)	14 (13.6%)	5 (10%)
Acinetobacter	28 (18.1%)	45 (30%)	16 (15.5%)	15 (30%)
Enterobacteriaceae	19 (12.2%)	13 (8.7%)	9 (8.7%)	10 (20%)
Enterobacter	23 (14.8%)	5 (3.3%)	0 (0%)	0 (0.0%)
Enterococcus	4 (2.6%)	4 (2.7%)	1 (0.1%)	0 (0.0%)
Total patients	155	150	103	50

During the 48 h post admission, approximately 50% of all wound cultures were positive, of which none were *P. aeruginosa* and/or *Acinetobacter* (they were all Staphylococcus spp., Enterobacteriaceae, and Enterococcus spp). On the 2nd, 3rd, and 4th week of hospitalization, *P. aeruginosa* was the most common pathogen followed by *Acinetobacter*, while the culture positive rate for Staphylococcus spp., Enterobacteriaceae, and Enterococcus spp. significantly decreased ($P < 0.001$). In this study, 70 of 155 (45.2%) patients had at least *Acinetobacter* positive culture, which was significantly lower than that seen a decade ago (8%).

In this study of the 16 deaths, 10 patients had a TBSA greater than 70% and all of the deceased patients had at least one *P. aeruginosa* and/or *Acinetobacter* positive culture.

Discussion

After the initial period of shock, infection is the major complication in burns.[6] The development of infections in burn patients is a crucial matter because of their effects on the course of the disease and patient outcomes. Many burn patients die as a result of infection during their hospitalizations. The rate of infection among burn patients is remarkably high in developing countries.[6, 9, 10] Despite advances in the use of topical and parenteral antimicrobial therapy, and the practice of early tangential excision, bacterial infection remains a major problem in the management of burn victims in our center as well as other burn centers across Iran.[6, 13-16] Few patients are as susceptible to the development of infections as burn patients. Severe dysfunction of the immune system, a large cutaneous colonization, the possibility of gastrointestinal translocation, prolonged hospitalization and invasive diagnostic and therapeutic procedures, all contribute to infections.

P. aeruginosa was found to be the most common pathogen causing wound infection in this study after one decade.[6] This is consistent with other studies, especially from developing economies including Iran, where they reported *P. aeruginosa* to be the most common pathogen.[6, 10, 13-18] However, this is in contrast to some other studies, which report coagulase-negative staphylococci and *S. aureus* as the most predominant organisms in burn infection.[19-23] In our previous study a decade ago, *S. aureus* was reported to be the second most common isolate. Staphylococci were the predominant causes of burn-wound infections in the pre-antibiotic era, and have remained important pathogens.[6]

With the advent of systemic antimicrobial agents, *P. aeruginosa* has become a major problem in burn-wound management.[6] Presently this epidemiology profile has changed and *Acinetobacter* is the second most common hospital pathogen among burn patients, which is of paramount importance. Interestingly enough, a decade ago approximately 8% of hospitalized burn patients had at least one *Acinetobacter* positive culture.[6] while today and in the present study this figure has significantly increased to 45.2%. Further, our analysis showed that during the course of hospitalization (particularly 48 h post admission), burn wounds are increasingly colonized with *P. aeruginosa* and/or *Acinetobacter* at the expense of a decrease in Staphylococcus spp., Enterobacteriaceae, and Enterococcus spp. colonization rates. Moreover, of the 16 deaths, all of them had at least one culture positive to *P. aeruginosa* and/or *Acinetobacter*. Consistent with our findings, Estahbanati et al.[14] in a study from Iran reported *Acinetobacter* to be the second most common isolated microorganism after *P. aeruginosa*. Similarly, Rezaie et al. in a recent study from an eastern province in Iran reported *P. aeruginosa*, and *Acinetobacter* as the most commonly isolated organisms from burn patients.[24]

According to Towner[25] *Acinetobacter* is an old friend, but a new enemy which emerged as a significant nosocomial pathogen during the late 1970s, probably as a consequence, at least in part, of increasing use of broad-spectrum antibiotics in hospitals. Most clinically significant isolates belong to the species *Acinetobacter baumannii* or its close relatives, with many infections concentrated in intensive care, burns or high dependency units treating severely ill or debilitated patients. Challenges caused by *Acinetobacter* in the hospital setting are exacerbated by the high degree of resistance of these organisms to drying and disinfectants, leading to long-term persistence in the hospital environment and to the occurrence of outbreaks of infections affecting many patients, and to the ever-in-

creasing proportion of multi-drug resistant isolates.[25]

Although investigating the antibiotic resistance patterns was not within the scope of this study, preliminary findings showed that the rates of antibiotics resistance among pseudomonas spp. (as the most common microorganism) for Ciprofloxacin, Amikacin, and Gentamicin were 88%, 79%, and 72%, respectively. The corresponding figures in our previously published study (over a decade ago) were 45%, 48%, and 88%, respectively.[26] This shows that in our setting both the nosocomial infection epidemiology and the antimicrobial resistance patterns among hospitalized burn patients have drastically changed.

We recognize that nosocomial infection is a critical challenge we face in our center. The isolation care practice in general is important in the prevention of nosocomial transmission of infections. It is clear that cross-transmission of multi-resistant microorganisms is common in burn centers. This cross-transmission is an indicator of patient crowding and/or poor compliance with infection control guidelines by patient care personnel. At present the main infection control measures in many burn centers in Iran as well as ours are early excision and grafting, improved barrier nursing and regular microbiological analysis of the hospital's environment and staff.

Microbiological surveillance of burn patients, when done routinely, can assist in monitoring and assessing the rate of infections and the types of organisms involved. Every burn center varies in its baseline population of microorganisms over time, and generalizations from one unit may have little applicability to others.

Measures to prevent and treat infections are essential for the survival of patients with extensive burns, and infection is correlated to mortality. Further, in patients with less extensive burns, infections may increase morbidity and hospital stay. Infection is one indicator of outcome in the field of quality assurance in burn management and has been considered in our center as well. Careful surveillance of infection, good isolation techniques and procedure routines, and a restrictive antimicrobial policy can keep antimicrobial resistance rates and infection rates low in infection-prone burn patients.

Conclusions

Our results show that *P. aeruginosa* is still the leading cause of nosocomial infections in our burn center after a decade. Additionally, *Acinetobacter* has appeared as an emerging nosocomial pathogen, which is often resistant to many available antimicrobial agents, and should be considered as a serious risk. We believe that changes in burn wound bacterial colonization over time require consistent assessment of these changes in any burn center. Further, efforts should be aimed at controlling factors involved in microbial agents' colonization.

RESUME. Les Auteurs de cette étude se sont proposés de déterminer l'épidémiologie des infections nosocomiales chez les patients brûlés dans un centre tertiaire des soins à Téhéran, Iran. Ils ont effectué une étude transversale au cours d'une période de six mois (août 2010 jusqu'à janvier 2011) au Centre de Motahari pour les Patients Brulés et la Reconstruction à Téhéran. Ils ont trouvé que dans les quatre semaines de l'hospitalisation les 677 échantillons prélevés à 155 patients atteints de brulures présentaient après culture un taux de positivité de 76,3%, 99,3%, 100% et 100%, respectivement. Pendant la 2e, 3e et 4e semaine de l'hospitalisation, *Pseudomonas aeruginosa* était le pathogène le plus commun, suivi par *Acinetobacter*, tandis que le taux de positivité dans les cultures de *Staphylococcus* spp, *Enterobacteriaceae* et *Enterococcus* spp diminuait de façon significative ($p <$ 0,001). Dans cette étude, 70 des 155 (45,2%) patients avaient au moins une culture positive d'*Acinetobacter*. Ces résultats ont démontré que *P. aeruginosa* est encore la principale cause des infections nosocomiales. En outre, *Acinetobacter* constitue aujourd'hui un pathogène nosocomial émergent qui doit être considéré comme un risque sérieux. Les Auteurs soutiennent la nécessité de monitoriser continuellement les modifications de la colonisation bactérienne des patients brûlés et leur suivi dans tous les centres des brûlés à tous les niveaux. Il faut aussi chercher de controller les facteurs qui jouent un role dans la colonisation des agents microbiens.

Mots-clés: infections nosocomiales, épidémiologie

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This paper was accepted on 9 February 2012.