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Profile of microorganisms and antimicrobial resistance at a tertiary care referral burn centre in Iran: Emergence of *Citrobacter freundii* as a common microorganism

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ARTICLE INFO

Article history:
Accepted 11 December 2007

Keywords:
Burn
Wound infection
Pseudomonas aeruginosa
Citrobacter freundii
Antimicrobial resistance

ABSTRACT

Infection and antimicrobial resistance are important issues in severe burn. The aims of this prospective study were to investigate the profile of microorganisms and resistance to antimicrobial agents in a tertiary referral burn centre; 113 people aged >10 years, with partial- or full-thickness burns, were included in the study. A total of 733 samples including 275 swabs, 164 tissue biopsies, 258 urine samples, 26 blood samples and 10 sputum samples were collected, from which 124 microorganisms were isolated.

Pseudomonas aeruginosa and *Citrobacter* spp were the most prevalent isolates (57.3% and 35.5%, respectively); 95.5% of *Citrobacter*. isolates were *Citrobacter freundii*. Antibiogram results obtained from 15 antimicrobial agents demonstrated that imipenem was the most effective agent against *P. aeruginosa*, followed by ciprofloxacin and piperacillin/tazobactam (67.9%, 43% and 37.5% sensitive, respectively). At least 60% of all *Citrobacter* isolates were sensitive to various antimicrobial agents, the highest sensitivity being obtained by ceftazidime and cefepime (81.6% and 78.4%, respectively). Sensitivity of *P. aeruginosa* isolates to the agents of each antimicrobial class was significantly different ($p < 0.001$). The incidence of *C. freundii* and the resistance of *P. aeruginosa* to anti-pseudomonas agents were exceptionally high.

1. Introduction

Severe burn causes complex changes in homeostasis that can hardly be compared with other traumas or disorders, and mortality is relatively common in the early phase. If the burn exceeds 40% of the total body surface area (TBSA), wound infection will be one of the main complications that can cause death in up to 75% of victims [1]. Infection in the wound prolongs the healing process; treatment includes rational antibiotic administration, removal of necrotic tissues, sufficient blood and oxygen supply to the wound and good nutritional support. All these measures are very important in the care of burn victims [2]. From 11% to 30% of burns are contaminated by microorganisms of the gastrointestinal tract, skin and upper respiratory system, including *Pseudomonas aeruginosa* (P.), *Staphylococcus aureus* (S.), *Escherichia coli* (E.), *Klebsiella* spp, *Enterococcus* spp and *Candida* spp [3,4].

Antimicrobial resistance is a great problem in infectious disease. In burn units, because of the wide use of antibiotics and particularly the empirical administration of broad-spectrum antimicrobials, this problem is worse than in other hospital departments [5]. Another important point is that the epidemiology of microorganisms; antimicrobial sensitivity may vary from area to area. For example, one report demonstrates

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0305-4179/$34.00
doi:10.1016/j.burns.2007.12.008

different susceptibilities of *P. aeruginosa* in two hospitals of the same city [6]; another report documents a 0–89.5% variation in the prevalence of oxacillin-resistant *S. aureus* microorganisms in different hospitals in the same country [7].

The present prospective study was conducted to determine the profile of microorganisms and their antimicrobial resistance in the burn unit of Zare hospital, a tertiary university-related referral centre located in Mazandaran province of Iran. The secondary aim was to evaluate current empirical use of broad-spectrum antibiotics, such as imipenem and meropenem, for burns and to derive suggestions for more effective administration.

2. Materials and methods

2.1. Setting and patients

This prospective cross-sectional study involved 113 patients who were enrolled from September 2006 to March 2007. Individuals aged >10 years, with partial- or full-thickness burn, were included. Demographic and clinical data, including gender, age, height, burn degree, TBSA burned, cause of burn, and antibiotic therapy were collected for each participant.

2.2. Sampling

According to the clinical status of the participants, appropriate samples including wound swab, tissue biopsy, and urine, sputum and blood samples were taken. The first swabs were obtained from deep areas of the burns before any cleaning, and tissue samples were taken and transferred to the laboratory via sterile plates. Blood and sputum samples were collected in particular from individuals with signs and symptoms of septicaemia or pneumonia. Blood sampling was repeated three times.

2.3. Microbiology

The swabs were dipped in Stuart's transport medium and plated on blood agar, eosin methylthionine blue and chocolate agar. After incubation for 18–48 h at 37 °C, the isolates were identified using conventional identification media. A similar method was used for other specimens except for the blood samples, which were first transferred to brain–heart infusion agar.

The isolates' susceptibility patterns to antibiotics were determined by the method of Bauer et al. [8] using Muller Hinton agar (Merck, Germany) and commercially available paper discs (Hi-Media, India). The antibiotics tested included imipenem, meropenem, ceftazidime, ceftriaxone, ceftizoxime, cefixime, cefazolin, cefepime, vancomycin, ciprofloxacin, ofloxacin, amikacin, tobramycin, gentamicin, piperacillin and piperacillin/tazobactam. Results were interpreted according to the guidelines of the National Committee for Clinical Laboratory Standards [9].

2.4. Statistical analysis

Statistical analysis was performed with SPSS 10 software. Descriptive statistics were used for demographic and bacteriological profiles of each case; χ^2 testing compared the microorganisms' sensitivity and resistance patterns to the examined antimicrobials; $p < 0.05$ was considered significant.

3. Results

A total of 113 people were included in this study. Their characteristics, including gender, distribution of age, cause of burn and TBSA burned are presented in Table 1. Nearly 50% of the participants were aged from 21 to 40 years, and the most common type of burn was flame injury (Table 1).

Antibiotics administered are shown in Table 2. Ceftazidime, ciprofloxacin, amikacin and imipenem were the most commonly used.

In all, 733 samples, including 275 swabs, 164 tissue biopsies, and 258 urine, 26 blood and 10 sputum samples, were collected. From these, 124 microorganisms were isolated. *P. aeruginosa*, *Citrobacter* spp, *Enterobacter*, *S. aureus*, *Klebsiella*, *E. coli*, *Proteus* and *Serratia* were identified. *P. aeruginosa* and *Citrobacter* spp were the most prevalent in all samples (57.3% and 35.5%, respectively). Although many of the participants did not have enough sputum, all sputum samples of individuals with evidence of pneumonia contained organisms. None of the 26 blood samples contained them (Table 3).

Among 44 *Citrobacter* isolates, 42 (95.5%) were *C. freundii* and 2 (4.5%) were *Citrobacter amalonaticus*; two isolates of *C. amalonaticus* were from a person whose swab and biopsy cultures grew microorganisms. To determine the source of *Citrobacter*, we reviewed 350 samples from different equipment and instruments on the ward, floor swabs of the operating theatre and intensive care unit, and samples from the hands, nails and clothes of staff; five isolates of *C. freundii* were obtained from boot and faucet samples.

Antibiograms of *P. aeruginosa* and *Citrobacter* spp to 15 antimicrobial agents including carbapenems (imipenem, meropenem), cephalosporins, fluoroquinolones, aminoglycosides,

Table 1 – Characteristics of patients (total 113)

Characteristic	Number of patients	Percentage of total
Gender (male)	67	59.3
Age in years		
11–20	20	17.7
21–40	56	49.5
41–60	26	23.0
61–80	10	8.9
>80	1	0.9
Cause of burn		
Scald	10	8.8
Flame	60	53.1
Electrical	13	11.5
Gas explosion	29	25.7
acid	1	0.9
TBSA burned		
<10%	14	12.3
10–20%	36	31.9
>20%	63	55.8

TBSA, Total body surface area.