

The Pattern of Burn Infection in the Singapore National Burns Centre[†]

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Abstract

As part of the multi-pronged strategy in the fight against burn infection, we conducted a retrospective study of the pattern of infection in our burn patients for a period of 15 months from January 1993 to March 1994. We studied culture and sensitivity reports to determine the incidence of each organism, their antibiotic sensitivity patterns and the time interval between the burns injury and the appearance of these organisms. Organisms like methicillin-resistant Staphylococcus aureus (MRSA) and multiply-resistant Acinetobacter baumannii constituted a problem in our patients. Other organisms that were isolated from our patients included Pseudomonas aeruginosa, Enterobacter species and Klebsiella species. The infection control measures in our burns centre are aimed at combating the spread of gram-positive and gram-negative organisms. This study has helped to influence our antibiotic administration policy for treating infection in our centre based on the sensitivity patterns of the prevailing flora.

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Key words: Antibiotic policy, Burns flora, Multi-resistant organisms, Stringent measures

Introduction

A burn injury predisposes a patient to infection^{1,2} because of a variety of reasons, including the loss of integument, which would otherwise serve as a natural barrier to microorganisms, the availability of nutrients for microbial proliferation and the immunosuppressive effects of the burn injury,³⁻⁵ which depresses both cellular and humoral immunity. Microorganisms that normally reside on the skin surface can multiply to high concentrations in the presence of these factors and lead to an invasive burn infection. Despite advances in wound care and intensive care management, early excision and grafting combined with improved anaesthetic techniques together with placement of a strict infection control protocol, infection in the burn patient still remains a significant and challenging problem. Burn wound infection results in increased morbidity and mortality. Locally, infection causes loss of grafts over surgically-excised wounds, converts partial thickness wounds to full-thickness ones,⁴ and causes wounds to hypertrophy if allowed to granulate. Infection necessitates the use of often toxic chemotherapeutic agents; when unbridled, infection may lead to bacteraemia resulting in multi-organ failure and/or septic shock. A multi-pronged strategy is needed to combat both gram-positive and gram-negative infection in burn patients.^{6,7} One aspect

of this strategy is the judicious use of antibiotics, and familiarity with the resident flora of the burns centre^{8,9} as a guide to appropriate prescription. There is often a need to commence antibiotics in the septic patient without the benefit of confirmatory cultures, as a delay in instituting antibiotics might severely jeopardize a patient's safety. Delivery of appropriate antibiotics increases the effectiveness of eradication of the infecting organisms and diminishes the need to administer broad-spectrum preparations blindly.

Materials and Methods

We conducted a retrospective survey of the prevailing bacteria flora in our unit over a fifteen-month period from January 1993 to March 1994. Records of all patients admitted during this time were reviewed and information regarding patient and burn characteristics were collected. We reviewed the culture and sensitivity records of all burn wound isolates that were cultivated in the first two weeks of hospital stay. Patients requiring fluid resuscitation in the acute stage [more than 10% Body Surface Area (BSA) for children and >15% BSA for adults] were given plasma based on the Muir and Barclay formula? Topical therapy with silver sulphadiazine was employed for mid to deep dermal partial thickness wounds and full thickness wounds.¹¹

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Early excision and grafting was performed for deep burns that were judged to require more than two weeks for spontaneous healing. Wound cultures were taken by the swab method on admission and every five days until the wounds are healed and sent to the hospital's microbiology laboratory for organism identification and antibiotic susceptibility testing (disc diffusion method). As long as a microorganism was isolated, the patient was presumed to have a potential burn wound infection from that particular organism. The decision to treat with systemic antibiotics depended on the presence or absence of other clinical markers of infection.

Results

Patient Characteristics

Three hundred and ninety-two patients were admitted during the study period. Case sheets were available in 362 patients and this constituted the study population. There were 322 males and 40 females. Their ages ranged from 1 year to 87 years with a median age of 32 years. Three hundred and seventy-five patients survived and 17 patients succumbed to their burn injuries.

Cause of Burn Injury

Scalds and flame burns were the two most common causes of burn injuries in our centre (Fig. 1). Patients with less than 15% burns were admitted because of a specific indication like associated inhalational injury, suspected or established, involvement of specialised areas like the eyes, hands, perineum, and genitals which require specialised care, and involvement of areas requiring early surgery. Other patients included those with chemical and electrical injuries. None of our patients had radiation injuries.

Type of Organisms Isolated

A total of 1250 wound cultures from burn sites were collected in the first two weeks of admission. Overall, the most prevalent organism isolated was *Staphylococcus aureus*, followed by *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, *Enterobacter* species and *Klebsiella* species were

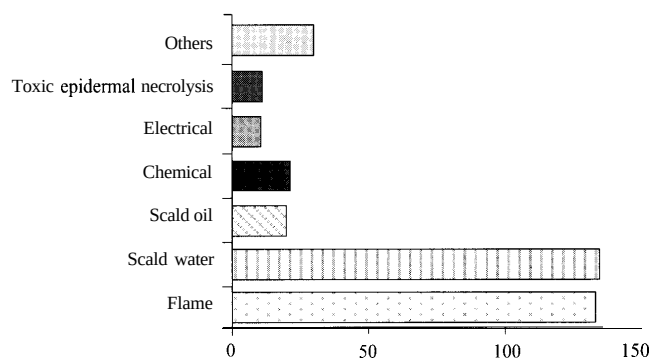


Fig. 1. Causes of burn injuries.

less commonly isolated. In terms of patients with larger burned body surface areas, *Acinetobacter baumannii* was more prevalent than *Staphylococcus aureus* (Fig. 2). Other less common organisms, including *Streptococcus* species, *Enterococcus* species, *Escherichia coli*, *Proteus mirabilis* and *Serratia* species, were also encountered.

Antibiotic Sensitivity Patterns

With regards to antibiotic sensitivity patterns, most of the *Staphylococcus aureus* were resistant to penicillin and cloxacillin. None were resistant to vancomycin (Fig. 3). *Acinetobacter baumannii* present in our centre was multiply- and variably-resistant, raising the possibility of different strains present in a patient at any time. A quarter of the isolates was imipenem-resistant (Fig. 4). *Pseudomonas aeruginosa* encountered in our patients were usually sensitive to ceftazidime, ciprofloxacin and imipenem (Fig. 5).

Discussion

Staphylococcus aureus was the most common organism isolated during the study period, as is the experience with other units.^{9,12-14} No strains were resistant to vancomycin. In contrast to the experience of other centres, *Acinetobacter baumannii* was the next most common organism isolated.^{9,12-14} *Pseudomonas aeruginosa* was not as big a problem in our centre as it was in the 1970s, probably as a result of the widespread use of silver sulphadiazine as a topical antimicrobial agent.^{11,15} Gram-positive colonisation and infections are more common in the present situation; with growing resistance to penicillin, these infections need to be treated with vancomycin. The growing incidence of gram-negative organisms is of additional concern because gram-negative organisms are often multiply-resistant, thereby posing difficult therapeutic problems¹⁶⁻¹⁸ where the use of effective antibiotics is concerned, especially when resistance to antibiotics can be transferred.¹⁹

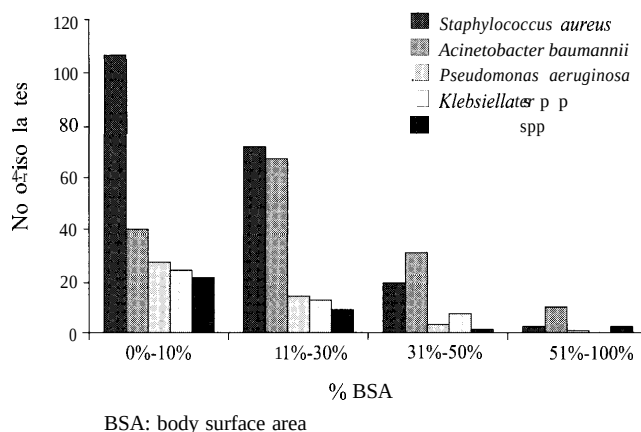


Fig. 2. Profile of organisms isolated in the first 2 weeks of admission by body surface area burns

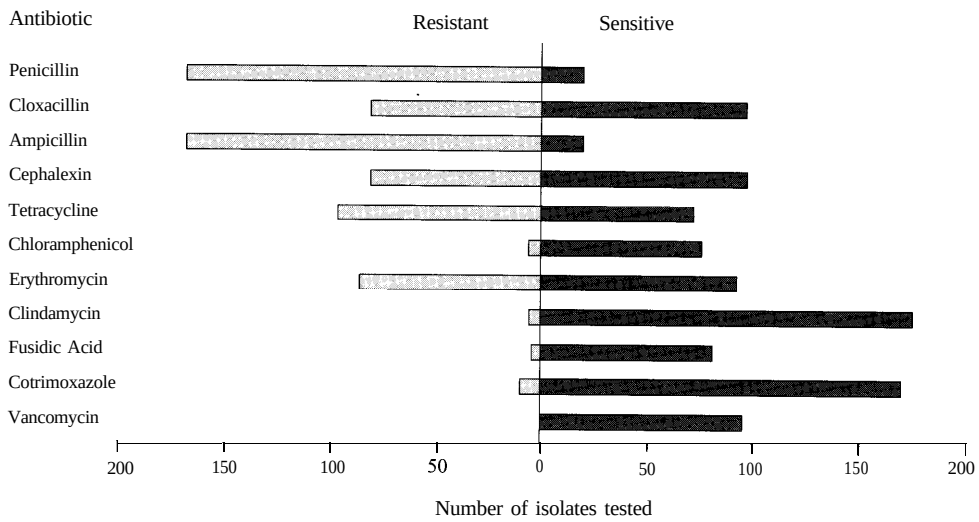


Fig. 3. Antibiotic sensitivity pattern of *Staphylococcus aureus*.

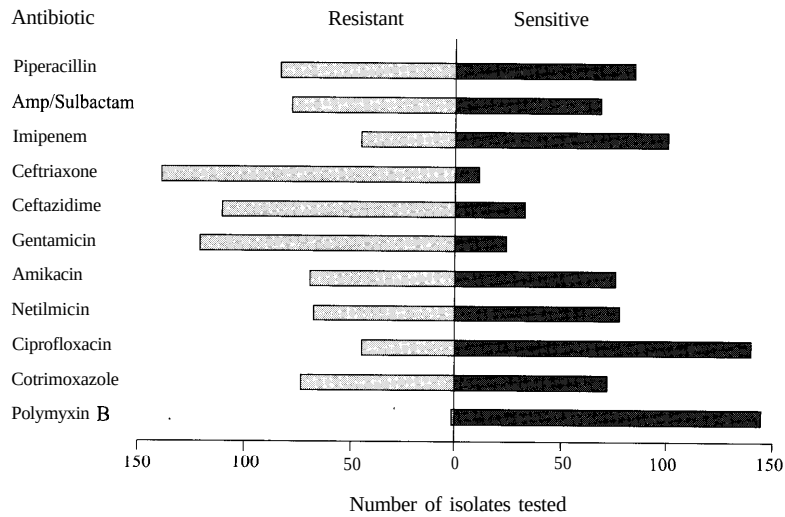


Fig. 4. Antibiotic sensitivity pattern of *Acinetobacter baumannii*.

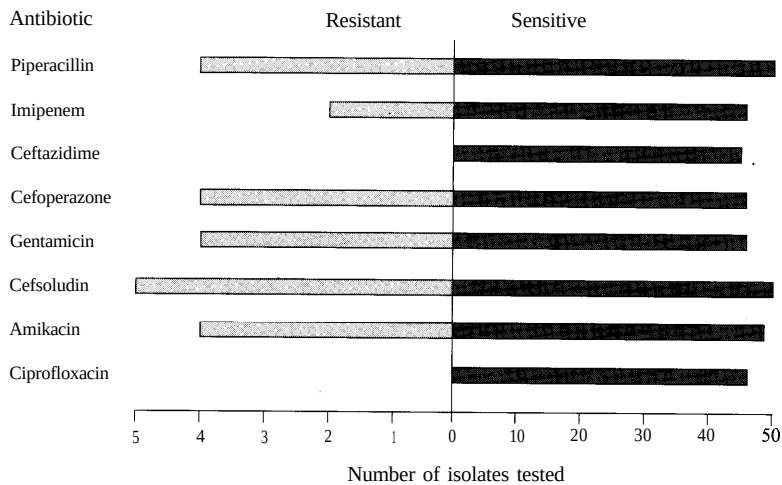


Fig. 5. Antibiotic sensitivity pattern of *Pseudomonas aeruginosa*.

Burn wound infection and colonisation with multiply-resistant *Acinetobacter baumannii* was first noted in our burns centre in 1990²⁰ and it remains a major problem.²¹ Strains of *Acinetobacter baumannii* present in Singapore patients are resistant to many antibiotics, including cephalosporins, aminoglycosides and quinolones.²² About one third of the isolates are resistant to imipenem and exhibit sensitivity only to polymyxin B. This is especially worrying because imipenem is used to treat many serious gram-negative infections and there is a potential of transference of resistance to other organisms.¹⁹ Moreover, polymyxin B has a narrow therapeutic range because of its renal toxicity, and the administration of this drug to patients with multiply-resistant *Acinetobacter baumannii* infection may further compromise the health of these patients who are already debilitated by a severe burn injury. The incidence of multiply-resistant *Acinetobacter baumannii* appears to have increased in the period from 1990 to 1994,²⁰ but appears to have abated in 1996.²³

Infection control strategy in our burns centre is multi-pronged, and is designed to combat the spread of both gram-positive and gram-negative organisms.^{6,7} This strategy combines medical management such as early excision of deep burns, frequent dressing changes and the judicious use of antibiotics, with measures like bacteriological surveillance, hand-washing, cohort nursing and isolation procedures.

In an attempt to limit the emergence of multi-resistant organisms, antibiotic usage is restricted.²⁴ Based on studies of the microbiologic and antibiotic sensitivity profile of our burns centre, we have been able to modify our burns centre's antibiotic prescription policy that was formulated in 1990. Prophylactic antibiotics are not given routinely, except for patients who have had escharotomy or who are on ventilator therapy for moderate to severe respiratory burns. Therapeutic antibiotics are given only when there are clear signs of infection, both systemic and local. As far as possible, antibiotics are given based on available culture and sensitivity results. In the absence of positive confirmatory cultures, if antibiotics are necessary within the first week of the burn injury, crystalline penicillin, cloxacillin and gentamicin are administered. The penicillins cover community-acquired gram-positive organisms and gentamicin covers the gram-negative organisms. In the previous protocol, ampicillin/sulbactam and amikacin were given should there be no improvement following a 5-day course of the "first line" antibiotics or for infections that occur after the first week of admission. Based on our present study, piperacillin may be more effective for gram-negative coverage than ampicillin/sulbactam for use as "second line". Vancomycin and either imipenem, ciprofloxacin or polymyxin B are prescribed should there be no improvement following the use of

"first" and "second-line" antibiotics.

We have in place a strict bacteriological surveillance protocol for both people and the environment. Patients are screened weekly for nasal methicillin-resistant *Staphylococcal aureus* (MRSA) carriage and their burn wounds are swabbed regularly for microbiology testing. Medical and ancillary staff managing the burns centre receive weekly nasal MRSA screening. The environment, including air-conditioning vents, taps, individual rooms and cupboards of the whole burns centre is subjected to weekly bacteriological surveillance.

The burns centre is fully air-conditioned with at least 20 air changes per hour which has previously been found to rapidly remove airborne bacteria.^{25,26} Non-staff access into the unit is restricted to two visitors per patient for one hour at noon and two hours in the evening. Every major burn patient is isolated in the acute phase and barrier nursed. It is compulsory for staff to handwash with HibiscrubTM prior to and following patient contact. In addition, we have in place a cohort nursing policy. Patients identified as having MRSA, either based on positive nasal swabs or positive wound cultures, are nursed in a separate "MRSA wing". Patients identified as having MRSA have a 3-cm diameter orange sticker pasted on the door to their rooms. These orange roundels serve to alert staff to the need to undertake special precautions with regard to MRSA infection. Since January 1996, we have introduced a few additional measures in the hope of further limiting the spread of multiply-resistant organisms. Patients who are admitted to our centre more than 3 or 4 days following a burn injury are presumed to be at risk of harbouring MRSA and are nursed in a non-contaminated area of the "MRSA wing". Secondly, we have started the use of red 3-cm diameter roundels for patients identified as having multiply-resistant *Acinetobacter baumannii* to serve as a reminder to our staff to take special precautions just as the orange roundels serve to alert the staff to the presence of MRSA. Thirdly, signboards attached to each patient's door remind staff and visitors to observe isolation procedures.

Despite the dynamic nature of continual change with time in the microbial flora in our burns centre, as it is in any other burns centre,⁵ with constant vigilance in our bacteriological surveillance, we are able to identify the emergence of different multiply-resistant microorganisms early, whatever it may be, modify our antibiotic policy accordingly, and prevent these microorganisms from attaining epidemic proportions.

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