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Hospital-acquired infections in a burns unit caused by an imported strain of *Staphylococcus aureus* with unusual multi-resistance

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SUMMARY

During the past year five patients from countries in the Middle East admitted to a burns unit were found to harbour a strain of *Staphylococcus aureus* with unusual multi-resistance to antibiotics. The admission of the first patient was followed by an outbreak of infection with this strain involving ten patients in the unit. In addition five staff members were found to be nasal carriers of the strain. As a result of this incident, the following four patients admitted to the unit were isolated on admission and the spread of their strains was thus prevented. It is recommended that patients on admission to burns units, or similar departments with patients very susceptible to infection, are isolated until their bacterial floras have been examined.

INTRODUCTION

In 1946 strains of penicillinase producing *Staphylococcus aureus* resistant to penicillin were first reported (Barber, 1947*a*,*b*) and other antibiotics were used to treat staphylococcal infections. In consequence strains of staphylococci resistant to these antibiotics appeared rapidly and multiply resistant strains became a serious problem (Finland, 1971).

The introduction of penicillinase-resistant penicillins was followed by the appearance of methicillin-resistant strains of staphylococci (Jevons, 1961; Eriksen, 1965). Such strains were found world wide and caused serious problems in hospitals. Since 1969 there has been a general steady decrease in infections caused by methicillin-resistant staphylococci (Jessen *et al.* 1969; Williams & Dean, 1974; Rosendal *et al.* 1977). Recently, however, outbreaks caused by methicillin and aminoglycoside-resistant staphylococci have been reported (Recco, Schaefler & Gladstone, 1976; Soussy *et al.* 1976; Bint *et al.* 1977; Crossley *et al.* 1979). It is well known that differences in the incidence of resistant strains of *S. aureus* exist in different parts of the world (Borowski, Kamienska & Rutecha, 1964). In

Denmark a high incidence of *S. aureus* resistant to methicillin and most other antibiotics has been observed in Vietnamese refugees (Jensen, unpublished observations).

In burned patients staphylococcal infections are of special importance as the use of antibiotics in burns units is followed by the rapid emergence of resistant strains which are easily spread in these units (Thomsen, 1970; Lowbury, 1972). In our burns unit, therefore, the policy adopted has been to restrict the use of antibiotics and to rely on very extensive hygiene precautions to limit the occurrence and spread of infection. Despite these measures, an imported strain of *S. aureus*, resistant to many antibiotics including methicillin and gentamicin was spread in our hospital. At later dates, four patients infected with similar multi-resistant staphylococci have been admitted to our unit. This strain would appear to be common and we therefore consider it justified to report our experience.

MATERIALS AND METHODS

The burns unit

The burns unit has 21 beds, of which seven form an intensive treatment unit staffed by its own personnel. Each room in the intensive care unit is a self-contained isolation cubicle with toilet, bathroom and sluice. The cubicles are pressure ventilated, with eight changes of germ-free air per hour without recirculation. Clean and dirty goods are kept separate and are transported in closed containers by automatic conveyors. Staff and visitors use protective clothing including masks and caps when entering a room. In-and-out traffic is kept to a minimum by means of a closed circuit television and communication systems. The cubicles are cleaned twice daily using detergents containing chloramine T. The equipment is sprayed with 60% ethanol. All patients are supplied with disinfected beds at least twice weekly. After discharge of a patient the cubicle is disinfected.

During the period of the outbreak 23 patients were treated in the burns unit.

Treatment in the burns unit

All patients are admitted to an isolation cubicle in the intensive unit where they are washed with soap and water for 10 minutes. As a rule burns are treated by 'exposure' for about two weeks. After the period of exposure unhealed areas are treated by excision and autograft or if necessary homograft transplantation. For deep burns early excision with transplantation is often practised. When the wounds have dried, the patients are moved from the cubicle in the intensive care unit to one of the rooms outside. Antibiotic prophylaxis is not used. On arrival, and twice weekly thereafter, swabs from nose, throat, perineum and wounds are examined bacteriologically. All pathogenic or potentially pathogenic micro-organisms are identified. Antibiotic sensitivity is determined using the standard agar diffusion technique.

The hospital epidemic

Introduction of the infection

A diabetic patient from the Middle East with deep burns covering 55% of his body surface was admitted to the burns unit (day 0) three days after an accident during which time he had received hospital treatment in his own country. He was seriously ill on admission and died from a streptococcal septicaemia four days after admission.

A multi-resistant strain of *S. aureus* was identified on day 1 in cultures from his burns. The burns unit was informed on day 4. The strain was phage untypable and was resistant to penicillin, methicillin, cephalosporin, streptomycin, kanamycin, neomycin, gentamicin, tobramycin, tetracycline, chloramphenicol, erythromycin, lincomycin, clindamycin and sulphonamides. It was sensitive to vancomycin, fucidic acid and rifampicin.

This resistance pattern has not been seen before in our department. All the strains of *S. aureus* isolated during the epidemic had the same pattern of resistance and the same phage type.

The spread of infection

During the 28 days following the death of the index patient the same strain of *S. aureus* was isolated from 10 patients and five members of staff. Nine of the 10 patients developed superficial wound infections without serious illness; the tenth patient developed pneumonia and became seriously ill. The resistant strain was not, however, found on blood culture.

Five out of 317 staff members from the departments involved were found to harbour the strain. All five worked in the intensive unit.

Epidemiology

The ten patients infected were found in the order given in Table 1. Patient no. 1 was most probably infected in the room formerly occupied by the index patient. Although this room had been disinfected between the two patients bacteriological examination revealed survival of *S. aureus* in dust adherent to the air inlet of the ventilation system.

Three patients, nos. 2, 3 and 4, were infected during isolation in cubicles. All were detected on day 7, before the carriers had been detected amongst the staff. The staff members with whom these patients had been in contact were later found to be carriers.

Two patients, nos. 5 and 6, occupying a two-bedded room were both detected on day 11. These patients had not been outside the room but had been in contact with carriers among the staff. The above five patients were therefore considered to have been infected by contact with the staff.

Patient no. 7 was infected in the general ward of the burns unit. He occupied a two-bedded room and on days 2–5 his room mate was patient no. 2 who was infected but not detected at the time.

Patient no. 9 was in error placed next to an infected patient on day 8. The route of infection in these two cases could have been either airborne or by the staff.

Table 1. *Epidemiological data for the* 10 *patients infected during the epidemic*

Patient number	Sex/age	Diseases	Site of infection	Course	Day of the first isolation of the epidemic strain	Location of the patient when infected	Possible source of infection
1	M/25	Burns 10%	Burns	Uncomplicated	5	I	Environment
2	F/74	Burns 8%	Burns	Uncomplicated	7	I	Staff
3	M/27	Burns 13% Diabetes	Burns	Uncomplicated	7	I	Staff
4	M/33	Burns 18% Tibial fracture	Burns	Uncomplicated	7	I	Staff
5	M/69	Burns 16%	Burns	Uncomplicated	11	I	Staff
6	M/60	Burns 19%	Burns	Uncomplicated	11	I	Staff
7	M/69	Intestinal fistula Cirrhosis	Wound infection	Uncomplicated	12	II	Airborne or Staff
8	F/21	Breast prosthesis	Surgical wound infection	Delayed recovery	20	O	Staff
9	M/80	Burns 24%	Burns	Died of heart attack	21	I	Airborne or Staff
10	M/57	Chronic bronchitis	Pneumonia	Delayed recovery	32	O	Respirator

I denotes burns unit, intensive ward; II denotes burns unit, general ward and O denotes outside burns unit.

Two patients were infected outside the burns unit. A surgeon from the burns unit operated on patient no. 8 in the open ward. Patient no. 10 was infected in the department of anaesthetics by a respirator which had been used in the treatment of the index case. The respirator was transferred from the intensive unit to the anaesthetic department on day 26. Due to a mistake this respirator was not disinfected between use on patients.

Six of the 10 patients were probably infected by the carriers among the staff as evidence of environmental contamination (equipment, floors, walls and air) was found only in those rooms occupied by patients already infected.

Control of the outbreak

The following measures were taken to control the outbreak:

Patients. Swabs were taken thrice weekly from nose, axillae, perineum, and wounds. Patients found contaminated were isolated in the intensive unit and treated by separate staff wearing protective gowns, masks, and gloves which were changed between treatments of patients.

Patients, other than burned patients, who were found not to harbour the *S. aureus* strain were transferred to another unit. From day 8 onwards no patients were admitted to the burns unit.

Infected patients received systemic treatment with a combinaton of fucidic acid and rifampicin, and local treatment to lesions with chlorhexidine (Jensen, 1967).

Staff. Nasal swabs were cultured from the staff of the departments involved in the attack. Carriers were treated with local applications of chlorhexidine and were excluded from the unit until negative cultures were obtained. Daily surveillance of the routine and special precautions instituted was carried out by the infection control nurse.

Effect of control measures

After day 32 no new infections amongst patients and staff were found. The burns unit was reopened on day 42. The five nasal carriers among the staff cleared within a week by local treatment. Nine of the infected patients received systemic treatment and their infections cleared within 10 days. The remaining patient could not be treated systemically due to his primary disease, and the resistant strains continued to be isolated from his wounds until his death from a heart attack on day 71. After this day the resistant strain was not isolated.

As a result of this outbreak all patients from countries other than Denmark are placed in isolation after admission until bacteriological examination confirms that they do not harbour similar multiply resistant strains. Four patients admitted from countries in the Middle East after the above outbreak were found to be carrying methicillin- and gentamicin-resistant *S. aureus* strains. As these patients were isolated on admission and received treatment as described above, no secondary spread of infection occurred.

DISCUSSION

Five patients admitted from Middle Eastern countries to our burns unit were found to harbour multiply resistant strains of *S. aureus*. An increase in the occurrence of resistant strains in this area could result from differences in antibiotic policy (Ridley *et al.* 1970; Falkow, 1975) as it is known that methicillin-resistant strains of *S. aureus* can be selected not only by the use of methicillin but also by the use of other antibiotics (Plorde & Sherris, 1974; Rosendal *et al.* 1977). The admission of a patient infected with a multiply resistant strain of *S. aureus* to our burns unit caused the outbreak described in this paper in which 10 patients were infected despite the restricted antibiotic policy and strict hygienic precautions in force in the unit.

This outbreak again demonstrated the very high susceptibility to infection of burned patients (Lowbury, 1972; Moncrieff, 1973; Ransjö, 1978) resulting from the loss of the skin barrier; the excellent medium for bacterial growth presented by the exudate from burn wounds; the failure of the humoral and cellular defence mechanisms to reach the infected surfaces because of the obstructed microcirculation; and finally by impairment of the functions of neutrophil leucocytes in burned patients. The inefficiency of hygienic precautions against transfer of infection when practiced as a routine was demonstrated. The major route of transmission in this outbreak was through staff, probably from clothing (Hambraeus, 1973*b*). *S. aureus* can be transmitted by air (Lidwell *et al.* 1975) but airborne transmission from room to room was not observed in this outbreak which is in accordance with previous observations (Hambraeus & Sanderson, 1972; Hambraeus, 1973*a*). Some patients were infected because the routine hygienic and isolation policies were disregarded, particularly in the instances where an infected and a non-infected patient were treated in the same room (Ransjo, 1978).

No estimate of the virulence of this resistant strain of *S. aureus* could be made because those patients infected were treated with fucidic acid and rifampicin – a very effective combination against methicillin-resistant staphylococci (Jensen, 1967). Indiscriminate use of these antibiotics, especially if used singly and not in combination, will undoubtedly induce development of resistance to them. If this should happen eradication of such a resistant strain will be extremely difficult. As a consequence local spread of infection within the burns unit might increase the virulence of the strain to such extent that infection might occur in patients less susceptible to infection than burned patients and thus cause serious outbreaks outside the burns unit.

To obviate this possibility we have introduced stricter hygienic precautions within the burns unit and admit to isolation all patients admitted from outside Denmark until bacteriological examination has confirmed the absence of strains of multiply resistant *S. aureus*. By isolation on admission we have detected four such infected patients, all from the Middle East, and have prevented further spread.

We recommend that this policy be adopted in all burn units and in departments treating patients similarly susceptible to infection.

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