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Infections in a hospital for patients with diseases of the skin

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SUMMARY

Studies on infections in a hospital for diseases of the skin are described. Patients were shown to acquire staphylococci in the groin and on the chest at about the same rate as in the nose. In contrast to surgical wards, many staphylococci were resistant to tetracycline but sensitive to penicillin. Nevertheless, much of the epidemic spread of staphylococci was with typical surgical-ward strains rather than with phage group II strains which might be thought typical of skin diseases.

INTRODUCTION

Much has been written on the incidence and mechanism of cross-infection in surgical patients and a little has been carried out on patients with diseases of the skin (Biro, Gibbs & Leider, 1960; Biro, Buchbinder *et al.* 1960; Selwyn, 1963, 1965; Hellerstrom, Linneroth & Nilzen, 1966). Such patients present many problems in the field of cross-infection for they may carry large numbers of potentially pathogenic bacteria on apparently normal skin; they may be admitted to hospital already carrying pathogenic bacteria on their lesions; and they may be more susceptible to colonization and infection whilst in hospital than are surgical patients.

This paper reports some of the findings which have emerged from studies on the transmission of organisms within a hospital for patients with diseases of the skin.

MATERIALS AND METHODS

During the period of this study the hospital had four wards each housing 16 or 17 patients. These wards were of the conventional open type. In addition, each of the two female wards had a single-bed side ward attached to it. The two wards for males, A and B, were on the ground floor and shared a treatment room situated between the two wards. Although there was no direct contact between the patients in this treatment room there was ample opportunity for airborne spread of bacteria to occur. One ward for females (C) was situated on the floor above wards A and B. The fourth ward (D) was in a different wing of the hospital. Wards C and D did not share any facilities.

Initially, patients were swabbed once a week, but this was later increased to

twice a week (Fig. 1) and throughout this paper the results are based on a twice-weekly swabbing regimen.

Because it seemed likely that patients would carry pathogenic organisms at sites other than the nose, the patients were swabbed in the nose, chest and groin using cotton-tipped swabs moistened with broth. An attempt was made to obtain true perineal swabs but this proved socially unacceptable and the groin was sampled instead. The chest was used as a convenient site of normal glabrous skin; skin lesions were avoided, an attempt being made always to sample normal skin. Swabs were inoculated on blood agar plates and incubated aerobically at 37° C. for 18–24 hr. Potentially pathogenic organisms were tested for sensitivity to a

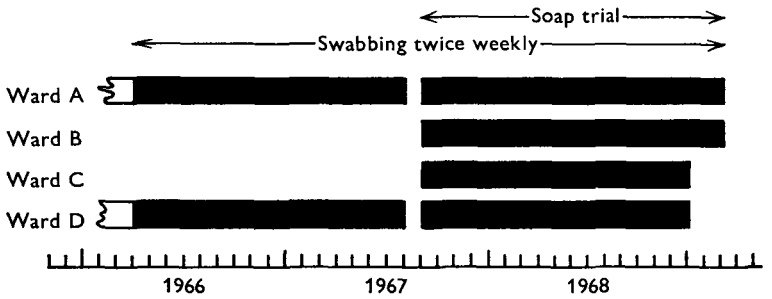

Fig. 1. Calender of investigation.

standard panel of antibiotics (penicillin, tetracycline, cloxacillin and neomycin in the case of Gram-positive cocci, and ampicillin, sulphonamides, thiosporin, colistin, gentamicin, furadantoin, kanamycin and soframycin in the case of Gram-negative rods) and subcultured on agar slopes. All tetracycline-resistant staphylococci were phage-typed. Pathogens isolated from routine clinical bacteriology specimens were treated in the same manner although tested with a greater range of antibiotics.

Upon discharge of a patient, details of treatment, diagnosis, age, etc., were abstracted from the patient's notes and all the data transferred to edge-punch cards.

During the second period of these investigations a trial of antibacterial soaps was carried out in the wards. Whilst this practice had a marked effect on the acquisition rates for *Staphylococcus aureus*, the effect was balanced between the wards and does not influence the results quoted here. The results of the soap trial are published separately (Wilson, 1970).

RESULTS

The individual wards differed slightly in the type of patient admitted (Table 1) and this was reflected in duration of the patient's stay in hospital. Two diagnostic categories, eczema and psoriasis, contributed more than half of the patients. Light-sensitivity patients, who had the shortest stay, were admitted mainly to wards B and D.

Carrier status

Table 2 shows the carrier status on admission for patients in the different diagnostic categories. Patients with eczema more often carried staphylococci on admission than did other patients, particularly in the chest and groin. The carriage of tetracycline-resistant staphylococci was greatest in patients with leg ulcers – this may be related to the prolonged therapy and multiple admissions sustained by these patients.

Table 1. *Distribution of diagnoses between wards*

	Distribution (%)					
Ward	Eczema	Psoriasis	Light sensitivity	Ulcer	Other	Total patients
A (male)	40	20	2	3	35	569
B (male)	30	27	9	1	33	276
C (female)	30	35	2	4	29	236
D (female)	21	28	8	6	36	467

Table 2. *Carriage of* Staphylococcus aureus *on admission*

	Carriage on admission (%)					
Staphylococcus	Eczema	Psoriasis	Light sensitivity	Leg ulcer	Other	Total
Nose S/PT	38	32	14	17	23	28
R/P	13	13	15	7	10	11
R/T	9	3	4	12	5	5
R/PT	6	3	3	7	5	4
Chest S/PT	32	15	11	2	12	16
R/P	11	7	6	0	7	6
R/T	5	2	3	14	3	3
R/PT	5	1	3	9	4	3
Groin S/PT	21	12	8	14	12	12
R/P	9	5	4	0	4	5
R/T	5	2	0	5	4	3
R/PT	4	2	3	10	4	3
Total patients	457	389	80	57	509	1492*

* Because of occasional weekend admissions, some patients were not swabbed on admission or within 48 hr. of admission and have been excluded from this analysis.

S/P, Sensitive to penicillin; S/T, sensitive to tetracycline; R/P, resistant to penicillin; R/T, resistant to tetracycline.

Acquisition of an organism was defined by the recovery on culture medium of six or more colonies of an organism not previously cultured from that site. The organisms were distinguished on the basis of their antibiotic-sensitivity pattern where phage typing was not carried out. This procedure probably seriously underestimates the acquisition rates for tetracycline-sensitive strains.

Acquisition at all sites proceeded at an even rate, the chance of acquiring an organism being linearly related to the duration of stay in hospital for about the first 4 weeks of stay, thereafter a drop in the rate occurred. In the two largest

homogeneous groups, eczema and psoriasis, acquisitions in the nose and in the groin proceeded at the same rates but eczema patients more often acquired staphylococci on the chest than did patients with psoriasis (Fig. 2). This may reflect fundamental differences in the 'normal' skin of these patients or it may be a consequence of the greater local environmental contamination of eczema patients. That chest acquisitions were not simply a reflexion of acquisition at other sites is demonstrated by the fact that 27% of the 483 chest acquisitions were of strains not carried on admission at any site or acquired in the nose or groin during the hospital stay.

Topical steroids are used extensively in the management of skin disease and it has not proved possible to analyse these results in terms of steroid prescription; 80% of patients received topical steroids, those who did not were mainly light-

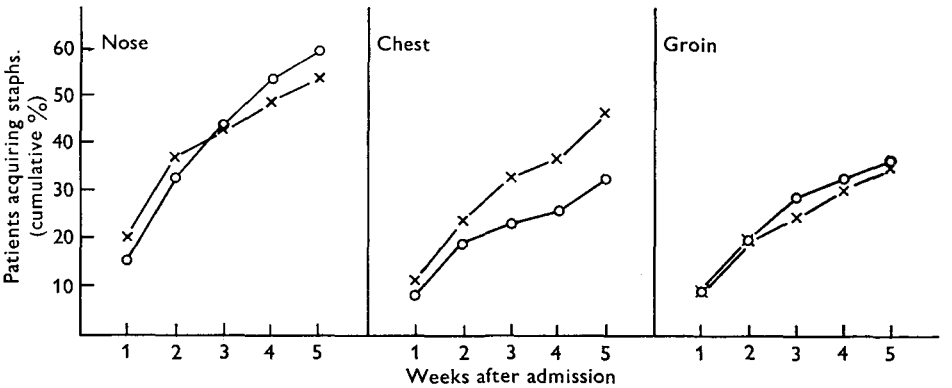

Fig. 2. Acquisition in nose, chest and groin in relation to hospital stay.
○, Psoriasis; ×, eczema.

Table 3. *Acquisitions in relation to antibiotic treatment*

Acquisition site	Antibiotic therapy	Acquisitions per 100 patient-weeks occurring after admission: 1–14 days		15–28 days		29+ days	
Nose	Topical	24	***	15	***	3	†
	Systemic	21		6		6	
	None	16		8		3	
Chest	Topical	17	***	12	***	4	†
	Systemic	15		8		4	
	None	10		5		3	
Groin	Topical	17	***	8	*	5	**
	Systemic	12		8		5	
	None	8		6		2	
Total patient-week contributing	Topical	304		256		170	
	Systemic	446		358		170	
	None	2322		1416		410	

Statistical significance: *** $P < 0{\cdot}01\%$; ** $0{\cdot}1\% < P < 1\%$; * $2\% < P < 5\%$; † not significant at the 5% level.

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sensitivity patients. An examination of the use of antibiotics has yielded an unexpected result however (Table 3); because it is almost inevitable that patients receiving antibiotics will have a longer stay in hospital than those not receiving antibiotics (the diagnosis and severity of the disease will influence both factors) the results are presented in the form of acquisition for various periods of hospitalization. It is curious that the giving of *topical* as well as systemic antibiotics should lead to increase in the acquisition rate, for topical preparations might be expected to act only locally. However, as shown in Table 4, the giving of any antibiotic increased the likelihood that a tetracycline-resistant staphylococcus would be acquired (45% of the tetracycline-resistant staphylococci were sensitive to penicillin, compared to 65% of the tetracycline-sensitive strains).

Table 4. *Acquisition of tetracycline-resistant staphylococci in relation to antibiotic therapy*

		Antibiotic therapy		
		Topical	Systemic	None
	Strain acquired	Acquisitions (%)		
Nose	S/T	50	46	65
	R/T	50	54	35
Chest	S/T	39	47	62
	R/T	61	53	38
Groin	S/T	37	36	51
	R/T	63	64	49
Total acquisitions		282	404	1038

S/T, Strain sensitive to tetracycline; R/T, strain resistant to tetracycline.

Infections and antibiotics

It has proved exceptionally difficult to define 'infection' or 'sepsis' in skin diseases (e.g. Noble, 1970) and in this paper the word infection refers to the isolation of potentially pathogenic bacteria from a swab submitted to the laboratory under the heading 'infected eczema', 'boil', 'infected ulcer', etc.

In all, *Staphylococcus aureus* was recovered from 64% of the infected lesions, but the lesions frequently yielded more than one 'pathogen'. Only one-third of the streptococcal lesions yielded a pure growth of streptococci, most being mixed with staphylococci, and nearly 10% of all lesions yielded both Gram-positive cocci and Gram-negative rods. However, it can be seen (Table 5) that there was a considerable change in the organisms isolated from these lesions over the short period of the survey. In the first period there was an accent on penicillin-sensitive staphylococci and on staphylococci resistant to tetracycline only. In the second period there was a shift towards penicillin-resistant strains. There was also a marked drop in the isolation of *Pseudomonas aeruginosa* in the second period, this may be attributed to the greater awareness of the problems of *Pseudomonas* infection (Noble & Savin, 1966; P. M. White, in preparation). The change in the staphylococci, however,

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may reflect changes in therapeutic preference (Table 6), for whilst there was no major change in the rate of prescribing antibiotics there was a swing to greater use of penicillin (penicillinase-*sensitive*) as a systemic antibiotic. In the topical antibiotics there was a change from neomycin to gentamicin and a reduction in the use of tetracycline, and these changes are reflected in the sensitivity of the bacteria isolated from the lesions.

Table 5. *Distribution of 'infections'*

% patients with lesions yielding:	1st period	2nd period
Staph. aureus		
S/PT	22	10
R/P	4	7
R/T	11	3
R/PT	3	5
β-Haemolytic streptococcus	9	7
Ps. aeruginosa	9	2
Proteus	3	2
Coliform-type organisms	2	3
Total patients	531	1100

S/PT, Sensitive to penicillin and tetracyline; R/P, resistant to penicillin only; R/T, resistant to tetracycline only; R/PT, resistant to penicillin and tetracycline.

Table 6. *Distributions of antibiotic prescriptions*

		No. of prescriptions	
Route	Antibiotic	1st period	2nd period
Systemic	Penicillin	16 (12%)	68 (30%)
	Orbenin + ampicillin	28 (22%)	41 (18%)
	Tetracycline	60 (46%)	100 (44%)
	Other	25 (19%)	18 (8%)
	Total	129	227
Topical	Tetracycline	49 (70%)	42 (45%)
	Neomycin	17 (24%)	1 (1%)
	Gentamicin	0	38 (40)
	Other	4 (6%)	13 (14%)
	Total	70	94
Total patients		531	1017

Epidemic spread of staphylococci

The phage-typing results for the tetracycline-resistant staphylococci were used to study the spread of organisms between and within the wards. As was expected, the two wards for male patients (A and B) shared their epidemic staphylococci – presumably via the treatment room. Each ward had several small episodes of spread of the type familiar from surgical ward studies. Only one strain became widespread in all four wards and this was a penicillin- and tetracycline-resistant strain of phage type 6/47/54/75/83A.

Most of the strains which were observed to spread were of phage group III and

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the remainder of phage group I or mixed group I and group III. No phage group II strains (which are the classic 'skin' strains) were observed to spread, although this may be an artifact due to the restriction of typing only the tetracycline-resistant strains. Nevertheless, nine patients carried tetracycline-resistant group II strains; one patient with eczema carried a penicillin- and tetracycline-resistant type 71 in the nose, chest, groin and skin lesions without this strain being recovered from any other patient.

DISCUSSION

The findings reported in this paper are remarkably similar to those published in the past on surgical-ward sepsis (e.g. Shooter *et al.* 1958; Williams *et al.* 1962) in relation to epidemic spread, type of infecting organism, etc., with the exception that many more tetracycline-resistant but penicillin-sensitive strains were encountered. In surgical wards such strains have formed less than 1% of the nasal staphylococci but in the skin hospital they accounted for more than 10% of the strains colonizing patients on admission to the wards. This doubtless reflects the use of topical tetracycline as a therapeutic agent; penicillin is not used for this purpose. Changes in the prescription of antibiotics during the period of study were reflected in the organisms isolated from infected lesions.

Few if any other investigators appear to have considered the skin as a possible site for colonization with staphylococci and indeed it may be that the results reported here apply only to patients with diseases of the skin. Nevertheless, in these wards carriage of staphylococci on areas of 'normal' skin was high and must be considered as a source of infection. It is a moot point whether the clinically uninvolved skin of a patient with extensive eczema or psoriasis can be considered 'normal'.

The definition of 'sepsis' in patients with diseases of the skin is difficult. In a rather subjective survey of clinicians' opinion (Noble, 1970) there was a tendency to equate severity of infection with the isolation of an organism resistant to two or more antibiotics and to regard those patients who suffered cross-infection as more severely infected than those who were self-infected. Since about 42% of the patients had some degree of colonization or sepsis of skin lesions, the problem is a considerable one. Although clearly there are factors other than sepsis which determine the length of hospital stay, in this series eczema patients who had no sepsis had a mean stay of 17 days whilst those with some degree of sepsis stayed 23 days in hospital; for psoriatics the figures were 23·5, and 34·5 respectively. These figures agree broadly with those published by the Public Health Laboratory Service (1960) for surgical patients, where the difference in hospital stay between those developing and those not developing sepsis was about 8 days.

The finding that much of the 'infection' was with phage group III staphylococci was unexpected, for the classic skin strains are those of phage group II. The type 71 strains of *Staph. aureus* in particular have been associated with impetigo (Parker & Williams, 1961) and more recently with toxic epidermal necrolysis (Lyell, Dick & Alexander, 1969). The phage group I has more frequently been associated with skin sepsis, for the classic type 80 strain first appeared in an out-

break of boils and other local sepsis in a general population (e.g. Rountree & Beard, 1958) and was found to be extensive in studies of skin patients in the U.S.A. (Greer, Menard & Livingood, 1961).

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