

Hair as a reservoir of staphylococci

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SYNOPSIS The occurrence of *Staphylococcus aureus* in the hair of the scalp was investigated in three groups: out-patients, in-patients, and staff of a general hospital. Bacteria were grown from the hair of all the subjects tested and *Staphylococcus aureus* was the commonest pathogen isolated. It was found more frequently in the hair than in the nose but 20% of hair carriers of *Staph. aureus* were not nasal carriers. In hospital staff and in-patients, the staphylococci were highly resistant to antibiotics, and phage types usually classified as 'hospital staphylococci' predominated. There were more staphylococcal post-operative wound infections in hair carriers than in non-carriers, and in three cases the *Staph. aureus* was of the same phage type as that isolated pre-operatively from the hair.

Since the turn of the century it has been customary for surgeons and nurses to wear caps in the operating theatre because it is accepted that bacteria are disseminated from the hair, but no work appears to have been carried out within recent years to find out if pathogenic organisms in fact are present, and to assess the number of individuals who carry them in the hair.

THE INVESTIGATION

The chance finding that *Staphylococcus pyogenes* could be cultured from human hair led to this investigation of the rate of hair carriage in hospital patients and staff as compared with nasal carriage in the same persons. Three groups were studied: (1) 100 out-patients attending hospital for the first time; (2) 422 in-patients before operation; and (3) 164 nursing and medical staff.

METHODS

SAMPLING OF HAIR Five per cent horse blood agar plates were pressed against the scalp so that the hair came in direct contact with the surface of the agar.

NASAL SWABS Both anterior nares were sampled with sterile cotton wool swabs moistened with sterile broth. These were inoculated on 5% horse blood agar medium.

BACTERIOLOGICAL METHODS Plates were incubated for 24 hours and the colonies of bacteria found identified by routine bacteriological methods. Coagulase-positive

staphylococci were phage typed using the basic set of 22 phages supplied by the Central Staphylococcal Reference Laboratory, Colindale. The resistance of *Staph. aureus* to penicillin, streptomycin, chloromycetin, aureomycin, terramycin, and erythromycin was tested by the disc technique using Sentests (Evans).

RESULTS

Not a single sterile hair plate was obtained from any of the subjects tested; the photograph demonstrates the numbers of colonies usually obtained on a hair plate after 24 hours' growth. Pathogenic bacteria (listed in Table I) were isolated from the hair in 72% of out-patients, 61% of in-patients, and 46% of medical and nursing staff. *Staphylococcus aureus* was the commonest pathogen found; other pathogens occurring in significant numbers were *Escherichia coli* and *Streptococcus viridans* whilst β haemolytic streptococci, the Proteus group, Freidlander's bacilli, *Pseudomonas pyocyanea*, and *Streptococcus faecalis* were found less frequently.

Table II, showing the carriage of *Staph. aureus* in the hair and nose, brings out the following points: In the three groups there were more hair carriers than nasal carriers. Hair carriage rates were 37% of out-patients, 40% of in-patients, and 27% of medical and nursing staff. A proportion of nasal carriers were not hair carriers and a proportion of hair carriers were not nasal carriers. The carriage of *Staph. aureus* was confined to the hair in 25% of out-patients, 20% of in-patients, and 12% of hospital staff whereas the number of nasal carriers who did not have *Staph. aureus* in the hair was 9%, 15%,

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and 21% in the three groups. Only a small percentage of those who were both nasal and hair carriers carried strains of the same phage type in both sites.

TABLE I

| Bacteria | PATHOGENIC BACTERIA ISOLATED FROM HAIR | | |
|---------------------------------|--|-------------|---------------------------|
| | Out-patients | In-patients | Medical and Nursing Staff |
| | No. | No. | No. |
| <i>Staphylococcus aureus</i> | 37 (37%) | 170 (40.3%) | 45 (27.4%) |
| <i>Escherichia coli</i> | 17 (17%) | 88 (20.9%) | 15 (9.1%) |
| <i>Streptococcus viridans</i> | 17 (17%) | 27 (6.4%) | 30 (18.3%) |
| Proteus group | 0 0 | 9 (2.1%) | 3 (1.8%) |
| β haemolytic streptococci | 4 (4%) | 7 (1.7%) | 1 (0.6%) |
| <i>Pseudomonas pyocyanea</i> | 1 (1%) | 0 0 | 1 (0.6%) |
| Freidlander's bacillus | 0 0 | 6 (1.4%) | 1 (0.6%) |
| <i>Streptococcus faecalis</i> | 0 0 | 1 (0.2%) | 0 0 |
| Numbers carrying pathogens | 72 (72%) | 257 (60.9%) | 76 (46.3%) |
| Total tested | 100 | 422 | 164 |

TABLE II

CARRIAGE OF *STAPHYLOCOCCUS AUREUS* IN THE NOSE AND HAIR

| Site of Carriage | Staphylococcus aureus | | |
|----------------------------------|-----------------------|-------------|---------------------------|
| | Out-patients | In-patients | Medical and Nursing Staff |
| | No. | No. | No. |
| Hair | 37 (37%) | 170 (40.3%) | 45 (27.4%) |
| Nose | 21 (21%) | 153 (36.3%) | 62 (37.8%) |
| Nose and hair | 12 (12%) | 89 (21.1%) | 26 (15.8%) |
| Hair only | 25 (25%) | 83 (19.7%) | 19 (11.6%) |
| Nose only | 9 (9%) | 65 (15.4%) | 35 (21.3%) |
| Same phage type in nose and hair | 8 (8%) | 42 (10.0%) | 10 (6.1%) |

PHAGE TYPING OF STAPHYLOCOCCI Examination of the results of phage typing revealed that no one lytic group predominated in out-patients in either nose or hair; in the case of in-patients a higher percentage of strains of lytic group III was found in the hair, whereas strains of lytic group I occurred most frequently in the nose. Amongst medical and nursing staff lytic group I staphylococci were the most prevalent in both sites (Table III).

TABLE III

PHAGE TYPES OF *STAPHYLOCOCCUS AUREUS* ISOLATED FROM THE NOSE AND HAIR

| Lytic Group | Out-patients | | In-patients | | Medical and Nursing Staff | |
|--------------|--------------|------------|-------------|------------|---------------------------|------------|
| | Nose | Hair | Nose | Hair | Nose | Hair |
| | No. | No. | No. | No. | No. | No. |
| I | 6 (28.6%) | 11 (29.7%) | 52 (35.3%) | 35 (20.6%) | 27 (43.5%) | 23 (51.1%) |
| II | 4 (19.0%) | 3 (9.1%) | 18 (11.8%) | 20 (11.8%) | 4 (6.4%) | 2 (4.4%) |
| III | 4 (19.0%) | 6 (16.2%) | 34 (22.2%) | 54 (31.8%) | 15 (24.2%) | 5 (11.1%) |
| I & III | 4 (19.0%) | 3 (8.1%) | 19 (12.2%) | 13 (7.6%) | 8 (12.8%) | 2 (4.4%) |
| IV | 1 (4.8%) | 2 (5.4%) | 0 0 | 0 0 | 0 0 | 0 0 |
| Not typable | 2 (9.6%) | 12 (32.4%) | 22 (14.4%) | 41 (24.1%) | 8 (12.8%) | 13 (28.8%) |
| Others | 0 0 | 0 0 | 8 (5.2%) | 7 (4.1%) | 0 0 | 0 0 |
| Total tested | 21 | 37 | 153 | 170 | 62 | 45 |

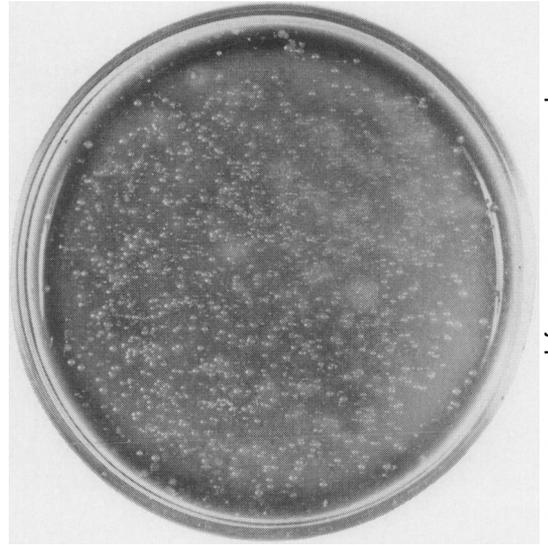


FIG. 1. Plate showing the numbers of colonies after 24 hours' growth.

RESISTANCE OF THE STAPHYLOCOCCI TO ANTIBIOTICS Almost identical resistance patterns to the six antibiotics tested were obtained from the strains isolated from the nose and hair of out-patients and in-patients, but the degree of resistance was less in strains from the nose; on the other hand, strains from the nose and hair of the medical and nursing staff were highly resistant to penicillin and streptomycin, and the incidence of resistant strains from the two sites was very similar (Table IV).

RELATIONSHIP TO WOUND INFECTION Twenty-two wounds were infected with staphylococci in the 422 in-patients studied (Table V). The number of staphylococcal infections in nasal carriers was less than in patients who did not carry *Staph. aureus* in the nose, and in only one case was a staphylococcus of the same phage type isolated pre-operatively

TABLE IV

ANTIBIOTIC RESISTANCE OF *STAPHYLOCOCCUS AUREUS* ISOLATED FROM THE NOSE AND HAIR

| Antibiotics | Resistant Strains of <i>Staphylococcus aureus</i> | | | | | |
|---------------|---|------------|-------------|------------|---------------------------|------------|
| | Out-patients | | In-patients | | Medical and Nursing Staff | |
| | Nose | Hair | Nose | Hair | Nose | Hair |
| | No. | No. | No. | No. | No. | No. |
| Penicillin | 8 (38.1%) | 19 (51.3%) | 59 (38.6%) | 87 (51.2%) | 51 (82.2%) | 40 (88.8%) |
| Streptomycin | 1 (4.8%) | 7 (18.9%) | 14 (9.2%) | 38 (22.4%) | 18 (29%) | 15 (33.3%) |
| Chloromycetin | 0 0 | 0 0 | 0 0 | 2 (1.2%) | 0 0 | 1 (2.7%) |
| Aureomycin | 2 (9.5%) | 10 (27%) | 14 (9.2%) | 40 (23.5%) | 12 (19%) | 12 (24.4%) |
| Terramycin | 2 (9.5%) | 10 (27%) | 12 (7.8%) | 39 (22.9%) | 12 (19%) | 12 (24.4%) |
| Erythromycin | 0 0 | 0 0 | 2 (1.3%) | 3 (1.8%) | 0 0 | 0 0 |
| Total tested | 21 | 37 | 153 | 170 | 62 | 45 |

TABLE V

CARRIAGE OF *STAPHYLOCOCCUS AUREUS* AND INCIDENCE OF POST-OPERATIVE WOUND INFECTIONS IN 422 IN-PATIENTS

| Subjects | Nose | Hair |
|------------------------------|-------------|-------------|
| | No. | No. |
| Carriers | 153 (36.3%) | 170 (40.3%) |
| Non-carriers | 269 (63.7%) | 252 (59.7%) |
| Infections in carriers | 7 (4.5%) | 13 (7.6%) |
| Infections in non-carriers | 15 (5.6%) | 9 (3.6%) |
| Total infections = 22 (5.2%) | | |

from the nose and from the subsequent wound infection. In hair carriers the incidence of staphylococcal wound infections was higher than in the non-carrier group, and in three cases staphylococci of the same phage type were isolated from the hair and from the wound infection.

CONCLUSIONS

Human hair is shown to harbour many pathogenic bacteria, particularly *Staph. aureus*, and hair carriers of this organism are at least as common, if not more prevalent, than nasal carriers. In the majority of people studied, carriage in the hair appears to be independent of passive transfer from the nose, because individuals who are not nasal

carriers were found to have *Staph. aureus* in the hair, and of the subjects who carried them in both sites in only a small minority were strains of the same phage type isolated from the nose and hair.

A large number of the staphylococci carried in the hair of in-patients, doctors, and nurses were highly resistant to antibiotics and belonged to lytic groups I and III, a combination often found in outbreaks of cross infection in hospitals (Williams, Blowers, Garrod, and Shooter, 1960).

These results show that the hair is a potential source of cross infection, and we recommend that it should be completely covered in both the patient and his attendants for minor surgical procedures or re-dressing of wounds as well as for major operations.

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