for keeping records, controlling the issue of cream, and much other help without which the investigation would not have been possible.

REFERENCES

- Colbeck, J. C., Robertson, H. R., Sutherland, W. H., and Hartley, F. C. (1959). *Med. Serv. J. Can.*, **15**, 326.
 Elek, S. D., and Fleming, P. C. (1960). *Lancet*, **2**, 569.
 Gillespie, W. A., Alder, V. G., Ayliffe, G. A. J., Bradbeer, J. W., and Wypkema, W. (1959). *Ibid.*, **2**, 781.
 Public Health Laboratory Service (1960). *Ibid.*, **2**, 659.
 Weinstein, H. J. (1959). *New Engl. J. Med.*, **260**, 1303.
 Williams, R. E. O., Blowers, R., Garrod, L. P., and Shooter, R. A. (1960). *Hospital Infection: Causes and Prevention*. Lloyd-Luke, London.
 — Jevons, M. P., Shooter, R. A., Hunter, C. J. W., Girling, J. A., Griffiths, J. D., and Taylor, G. W. (1959). *Brit. med. J.*, **2**, 658.

SELF-CONTAMINATION OF PATIENTS WITH STAPHYLOCOCCAL INFECTIONS

BY

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There is little doubt that staphylococci from an infective process in a patient or member of the staff of a hospital can be transferred to another individual in the same environment, and so parasitize his nose or an open wound. The exact route followed by the organisms from the donor to the recipient has not yet been determined, but it is probable that the first step in this process is transference of the organisms from the site of infection to the donor's skin, clothing, and bedding or objects in his vicinity. That such contamination can occur has certainly been shown regarding streptococcal infection of wounds (Willits and Hare, 1941) and of the throat (Thomas and van den Ende, 1941), and in the particular case of staphylococcal infections it has been found that hospital blankets may be contaminated by *Staph. aureus* (Blowers and Wallace, 1955; Schwabacher *et al.*, 1958), as may the floors of wards in which there are infected cases (Foster, 1960). There are also many other references in the literature to the presence of this organism on objects such as curtains and lockers in the vicinity of the infected cases. Nevertheless, little is still known of the number of organisms likely to be found on the person and bedding and in the environment generally of such patients, or the type of infection most likely to produce heavy and persistent contamination. The studies reported in this paper form part of an attempt to throw further light on these matters.

Methods

Sampling.—For infected processes, an ordinary cotton-wool swab was employed to obtain some of the exudate. A similar swab was employed to investigate nasal carriage, both nostrils being sampled with the same swab. Specimens from the skin were obtained by rubbing somewhat larger swabs soaked in broth over a 5-cm. square, giving an area of 25 sq. cm. For each hand one swab only

was employed, rubbed over both front and back of all the fingers and the thumb. Calculation showed that the total area sampled was about 150 sq. cm. The swabs, obtained as above, were rubbed over the whole surface of an agar plate. For the bedding, nightdress, or pyjamas, and the underclothing of ambulant patients, press-plates were employed, the fabric being sandwiched between the surface of the agar and a round wooden applicator (Ridley, 1959). The area investigated in this way was approximately 50 sq. cm. Sweep-plates (Blowers and Wallace, 1955) were employed for the outer clothing of the two ambulant patients, each plate being rubbed backwards and forwards the whole length of the garment. Specimens from the floor were obtained by the method described by Foster (1960), in which agar slabs, 50 sq. cm. in area, stiffened with bandage were applied direct to the floor and then returned to the lid of the Petri dish.

Isolation of *Staph. aureus*.—The medium employed for most of the estimations was ordinary nutrient agar, phenolphthalein phosphate agar (Barber and Kuper, 1951), used in previous investigations, having been found to possess no marked advantages. It was, however, found essential to allow the plates to stand at room temperature for 24 hours after the initial overnight incubation to permit the colonies to acquire their characteristic colour. The number of *Staph. aureus* colonies on each plate was then determined. Two, and when there was any doubt many more, colonies were picked and saved for examination after sub-cultivation. Ability to produce coagulase was confirmed by the slide method, and the strains were preserved on agar in bijou bottles until they could be phage-typed. This was carried out for us by our colleagues Dr. W. D. Foster and Dr. Eva Letchner, employing phage suspensions kindly supplied by Dr. R. E. O. Williams and Dr. Patricia Jevons, of the Central Public Health Laboratories, Colindale.

Results

Post-operative Infections

The results obtained with 10 such patients are given in Table I. The areas sampled in the case of two patients were, in general, heavily contaminated, and it is perhaps significant that these were the only really severe infections in the series. None of the remainder was mild or trivial, but there was very little contamination in the case of four, while the remaining four had some contamination, the distribution of which was patchy.

The surveys were all carried out on the third or fourth day from the time it had become evident that the wound was infected, but there was no indication that the contamination increased with the passage of time. Indeed, repeat investigations carried out with three patients (Table II) would suggest that it tends to remain stationary and then become less as the infection subsides.

Although all the patients were under treatment with antibiotics it is evident that this had not eliminated the infection, for heavy growths of *Staph. aureus* were in all instances obtained from the wounds. It is evident, therefore, that chemotherapy does not, in itself, reduce the risk of contamination.

Patients with an Infective Process Other than an Operation Wound

Eleven patients were studied, and it will be seen from Table III that there was very little self-contamination when the organisms were derived from such conditions

Ambulant Patients with Skin Infections

In addition to patients confined to bed, two individuals with skin infections who were ambulant were also investigated, one of them on several occasions. The results are given in Table V. The first (J.) had persistent staphylococcal infection complicating dermatitis of the little and ring fingers of both hands. He was treated in a variety of ways, but at no time were dressings applied. Surveys carried out at intervals over a period of 18 months showed that many areas of his skin and clothing were heavily contaminated by organisms of the same phage type as those found in the lesions. For no very obvious reason the condition began to clear up in the summer of 1960, and the fingers were completely free of infection at the time of the last survey in February, 1961, when no *Staph. aureus* were found anywhere. The second patient (P.) had mild furunculosis of the face which had not been treated. There was heavy contamination of his skin and clothing.

Since it has been shown in previous communications (Hare and Thomas, 1956; Hare and Ridley, 1958; Ridley, 1959) that a proportion of nasal and perineal carriers may contaminate their skin and clothing quite heavily, it became a matter of importance to determine whether individuals with an infection constitute a greater or lesser hazard. For this reason, Table V includes the results obtained in surveys of the four most heavily contaminated carriers so far encountered. Two (B. Y. and B. T.) were nasal carriers and two (H. N. and S. T.) were both nasal and perineal carriers. It is evident that, on the whole, carriers are less heavily contaminated than individuals with an exposed active infection.

Discussion

The results obtained in these investigations show clearly that, although patients vary considerably in their ability to contaminate themselves and their environment, no part of the patient himself, his clothing, his bedding, or the floor in his vicinity is likely to be free of

Staph. aureus if his lesion is such that it causes any contamination at all. In consequence, the organisms may be conveyed to any person who touches any part of the bed and its contents, or who is downwind when contaminated fluff from the bedding, scales from the skin, or dried secretions from the lesions are released into the air as a result of friction or movement.

In consequence, little is likely to be achieved towards preventing transfer of organisms from infected cases by employing measures such as replacement of woollen by cotton blankets and the use of antiseptics when they are laundered, and the treatment of floors by oil, because they deal with only a comparatively small part of the contaminated bed, its contents, and its environment.

It therefore follows that complete isolation or segregation of patients with lesions likely to produce severe contamination should, if possible, be the rule. But because few hospitals could undertake anything so drastic, it becomes necessary to establish a system of priorities so that whatever facilities are available can be used to the best advantage.

Our results would suggest that the most dangerous patient is one whose infective process cannot be contained within some form of dressing. The four patients with exposed infections of the skin who were being nursed in hospital, the two individuals with less extensive but similarly exposed lesions who were ambulant, the two patients with staphylococcal pneumonia who were coughing up masses of sputum, and the patient with severe diarrhoea due to enterocolitis were all in this category, whereas patients with surface infections which could be dressed, such as a boil, a varicose ulcer, or a bedsore, were much less heavily contaminated. All the cases of post-operative infection also had some form of dressing, and only two of these patients contaminated themselves to the same extent as did the non-surgical patients; it is therefore of some importance that these were the only patients who had large amounts of exudate in their dressings.

TABLE IV.—Number of *Staph. aureus* Isolated from Different Sites on Surgical Patients who were Nasal Carriers and whose Wounds were Free of Infection

Patient	Nose	Hair	Face	Chest	Abdomen	Fingers		Legs		Night-dress	Pillow	Sheet		Blanket		Floor	
						L.	R.	L.	R.			Top	Bot.	Top	Bot.	L.	R.
C. K.	∞	5	50	0	10	0	2	0	0	0	0	5	2	0	—	1	1
P. R.	∞	7	4	10	1	0	1	0	0	1	0	0	0	0	0	0	2
G. M.	∞	2	5	0	0	0	10	0	0	2	50	4	0	0	0	4	4
H. L.	∞	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G. N.	∞	0	0	0	0	0	0	0	0	0	4	0	0	0	1	0	0
S. S.	∞	0	14	0	0	0	0	0	0	0	0	7	4	1	2	1	0
Area sampled in sq. cm.	25	25	25	25	150	150	25	25	50	50	50	50	50	50	50	50	50

TABLE V.—Number of *Staph. aureus* Isolated from Different Sites on Ambulant Patients with Skin Infections and on Symptomless Carriers

Subject	Date	Nose	Hair	Face	Chest	Abdomen	Fingers		Leg		Perineum	Coat		Shirt	Trousers		Drawers		Lesion
							L.	R.	L.	R.		Front	Back		Front	Back	Front	Back	
J.	June '59	74	—	200	—	20	∞	300	30	4	100	12	7	4	300	300	∞	27	∞
	Sept. '59	1,000	177	220	—	38	∞	3	160	72	30	—	—	50	—	—	840	—	∞
	Feb. '60	76	118	120	∞	0	∞	∞	0	15	9	14	0	14	112	18	1,000	14	∞
	July '60	7	0	3	0	0	1	35	0	0	0	0	0	0	0	0	—	—	None
	Feb. '61	0	0	0	0	0	0	0	0	0	—	0	—	0	—	—	—	—	∞
P.		500	100	—	150	70	150	200	—	—	40	4	10	5	17	—	6	2	∞
B. Y.		∞	2	17	3	0	33	13	5	5	4	0	0	0	1	25	0	0	None
B. T.		∞	0	60	3	3	100	1	0	0	0	22	2	0	8	20	9	12	∞
H. N.		∞	100	—	8	0	65	6	30	1	2,000	55	5	55	49	22	8	9	∞
S. T.		∞	—	—	—	30	150	∞	12	12	∞	1	5	3	2	6	36	57	∞
Area sampled in sq. cm.		25	25	25	25	150	150	25	25	25	Sweep	50		Sweep	50	50			

Summary

Estimates were made of the numbers of *Staph. aureus* present on selected sites on the skin, clothing, bedding, and floor in the vicinity of patients suffering from various forms of infection by this organism. When the source of the organisms was a post-operative infection the numbers found were not large unless there was an unusually profuse discharge into the dressings. There was, similarly, little contamination when the organisms were derived from surface lesions, such as a bed sore, boil, or varicose ulcer, which, like the post-operative infections, were covered with a dressing. But extensive and heavy contamination occurred when the source of the organisms was secondary infection of a widespread dermatological condition, pneumonia, or enterocolitis, in none of which was it possible to cover the lesions with a dressing. This suggests that, since self-contamination to any marked extent is likely to occur only when the organisms cannot be contained within a dressing, it is the latter type of case that should be isolated or segregated when only limited facilities for this are available.

Our thanks are due to Dr. Eva Letchner for assistance with phage-typing, to Dr. W. D. Foster for the results obtained with one patient, and to the members of the staff of this hospital for allowing us access to their patients.

REFERENCES

- Barber, M., and Kuper, S. W. A. (1951). *J. Path. Bact.*, **63**, 65.
 Blowers, R., and Wallace, K. R. (1955). *Lancet*, **1**, 1250.
 Foster, W. D. (1960). *Ibid.*, **1**, 670.
 Hare, R., and Ridley, M. (1958). *Brit. med. J.*, **1**, 69.
 — and Thomas, C. G. A. (1956). *Ibid.*, **2**, 840.
 Ridley, M. (1959). *Ibid.*, **1**, 270.
 Schwabacher, H., Salsbury, A. J., and Fincham, W. J. (1958).
 * *Lancet*, **2**, 709.
 Thomas, J. C., and van den Ende, M. (1941). *Brit. med. J.*, **1**, 953.
 Willits, R. E., and Hare, R. (1941). *Canad. med. Ass. J.*, **45**, 479.

STAPHYLOCOCCAL SEPTICAEMIA IN A GENERAL HOSPITAL

BY

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There have been surprisingly few studies of staphylococcal septicaemia in hospitals in the United Kingdom. Some of the more important recent reports (all from overseas) have been those of Collins *et al.* (1956), Wilson and Hamburger (1957), Faber (1959), Finland *et al.* (1959), Hassall and Rountree (1959), Faber *et al.* (1960), and Smith and Vickers (1960). In all these studies emphasis has been placed on the properties of the infecting organism, but attention is also drawn to the frequency and seriousness of septicaemia caused by *Staph. aureus*. Even this point, however, is not generally conceded. Thus Florey (1958), from a study in the New York Hospital of 11,670 patients admitted during a six-month period, did not find a single case of staphylococcal septicaemia, and concluded that staphylococcal infections in her special study were probably not of serious import.

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Present Investigation

This paper gives an account of the incidence and prognosis of staphylococcal septicaemia as it occurred in a 360-bed general teaching hospital. The series carried a high mortality rate, and attention is drawn to the factors which appear to influence the incidence and outcome of the disease.

Collection of Cases.—The years 1950–8 were chosen for study. Care was taken to search for cases where the diagnosis was revealed only at necropsy. All cases accepted into the series had a history which was at least suggestive of septicaemia, and in addition grew a coagulase-positive *Staph. aureus* in pure culture from the blood either during life or after death. All fatal cases showed at least two metastatic foci of staphylococcal suppuration. Several cases would have been missed had not necropsy reports and much post-mortem material been examined in addition to the patient's clinical notes and laboratory blood-culture records. During the nine years the average bed complement was 367, and the average number of annual discharges 6,550.

Incidence.—A total of 49 cases were found. Tables I and II summarize the annual incidence and age, sex,

TABLE I.—Annual Incidence of Staphylococcal Septicaemia

Year	No. of Cases	Year	No. of Cases	Year	No. of Cases
1950	3	1953	2	1956	10
1951	2	1954	4	1957	9
1952	3	1955	9	1958	7

TABLE II.—Age, Sex, and Mortality Ratios

Age	No. of Cases	Male	Female	Deaths	Recoveries
0–10	7	2	5	5	2
11–20	1	1	0	0	1
21–30	6	4	2	4	2
31–40	12	5	7	11	1
41–50	6	2	4	6	0
51–60	8	3	5	7	1
61–70	6	3	3	5	1
71–80	3	1	2	2	1
Total	49	21	28	40	9

and mortality ratios. There appears to have been an increasing frequency of the condition since 1955.

Mortality.—The overall mortality was 40 deaths in a series of 49 (82%). The corrected ratio after excluding two home deaths and seven hospital transfers is 78%.

Duration of Symptoms.—The patients who recovered were those admitted to hospital with a history of a few days' duration only. All with a history of more than 21 days died. The duration of illness in hospital varied from one day to over one year.

Site of Primary Lesion.—There was presumptive clinical evidence of the site of the primary lesion in 37 cases: skin (non-surgical) in 13; respiratory tract in 10; central nervous system in 6; bone in 3; genito-urinary tract in 3; and cardiovascular system in 2. The nine recoveries included all three patients suffering from septicaemia with osteomyelitis. Involvement of the central nervous system or cardiovascular system was nearly always lethal and often clinically silent.

TABLE III.—Relation of Blood-urea Level in Staphylococcal Septicaemia to Prognosis

Highest Recorded Blood Urea	No. of Cases	Died	Recovered
<100 mg./100 ml.	7	5	2
101–500 "	11	11	0