PRE-OPERATIVE SEGREGATION OF PATIENTS IN A SURGICAL WARD

BY

R. A. SHOOTER, M.D., M.R.C.P.

B. T. THOM, M.B., B.S.

D. R. DUNKERLEY, M.B., B.Chir.

G. W. TAYLOR, M.S., F.R.C.S.

St. Bartholomew's Hospital, London

M. T. PARKER, M.D., Dip.Bact.

MADELEINE JOHN, B.Sc.

I. D. G. RICHARDS, M.B., B.Ch., D.Obst.R.C.O.G., D.P.H.

Cross-infection Reference Laboratory, Central Public Health Laboratory, London

Earlier investigations in St. Bartholomew's Hospital showed that wound sepsis rates were lowest in patients who did not carry *Staphylococcus aureus* in the nose during their stay in hospital, highest in those who acquired a staphylococcus in the ward, and intermediate in those who retained the strain they carried on admission (Williams *et al.*, 1962). Wound sepsis might therefore be reduced if surgical patients could be shielded from the staphylococci prevalent in the hospital. In most British hospitals it is impracticable to isolate every patient throughout the whole of his stay. This paper describes our experience with a simple method of segregation, designed to protect surgical patients from contact with endemic hospital staphylococci during the pre-operative period. Briefly, a male surgical ward was divided by a partition into a pre-operative and a post-operative section. The intention was that the patients should, with certain exceptions, be admitted to the pre-operative section and kept there until their departure for the operating-theatre.

Methods

The Ward.—A surgical ward was divided by a wood-and-glass partition, reaching from floor to ceiling, into a pre-operative side containing nine beds and a post-operative section containing 13 beds (see Plan). No artificial ventilation was in use in the main part of the ward, but there were two ventilated isolation cubicles (see Williams *et al.*, 1962) on the post-operative side. The sliding doors at each end of the pre-operative section were kept shut when not in use. Separate bathrooms and lavatories were available for each side of the ward, but patients from the pre-operative side had to cross part of the post-operative section to reach those allotted to them. The nursing staff was common to the two sides.

The Patients.—Whenever possible, patients were admitted to the pre-operative side, unless they (1) came from another

ward, (2) had been in hospital during the previous year, (3) had a septic lesion, or (4) were emergencies for immediate operation. They were instructed not to mingle with the post-operative patients. At the end of the operation, patients were returned from the theatre to the post-operative division. Transfer to the post-operative side

was otherwise supposed to occur only if a patient acquired a tetracycline-resistant strain of *Staph. aureus*. All such patients were treated with nasal inunctions of a cream containing chlorhexidine and neomycin and supplied with hexachlorophane soap for washing. Whenever possible they were placed in one of the two ventilated cubicles.

Bacteriological Investigations.—A nasal swab was taken from each patient on admission and thereafter at weekly intervals, and also on the day of operation. Appropriate specimens from any form of clinical infection were examined bacteriologically. Nasal swabs were taken weekly from surgeons, nurses, students, and domestic staff. Coagulase-positive staphylococci were regarded as *Staph. aureus*, and were phage-typed and tested for resistance to penicillin and tetracycline. Air sampling was carried out simultaneously on both sides of the ward for one hour three times a week, using slit samplers which collected 108 cu. ft. (3 cu. m.) of air per hour.

Results

We made observations on 412 patients, of whom 276 were first admitted to the pre-operative side and 136 to the post-operative side. The scheme was more difficult to work than we had anticipated. There was often need for post-operative beds at a time when there were not enough patients awaiting operation to fill the beds on the pre-operative side. Therefore, 102 of the 205 patients admitted to the pre-operative side and subsequently operated upon were returned from the theatre to the same side, and only 23 of them were later transferred. At other times the pre-operative side was full, and 40 patients were first admitted to the post-operative side for this reason only.

The investigation lasted for 10 months. We tried to assess the effectiveness of our ward division by considering how it interfered with air movements between the two sides, by comparing the staphylococci isolated from the air of the two sides, by recording the acquisition of new strains of staphylococci by patients in the two sections of the ward, and by observing the sepsis rate.

Air Movements

On 211 occasions observations were made of the direction of air movement around the doors between the two parts of the ward, using titanium tetrachloride smoke. On 112 (53%) of these occasions there was a substantial flow of air from the post-operative to the pre-operative side and only on 36 (17%) was the flow reversed. The air movement was slight and irregular on the remaining 63 occasions (30%).

Measurements were also made on two occasions of the extent to which a gas tracer (nitrous oxide) liberated on the post-operative side reached the pre-operative side when the air flow was in this direction. The exposure to tracer (Lid-

Plan of divided ward.

well, 1960) recorded on the pre-operative side was about one-third of that found on the post-operative side. This differs very little from the fractional exposure found at this separation in a room of the same size without any partition.

Staphylococci in the Ward Air

Air sampling was carried out on 133 days; up to five colonies of *Staph. aureus* from plates exposed on the post-operative side and all colonies from those on the pre-operative side were isolated and phage-typed. Each air strain was matched, where possible, with strains from patients or members of the staff. Some strains could have had more than one source, and the most likely source was selected by giving preference to (1) patients over staff, (2) patients on the same side over those on the opposite side, (3) patients on the post-operative side over those in isolation, (4) patients in the ward at the time of sampling over those recently discharged, (5) the nose as a source over wounds or other sources of sepsis (but secondary to 1-4).

By these criteria it appeared that the patients in both divisions of the ward contributed more staphylococci to the air of the same side than of the opposite side, but that there was a considerable exchange of strains between the two sides (Table I). The evidence suggested that staphylo-

TABLE I.—Probable Source of *Staph. aureus* Strains Found in the Air. Percentage of Strains in the Air of the Pre-operative and the Post-operative Side Thought to Have been Derived from the Sources Shown

	Pre-operative Patients	Post-operative Patients	Patients in Cubicles	Staff	No Source Found
Air on pre-operative side	34	28	2	12	24
„ post-operative „	9	50	6	13	22

cocci were carried from the post-operative to the pre-operative side more frequently than in the opposite direction. Thus 28% of the strains isolated from the air of the pre-operative division appeared to come from patients on the post-operative side, but only 9% of the air strains in the post-operative division could be traced to patients on the other side. There was no difference between the two sides of the ward in the mean air count of *Staph. aureus*, or in the proportion of strains that were resistant to penicillin or to tetracycline.

Acquisition of Nasal Staphylococci

Ninety-five strains of *Staph. aureus* not found in the admission swab were isolated subsequently from 82 of the 412 patients; 30 of these strains were acquired when the patients were on the pre-operative side and 65 on the post-operative side. The apparent rate of acquisition of new strains was 1.42 per 100 days of exposure on the pre-operative side and 1.70 on the post-operative side. These "apparent acquisitions" probably included, as well as true acquisitions of new strains, a number of instances in which the admission swab was negative because an organism could be isolated only intermittently from the nose. The effect of intermittency of isolation on the apparent rate of acquisition of new strains was naturally greatest in the early part of the stay in hospital. For this reason the apparent isolation rate was probably inflated by intermittent isolation more on the pre-operative than on the post-operative side. Colonization with tetracycline-resistant strains, moreover, was more than twice as common in the post-operative division (0.60 per 100 patient-days) as in the pre-operative division (0.28 per 100 patient-days).

The probable source of the "acquired" strain could be identified in only 40 of 95 instances (Table II). Thirty-three of the apparent acquisitions for which no source could be found were observed within seven days of admission, and there was good reason to believe that most of

TABLE II.—Apparent Nasal Acquisition of *Staph. aureus*

	No. of Patient Days of Exposure	Strains of <i>Staph. aureus</i> Apparently Acquired					
		Total No.	No. Penicillin-resistant	No. Tetracycline-resistant	Probable Origin		
					Pre-op.	Post-op.	Not Known
Pre-operative side	2,112	30	16	6	5	4	21
Post-operative side	3,822	65	44	23	3	28	34

them were examples of intermittent isolation. In another investigation, in which the patients were in cubicles and true acquisition was infrequent, we found a change from positive to negative, or the reverse, in approximately 10% of all pairs of successive nasal swabs. A similar intermittency of isolation in the present investigation would account for most of the apparent acquisition for which no source was found. When an organism was acquired in the pre-operative division, and the source could be identified, it was almost as often on the post-operative as on the pre-operative side. In the post-operative division, on the other hand, most of the known sources from which organisms were acquired were on the same side of the ward.

Sepsis

Of 257 patients operated upon, 14 (5.4%) developed staphylococcal wound sepsis; other forms of staphylococcal infection occurred in 16 of the 412 patients in the ward (3.9%). Nine of the 30 lesions—including five wound infections and four others—were due to an organism carried by the patient on admission to hospital.

The nine staphylococcal wound infections due to organisms acquired in hospital included one thought to have been derived from a surgeon in the theatre, one from a ward nurse, and four from patients on the post-operative side; three could not be traced. There was no instance of a patient developing wound sepsis with a staphylococcus acquired in the pre-operative section before operation.

Seven of the 12 other staphylococcal infections with organisms acquired in the hospital occurred in the post-operative section; two of them were derived from other patients on the same side and five were untraced. Five were in patients in the pre-operative section, but one of them had recently been transferred from the other side; of the remaining four infections, three were due to organisms from the post-operative side and one was untraced.

Twenty-six patients already had septic lesions due to *Staph. aureus* when admitted to the ward. They were all nursed in the post-operative side, and no later septic lesions could be attributed to their organisms.

Discussion

It is now clear that no single measure can be expected to exert more than a marginal effect on the sepsis rates we observe in St. Bartholomew's Hospital, because the infections we fail to prevent arise from a number of sources, and are acquired in various ways (Williams *et al.*, 1962). A sufficiently large number of them, however, are due to antibiotic-resistant staphylococci acquired from other patients in the hospital to make some form of

isolation policy essential. It is equally clear that such a policy must be one that will be applicable, with a minimum of expenditure on structural alterations, to the old-fashioned large wards in which we are destined to work for many years to come. Our earlier attempts to influence the sepsis rate by isolating in cubicles with controlled ventilation all carriers of tetracycline-resistant strains of *Staph. aureus* gave encouraging results (Williams *et al.*, 1962). They indicated, however, that many more than four cubicles would be needed for each 25-bedded ward, and that even with close and continuous bacteriological control it was very difficult to detect and isolate carriers of dangerous strains quickly enough to prevent the spread of infection.

The idea was attractive that, by segregating as a group those pre-operative patients not likely to harbour hospital staphylococci on admission, we might increase their chances of reaching the operating-theatre without acquiring a dangerous strain. It seemed possible that this could be done with a minimum of alteration of the ward, without greatly increasing the work of the nurses, and it could eventually be adopted without detailed bacteriological control.

Our aims were not realized. In the first place the proportion of pre-operative to post-operative patients fluctuated widely, and the allocation of a substantial minority of patients to the wrong side could not be avoided. Secondly, the movement of air and of airborne staphylococci between the two sides was considerable. Possibly because of the direction of the prevailing wind, the drift was more often from the post-operative to the pre-operative side than in the opposite direction. Another factor was the general direction of the movement of air throughout the hospital block, which was upwards in the stair-well and outwards through the wards on the upper floors (Lidwell, 1961), including the one in which our experiment was conducted. Since the post-operative side communicated directly with the stair-well through doors that were usually kept open, air from the rest of the hospital tended to drift through the post-operative into the pre-operative division. It is not surprising, therefore, that there were many staphylococci in the air that we were unable to ascribe to particular carriers in the ward.

On the credit side, nasal colonization with tetracycline-resistant staphylococci was more than twice as common in the post-operative division as in the pre-operative side, and no patient developed wound sepsis with a staphylococcus acquired in the pre-operative side before operation. These results might, however, have been less satisfactory if it had not been our policy to remove carriers of tetracycline-resistant staphylococci from the pre-operative side as soon as they were recognized. Before abandoning the divided ward as a means of reducing the acquisition of hospital staphylococcus by patients, we propose to investigate the effect of controlled ventilation of the existing pre-operative side.

Summary

A 10-months study has been made of a surgical ward divided by a simple partition into a pre-operative section and a post-operative section, with the intention of shielding patients from hospital staphylococci before operation.

Observations were made of air movements between the two sections, of the number of staphylococci in the air, of the rates of nasal colonization by staphylococci, and of sepsis rates.

It was found that because of fluctuations in the numbers it was difficult to allot patients to their correct section of the ward. Pre-operative isolation was only partial, possibly because there was considerable movement of airborne staphylococci between the two divisions of the ward. Nasal colonization, however, with tetracycline-resistant staphylococci was more than twice as common in the post-operative section as in the pre-operative section, and no patient developed wound sepsis with a staphylococcus acquired before operation.

We would like to thank the sister and nursing staff of the ward for their willing co-operation, and Dr. O. M. Lidwell for carrying out the gas-tracer experiment. We are indebted to the Medical Research Council and to the Treasurer and Governors of St. Bartholomew's Hospital for a grant in support of this work.

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DEVELOPMENT OF AN EARLY TREATMENT UNIT FROM AN OBSERVATION WARD

BY

D. R. BENADY, M.B., B.S., D.C.H., D.P.M.
*Formerly Senior House Officer**

JOHN DENHAM, M.D., D.P.M.
Consultant Psychiatrist

St. Clement's Hospital, London

The Mental Health Act of 1959 provides for all psychiatric hospitals to receive patients for a period of observation which has been increased from 17 to 28 days. This has changed the formal status of the observation wards situated mainly in the poorer municipal hospitals or Poor Law institutions of the great cities and of the few county mental hospitals which were recognized to receive patients under Section 20 and 21 of the Lunacy Act, 1890. In practice, however, the need for beds to receive the acutely disturbed patient continues and admissions to the emergency units have changed little, as is shown below.

This paper describes the influence of the Mental Health Act, 1959, on admission, management, and immediate out-

come of psychiatric patients admitted to St. Clement's Hospital Emergency Unit in 1960-1 and compares them with those of 1955-6.

It also describes how psychiatric treatment has influenced the traditional role of the observation ward from diagnosis and disposal towards a short-stay treatment unit. Only when this traditional anomaly has been superseded by active treatment and discharge home will the emergency unit provide significant data for the placing of short-stay units in general hospitals and elsewhere.

Mapother (1929) recognized that only two-thirds of all patients required mental hospital care and treatment, while the present study shows that this proportion can be halved. Eilenberg *et al.* (1962) ably reviewed the history and the

*Now Registrar, Long Grove Hospital, Epsom, Surrey.