The dispersal of organisms from minor septic lesions

B. T. THOM AND R. G. WHITE

From the Department of Bacteriology, St. Bartholomew's Hospital, London

SYNOPSIS Air sampling during the incision of 40 septic lesions did not produce any evidence of dispersal of pathogenic bacteria.

The removal of dressings in a sterile dressing-box was associated with the dispersal of both pathogenic and non-pathogenic bacteria. From 45 dressings the average total bacterial count was 104 bacteria-containing particles per cubic foot. Thirteen out of 26 staphylococcal lesions dispersed staphylococci when the dressings were removed, the levels of staphylococci ranging from 0.3 to 33.3 colonies per cubic foot.

A proportion of minor wounds treated in out-patient departments fail to heal by first intention and become infected. Buchanan, Curwen, Shooter, and White (1961) working at this hospital studied 362 patients with clean incisions resulting from trauma or minor surgery. Forty-nine became infected (13.5%), and their period of attendance at hospital was double that of the uninfected patients. As a first stage of an investigation into the origin of out-patient sepsis attempts have been made to measure aerial contamination with bacteria during the surgical treatment, and subsequent dressing, of minor septic lesions.

MATERIALS AND METHODS

AIR SAMPLING DURING OPERATION The air was examined bacteriologically at the time of incision of septic lesions in the out-patient theatre. Sampling was begun when the patient entered the theatre and was continued for two and a half to five minutes, during which time the patient was prepared for the operation and anaesthetized with nitrous oxide and oxygen. A second air sample was then taken when the surgeon began the incision, and was usually continued for five minutes. The slit sampler employed collected air at a rate of 6.3 cu. ft. per minute; the inlet of the sampler was 30 in. above the floor and was situated as close as possible to the operation site, usually within 24 inches. During half of the operations settle plates were exposed for 10 to 15 minutes; two or three plates were placed on the floor at the side of the operating table, almost directly beneath the septic lesion.

DRESSING BOX In order that organisms liberated during the removal of dressings or the performance of wound toilet could be isolated, dressings were done in a box of inside dimensions $22\frac{1}{2} \times 18\frac{1}{2} \times 10$ in. and 2.4 cu. ft.

capacity. The box had a wooden framework, with the top and one side of Perspex, and was mounted on table. In two opposing sides of the box were double arm holes with rubber cuffs, so that the affected arm of the patient, and both arms of the dresser, could be inserted into the box and the cuffs sealed by tying. In the floor of the box was an air inlet consisting of a tube packed with sterile cotton-wool, and an outlet tube, diameter $1\frac{1}{2}$ in., which led directly to a slit-sampler. Air was sampled at a rate of 1 cu. ft. per minute. After use the inside of the box and the cuffs were wiped clean and sprayed with a solution of Cetrex (containing 0.5% cetrimide and 0.005% chlorhexidine). A control air sample was taken before each dressing manoeuvre after the arms had been inserted into the box. Swabs taken from the inside of the box before use were sterile. Smoke testing, using titanium tetrachloride, confirmed that air was being drawn through the cotton-wool filter, and was not entering through the sides, or cuffs, of the box. Air sampling outside and inside the box simultaneously confirmed that the filter was functioning.

DRESSING TECHNIQUE For the removal of dressings the outer bandages were usually removed by hand, and the inner dressings by sterile forceps. Fingers were frequently bandaged with Tubegauze and this was removed by cutting, rather than by unravelling the whole bandage. In dressing the wound a non-touch technique was employed. The hands of the dressers, neither of whom was a nasal or skin carrier, were tested both before and after the removal of dressings, either by swabbing with a dry swab or by pressing the fingers directly onto a culture plate.

BACTERIOLOGICAL METHODS Lesions were swabbed with dry cotton-wool swabs and plated onto 4% horse-blood agar plates. Air sampling in the theatre was performed on phenol-phthalein-phosphate serum agar plates which were incubated for 18 hours and the colonies counted and staphylococci recognized after exposure to ammonia vapour. Dressing-box air samples were taken on blood

agar plates; after incubation the plates were left on the laboratory bench for 24 hours before reading. Sensitivity tests were performed on all pathogens obtained, and staphylococci were tested for coagulase production. Coagulase-positive strains were kindly phage-typed by Dr. Jevons of the Central Public Health Laboratory.

RESULTS

AIR SAMPLING DURING OPERATION Forty patients were studied, all of whom were thought to have localized infection warranting incision and drainage. In 34 of the lesions pus was found to be present in varying quantities from a minute amount to 3 ounces. Seven of the lesions yielded sterile swabs, five with pus and two without; these were lesions that had been treated with antibiotics but had failed to resolve. The type of lesion and bacteria isolated are shown in Table I. The majority (27) of the infections were staphylococcal, and the staphylococci were almost equally divided into penicillin-sensitive and penicillin-resistant strains.

TABLE I

LESIONS INCISED IN MINOR OPERATING THEATRE

Type of Lesion	Total	Pus in Lesion	Staph. aureus in Lesion	Sterile or No Swab
Septic finger	16	14	12	3
Abscess	12	12	9	2
Boil	4	4	3	1
Miscellaneous	8	4	3	3

Abscess: Five axillary, four face or neck, one arm, one breast, and one abdominal wound.

Miscellaneous: Two sebaceous cysts, two ingrowing toe-nails, one haematoma, one septic blister, one antral wash-out, one infected corn.

The average total counts of organisms in the air of the theatre before and during operation are shown in Table II. The higher counts before operation are thought to reflect the increased activity during preparation for the operation. A close relationship was found between the number of persons present in the theatre and the total bacterial air count, the average count being twice as high when nine persons were present as when six were present (Fig. 1).

From the air samples taken during the operations

FIG. 1. Graph illustrating the relationship between the number of persons present in the theatre and the total bacterial air count.

on the 27 staphylococcus-infected lesions only 38 staphylococcus-containing particles were obtained. The highest level recorded was three staphylococcus particles in 31.5 cu. ft., and during 17 of the operations no staphylococci were isolated (Table II).

AIR SAMPLING IN DRESSING-BOX Sixty-five patients had dressings removed or wound toilet performed in the dressing-box. Of the 65 patients, 45 had the bandages and other dressings removed in the box and 20 patients had a previously exposed lesion dressed. The dressing procedure consisted of cleaning the lesion and removing pus; sodium sulphate or magnesium sulphate dressings were applied in 15 cases, and sutures were removed in five cases. The

TABLE II

AIR CONTAMINATION BEFORE AND DURING OPERATIONS ON INFECTED LESIONS

	Staph. aureus-infected Cases		Non-staphylococcal Cases		Total Cases	
	27 Before	During	13 Before	During	40 Before	During
Total number of cu. ft. sampled	757	824	375	394	1,132	1,218
Average total count per cu. ft.	13.6	8.8	10.7	8.6	12.6	8.8
Average <i>Staph. aureus</i> per cu. ft.	0.03	0.018	0.019	0.018	0.026	0.018
Ratio of <i>Staph. aureus</i> to total count	1 : 446	1 : 486	1 : 572	1 : 486	1 : 475	1 : 486

TABLE III

BACTERIOLOGY OF LESIONS DEALT WITH IN STERILE DRESSING-BOX

Type of Lesion	Staph. aureus	Staph. albus	Haem. Strep.	Coliform	No Swab	Total
Infected with pus	28	—	—	1	—	29
Infected without pus	10	4	1	2	2	19
Colonized	1	3	—	1	2	7
Sterile	—	—	—	—	—	10
Total	39	7	1	4	4	65

TABLE IV

RESULTS OF AIR SAMPLING IN STERILE DRESSING-BOX

		Control	All Cases	Infected		Sterile or Colonized
				No Pus	Pus	
Removal of Dressings	Number	45	45	19	16	10
	Average total air count	5	104	172.3	65.1	65.6
	Average <i>Staph. aureus</i> air count (<i>Staph.</i> cases only)	0	2	0.9	2.7	0
Performance of Dressings	Number	20	20	—	13	7
	Average total air count	9.4	10.3	—	12	6.6
	Average <i>Staph. aureus</i> air count	0	0	—	0	0

bacteria isolated from the lesions are shown in Table III.

Organisms were not released during the performance of dressings. The average count before dressing was 9.4 colonies per cu. ft. and while the lesion was being dressed it was 10.3 colonies per cu. ft. (Table IV).

When dressings were removed in the box there was considerable aerial contamination, with an average count of 104 colonies per cu. ft., ranging from 2 to 700 colonies per cu. ft. Most of the organisms released were not pathogenic, comprising micrococci, sarcinae, and coagulase-negative staphylococci; these organisms also predominated in the control samples.

In 26 of the 45 occasions on which dressings were removed the lesion was infected with *Staphylococcus aureus*, and on 13 out of these 26 occasions staphylococci were released into the air. The staphylococcal air count ranged from 0.3 to 33.3 particles per cu. ft. Six cases yielded less than 1 particle per cu. ft., five yielded 1 to 5 particles per cu. ft., and the two highest counts were 7.2 and 33.3 particles per cu. ft. Twelve out of the 13 staphylococcal strains isolated from the air were of the same phage type as that of the lesion. The one streptococcal lesion yielded 11 streptococcal colonies per cu. ft. The two coliform lesions both produced aerial contamination, but quantitative estimations were not performed.

The average number of bacteria recovered from each dresser's hand before the removal of dressings was 38.5, and after removing the dressings the average number was 105. After removing dressings staphy-

lococci were isolated from one or other hand on seven out of 28 occasions, with counts of only one to four staphylococcal colonies per hand.

DISCUSSION

In our investigations we found that only during the removal of contaminated dressings was there evidence of aerial dispersal of bacteria. There was no significant dispersal during the incision of septic lesions, or during the actual performance of wound toilet. This is in accord with the findings of Bourdillon and Colebrook (1946) during the removal of burns dressings in a dressing-room, when air levels of staphylococci up to 60 colonies per cu. ft. were obtained. Willits and Hare (1941) found that dressings contaminated with haemolytic streptococci, when slightly agitated, released these pathogens into the air, and more profusely from dry than from moist dressings.

The reason for the absence of aerial contamination is probably that the viscid pus, escaping from a boil or abscess, is not a suitable vehicle for the release of bacteria-containing particles. However, when the pus has dried on dressings, swabs, or protective towels the subsequent agitation of such material can dislodge bacteria into the air.

The use of the dressing-box enabled us to ensure that any bacteria collected from the air within were arising from the dressings and not from the clothes, or carrier sites, of patient or dresser. The highest level of staphylococci recorded, 100 colonies in 3 cu. ft., would produce a level of 0.025 colony per cu. ft.

if evenly dispersed in a room of 4,000 cu. ft. capacity. This is assuming that our sample of 3 cu. ft. extracted all the organisms from the box.

Even a small number of pathogenic staphylococci in the air present a risk of cross-infecting clean wounds, particularly if such clean wounds are exposed close to a patient having an infected dressing removed. The minimum number of staphylococci required to initiate wound infection is not known, although Foster and Hutt (1960) obtained infection in artificial skin lesions with doses of 15 cocci.

Our investigations showed that the hands of the dresser were contaminated with staphylococci in approximately 25% of instances during the removal of infected dressings. A more efficient method of

hand sampling might have shown a higher proportion to be infected.

We would like to express our gratitude to Professor R. A. Shooter for his help and encouragement in the preparation of this article. We would also like to thank the sister and nursing staff of the Out-patient Department for their cooperation. This work was performed during the tenure of a grant from the Medical Research Council.

REFERENCES

- Bourdillon, R. B., and Colebrook, L. (1946). *Lancet*, 1, 561 and 601.
Buchanan, J. McK., Curwen, M. P., Shooter, R. A., and White, R. G. (1961). *Brit. med. J.*, 2, 1678.
Foster, W. D., and Hutt, M. S. R. (1960). *Lancet*, 2, 1373.
Willits, R. E., and Hare, R. (1941). *Canad. med. Ass. J.*, 45, 479.