J. Hyg., Camb. (1980), **84**, 37
Printed in Great Britain

Evaluation of airborne operating room bacteria with a Biap slit sampler

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(*Received* 28 *November* 1978)

SUMMARY

A Biap slit sampler and a Casella Mk 2 slit sampler were studied in an orthopaedic operating theatre. Both showed similar bacterial counts in the range of 74–640 c.f.u. (colony forming units)/m³. During operations, an average count of 220 c.f.u./m³ (range 52–482) was obtained. A close relationship was demonstrated between the number of airborne bacteria and the frequency of traffic through doors.

INTRODUCTION

The airborne contamination of bacteria in operating units may be monitored by air samplers (Lidwell *et al.* 1970; Charnley, 1972; Aglietti, Salvati & Wilson, 1973). Unfortunately, the air suction devices used often produce excessive noise, and have sometimes been discarded because of this (Ostertag, 1973). The Biap slit sampler which we used, was fitted with an acoustic baffle.*

MATERIALS AND METHODS

The Biap sampler

This sampler collected air at the rate of 2·0 m³/h. The noise level according to the manufacturer did not exceed 54 dB, measured at 1000 Hz 1·3 m in front of the exhaust outlet. The agar plate stopped automatically after one rotation. A 1 h cycling time was used in these tests.

Operating theatre

The theatre which was reserved for clean orthopaedic operations was old-fashioned in design and lacked any ventilation system. When the air became too hot, fresh air was supplied by an open window. Patients and large pieces of equipment were brought directly into the room from the neighbouring corridor.

Media and cultivation

Blood agar plates (14 cm diameter) were used for bacterial collection. They were prepared from Blood Agar Base no. 2 (Oxoid) supplemented with 7% citrated

* Manufactured by Mikrobiologiska och Biotekniska Testprodukter AB, Malmö, Sweden.

0022–1724/80/0137–1978 $01.00

horse blood. The final pH was 7·6. After exposure, the plates were incubated overnight at 37 °C and one day at 25 °C before the total number of c.f.u. was determined.

Comparison of Biap and Casella samplers

A standard model Casella Mk 2 was run together with the Biap for eight series on 5 different days. The samplers were placed side by side. The Biap was run continuously. The Casella, which sampled 700 l of air per minute (according to the manufacturer), was run for 2 min in the middle of each 15 min period sampled by the Biap. The airborne bacteria were thus compared in samples of 0·5 and 1·4 m^3, collected with Biap and Casella respectively.

Regular monitoring

The Biap was employed regularly during operations for a period of 5 months, and the number of airborne bacteria determined on the basis of the bacterial count on plate sectors representing 0·5 m^3 air.

RESULTS AND DISCUSSION

Biap as compared with the Casella sampler

With the Biap and Casella samplers run in parallel, three samples showed less than 35 c.f.u. and two more than 1000 c.f.u. Cancelling these extremes together with two others suffering from sampling failure, 33 pairs of corresponding counts were left; these indicated bacterial concentrations between 74 and 640 c.f.u./m^3 air. These counts had a correlation coefficient of 0·98 and a t-test ($P < 0{\cdot}10$) of their difference proved insignificance. Low counts, which the Casella sampler, with its higher sampling rate, might be expected to estimate more accurately, were not under-represented, since seven of 33 count pairs fell in the range of 74–100 c.f.u./m^3. The difference in sampling time between the samplers did not influence the results appreciably, because the bacterial count did not vary much during the daily sampling period. Only a 12–72 % variation occurred relative to the daily minimum. On the basis of these results, it can be concluded that the two samplers gave equal results.

Regular monitoring

In regular monitoring of airborne bacteria during various operations with only the Biap, all except one count fell in the range where the Biap and Casella samplers offered equal results. Thus, the bacterial particle density determination of Biap (Table 1), were determined with the same confidence as with a Casella apparatus. The maximum count during an operation varied between 124 and 482 c.f.u./m^3, the minimum between 52 and 312 c.f.u./m^3, and the average between 114 and 375 c.f.u./m^3. On the average the maximum during operation was 276, the minimum 168, and the average 220 c.f.u./m^3. There was a great variation in the bacterial contamination from one operation to another. This may be ascribed

Table 1. *Bacterial contamination monitored by the Biap slit sampler during 49 operations*

	Contamination (c.f.u./m³)				
	Start	End	Max.	Min.	Average
Obs.	49	49	49	49	49
Max.	442	360	482	312	375
Min.	120	106	124	52	114
Average	248	218	276	168	220
S.D.	72·5	65·5	76·3	62·7	64·0

S.D. = standard deviation.

partly to the fact that the operating theatre lacked a good ventilation system, so that the stream of bacteria into the room from surrounding areas as well as the accumulated bacterial particles originating from the room activity could vary within wide limits.

The importance of this influence was examined by correlating traffic through the doors with contamination. Table 1 shows that the average number of airborne bacteria was greater at the onset than during, or at end of the operation. The frequencies of movement through the doors during the period of operation and during the preparation for operation were 15·4 ± 5·6 and 26·2 ± 7·4 passages/h respectively. The two frequencies were clearly different ($P < 0{\cdot}005$). Thus, it is reasonable to associate the high level of contamination at the start of the operation with a high level of traffic through the doors. The door traffic could have influenced the air

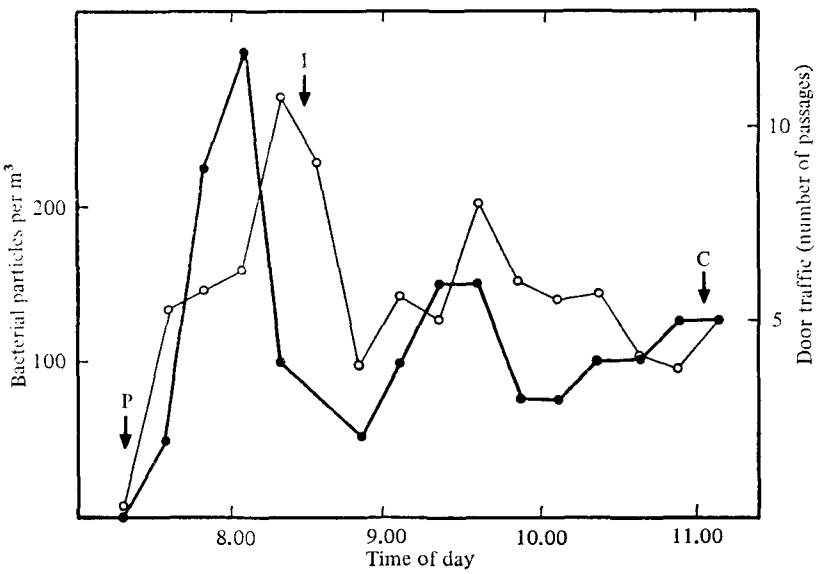

Fig. 1. Airborne bacterial contamination and traffic through doors before and during a hip joint replacement procedure. ○, Bacterial contamination; ●, traffic through doors. The start of preparing work and incision are marked P and I respectively, and the finish of closure, C.

https://doi.org/10.1017/S0022172400026498 Published online by Cambridge University Press

contamination directly by increasing the inflow of dirty air and by stirring up dust, as well as through movement within the room. The door traffic was closely associated with the amount of movement inside the room, and we suggest this is the most important factor.

In a few cases, the relationship between contamination and traffic was demonstrated very clearly during single operations (Fig. 1). Note that the changes in the level of contamination followed behind those of door traffic. All operations gave a correlation coefficient of 0·55 for the relationship.

On the basis of these results, it can be concluded that the Biap sampler is suitable for the monitoring of airborne bacteria in operating units.

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