OPTIMISATION OF ULTRACLEAN AIR

THE ROLE OF INSTRUMENT PREPARATION

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The use of ultraclean air (UCA) in operating theatres reduces the infection rate after joint replacement but some cases of infection still occur. We investigated one possible source of contamination, namely the setting up of instruments in a conventional plenum-ventilated preparation room.

We measured bacterial fallout using agar settle plates and compared instruments set up in the preparation room with those set up in the UCA theatre, assessed the effect of covering instruments after preparation and compared fallout during their preparation with total fallout throughout the operation.

Our findings showed that covering the instruments reduced total bacterial fallout fourfold by reducing the exposure time, particularly during periods of increased activity and bacterial dispersal. Preparation in the UCA theatre and subsequent covering of the instruments reduced total fallout 28-fold. All measurable bacterial fallout occurred during the setting up and not during surgery.

PATIENTS AND METHODS

We allocated to one of three instrument preparation groups 41 total joint replacements (27 hip, 14 knee) which were to be performed in a partially-walled, vertical, exponential laminar-downflow ultraclean air system (Howorth Exflow; Howworth Airtech Ltd, Bolton, UK).

In group 1 (n = 15) the instruments were prepared in the UCA theatre. In groups 2 (n = 14) and 3 (n = 12) they were prepared in a separate preparation room with conventional plenum ventilation. In groups 1 and 3 the instruments were temporarily covered once preparation was complete. Allocation to either group 1 or 2 was randomised using a random-number chart. By contrast, group 3, which was added later, was consecutive and assessed the effect of simply covering the instruments. The preparation of the instruments required the activity of two theatre personnel; one who was scrubbed and gowned setting out the instruments and the other unscrubbed and ungowned fetching and opening the packs.

Two sets, A and B, of four Petri dishes, 9 cm in diameter and containing nutrient agar, were used to mirror bacterial fallout on instruments. These were placed on a trolley next to the instruments and followed the movements of the instrument trolleys. Both sets were uncovered at the start of instrument preparation. In groups 1 and 3 in which the instruments were temporarily covered, the Petri dishes were also covered. Two control plates remained covered for the duration of the experiment. The plates were incubated at 37°C for 48 hours before colony counting by an assessor who had no knowledge of the group allocation. We also recorded the exposure times of the instrument sets.

Statistical analysis. We used a total of ten plates in each case, and calculated the mean values for set A, set B and the control plates; these were then used for subsequent statistical
analysis. Since the distribution of the data was not normal we used the non-parametric Kruskal-Wallis test.

RESULTS

The control plates were equally contaminated in the three groups (Kruskal-Wallis test, p = 0.82). The mean control value was 0.31 colonies per plate but exclusion of a single extreme value of 20 colonies on one plate produced a mean background level of contamination of 0.064 colonies per plate (median 0.0; range 0 to 1.5). Despite this extreme value the settle plate method still detected more contaminants on plates exposed during instrument preparation in UCA than in the control group (Mann-Whitney U test, p = 0.006).

Bacterial fallout during instrument preparation (set A) and during instrument preparation and operation (set B) was similar for all three groups separately and combined (Table I). Thus, all the bacterial fallout occurred during instrument preparation and there was no additional fallout on the instruments while operating in the UCA theatre.

The mean bacterial fallout during instrument preparation in groups 1, 2 and 3 was 0.20, 5.64 and 1.38 colonies per plate, respectively (Table I). Some of the observed colonies would have been due to background contaminants on the agar; thus any comparison between the groups will tend to be an underestimate. Nevertheless, our findings show that setting up instruments in the UCA theatre and covering them until the patient was transferred on to the operating table produced an overall 28-fold reduction in instrument contamination. By contrast, covering the instruments after setting them up in the preparation room produced only an overall fourfold reduction.

This observed reduction could have been due to the shorter periods of exposure of the groups in which the instruments were covered after preparation. The mean times for instrument preparation in groups 1, 2 and 3 were 24, 29 and 20 minutes, respectively, with shorter periods of exposure when the instruments were covered (ANOVA, p = 0.007).

The duration of instrument exposure in cases prepared in the preparation room, whether covered or not, correlated with bacterial fallout (Spearman’s correlation coefficient, \( r = 0.5 \), \( p = 0.007 \)). The longer the instruments were exposed the more the bacterial fallout. Thus, to assess the effect of instrument preparation without the effect of time of exposure, the bacterial fallout was expressed as bacteria per plate per minute. One case in the UCA preparation group was excluded from this analysis as the instrument preparation time was not recorded.

The instrument preparation environment strongly affected bacterial fallout (Kruskal-Wallis test, \( p < 0.0001 \)). The mean number of colonies per plate per minute for groups 1, 2 and 3 were respectively 0.0071, 0.1674 and 0.0729. These findings show that with the effect of time of exposure removed, instrument preparation in the UCA theatre still resulted in a 24-fold reduction in bacterial fallout when compared with that in the preparation room (Mann-Whitney U test, \( p < 0.0001 \)).

Covering the instruments after setting them up should not have influenced the rate of bacterial fallout in the preparation room and the measured colonies per plate per minute should have been the same. Nevertheless, this practice reduced the measured total bacterial fallout before surgery by half (Mann-Whitney U test, \( p = 0.008 \)).

DISCUSSION

The level of airborne contamination has been shown to correlate with subsequent infection of the prostheses (Lidwell 1988). We chose to use agar settle plates rather than volumetric air analysis because we felt that this would better represent bacterial fallout on to instruments during their preparation and thus instrument contamination.

Charnley (1979) advocated the use of sequential instrument trays during total hip replacement. Each tray contained only the instruments required for the next stage of the operation, and these were opened in the clean-air enclosure. This method, however, is not widely used nowadays, and furthermore, its importance in this respect was not quantified by Charnley.

The practice of preparing instruments in a conventional plenum-ventilated preparation room may be expected to result in some bacterial fallout and thus potential airborne instrument contamination, but the importance of this route of contamination is less obvious. Within the confines of our experimental design, our results suggest that this was responsible for nearly all the airborne instrument contamination during the whole period of preparation and surgery.

The covering of instruments after setting them up reduced
instrument contamination fourfold. Half of this benefit was due to the shorter instrument exposure time, and the other half was probably due to the shielding of the instruments during the increased activity and bacterial dispersal during the transfer of the patient to the operating table. Covering the instruments alone, however, is not the best method.

Instrument contamination as a potential route of infection was reduced 28-fold by preparing the instruments in the UCA theatre and then covering them until the activity of transferring the patient on to the operating table was complete. This procedure resulted in short delays between cases which could be prevented by providing ultraclean air in the preparation room. A less expensive alternative which would incur minimum delay would be a return to the sequential-tray system of Charnley, but our study suggests that the important part of Charnley’s method was the opening of the instruments in ultraclean air, and not the brief use and discarding of the instruments.

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REFERENCES


