

## DISPERSAL OF BACTERIA BY AN ELECTRIC AIR HAND DRYER

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### Summary

The potential risk of an electric air hand dryer contributing to airborne infection in a hospital was investigated using a strain of *Serratia marcescens* and a strain of coagulase-negative, streptomycin-resistant Staphylococcus. Dispersal of marker bacteria by the air dryer was demonstrated within a radius of about 3 feet from the dryer and to the investigator's laboratory coat. When paper towels were used for hand drying, no dispersal of marker bacteria was demonstrated. It is suggested that air hand dryers are unsuitable for use in critical patient care areas as they may contribute to cross infection either via airborne dissemination or via contaminated personnel.

Keywords: Air hand dryer, hospital cross infection.

### INTRODUCTION

Handwashing is generally considered to be the single most important procedure in the prevention of hospital infection. The purpose of most handwashing in patient care is to remove potential pathogens which have been acquired by contact with infected or colonized patients or their environment so that these diseasecausing microbes are not passed on to other susceptible patients. While much has been written about the use of different disinfectants for washing, there is little information on methods of hand drying after washing. It is not often realized that inappropriate methods of hand drying after the washing process may also contribute to hospital cross infection.

In most modern hospitals, disposable paper towels are used for drying hands but many hospitals with smaller budgets are still compromising with the use of cloth towels which are changed only once or twice a day. Electric air hand dryers are now widely used in public eating places and restrooms. It has been suggested that these may be preferable to multiple use cloth towels in hospital wards. However, there are reservations that these air-blowing devices may cause dispersal of nosocomials. This paper describes an investigation into the potential risk of the air hand dryer contributing to airborne infection in a hospital environment and attempts to compare bacterial dispersal by an air dryer with that caused by the use of paper towels.

### MATERIALS AND METHODS

#### Bacteria

The marker bacteria used are a strain of pigmented *Serratia marcescens*, maintained on agar slope for students' practicals and a strain of pigmented, streptomycin-resistant coagulase-negative staphylococcus (Staph SR). Staph SR was an environmental strain made streptomycin resistant by repeated subcultures in broth containing increasing concentrations of streptomycin sulphate (Glaxo) until the minimum inhibitory concentration of streptomycin exceeded 50 mg/l.

On the day of the experiment, a fresh suspension of bacteria was made to a density of about 10 organisms/ml by diluting an overnight broth culture 7-10 times for *S. marcescens* and 6-10 times for Staph SR.

#### Media

Overnight bacterial cultures were grown in Nutrient Broth (Oxoid) and diluted with normal saline. Blood Agar (Oxoid BAB) was used as settle plates and contact plates for the recovery of *S. marcescens*. Blood Agar containing 50 mg/l streptomycin sulphate was used as settle plates and contact plates for the recovery of Staph SR.

#### Hand dryer and paper towels

The electric air hand dryer used was Supreme (Scott and English Sdn Bhd) which had a no-touch mechanism and which operated automatically as soon as hands were held under the nozzle.

Paper towels for hand drying (23cm x 35cm, embossed variety) were from Scott Paper (M) Sdn Bhd, Johore, Malaysia.

### Test procedures

All tests were carried out in a hospital side room which layout is as shown in Fig. 1. The numerals 1 to 12 in the figure indicate the positions of settle plates. Plate 1 was placed on a sink positioned 1.5 feet immediately below the hand dryer. Plates 2 and 3 were placed about 1 foot to the left and right of plate 1. Three plates were placed in each of the remaining positions 4 to 12. All plates were left covered until the hand drying procedures were carried out.

Procedure 1: The investigator immersed both his hands (up to the wrists) in a suspension of marker bacteria contained in a beaker, allowed his hands to drip dry for about a minute then held them beneath the air dryer and gently rubbed them until they were completely dry.

Procedure 2: After immersing his hands in the bacterial suspension, the investigator washed his hands in the sink with soap and water for about a minute in the manner of a routine handwash by a nursing staff, before holding up his hands to drip dry and to dry under the air dryer.

Procedure 3: This is the same as for procedure 1 except that a paper towel was used for hand drying.

Procedure 4: This is the same as for procedure 2 except that a paper towel was used for hand drying.

At the end of each hand drying, plates 1, 2 and 3 were immediately incubated at 37°C. One set of plates 4 to 12 were collected at 1/2, 1 and 4 hours later for incubation at 37°C. The front of the investigator's laboratory coat was sampled with 4 contact plates each 28 cm<sup>2</sup> in area.

Each test procedure was carried out on a different day (at least a week after the previous test) with a single marker bacterium. The first 2 procedures were repeated twice for both *S. marcescens* and Staph SR. Procedures 3 and 4 were also repeated twice each but were carried out with *S. marcescens* only.

After incubation, plates were examined for the growth of the marker bacteria by standard bacteriological methods.

### RESULTS

Table 1 shows that when the air dryer was used, for both Staph SR and *S. marcescens*, there was limited dispersal from the contaminated hands to the settle plates directly beneath the dryer (plates 1, 2, 3) and within a radius of about 3 feet from the dryer (plates 4, 10, 11). Staph SR was dispersed a little more

widely than the *Serratia* as it was recovered from plates 4, 10 and 11 on all 4 occasions of testing while the *Serratia* was only recovered from plate 11 and only on 1 out of 4 occasions. Bacteria were deposited on plates 1, 2 and 3 during the drying of hands as these were incubated immediately after the drying procedure. It took more than 1/2 hour for the bacteria to settle on plates 4, 10 and 11 as the plates collected from these positions after 1/2 hour of exposure consistently showed no growth of the markers. Other plates were negative for the marker bacteria up to 4 hours of exposure.

On all occasions, marker bacteria were recovered from the front of the investigator's laboratory coat.

On the other hand, when paper towels were used, no growth of *S. marcescens* was obtained in any of the settle plates used on all 4 occasions when procedures 3 and 4 were carried out. Furthermore, the marker bacteria was not recovered from any of the contact plates used to sample the investigator's laboratory coat.

### DISCUSSION

Bacteria may be present on the hands as resident or transient flora. Unlike the resident flora which can survive and multiply on the skin and which are not easily removed by handwashing, transient flora picked up by recent contact with contaminated persons or fomites are quite readily got rid of by scrubbing with soap and water. However, as demonstrated in this study, a routine hand wash by medical health personnel often leaves behind sufficient bacteria for further transmission as, for instance, when cloth towels are repeatedly used for hand drying. This study presents some evidence that transient flora remaining on the skin can also be dispersed by air when an air dryer is used for hand drying.

In airborne transmission of disease, microbes may be disseminated in the form of infectious droplets, droplet nuclei or dust. The act of coughing or sneezing may expel droplets carrying respiratory tract pathogens. Aerosols from nebulizers, suction apparatus, shower heads and air-conditioning systems are important vehicles of airborne bacteria, particularly Gram-negative bacilli. Dust from floors, bedding and other fomites are more likely to carry Gram-positive bacteria which are less sensitive to the lethal effects of drying in the environment.<sup>3</sup> Particles projected into the air would eventually fall to the ground or on to some other surfaces. The distance travelled and the duration of suspension of

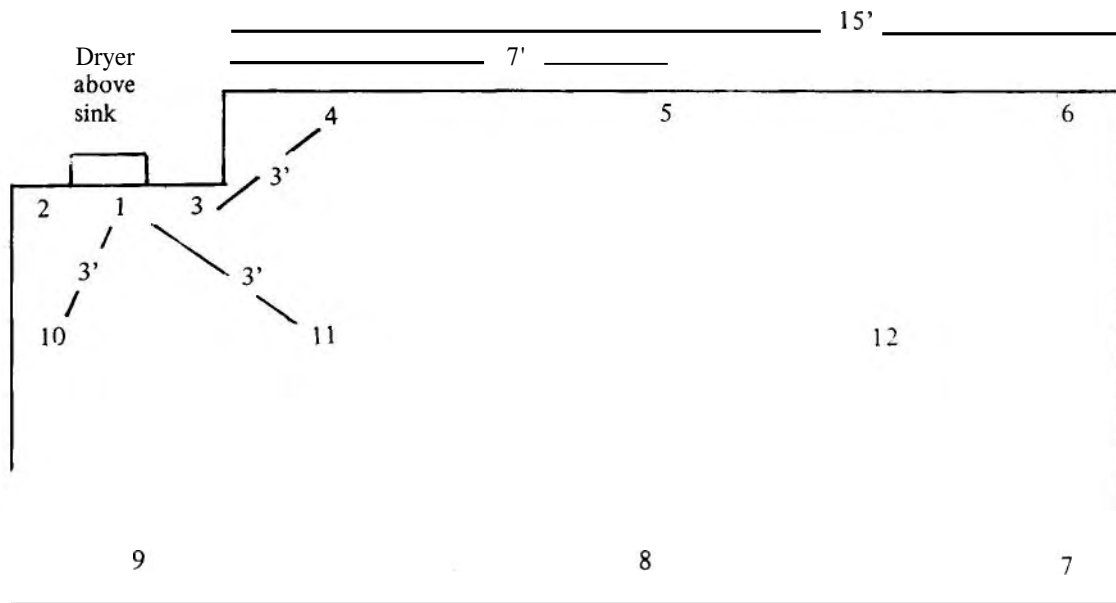


FIG. 1. Positions of settle plates in test room.

TABLE 1  
RECOVERY OF *S. MARCESCENS* AND STAPH SR FROM SETTLE  
PLATES AND CONTACT PLATES AFTER THE USE OF AIR HAND DRYER

Plate no.	Mean of 2 bacterial counts			
	Without handwashing		With handwashing	
	Serratia	Staph	Serratia	Staph
1	60	22	10	3
2	3	3.5	5	2
3	2.5	3	10	5
4	0	1.5	0	4
5-9	0	0	0	0
10	0	2.5	0	2
11	0	2	4	5
12	0	0	0	0
Total of 4 contact plate counts on laboratory coat	2	6	4	4

bacteria in the air depend on factors like air currents, the amount and type of human activity in the room and the size of the particles. The room used in this study is one with relatively light traffic and few draughts. Wider dispersal of the marker bacteria would probably be demonstrated had the tests been carried out in a more heavily utilized part of the hospital ward. Moreover, it has been shown that settle plate counts do not show smaller particles like droplet nuclei which do not settle.<sup>3</sup> Hence, the actual dispersal of marker bacteria in this study is likely to be greater than what was shown by the plate counts obtained.

There is a considerable risk of the person standing in front of the dryer acquiring the bacteria being dispersed in the air current directed towards him. The bacteria may be inhaled, resulting in nasal carriage or may be deposited on other parts of the person's body or clothing thus making him a potential mobile source of infection for susceptible patients. Dispersal of bacteria from the contaminated uniform of medical and nursing staff has been implicated as an important mode of spread of staphylococci in a well-ventilated, fully air-conditioned hospital.<sup>4</sup>

It could be argued that, since hand washing itself can create aerosols and contribute to bacterial dispersal, what was picked up by the settle plates and contact plates could have been contributed to by the hand washing procedure. However, there was no hand washing in procedure 1. Yet, the dispersal pattern after procedure 1 was similar to that obtained for procedure 2 which involved hand washing before drying. On the other hand, hand washing did not make any difference to the recovery of marker bacteria in procedures 3 and 4 when paper towels were used for hand drying although no special care was taken to minimize the amount of splashing during any of the hand washing procedures. This seems to suggest that the marker bacteria picked up after procedures 1 and 2 were carried in the air current generated by the air dryer. The non-recovery of marker bacteria in procedures 3 and 4 was somewhat unexpected as the use of paper towels can also cause bacterial liberation from the hands. This may reflect the difference between theoretical risks and actual risks in hospital infection practice.

In this study, no quantitative measurement was made of bacteria released into the air from the hands. Matthews and Newsom,<sup>5</sup> using a slit sampler, compared the use of 4 models of air dryers with the use of paper towels and found that air dryers caused the

same or less amount of bacterial dispersal as paper towels. In quantitative studies such as theirs, the background bacterial count in the room air and the bacterial count on the hands before drying can make a significant difference to the amount of bacteria picked up by the slit sampler. These factors are less important with the use of marker bacteria to trace the movement of bacteria in air currents.

Compared to the use of paper towels, there are other disadvantages with the use of the air dryer. Generally, it takes a longer time to dry hands with the air dryer. Impatient or busy staff may walk away before their hands are completely dry. This poses an infection risk as wet hands tend to harbour more bacteria than dry ones. When towels are used for drying hands, they can be used to turn off the faucet without recontaminating the hands. This advantage is lost with the air dryer. The mechanical friction of wiping hands on towels helps in the removal of residual bacteria on the hands. It seems reasonable that, with a good quality absorbent paper, a large proportion of the bacteria removed would be transferred onto the paper. With the air dryer, rubbing hands together to hasten drying would only lead to greater airborne dissemination. When wet hands are held up for drying under the air dryer, water dripping down to the elbows frequently occurs thus spreading organisms picked up by the hands to other areas on the arms. These associated infection risks plus the fact that many air dryers are noisy when in operation make these hand drying devices unsuitable for use in critical patient care areas.

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