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ORIGINAL ARTICLE

Assessment of the bacterial contamination of hand air dryer in washrooms

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Abstract The present study was carried out, using standard techniques, to identify and count the bacterial contamination of hand air dryers, used in washrooms. Bacteria were isolated from the air flow, outlet nozzle of warm air dryers in fifteen air dryers used in these washrooms. Bacteria were found to be relatively numerous in the air flows. Bacterially contaminated air was found to be emitted whenever a warm air dryer was running, even when not being used for hand drying. Our investigation shows that *Staphylococcus haemolyticus*, *Micrococcus luteus*, *Pseudomonas alcaligenes*, *Bacillus cereus* and *Brevundimonad diminuta/vesicularis* were emitted from all of the dryers sampled, with 95% showing evidence of the presence of the potential pathogen *S. haemolyticus*. It is concluded that hot air dryers can deposit pathogenic bacteria onto the hands and body of users. Bacteria are distributed into the general environment whenever dryers are running and could be inhaled by users and none-users alike. The results provide an evidence base for the development and enhancement of hygienic hand drying practices.

1. Introduction

Hand drying is the last part of the hygiene procedure in a public washroom; if the washroom is well-designed, the number of surfaces which the user subsequently touches will be limited or reduced to near zero. Hygiene of hands is an essential component for controlling the spread of infection (Larson, 1981; Lowbury et al., 1970). Wet hands can spread up to 1000 times more bacteria than dry hands (Smith and Lokhorst, 2009). This is because water transfers easily between surfaces and because bacteria thrive in damp environments (Redway and Fawdar, 2008). It is critical therefore, that hands are not contaminated with bacteria as the result of the drying process (Harrison et al., 2003).

Evidence regarding whether hand-drying methods vary in their tendency to aerosolize, and so transmit microorganisms,

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is conflicting (Taylor et al., 2000; Ansari et al., 1991; Matthews and Newsom, 1987; Blackmore and Prisk, 1984; Blackmore, 1989; Meers and Leong, 1989). Various studies recommend that drying hands with warmed air is connected with amplified aerosolization of microorganisms (Meers and Leong, 1989). However, others have recommended that there is small differentiation in aerosolization for the different drying methods (Taylor et al., 2000). Several studies have reported an extent in the numbers of bacteria through drying with paper towels compared with drying with a warm air dryer (Gustafson et al., 2000; Huang et al., 2012; Meers and Yeo, 1978).

Paper towels, hot air dryers, jet air dryers and cloth towels are the most frequently used means of hand drying in public washrooms. Snyder (1998) suggested that air dryers should not be used, as they accumulate aerosols from the toilets and then contaminate hands (Snyder, 1998). He refers to studies were the use of paper towels was shown to decrease the amount of bacteria on hands, while hot-air dryers increased contamination by some bacteria. Whether or not hot air dryers actually are worse than paper towels in this respect is debatable (Holah and Lelieveld, 2011) but what is clear is that hot air dryers are often slow and inefficient, leaving the hands of users moist and possibly still contaminated. Redway and Fawdar (2008) reported a notable increase of bacteria when using hot air dryers compared to when using paper towels; the latter generally led to a decrease in bacterial numbers (Redway and Fawdar, 2008). These authors stated that this is largely due to the fact that hot air dryers do not dry hands as effectively as do paper towels. The same study showed that although air dryers dry the hands as effectively as paper towels, they still increase the number of bacteria on the hands. Cloth roller towels are similarly not recommended essentially because they are low in capacity, and when a roll is finished, it becomes a common-use towel which many people touch and is therefore likely to increase the spread of pathogens (Snyder, 1998). Smith and Lokhorst (2009) refers to a recent study in which European respondents overwhelmingly (96%) considered hand paper towels to be the most hygienic way of hand drying (Smith and Lokhorst, 2009).

This work was assumed with the aim of evaluating the performance of warm air hand driers, in washrooms, in relation to bacterial contamination. First, the ability of warm air driers to dry hands hygienically was evaluated by measuring the number of microorganisms on different working days. Secondly, we determined if warm air driers do in fact alter levels of air-borne microorganisms in the washroom environment, as was suggested (Knights et al., 1993). Finally, the surfaces of warm air driers and other washroom areas were examined for total viable counts in order to determine if the use of air driers alters the distribution of bacteria. The results provide an evidence base for the development and improvement of hygienic hand drying practices.

2. Materials and methods

The fifteen air-dryers in the washroom of an academic institution in the Kingdom of Saudi Arabia were used to assess the bacterial contamination. The air-dryers were turned on for 30 s and the air was played onto nutrient agar medium in the petri dishes. The petri dishes were then incubated at 37 °C for 48 h and after incubation a total count of bacteria was calculated. Bacterial contamination of the surface was evaluated by placing petri dishes containing nutrient agar medium in a washroom for a period of ten minutes, followed by incubation at 37 °C for 48 h.

2.1. Bacterial isolates and Identification

Identification of bacterial isolates was performed using conventional methods (Murray et al., 2003) including, colonial morphology, culture characteristics on nutrient agar media. The gram staining of the isolates was also studied for identification of gram-positive and gram-negative bacteria to species level using the Vitek2^{R}Automated Microbiology System.

3. Results and discussion

Hand drying is an essential component of the hand sanitation development, which aims to optimize the removal of potentially pathogenic microorganisms that may be acquired through toileting and making use of bathrooms. The published confirmation regarding whether hand-drying methods may vary in their propensity to aerosolize and so transmit microorganisms is contradictory (Taylor et al., 2000; Ansari et al., 1991; Matthews and Newsom, 1987; Blackmore and Prisk, 1984; Blackmore, 1989; Meers and Leong, 1989). Some studies suggest that drying hands via warmed air is associated with increased aerosolization of microorganisms, and others suggest there to be no difference (Gustafson et al., 2000; Hennessy et al., 2007; Boyce and Pittet, 2002; Anderson et al., 2008; Garbutt et al., 2007). Methodological issues may explain these discrepancies.

The aim of the study was to determine the effect of the use of hand air dryers on microbial contamination of the washroom environment. Nutrient agar plates were exposed for 30 min in order to evaluate total viable counts on three days (Sunday, Thursday and Friday/Saturday). Control and exposure plates involved the same sampling time; therefore, they provide an indication of the contamination level before and after each trial and also indicate how contamination differed between the 3 days.

Table 1; Figs. 1 and 2 show that *Staphylococcus haemolyticus*, *Micrococcus luteus, Pseudomonas alcaligenes, Bacillus cereus* and *Brevundimonad diminuta/vesicularis* were emitted from all of the dryers sampled, with 95% showing evidence of the presence of the potential pathogen, *Staphylococcus*. The presence of these bacteria in the air flow of such a high proportion of warm air dryers and the increase in the numbers of these bacteria on the hands of the user demonstrate the potential for the spread of food poisoning organisms after

Table 1 Identities of bacteria detected after exposure to air-dryer for 30 s.

Bacteria isolated	Frequency of cfu isolated per sampling air-dryer (%)
Brevundimonad diminuta/vesicularis	3
Staphylococcus haemolyticus	52
Micrococcus luteus	29
Bacillus cereus	4
Pseudomonas alcaligenes	12