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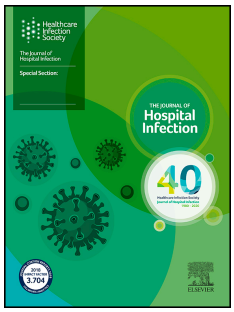

Impact of different hand drying methods on surrounding environment: aerosolization of virus and bacteria and transference to surfaces

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PII: S0195-6701(24)00099-9

DOI: https://doi.org/10.1016/j.jhin.2024.03.005

Reference: YJHIN 7186

To appear in: *Journal of Hospital Infection*

Received Date: 11 December 2023

Revised Date: 27 February 2024

Accepted Date: 9 March 2024

Please cite this article as: Hervé RC, Bryant C, Sutton L, Cox C, Gião MS, Keevil CW, Wilks SA, Impact of different hand drying methods on surrounding environment: aerosolization of virus and bacteria and transference to surfaces, *Journal of Hospital Infection*, https://doi.org/10.1016/j.jhin.2024.03.005.

Impact of different hand drying methods on surrounding environment: aerosolization of virus and bacteria and transference to surfaces.

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Running title: Aerosolization and transference to surfaces after hand drying.

Summary

***Background*:** In recent years, hand drying has been highlighted as a key step in appropriate hand hygiene (WHO 2009), as moisture on hands can increase transference of microorganisms from hands to surfaces and vice-versa.

***Aim*:** To understand bacterial and viral aerosolization following hand drying and study transference of microorganisms from hands to surfaces after drying using different methods.

***Methods*:** Groups of five volunteers had their hands pre-washed with soap, rinsed and dried then inoculated with a concentrated mixture of *Pseudomonas fluorescens* and MS2 bacteriophage. Volunteers entered, one at a time, an empty washroom and rinsed or washed (with soap) their hands prior to drying with a jet dryer or paper towels. Each volunteer also applied one hand successively to various surfaces, while their other hand was sampled using the glove juice method. Both residual bacteria and viruses were then quantified from the washroom air, surface swabs and hand samples.

Findings: Results showed *P. fluorescens* and MS2 bacteriophages were rarely aerosolized while drying hands, for any of the drying methods studied. Results also showed limited, and similar, transference of both microorganisms studied onto surfaces, for all drying methods used in this work.

***Conclusion*:** The use of jet dryers or paper towels produce low levels of aerosolization while drying hands in a washroom. Similarly, both drying methods result in low transference to surfaces. While the COVID-19 pandemic raised concerns regarding public washroom, this study shows that all methods tested are hygienic solutions to dry washed hands.

Keywords: hand hygiene; hand drying; transference from hands; bacteria; viruses; aerosolization; washroom; jet dryers; paper towels

Introduction

The importance of hand hygiene has been known since the 19th Century, when it was demonstrated that washing hands decreased the incidence of puerperal fever [1]. Several studies have shown that hand-washing with soap reduces the incidence of gastrointestinal and respiratory illnesses [2-4]. This is due to the removal of pathogens, which might have contaminated hands when handling raw food, visiting the toilet, etc. [1, 5].

The focus of hand hygiene in public places including clinical settings has mainly focused on washing, however in recent years hand drying has gained importance as an essential step in appropriate hand hygiene [6]. Indirect transmission of disease through fomites has been well documented [7] and moisture on hands can increase transference of microorganisms from hands to surfaces and vice-versa [8-10]. The most common hand drying solutions found near handwashing sinks are paper towels or electric dryers. Paper towels dry hands by absorbing water, while electric dryers dry hands through water evaporation due to a heated air flow (warm air dryers) or through removal of water by the action of high-speed air flow (jet dryers).

As handwashing facilities are used by several people, often simultaneously, it is important the hand drying method available is hygienic, i.e., does not re-contaminate hands or the surrounding environment. Previous studies showed that both jet dryers and paper towels have a limited effect on the number of bacteria and viruses in hands [11-13], meaning both methods are unlikely to re-contaminate hands. However, contamination of the surrounding environment, both air due to aerosolization or surfaces due to transference from hands through touch, is still an area of concern due to inconsistent research. A study in hospital washrooms in three different countries showed that the number of bacteria in the air were similar for washrooms with jet

dryers and paper towels, while most samples were negative for the presence of pathogenic bacteria [14]. Other studies showed similar numbers of bacteria quantified in air after drying hands with a jet dryer or paper towels. The experiments were carried out in a chamber with controlled conditions, suggesting the increase of airborne bacteria was due to people moving around the room and not due to drying hands, regardless the method [15, 16]. Recent studies reported that drying hands with electric dryers disperses bacteria and viruses in the air [17, 18], but the methodology used has been assessed as unrealistic as it employed gloved and unwashed hands and results did not show any health risk [19].

Different hand drying solutions might result in different levels of transference, but little is known. A recent study showed more transference when hands were dried with hand dryers compared to paper towels [20], however like the studies above it used gloved and unwashed hands and studies with more realistic conditions are needed to understand risks associated to different hand drying methods.

The objective of this study was to quantify viral and bacterial dispersal in the environment after drying hands with different hand drying methods. We also aimed to understand the differences if hands were poorly washed (only rinsed with water) or properly washed (with soap and water). The research hypothesis was that different drying methods do not produce significant differences on virus and bacteria aerosolization and transference to surfaces for both rinsed and washed hands.

Methods

Volunteers and number of repeats

Appropriate local ethical approval was obtained (University of Southampton Ethics and Research Governance Online number 76203), and a total of 21 volunteers aged 20 to 55 (11 males, 10 females) were recruited. People with a history of skin condition or immunocompromise were excluded. All volunteers were randomly mixed in different groups of five throughout the study. We conducted 5 repeats for each drying condition (see below), with 12 experimental conditions in 60 sessions with 5 volunteers each (Supplementary Table I). Each participant was involved in all different experimental conditions and some participants took part in more than one repeat of the same experimental condition while mixed in different groups.

Preparation of cultures

Escherichia coli C-3000 (ATCC 15597) was grown in LB broth (Sigma, UK) for 24 hours at 37 ^{o}C while shaking at 160-180 rpm to reach an OD_{600} of 0.1 to 0.4. After 24 hours every 5 ml of *E. coli* culture was infected with 100 µl of MS2 bacteriophage and incubated with shaking at 160-180 rpm for 48 hours at 37 °C to reach a concentration in the range of 10^9 PFU/ml. The MS2 stock culture produced was filtered using a 0.45 µm membrane (Merck, UK) to remove the *E. coli* host and stored at 4 ^{o}C.

Pseudomonas fluorescens (ATCC 13525) was maintained in culture by subsequent passages, grown while shaking at 120 rpm in tryptone soy broth (TSB; Sigma, UK) for 48 hours at 30 ^{o}C to reach an expected concentration in the range of 10^8 CFU/ml. The 48-hours old *P. fluorescens* culture was spun down at 4,000 g for 10 minutes and the resulting pellet was resuspended in phosphate buffered saline (PBS; SLS, UK) to recreate a 10^9 CFU/ml

129 concentration which was combined with the filtered MS2 solution to create the "test solution"
130 to inoculate hands (referred to as inoculum throughout the text). This inoculum was prepared
131 daily and stored at 4 ^{o}C for up to six hours.
132
133 *Experimental set up*
134 All tests were conducted in a toilet room (total volume 29.2 m^3; Supplementary Figure 1A and
135 1B) which was dedicated to this study for its entire duration. Four models of hand dryers
136 (Supplementary Figure 1C) representing a range of jet dryers commonly found in public
137 washrooms were used, referred to as Model A, B, C and D (Dyson Technology Ltd., UK). All
138 models have HEPA filters fitted to clean the air before drying hands, and respective
139 characteristics are shown in Supplementary Table II.
140 Paper towels (Katrin Classic One Stop M2, Hygiene 24-7, Herts, UK) with no antimicrobial
141 additives (to represent paper towels commonly found in public toilets) were also used as a
142 fifth drying method for comparison (Supplementary Table I). The Model D has its dryer
143 integrated with the tap on a stand-alone sink, whereas the other Models were mounted
144 according to instructions, on a movable plywood panel (Supplementary Figure 1B). When
145 used, stacks of three sheets of paper towels (found sufficient to dry hands in preliminary tests)
146 were placed on the cleaned surface of Model D sink, separated from each other and ready to
147 use by each participant to avoid cross contamination. Thus, hand drying was always performed
148 in the same location within the toilet room.
149 Temperature and relative humidity were not controlled (on average 21 °C and 25%
150 respectively). The washroom did not have ventilation but two portable air cleaners (TP07 air
151 purifiers, Dyson Technology Ltd., UK) were used to clean the washroom air for sixty minutes
152 prior to each test to reduce any background contamination to below detectable levels. The two
153 air purifiers were removed from the room prior to the arrival of the 5 participants. From this

moment and throughout the rest of the procedure the room was closed (including the two cubicle doors), except for the entry and exit of the participants and researcher, and no fans or ventilation were active.

The same hand washing sink was consistently used and cleaned between each test, except when evaluating the Model D combined, i.e., hands were washed in the sink that was integrated with the dryer (Supplementary Table I). Dryers not in use were covered with cling film to prevent their contamination. Inoculation of hands, transference tests and glove juice sampling were all performed in the anteroom.

Hands preparation, inoculation, washing and drying procedure

Individually, volunteers wearing protective clothing (clean lab coats, facemasks and safety goggles) were asked to wash with soap (Softaskin, Braun, Switzerland) and dry their hands in a separate, adjacent toilet room to reduce their hands' transient flora and other contaminants. Volunteers then moved to the anteroom without touching any surface (e.g., doors), where the researcher inoculated their hands with 2 ml of the test solution (i.e., 1 ml per hand). Volunteers were asked to spread the inoculum evenly over the palm and fingers of both hands and leave to air dry before entering the washroom where the experiments took place.

To understand the differences on the environment from drying following hand rinsing or washing, two sets of experiments for each hand drying method were performed. In one set of experiments the volunteers walked to the designated sink and only rinsed hands for 20 seconds in water without using any soap, to represent poorly washed hands. In a second, parallel set of experiments (run concomitantly throughout the study period) the volunteers washed hands with a soft soap (Softaskin, Braun, Switzerland) following WHO guidelines for general public (2009), with wetting, soaping, rubbing and rinsing time adjusted to a total of 20 seconds. This represented properly washed hands.

When using Model A hands were inserted from the top and moved up and down four times; water was removed from both sides of the hands simultaneously. When using Model B, C and D hands were placed under the hand dryer and moved backward and forward four times, changing hand side each time. In Model B and D air exits through straight apertures while Model C has curved air apertures (Supplementary Figure 1C). When testing Model D two sets of experiments were performed. One experimental condition consisted in washing hands in the washroom sink and move to the standalone sink to dry with Model D. In another set of experiments hands were washed using the standalone sink and the Model D integrated tap, then immediately dried above the sink to measure potential differences in aerosolization due to any contaminated water remaining in the washbasin. This used a closed water circuit with a cleaned tank which was replenished with warm tap water just before the tests. To compare aerosolization, all dryers were run for 20 seconds. Paper towels were used until hands appeared dry and discarded in a dedicated bin in the anteroom. Participants then left the room without touching surfaces and entered the anteroom for hand sampling and surface transference experiments.

Surface transfer and sampling

To study the impact of different hand drying methods on surface transference, each volunteer re-entering the anteroom (without touching the door) firmly pressed their dominant hand successively on stainless steel (SS, 316L), wood (oak veneered MDF) and ABS plastic pre-cut surfaces (25 x 15 cm). These materials and order represent usual activities when leaving a bathroom: opening the door by touching handles (SS), touching other doors or handrails (wood) and working on a computer keyboard (ABS). The virus and bacteria were recovered from each surface with a cotton swab (SLS, UK) moistened with PBS, placed in a sterile tube containing 5 ml PBS and kept at 4 °C until analysis.

204

205 *Glove juice sampling*

206 The glove juice method has been described elsewhere [21]. Briefly, a powder-free sterile glove
207 was placed on the volunteer's hand not used for the transference test and filled with 50 ml of
208 recovery solution (PBS). The wrist was secured to prevent leakage and the hand was massaged
209 through the glove for 60 seconds to detach remaining bacteria and virus after rinsing/washing
210 and drying. The recovered glove juice fluid was then stored at 4 ^{o}C until analysis. Participants
211 were then invited to wipe and sterilise their hands using gel sanitiser to inactivate any residual
212 contamination from the inoculum.

213

214 *Air sampling*

215 After 5 participants went through the same experimental condition, and within 5 min of the last
216 participant leaving the washroom, room air was collected into three sterilised glass impingers.
217 The impingers were placed at 25 cm above the ground and connected to a vacuum pump
218 (BioLite+, SKC, Blandford Forum, UK) set at a flow rate of 10L/min. Air was collected for 30
219 min, with each impinger collecting 300 L of air into 20 ml PBS. The impingers were placed in
220 three different points in relation to the drying area: location 1 was directly in front of the drying
221 point, to represent the user exposure, locations 2 and 3 were 65 cm to the side and 1.20 m in
222 front of the drying point, respectively, to represent exposure of other washroom users
223 (Supplementary Figure 1A) as described elsewhere [16]. Solutions were then transferred to
224 sterile tubes and kept at 4 °C until analysis. Once air sampling was completed, the washroom
225 surfaces were cleaned by wiping with 70 % ethanol and air filtered using the air filter in
226 preparation for the following session as described above.

227

228

Sample processing and analysis

Fifteen air samples (5 per location) were taken for each experimental condition; collected after 5 volunteers in each repeat had been through the washroom. For each surface and for hands there were 25 samples for each experimental condition with samples obtained from each volunteer (Supplementary Table I). Daily prepared inoculum and all samples were homogenised and split into two sets. One set was used to quantify *P. fluorescens* by spot plating 10 µl triplicates of a neat or appropriate dilution onto 4% tryptone soya agar (TSA; Sigma, UK) and incubated for up to 48 hours at 30 ºC to enumerate colony forming units (CFUs). *P. fluorescens* colonies were distinguished from other hand flora colonies by morphology and fluorescence under UV light. The other set was used to quantify MS2 bacteriophages. The solution was passed through a 0.2 µm filters to remove bacteria prior to spot plating 2 µl triplicates of a neat or appropriate dilution onto 0.8% LB agar (Sigma, UK) plates containing 1% (v/v) Log phase *Escherichia coli* (ATCC 15597). The plates were then incubated for 24 hours at 37 ºC for quantification of plaque forming units (PFUs). For comparative analysis, the results for each experimental condition were normalised by calculating the ratio of bacteria and viruses in the samples obtained for air, surfaces and hands (glove juice) in relation to the inoculum (considering sample volumes), presented as PFU or CFU per m^3 of air, per cm^2 of surface or per hand. The calculated LoD of each method for *P. fluorescens* and MS2 were 2.22 x 10^3 CFU and 1.11 x 10^4 PFU / m^3 (air samples), 0.44 CFU and 2.22 PFU / cm^2 (surface samples), 1.66 x 10^3 CFU and 8.33 x 10^3 PFU per hand (glove juice sampling).

Statistical analysis

Normalised data were not normally distributed according to the Kolmogorov-Smirnov and Shapiro-Wilk tests. The effect of soap was examined overall and between the independent,

corresponding drying methods. Differences linked to drying method used were examined within each rinse only or wash and rinse groups.

For post-hoc tests we used the independent samples Kruskal-Wallis and Mann-Whitney U tests. Significance values were adjusted by the Bonferroni correction for multiple tests (IBM SPSS software). Values of $P \leq 0.05$ were considered significant.

Results

Aerosolization of bacteria and viruses

Airborne MS2 was detected in only 6 of 180 samples (Supplementary Table III), 5 of which were after hand rinsing with water (Figure 1A). All other air samples were below the LoD. The highest concentration of MS2 in the air was detected in location 2 after a single test where 5 participants washed their hands with soap and used paper towels (Figure 1B). This was not associated with a notably higher titre in the initial inoculum on hands. Half of the positive samples (3) appear in location 1 and only one positive in location 3, possibly due to being the closest and farthest locations to the drying area.

Only one air sample showed *P. fluorescens* above the LoD, from location 2 after five participants using soap and the Model B dryer (Figure 1B).

In this experimental set up, the concentration of MS2 or *P. fluorescens* in the positive samples did not lead to statistically significant differences between experimental conditions after 5 repeats. Model C was the only hand dryer where air samples did not have detectable levels of microorganisms in any experiments. This could have been due to the configuration of the hand dryer (combination of air apertures shape, air flow, speed and direction, Supplementary Table I) or simply due to experimental variation since there was no statistical difference between the

inoculum concentrations from 5 repeats per condition. No microorganisms were detected in control air samples (participant washing and drying non-inoculated hands) or after air purification of the room.

Transfer of virus and bacteria onto surfaces from rinsed or washed hands

Transfer of residual *P. fluorescens* from hands to surfaces was only detected on one of 897 surfaces touched (one set of samples was spoilt), corresponding to the first surface touched, stainless steel, after the volunteer hands were rinsed only with water and dried using Model A (Figure 2A). Natural and transient bacterial flora from the volunteers' hands was also occasionally recovered from stainless steel and plastic surfaces (results not shown), indicating the pressing of surfaces was adequate to transfer microorganisms from hands to surfaces. Transfer of MS2 from hands to stainless steel surfaces was seen in all experimental conditions (Figure 2) but not all samples. The limited recovery from wood was likely due to increased absorption by this material, as this was observed in control experiments by pipetting 1µl of test solution directly onto the test surfaces, which affected recovery by swabbing. Furthermore, MS2 was also recovered from some of the plastic test surfaces, touched last. Overall, 45/450 and 28/447 surfaces were positive for MS2 after rinsing only and after washing and rinsing hands, respectively (Supplementary Table III). Once adjusted by the Bonferroni correction for multiple tests, there were no significant differences in transference between washed and rinsed hands or between different drying methods after 5 repeats.

Quantification from hands

Contrary to surfaces and air samples, where a small proportion of total samples showed concentration of MS2 above the LoD, samples from hands (glove juice recovery) were consistently positive for the presence of residual MS2 (Figure 3), with PFUs quantified in

141/148 hands after rinsing only and 122/147 hands after washing and rinsing (5 sample were spoilt during processing). Both rinsing with water only and washing with soap before drying resulted in a reduction of MS2 by approximately 2-Log compared to the inoculum (no statistical difference; Figure 3).

Residual *P. fluorescens* was recovered sporadically from the hands of 25 participants (14/150 rinsed and 11/149 washed) in 9 of 60 tests (5 rinse and 4 wash, i.e., often clustered in the same tests). The reduction of *P. fluorescens* was on average 6-Log, for all conditions, with the only statistical difference measured after rinsing hands and drying with model C, compared to drying with model B or D combined. No residual *P. fluorescens* was measured above the LoD after rinsing with water and drying using Model B or D combined (Figure 3A) and after washing with soap and drying with Model D (dry only or combined; Figure 3B). In addition, only two volunteers returned positive samples for *P. fluorescens* after drying using paper towels, one after rinsing with water and one after washing with soap.

Interestingly, participants natural and transient bacterial microflora was still present after washing hands twice (considering the hand preparation), followed by any of the drying methods assessed. Overall, there was a direct correlation between residual MS2 on hands and transfer onto surfaces (for all surfaces; P = 0.045), but not for *P. fluorescens*.

Discussion

The findings from this study suggest that just rubbing hands under tap water contributes to reducing recently added bacterial bioburden (approximately 6-Log) but is more limited against recent viral contamination (approximately 2-Log reduction). This is in accordance with another study showing higher removal of bacteria (*E. coli*) than virus (norovirus) [22]. Washing with non-medicalised soap did not significantly increase virus or bacteria removal compared to only rinsing with water, which is contrary to previously published work [23]. However, here we sampled hands after the drying step as a confirmation of microorganisms' presence for the transference experiments. Since results showed presence of *P. fluorescens* and MS2 bacteriophage on hands, we did not investigate the glove juice results further.

To increase the probability of quantifiable signal for air and surfaces samples, the inoculum used was intentionally concentrated, above what would be expected from hands in real life. Nevertheless, most air samples were below the LoD, showing limited aerosolization of bacteria and viruses during hand drying, regardless of the drying method. Comparable results were obtained previously using the same different drying methods, but where hands were washed and dried without being artificially inoculated. In that study the bacterial increase in air was attributed to other activities in the chamber, such as walking [16]. Here, hands were inoculated with *P. fluorescens* to isolate the results and better understand if there was any aerosolization of bacteria during drying activities, but virtually none was seen. This is also in agreement with a study conducted in public toilets in hospitals, where the airborne bacterial numbers were similar in washrooms with electric driers and paper towels [14]. Other studies have reported aerosolization of bacteria and viruses during drying procedures with electric dryers, however those used gloved hands dipped in a bacterial or viral solution and immediately dried without being washed [17, 18]. That method is not representative of real life since microbial attachment is different between gloves and skin [19]. The dispersal of microorganisms in those studies is likely to have been facilitated by the fact the bacterial and viral particles were still suspended

in the liquid and not adsorbed onto the hands. The present study suggests that microorganisms remaining on hands after rinsing or washing are difficult to dislodge by the action of the high-speed air and therefore unlikely to be aerosolized during drying.

Pressure contact of dried hands onto the three dry surfaces resulted in very few positive samples above the LoD(Supplementary Table, with no statistical differences between experimental conditions despite most glove juice samples confirming the presence of 1 to 10% of the virus inoculum remaining on hands. These results show that jet driers and paper towels are both effective methods to reduce moisture and the risk of transference to surfaces. Moura *et al.* reported differences in virus transference between the two drying methods [20]. That study also used unwashed gloved hands inoculated by immersion in a virus suspension. This might explain differences in surface retention of viral particles during and after drying compared with our study on actual hands. Furthermore, we found the results for wood surfaces (only five MS2-positive samples out of 299; Supplementary Table III) were affected by the absorbing nature of this material, which might be relevant to other similar studies.

While residual *P. fluorescens* was detected in 10% of hands, the limited transference results might have been due to numbers being below the LoD or poor recovery of bacteria from surfaces using swabs [24]. Nevertheless, the results indicate a low or no transference of residual bacteria from hands to the surfaces after drying them with jet dryers or paper towels, which is in accordance with other studies [8, 10].

The concern that using integrated tap dryers (wash and dry above the sink, found in many public toilets) could lead to more aerosolization has been raised. Here, 2 air samples were positive for MS2 using Model D combined, out of 6 positive and 180 total samples, though this was not significant compared to other jet dryers or paper towels which is in agreement with a previous study [16].

Limitations of work

A number of participants took part in several repeats within different groups, however there was no correlation with particular outcomes.

Participants rinsed or washed their hands as soon as the inoculum had dried. In real life the efficacy of hand washing may vary depending on the microbial load, type of microorganism, interaction with skin microflora and time between contamination and washing. Delaying rinsing or washing inoculated hands might have increased variability between experiments for the same reasons and affected the interpretation of results. Sampling air while participants were entering and leaving the washroom was deemed unpractical, nevertheless this study examined cumulative microorganisms aerosolization from 5 participants and each session's duration was short enough to ensure microorganisms were still in the air and results were robust.

This study also focused on transference from dried hands but we did not examine the washroom surfaces. Participants used the different drying methods in a strictly controlled manner, particularly avoiding touching any surfaces between hand inoculation and final sampling. No increase in residual microorganisms was measured from participant 1 to 5 in any session, and the washroom air and relevant surfaces were decontaminated between each session. In public washrooms, commonly found push taps may be cleaned less frequently and produce increased cross-contamination.

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In this study each volunteer only touched three clean surfaces successively, while in reality multiple people will interact with multiple surfaces. Further adequately controlled studies could clarify these potential two-way cross-contamination dynamics.

Finally, The LoD values could be reduced by use of alternative methods with larger volumes but this would restrict the size of the study.

Conclusions

Handwashing and drying are fundamental for good hand hygiene, which is recognised as an efficient method to reduce infection transmission. The COVID-19 pandemic revived concerns about contamination of washroom air and surrounding surfaces by poor drying methods. This work shows that a proportion of *P. fluorescens* and MS2 bacteriophage inoculated still remained on hands after rinsing/washing and drying with all dryer models studied and paper towels, however none of these methods resulted in significant aerosolization of these microorganisms. Moreover, all methods were equally effective in limiting transference of remaining microorganisms to surfaces and therefore can be considered adequate and hygienic solutions for public washrooms.

Data availability statement: The raw data supporting the conclusions of this article will be made available by the authors without undue reservation.

Funding: The experimental work was financially supported by Dyson Technology Ltd. (UK) and BBSRC (Flexible Talent Mobility Account) via the National Biofilm Innovation Centre (Southampton, UK).

Declaration of interest: The experimental work was financially supported by Dyson Technology Ltd. (UK). MSG was an employer of Dyson Technology Ltd. The funder did not have further involvement in the work.

Acknowledgements: The authors would like to thank Sarah Embleton and Cassie Reis for the support during this research work. Thanks to Thomas Todeschini, Daniela Rothschild Rodriguez and Yi Wu for their help setting up the phage assay, and Mark Dixon for facilitating the use of the washroom.

Author contributions: Conceptualization: MSG. Experimental design: MSG, CC, SW, CWK and RH. Samples processing and assays: RH, CB and LS. Results analysis: RH and MSG. Manuscript preparation: RH and MSG. Manuscript review and edits: RH, MSG, SW and CWK.

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Legends to figures:

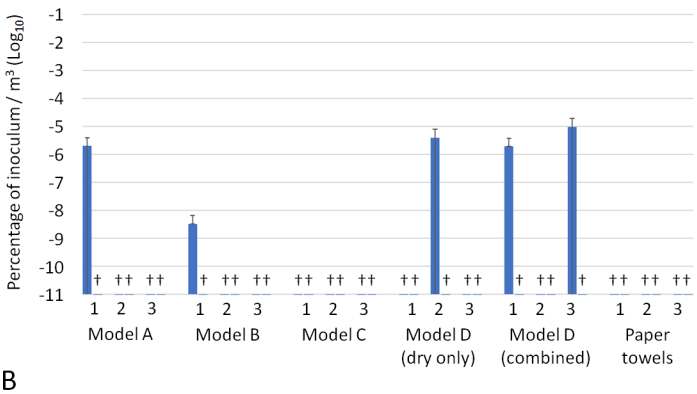
Supplementary Figure 1: (A) Situation plan and (B) panoramic photograph of toilet room used for this study. For each session, the studied dryer was moved to the same common location (in front of the existing wall-mounted hand dryer seen on the picture above). Cubicle doors were kept shut throughout. The first sink on the left was used for hand washing (except when testing Model D combined). Room height was 230 cm (total volume approximately 29.2 m^3). (C) Hand dryer models and hands position when using each hand dryer.

Figure 1: Profiles of *P. fluorescens* (red) and MS2 phage (blue) in air samples recovered from the three sampling locations shown in Figure 1A after (A) hands rinsed with water (poor hand wash) and (B) hands washed with soap (properly hand wash), for the different drying methods studied. Data shows means ± SEM of the percentage of spike from five tests for each condition. †: below the LoD.

Figure 2: Profiles of *P. fluorescens* (red) and MS2 phage (blue) recovered from the three types of surface touched (S: stainless steel; W: veneered MDF wood and P: ABS plastic) after (A) hands rinsed with water (poor hand wash) and (B) hands washed with soap (properly hand wash), for the different drying methods studied. Data shows means ± SEM of the percentage of inoculum from 25 samples for each experimental condition. †: below the LoD.

Figure 3: Profiles of residual *P. fluorescens* (red) and MS2 phage (blue) recovered from the glove juice sampling after (A) hands rinsed with water (poor hand wash) and (B) hands washed with soap (properly hand wash), for the different drying methods studied. Data shows means ± SEM of the percentage of inoculum from 25 samples for each experimental condition. †: below the LoD.

A



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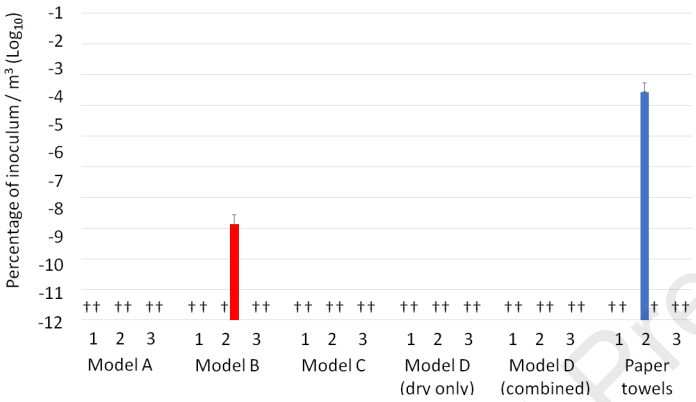

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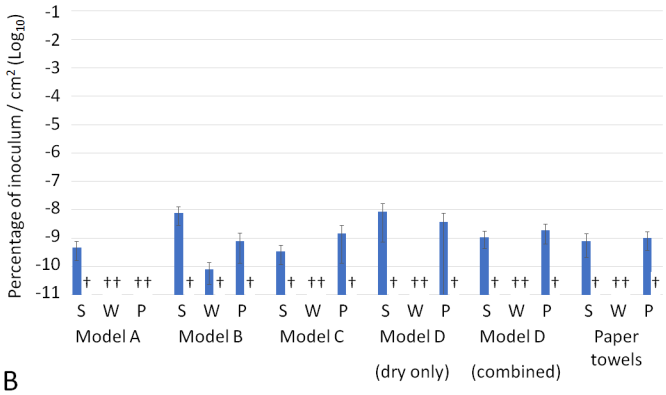

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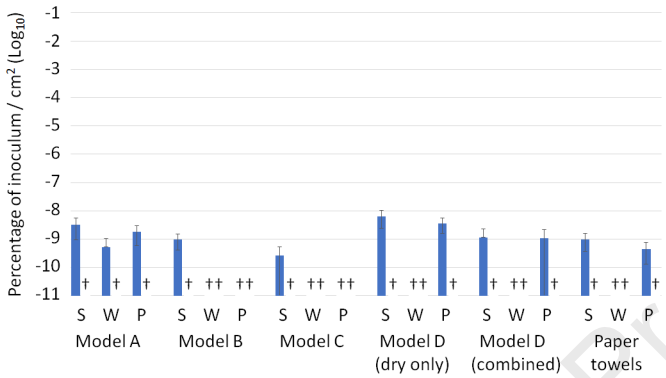

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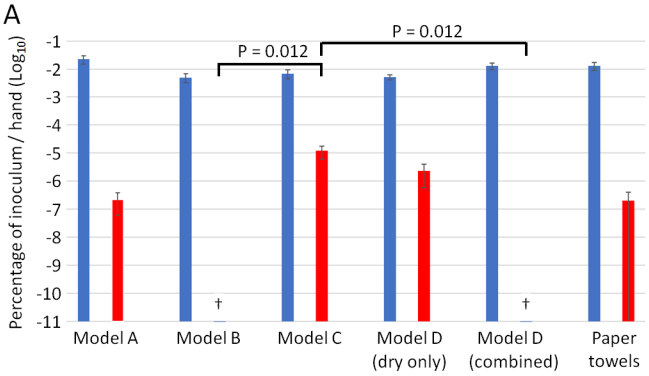

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