A quantitative evaluation of three hand drying methods and the potential for dissemination of virus particles into the environment

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A QUANTITATIVE EVALUATION OF THREE HAND DRYING METHODS AND THE POTENTIAL FOR DISSEMINATION OF VIRUS PARTICLES INTO THE ENVIRONMENT

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BACKGROUND

- Our previous studies have shown that high-speed jet air dryers produce greater dispersal of contamination on the hands of participants drying their hands than paper towels, textile towels, or warm air dryers.
- Chemical dispersal was assessed by artificial contamination of the hands of participants with a weak acid solution and using indicator paper.
- Fungal and bacterial dispersal was assessed using appropriate agar plates (Sabouraud dextrose agar, blood agar and mannitol salt agar).
- In all cases the jet air dryer produced more dispersal at different heights, different angles and greater distances than other hand drying methods.
- This new study assessed the potential for viral dispersal from the hands of users of paper towels, warm air dryers and jet air dryers.

AIMS/OBJECTIVES

To use a bacteriophage model to determine differences between hand drying methods in their capacity to disperse viruses on the hands of users to other occupants of public washrooms and into the washroom environment.

MATERIALS AND METHODS

MS2 bacteriophage (ATCC 15597-B1) was propagated at 37ºC overnight in log phase tryptone soya broth (Oxoid) cultures of *Escherichia coli (ATCC 15597)* to yield a mean count in the range of 10^{10} plaque-forming units per mL. Participants were asked to wash their gloved hands in 50 mL of the phage suspension for 10 seconds followed by shaking and then drying them using one of the hand drying devices: paper towel dispenser (Wepa Clou Comfort) for 10 seconds; warm air dryer (World Dryer Corporation, model LE48) for 20 seconds; jet air dryer (Dyson Airblade, model AB01) for 10 seconds. To assess dispersal at different heights tryptone soya agar (Oxoid) plates with an overlay of 0.5% sloppy agar containing log phase *E.coli* cells were affixed at 6 different heights to a vertical board held 0.4 m from the hand drying device. After incubation at 37ºC overnight the plates were examined for the presence of viral plaques and the numbers recorded. To assess dispersal at varying distances from the different hand drying devices the same type of standard agar plates were laid out at intervals of 0.5 m up to a maximum of 3 m. Dispersal was also assessed using an air sampler (Air Trace Environmental, model ATEM 240) with an inlet tube (Tygon) and larger (140 mm) tryptone soya agar plates used with the same bacterial overlay and that were rotated inside the air sampler body. The air sampler was set to sample the air for up to 15 minutes after use by a participant and sampling carried out at 0.1 m and 1.0 m distances from the side of the hand drying device and also at a 1.0 m offset distance behind. Equal numbers (10) of samples were taken for the left and right-hand sides for each of the distances and positions used. After incubation plates were divided up into 6 sectors, each sector representing 2.5-minute time intervals, and the number of viral plaques in each sector counted. Where plaque formation was confluent, semi-confluent or the number of plaques uncountable (>1000), the number of plaques per sector was recorded as 1000 for calculation purposes.

RESULTS

Table 1: Mean number of viral plaques on agar plates at 6 different height zones at a set distance (0.4 m) from hand-drying devices used to dry the hands of participants artificially contaminated with bacteriophage suspension. (n = 10)

HEIGHT ZONE	HEIGHT RANGE FROM FLOOR (m)	HAND-DRYING DEVICE		
		PT	WAD	JAD
I (TOP)	1.525 - 1.830	0.4	0.7	248.9
II	1.220 - 1.525	0.6	8.7	335.9
III	0.915 - 1.220	0.1	4.6	709.5
IV	0.610 - 0.915	0.1	5.4	833.6
V	0.305 - 0.610	0.1	3.9	63.9
VI (BOTTOM)	0.000 - 0.305	0.1	11.1	26.9
TOTAL (all heights)		1.4	34.4	2218.7

Key: PT = paper towel; WAD = warm air dryer; JAD = jet air dryer.

Figure 1: Mean number of plaques per agar plate at different distances from hand drying devices. (n = 20)

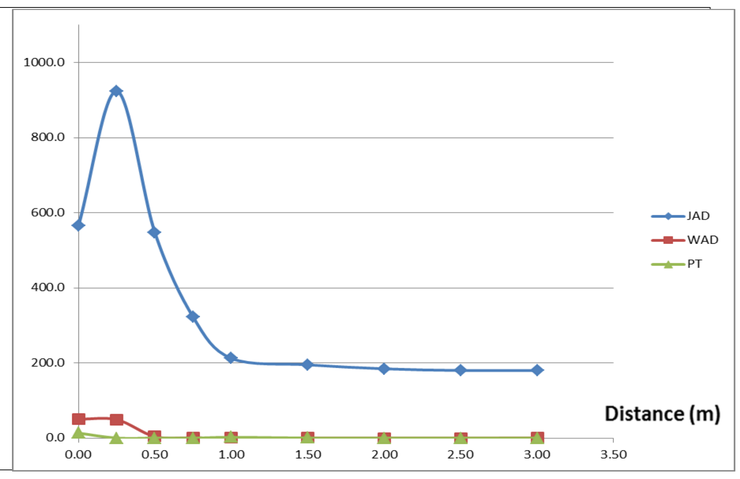
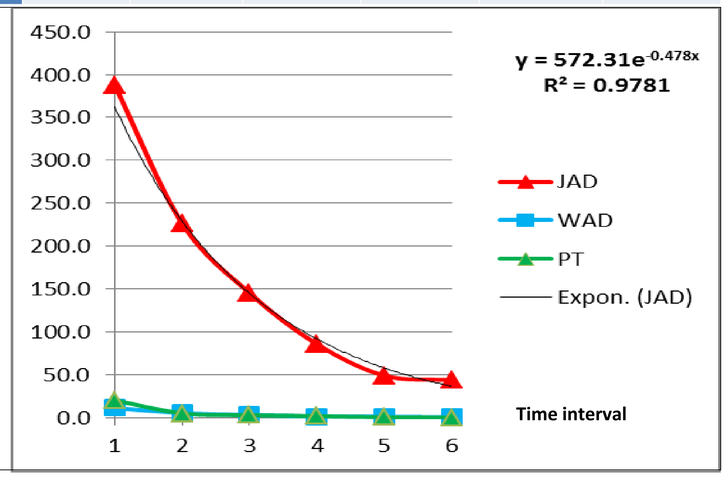


Table 2: Mean number of plaque-forming units detected in air samples at different times, distances and positions on a rotated agar plate. (n = 10)

DEVICE	DISTANCE (m)/ POSITION	TIME (minutes)					
		0 – 2.5	2.5 - 5	5 – 7.5	7.5 - 10	10 – 12.5	12.5 - 15
PT	0.10	36.7	5.2	4.2	1.8	1.1	0.0
PT	1.00	17.8	6.8	2.3	1.9	0.9	1.0
PT	BEHIND	6.9	3.7	2.7	2.4	0.4	0.1
WAD	0.10	15.9	4.4	2.2	2.7	1.8	1.4
WAD	1.00	9.2	5.2	1.9	1.0	0.8	0.5
WAD	BEHIND	9.1	7.3	5.5	1.2	1.9	0.6
JAD	0.10	470.0	235.7	17.8	101.2	57.2	61.0
JAD	1.00	350.0	200.0	134.5	85.8	46.5	38.5
JAD	BEHIND	343.0	230.0	122.0	70.3	43.9	31.8

Figure 2: Combined mean number of plaque-forming units detected in air at all distances and positions at 6 succeeding 2.5-minute time intervals after use of hand drying devices. (n = 30)



CONCLUSIONS

The jet air dryer was shown to produce significantly more dispersal of virus from the hands than the warm air dryer or paper towels. After use of the jet air dryer, high numbers of virus were detected at a range of heights with maximum numbers between 0.61 and 1.22 metres. Virus was also detected at distances of up to 3 metres from the jet air dryer and in the air for up to 15 minutes after its use with exponential decline in number. The warm air dryer and paper towel dispenser produced lower viral counts at different heights, different distances and times after use. The visualization (Figure 3) shown below of the air flow from a jet air dryer helps explain the results of this study. Claimed air speeds for jet air dryers of over 600 kph are likely to increase the risk of transmission of viruses from the hands of users to other occupants of public washrooms.

Figure 3: Visualization of the air flow from a jet air dryer.

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