

Effectiveness of Hand Sanitizers with and without Organic Acids for Removal of Rhinovirus from Hands[∇]

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These studies evaluated the effectiveness of ethanol hand sanitizers with or without organic acids to remove detectable rhinovirus from the hands and prevent experimental rhinovirus infection. Ethanol hand sanitizers were significantly more effective than hand washing with soap and water. The addition of organic acids to the ethanol provided residual virucidal activity that persisted for at least 4 h. Whether these treatments will reduce rhinovirus infection in the natural setting remains to be determined.

Direct hand-to-hand transmission of virus appears to play an important role in the spread of rhinovirus infections. The purpose of the studies described in this article was to compare the immediate and residual effectiveness of different hand treatments for removal of rhinovirus from the hands.

Comparison of hand washing with hand disinfectant for removal of virus from hands. The fingers of 95 healthy volunteers were contaminated with 125 50% tissue culture infective doses (TCID₅₀) of rhinovirus, type 39, by placing the virus into a “cup” formed by the tip of the index finger, middle finger and thumb of the right hand. The contaminating virus was distributed over the tips of the index and middle fingers by rubbing with the thumb and then allowed to dry for 5 min. The volunteers were block randomized to one of six hand treatments. A control group had no hand treatment. A second group washed their hands by rubbing under running water for 15 s. A third group washed their hands with 2 ml of nonmedicated liquid soap by rubbing their hands together and then rinsing under running water for 15 s. Both of the groups who used a water rinse dried their hands by pat-drying with a paper towel. A fourth group had 1.5 ml of 65% ethanol hand sanitizer applied to the palm of the hand. This group of volunteers then rubbed the sanitizer over the hands until the material was evaporated. A fifth group of volunteers also applied 1.5 ml of 65% ethanol hand sanitizer, although this group repeated the process two times for a total application of 3 ml of the hand sanitizer. The final group applied 1.5 ml of an 83% ethanol hand sanitizer in the manner described above. The goal in all of the treatment groups was to mimic the natural use of hand washing or application of hand sanitizer; only the duration of the hand wash was controlled. After the hand treatment, all volunteers had the fingertips of the contaminated hand rinsed 10 times with 1.5 ml of viral collecting broth for detection of residual virus.

The ethanol hand sanitizers removed detectable virus from at least 80% of hands. All ethanol treatments were significantly more effective than no treatment, water alone, or soap and

water for removal of detectable rhinovirus from the hands (Table 1). Soap and water removed detectable virus from 5 (31%) of 16 hands ($P = 0.04$ compared to the no-treatment control). There was no difference detected among the various hand sanitizer regimens.

Assessment of residual activity against rhinovirus hand contamination and infection following organic acid lotion treatment. The experiment described above demonstrated the ability of ethanol hand sanitizer to remove virus from the hands. This second experiment evaluated whether addition of organic acids would provide antiviral activity that would persist for some period of time after application of the sanitizer. This study involved 197 healthy volunteers susceptible to rhinovirus, type 39. The organic acid test product consisted of 2% malic acid and 2% citric acid in a 70% solution of ethanol. The control was a 65% ethanol hand sanitizer (Purell instant hand sanitizer; GOJO Industries, Akron, OH). Subjects were randomized to three treatment arms by block randomization. Two groups of subjects applied either the organic acid or control treatment to the thumb and first two fingers of each hand. The third group of volunteers applied the test product to both hands as a hand lotion. After the application, the first two groups waited 2 h and the third group waited 4 h without using their hands until the virus challenge. After the assigned treatment time had elapsed, the subjects' hands were challenged with approximately 250 TCID₅₀ of rhinovirus, type 39, on the right hand and approximately 125 TCID₅₀ on the left hand by the method described above for the previous experiment. After allowing the challenge virus to dry for approximately 10 min, the fingers of the left hand were then rinsed 10 times with 1.5 ml of viral collecting broth. The fingers of the right hand were used to attempt intentional inoculation of the rhinovirus onto the nasal and conjunctival mucosa. After the challenge procedure, all volunteers had nasal lavage collected daily for 5 days for rhinovirus culture. Volunteers who had rhinovirus detected in cell culture or who had a serologic response to the study virus were considered infected.

Fifteen (8%) of the 197 subjects were excluded from the efficacy analysis by protocol. There were no significant differences in the distribution of subjects among the treatment groups by gender, race, or age. The organic acid hand treatment had residual activity that both inactivated virus on the

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TABLE 1. Recovery of rhinovirus from hands of volunteers after various hand treatments

Treatment group	No. of hands positive/no. tested
No-treatment control	16/16
Water alone.....	14/16
Water + soap ^a	11/16
1.5 ml 65% ethanol.....	2/15
1.5 ml 65% ethanol × 2.....	3/16
1.5 ml 83% ethanol.....	3/16

^a All ethanol-treated groups were significantly different from the group treated with water plus soap ($P = 0.01$).

hands and prevented infection 2 and 4 h after application (Table 2).

The ethanol-containing hand disinfectants were significantly more effective than hand washing with water or with soap and water for removal of detectable rhinovirus from the hands in this study. Furthermore, a formula containing organic acids and ethanol resulted in residual activity that significantly reduced virus recovery from the hands and rhinovirus infection for up to 4 h after application. Although the alcohol hand sanitizers appear to be effective for removal of virus from the hands, efforts to demonstrate prevention of viral respiratory infection in the natural setting with these agents have been disappointing (1, 2). This disparity may reflect inconsistent compliance with hand cleansing after contamination or inadvertent recontamination after cleansing. These concerns might reasonably be addressed by efforts to increase compliance or by a hand treatment that provides residual protection for some period of time after application. Organic acids have previously been shown to have residual activity against rhinovirus (3). This study suggests that the combination of malic and citric acid may provide longer residual protection than the previous formulation. Whether this residual activity will provide protec-

TABLE 2. Recovery of rhinovirus from hands of volunteers at 2 and 4 h postapplication of organic acid-containing sanitizer

Parameter	Result for group:		
	Control (2 h)	Organic acid treated	
		2 h	4 h
No. of hands positive/no. tested (%) ^a	57/61 (93)	1/60 (2)	0/61
No. of volunteers infected/no. tested (%) ^a	26/61 (43)	1/60 (2)	2/61 (3)

^a $P < 0.0001$ for both acid groups compared to control.

tion from infection in the natural setting remains to be determined.

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