

# ANTIMICROBIAL ACTIVITY OF HOME DISINFECTANTS AND NATURAL PRODUCTS AGAINST POTENTIAL HUMAN PATHOGENS

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## ABSTRACT

**OBJECTIVE:** To assess the efficacy of both natural products (vinegar, baking soda) and common commercial disinfectants (Vesphene Ise, TBQ, Clorox, Lysol Disinfectant Spray, Lysol Antibacterial Kitchen Cleaner, Mr. Clean Ultra, ethanol) designed for home or institutional use against potential human pathogens, including selected antibiotic-resistant bacteria.

**DESIGN:** A quantitative suspension test was used to assess the efficacy of selected disinfectants following exposure times of 30 seconds and 5 minutes. Activity was assessed against *Staphylococcus aureus*, *Salmonella choleraesuis*, *Escherichia coli* O157:H7, and *Pseudomonas aeruginosa*. Selected disinfectants were also tested against poliovirus, vancomycin-susceptible and -resistant *Enterococcus* species, and methicillin-susceptible and -resistant *S aureus*.

**RESULTS:** The following compounds demonstrated excellent antimicrobial activity (>5.6-8.2 log<sub>10</sub> reduction) at both expo-

sure times: TBQ, Vesphene, Clorox, ethanol, and Lysol Antibacterial Kitchen Cleaner. Mr. Clean eliminated 4 to >6 log<sub>10</sub> and Lysol Disinfectant ~4 log<sub>10</sub> of pathogenic microorganisms at both exposure times. Vinegar eliminated <3 log<sub>10</sub> of *S aureus* and *E coli*, and baking soda <3 log<sub>10</sub> of all test pathogens. All tested chemical disinfectants completely inactivated both antibiotic-resistant and -susceptible bacteria at both exposure times. Only two disinfectants, Clorox and Lysol, demonstrated excellent activity (>3 log<sub>10</sub> reduction) against poliovirus.

**CONCLUSIONS:** A variety of commercial household disinfectants were highly effective against potential bacterial pathogens. The natural products were less effective than commercial household disinfectants. Only Clorox and Lysol disinfectant were effective against poliovirus (*Infect Control Hosp Epidemiol* 2000;21:33-38).

Emerging infectious diseases that have raised growing concern in recent years include foodborne infections, nosocomial infections, and infections associated with child-care centers.<sup>1</sup> More than 30,000,000 foodborne infections are estimated to occur per year, resulting in more than 9,000 deaths (*The New York Times*, July 4, 1998:A1), and more than 2 million nosocomial infections are estimated to occur each year, causing or contributing to more than 75,000 deaths.<sup>2</sup> In the hospital, environmental contamination has been linked to transmission of some important nosocomial pathogens, including methicillin-resistant *Staphylococcus aureus*,<sup>3-5</sup> vancomycin-resistant *Enterococcus* species,<sup>6,7</sup> and *Clostridium difficile*.<sup>8-11</sup> In day-care centers, environmental contamination with fecal pathogens has been linked to acquisition of diarrheal diseases.<sup>12,13</sup> Studies on the extent of environmental contamination in the home and its role in the transmission of infectious diseases are limited, but the frequency and level of microbial contamination of home environmental surfaces have been investigated.<sup>14,15</sup> Environmental surfaces, especially those in kitchens and bathrooms, frequently have been found to be contaminated with potential pathogens, including enteric gram-negative bacilli.<sup>14,15</sup>

Human challenge studies have shown that contaminated surfaces may serve as the source for transmission of infectious agents. Contact with experimentally contaminated coffee cups has led to acquisition of rhinovirus infection,<sup>16</sup> and contact with experimentally contaminated surfaces has led to acquisition of rotavirus infection.<sup>17</sup>

Many human pathogenic viruses and bacteria may survive in a sufficient dose and for an appropriate duration to serve as a source of human exposure.<sup>6,18,19</sup> In experimental trials, disinfection of environmental surfaces has been shown to decrease or eliminate potential pathogens and thereby decrease or eliminate acquisition of disease.<sup>17</sup> The purpose of this study was to evaluate both natural products and commercial disinfectants for home use for their efficacy against potential human pathogens. In addition, we evaluated the activity of these products against antibiotic-resistant bacteria.

## METHODS

### Bacterial Isolates

Bacterial isolates were obtained from American Type Culture Collection (ATCC; Rockville, MD): *S aureus* (ATCC strain 6538), *Salmonella choleraesuis* (ATCC strain 6539), *Pseudomonas aeruginosa* (ATCC strain 1542), and

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*Escherichia coli* O157:H7 (ATCC strain 11229). Lyophilized cultures were received from ATCC and reconstituted as directed. Cultures were grown on trypticase soy agar ([TSA] Difco, Detroit, MI) and stored at 4°C on agar slants.

Clinical strains of antibiotic-resistant or -susceptible bacteria were obtained from the University of North Carolina Hospitals, Chapel Hill. These isolates were tested for methicillin susceptibility by the oxacillin plate method and vancomycin resistance by the E-test strip method (Remel, Lenexa, KS). Cultures were maintained on TSA and stored on agar slants at 4°C.

Prior to experimental use, cultures were initiated from single colonies and grown in trypticase soy broth ([TSB] Difco) for 48 hours at 37°C. Log-phase cultures, used as seed in disinfection studies, were obtained by inoculating 49 mL of TSB with 1.0 mL of a 48-hour culture, then incubating for 5 hours at 37°C.

### Cell Cultures and Poliovirus

Poliovirus type 1 (strain LSc) was maintained in Buffalo green monkey kidney (BGMK) cells. Cells were grown and maintained in Eagles' Minimum Essential Medium (Sigma, St Louis, MO) supplemented with 10% and 2% fetal calf serum, respectively. Poliovirus was grown and assayed by a plaque technique in confluent layers of BGMK cells. Virus titers were expressed as plaque-forming units (PFU) per mL. Neutralization of virus infectivity by type-specific antiserum was used to confirm the identity of the virus.

### Disinfectants

Several commercial disinfectants and two natural products were chosen for testing. The three hospital disinfectants tested were a phenolic, Vesphene IIs (Calgon-Vestal, St Louis, MO), a quaternary ammonium compound, TBQ (Calgon-Vestal), and an alcohol, ethanol (Fisher Scientific, Norcross, GA). The active ingredients and the use dilution for the tested products were as follows: the phenolic, 9.65% sodium o-phenylphenate, 8.34% sodium p-tertiary-amylphenate, 1:128; the quaternary ammonium compound, 8% alkyl (50% C<sub>14</sub>, 40% C<sub>12</sub>, 10% C<sub>16</sub>) dimethyl benzyl ammonium chlorides, 1:128; and the alcohol, ethanol, 70% by volume.

The household disinfectants and natural products tested and the active ingredients and use dilutions were as follows: Regular Clorox Bleach (The Clorox Co, Oakland, CA), 5.25% sodium hypochlorite, 1:10; baking soda (Arm & Hammer, Church and Dwight, Princeton, NJ), sodium bicarbonate, 8%; vinegar, white distilled (Food Lion, Inc, Salisbury, NC), 5% vol/vol acidity, undiluted; Lysol Disinfectant Spray (Reckitt & Colman Inc, Montvale, NJ), 79% ethanol, 0.1% alkyl (50% C<sub>14</sub>, 40% C<sub>12</sub>, 10% C<sub>16</sub>) dimethyl benzyl ammonium saccharinate, undiluted; Lysol Antibacterial Kitchen Cleaner, 0.02% alkyl (50% C<sub>14</sub>, 40% C<sub>12</sub>, 10% C<sub>16</sub>) dimethyl benzyl ammonium chlorides, 0.08% alkyl (67% C<sub>12</sub>, 25% C<sub>14</sub>, 7% C<sub>16</sub>, 1% C<sub>8</sub>-C<sub>10</sub>-C<sub>18</sub>) dimethyl benzyl ammonium chlorides, undiluted; Mr. Clean Ultra (Procter & Gamble, Cincinnati, OH) ionic and nonionic surfactants,

undiluted. Sterile phosphate dilution buffer (0.25 µM, pH 7.2) and neutralizer were used as controls.

Household disinfectants were purchased from the shelf of a local grocery store. The disinfectants and natural products were stored in the dark at room temperature and prepared at their recommended use dilution in sterile distilled water (conductivity less than 0.7 µmhos/cm) on the day of the evaluation. All products were tested within the specified use-life.

The sodium hypochlorite was tested using a pHydriionTestuff Sanitizer Kit (Fisher Scientific) and found to be approximately 5% concentration, and was completely neutralized by a 1:10 dilution into 1.1% sodium thiosulfate.

### Neutralization of Chemical Agents Tested

To verify the loss of bactericidal activity after neutralization, the following assay was performed: 1.0 mL of disinfectant product (at its use dilution) was mixed with 9 mL of neutralizer, and approximately 300 colony-forming units (CFU) of bacteria were added to the disinfectant-neutralizer mix or controls consisting of phosphate buffer or neutralizer alone. Representatives of both gram-negative (*S. choleraesuis*) and gram-positive (*S. aureus*) bacteria were used as challenge organisms. Bacterial viability was determined 30 seconds and 1 hour after neutralization at 20°C. Samples were plated in duplicate on TSB agar plates and incubated for 18 to 24 hours at 37°C, and surviving bacteria were enumerated.

An appropriate neutralizer was used to terminate the reaction at the end of the test exposure. A 1:10 dilution into Lethen Broth (Difco) was adopted as a neutralizer for Vesphene IIs, TBQ, Mr. Clean, Lysol products, and baking soda. In antimicrobial susceptibility testing, Neutralization Broth (Difco) was adopted as the inactivation reagent for these products. For vinegar, the neutralizer was TSB with 10% calf serum. The neutralizer for ethyl alcohol was 0.5% Tween 80. The neutralizers did not retard the growth of the test organisms.

### Cytotoxicity Testing of Products in BGMK Cell Cultures

Testing was based on a procedure previously described by Sattar et al.<sup>20</sup> For this assay, BGMK cells were seeded into 12-well culture plates. The plates were incubated at 37°C for 48 hours, and then monolayers were exposed to 0.1 µL of serial 10-fold dilutions of disinfectant products along with a negative control for 1 hour at 37°C. After exposure, 2 mL of media were added and cultures then returned to 37°C. Cells were observed daily for evidence of cytotoxicity for 1 week. Evidence of toxicity for all products was not observed above a 1:100 dilution of the use dilution in all products evaluated. Test products at the dilutions plated were also shown not to alter the viral susceptibility of BGMK cell cultures.

### Quantitative Suspension Procedure for Testing Products

**Bacterial.** Susceptibility testing of products was performed using a standard quantitative suspension test.

TABLE 1  
EFFECTIVENESS OF DISINFECTANT AGAINST POTENTIAL PATHOGENS

Product	Log <sub>10</sub> Reductions							
	<i>Staphylococcus aureus</i>		<i>Salmonella choleraesuis</i>		<i>Escherichia coli</i> O157:H7		<i>Pseudomonas aeruginosa</i>	
	0.5 min	5 min	0.5 min	5 min	0.5 min	5 min	0.5 min	5 min
Vesphene Ilse	>8.2	>8.2	>6.7	>6.7	>6.6	>6.6	>6.7	>6.7
TBQ	>6.4	>6.4	>6.6	>6.6	>6.4	>6.4	>6.9	>6.2
Clorox	>5.8	>5.8	>5.9	>5.9	>5.6	>5.6	>5.3	>5.3
Ethanol	6.2	>6.7	>6.0	>6.0	>6.8	>6.8	>6.4	>6.4
Lysol Disinfectant	4.2	4.3	4.0	3.9	4.0	4.1	4.2	4.0
Lysol Antibacterial	>5.6	>5.6	>5.8	>5.8	>5.7	>5.7	>5.5	>5.5
Mr. Clean	4.1	>6.0	>5.7	>5.7	>6.1	4.7	>5.7	>5.7
Vinegar	0.03	0.3	>6.0	>6.0	0.4	2.4	>5.8	>5.8
Baking soda	0.2	0.5	2.3	2.3	0.4	0.7	1.1	1.1

Data represent mean of two replicates. Values preceded by ">" represent the limit of detection of the assay. Assays were conducted at a temperature of 20°C and a relative humidity of 45%. Results were calculated as the log of Nd/No, where Nd is the titer of bacteria surviving after exposure and No is the titer of the control.

All products were evaluated against the test organisms *S aureus*, *S choleraesuis*, *E coli* O157:H7, and *P aeruginosa*. A subset of the products was evaluated against resistant and susceptible strains of *S aureus* and *Enterococcus* species. The basic procedure was as follows: 0.5 mL of a 5-hour log-phase culture (inocula range 10<sup>7</sup>-10<sup>8</sup> CFU/mL) of each of the six strains was added to 49.5 mL of test product or phosphate dilution buffer pre-equilibrated to an exposure temperature of 20°C. Test organisms were exposed to products or controls for 30 seconds or 5 minutes in a thermostatically controlled waterbath set at 20°C. At completion of each exposure period, 1.0 mL samples of challenged disinfectant were removed and immediately added to 9.0 mL of neutralization broth. Ten-fold serial dilutions of neutralized test samples were prepared in phosphate dilution buffer and dilutions plated in duplicate onto TSA by the spread-plate method. Culture plates were incubated at 37°C for 18 to 24 hours and surviving test organisms enumerated. Colony counts (CFU) of surviving organisms were compared with control CFU to quantify microbial activity. Disinfectant efficacy was calculated by dividing the surviving CFU or the detection limit of the assay when no CFU were detected by the mean CFU in the disinfectant-free phosphate buffer control and then converting the result to its log<sub>10</sub> value.

**Test virus and virus assay.** Twenty µL of a virus suspension containing 10<sup>6</sup> plaque-forming units of poliovirus was seeded into 1.5-mL sterile polypropylene microtubes and 80 µL of disinfectant product or control was added to virus. The contents were then mixed. The reaction mixture was held at 20°C, and, after exposure periods of 30 seconds and 5 minutes, 0.1-mL samples were removed and immediately diluted with 9.9 mL of neutralization broth. Serial 10-fold dilutions were prepared in phosphate-buffered saline (pH 7.4). For plaque assay, 4-day-old BGMK monolayers were grown in 60-mm Petri dishes in 5% CO<sub>2</sub>. One-tenth mL of the test dilutions (10<sup>-3</sup>, 10<sup>-4</sup>, and 10<sup>-5</sup>) was placed on the cell monolayers

and allowed to adsorb for 60 minutes. After adsorption, 5 mL of 0.75% agar medium overlay containing neutral red was added to the cell monolayer, and then plates were returned to 37°C. After 48 hours, surviving viruses were enumerated. The effectiveness of the disinfectant was calculated by dividing the surviving virus concentration (or detection limit when no virus was recovered) by the initial virus concentration and then converting to the log<sub>10</sub> value.

## RESULTS

### Potential Household Pathogens

The following compounds demonstrated excellent antimicrobial activity (a log<sub>10</sub> reduction of more than 5.6 to 8.2, depending on the sensitivity of the assay) at both 30-second and 5-minute exposures: a quaternary ammonium compound (TBQ), a phenolic (Vesphene Ilse), a hypochlorite (1:10 Clorox), an ethanol, and a household disinfectant (Lysol Antibacterial Spray; Table 1).

Another household disinfectant (Mr. Clean) eliminated 4 to >6 logs<sub>10</sub> of pathogenic microorganisms. A third household disinfectant (Lysol Disinfectant) consistently eliminated ~4 logs<sub>10</sub> of microorganisms at both 30-second and 5-minute exposures.

Two natural products, vinegar and baking soda, were much less effective than commercial disinfectants. However, vinegar demonstrated substantial activity against two gram-negative bacilli, *P aeruginosa* and *S choleraesuis*.

### Antibiotic-Resistant Pathogens

Selected disinfectants were tested against antibiotic-susceptible and -resistant strains of *S aureus* and *Enterococcus* (Table 2). All commercial disinfectants completely inactivated both resistant and susceptible bacteria at both 30-second and 5-minute exposures. Vinegar inactivated ≤1 log<sub>10</sub> of all bacteria tested at 30 seconds, but demonstrated 3.7-5.3 log<sub>10</sub> reduction of both antibiotic-susceptible and -resistant *Enterococcus* at 5-minute exposure.

**TABLE 2**  
DISINFECTANT ACTIVITY AGAINST ANTIBIOTIC-SUSCEPTIBLE AND ANTIBIOTIC-RESISTANT BACTERIA

Product	Log <sub>10</sub> Reductions							
	VSE		VRE		MSSA		MRSA	
	0.5 min	5 min	0.5 min	5 min	0.5 min	5 min	0.5 min	5 min
Vesphene Ilse	>4.3	>4.3	>4.8	>4.8	>5.1	>5.1	>4.6	>4.6
Clorox	>5.4	>5.4	>4.9	>4.9	>5.0	>5.0	>4.6	>4.6
Lysol Disinfectant	>4.3	>4.3	>4.8	>4.8	>5.1	>5.1	>4.6	>4.6
Lysol Antibacterial	>5.5	>5.5	>5.5	>5.5	>5.1	>5.1	>4.6	>4.6
Vinegar	0.1	5.3	1.0	3.7	+1.1	+0.9	+0.6	2.3

Abbreviations: MRSA, methicillin-resistant *Staphylococcus aureus*; MSSA, methicillin-susceptible *S aureus*; VRE, vancomycin-resistant *Enterococcus*; VSE, vancomycin-susceptible *Enterococcus*. Data represent mean of two trials (n=2). Values preceded by ">" represent the limit of detection of the assay. Assays were conducted at a temperature of 20°C and a relative humidity of 45%. Results were calculated as the log of Nd/No, where Nd is the titer of bacteria surviving after exposure and No is the titer of the control.

**TABLE 3**  
DISINFECTANT ACTIVITY AGAINST POLIOVIRUS

Product Tested (Concentration)	Mean Log <sub>10</sub> Reductions at Exposure Time*	
	0.5 min	5 min
Vesphene Ilse (1:128)	0.033	0.22
TBQ (1:128)	0.10	0.09
Clorox (1:10)	≥3.3	≥3.3
Ethyl alcohol	0.03	0.65
Lysol Disinfectant	≥3.3	3.1
Lysol Antibacterial	0.10	0.27
Mr. Clean	0.19	0.15
Vinegar	0.25	0.32
Baking soda (8%)	0.14	0.42

\* Data represent mean of two trials.

### Poliovirus

Only two products demonstrated excellent activity (ie, greater than 3-log<sub>10</sub> reduction) against poliovirus: Clorox 1:10 dilution and Lysol Disinfectant (Table 3). All other products tested inactivated less than 1 log<sub>10</sub> of poliovirus.

### DISCUSSION

Emerging infectious diseases that have raised growing concern in recent years include foodborne infections, nosocomial infections, and infections associated with child-care centers.<sup>1</sup> It has been estimated that there are more than 30,000,000 foodborne infections per year, resulting in more than 9,000 deaths (*The New York Times*, July 4, 1998). Between 1988 and 1992, surveillance by the Centers for Disease Control and Prevention detected 2,433 outbreaks that caused more than 77,000 persons to become ill.<sup>21</sup> Fresh produce is contaminated with high levels of gram-negative bacilli such as *P aeruginosa*.<sup>22</sup> Fresh poultry is frequently contaminated with *Salmonella*.<sup>21</sup> Meat, especially ground beef, may be contaminated with *E coli* O157:H7,<sup>23,24</sup> since it is found in the intestines of approximately 1% of healthy cattle.<sup>23</sup> Such pathogens frequently may be found on kitchen

sites such as counter tops and cutting boards.<sup>14,15</sup> Mechanisms of acquisition of foodborne pathogens include ingestion of contaminated raw fruits and vegetables, inadequate cooking of contaminated produce or meats, and direct contact with contaminated surfaces. The relative role of each of these mechanisms has not been elucidated.<sup>21</sup> However, surface disinfection has been widely recommended to reduce the incidence of foodborne infections.<sup>25</sup>

Nosocomial infections are estimated to cause more than 19,000 deaths per year and contribute to another 58,000 deaths.<sup>2</sup> Environmental contamination has been demonstrated to play an important role in the transmission of certain nosocomial pathogens, including vancomycin-resistant *Enterococcus* species,<sup>6,7</sup> methicillin-resistant *S aureus*,<sup>3-5</sup> and *C difficile*.<sup>8-11</sup> Careful studies using molecular analysis<sup>6-8</sup> have suggested that, for these pathogens, environmental contamination has contributed to transmission between patients.

Widespread contamination of environmental surfaces with enteric organisms has been found in child-care centers, especially in rooms housing diaper-age children.<sup>12,13</sup> This contamination has been felt to play a role in person-to-person transmission of enteric pathogens.<sup>12</sup> Only limited data are available on the role of environmental contamination in the home and the role of such contamination on the transmission of pathogens in the home setting. In a sample of 21 English homes, Finch and colleagues found frequent colonization of kitchen sinks and drains with large numbers of *E coli* and sometimes *Klebsiella pneumoniae*, *Citrobacter*, and *Enterobacter*.<sup>14</sup> Scott and colleagues sampled multiple sites in 251 English homes and commonly isolated enteric bacteria from sinks, washing-up bowls, draining boards, and cleaning cloth. Less-contaminated sites included cooker surfaces, worktop and chopping board, food shelf, refrigerator, cutlery and crockery, and cleaning utensils. Importantly, *Salmonella* occasionally was isolated from the sinks (1.0%), refrigerators (0.3%), and cutlery (0.2%). Enteric bacteria were isolated from multiple bathroom sites, including basin, soap dish, toilet seat, and door handles.<sup>15</sup>

Many viral pathogens and enteric bacteria have been shown to be capable of surviving on environmental surfaces in sufficient doses and for sufficient time to serve as

a source of infection for humans.<sup>18</sup> Contaminated environmental surfaces have been shown in human studies to be capable of transmitting viral pathogens.<sup>16,17</sup> For these reasons, disinfection of environmental surfaces has been proposed as a means to decrease or eliminate potential pathogens and thereby decrease acquisition of disease. A variety of commercially available disinfectants are used by the public in their homes. In addition to commercially available products, several natural products also have been used by the public or for home health care.<sup>26</sup> In recent years, concern for the environment has resulted in a movement to eliminate or replace antimicrobials such as disinfectants with environmentally safe or "green" alternative chemicals.<sup>27-29</sup> In some countries, phenolics are seldom used in disinfectant formulations.<sup>30</sup> In some states, phenolics cannot be disposed of via a sanitary sewer.

Four commonly used household disinfectants (Lysol Disinfectant, Lysol Antibacterial Spray, Mr. Clean, Clorox), several disinfectants commonly used in healthcare (a quaternary ammonium compound [TBQ], a phenolic [Vesphene Ise], ethanol), and vinegar and baking soda were studied. These products were tested against a variety of bacteria representing medically important pathogens likely to contaminate the surface environment in the home: *S aureus*, *Enterococcus*, *S choleraesuis*, *E coli*, and *P aeruginosa*. Our data are based on a suspension test that may not fully evaluate the ability of these disinfectants to eliminate microorganisms dried on environmental surfaces.

The following products were found to be highly effective in inactivating all bacteria tested at both 30-second and 5-minute exposures: 1:10 Clorox, Lysol Antibacterial, ethanol, TBQ, and Vesphene Ise. Two other household disinfectants, Mr. Clean and Lysol Disinfectant, were capable of eliminating 4-6 log<sub>10</sub> of pathogens. These agents are sufficiently active to be effective in the home. Two natural products, vinegar and baking soda, were much less effective than disinfectants. However, vinegar demonstrated substantial activity against *P aeruginosa* and *S choleraesuis*. Vinegar was not effective against *E coli* or *S aureus*.

Viral respiratory pathogens such as respiratory syncytial virus and rhinoviruses cause significant morbidity. These agents are transmitted by close contact. They have been shown to be transmitted by contaminated surfaces between humans.<sup>16,20</sup> The efficacy of disinfectants on poliovirus was studied because small hydrophobic viruses are the most resistant to chemical agents. Disinfectants that inactivate poliovirus could be considered reliably capable of inactivating other pathogenic enteric and respiratory viruses. Only two of the tested products demonstrated excellent activity against poliovirus, 1:10 dilution of Clorox and Lysol Disinfectant. All other products inactivated less than 1 log<sub>10</sub> of poliovirus. These agents may have activity against other enteric and respiratory viruses, but this would need to be proved in appropriate scientific studies.

Gram-negative bacilli with multiple-drug resistance and antibiotic-resistant gram-positive cocci are major nosocomial pathogens, especially methicillin-resistant *S aureus* and vancomycin-resistant *Enterococcus*.<sup>2</sup> Previous

data suggested that these pathogens do not exhibit decreased susceptibility to disinfectants used in the hospital setting.<sup>31,32</sup> This study is the first to provide evidence that methicillin-resistant *S aureus* and vancomycin-resistant *Enterococcus* are as susceptible to household disinfectants as are antibiotic-susceptible strains. These pathogens were eliminated with both 30-second and 5-minute exposures to all tested disinfectants (Vesphene Ise, 1:10 Clorox, Lysol Disinfectant, and Lysol Antibacterial). Vinegar was ineffective at 30 seconds against both susceptible and resistant strains of *S aureus* and *Enterococcus*, but demonstrated 3.7- to 5.3-log<sub>10</sub> reduction against the *Enterococcus* at 5-minute exposure.

Scientific evidence supports the use of disinfectants as part of a program to control infectious disease by interrupting transmission via surface contamination. Their use in healthcare facilities is recommended by the Centers for Disease Control and Prevention,<sup>33,34</sup> the Occupational Safety and Health Administration,<sup>35</sup> and professional organizations such as the Association for Professionals in Infection Control and Epidemiology, Inc.<sup>36</sup> Disinfectants are also used in child-care centers, extended-care facilities, restaurants, and the domestic home as part of an effort to control transmission of infectious diseases.<sup>37</sup> The use of disinfectants on contaminated surfaces has been cited as a means to reduce or prevent the spread of gastrointestinal or respiratory pathogens.<sup>16,17,20,38</sup> Only limited data exist regarding the use of disinfectants in nonhealthcare settings. Kotch and colleagues demonstrated that routine use of disinfectants as part of a comprehensive intervention effort could decrease the incidence of severe diarrhea illnesses in child-care centers.<sup>37</sup>

Our data demonstrate that currently available home disinfectants have excellent activity against potentially pathogenic bacteria likely to contaminate home environmental surfaces. Some, but not all, products were highly active against polioviruses. Further, these products were active against both antibiotic-susceptible and antibiotic-resistant *S aureus* and *Enterococcus*. The natural products, vinegar and baking soda, demonstrated inadequate activity and therefore should not be used as home disinfectants. Now that the efficacy of commercial disinfectants for use in the home has been demonstrated, a controlled trial should be undertaken to determine if routine disinfection of home environmental surfaces will lead to decreased infection rates among household members.

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## Quinolone-Resistant *E coli* in the Community

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Garau and colleagues observed from 1992 to 1997 in Barcelona, Spain, an increasing proportion of quinolone-resistant *Escherichia coli* (QREC) infections. QREC strains increased in patients with community-acquired infections, from 9% in 1992 to 17% in 1996. Seventy (12%) of 572 episodes of *E coli* bacteremia were due to QREC. In a multivariate analysis, only prior exposure to antimicrobial agents, specifically to quinolones,

and the presence of a urinary catheter were significantly associated with QREC bacteremia. Among 16 QREC isolates from cultures of blood of community origin selected at random, 13 different pulsed-field gel electrophoresis patterns were recognized, showing the genetic diversity of these isolates and in turn indicating the independent emergence of QREC in the community.

The prevalence of QREC in the feces of healthy people was unexpectedly high (24% in adults and 26% in children). A survey of the prevalence of

QREC of avian and porcine origin revealed a very high proportion of QREC in animal feces (up to 90% of chickens harbored QREC). The high prevalence of QREC in the stools of healthy humans in the study area could be linked to the high prevalence of resistant isolates in poultry and pork.

FROM: Garau J, Xercavins M, Rodriguez-Carballeira M, Gomez-Vera JR, Coll I, Vidal D, et al. Emergence and dissemination of quinolone-resistant *Escherichia coli* in the community. *Antimicrob Agents Chemother* 1999;43:2736-2741.