Where the Germs are & How to get Rid of Them

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And

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Did you know??

- 80% of all common infections (colds, flu, diarrhea) can be spread through the environment (air, water, food, fomites)
- Approximately 1,000,000,000 cases of respiratory and enteric infections per year in the U.S.

Influenza Virus
Kids get sick.....A Lot!

- 40% of children aged 5–17 years missed 3 or more school days in the past year because of illness or injury.

- The “Common Cold” costs kids more than 189 million school days each year.

- Influenza costs kids nearly 40 million days each year.
$\$ Illness is Costly $\$

- **Student performance suffers**
  - Student absences have been found to be related to: lowered pupil achievement, IQ scores, delinquency, and higher school dropout rates
  - Ill students are often present, but perform poorly [“presentee-ism”]

- **Parents’ work is affected**
  - In the US caring for a sick child results in 126 million lost work days and $14.5 billion in lost productivity annually

- **Budgets are affected too**
  - Teacher illness-related absences average 5.3 days/year
    - Schools spend ~$80 per day for substitutes or about $424 per teacher per year
    - Studies show that teacher absenteeism affects student achievement
Challenges in Infection Control in the 21st Century

- Good hygiene had more impact on human health than the development of vaccines and antibiotics.

- Infectious diseases are the 3rd leading cause of death in the United States today. They are 1st in the developing world.

- Continued emergence and re-emergence of pathogens (SARS, MRSA, bird flu, etc).
What are the Routes of Transmission?
Life in the 21st Century

- Most of our time is spent indoors (80 - 90%)
- More people work in offices than ever before
- We travel more than ever before
- We spend less time cleaning than the last generation (50% less than 50 years ago)
- We are less clean (e.g. laundry practices)
- We spend more time in public places
- We are more mobile and have more electronic equipment (e.g. cell phones, ipods)
- We share more common surfaces (fomites) with more people than ever before in history
Cleaning vs. Hygiene

**Cleaning** is the removal of unwanted matter

**Hygiene** is reducing the risks of infection
Cleaning vs. Hygiene

- Meta-analysis of impact of cleaning and disease reduction indicates normal household cleaning may increase illness rates (Paul Hunter)

Cleaning alone may increase risks by spreading pathogens

*Is cleaning hazardous to your health?*
The Importance of Cleaning Tools in the Spread of Germs
Role of fomites in transmission of a disease

Sick person sneezes, coughs and pathogens falls on fomite or get aerosolized.

Pathogen falls on fomites e.g. phone, computer

Person picks up pathogen through contaminated fomite.

Person touches nose or eyes with contaminated fingers and becomes infected with pathogen.
Mouthing Events in Children (per hour)
- 81 times under two years
- 42 times two thru five years
- A child swallows the about of dirt on six kitchen floor tiles per day
Hand Contact in Adults

- Adults touch their face 15.5 times per hour
  - 2.5 eyes
  - 5 nose
  - 8 lip
The Campus Craps

- Posted at 4:22 PM on November 11, 2010
- Norovirus Hits Chicago Schools
- Dozens of people from at least 25 suburban Cook County schools have been sickened with an intestinal illness.
- That's up from only four schools less than two weeks ago.
What is Norovirus?

- Leading cause of non-bacterial gastroenteritis in the US
- Nausea, vomiting, diarrhea
- Incubation time 12-48 hours
- Duration 1-3 days
- Highly contagious
Norovirus

- No long term immunity
- Susceptibility related to blood group
- Transmitted by aerosolized vomit and feces
- Only infects humans
Identifying Critical Control Points

Home/Work/Play/Shopping

Germs that make you ill are not everywhere
Coliform Bacteria and *E. coli*

- Coliform bacteria and *E. coli* are found in feces and their presence on surfaces indicates contamination by feces and the potential presence of disease-causing microorganisms.
Environments Most Contaminated With Body Fluids

<table>
<thead>
<tr>
<th>Environment</th>
<th>% Surfaces Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daycare</td>
<td>46</td>
</tr>
<tr>
<td>Playgrounds</td>
<td>36</td>
</tr>
<tr>
<td>Bus travel</td>
<td>35</td>
</tr>
<tr>
<td>Park</td>
<td>29</td>
</tr>
<tr>
<td>Gym</td>
<td>28</td>
</tr>
<tr>
<td>Theater</td>
<td>26</td>
</tr>
<tr>
<td>Pool</td>
<td>14</td>
</tr>
<tr>
<td>Restaurant</td>
<td>14</td>
</tr>
<tr>
<td>Work</td>
<td>11</td>
</tr>
<tr>
<td>Doctor’s office</td>
<td>10</td>
</tr>
</tbody>
</table>
Bacteria in Offices

<table>
<thead>
<tr>
<th>Surface</th>
<th>Number of Germs per Square Inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phone</td>
<td>25,127</td>
</tr>
<tr>
<td>Desktop</td>
<td>20,961</td>
</tr>
<tr>
<td>Keyboard</td>
<td>3,295</td>
</tr>
<tr>
<td>Mouse</td>
<td>1,676</td>
</tr>
<tr>
<td>Fax Machine</td>
<td>301</td>
</tr>
<tr>
<td>Photocopier</td>
<td>69</td>
</tr>
<tr>
<td>Toilet Seat</td>
<td>49</td>
</tr>
</tbody>
</table>
Teaching: The “Germiest” Profession?

The most bacteria per square inch was found on surfaces commonly used by school teachers.

Measures taken of the phone, desk and computer mouse.
Germs at School
Schools – The Perfect Storm

- Lots of individuals, confined spaces
- High touch areas often not effectively disinfected

- Busy hands touch EVERYTHING
  - Kids touch faces, eyes, mouth 5+ times a minute
  - Hand washing is not thorough

- Viral transfer—up to 50% of viruses on a surface are picked up by the hand when the surface is touched
The Perfect Storm, cont’d

- Most school cases are NOT food-borne

- Hugh amounts of virus are shed before symptoms occur
  - Virus on dust particles in the air, settles on surfaces

- Disease transmission via 1-10 virus particles.
  - 1 trillion per gram of feces (size of peanut)
Day Care Study Results

- Samples positive in daycare for influenza A by month.
Occurrence of Bacteria by Grade – Top Three Surfaces with Bacteria

<table>
<thead>
<tr>
<th>Kindergarten</th>
<th>1-2</th>
<th>3-4</th>
<th>9-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bathroom Sink Faucet</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
<tr>
<td>Cafeteria Table</td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
</tr>
<tr>
<td>Desk</td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
<td><img src="image9.png" alt="Image" /></td>
</tr>
<tr>
<td>Water Fountain</td>
<td><img src="image10.png" alt="Image" /></td>
<td><img src="image11.png" alt="Image" /></td>
<td><img src="image12.png" alt="Image" /></td>
</tr>
<tr>
<td>Paper Towel Handle</td>
<td><img src="image13.png" alt="Image" /></td>
<td><img src="image14.png" alt="Image" /></td>
<td><img src="image15.png" alt="Image" /></td>
</tr>
</tbody>
</table>
## Coliform Bacteria Occurrence by Grade

<table>
<thead>
<tr>
<th>Grade</th>
<th>Kindergarten</th>
<th>1-2</th>
<th>3-4</th>
<th>9-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pencils</td>
<td><img src="image1.png" alt="Pencils" /></td>
<td><img src="image2.png" alt="Pencil Sharpener" /></td>
<td><img src="image3.png" alt="Library Table" /></td>
<td><img src="image4.png" alt="Desk" /></td>
</tr>
<tr>
<td>Bathroom Sink Faucet</td>
<td><img src="image5.png" alt="Bathroom Sink Faucet" /></td>
<td><img src="image3.png" alt="Library Table" /></td>
<td><img src="image6.png" alt="Bathroom Sink" /></td>
<td><img src="image7.png" alt="Locker Handle" /></td>
</tr>
</tbody>
</table>
School Study (Grade K thru 12)- 2009

Figure 1
Top Three Contaminated Sites in All Schools

- Cafeteria Table: 4.77E+06
- Computer Mouse: 1.70E+06
- Desk: 8.60E+05

Total Bacteria/approximate 100 cm sq
Sites with the Highest Percent of Coliforms in all Schools – it’s not the Restroom!!

<table>
<thead>
<tr>
<th>Site</th>
<th>Percent of sites positive for Coliforms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desk</td>
<td>59</td>
</tr>
<tr>
<td>Computer Mouse</td>
<td>57</td>
</tr>
<tr>
<td>Cafeteria Table</td>
<td>55</td>
</tr>
<tr>
<td>Library Table</td>
<td>53</td>
</tr>
<tr>
<td><strong>Bathroom Sink Faucets</strong></td>
<td><strong>36</strong></td>
</tr>
<tr>
<td>Water Fountain</td>
<td>33</td>
</tr>
<tr>
<td>Keyboard</td>
<td>33</td>
</tr>
<tr>
<td><strong>Bathroom Paper Towel Handle</strong></td>
<td><strong>29</strong></td>
</tr>
</tbody>
</table>
Viruses Isolated from School Desks Grades 3-4

- Most common viruses isolated on classroom desks
  - Influenza
  - Norovirus
  - Parainfluenza
The Importance of Cleaning Tools in the Spread of Germs
Norovirus
## Reported Norovirus Outbreaks

<table>
<thead>
<tr>
<th>Setting</th>
<th>Foodborne</th>
<th>Nonfoodborne†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Long-term care facility</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>School</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>Other/Multiple settings</td>
<td>114</td>
<td>13</td>
</tr>
<tr>
<td>Hospital</td>
<td>2</td>
<td>0.2</td>
</tr>
<tr>
<td>Day care</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Restaurant</td>
<td>574</td>
<td>64</td>
</tr>
<tr>
<td>Catering or banquet facility</td>
<td>151</td>
<td>17</td>
</tr>
<tr>
<td>Private residence</td>
<td>37</td>
<td>4</td>
</tr>
<tr>
<td>All settings</td>
<td>904</td>
<td>100</td>
</tr>
</tbody>
</table>
A Real-World Outbreak

- Staff members and students quickly ill
- 25+ staff members absent multiple days
- Spread to other schools and the parochial school in the community
  - Team activities
  - Extracurricular activities at church (choir, Boy Scouts, first communion instruction)
- Closed 11 schools for one week (school days, one holiday)
- 5000+ enrollment
Real-World Outbreak Costs

**DIRECT = @ $93K**

- **Disinfection = $45K**
  - Outside haz mat vendor = $25K
  - Supplies = $10-15K
  - Janitorial staff overtime = $5K

- **Personnel = $7875**
  - Cost of substitute teachers = $105/day per sub
  - 25 teachers x 3 days

- **Cancelled class trip = $40K**
Real-World Outbreak Costs

INDIRECT = $1,015,050

- School operations = $335,000 per day
  - Three lost days of school = $1,005,000
- State reimbursements = $10,050
  - 3350 x 3+ days out (plus earlier absentees)
Quat-Based Products

- “Quats” on the market for 60+ years
- 30+ quat-based EPA-registered formulations in 1500 products that control norovirus
- Our studies in schools show disinfecting with a norovirus-specific quat-based wipe prevents illness
  - These wipes also kill flu virus and other pathogens
Impact of Disinfectant Wipes on Absenteeism - Seattle

➢ Study
- Two school semesters
- 3rd and 4th graders

➢ Intervention
- Children’s desk wiped with a disinfectant wipe at the end of each school day

➢ Results
- 50% reduction in absenteeism
- From Bright et al, 2010; J. School Nursing
Ohio School Study

- Epidemiological study that looked rates of gastroenteritis and respiratory disease in elementary school
- Study compared classrooms which used disinfecting wipes at end of day on each desk and used alcohol gel sanitizer for hands
- Less incidence of gastroenteritis in intervention classrooms and fewer fomites contaminated with norovirus and lower concentration of norovirus on fomites.
## Norovirus Detection

<table>
<thead>
<tr>
<th>Surface</th>
<th>% Samples Norovirus Detected</th>
<th>Control</th>
<th>Intervention</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>desk</td>
<td>45</td>
<td>0</td>
<td>&lt;0.01</td>
<td></td>
</tr>
<tr>
<td>computer</td>
<td>63</td>
<td>0</td>
<td>&lt;0.01</td>
<td></td>
</tr>
<tr>
<td>water fountain</td>
<td>50</td>
<td>14</td>
<td>0.238</td>
<td></td>
</tr>
</tbody>
</table>

*significant difference if p = 0.01 or less
Outcome of Study

- Use of disinfecting wipes reduced the detection of noroviruses on fomites in the classroom
- Classrooms which did not use disinfecting wipes had a greater incidence of gastroenteritis
- Reduce risk by gastroenteritis by 20%
Annual Costs for Quat Wipes for Norovirus/Flu

- 180 school days
- 30 desks per class
  - 1 wipe for two desks
- 15 wipes per classroom per day (2700 per year)
- Canister is $8.72, contains 160 wipes = 5.45 cents per wipe
- **Cost per year is $147 per classroom**
The Importance of Cleaning Tools in the Spread of Germs

Bizarro

As I suspected, you're full of bacteria. We're going to have to throw you away.
Towels/Cleaning cloths

Dirt removal vs. germ removal

Clean vs. hygienic
Average Number of Bacteria in Towels used to Clean Rooms (before use) – Big Difference between Facilities

<table>
<thead>
<tr>
<th>Facility</th>
<th>Total Bacteria</th>
<th>Coliforms*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12,600</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>63</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>6,310</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>7,943</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>31,622</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>100,000</td>
<td>20</td>
</tr>
<tr>
<td>7</td>
<td>1,000</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>5,012</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>6,310</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>398</td>
<td>25</td>
</tr>
</tbody>
</table>

*E. coli was identified in two towels
Effect of Disinfectant Application Method
Soaked better than spray

<table>
<thead>
<tr>
<th>Organism</th>
<th>Soaked</th>
<th>Sprayed</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total bacteria</td>
<td>2,239</td>
<td>104,713</td>
<td>0.01</td>
</tr>
<tr>
<td>Coliforms</td>
<td>1</td>
<td>18</td>
<td>&gt;0.0001</td>
</tr>
<tr>
<td>Mold</td>
<td>1</td>
<td>2,188</td>
<td>&gt;0.0001</td>
</tr>
<tr>
<td>Spores</td>
<td>15</td>
<td>4,074</td>
<td>0.04</td>
</tr>
</tbody>
</table>
Effect of Cleaning Cloth Material on Bacteria in the Cloth - More Bacteria in Microfiber clothes after washing

<table>
<thead>
<tr>
<th>Organism</th>
<th>Cotton</th>
<th>Microfiber</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total bacteria</td>
<td>1,995</td>
<td>24,547</td>
<td>0.01</td>
</tr>
<tr>
<td>Coliforms</td>
<td>1</td>
<td>6</td>
<td>0.0002</td>
</tr>
<tr>
<td>Molds</td>
<td>1</td>
<td>47</td>
<td>0.001</td>
</tr>
</tbody>
</table>
Conclusions

- Reuseable cleaning/towels/cloth can contain opportunistic pathogenic bacteria
- Washing practices can effect microbial loads in reusable cleaning clothes/towels
- Microfiber clothes contain more bacteria than cotton
- A wide range of enteric bacterial types are present in cleaning clothes
Take Home Messages

- Norovirus and flu are major causes of school closures, absenteeism
- Use quat-based disinfectant formulations registered for efficacy for norovirus and flu
  - Labels state specific pathogens killed by the product
- Simple interventions are cost effective, reduce transmission of common school-based infections
- Follow label directions
Take Home Messages

- Cleaning and disinfecting need to be focused and strategic
- Be aware of cross contamination with cleaning tools
Are we too Clean?

- The “Hygiene Hypothesis”
  - Getting ill is make you more healthy ???
  - No long term immunity for common infections
  - Chronic illnesses associated with *Campylobacter*, enteric viruses, *Salmonella*, *Giardia*, etc. (e.g. reactive arthritis)
  - Development of autoimmune diseases possible (classic case – rheumatic fever)
  - Germ exposure is more likely increasing not decreasing