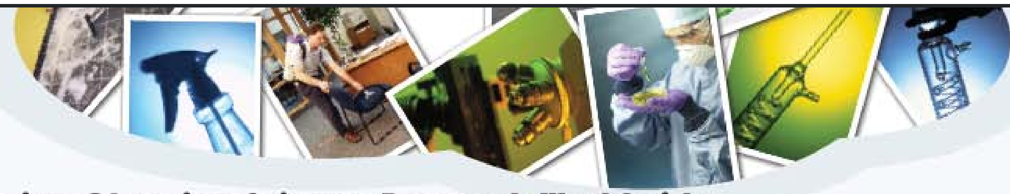

Article

Bringing Home Something Other than Homework from School: Microbial Contamination from Highly Touched Objects

By Dr. Jay Glasel

CATEGORIES: SCHOOLS, HEALTH & HYGIENE

Increasing quantitative evidence points to the conclusion that children are more susceptible to infection by microbial pathogens picked up from their environments than older persons exposed to the same pathogens [1]. There are many causes that underlie this increased risk but probably the major one is that childrens' immune systems (the natural protection against pathogens) don't fully develop until adulthood.

The increased risk for infection coupled with crowding in schools, the fact that children may not all have developed sanitary habits and have frequent hand-to-mouth and object-to-mouth contacts, etc. make it very important to understand what environmental sources present the most important risks for infection. If the properties of these pathogen sources can be understood, then cleaning and disinfection science may be used to minimize the risk for infection. Fortunately, scientific studies exist that have examined environmental microbial contamination in public places like schools. The results of these studies are sometimes surprising.

We all know that a major source of the spread of pathogens can be direct person-to-person transfer via sneezes and coughs. But this is actually a very inefficient way of transferring disease. A more efficient way is the transfer of human microbial pathogens to a surface or material that is touched by many other individuals (highly touched objects, HTOs) in the course of their daily lives and to allow each individual's touch-to-mouth, or touch-to-hand-to-mouth practice to spread infection. To be kept in mind is the fact that many individuals who are infected with pathogens don't necessarily become sick: they are "carriers".

The frequency of hand-to-surface and hand-to-mouth contacts has been quantitatively reported in a number of studies [2, 3]. These studies have shown that this behavior is age-related. For example, it was found that children <24 months old perform more than 80 hand-to-mouth actions per hour while the average for children 2-6 years old is 9 such events per hour. And the number of hand-to-surface events is very high for all ages. The high frequencies of these events highlight the efficiency of bidirectional transfer of pathogens from mouths to surfaces in daycare centers and in schools. But it brings up the questions of whether or not microbial pathogens can survive on surfaces, which surfaces have a high probability of harboring microbial contamination, and how can microbials best be removed from these surfaces. Fortunately, all of these questions have been addressed by quantitative scientific studies within the last few years.

As far as the survival of pathogens on surfaces is concerned , a very important and widely quoted recent paper reveals that viable common pathogens may persist on surfaces for times ranging from 2 hours to more than 4 years (!), depending upon the species. The range of persistences for pathogenic bacteria and viruses is given in Table 1.

So the answer to the question, "can viable microbial pathogens persist on surfaces ready to be touched and passed to the mouth?" is an empathetic "yes."

Table 1.

Type of bacterium	Duration of persistence (range)
Clostridium difficile (spores)	5 months
Corynebacterium diphtheriae	7 days – 6 months
Escherichia coli	1.5 hours – 16 months
Haemophilus influenzae	12 days
Klebsiella spp.	2 hours to > 30 months
Listeria spp.	1 day – 4 months
Mycobacterium tuberculosis	1 day – 4 months
Neisseria gonorrhoeae	1 – 3 days

Mop Bucket Liquid - Cleaning or Polluting?

"Bucket solutions become contaminated almost immediately during cleaning, and continued use of the solution transfers increasing numbers of microorganisms to each subsequent surface to be cleaned."

Source: Centers for Disease Control (CDC) and Prevention Healthcare Infection Control Practices Advisory Committee (HICPAC) "Guidelines for Environmental Infection Control in Health-Care Facilities."

Pseudomonas aeruginosa	6 hours – 16 months; on dry floor: 5 weeks
Salmonella typhi	6 hours – 4 weeks
Salmonella typhimurium	10 days – 4.2 years
Shigella spp.	2 days – 5 months
Staphylococcus aureus, including MRSA	7 days – 7 months
Streptococcus pneumoniae	1 – 20 days
Streptococcus pyogenes	3 days – 6.5 months
Vibrio cholerae	1 – 7 days
Type of virus	Duration of persistence (range)
Adenovirus	7 days – 3 months
Coronavirus	3 hours
SARS associated virus	72 – 96 hours
Coxsackie virus	> 2 weeks
Cytomegalovirus Echovirus	8 hours
HIV	> 1 week > 7 days
Herpes simplex virus, type 1 and 2	4.5 hours – 8 weeks
Influenza virus	1 – 2 days
Norovirus and feline calici virus (FCV)	8 hours – 7 days
Papillomavirus 16	> 7 days
Parvovirus	> 1 year
Poliovirus type 1	4 hours – < 8 days
Poliovirus type 2	1 day – 8 weeks
Pseudorabies virus	≥ days
Respiratory syncytial virus	up to 6 hours
Rhinovirus	2 hours – 7 days
Rotavirus	6 – 60 days
Vacciniavirus	3 weeks – > 20 weeks

The next question is, "which surfaces are most likely to harbor significant numbers of viable microbial pathogens?" The results of detailed scientific investigations that have focussed on answering this question have also been published. The results of these studies are harder to interpret because the recovery methods data analyses used vary widely. Even so, some general conclusions can be drawn. One surprising conclusion is that restroom floors and walls do not rank at the top of the list of sources of potential microbial contamination [5], possibly because most cleaning efforts are concentrated there.

HTO surfaces that do act as potential sources of contamination include: childrens' playground equipment, shopping cart handles, faucets, chair armrests, telephones and—of great importance in modern schools—computer keyboard keys [6-9].

We have seen that the microbial contamination can persist on HTOs such as just described, but this would not be a health threat if the contamination couldn't be easily removed by hand-to-surface contact. Studies have been performed on the efficiency of pickup of bacterial contamination from surfaces. The overall conclusion from these studies is that pickup efficiencies are very high (30-40%) from hard, non-porous, surfaces such as faucets but very low (<0.01%) from porous objects such as towels [10].

The efficiencies of transfer of microbials to mouths from hands that have become contaminated by touching contaminated surfaces have been found to be about the same as the transfer efficiencies from hard surfaces to hands—30-40% [10].

The general picture developed so far is that:

- Microbial contamination of HTOs present in schools is high
- The contamination can persist a long time in a viable state
- Transfer of microbial contamination to hands from some common HTOs is very efficient
- Transfer from contaminated hands to mouths is very efficient

Thus, in the case of schools, HTOs can be efficient intermediaries for spreading person-to-person and person-to-home microbial contamination. The microbials can come from a wide variety of human sources and consist of a wide variety of pathogens including antibiotic-resistant species ("superbugs") that, at the present time, are no longer confined to hospitals, but have become "community associated" [11].

What can be done to minimize the spread of pathogens in schools and from school to home? To answer that question, some aspects of cleaning and disinfection need to be addressed.

Cleaning and Disinfection

Considering only microbial contamination, cleaning and disinfection are basically two separate processes and thorough cleaning must be done prior to disinfectant use. According to the Center for Disease Control (CDC) cleaning consists of removing foreign material (soil and organic materials) from objects normally using water with detergents coupled with agitation of the cleaning solution as it's applied to the surfaces. Although the cleaning step may reduce the amount of microbial contamination on a surface (called the "bioburden"), a separate disinfectant solution having Environmental Protection Agency (EPA) approved efficacy in killing microbials should then be used. In particular, the disinfectant used must be shown to be efficient in killing the bacterial species found in the particular environment being disinfected.

Wherever there is pressure to control budgets, there is a tendency for directors and workers involved in cleaning and sanitization programs to scrimp on using proper concentrations of disinfectant solutions, to not allow enough time for applied disinfectants to act, to use less efficient wipers or methods to apply the disinfectants, and/or to neglect highly touched objects. This sort of pressure must be resisted because any successful cleaning/disinfection program includes:

- Using the correct tools and products for the job
- Monitoring cleaning activities and measuring efficacy
- Training personnel effectively
- Creating a culture of professionalism within the cleaning services staff

The spread into the community of pathogens that previously have been chiefly found in hospitals coupled with the increased susceptibility of children to infections makes it imperative that school cleaning efforts must minimize pupils' exposure to picking up pathogens from their school environments and spreading it into their homes.

Fortunately, a great deal of practical research has been forthcoming in recent years on how to stem hospital infections. It seems logical that many of the methods developed for minimizing hospital infections should be applied to cleaning school environments.

One of the most important findings of this research is that HTOs in hospital rooms including door knobs, light switches, armrests, and telephones are well cleaned only about 50% of the time. On the other hand, toilets, toilet seats, and sinks are well cleaned 85-90% of the time [12-15]. Thus, the normal hospital situation is that HTOs that are the most contaminated are the least well-cleaned. It is hard to see why this situation will be different in schools.

Optimizing the method of disinfection of HTOs is a necessary, but not always a simple task. For example, the most common method of applying a disinfectant is as a liquid deposited from a wiper. But, it has been found that wipers vary greatly in their ability to release disinfectants to surfaces [16]. In particular, after several wipes, the least expensive cotton rag or cellulose-based wipers release far less of some disinfectants than nonwoven, microfiber-based, wipers.

Tools to monitor the efficiencies of both cleaning and disinfection are readily available from commercial sources. For example, HTOs may be coated selectively with a water-soluble dye that is invisible in ordinary light, but fluoresces under UV ("blacklight") irradiation [17]. The dye solutions and hand-held blacklights may be obtained from many sources. The HTOs to be audited are coated with the dye prior to cleaning and the efficiency of cleaning is determined visually by the intensity of the fluorescence. This tool can also be used for training purposes. Adenosine triphosphate (ATP) levels monitored by luminometer devices have been shown to be a reliable and sensitive method for determining amounts of microbial contamination remaining on HTOs after cleaning and disinfection [15].

In conclusion, HTOs can be an efficient way of spreading infections within schools and from schools to homes. The physical and organizational tools that can be used to clean and disinfect HTOs and to monitor the effectiveness of the cleaning and disinfection are well known and available. What is required is the knowledge that it is important to implement and use these tools.

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Comment by jglasel on July 28th, 2009 at 2:08pm

Excellent article again driving home the importance of separating cleaning from disinfection. Recent studies indicate that the use of oxidizing cleaners may well become the product of choice in schools and healthcare settings.

About Dr. Jay Glasel

Dr. Jay Glasel is the Managing Member and Founder of Global Scientific Consulting, LLC. He is a Professor Emeritus in the Department of Microbial, Molecular and Structural Biology at the University of Connecticut Medical/Dental School in Farmington, Connecticut. He has lectured and done research in many countries in Europe and Asia. Dr. Glasel's scientific research has been in the fields of structural biochemistry, molecular immunology, pharmacology, and cell biology. Major portions of the research involved the structure and properties of water and aqueous solutions and on the structural chemistry and molecular biology of opiates and opiate peptides. He pioneered the uses of anti-morphine monoclonal antibodies and anti-opiate receptor anti-idiotypic antibodies in research on the cellular effects and actions of narcotics.

Dr. Glasel is co-editor and an author for the Academic Press textbook "Introduction to Biophysical Methods for Protein and Nucleic Acid Research" and many other contributed book chapters and original scientific

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Dr. Glasel obtained a B.S. in chemistry and physics from Caltech. His Ph.D. from the University of Chicago was in chemical physics for work on chemical reactions on comets. He has served on active duty in the U.S. Air Force as a nuclear research officer.

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