S O L U T I O N S

VIROX® TECHNOLOGIES INC.

Also In This Issue:

No financial support has been provided by Virox Technologies Inc. to authors of articles included in this newsletter.

VOLUME 33

The Time Spent Cleaning a Hospital Room Does Not Correlate With the Thoroughness of Cleaning

MARK E. RUPP, MD
UNIVERSITY OF NEBRASKA MEDICAL CENTER

Despite attempts at standardization of training and cleaning techniques in hospital settings, there remains great variation between housekeepers with regard to room cleaning practices. Environmental cleanliness can be assessed by direct observation, surface cultures, detection of adenosine triphosphate, or use of a fluorescent marking solution. Each monitoring technique has limitations. In a single center study (Infection Control and Hospital Epidemiology, Vol. 34, No. 1, 100-102,2013) we sought to examine the relationship between the amount of time that a housekeeper spent cleaning a hospital room and the thoroughness of surface cleaning.

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Spring/Summer 2014 Virox Update

2014 IPAC Cleaning, Disinfection and Sterilization Symposium

In line with our mandate to provide educational opportunities to the Infection Control Community, Virox has partnered with IPAC-Canada to sponsor the third bi-annual pre-conference day on Sunday May 25th on cleaning, disinfection and sterilization at the 2014 IPAC National conference in Halifax, Nova Scotia. The day promises to provide the most current information on disinfection of the environment, medical device reprocessing, patient safety, audit tools and occupational health and safety. The breadth of subject matter is sure to lead to debate of best practices, reflection on misconceptions and lead us to search for responses in face of the challenges we face in our daily practice and research. It is in this sense that Virox hopes to furnish information, practical skills and common ground for everyone who is actively in and/or interested in cleaning, disinfection and sterilization. For more information on the day please check out the IPAC-Canada website at www.ipac-canada.org. Please visit our booth at the IPAC – Canada Conference for more info.

Virox Technologies Inc Awarded 2013 Ontario Business Achievement Award as the Global Innovator

Virox Technologies Inc. has been awarded the prestigious Global Innovator Award, presented at the Ontario Business Achievement Awards (OBAAs) on November 20th, 2013 in Toronto, ON. Sponsored by the Government of Ontario, this award is presented to an Ontario business whose product has resulted in expanded exports and new jobs. Virox now stands amongst top companies such as PricewaterhouseCoopers LLP, Bombardier Aerospace, Magna International and Mercedes Corporation as a leader for driving economic growth in Ontario.

For over 30 years, The Ontario Business Achievement Award (OBAA) has been the most recognized industry gala in the province with a single focus on celebrating business success. Every year, the Ontario Chamber of Commerce recognizes businesses for their achievements in areas including innovation, market expansion, exports and corporate citizenship. Nominees are business leaders and entrepreneurs that drive the Ontario economy. They represent small, medium, and large enterprises from across sectors.

Since 1999, Virox has evolved from being a small company at the forefront of SARS, to providing disinfectant products to 60 countries worldwide. As a leading Research & Development company, Virox has seven issued global patents and more pending and has partnered with 9 tier-one industry leading companies. As the proud recipient of the Global Innovator Award, Virox will continue to help save lives and interrupt the spread of infections by providing a safer alternative to toxic legacy disinfectant chemistries.

Sixth Annual Virox Future Forum - Sheridan School of Business

The annual Virox Future Forum is an opportunity for Sheridan School of Business graduating students to look into emerging trends in the work world and to get advice on pitching business ideas. Sponsored by Virox Technologies Inc., the event connected more than 100 Sheridan Faculty of Business students with leading experts including demographer David K. Foot and Unmarketing President, Alumnus, Scott Stratten.

Talk Clean To Me Blog Round Up

The Talk Clean to Me Blog had an amazing year in 2013 and we wanted to say thank you to all of our loyal followers and fellow Clean Freaks who are just as passionate about saving lives through cleaning and disinfection as we are! As mentioned in the inaugural blog for 2014, this year will be the year of themes. We're winding down our focus on pathogens, and as you've likely gleaned, we're already introducing the idea of cost and return on investment in implementing a well oiled environmental hygiene program. One of the key areas we'll focus on in our "True Cost" discussion is the concept of contact time. Have you considered what impact not complying with the required contact time listed on the label has on disinfection, labour costs, and potential transmission of HAIs? We'll tell you, but you'll have to wait to read about it!

Here are a few of our favorite blog topics ... so far!
H1N1, H5N1, H10N8, H7N9, H5N8 - What Influenza strain will we see next?
Stuffies - Children's Comfort Toys and Home to Bacterial Burden!
PEDv Pooping Pigs Pose Pharaonic Problems!
Norovirus - It's a game of Cat and Mouse
ACMNPV - the new, but not so catchy HAI acronym!

To check out the full blogs go to the www.talkcleantome.com website and if you like what you read don't forget to subscribe to the blog! Most importantly, we love to hear your thoughts, questions and suggestions for new blog topics, so if you have some time, come TALK CLEAN TO ME.

Bugging Off! Nicole Kenny - Clean Freak

You can also follow our conversations on Twitter using #TCTM (or #TalkCleanToMe or #TalkCleanToMeBlog). If you're really interested in joining in the conversation about the safe and effective use of cleaners, sanitizers and disinfectants for hands, surfaces and devices join our LinkedIn Group - aptly named Talk Clean To Me!

Virox Insights

If you have ever wanted to get the inside scoop on all things Accelerated Hydrogen Peroxide® (AHP®), the Virox Insights Blog was created for you! Each month we, will provide insight on a new topic relating to AHP! Here is a recap of our awesome blogs so far:

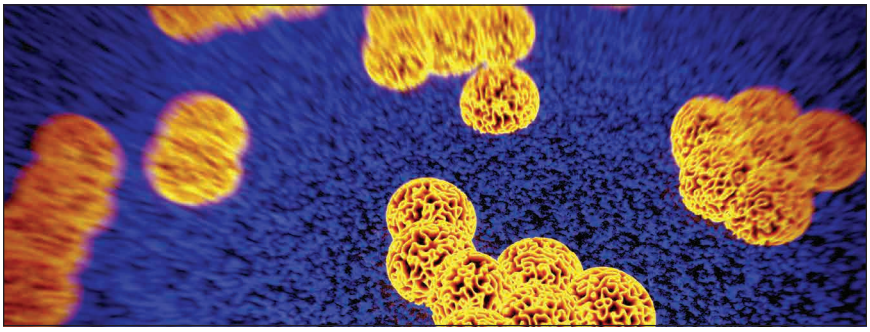
- Norovirus, A pain in the...
- Hey Hey, Ho Ho, PEDv has got to go!
- Don't let influenza take the spring out of your step

Come join our conversation and don't forget to subscribe!
www.viroxinsights.com

Insightfully yours,
Mikeisha Paul, Clinical and Technical Services Associate

The Dynamics of Methicillin-Resistant *Staphylococcus aureus* Exposure in a Hospital Model and the Potential for Environmental Intervention

DR. NOTTASORN PLIPAT, DEPARTMENT OF EPIDEMIOLOGY
SCHOOL OF PUBLIC HEALTH, UNIVERSITY OF MICHIGAN



Healthcare workers (HCWs) play important roles in the transmission of healthcare-associated pathogens such as MRSA. HCWs colonized with Methicillin-resistant *Staphylococcus aureus* (MRSA), although rarely reported, have been shown to be important sources of infections that have led to outbreaks. Additionally, HCWs have been implicated as mechanical vectors of transmission between patients. A few modeling studies examined the importance of HCWs as vectors, but did not explicitly include the environment.

An important strategy for preventing healthcare-associated infections (HAI), including MRSA infections, has been hand hygiene, but prevention of MRSA infections will likely need more than hand hygiene intervention. This is partly because of poor compliance, and also because of possibility of recontamination of hands from surface as well as cross-contamination from the skin. Due to these limitations, interventions performed in concert with hand hygiene, such as environmental cleaning, may be important to further decrease MRSA HAIs.

Environmental cleaning is aimed at removing or inactivating pathogens in the environment. Generally, hospital surface decontamination is performed by environmental health personnel, who manually apply liquid disinfectant to the surfaces on a regular basis. Another method of environmental cleaning is surface wiping. This can be done by anyone including healthcare workers by wiping a surface immediately after touching it. Surface wiping relies on the mechanical removal of contamination, thus, does not require a strong microbicidal formulation.

Exposure Assessment Model

In a recent publication (Plipat et al. BMC Infectious Diseases 2013, 13:595), we discussed an exposure assessment model that we developed, where MRSA is continuously shed from a colonized patient into the environment and is spread through HCWs' hands acting as vectors to another patient. The model includes one colonized patient, one uncolonized patient, and HCWs who care for them. The analysis was focused on MRSA exposure pathways to HCWs and the uncolonized patient. Direct MRSA exposure to the HCW was quantified by the net flow of MRSA resulting from the skin-to-skin contact with the colonized patient, while indirect exposure was quantified by the net flow of MRSA due to contamination of two surface types in the room, porous and nonporous. We employed similar procedures to quantify both direct as well as indirect exposure to the uncolonized patient.

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Healthcare Workers' Role in Maintaining a Clean Environment

NICOLE KENNY, VIROX TECHNOLOGIES INC.

The Journal of Hospital Infection recently published a tremendously comprehensive document entitled "epic3: National Evidence-Based Guidelines for Preventing Healthcare-Associated Infections in NHS Hospitals in England" (volume 86, January 2014), a full text of which is available at www.journalofhospitalinfection.com/supplements. The entire document is a worthwhile read, and one section in particular was notable - Healthcare Workers' Role in Maintaining a Clean Environment.

In systematic reviews of healthcare workers' knowledge about frequency of cleaning practices, the authors evaluated three studies that indicated that staff members were not using appropriate cleaning practices with sufficient frequency to ensure minimization of MRSA contamination of personal equipment. The studies also suggested that a lack of effectiveness was, in many instances, due to inadequate strengths of disinfectants, probably resulting from a lack of knowledge.

The authors identified no new, robust research studies of education or system interventions for this review. However, they noted that creating a culture of responsibility for maintaining a clean environment, and increasing knowledge about how to decontaminate equipment and high-touch surfaces effectively requires education and training of both healthcare cleaning professionals and clinical staff.

The section of the guideline concluded that all healthcare workers need to be educated about the importance of maintaining a clean and safe care environment for patients; and that every healthcare worker needs to know their specific responsibilities for cleaning and decontaminating the clinical environment and the equipment used in patient care.

I would like to see more on this topic, particularly the clarification of roles for various healthcare workers and the decontamination of surfaces and equipment. Hopefully we will have more to say on this in future issues of this newsletter.

The Role of Surface Disinfection in Infection Prevention - A European Perspective

The Rudolf Schuelke Foundation organizes a regular symposium inviting a panel of eminent scientists from various European countries to discuss a topic of current concern and special relevance for the field of hygiene. In a recent symposium, the Schuelke Foundation decided to assess "The Role of Surface Disinfection in Infection Prevention" - this is an overview of the consensus paper derived from those proceedings.

The view that environmental disinfection is important has recently begun to gain more ground. This increasing emphasis on the use of disinfectants for environmental decontamination is, to a certain extent, the consequence of a worldwide increase in the occurrence of microorganisms multi-resistant to antimicrobials, and associated with high rates of nosocomial infections. In addition, numerous scientific studies have furnished evidence for the transfer of microorganisms between surfaces and patients.

In recent years, scientific evidence has accumulated which has confirmed the following concepts:

- Bacteria, bacterial spores and viruses are shed from infected and/or colonized patients or staff into the hospital environment, especially into areas frequently touched by staff hands.
- Some bacterial species can survive for 4–5 months or more on dry surfaces, and norovirus can survive for up to one week.
- The levels of surface contamination by microorganisms in hospitals are low in comparison to the concentrations on patient skin or in stools. However, there is a risk of transmission even at low concentrations.
- The risk of transfer is also affected by the infectious dose, which is low for many nosocomial pathogens.
- Good evidence of the importance of environmental transmission is provided by a number of studies showing an increased risk of infection in patients admitted to side rooms previously occupied by other infected cases.
- The importance of surface contamination is also shown by the reduction in the rate of healthcare-associated infections when effective measures of environmental hygiene are implemented.

Surface disinfection as part of a multi-barrier approach

It has been found that compliance with hand hygiene is significantly less after contact with the environment than with the patient. This underlines the need to perform proper surface decontamination procedures within a multi-barrier approach (a "bundle strategy") to reduce and control pathogen transmission. Environmental disinfection policies should be based on risk assessments for different surfaces, with specific guidelines for different cleaning and disinfection measures. Education and training in cleaning procedures are also important and have been shown to improve both cleaning performance and infection rates. Recommendations should be based on objective assessment of the various methods of decontamination, such as cleaning with standard cleaning agents and water and disinfection with different biocidal agents.

The purpose of routine or targeted disinfection of inanimate surfaces is the killing or inactivation of pathogens to an extent which prevents subsequent infection transmission. Disinfection may be required in the following situations:

1. "High-touch" surfaces near patients
2. Surfaces where contamination is assumed
3. Surfaces with visible contamination (blood, pus, excrements)
4. Terminal disinfection in rooms or areas where infected or colonized patients were treated or nursed, or in outbreak situations.

The effectiveness of a disinfectant depends on a number of factors: those inherent to the product, those inherent to the application, and those inherent to the microorganism. Product factors include concentration, formulation, water solubility and pH. For example, the concentration exponent, (describing the relationship between dilution and activity of a biocide) must be considered, as well as the bioavailability of the substance and its stability. Application factors include the type of surface, the type of (organic) soil, the temperature and contact time as well as humidity and the mode of application (with or without mechanical action).

Toxicity

All biocides have some toxicological risks to human health and/or the environment. Therefore, disinfection procedures must include a risk assessment of potential toxicological hazards. These hazards mainly depend on the active ingredient used.

- Alcohol-based compounds, oxidants (e.g. hydrogen peroxide), sodium hypochlorite and formic acid are used for small and/or large surfaces and also do not have significant toxic side effects.
- Phenolic compounds vary considerably in their properties, depending on their chemical structure. In general, however, phenolics are regarded as slightly toxic. They possess a low sensitizing risk, but they are somewhat mutagenic and they have a high aquatic toxicity, especially triclosan.
- Aldehydes, such as formaldehyde, glutaraldehyde and glyoxal, are classified as highly toxic, and depending on the compound they can have sensitizing, carcinogenic, mutagenic and neurotoxic effects.
- Quaternary ammonium compounds (QACs) are often regarded as substances without toxic risks. This has led to their widespread use in households as well as healthcare institutions, despite their rather limited spectrum of activity. However, recent research has shown that benzalkonium chloride, a prototype QAC, may induce strong inflammatory irritation, including asthma and eczema, by contact as well as by inhalation. Air contamination with QACs may occur as a result of QAC particles being released from surfaces, followed by accumulation in dust. Thus, QACs may exhibit a higher allergenic potential than previously assumed, although there is no evidence of mutagenicity, teratogenicity or carcinogenicity.

Biocides and antimicrobial resistance

There are a number of questions under discussion concerning the use of biocides and antimicrobial resistance, including:

1. Can microorganisms become resistant to biocides?
2. Are there correlations between biocide usage and resistance to antibiotics?
3. What other factors contribute to a reduced susceptibility of microorganisms to biocides?

Resistance to biocides is assumed to be mainly a result of the ability of a bacterium to decrease intracellular biocide concentrations below the harmful threshold. Mechanisms such as changes in cell envelope, changes in permeability, efflux and degradation can be the reasons for such a decrease. They can be intrinsic or acquired. Some data show a possible relationship between biocide exposure and antibiotic resistance, especially for triclosan, silver, chlorhexidine and quaternary ammonium compounds.

Current data suggest a possible linkage between usage of certain biocides and resistance to both biocides and antibiotics. However, there is considerable variation between bacterial species and individual biocides and antibiotics. The present scientific data does not suggest that resistance problems will emerge, provided there is proper use of efficacious surface disinfectants.

Focus on disinfection as a procedure

Disinfection must be viewed as a holistic process, taking into account aspects inherent to the following:

- the product itself
- the application of the product
- the target microorganisms
- disinfection efficacy
- the methods of monitoring compliance.

Every attempt must be made to harmonize basic principles, standards and techniques for cleaning and disinfection of environmental surfaces. These standards should be based on risk assessments of contaminated surfaces and should include common requirements for product efficacy, correct dosage, shelf-life, application techniques, toxicity, and resistance potential. The special needs of low-income countries and outbreak scenarios in disaster areas should also be addressed.

Define a core curriculum for cleaning personnel

A core curriculum should be adopted for the training and education of cleaning personnel in medical facilities, including the necessary qualifications of their trainers and supervisors. Currently, curricula for hospital cleaning specialists differ considerably in contents and length even within the same country, ranging from 4 week courses to a 2 year course with a diploma from a technical college (in France).

Raise awareness

Healthcare personnel, hospital directors, patients, politicians, and the public should be made more aware of the need to include appropriate environmental disinfection procedures within the infection control strategy and of the adverse consequences of failures in compliance or improper performance. A better understanding of the role of environmental disinfection will also encourage the funding of any additional costs involved in implementing a quality-assured environmental disinfection program in medical facilities.

Concluding remarks

Disinfection must be viewed as a holistic process. There is a need for defining standard principles for cleaning and disinfection for ensuring compliance with these principles by measures such as written standard operating procedures, adequate training and suitable audit systems. There are many reports of insufficient and inadequate implementation of existing environmental cleaning and disinfection regimens. Therefore, future activities should focus on improving the quality of and the compliance with environmental disinfection procedures in accordance with a carefully designed set of standards.

This text is available with generous permission of the authors of the consensus paper on behalf of the Scheulke Foundation: Jurgen Gebel, Martin Exner, and Stefanie Gemein of Bonn University in Germany, Gary French of St. Thomas' Hospital in London, Yves Chartier of the WHO in Genva, Barbel Christiansen of the University of Schleswig-Holstein in Germany, Peter Goroncy-Bermes and Peter Oltmanns of Schulke & Mayr in Germany, Philippe Hartemann of the S.E.R.E.S. Faculte de Medicine in France, Ursel Heudorf of the Frankfurt Public Health Department, Axel Kramer of the Institute of Hygiene and Environmental Medicine in Germany, Jean-Yves Maillard of the University of Cardiff, Manfred Rotter of the Hygiene Institute of Vienna University in Austria, and Hans-Gunther Sonntag of the Institute of Hygiene and Medical Microbiology in Germany.

At Virox Technologies we have been proud supporters of the Teleclass Education initiative from it's launch, more than a decade ago. It has become the single most frequently accessed source for infection prevention and control information worldwide. For your convenience, this is a schedule of the English-language teleclasses planned for this year

2014 Teleclass Education Lecture Series

www.webbertraining.com

January
16 – *Hand Hygiene Over the Decade: 2004-2014*, Dr. Elaine Larson
21 – *Human Error Theory - Can it Help Us Understand and Minimize the Incidence and Impact of Outbreaks?,* Dr. Evonne Curran
29 – *Innovation and Implementation Strategic Approaches to Reduce Catheter-Related Bacteremia: The Results of a European Multicentre Study (PROHIBIT)*, Dr. Walter Zingg
30 – *Universal MRSA Screening - Is it Worthwhile and for Whom?*, Dr. Barry Cookson

February
06 – *Hand Hygiene - Is it the 100% Solution?*, Dr. Yves Longtin
12 – *Preventing Catheter Associated Urinary Tract Infections: What's New*, Prof. Paul A Tambyah
20 – *Eliminating Preventable Harm Through Building a Reliable Culture of Safety*, Dr. Denise M Murphy
27 – *Rapid Bacterial Diagnostics - Impact on Patient Care and Infection Control*, Dr. Stephen M Brecher

March
07 – *How to Prevent the Spread of Multi-Resistant Bacteria*, Dr. Stephan Harbarth
20 – *Friday Outbreaks - Fact or Fiction?*, Chingiz Amirov
27 – *Integrating Human Factors with Infection Prevention and Control*, Jules Storr, Claire Kilpatrick and Dr. Neil Wigglesworth

April
03 – *How to Bridge the Gap Between Knowledge and Practice*, Gertie van Knippenberg-Goerdebeke
08 – *Antibacterial Efficacy of Atmospheric Pressure Non-Thermal Plasma*, Dr. Brendan Gilmore
09 – *Highlights on Surgical Site Prevention: The New CDC Guidelines (and More)*, Dr. Joseph Solomkin
16 – *Prevention of MRSA Bacteraemia in European Hospital: Secrets of Success*, Dr. Michael Borg
17 – *Chlorhexidine Patient Bathing as a Means to Prevent Healthcare-Associated Infection*, Prof. Mark Rupp
24 – *Are We Too Clean for Our Own Good? The Hygiene Hypothesis and its Implications for Hygiene, Lifestyle, and Public Health*, Dr. Sally Bloomfield

May
05 – *Special Lecture for May 5th*, Prof. Didier Pittet
08 – *Ventilator-Associated Events: A Patient Safety Opportunity,* Dr. Michael Klompas
13 – *Ventilation in Healthcare Facilities*, Peter Hoffman
15 – *Methods to Evaluate Hand Hygiene Products*, Dr. Timothy Landers and Dr. David Macinga
26 – *Too Posh to Wash*, Martin Kiernan
27 – *Infection Control in Long Term Care*, Tina MacNamara and Jim Gauthier

June
05 – *Come Hell or High Water - Infection Control During and After Floods*, Gwyneth Meyers and Barbara Long
19 – *Chemotherapy - Health, Safety, and Waste Management Issues*, Ed Krisiunas
25 – *Healthcare-Associated Infections and Their Prevention After Extensive Flooding*, Dr. Anucha Apisarnthanarak

July
08 – *Controlling the Spread of Multidrug-Resistant Organisms in Healthcare Settings: Is it Really Possible?*, Prof. Pierre Parneix
17 – *Using Social Marketing to Improve Healthcare Quality,*Jason Tetro

August
14 – *Infection Prevention and Control - The Argentina Experience,* Caroline Giuffre
27 – *Diagnosis, Treatment and Prevention of Prosthetic Joint Infections - A Surgeon's Perspective*, Prof. Gary Hooper

September
03 – *New WHO Campaign to Eliminate Unsafe Therapeutic Injections*, Dr. Benedetta Allegranzi
11 – *Economic Analysis of VRE: Assessing Attributable Cost and Length of Stay*, Dr. Marc Romney
18 – *Health Economic Evaluation of an Infection Prevention and Control Program*, Dr. Elizabeth Bryce
25 – *Antimicrobial-Impregnated Surfaces in Preventing Healthcare-Acquired Infections - Differentiating the Hype From the Hope,* Prof. Hilary Humphreys

October
02 – *Infection Prevention & Control in Cystic Fibrosis,* Prof. Lisa Saiman
08 – *Public Reporting and Disclosure of HAI Rates: Positive Impact or Confusion?*, Dr. Maryanne McGuckin
09 – *Enhanced Environmental Cleaning in Controlling Clostridium difficile Infections in the Hospital Setting: Does it Matter?,* Prof. Farrin A Manian
16 – *Healthcare Laundry: Epidemiology and Microbiology Issues*, Dr. Lynne Sehulster
23 – *Infection Prevention in Outbreak Oncology Settings,* Dr. Alice Guh

November
05 – *Global Application of Behaviour Change Models and Infection Control Strategies*, Dr. Michael Borg
13 – *Emerging Respiratory Viruses: Are Healthcare Workers Protected?*, Dr. Virginia Roth
20 – *The Role of Companion Animals in Infection Transmission,* Prof. Timothy Landers and Prof. Jason Stull

December
02 – *Update of Clostridium difficile Infections in Europe,* Prof. Ed Kuijper
04 – *CDC/HICPAC Update to the Guideline for Prevention of Surgical Site Infection*, Dr. S.I. Berrios-Torres
11 – *Environmental Cleaning in Healthcare: Is Monitoring of Cleaning Compliance Really Needed?*, Dr. Michelle Alfa

Teleclass Education

Teleclass Education is an international infection control lecture series, made possible through the efforts of volunteers around the globe. A "teleclass" is a lecture delivered over the telephone, PowerPoint slides and handout notes having been provided to registrants in advance. The mandate of Teleclass Education is: (1) to bring the best possible infection control information, (2) to the widest possible audience, (3) with the fewest barriers to access. This initiative is funded by modest registration fees, corporate sponsorships, governmental and NGO grants, and private donations. Healthcare workers in developing nations are entitled to unlimited free access to Teleclass Education materials. A free-access archive of lecture recordings and handout notes is available on www.webbertraining.com.

Use of Household Disinfectants

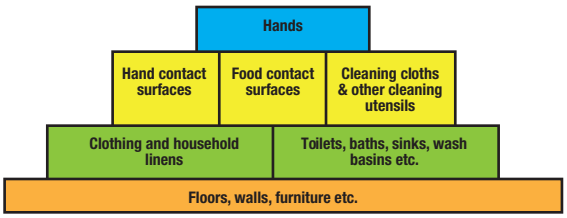
DR. SALLY BLOOMFIELD, INTERNATIONAL SCIENTIFIC FORUM ON HOME HYGIENE

Home Hygiene means the prevention of spread of pathogens in the home to stop family members from becoming infected. Pathogens are introduced continually into the home, by people (who may have an infection, or who may be asymptomatic), by contaminated food and domestic animals, and also sometimes in water, or via the air. Additionally, sites where stagnant water accumulate such as sinks, toilets, baths, tiled surfaces, waste pipes, or cleaning and face cloths readily support microbial growth and can become a reservoir of infection; although, in this case, species are mostly those which represent a risk only to vulnerable groups.

Within the home, there is a chain of events (see Fig. 1) that results in spread of infection from these sources to a new recipient. Limiting the exit and entry of pathogens from or into the human body involves activities such as good respiratory hygiene, care of wounds, etc. Thorough cooking and safe storage of food and household water treatment and safe storage are also part of home hygiene. In communities where public water supplies are unsafe and/or inadequate, provision of safe water for the family through "household water treatment and safe storage" is also part of home hygiene.

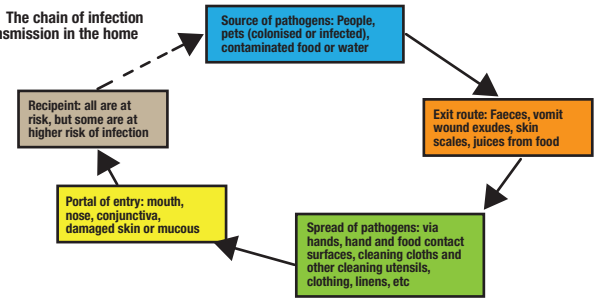
The approach that International Scientific Forum on Home Hygiene (IFH) has adopted to breaking the "spread of infection" link in the home is known as "targeted hygiene". Targeted hygiene means understanding the routes of spread of infection in the home and targeting hygiene measures at critical points to prevent the spread. This risk-based approach suggests that the "critical control points" for breaking the chain of infection are the hands, together with hand and food contact surfaces, cleaning cloths and other cleaning utensils. Although this is a useful "rule of thumb" ranking, it is not a constant. For example, although the risks from toilets, sinks and floors relate mainly to the relatively lower risk of transfer from these sites to hands, hand and food contact surfaces and cloths, this risk can increase substantially where an infected family member has fluid diarrhea, or where a floor surface is contaminated with vomit, urine or faeces.

Fig. 2 - Ranking of sites and surfaces in the home based on risk of transmission of infections



Key to breaking the chain of infection in the home is the application of hygiene procedures to critical surfaces (e.g. hands, hand contact and food contact surfaces) at the appropriate time to eliminate pathogenic contamination. Decontamination of surfaces may be achieved either by soap or detergent-based cleaning, the application of a "microbicidal process", (either heat or a chemical disinfectant), or a combination of both. In general, for hand hygiene and for cooking and eating utensils, contamination can be effectively removed using soap or detergent and hot water. The soap or detergent helps to detach the organisms from the surface. The rinsing process then removes the organisms from the surface leaving it "hygienically clean".

Fig.1 The chain of infection transmission in the home



In some cases however "rinsing" with water is not an option. Where surfaces are cleaned with a cloth or mop without rinsing, this removes visible soiling and a large proportion of the contamination, but still leaves behind some pathogens, which can be enough to cause an infection. In these situations, use of a chemical disinfectant (or a heat process) that kills or inactivates these residual contaminants is advisable. Areas where a chemical disinfectant may be required include larger surfaces that cannot be adequately rinsed, such as bedside tables and food preparation surfaces, and surfaces such as handles, toilet seats. It can sometimes also include floor surfaces, which have become contaminated by pet faeces or body fluids etc – particularly where there is a crawling baby. Chemical disinfection or the combined action of heat and a bleach-based laundry powder is also recommended for cleaning cloths, mops, clothing, and linens because detergent-based cleaning is found to be insufficient to detach microbes.

Use of disinfectants is particularly advised in situations of high risk such as caring for family members who are infected, or who are at increased risk of infection. For example, use of hand and surface disinfectants in private homes is advisable in the following risk situations:

- The presence of gastrointestinal infections, if immunosuppressed or susceptible persons (including newborns) are household members, provided the focus is on hand disinfection, supplemented by disinfection of risk areas in the bathroom and kitchen;
- If a family member has an infection caused by a highly contagious pathogen such as norovirus, tuberculosis or enteropathogenic *E. coli*. If Norovirus is involved, virucidal surface disinfection must be used after contamination with faeces or vomitus;
- If a patient discharged from hospital returns home with invasive medical devices or wound dressing still in situ;
- If preventative measures for re-colonization of MRSA carriers are implemented, which include hand disinfection in combination with the disinfection of relevant contact surfaces.

For more details go to Cleaning and Disinfection: Chemical Disinfectants Explained www.ifh-homehygiene.org/factsheet/cleaning-and-disinfection-chemical-disinfectants-explained

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Fifteen high-touch surfaces in each of 74 patient rooms located in 4 adult medical-surgical critical care units were covertly marked by study personnel with a transparent, water-soluble solution that fluoresces when exposed to UV light. The marked surfaces consisted of the room door handle, thermometer, patient monitor, bedside tray table, bedrails and release buttons, nurse call box, faucet handle, computer mouse, light switches, cabinet handle, and hand gel dispenser handle. After discharge of the patient from the hospital and routine terminal cleaning of the room, the high-touch surfaces were surveyed, and the rooms were scored according to the percentage of surfaces appropriately cleaned.

Twenty-four different housekeepers were involved. The amount of time spent by housekeepers to clean a room was monitored through use of an automated system, requiring housekeepers to document by telephone when they arrived at the room and when room cleaning was complete. Fisher's exact test was used to evaluate associations between the cleanliness of individual surfaces and the hospital unit. The Kruskal-Wallis test was used to compare one unit with another with regard to the median amount of time required to clean a room and the median number of surfaces adequately cleaned. The Spearman correlation test was used to compare the overall thoroughness of cleaning versus the amount of time required to clean the room. A P value of less than .05 was considered significant.

There was a wide discrepancy between thoroughness and efficiency. Although a few rooms were fairly well cleaned within 30 minutes (which is an accepted industry benchmark), many of the rooms with below-average cleaning took considerably longer to clean. There was no correlation between the amount of time spent cleaning a room and the thoroughness of cleaning high-touch surfaces as documented by the UV-tagged marking system. Clearly, adequate time must be allotted for personnel to clean a room properly, but it is apparent that additional time taken to clean a room is no guarantee of adequate cleaning.

The primary limitation of our study is that we did not evaluate the impact of cleaning on surface contamination or healthcare-associated infections. Also, the study consisted of a small sample size of rooms and housekeepers, and the amount of time spent cleaning each room was not validated by direct observation.

We documented a counter-intuitive observation that a greater amount of time spent cleaning a hospital room does not necessarily correlate with the effectiveness of cleaning high-touch surfaces. If the efficiency of cleaning is similar in other settings, it is likely that substantial opportunities to improve both the thoroughness of cleaning and the overall efficiency of practice exist in many healthcare settings. Our finding emphasizes that process improvement interventions should evaluate both the efficiency and thoroughness of hospital surface cleaning to optimize the cost effectiveness of cleaning practice in healthcare settings.

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Our model for MRSA exposure assessment highlights the dynamic interplay between MRSA colonized and uncolonized patients, HCWs, and environmental surfaces. In reality, HCWs touch room surfaces more frequently than they touch patients, indicating that we might be underestimating the importance of indirect exposure through environmental surfaces. HCWs are frequently viewed as vectors of transmission, also assumed in our model. However, HCWs may also be the source of transmission. Since our model only considered the HCWs as mechanical vectors, we probably underestimated the exposure to the uncolonized patient.

Given the role of HCW's hands in spreading contamination, hand hygiene is potentially a strong effect modifier of cleaning. This is clearly true if hand hygiene is done perfectly, i.e., if contamination never gets on the hand, surface cleaning is irrelevant. In reality, however, hand hygiene is never perfectly implemented. Real-world impediments include the following: (1) imperfect compliance with hand hygiene procedures, (2) cross-contamination of HCW hands when HCWs touch their own contaminated clothing, and (3) recontamination due to the touching of contaminated surfaces. Although beyond the scope of this manuscript, describing the joint effects of hand hygiene (considering compliance and recontamination) and surface cleaning would provide valuable information for developing realistic intervention strategies.

Our model assumed that surface decontamination thoroughly cleaned the entire surface. In reality, such thoroughness is often lacking. A review of environmental hygiene in healthcare settings showed that only 40% of the surfaces were being thoroughly cleaned in accordance with existing policies. Some have used a monitoring system to improve cleaning thoroughness, which resulted in decreased MRSA infection; for example, when hand-touched surfaces near patients and HCWs' station were cleaned more frequently by extra personnel, there was a 32.5% reduction in environmental contamination sites and 26.6% reduction in new MRSA infections.

Similarly, our model assumed that surface wiping was conducted using proper techniques. The true effectiveness of surface wiping was difficult to define due to a wide variety of commercially available wipes and microfiber-based fabrics, as well as a variation in test protocols. One study showed that wiping plastic surfaces three or more times with saline-moistened wipes is as effective as disinfectant wipes. At the same time, disinfectant wipes may serve as vectors in transferring pathogen between surfaces when reused without proper cleaning. Nevertheless, as suggested in our analysis, the frequency of wiping with presumably good technique can significantly reduce the environmental contamination.

Environmental cleaning should be considered as an integral component of MRSA infection control in hospitals. Given the previously under-appreciated role of surface contamination in MRSA transmission, this intervention mode can contribute to an effective multiple barrier approach in concert with hand hygiene.