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The Canadian Journal of INFECTION CONTROL

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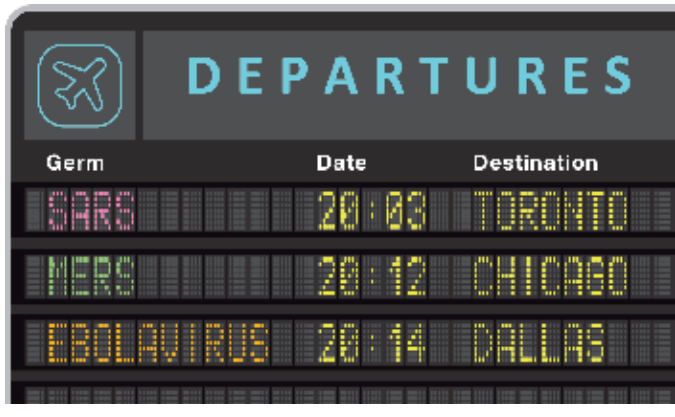

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PUBLISHER
Craig Kelman & Associates

3rd Floor, 2020 Portage Avenue
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Tel: (204) 985-9780 Fax: (204) 985-9795
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EDITOR - Cheryl Parisien
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Send change of address to:
IPAC Canada
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University Health Network
200 Elizabeth Street, Toronto, ON M5G 2C4
Tel: 416-340-3758 Fax: 416-340-5047
michael. gardam@uhn.on.ca

Other Positions

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Chingiz Amirov, MPH, MSc QIPS, CIC
Director, Infection Prevention and Control
Baycrest Health Sciences
3560 Bathurst Street
Toronto, Ontario M6A 2E1
camirov@baycrest.org

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Assessment of biocides in order to minimize the potential of bacterial resistance

Author and corresponding author:
Pierre Grascha, PhD, Chief Scientist
Deb Group Limited
Denby Hall Way
Denby, Derbyshire, DE5 8JZ
United Kingdom
Tel: +44 1773 855 100
Mobile: +33 603 355 837
Fax: +44 1773 855 250
Email: *pierre.grascha@debgroup.com*

ABSTRACT

Antibiotics mainly, but also antiseptics and disinfecting agents, are increasingly suspected of inducing bacterial resistance and cross-resistance. This paper aims to provide a clearer understanding of the interaction between biocides and microorganisms which eventually lead to resistance. Actually, the term "bacterial," which is related to bacteria only, should be replaced with the more generic term "microbial" as the emerging resistance phenomenon also concerns other micro-organisms such as fungi and viruses.

The second objective is, through a comprehensive review of the main current biocidal agents, to clarify why a strategic choice of biocidal agent helps to combat resistance mechanisms. Hydrogen peroxide, iodine, and alcohols are identified as lowest risk solutions.

KEYWORDS
Biocides, antimicrobials, bacterial resistance, alcohol, hydrogen peroxide.

INTRODUCTION

Although the development of microbial resistance may be considered as a natural consequence of biocide usage, the medical and economic consequences are profound and have been recently extensively studied (1, 2), and overall estimates indicate that more than 1.4 million patients worldwide are affected at any specific time (3). Cost to US medical care sector of treatment for patients with infections caused by resistant organisms is estimated to be $4 to 20 billion USD per year (4, 5, 6). On the other hand, it is also fair to state that the increase in microbial resistance also represents an economic opportunity to the pharmaceutical industry for the development of new antimicrobial agents as well as a challenge for formulators who must find the best strategies for limiting the risk of making the bacterial resistance situation even worse.

Bacterial resistance is a spontaneous or acquired natural phenomenon which occurs when microorganisms are exposed to biocides. Poor infection control and overuse of disinfectants, antiseptics and antibiotics, more particularly at sublethal concentrations, may accelerate this natural phenomenon.

At the present time infection prevention and control practices do take into account strategies for limiting the risk of inducing bacterial resistance. One strategy may consist of associating synergistic combinations of biocidal agents. By doing this, the number of microbial cell-targets will be increased, and therefore the risk of developing a specific resistance should be proportionally reduced. Another strategy, which is actually complementary to the previous one, consists of selecting the biocidal agents which have the lowest potential of inducing resistance because their mode of action is not specific to one single cell component; the higher the number of cell targets, the lower the risk of microbial resistance (Table I).

THE MECHANISMS OF MICROBIAL RESISTANCE

Microbial resistance may be defined as the capacity for microorganisms to survive exposure to one or more biocides. This property may be intrinsic, or spontaneous through random genetic mutations, or acquired through induced genetic mutations (7, 8).

Cross-resistance relates to the capacity of micro-organisms which are already resistant to a given biocide, to develop resistance to some other chemical

TABLE 1 - Activity and potential for acquired resistance of the currently used families of biocidal agents

	Bactericidal	Sporicidal	Fungicidal	Mycobactericidal	Virucidal (enveloped)	Virucidal (non-enveloped)	Acquired microbial resistance
Alcohols	☆	no	☆	☆	☆	no	Unlikely
Aldehydes	☆	☆	☆	☆	☆	☆	☆ Mycobacteria and Gram negative bacteria
Chlorhexidine	☆	no	☆	no	☆	no	☆ Gram positive and Gram negative bacteria
Chlorine compounds	☆	☆	☆	☆	☆	☆	☆ Gram positive and Gram negative bacteria
Iodine and iodophors	☆	☆	☆	☆	☆	☆	☆ Gram positive and Gram negative bacteria
Quaternary ammoniums	☆	no	☆	no	☆	no	☆ Gram Gram negative bacteria
Metal ions	☆	no	☆	☆	☆	☆	☆ Gram positive and Gram negative bacteria
Peroxides	☆	☆	☆	☆	☆	☆	Unlikely
Phenolics	☆	no	☆	☆	☆	no	☆ Mycobacteria and Gram negative bacteria

structure-like biocides too; the level of chemical structure similitude being limited to one chemical function (i.e., methyl, lactone, phenol) or to a greater structure analogy.

Intrinsic resistance:

Various cellular and chromosomally mediated pathways may contribute to higher resistance to biocides:

Physiological factors: Biocides interact with micro-organisms initially at the cell surface. Gram-positive and Gram-negative bacteria, mycobacteria, yeasts, molds, and viruses respond differently because of their physiological and biochemical differences. Within these families of germs, and from species to species, and even from strains to strains, differences of level of intrinsic resistance have been described. At the microbial family level, Gram-negative bacteria for instance, show higher resistance to many biocides than Gram positives because their outer cell layer (peptidoglycan and phospholipids, narrow porin channels) acts as a permeability barrier which limits the penetration of hydrophobic molecules.

For a similar reason, mycobacteria are also known for resisting antibiotics because they are enveloped by a thick and waxy outside layer of glycolipids (mycolic acid, arabinogalactan, and peptidoglycan) that prevents the binding of some biocides. The coat and cortex of bacterial spores also represent a perfect barrier to most physical and chemical biocidal agents. Last but not the least example is enveloped viruses which are much more "biocide-sensitive" than naked viruses because their external membrane of phospholids is very easily solubilized by most surfactants and solvents.

An alternative common strategy used by many bacteria is the enzymatic inactivation of drugs. In this process, a bacterial enzyme is modified to deactivate the drug in such manner that it no longer affects the microorganism or has less detrimental effect on it.

Efflux pumps: Bacteriologists have experimentally demonstrated that some membrane proteinaceous transporters (called "efflux pumps") are responsible for the extrusion of xenobiotic substances outside the cell. Such a physiological aptitude contributes to the intrinsic resistance of bacteria by pumping out a variety of agents, including protons, surfactants and biocides.

Biofilm: Some micro-organisms also demonstrate intrinsic resistance through inactivation of biocides; the production by some bacteria of a protective mucoexopolysaccharide (glycocalyx) is associated with reduced biocide diffusion (9).

Acquired resistance:

The widespread and large-scale use of biocidal agents, including antibiotics, creates a selective pressure on the micro-organisms which induces spontaneous genetic and phenotypic mutations. Another possible route is represented by the acquisition of a plasmid or transposon.

Sometimes, these changes are in favor of increasing the capability of the micro-organisms to adapt to the stressing environmental conditions. A direct consequence of this evolution may be the emergence of a new strain of bacteria, fungi or virus showing a high level of resistance to the stress exposure.

Several mechanisms have evolved in bacteria which confer drug resistance to them.

Exposure to sub-lethal concentrations of biocide: Misuse, as well as under-concentrated microbiocidal molecules, risk promoting the emergence of resistance.

It is possible that residual sub-lethal concentrations play an important role in the selection of less biocide-sensitive strains, and/or in the induction of resistance by the process of stressing the microorganisms, therefore creating the possibility of the microorganism developing survival strategies. This was demonstrated by numerous studies, some of which will be presented in the next section.

Plasmid-mediated resistance: Bacterial resistance to biocides may be plasmid-borne and may be naturally transferred from bacteria to bacteria by conjugation or transduction.

Bacterial conjugation corresponds to the horizontal transfer of genetic material between bacteria by direct contact or by a bridge-like connection between two cells. During this process the donor cell provides, via its F-pilus, a small part of its genome, a plasmid (DNA sequence that can replicate independently), or a transposon (DNA sequence that can change its relative position within the genome), to a recipient or "female" bacteria. The transferred portion of genome is sometimes beneficial to the recipient in terms of biocide resistance for instance, or in terms of capacity of metabolizing new nutrients.

Transduction is the process by which genes are transferred from bacteria to bacteria via a viral vector (i.e., bacteriophage). Such phenomenon occurs when the viral "lysogenic" rather than the "lytic" route is randomly happening. Lysogeny corresponds to the integration of the viral genetic material, called "prophage," into the bacterial genome. The prophage is transmitted to daughter cells during each cell division, but a later event (i.e., exposure to UV radiations) can release it; then new bacteriophages are produced by the infested bacteria via the lytic cycle.

Both conjugation and transduction phenomenon may explain why some antibiotic and biocides become less effective or totally ineffective.

Genetic mutation: The replication of the genome (DNA or RNA) is such a complex process that spontaneous mutations do occur randomly. The estimated average number of spontaneous mutations within a given strain of bacteria in culture ranges from $1/10^{9}$ to $1/10^{13}$. Mutations may also be induced by mutagenic non-lethal chemicals or radiations, or via the microbiological route. In all cases, they are materialized by changes in a genomic sequences and lead to physiological and/or metabolic changes in the cell.

Lethal mutations lead to the death of the cell but non-lethal mutations, when they are not properly repaired by the cell itself, can result in several different types of changes. There are three possible scenarios; they may have no effect, or they may prevent the genes from functioning properly, or they may allow the micro-organisms to survive in hostile environments, which includes in the presence of toxic substances.

REVIEW OF CURRENT MICROBIOCIDAL MOLECULES VERSUS THE RISK OF MICROBIAL RESISTANCE

Alcohols

Alcohols are organic compounds having hydroxyl functional group(s) (-OH) bounded to a carbon atom (R-OH). They may be primary, secondary or tertiary alkyl or aryl alcohols.

For linear alcohols, the microbiocidal activity increases with the length of the carbon chain, from 1 to 5 and then decreases. The microbiocidal potential also decreases with the number of ramifications.

Alcohols used for skin disinfection are ethanol, n-propanol and isopropanol.

The antimicrobial activity of alcohols is not specific as they can inhibit the DNA and RNA, as well as the protein and peptidoglycan synthesis. They are membrane disrupters and they also denature the cytoplasmic proteins and microbial enzymes, but this requires the presence of water (most effective alcohol-based formulations contain 60 to 80% alcohol).

Alcohols have good germicidal activity against Gram-positive and Gram-negative vegetative bacteria (including multi-drug-resistant pathogens such as MRSA and VRE), mycobacteria, enveloped viruses, yeasts and moulds. However, their efficacy against bacterial spores is nil, is very poor against non-enveloped viruses and no residual activity may be expected as alcohols evaporate after application.

Microbial resistance to alcohols is not an issue at in use concentrations. Studies involving 50 passages of *Staphylococcus aureus* in the presence of 3.5% and 7% isopropanol did not increase its MIC or MBC. Even when sub-bacteriostatic concentrations were used and an associated decrease in sensitivity, the change was reversed by exposure to cidal concentrations of alcohol (10).

Aldehydes:

This class of biocides, mainly represented by formaldehyde and glutaraldehyde, is no longer used for skin disinfection purposes because of their high level of toxicity (potential mutagenicity and high sensitizing properties). They have a very broad spectrum of activity which includes sporulating bacteria and non-enveloped viruses thanks of their pH-dependent (4 to 9) alkylating properties on carboxylic, sulfhydryl (thiol) and e-amino groups in proteins and enzymes, as well as DNA.

Some studies showed that bacteria develop little resistance to aldehydes (11). However, other studies concluded that high level of resistance to glutaraldehyde could be observed in particular in *Mycobacterium chelonae* and *Mycobacterium avium intracellulare* strains (12). Plasmid-mediated modification in membrane lipopolysaccharide and numbers of porins associated with decreased susceptibility to formaldehyde has also been shown in Gram negatives such as *Escherichia coli* and *Serratia marcescens* (13).

Chlorhexidine digluconate (CHG)

CHG is a cationic bis-biguanide which has good activity against Gram-positive bacteria. It is a bit less effective on Gram-negatives and fungi, almost ineffective on mycobacteria, and not at all on spores. It shows *in vitro* activity against enveloped viruses (i.e., herpes simplex virus, HIV, cytomegalovirus, and influenza), but it is much weaker on non-enveloped viruses (i.e., poliovirus, rotavirus, and adenovirus). Due to its cationic character and to its related high level of affinity for negatively charges surfaces such as the skin itself, CHG has significant residual activity.

CHG is a cytoplasmic membrane disrupter and it also precipitates the cytoplasmic proteins.

Plasmid-encoded bacterial resistance to chlorhexidine has been described in antibiotic-resistant *Staphylococcus*

aureus, *Staphylococcus epidermidis* and some Gram-negative bacteria (14, 15). 10^3 to 10^6 chlorhexidine-resistant bacteria/100 mL were isolated in a Buenos Aires hospital effluent (20).

Chlorine compounds

Chlorine containing products (bleach in particular) are widely used surface disinfectant. Chlorine compounds are strong oxidants but they are much less effective in the presence of organic soil and at pH above 8.5.

Available chlorine is a measure of the oxidizing capacity of hypochlorite anion ClO^- and it is expressed in terms of the equivalent amount of elemental chlorine. Hypochlorite anions are very effective on Gram-positive and Gram-negative bacteria. They are also virucidal, sporicidal and fungicidal. They do not have a specific mode of action and are considered as multi-target biocides (they mainly act on cell walls cell proteins and DNA synthesis) (16).

Sodium hypochlorite (NaClO) is a compound that has been effectively used for water purification, surface disinfection, bleaching, and odor removal. By adding hypochlorite to water, hypochlorous acid (HClO), a very active biocidal compound, is formed:

$NaClO + H_2O \longrightarrow HClO + NaOH.$

Although true resistance to chlorine may not be expected, some cases of intrinsic resistance have been described, more particularly in protozoans such as *Giardia intestinalis* and *Cryptosporidium*. Resistance has been also observed in biofilms of *Listeria monocytogenes*, *Pseudomonas fragi* and *Staphylococcus xylosus*. In this last study, only *Staphylococcus xylosus* showed a significant reduction of population at 200 ppm free chlorine. Only at 1000 ppm free chlorine a greater than 2 log cycles fall in bacterial numbers could be measured. In comparison, when planktonic cells were exposed to only 10 ppm free chlorine for 30 seconds, an 8 log reduction in numbers occurred.

Iodine and iodophors

The biocidal fraction of iodophors (i.e., Povidone-Iodine) is iodine, a halogen with the highest atomic weight (126.9). Iodine can rapidly penetrate the microbial cells and oxidizes the thiol groups (SH) of the cysteine amino acid in enzymes and proteins. Iodine is very effective against bacteria, spores, fungi and viruses and shows residual activity (16).

Due to their multitarget-based mode of biocidal action, iodine compounds are not likely to induce microbial resistance. In a study, the resistance of bacteria to iodine was studied by serial passage of two strains of *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella aerogenes*, and one strain of *Serratia marcescens* in sub-lethal concentrations. After 20 passages, no significant change was observed in the MIC, MBC, and killing times between parent strains and 20th subcultures under standardized conditions (17). However, it was also observed that the bacterial susceptibility to iodine was regulated by nutrient status. The resistance increases in nutrient oligotropic environments like the water systems of hospitals, and mechanisms such as cell aggregation, biofilms, usually occuring in sewage works, may also be responsible for iodine resistance (17).

Quaternary ammonium compounds

Quaternary ammonium compounds (Quats) are cationic polyatomic ions of the structure $RN4^+$, R being an alkyl or an aryl group. Their salts are quaternary ammonium cations with an anion.

Alkyl benzalkonium chlorides benzethonium chloride, dodecyl ammonium chloride, and cetylpyridium chloride are the most widely used as antiseptics.

The antimicrobial activity of Quats is based on their adsorption to the cytoplasmic membrane, with subsequent destruction and leakage of cytoplasmic constituents. They are more active on against Gram-positive bacteria than against Gram-negatives. They are also more active on enveloped viruses than on naked viruses. They are relatively weak on mycobacteria and fungi and totally inactive on bacterial spores.

Resistance to quaternary ammoniums such as Cetrimide and benzalkonium chloride has been proven to be mediated by encoding qac genes (18). *Pseudomonas* species are also intrinsically highly resistant to Quats. Resistant strains of *Pseudomonas aeruginosa* and a waterborne *Pseudomonas* sp. (strain Z-R) were able to grow in solutions of benzalkonium chloride at various concentrations (19).

Metal ions

Metal ions such as mercury (Hg^{2+}), copper (Cu^{2+}), and silver (Ag^+) are by definition metals with a specific gravity equal or greater than 5. Their biocidal mode of action is based on metabolic interferences. They also interact strongly with thiol groups in bacterial enzymes and proteins, as well as with ribosomes and membrane structures and with DNA. Bacterial spores are unaffected but metal compounds inhibit germination.

Plasmid-encoded bacterial resistance to metals ions has been described in antibiotic-resistant *Staphylococcus aureus*, *Staphylococcus epidermidis* and some Gram-negative bacteria (6, 17).

Bacterial resistance to heavy metal ions can result from energy-dependent ion efflux systems. It was experimentally demonstrated that *Escherichia coli* mutants that lacked the porins were more resistant to silver ions (11).

Peroxides

The most widely used peroxides are hydrogen peroxide (H_2O_2), peracetic acid (CH_3CO_3H) and ozone (O_3).

Hydrogen peroxide in particular is becoming a more and more popular disinfecting agent for surfaces as well as for the skin. This is related to the fact that this peroxide breaks down into oxygen and water after use; therefore no toxic residue may be found on the skin or in the environment.

The multitarget biocidal action of hydrogen peroxide occurs via the production of free radicals such as hydroxyl radicals ($^{\bullet}OH$) and superoxide anion (O_2^-). These highly Reactive Oxygen Species (ROS) oxidize the thiol groups in enzymes and proteins. They also have a detrimental effect on ribosomes, cell membrane, and DNA backbone.

A number of bacteria (i.e. staphylococci, pseudomonadaceae, enterobacteriaceae, yeasts, etc.) can intrinsically resist quite high concentrations of hydrogen peroxide because of their ability to produce the catalase, a peroxidase enzyme. Studies showed that catalase-deficient strains of *Helicobacter pylori* were highly sensitive to hydrogen peroxide, whereas wild strains could resist 100 mM hydrogen peroxide (21).

In a study, *Staphylococcus aureus* was exposed to sublethal conditions (acid and

alkaline pH, hydrogen peroxide, and heat) and then the acquisition of resistance to acid (pH 2.5), alkali (pH 12.0), hydrogen peroxide at sub-lethal concentration (50 mM), and heat (58°C) was determined. *Staphylococcus* incubated at 58°C and exposed or not to 50 mM of hydrogen peroxide developed 4.5 to 5.6 times greater resistance to both treatments; protective combinations of sublethal stress were: acid pH-hydrogen peroxide, alkaline pH-hydrogen peroxide, heat-acid pH, and heat-hydrogen peroxide. Catalase production by the stressed cells was significantly increased (22). This is not likely to happen at lethal concentrations such as 294 mM/L (1%) and more. Although catalase may effectively protect the micro-organisms from damage induced by H_2O_2, this intrinsic defense is known to be eliminated by higher concentrations normally used for effective disinfection (16). Also, most marketed hydrogen peroxide-containing formulations are acidic and contain various ingredients such as surfactants, stabilizers, chelating agents, etc., all having the potential to contribute to the deactivation of the catalase.

It is true to say that hydrogen peroxide at sublethal concentration can stimulate the production of catalase by some micro-organisms, but this corresponds to a response to the chemical stress at in use concentration (1% and more), and/or when hydrogen peroxide is associated with synergistic ingredients, this phenomenon is unlikely to occur (16). Also hydrogen peroxide has a non-specific mode of biocidal action, therefore various cell targets are damaged when in contact with this peroxide and this makes the risk of microbial resistance close to zero.

Phenolics

Among this class of biocides, Triclosan (2,4,4'–trichloro-2'-hydroxydiphenylether) is the most universally used in the world. Triclosan is a phenolic biocide widely used all other the world in antiseptics, skin sanitizers, antimicrobial soaps, as well as in a great variety of consumer products such as deodorants, toothpastes, shampoos, lotions, dressings and bandages, toys, toothbrushes, etc.

At slightly acidic pH (under the pKa value of 7.90) Triclosan has a quite broad bactericidal (greater on Gram-positives than Gram-negatives and mycobacteria), fungicidal (more effective on yeast than on molds) and virucidal (greater on enveloped viruses than on naked viruses) spectrum of activity. Because of its lipophilic properties, Triclosan has residual activity on the skin.

The antimicrobial mode of action of Triclosan is linked to its capacity to penetrate the microbial cells, to denature the cell proteins, and to disrupt the lipid biosynthesis by specifically inhibiting NADH-dependent enoyl-acyl carrier protein.

Chloroxylenol (para-Chloro-meta-Xylenol / PCMX), is a halogen-substituted phenolic biocide that has been used mainly as a preservative in cosmetics but also as biocidal agent in antimicrobial hand soaps. Its antimicrobial activity is due to the inactivation of the cytoplasmic proteins and enzymes, and alteration of the cell membrane. It is effective against Gram-positive and Gram-negative bacteria, less active against *P. aeruginosa*, mycobacteria and some viruses. Chloroxylenol is generally well tolerated by the skin, but some allergic reactions have been described (23).

During the last decade, concerns have been raised about Triclosan, because of the development of increasing bacterial resistance to biocides and cross-resistance to some antibiotics. For example, plasmid-encoded bacterial resistance to Triclosan has been described in antibiotic-resistant *Staphylococcus aureus*, *Staphylococcus epidermidis* and some Gram-negative bacteria (12, 14, 15).

Although, the clinical relevance of increased resistance to Triclosan at microbiostatic concentration (MICs) is unclear since this phenomenon is reversible at cidal concentrations (1-2%) (10). Some experiments also demonstrated that there was no evidence of tolerance to phenolics, except for *Pseudomonas aeruginosa* (intrinsically tolerant), due to the presence of residual Triclosan and chloroxylenol concentrations in the industrial environment (24).

However, many other studies reinforced the conviction that resistance to phenolics is possible.

Mycobacterium smegmatis mutations in inhA gene leading to Triclosan resistance are known to carry resistance also to isoniazid (10).

Mutations in efflux pumps have been reported in *E. coli* and *P. aeruginosa* (25). In other studies, exposure of *Listeria monocytogenes* to sub-lethal concentrations of Triclosan (1 and 4 /ml) did not alter its sensitivity. However, all tested strains became resistant to gentamicin (26).

Intrinsic bacterial resistance has also been studied; mutants lacking the bacterial enzyme enoyl reductase in *Escherichia coli* were less sensitive to Triclosan. This is probably due to the fact that Triclosan specifically blocks the lipid synthesis which requires the presence of enoyl reductase as catalyst (27, 28).

Under laboratory conditions, it was observed that Triclosan-resistant bacteria carry cross-resistance to antibiotics (29). Reduced Triclosan susceptibility or resistance was detected in clinical isolates of methicillin-resistant *S. epidermidis* and in MRSA, respectively (30).

CONCLUSION

There is no doubt that the development of biocides (antibiotics, antiseptics, disinfectants and preservatives) during the last century, has largely contributed to the reduction of the infectious disease-related complications and transmission of disease. However, micro-organisms have proven to be much more adaptive than expected and have increasingly developed resistance to biocides through various mechanisms. To some extent, misuses of these biocides ha also contributed exacerbating this situation.

From intrinsic to acquired resistance, microorganisms vary in their susceptibility to biocides, but the mechanisms involved in microbial resistance and the strategies to reduce this risk are better and better understood.

Intrinsic resistance occurs with bacterial spores, the capacity of the micro-organism for forming biofilms, as well as some physiological characteristics of the micro-organisms (i.e., the waxy cell wall of mycobacteria, or the production of catalase by staphylococci).

Acquired resistance occurs by genetic mutation or plasmid/transposon-mediated acquisition of resistance to biocides, by changes in cellular permeability as well as by adaptation to chemically stressing environments.

Therefore, microbial resistance to biocides is an increasing concern which requires the need to better inform/train end-users, as well as the development of new antimicrobial compounds and new strategies of formulation.

Among these formulation strategies, the choice of the biocidal s as ingredients in antiseptic or disinfect products is very important. The different classes of biocides available on the market present various levels of risk of inducing microbial resistance. However, some of these biocides such as alcohols, peroxides and iodophors may be preferred, mainly because they have a non-specific mode of action which theoretically leads to less resistance. Hydrogen peroxide is probably the best current biocidal agent, not only because it has a multi-target deleterious effect on micro-organisms, but also because it does not leave any residue on skin and environment (it breaks down into oxygen and water).

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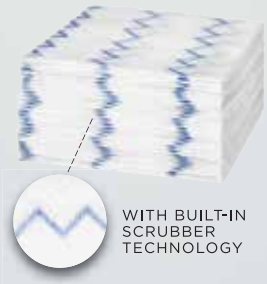

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The impact of changing from an enzyme immune assay (EIA) to a polymerase chain reaction (PCR) method for detecting *Clostridium difficile*

Authors
Victoria R. Williams, BSc, BASc, MPH, CIC[1]

Andrew E Simor, MD, FRCPC[2,3]

[1]Infection Prevention and Control, Sunnybrook Health Sciences Centre

[2]Department of Microbiology and the Division of Infectious Diseases, Sunnybrook Health Sciences Centre

[3]Department of Laboratory Medicine and Pathobiology, University of Toronto

Corresponding Author:
Victoria R Williams, BSc, BASc, MPH, CIC
Sunnybrook Health Sciences Centre
2075 Bayview Ave., Office B112
Toronto, ON Canada M4N 3M5
416-480-6100 ext. 7970
Fax: 416-480-6845
Victoria.Williams@sunnybrook.ca

ABSTRACT

This study assessed the impact of changing from an enzyme immune assay (EIA) to a polymerase chain reaction (PCR)-based method for detection of *Clostridium difficile* in adult acute care inpatients. The mean incidence of healthcare-associated CDI did not differ between the EIA and PCR test periods and no significant difference was observed in patient outcomes.

The mean number of *C. difficile* infection (CDI)-related isolation days per patient decreased from 7.7 to 6.3 days ($p<0.001$) after the introduction of the PCR assay.

INTRODUCTION

Clostridium difficile is the most frequent cause of healthcare-care associated infectious diarrhea and is associated with severe patient outcomes (1-4). In addition, healthcare-associated *C. difficile* infection (HA-CDI) places a considerable burden on the healthcare system with increased length of stay and financial costs (2,4). The diagnosis of *C. difficile* has been challenging because conventional test methods have lacked sensitivity and specificity. Polymerase chain reaction (PCR) assays have been shown to have higher sensitivities than enzyme immune assays (EIA) for the detection of *C. difficile* toxins in symptomatic patients (5-7). Commercial PCR-based assays for diagnosis of CDI have recently become available. The objective of this study was to assess the impact of changing from an EIA to a PCR-based method for *C. difficile* toxin B gene detection on HA-CDI rates, patient outcomes and CDI-related isolation days in hospital.

Methods

Study Design, Setting and Patient Population: A retrospective pre-post observational study was carried out at Sunnybrook Health Sciences Centre, a tertiary care facility located in Toronto, Ontario, Canada between October 2008 and September 2011. All adult, acute care inpatients positive for *C. difficile* were eligible for inclusion.

Laboratory testing: Detection of *C. difficile* occurred via EIA (Techlab *C. difficile* TOX A/B II) from October 2008 to September 2009 and was changed to PCR (BD GeneOhm) from October 2009 to September 2011.

Definitions: The medical records of all patients with a positive test were reviewed to confirm adherence to a case definition for CDI which was applied consistently throughout the entire study period. CDI was defined as laboratory confirmation of toxin accompanied by diarrhea which was defined as loose/watery bowel movements unusual for the patient and with no other recognized etiology (8). Patient data collected included demographics, laboratory values, treatment, complications, 30-day outcomes, and length of stay (LOS). HA-CDI was defined as onset of symptoms of CDI greater than 72 hours after admission or the presence of symptoms at the time of admission if the patient had been admitted to the study facility within the last four weeks (8). Patients with a recurrent case of CDI (identified within the past eight weeks) were excluded.

Infection Prevention and Control Practices: Patients with acute diarrheal symptoms were placed in pre-emptive contact precautions which were discontinued when a CDI patient had been asymptomatic for greater than 48 hours. For patients without a positive test for *C. difficile*, contact precautions were discontinued after two stool specimens negative for toxigenic *C. difficile* by EIA or one stool specimen

TABLE 1. Characteristics of patients with diagnosed Clostridium difficile infection (CDI) by detection method

Variable		EIA (n=145)	PCR (n=371)	*P*-value
Demographics				
	Gender (% male)	52.4	46.4	0.24
	Age (yrs)	72±17	70±18	0.38
Laboratory Values				
	Creatinine (umol/L)	117±109	125±132	0.53
	Albumin (g/L)	26±6.5	30±7.7	<0.001
	WBC (x10^9/L)	13.5±9.5	13.8±12.8	0.78
Length of Stay (days)				
	Overall	51±73	32±73	0.007
	Post CDI diagnosis	32±50	20±39	0.011
Patient Outcomes (%)				
	ICU admission	7.6	7.0	0.85
	Colectomy	2.8	2.4	0.76
	Death	13.8	17.5	0.36

EIA, enzyme immune assay; PCR, polymerase chain reaction; WBC, white blood count; ICU, intensive care unit

negative for toxigenic *C. difficile* by PCR. The initiation and discontinuation dates of contact precautions were recorded for all cases of suspected and confirmed CDI and the number of isolation days calculated.

Statistical Analysis: The overall CDI and HA-CDI incidence rate for the EIA and PCR study periods were calculated and reported per 10,000 patient-days. The number of contact isolation days per patient was calculated as the date of discontinuation minus the date of initiation plus one. Categorical variables were expressed as numbers and percentages and were compared between the *C. difficile* testing methodologies using the X^2 test. Continuous variables were expressed as means with standard deviations and were compared using the t-test. A p-value<0.05 was considered significant.

Results

A total of 516 patients met the case definition for CDI from October 2008 to September 2011; 145 identified during the EIA period and 371 during the PCR period. The patients in the two study periods did not differ with regards to age, gender, creatinine level or white blood counts (Table 1).

The mean incidence of HA- CDI did not differ between the EIA and PCR study periods (6.4 vs. 6.6/10,000 patient-days; p=0.79). There was a trend towards a higher overall CDI incidence during the PCR testing period but this was not statistically significant (0.9 vs. 1.2/10,000 patient-days; p=0.057).

In patients with confirmed CDI, a significant decrease was seen in the mean LOS overall (51 vs. 32 days; p=0.007), and after confirmation of infection (32 vs. 20 days; p=0.011) (Table 1). No significant difference in patient outcomes (ICU admission, colectomy or death at 30 days) or the time from symptom onset to initiation of antibiotic treatment (p=0.86) was observed.

From October 2008 to September 2011 a total of 2001 patients were placed in pre-emptive contact precautions for gastrointestinal symptoms and suspected CDI; 469 during the EIA period and 1532 during the PCR period. The mean number of isolation days per patient decreased from 7.7 to 6.3 days (p<0.001) after the introduction of the PCR assay (Table 2).

DISCUSSION

This study found that the change from EIA to PCR testing for CDI diagnosis did not significantly affect either healthcare associated or overall incidence of CDI although there was a trend towards an increase in the overall CDI incidence in the PCR study period. This finding differs from previous reports by Belmares who reported an increase in overall incidence (7.8 vs. 15.4/10,000 patient-days) (9). Although two of the ten hospitals included in a study by Moerhing reported a decrease in the incidence of healthcare facility-associated CDI following a switch from nonmolecular testing methods to PCR the average increase in the rate was 56% similar to the 52% difference in the incidence of HA-CDI reported by Longtin for concurrent testing by PCR versus EIA in a single Canadian hospital (10,11). Similar to our study, Catanzaro demonstrated no change in overall CDI incidence but did report a decrease in the HA-CDI rate (4.4 vs. 0.9/10,000 patient-days; p=0.02) (12). Catanzaro attributed the reduction in their HA-CDI incidence to a decrease in transmission due to accurate identification of CDI and placement of infected patients in appropriate isolation. At our facility, patients with acute diarrheal illness are placed into pre-emptive contact precautions before CDI tests results are available. This infection prevention and control policy may have a greater effect on reducing CDI transmission than the availability of PCR testing.

The introduction of PCR testing did not have an effect on patient outcomes including ICU admission, colectomy, and death. Longtin found that the rate of complications (30-day mortality, ICU admission, colectomy, readmission for CDI) was 30% lower and overall mortality was decreased among CDI cases who were identified via PCR as compared to EIA, but the difference was not statistically significant (11). Hypotheses proposed by Longtin to explain the decreased rate of complications associated with PCR detection of CDI included detection of less severe cases with the increased sensitivity of the testing methodology, earlier initiation of treatment due to earlier detection, and identification of *C. difficile* carriers as well as those with CDI (11). Our study did not find a decrease in the time from symptom onset to initiation of appropriate antibiotic treatment for CDI once PCR testing was introduced. While the increased identification of carriers of *C. difficile* may be a factor in increased incidence and decreased rates of complications associated with PCR testing, adherence to the CDI case definition should limit inclusion of these cases. We noted an increase in the detection of *C. difficile* carriers following the introduction of

PCR testing with the proportion of patients with positive specimens who did not meet the CDI case definition increasing from less than 1% to 8% but these cases were excluded from the analysis.

The switch from EIA to PCR was associated with a decrease in the LOS for CDI patients from 51 to 32 days overall in the context of a mean decrease in the facility-wide LOS for adult acute care inpatients of 5% during the same time period. In addition, the mean number of isolation days per symptomatic patient (CDI confirmed or not) decreased by greater than one day. Although, Catanzaro did not find a reduction in the mean number of isolation days per patient both they and Belmares did report a reduction in the overall number of isolation days between the EIA and PCR study periods at their facilities (9,12). This decrease is likely associated with the corresponding change in IP&C practices that allowed for the discontinuation of contact precautions for symptomatic patients following one negative specimen during the PCR period as opposed to the requirement for two negative stool specimens during EIA testing.

There are a number of limitations to this study. This was a nonrandomized, retrospective, before-after study that may have been affected by changes in CDI incidence over time irrespective of testing methodology. Limitation data was available on each CDI case and there may have been additional confounding factors that differed between the two study periods. Also, this study reflects the experience of a single institution and may not be generalizable to other settings.

In conclusion, this study, using a stringent case definition, did not demonstrate a change in the incidence of overall or healthcare-associated CDI following the change from EIA to PCR testing. Although there was no identified change in patient outcomes, the decrease in LOS and time spent in isolation associated with PCR testing for CDI has the potential to improve patient care and patient flow efficiency.

TABLE 2. Duration of contact precautions (days) for patients with confirmed (CDI +ve) and suspected (CDI -ve) *Clostridium difficile* infection by detection method

Patients Included	Duration of Contact Precautions (mean isolation days ± standard deviation)		*P*-value
	EIA	PCR	
CDI +ve and CDI –ve	7.7±11.0	6.3±8.3	0.006
CDI –ve only	5.9±3.9	5.0±7.3	0.02
CDI +ve only	15.3±22.6	11.4±9.7	0.12

EIA, enzyme immune assay; PCR, polymerase chain reaction

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Multi-drug resistant tuberculosis: Mitigating risk of transmission from a surgical patient

Authors:
May Griffiths-Turner, MLT, CIC
St. Joseph's Healthcare
50 Charlton Ave. East
Hamilton, ON L8N 4A6
905-522-1155 ex.33596
Fax: 905-540-6557
griffitm@stjoes.ca

Anne Bialachowski, RN, BN, MS, CIC

Dr. Christine Lee, MD, FRCP(C)

ISSUE

A patient with multi-drug resistant tuberculosis (MDR-TB) was referred to a tertiary academic healthcare facility with a centre for minimal access surgery, for a laparoscopic right upper lobe lobectomy for surgical management of a TB-related granuloma to expedite resolution of infection.

Project

A multidisciplinary team was convened to mitigate risk of transmission, preoperatively, intraoperatively and postoperatively while providing safe, empathic patient care. Healthcare workers were informed of the pending surgical case and provided education and information about MDR-TB to address any perceived risk of exposure or infection and alleviate any potential anxiety. Prior to the patient's arrival, the team prepared for all aspects of the patient admission, by developing a comprehensive plan to ensure safe and optimal patient management.

Results

The patient traversed safely and smoothly through each transition point during the hospital admission. Microbiological culture of tissue obtained intraoperatively revealed MDR-TB with the identical antibiotic susceptibility profile as previous clinical sputum samples. The patient was discharged to an ancillary facility and continued to recover. Due to advance preparation, communication and education, healthcare workers were confident that all necessary measures were undertaken to ensure patient and staff safety, mitigating risk of MDR-TB transmission or acquisition.

Lessons Learned

Potential gaps in the process were identified and closed prior to patient admission. Risks of exposure or infection were minimized. Anxiety was mitigated among healthcare workers. Advanced planning and communication facilitated safe patient management from admission through to discharge. This project resulted in a practical template to manage other potentially complex case situations that may arise in the future.

KEYWORDS:
Tuberculosis; multi-drug resistant tuberculosis

INTRODUCTION

A patient with multi-drug resistant tuberculosis (MDR-TB) was referred to a tertiary academic healthcare facility with a centre for minimal access surgery, for a laparoscopic right upper lobe lobectomy for surgical management of a TB related granuloma to expedite resolution of infection. Public Health had been following the patient and provided clinical information to assist in the planning for this admission. The patient had received appropriate antibiotic therapy for 18 months, however, the recovery had stalled. As of July 2011 they had three acid fast bacilli negative sputum smears and negative TB cultures. Based on this they were deemed to be at very low risk for transmission. The risk of TB transmission was considered to be further reduced following the lobectomy, however, there remained a theoretical risk of some TB bacteria being dislodged during anesthesia and surgery and the possibility of the patient coughing postoperatively.

TABLE 1: Preadmission Checklist

St. Joseph's Healthcare Hamilton

Multi-Drug Resistant Tuberculosis (MDR-TB) Case Preadmission Checklist

Item	Most Responsible Department	Date(s) Completed
☐ Liaise with Public Health RN following patient	Infection Prevention & Control	6 December 2011 9 December 2011 12 December 2011
☐ Negative pressure room checks ☐ Intensive Care Unit ☐ Chest unit	Engineering/Building Services	12 December 2011
☐ HEPA units serviced	Engineering/Building Services	14 December 2011
☐ Review respiratory protection required N95, N100, versus PAPR	Operating Room Occupational Health & Saftey (OH&S) Infection Prevention & Control	9 December 2011 - OH&S working with 3M to source PAPRs 12 December PAPR reviewed 13 December - N100 ruled out due to exhalation valve. **N95 selected for use** 14 December - N95 Fit testing completed
☐ Recent TB skin test for OR staff	Occupational Health & Safety Operating Room	9-15 December
☐ Current mask fit testing reults for staff Chest, OR, ICU, Portering, Environmental Services, Engineering	Managers Occupational Health & Safety	13-15 December
☐ Information for staff involved in OR case	Infection Prevention & Control Occupational Health & Safety	Tools created 9 December 2011
☐ Liaise with Public Health Lab re specimen testing	Infection Prevention & Control Microbiology Laboratory	9 December 2011
☐ Prepare closed case cart	Medical Device Reprocessing	15 December 2011

Legend: HEPA = High Efficiency Particulate Air, OR = Operating Room, PAPR = Powered Air Purifying Respirator, RN= Registered Nurse

Although the risk of transmission of MDR-TB is similar to drug-sensitive TB, it is more difficult to treat if there is transmission; therefore the decision was made to put airborne precautions in place beginning in the operating room and continuing postoperatively throughout the patient's admission as a precautionary measure to mitigate the risk of transmission to others. To ensure that all required measures were in place to manage the case, a multidisciplinary working group was convened by infection prevention and control (IPAC) to plan and coordinate the appropriate management of the patient during every aspect of their admission.

Project/Methods

The multidisciplinary team consisted of representatives from all stakeholder departments. They met to plan the patient journey to mitigate risk, preoperatively, intraoperatively and postoperatively while providing safe, empathic patient care. The team included IPAC Medical Director, IPAC Manager, Infection Control Professional, Respirologist, Pathologist, Occupational Health & Safety Services (OH&SS) Director, Safety Consultant and Physician; Perioperative Director, Operating Room (OR) Manager and Educator, Managers of Day Surgery, Medical Device Reprocessing, Intensive Care Unit, Chest Unit, Environmental Services, and Engineering/Building Services. The team prepared for the patient admission, by developing a comprehensive plan for safe patient management prior to the patient's arrival. IPAC communicated with staff at Public Health and the specialized rehabilitation healthcare facility that were involved in the patient's ongoing care. Background health information about the patient was obtained.

"A Preadmission Checklist was developed to outline and prepare for all elements of patient care and contact to mitigate risk of transmission."

Prior to the patient's arrival, the multidisciplinary team considered every step of the patient's care during their hospital stay, then developed a comprehensive plan to ensure safe and optimal patient management. A Preadmission Checklist (Table 1) was developed to outline and prepare for all elements of patient care and contact to mitigate risk of transmission. An OR Suite Checklist (Table 2) was developed and strictly adhered to that outlined the process within the operating room during each stage of the surgery. A Process Map (Table 3) was developed and followed outlining patient management at each location of the patient journey from Day Surgery admission, to transport to Operating Suite, to Intensive Care Unit post-surgery, to Chest Unit 24 hours post-op, and then subsequent transfer to a specialized rehabilitation healthcare facility.

Healthcare workers were informed of the pending surgical case and provided education and information about MDR-TB to address any perceived risk of exposure or infection and alleviate any potential anxiety. IPAC provided information to all stakeholders and staff about TB including, that MDR-TB is NOT more transmissible than drug sensitive TB. TB is treatable; however, the treatment for MDR-TB is more limited and challenging. It is transmitted by airborne particles that can be breathed in. Only 5-10% of people exposed to TB develop a positive Tuberculin Skin Test (latent TB not infected or infectious). For immunocompetent people only 5-10% of those with latent tuberculosis will develop active TB during their lifetime. Patients with active TB require Airborne Precautions (1) which includes a negative pressure room, door closed, and all who enter must wear a fit tested N95 respirator. Appropriate accommodation of a patient with MDR-TB is the same as drug sensitive TB; however airborne precautions for MDR-TB remain in place for the duration of the patient's hospital stay. (2) A General TB Fact Sheet (3) as well as an MDR-TB Fact

TABLE 2: OR Suite Checklist

St. Joseph's Healthcare Hamilton

Multi-Drug Resistant Tuberculosis (MDR-TB) Case
OR Suite Checklist

Item	Person Responsible	Initials	Time
☐ Pre-op check - Patient in DSU (hat and clean gown on stretcher) - Routine Practices. No N95 respirator required			
☐ Transport patient to OR - Routine Practices. No N95 respirator required			
OR Preparation	**Person Responsible**	**Initials**	**Time**
☐ Set up 2 portable HEPA units in OR			
☐ Standard set-up for laparoscopic lobectomy-thorocotomy			
☐ Airborne Precautions sign on both doors and isolation cart			
☐ Anesthetic Maching • Disposable ambubag instead of standard one • Standard Anesthetic set-up • No masks or towels on top of machine • Disposable breathing circuit, filter, reservoir bag and CO2 absorber (biohazard bag)			
Non Sterile Team	**Person Responsible**	**Initials**	**Time**
☐ Routine OR Suite PPE + N95 respirator			
☐ 1st specimen for TB culture to be placed in saline and sent to SJHH Microbiology for transport to Toronto Public Health			
☐ 2nd Specimen to be placed in formalin and sent to Pathology			
Sterile Team	**Person Responsible**	**Initials**	**Time**
☐ Routine OR Suite PPE + N95 respirator. Eye Protection			
☐ Bronchoscope - Reprocess as per routine procedure (High Level Disinfection). Sent on closed cart system to MDR			
☐ Separation of surgical instruments used after 1st biopsy recommended			
☐ 2nd specimen - laparoscopy bag recommended			
End of Case	**Person Responsible**	**Initials**	**Time**
☐ Extubate patient in OR if possible			
☐ Instruments to be sent to SPD in closed case cart O2 Mask to SPD on closed case cart isolation			
☐ Leave portable HEPA units on for 30 minutes and no one to enter room			
☐ Engineering/Building Services to change both HEPA unit prefilters in OR prior to isolation cleaning - N95 to be worn and filters to be discarded in biohazard waste			
☐ Room closed fo an additional hour and no one to enter room			
☐ End of case cleaning by RBA - N95 to be worn			
☐ Dispose of breathing circuit, filter, reservoir bag and CO2 absorber (biohazard bag)			
☐ isolation clean by environmental services			

Legend: CO2 = carbon dioxide, DSU = Day Surgery Unit, HEPA = High Efficiency Particulate Air, MDR = Medical Device Reprocessing, OR = Operating Room, PPE = Personal Protective Equipment, RBA = Room Based Attendant, TB = Tuberculosis

"Airborne precautions would be used beginning in the operating room and continuing throughout the patient's admission as a precautionary measure to mitigate risk of transmission to patients and staff."

Sheet (4) was also provided. A Fact Sheet TB-Timeless was developed and distributed. (Table 4)

IPAC also provided pertinent background patient information to those in the circle of care that included the information that the patient had three TB negative sputum smears and negative TB cultures. They were considered to be currently non-infectious and at very low risk for transmission. However, airborne precautions would be used beginning in the operating room and continuing throughout the patient's admission as a precautionary measure to mitigate risk of transmission to patients and staff.

The team also discussed the merits of the surgical team using powered air purifying respirators (PAPRS) versus N95 respirators as their personal protective equipment during the case, as this was considered to be the period of elevated risk. The decision was made to use fit tested N95 respirators. The consensus was that due to the surgical team's lack of familiarity with the equipment and insufficient time to implement training to ensure appropriate use of the equipment, risks to the staff could actually be increased rather than providing improved personal protection.

OH&SS repeated Tuberculin skin testing (TST) on operating room personnel involved in the case and TST negative status nursing staff were preferentially assigned to the OR case. OH&SS scheduled follow-up TSTs for the OR personnel (those with negative TSTs) 8 to 12 weeks post-operatively. OH&SS repeated N95 respirator fit testing on operating room personnel assigned to the case, regardless of the date of the previous respirator fit test. Managers of units and departments involved in the case also reviewed their staff lists to ensure compliance with N95 respirator fit testing expiry date. Engineering/Building Services checked all negative pressure rooms in ICU and the Chest Unit to ensure functionality and serviced and tested the portable HEPA Units to be used in the OR during the surgery prior to the patient's admission.

Results

During surgery, tissue was obtained and subsequently processed for TB culture and pathology. 2+ Acid Fast Bacilli were demonstrated on concentrated smear. Culture revealed *Mycobacterium tuberculosis,* susceptible to pyrazinamide, amikacin, capreomycin, kanamycin, linezolid, and Para-aminosalicylic acid. This corresponded to the antibiotic susceptibility results from previous clinical sputum samples. The patient was discharged nine days post-op to a specialized rehabilitation healthcare facility, and continued to recover.

Repeat tuberculin skin testing was performed on previously negative OR personnel involved in the case at three months postoperatively. All staff tested remained TST negative. There were no TST conversions identified.

Advanced planning and communication facilitated safe patient management from admission through to discharge. Potential gaps in the process were identified and closed prior to patient admission. Risks of exposure or infection were minimized. The patient traversed safely and smoothly through each transition point during their hospital admission. Their journey was patient-centered and seamless.

Due to advance preparation, communication and education, anxiety was mitigated among healthcare workers. They were confident that all necessary measures had been undertaken to ensure patient and staff safety, mitigating risk of MDR-TB transmission or acquisition.

Interdepartmental, interdisciplinary relationships were enhanced. This process generated a positive atmosphere of collegial consultation and collaboration.

This project resulted in a practical template to manage other potentially complex case situations that may arise in the future.

LESSONS LEANED/ DISCUSSION

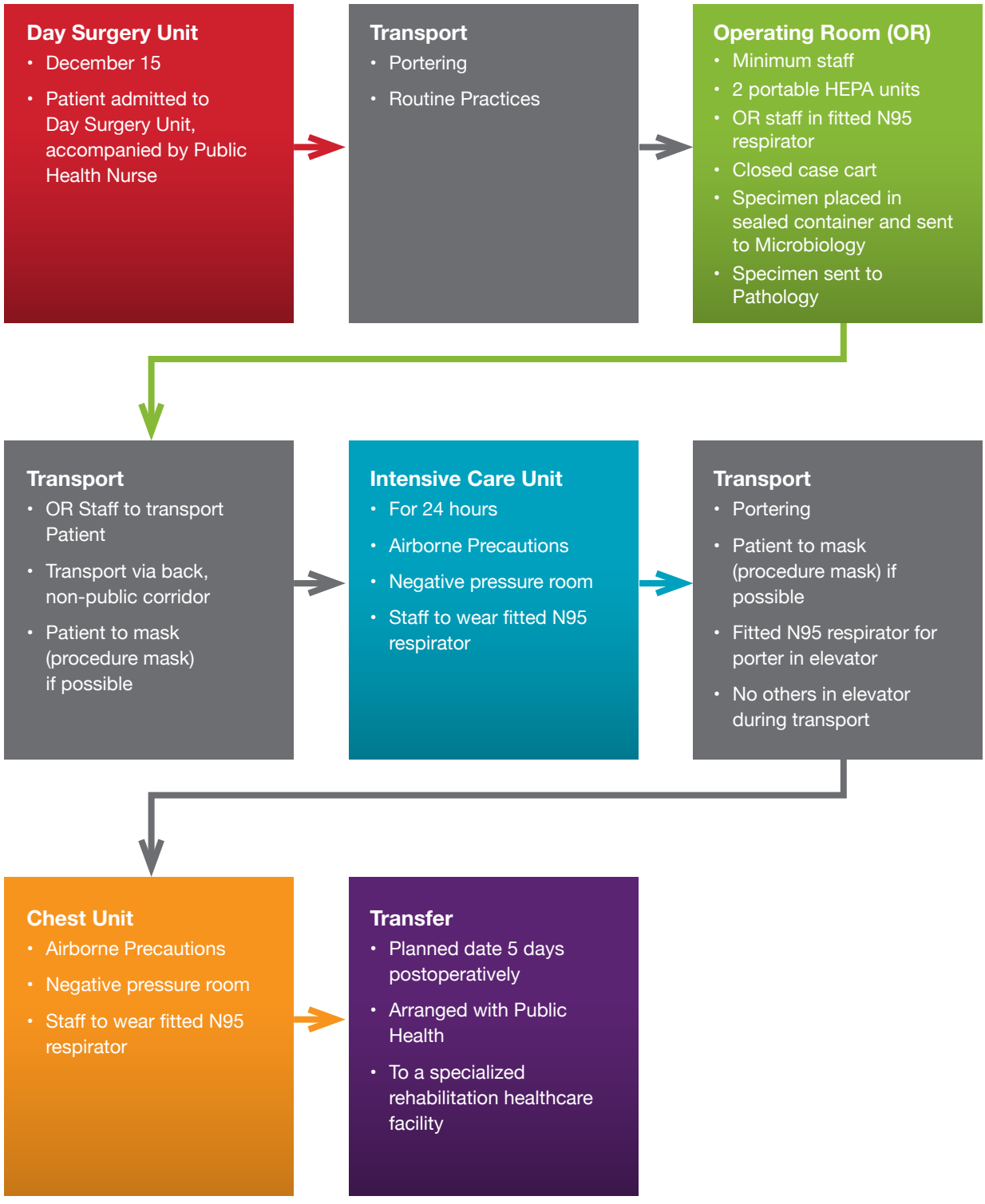
Advance notification to key stakeholders of an MDR-TB case to be scheduled for surgery is of paramount importance to ensure appropriate planning and safe patient management throughout a hospital admission.

With the worldwide increase in incidence of MDR-TB and XDR-TB (5, 6, 7) and the potential need for those patients to undergo surgical management, implementation of a number of safety measures should be considered for the protection of healthcare workers. Availability of a Class II biological safety cabinet in histopathology to provide

TABLE 3: Process Map

St. Joseph's Healthcare Hamilton

Multi-Drug Resistant-Tuberculosis Case Process Map



Legend: HEPA = High Efficiency Particulate Air

protection for staff when cutting potentially infectious surgical tissue is recommended (8, 9). Introduction of powered air purifying respirators (PAPRs) suitable for use during a high risk surgery would provide optimal protection to surgical staff. PAPR training should be performed prior to utilization on a high-risk case to ensure accurate and appropriate use of the equipment.

When undergoing redevelopment, tertiary-care centres that may perform thoracic surgery on patients with MDR-TB should strongly consider construction of an operating suite that provides a negative pressure environment (10). At a minimum, Perioperative Departments should have portable HEPA filter units available to be used during surgical cases that require airborne precautions.

TABLE 4: Fact Sheet TB-Timeless

October 2013

Infection Control...Timeless

Tuberculosis

About This Series....

Looking back in time, we gain a better understanding of infectious diseases and their ability to impact our lives. To celebrate Infection Prevention and Control week, SJHH is featuring this 'timeless' illness. Enjoy your read.

Cross of Lorraine
The international symbol of the fight against tuberculosis

La Miseria by Cristóbal Rojas (1886). The author, suffering from tuberculosis, depicts the social aspect of TB, and its relation with living conditions at the close of the 19th century

Romanticism of TB during the Romantic Era at the end of the 18th Century

Infection Control Timeless compiled and created adapted with permission of Public Health Ontario

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Historical Significance:

Consumption, phthisis, scrofula, Pott's disease, and the White Plague are all terms used to refer to TB throughout history.

It is estimated to have existed 15,000 and 20,000 years. Human bones from the Neolithic show a presence of TB.

Signs of the disease have also been found in Egyptian mummies dated between 3000 and 2400 BCE. It appears likely that Akhenaten and his wife Nefertiti both died from TB. Evidence indicates that hospitals for TB existed in Egypt as early as 1500 BCE.

In 1882, a Prussian physician, Robert Koch, identified the causal agent of the disease: *Mycobacterium tuberculosis*, or Koch's bacillus. He made his result public at the Physiological Society of Berlin on 24 March 1882, in a famous lecture entitled *ÜberTuberculose*. Since 1882, 24 March has been known as World Tuberculosis Day.

In 1890 Koch developed tuberculin, a purified protein derivative of the bacteria. It proved to be an ineffective means of immunization but in 1908, Charles Mantoux found it was an effective intradermic test for diagnosing tuberculosis.

In 1944 Albert Schatz, Elizabeth Bugie, and Selman Wakaman isolated *Streptomyces griseus* or streptomycin, the first antibiotic and first bacterial agent effective against TB. This discovery is generally considered the beginning of the modern era of TB although the true revolution began some years later, in 1952, with the development of Isoniazid, the first oral mycobactericidal drug. The advent of Rifampin in the 1970s hastened recovery times, and significantly reduced the number of TB cases until the 1980s.

Clinical Presentation:

Latent Tuberculosis:
Persons with latent TB have no signs or symptoms, do not feel sick and are not infectious. However viable bacilli can persist in granulomas for years. If the immune system later becomes compromised the disease can be reactivated.

Primary Progressive Tuberculosis:
Active TB develops in only 5-10% of persons exposed to TB. Symptoms include fatigue, malaise, weight loss, low grade fever accompanied by chills and night sweats. A cough may initially be non-productive progressing to a productive cough with purulent sputum and sometimes hemoptysis. Finger clubbing, a late sign of poor oxygenation may occur.

Extrapulmonary Tuberculosis:
Although pulmonary TB is the most common, extrapulmonary TB occurs in 20% of immunocompetent patients. Risk for extrapulomary TB increases with immunosuppression. The most serious is TB of the central nervous system which may result in meningitis or tuberculomas. It can be fatal. Headaches and change in mental status after exposure to TB or in high risk groups may indicate this. Another form of fatal TB is infection of the bloodstream called disseminated or miliary TB. It can spread through the body leading to multiorgan involvement.

Tuberculosis Today:

Hopes that the disease could be completely eliminated were dashed in the 1980s with the rise of drug resistant strains.

In response to the resurgence of tuberculosis, the World Health Organization issued a declaration of a global health emergency in 1993.

Every year, nearly half a million new cases of multidrug-resistant tuberculosis (MDR-TB) are estimated to occur worldwide.

About 440 000 new cases of multidrug-resistant tuberculosis (MDR-TB) emerge annually, causing at least 150 000 deaths.

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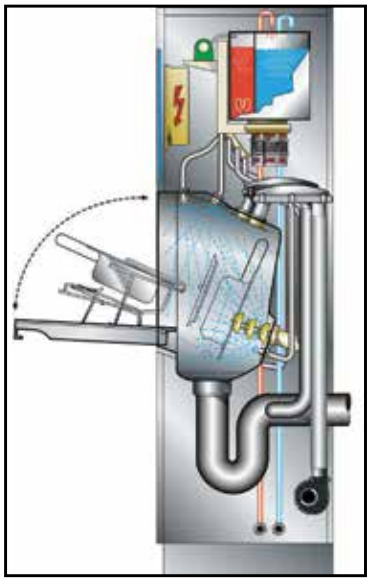

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Stethoscope contamination with Methicillin-resistant *Staphylococcus Aureus* (MRSA) in an inner-city emergency department

Authors
Jessica Thom, MD[1]
Gregory Kenzo Saito, MD[2]
Yanliang Wei[2]
Piraveina Gnanasuntharam, BSc[3]
Allison McGeer, MD[3]
Barbara M. Willey, ART[3]
Michelle Loftus, RN[3]
Bjug Borgundvaag, MD, PhD[3]

Institution:
[1]Washington University
School of Medicine
Saint Louis, Missouri, United States

[2]University of Toronto

[3]Mount Sinai Hospital
Toronto, Ontario, Canada.

Correspondence to:
Bjug Borgundvaag, M.D., Ph.D.
Mount Sinai Hospital Joseph
and Wolf Lebovic Health Complex
600 University Ave., Room 206
Toronto, Ontario M5G 1X5
416-586-4800 ext. 2144
Fax: 416-586-3111
b.borgundvaag@utoronto.ca

ABSTRACT

Background
Due to frequent exposure to individuals colonized and infected with MRSA, healthcare workers and their equipment are at increased risk for contamination. The prevalence of stethoscopes contaminated with MRSA has been examined in both inpatient and outpatient settings. However, little is known about the contamination rates within Canadian emergency departments (ED) that bridge these two settings.

Aim
The goal of this investigation was to screen stethoscopes of all healthcare providers within an inner-city emergency department for MRSA and other opportunistic pathogens.

Methods
A sample of 93 stethoscopes from emergency healthcare workers in a 472-bed tertiary care hospital were cultured for MRSA, Methicillin-susceptible *Staphylococcus Aureus* (MSSA), and other pathogens using standard microbiology techniques.

Results
Despite a relatively high background prevalence of MRSA in skin and soft tissue infections in the local ED (30% of *S. aureus*-positive infections), none of the sampled stethoscopes grew MRSA. 90 (96.7%) stethoscopes grew mixtures of environmental, skin and fecal bacteria. Species capable of causing opportunistic infections, such as MSSA, *Pseudomonas aeruginosa*, and *Acinetobacter baumannii* were isolated from seven stethoscopes (7.5%).

Conclusion
Stethoscopes present a potential vector for transmission of MRSA and other opportunistic pathogens to patients in the health care environment. While no MRSA-contaminated stethoscope was identified in this survey, the increasing prevalence of MRSA in skin and soft tissue infections in patients presenting to Canadian EDs highlights the need for regular disinfection of all medical equipment involved in patient care.

KEYWORDS
Staphylococcus aureus; MRSA; methicillin resistance; stethoscopes

INTRODUCTION

With the emergence of strains such as USA-300, Community-acquired Methicillin-resistant *Staphylococcus Aureus* (CA-MRSA) has replaced MSSA as the most common cause of skin and soft-tissue infection (SSTI) in the United States (US) (1). The proportion of *S. aureus*-related SSTIs attributable to MRSA in Canada varies by region, but is high overall, with a nationwide prevalence of 32% (2). Patient colonization with MRSA is associated with an increased risk of symptomatic infections (3), and it is estimated that isolation and management of MRSA-colonized patients in Canadian hospitals costs between $42 and $59 million annually (4). Healthcare workers and their equipment, for example contaminated stethoscopes, are potential vectors in the spread of epidemiologically significant organisms such as MRSA. While the data linking environmental contamination of MRSA to the development of patient carriage or infection is limited, it is

TABLE 1. Number and types of healthcare worker stethoscopes enrolled in the study

Type of health care worker	No. of screened stethoscopes
Emergency Medicine Registered Nurses	28
Emergency Medicine Physicians or Residents	18
Internal Medicine Physicians or Residents	17
Cardiology Physicians or Residents	8
Paramedics	8
Respiratory Therapists	2
Miscellaneous Physicians or Residents (Neurology, Urology, Gastroenterology, ENT, ICU, ED another hospital)	12
Total	**93**

Note: ED=emergency department; ENT=ear, nose, and throat; ICU=intensive care unit; No.=number

well established for other pathogenic bacteria, for example Vancomycin-resistant Enterococci (VRE) (5).

US studies have estimated the prevalence of MRSA-contaminated stethoscopes at 2% (6) and 7.3% (7) for inpatient and outpatient clinic setting, respectively. The prevalence of stethoscope contamination with MRSA in the ED and pre-hospital environments, which bridge these two settings, is variable. In the US, where the prevalence of MRSA is known to be high, MRSA colonization of stethoscopes in the pre-hospital/ED setting has also been shown to be high. A recent study conducted in 2009 among paramedics in an urban setting in Northeastern US found that 32% of the stethoscopes sampled were contaminated with MRSA (8).

Until recently, the prevalence of MRSA in Canadian EDs was poorly documented. In previous work, we have demonstrated a baseline MRSA colonization rate in a random sample of our ED patients of 1.9% (9). Additionally, we have documented a national average prevalence of MRSA in *S. aureus* positive SSTIs of 32%, but with significant geographical variation (2). The one published study to date examining stethoscope contamination with MRSA in Canada found only 1 MSSA and 0 MRSA contaminated stethoscopes in a sample from 100 ED staff (10). Unfortunately, the local prevalence of MRSA in this ED setting was not reported, making it difficult to know if the low contamination rate was a result of low exposure to MRSA, or some other factor(s).

The goal of this investigation was to determine the prevalence of stethoscope contamination with MRSA and other opportunistic pathogens among health care providers within a Canadian inner-city ED. These data, interpreted alongside concurrently collected MRSA colonization data among the general ED patient population, and prevalence of MRSA in skin and SSTI provide an accurate description of the relationship between the prevalence of MRSA and the associated rate of stethoscope contamination in a Canadian ED setting.

METHODS

Study setting and design. This prospective observational study was conducted in the ED of a 472-bed tertiary care hospital located in Toronto, Ontario, Canada. Approval was obtained from the hospital's Research Ethics Board. All healthcare providers with stethoscopes who were in the ED during the study period were considered eligible participants. Beginning July 2009, a convenience sample of 93 stethoscopes was obtained from emergency physicians and nurses, respiratory therapists, paramedics, as well as from consulting physicians from other departments within the hospital. A consenting health care worker was only excluded if their stethoscope had previously been swabbed during the collection period.

MICROBIOLOGICAL METHODS

Each stethoscope bell and diaphragm was sampled using a pre-sterilized cotton swab wetted in Brain-Heart Infusion Broth (BHIB), (Oxoid, Nepean, ON). After sampling the entire surface area, the swab was replaced into the 2 mL BHIB tube and incubated at 37°C to enrich for all bacteria. The following day, using fresh sterile cotton swabs, the broths were plated to Columbia agar with 5% sheep blood and MacConkey agars (Oxoid). After streaking for single colonies, the plates were incubated at 37°C for 48 hours before reporting as negative. For positive cultures, all colony types were identified to the genus and species level using basic standard tests including Gram stain, demonstration of catalase and oxidase production, detection of *S. aureus*-specific capsular antigens, and by use of automated organism identification instruments such as the Vitek II. Presence of MRSA isolates was ruled out using a monoclonal antibody assay to detect PBP2a and by absence of growth on Oxacillin Screen agar (Oxoid).

RESULTS

Between July and August 2009, samples were obtained from the stethoscopes of 93 healthcare workers whose job descriptions are presented in Table 1. Of the 93 stethoscopes sampled, none grew MRSA (95% CI: 0–4.7) (Table 2). While only three (3.2%) stethoscopes grew no bacteria, eight (8.6%) grew

TABLE 2. Flora types from screened stethoscopes

Flora types	Potentially pathogenic or opportunistic species (no. identified)	Generally non-pathogenic species (no. identified)
Environmental	*Pseudomonas aeruginosa* (1) *Acinetobacter baumannii* (1)	*Bacillus* species (81)
Skin	Methicillin-susceptible *Staphylococcus aureus* (5)	Coagulase-negative staphylococci (86)
Faecal	*Enterococcus* species (6) *Pantoea* species (1)	*Lactobacillus* species (2)
Oral	None	"Viridans" group *Streptococcus* species (5)
No bacteria	3 stethoscopes	
One species	8 stethoscopes	
Multiple species	82 stethoscopes	

Note: No.=number

a single species and 82 (88.1%) were contaminated with multiple bacterial species. Not unexpectedly, most stethoscopes grew mixtures of environmental, oral, skin and fecal bacteria. Species capable of causing opportunistic infections, such as MSSA, *Pseudomonas aeruginosa*, and *Acinetobacter baumannii* were isolated from seven stethoscopes (7.5%).

DISCUSSION

This is the first study to report Canadian ED stethoscope MRSA colonization rates in a setting where the prevalence of MRSA colonization and infection rates in the local ED population are both increasing and well documented (2,11,12). In this study, stethoscope bacterial contamination rates were obtained from a diverse sample of health professionals involved in emergency patient care. As the MRSA rates from wound cultures obtained from patients moving through the department during the study period were moderately high (30% of *S. aureus*-positive infections) (12), each worker likely had multiple opportunities to be exposed to MRSA. Rather than finding a MRSA colonization rate within the 2-32% range as identified in previous US studies where the prevalence of MRSA in SSTIs is similar (6,8), none of the stethoscopes were colonized with MRSA suggesting that the risk of stethoscope contamination with MRSA was low in this ED.

This result is consistent with previous Canadian stethoscope data (10), and may be the result of regular stethoscope cleaning or due to a lack of MRSA exposure immediately prior to sampling. However, our observed 96.7% colonization rate for other bacteria from the enriched samples is consistent with prior reports, and suggests it is unlikely that the stethoscopes were cleaned immediately prior to sampling.

While no stethoscope carried MRSA, 15.1% of the sampled stethoscopes grew potentially pathogenic species (MSSA, *P. aeruginosa* and *A. baumannii*) or species typically found in fecal flora (enterococci and *Pantoea* spp.). This finding is consistent with previous investigations (13).

Many of the organisms identified in the study share properties with MRSA, which make them hardy survivors on inanimate objects, yet vulnerable to the cleaning process (14). Our findings support the need to regularly disinfect commonly used medical equipment, including stethoscopes. Complete disinfection of non-spore forming organisms may be accomplished with the use of 70% alcohol, hydrogen peroxide or liquid soap. Despite the relative ease of decontamination, a recent study found that only 22% of physicians regularly cleaned their stethoscopes (6).

STUDY LIMITATIONS

Our study sampled a random convenience sample of healthcare workers who were in the ED on the days study staff were available, which may result in some selection bias. Study staff did not publicize the dates they would be swabbing stethoscopes, and were present to swab stethoscopes from both the day and night staff, mitigating any potential bias. Additionally, almost all staff working at any given time were asked to participate, and no healthcare worker declined participation, leading us to conclude that selection bias was likely not an important factor in our conclusions.

While the actual number of patients with MRSA colonization or infection present in the ED on the days the swabs were collected was not recorded, a concurrent point prevalence survey was performed at the same ED on 432 patients without known MRSA risk factors. This study demonstrated a background community-carriage rate at ~1.9% (9). Ongoing wound swab surveillance data collected during the months that this data was collected demonstrated a significant number of known MRSA carriers and patients with SSTI due to MRSA that were cared for by the same healthcare professionals whose stethoscopes were screened during this survey (2). In fact, of 163 patient surface swabs submitted to the microbiology laboratory during the study period, 15 (9.2%) were MRSA-positive (unpublished data).

Enrolled healthcare workers were not questioned about their stethoscope cleaning practices. While this data may have been helpful in determining whether the observed lack of stethoscope

MRSA colonization was due to disinfection practices or to a low MRSA prevalence, it would be inherently biased by recall and other factors.

CONCLUSION

This is the second Canadian study to report low stethoscope colonization rates with MRSA. The setting for this study documented significant MRSA exposure to health care workers in the ED at the time of the study (12), with ample opportunity for stethoscopes to become colonized. This finding is at odds with the reported pattern in American EDs, where high prevalence of MRSA infection is associated with a high level of stethoscope MRSA contamination. Whether these findings are due to differences in infection control practice, or for other reasons, is a question open to future study. MRSA is an important pathogen, and efforts to understand and control its transmission in the hospital setting merit further investigation.

While no MRSA-contaminated stethoscope was identified in this survey, the increasing MRSA incidence highlights the need for regular disinfection of all medical equipment involved in patient care. Furthermore, the high bacterial colonization rate we observed on staff stethoscopes with skin commensals and other potential pathogenic species suggests that better education surrounding stethoscope cleaning practices for ED workers in general is warranted.

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CONFLICT OF INTEREST STATEMENT

All authors do not have any conflicts of interest or financial interests to report.

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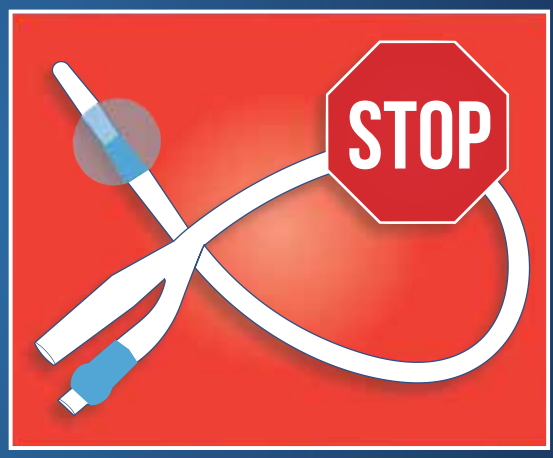

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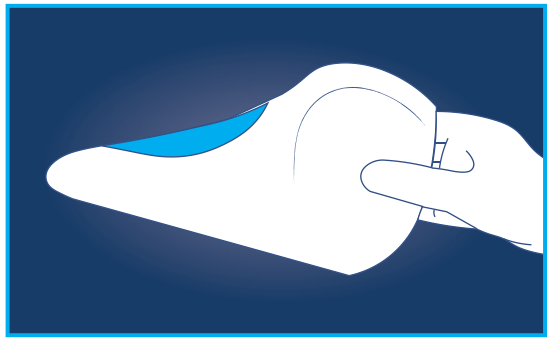

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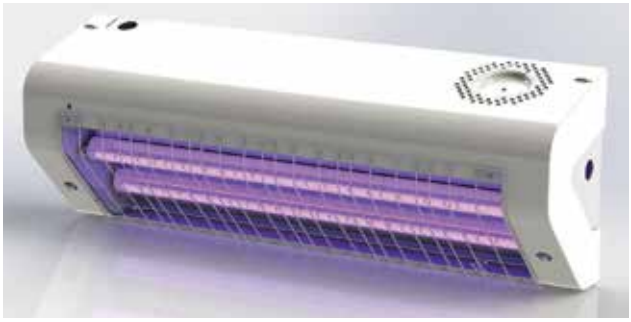

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Bruce Gamage, RN, BSN, CIC
President, IPAC Canada

Have we overreacted to Ebola?

Over the past few months I have watched with interest the response to the Ebola Epidemic in West Africa both in Canada and the United States. On October 31 the Government of Canada stopped issuing travel visas to residents of affected countries for the purpose of travel to Canada. This action was in direct opposition to the advice of the World Health Organization. The WHO is concerned that this action could be counterproductive and could actually increase the risk of international spread of the disease. At least the travel ban doesn't apply to Canadian healthcare providers returning from affected countries who have travelled there to participate in the humanitarian response. In the US, the governors of a number of states recently imposed quarantines on healthcare providers returning to the United States from West Africa where they may have cared for patients with Ebola virus disease (EVD).

The motivation for both these policies is an attempt to protect citizens from contracting Ebola. They concern me though, as they are not scientifically based, may in fact impede essential efforts to stop the Ebola outbreak and are for the most part a response to media hype.

We know that Ebola transmission arises from contact with bodily fluids of a person who is symptomatic. We know that transmission is more likely to occur when the viral load in bodily fluids is high. This is why we recognize that asymptomatic persons are unlikely to be contagious. Asymptomatic healthcare providers returning from treating patients with Ebola, even if infected, would not be putting anyone at risk. Furthermore, we now know that fever precedes the contagious stage, allowing people who are unknowingly infected to identify themselves before they become a threat to anybody. We should be honouring, not quarantining, healthcare providers who put their lives at risk helping bring an end to this epidemic.

Another question being hotly debated is the use of enhanced personal protective equipment (PPE) when caring for patients at higher risk of transmission – namely powered air purifying respirators (PAPR). Both the American CDC and some jurisdictions in Canada have recommended this PPE. Introducing the use of this equipment into the healthcare setting, in my opinion, creates greater risk as most healthcare providers are not familiar with its use, the removal of PAPR poses a greater risk of self-contamination and for the most part, this equipment is not readily available in Canadian hospitals. The goal is to ensure that healthcare providers are properly trained on any equipment they will need to use and that they will feel safe in using it. This is especially true if an aerosol generating medical procedure (AGMP) needs to be performed. Following our experience with SARS, we learned that viruses can be transmitted to healthcare providers through aerosols – even though they are not typically airborne viruses. Anyone present in the room when an AGMP is being performed on a suspected or confirmed EVD case needs to be properly protected – wearing a fit-tested, seal checked N95 respirator.

I am constantly being asked by colleagues and members of the public if we are overreacting to the current Ebola epidemic. Countless hours have been put in over the past few months by many members of our infection prevention and control community developing EVD plans and protocols. I think this is all very valuable work. To date we haven't seen any cases of EVD in Canada, and as the international response to this outbreak ramps up, the likelihood of us seeing any cases decreases. Nevertheless, we need to be ready. We need to make sure that our healthcare facilities are prepared, that our healthcare providers have been trained, and plans are in place. We should not become complacent and we should not be driven by media hype to overreact. Our role as IPAC professionals is to ensure our frontline healthcare providers understand what they need to do to keep themselves and others safe.

"The likelihood of us seeing any cases decreases. Nevertheless, we need to be ready. We need to make sure that our healthcare facilities are prepared, that our healthcare providers have been trained, and plans are in place."

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Ebola : **réaction excessive?**

Bruce Gamage, RN, BSN, CIC
Président, IPAC Canada

Je surveille avec intérêt la réaction du Canada et des ÉtatsUnis à l'épidémie de maladie à virus Ebola (MVE) qui frappe l'Afrique occidentale depuis quelques mois. Ainsi, le gouvernement du Canada a cessé, le 31 octobre, de délivrer des visas d'entrée aux résidents des pays touchés, à l'encontre des orientations élaborées par l'Organisation mondiale de la santé, qui s'inquiète des effets délétères, notamment la propagation de la maladie d'un pays à l'autre. Au moins l'interdiction ne s'applique-t-elle qu'aux prestataires de soins du Canada qui rentrent de mission humanitaire dans les pays en question. Aux ÉtatsUnis, les gouverneurs d'un certain nombre d'États ont imposé récemment une quarantaine aux prestataires de soins de retour d'Afrique occidentale, où ils risquent d'avoir traité des patients atteints de la MVE.

Certes, dans les deux cas, on tente de protéger la population. Toutefois, ces politiques m'inquiètent parce qu'elles n'ont pas de fondement scientifique, qu'elles risquent de nuire aux efforts déployés par ailleurs pour mettre fin à la flambée de la maladie et qu'elles sont en grande partie suscitées par la frénésie médiatique.

Nous savons que la MVE se transmet par contact avec les liquides corporels d'une personne qui en présente les symptômes. Nous savons également que plus la charge virale de ces liquides est grande, plus le risque de transmission est grand. Voilà pourquoi nous reconnaissons que les personnes asymptomatiques risquent peu d'être contagieuses. Les prestataires de soins asymptomatiques qui reviennent d'un pays où ils ont traité des personnes atteintes de MVE ne présentent donc aucun risque même s'ils sont infectés. Par ailleurs, puisque la phase contagieuse est précédée d'une fièvre, ceux d'entre eux qui sont infectés sans le savoir comprendront leur état avant de devenir une menace pour la santé d'autrui. Nous devrions honorer ces professionnels de la santé qui risquent leur vie pour enrayer l'épidémie plutôt que de les mettre en quarantaine!

Autre question chaudement débattue : l'usage d'un équipement de protection individuelle (EPI) perfectionné, et nommément d'un appareil filtrant à ventilation assistée (AFVA), pour traiter les patients qui risquent le plus de transmettre la maladie. Il est recommandé par le Center for Disease Control des États-Unis et certaines autorités canadiennes. Pourtant, je crois que son introduction en milieu de soins accroît le danger, puisque la majeure partie du personnel soignant ne sais pas comment l'utiliser et risque de se contaminer en le retirant. Par ailleurs, l'AFVA ne se trouve pas aisément dans les hôpitaux canadiens. L'objectif devrait être plutôt de bien former les prestataires de soins à l'utilisation de tout équipement qu'ils devront employer, pour qu'ils se sentent en sécurité le cas échéant, par exemple dans le cas d'une intervention respiratoire produisant des aérosols. Le syndrome respiratoire aigu sévère (SRAS) nous a montré en effet que les prestataires de soins attrapent les virus – même ceux qui ne sont pas transportés dans l'atmosphère – par l'entremise des aérosols. Toute personne présente dans une pièce où se pratique une intervention de ce type sur un malade qui est atteint ou que l'on soupçonne d'être atteint de la MVE doit se protéger adéquatement, c'est-à-dire porter un masque N95 dont l'ajustement et l'étanchéité ont été correctement vérifiés.

Des collègues et des membres du grand public me demandent régulièrement si notre réaction à l'épidémie causée par le virus Ebola est exagérée. Nombre de personnes travaillant à la prévention et au contrôle des infections ont consacré des heures à élaborer des plans et des protocoles à ce sujet. Ce sont à l'évidence des mesures très importantes. À ce jour, toutefois, il n'y a aucun cas de MVE au Canada, et comme l'intervention s'accélère sur la scène internationale, le risque d'incidence au Canada diminue. Quoi qu'il en soit, il faut être prêt. Nous devons veiller à ce que nos établissements de soins soient préparés, à ce que nos prestataires de soins soient judicieusement formés et à ce que tous les plans nécessaires soient en place. Il faut éviter les excès de confiance, mais éviter aussi de céder à la frénésie médiatique. Notre rôle de professionnels de la prévention et du contrôle des infections est de nous assurer que les prestataires de soins de première ligne comprennent les mesures à prendre pour leur sécurité et celle des autres.

« Nous devons veiller à ce que nos établissements de soins soient préparés, à ce que nos prestataires de soins soient judicieusement formés et à ce que tous les plans nécessaires soient en place. »

Interest groups: interested?

Gerry Hansen, BA
Executive Director, IPAC Canada

One of the benefits of membership in IPAC Canada is a complimentary membership in any of our 11 interest groups. These interest groups address unique needs for networking and information sharing associated with special professional interests. Members may belong to Interest Groups to receive communication and attend meetings, whether by conference call or in-person. Interest Groups are chaired by IPAC Canada members and there is one official representative per chapter to each of the interest groups. IPAC Canada provides a conference call line for interest groups members to ensure regular networking and project work. Many interest groups have a section of FAQs on its website. The question and responses are gathered through IPAC Chat (*www.ipac-canada.org* – IPAC Chat button). Following is a summary of the recent work undertaken by each of our interest groups.

Community Health Interest Group

Chair: Darlene Meeds Montero
Co-Chair: Samantha Sherwood
This very active interest group presented a half-day education workshop for community and public health at the 2014 IPAC Canada National Education Conference. At their 2014 in-person meeting in Halifax, the group discussed the definition of "Community Health Care" and developed a definition to be included in the interest group's Terms of Reference. They also discussed the equivalent number of FTEs that should be required for community infection prevention and control. The interest group has discussed the possibility of developing a position statement and/or practice recommendations around wound care. Also discussed was an Infection Prevention and Control Audit for Home Care.

Dialysis Interest Group

Chair: Victoria Williams
The Dialysis Interest Group is working on a Catheter Care Management Position Statement. They are also working on a survey on bacteremia rates across the country.

Environmental Hygiene Interest Group

Chair: Mark Heller
Co-Chair: Natalie Bruce
The philosophy behind inception of the Environmental Hygiene Interest Group is that in many institutions, ICPs play a coordinating/oversight role of the environmental hygiene program; there is a consensus that ICPs need more information, tools and support in fulfilling their mandate in this area. Since the launch of this interest group in 2013, members have started development of a product evaluation template, and have appointed a sub-committee to work on a Sustainable Hygiene/Disinfection Position Statement. The interest group chairs have a goal to provide a regular educational opportunity for members at its annual in-person meeting during the annual conference.

Healthcare Facility Design & Construction Interest Group

Chair: Tammy Barre
Co-Chair: Daphne Murray
The Healthcare Facility Design & Construction Interest Group is in the process of reviewing the relevant Position Statement to bring it up to date, particularly as to the CSA Z8000. An upcoming project is the Design Showcase Reference Resource. The purpose of this resource is to compile photos of new build ideas and renovation ideas that reflect appropriate IPAC principles in design and renovation (e.g. splashguards for sinks used in the ICU at University Health Network). The call for ICPs to provide IPAC consultancy service to new and renovated construction projects has resulted in a session around Becoming a Private Consultant at the 2015 National Education Conference. The session will review the legal and business implications of this role.

"One of the benefits of membership in IPAC Canada is a complimentary membership in any of our 11 interest groups. These interest groups address unique needs for networking and information sharing associated with special professional interests."

Long Term Care Interest Group

Chair: Helen Christou
Co-Chair: Adeline Griffin
The Long Term Care Interest Group was the first interest group established by IPAC Canada (then CHICA Canada). At various times, it has worked on position statements offering guidance to Long Term Care (LTC) ICPs. The LTC web page has many resources for IPAC Canada members from the LTC area.

Mental Health Interest Group

Chair: Norma Richards
The Mental Health Interest Group provides networking and information s haring for those employed as ICPs in the Mental Health sector.

Network of Networks

Chair: Jane Stafford
Co-Chair: Nadeen Bailey
The purpose of Network of Networks is to develop and support a sustainable mechanism for communication among IPAC Canada members working in regional, provincial, territorial or federal leadership positions and key national non-governmental organizations with a special interest in infection prevention and control. The use of masks and respirators has been a topic of discussion by this interest group. The Network of Networks (NON) recently completed a statement of support of certification which has been endorsed by the IPAC Canada Board and published.

Oncology Interest Group

Chair: Kimberly Mallory
Co-Chair: Cindy O'Neill
The Oncology Interest Group is poised for networking and information sharing amongst those in Oncology settings. Their website contains many resources for ICPs with the interest in Oncology.

Pediatrics and Neonatal Interest Group

Chair: Judy Dennis
Co-Chair: Patricia Bedard
This interest group was instrumental in the development of the Toys Position Statement and has reviewed and submitted a revised Human Milk Position Statement for Board approval (November 2014). The Terms of Reference have been revised to reflect its new name which now includes Neonatal interests.

PreHospital Care Interest Group

Chair: Lisa Young
Co-Chair: Jodi-Marie Black
This interest group is for those in the PreHospital Care area, including ICPs, EMS, Fire and Police. Since its inception, the interest group has delivered several education sessions at the IPAC Canada annual conference around issues affecting those in the sector. It has a very active working group that delves into issues such as hand hygiene auditing and cleaning of non-medical devices. This interest group has sent representatives to various projects that wish to ensure pre-hospital care is included in the context, for instance the Routine Practices E-Learning Tool and the Core Competencies for Healthcare Workers.

Surveillance and Applied Epidemiology Interest Group

Chair: Asha Sheikh
Co-Chair: Jenny Skoging
The purpose of the interest group is to develop and maintain a nationally representative network for exchanging information, ideas, and solutions to issues/problems and other resources related to infection prevention and control epidemiology with a focus on surveillance and applied research. The Interest Group has presented at several IPAC Canada conferences to fulfill its goal of ongoing education in the field.

For information on any of IPAC Canada's interest groups, please see the Interest Group pages at *www.ipac-canada.org* or contact IPAC Canada at *info@ipac-canada.org*.

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2014 National Infection Control Week: **Your Stories**

Lakeridge Health

In spite of Ebola this and Ebola that, at Lakeridge Health, the focus for IPAC week was to highlight the ICP role and our IPAC program. We created emails and links to specific information each day, for instance for Antibiotic Resistance, How does Infection Prevention and Control Affect You, Infection Control Starts with You, and International Infection Control Week. ICPs encouraged staff to review their emails, and were available to answer any questions. The last day comprised of inviting staff to complete the "What Germ Are You" quiz from APIC and then to send results with an explanation of how someone could prevent transmission of that germ. If an email was received without the answer, an ICP sent a message back to the individual requesting their full response. Staff was then entered into a draw only if they provided an answer. There was a lot of excellent feedback about the quiz. On a personal note: I sent an APIC e-card to every member of our IPAC team and those who were helping to make an impact with regard to infection prevention and control.

Teri Murduff, RN, BScN, CIC
Infection Prevention Professional, Infection Prevention and Control Program – Lakeridge Health, Oshawa

Sunnybrook Pictorial Stories

Submitted by **Bronwen Edgar**, BSc, MHSc, CIC
– Sunnybrook Health Sciences Centre, Toronto

2014 Ecolab Poster Contest Winner: David Ryding

Extendicare New Orchard Lodge

NICW was blended with Health and Safety Week, held October 20-24, 2014. We wanted a variety of activities to stimulate our staff both mentally and physically. Guest speakers from Shoppers Drug Mart, Swish, and Medigas. Speakers from our in-house restorative program and dietary department also held information sessions. We had a daily 15-minutes of exercise prior to morning report and a competitive game every day with a prize. On the last day we held wheelchair races in the back garden with a BBQ for staff and residents.

The Infection Prevention and Control focus was on Hand Hygiene. The goal was to reach as many staff as possible and to involve all departments. We decided on using a tree with a fall theme. The first problem to address was the tree: cardboard, paper or something more permanent. A leftover piece of drywall (4′x 8′) was found. We painted a landscape (grass and sky) and covered it with a leafless tree. The tree itself was taken from clip art and blown up to nearly 5′ at Staples. It was then traced onto the landscape and painted with folk art enthusiasm. Our maintenance department built a stand for it after altering the height by a few feet. The leaves, cut in the shape of hands, were cut out of red, orange, yellow and green construction paper by a select group of residents.

Throughout the week, every staff member was asked to list the "Four Moments" of hand hygiene. Written information was provided for study prior to the test. Each person then chose their colour and wrote their name on the hand. The leaf/hand was then added to the tree. The results were very gratifying. Every day new names were added until the tree was covered with personalized leaves/hands.

Staff members from all departments and a few residents and family members renewed their compliance with hand hygiene.

The tree was left on display for a time as a reminder to all of the importance of breaking the chain of transmission through the regular use of ABHR (alcohol based hand rub) and hand washing.

Annette Lafontaine, RN, ADOC
Extendicare New Orchard Lodge – Ottawa

Infection Control Week at Quinte Health Care

Using the NICW poster theme of "Defence is the best Offence" and highlighting areas of interest, we provided fact sheets on MRSA, Norovirus, Influenza, VRE, C difficile, and Ebola.

Our boards contained detailed information on Influenza and Ebola – transmission, symptoms, facts and treatment.

We used a mannequin and donned Ebola PPE to provide a visualization for staff on what the standards (at this time) were for protection.

We provided an updated Influenza package for 2014, as well as dates/locations for flu clinics in the community and hospital.

Interest and attendance at our booth has been well attended and ICPs are available to answer any questions that staff/visitors have.

We will be attending all sites (TMH, PECM and North Hastings) to provide the same information and support. Our displays have already been set up in preparation for the kick-off.

Lisa Triemstra
Infection Control, Quinte Health Care

Interior Health

Using the theme "Staying Ahead of the Game," as Mr. Monopoly, one of the games that we played was Wheel of Fortune/Misfortune. Staff got to "come on down" and "spin the wheel." Each slice of the wheel pie was related to infection control issues (i.e., true/false; myth/fact; open-ended questions). Issues addressed were routine practice, point of care risk assessments, hand hygiene, personal protective equipment, equipment cleaning, and personal care supplies).

Any staff member who spun the wheel got a prize. All disciplines were invited to participate. So that no one would feel that they were on the spot to answer the questions when they spun, I asked that anyone could shout out the answer when the wheel was spun.

Staff were very engaged, had lots of laughs, and everyone went home with a prize.

Lorena McLure
Infection Prevention and Control – Interior Health, Kelowna

Leeds Grenville Health Unit Hosts Infection Control Education Day "Infection Control – It Starts With Me"

Administrators, Infection Control experts and frontline staff from long-term care, retirement homes and local hospitals gathered at the Smiths Falls Memorial Centre on Oct 23 to increase their knowledge about protecting residents and the community from infections like the flu, antibiotic resistant organisms, and other significant infections.

Public Health Ontario (PHO), Leeds, Grenville and Lanark District Health Unit and the Perth, Smiths Falls District Hospital worked together to ensure that it was a thought-provoking, successful, and fun day.

Speakers from both the Champlain and South Eastern Ontario Regional Infection Control Networks talked about urinary tract infections, (when they need to be treated and when they don't), as well as how to manage antibiotic-resistant organisms like MRSA and VRE in facilities. A member of Public Health Ontario's Infection Control Resource Team shared lessons she learned across Ontario when helping long-term care and retirement facilities think about prevention related to managing outbreaks and daily challenges they face in keeping their facilities infection-free. Occupation Health and Safety from the Perth and Smiths Falls Hospital reviewed immunizations that healthcare workers need in order to protect themselves and the people they care for. Dr. Paula Stewart, Medical Officer of Health, presented up-to-date information on all the emerging infections, so everyone is prepared. Margaret Hendriks, RN and Infection Control Manager brought the group up to speed about how flu shots are being delivered in the community this year.

The Health Unit Infection Control Team was able to recognize Broadview Nursing Centre who won a Keurig coffee machine for their staff for having the highest staff flu immunization rate (100%) last season. This influenza season, another Keurig will be awarded to the long-term care, retirement facility or hospital having the most improved influenza immunization rate for their healthcare workers.

Additional interactive activities were included throughout the day such as voting questions with clickers, creation of an Infection Control team poster and a fashion show with our local staff using personal protective equipment. Resonating throughout the day was the theme; "Infection Control – It starts with me."

Back row L-R: Debbie McIntyre, Courtney Shaffer, Hanan Atwy, Barbara Vander Meer. Front row: Katie Willard, Michele de Jonge.

Top L-R: Sam McFarlane (PHO), David Ryding (PHO), Sue Cooper (PHO), Michele de Jonge (LGL Health Unit), Susan Merritt (LGLHU), Grace Volkening (PHO)
Bottom: Courtney Shaffer (LGLHU), Debbie McIntyre (LGLHU), Barbara Vander Meer (LGLHU), Hanan Atwy (LGLHU).

Leeds, *Grenville and Lanark District Health Unit, Smiths Falls*

Peterborough Regional Health Centre

http://www.youtube.com/playlist?list=PLo7KlH_kA-HEN5L7wbwkAg9GKZw5sK8Q7

Porcupine Health

The Porcupine Health Unit's infectious disease team challenged our staff with the popular word puzzle game 4 pics 1 word. Each day of the week, staff received an email containing four pictures that were linked to one word. For every correct answer, their name was entered in a draw. The following day we provided the answer along with education. It was an opportunity to familiarize staff with our "Your Health is in Your Hands" campaign key messages: clean your hands, cough and sneeze into your sleeve, keep commonly touched surfaces clean, get immunized and stay home if you're sick. The challenge was a great success!

Renelle Lafleur, RN, BScN
Public Health Nurse
Porcupine Health Unit, Timmins

Provincial Infection Control Network of British Columbia

For NICW, PICNet's approach to "staying ahead of the game" was to play a game! Last year, PICNet created an infection control educational workshop that runs like a game show, where staff are divided into two teams and compete for prizes by answering questions and taking part in activities. Each question/activity is built around a teaching moment, and the game is very hands-on, to keep the players engaged and have them learn by doing. The "Let's Go Viral!" game kit was a huge hit, with orders coming in from across Canada. Based on users' feedback, PICNet revised the game to include more focus on risk assessment. For NICW 2014, PICNet took the game on their Residential Care Roadshow; you can see from the photos how much the contestants enjoyed it! If you're interested in purchasing or downloading the game kit, visit *www.picnet.ca/letsgoviral*.

Helen Evans
Communications Officer – Provincial Infection Control Network of BC (PICNet)

Prince Rupert Regional Hospital

You can see the display table for Canadian Patient Safety week and Infection Control Week. Employees volunteered from the hospital to discuss with patients and the public the role Hand Hygiene plays in the prevention of infectious diseases especially HAIs as well as the role of housekeeping in cleaning the hospital environment and equipment. Pictured here is Roxanne Fitzsimmons, RN, Infection Prevention Nurse and Mary Wesley, Aboriginal Liaison.

Roxanne Fitzsimmons, RN
Infection Prevention – Prince Rupert Regional Hospital

South West Health Design the Sign Contest

Here in South West Health we are a small district with three facilities. The two ICPs and the Patient Safety Advisor teamed up and developed a "Design the Sign" poster contest to promote hand hygiene. The signs would then belong to the SWH IPAC program and be used for various promotions, messaging, etc. The contest was promoted throughout the three sites in the district via email and posters.

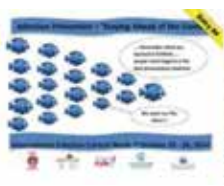
Ecolab very generously provided the grand prize which was a night's stay at a local resort. The runners up received goodies from our respective programs such as hand sanitizer, water bottles, etc.

We had a fabulous response to the contest, lots of buzz and received 17 wonderful entries from across the spectrum of healthcare workers. A panel of 6 judges met and reviewed the posters for: Creativity; Impact; Originality.

With a bit of enjoyable discussion the judges narrowed the entries down to five. These five entries were sent via email to all staff and poster displays were placed at the three sites. Folks voted via email and also by paper ballot at the displays. We had a great response and lots of expectation around the contest.

Eventually the ballots were tabulated and one clear winner emerged. The entries showed originality in promoting hand hygiene and a positive expression of teamwork. This was a simple way to involve multiple disciplines in hand hygiene and a fun way to promote hand hygiene during Infection Prevention and Control week!

Faith Stoll, Kathy Ellis, Michael Wheatley



Sturgeon Community Hospital
Staff at the Sturgeon Community Hospital Care about Clean Hands!

In celebration of National Infection Control Week (October 20-26, 2014), staff at the Sturgeon Community Hospital sealed their commitment to clean hands by adding their handprint and signature to banners that were displayed in the hospital.
In keeping with the theme of the week "Staying Ahead of the Game," staff from different departments competed in a fun game of "Infectious" Family Feud to test their knowledge of infection prevention and control. Congratulations to the grand winners, the "E.S.B.L." team of Unit Clerks/ Nurse from our Medicine program!

Megan Oppel & Tiffany Herrick,
Infection Control Professionals
Sturgeon Community Hospital,
St. Albert

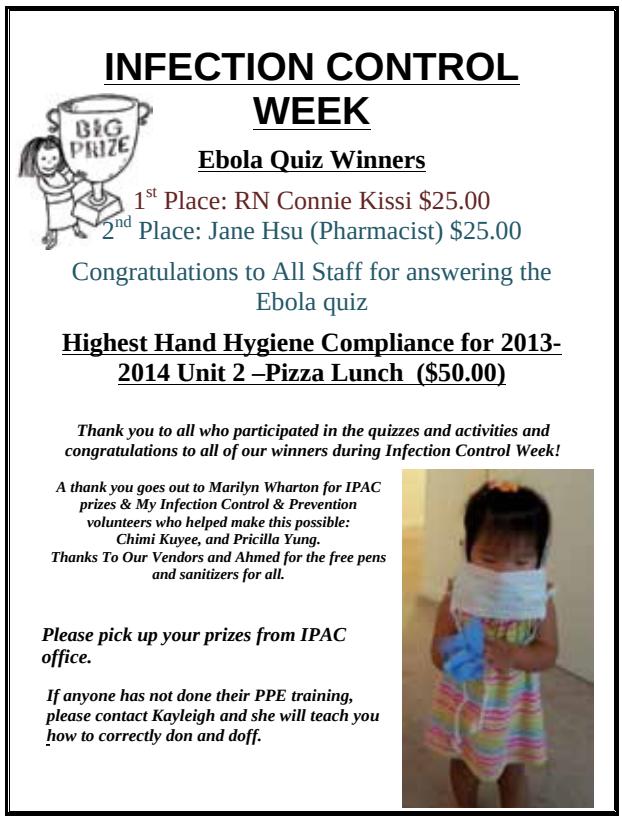
Staff at the Sturgeon Hospital Care about Clean Hands!
L-R: Dr. Stickney-Lee; Tiffany Herrick, ICP; Yoke Bovenmars, Service Aid; Melanie Owen-Schneider, Dietitian; Al Pagliaroli, FME, Megan Oppel, ICP.

"Infectious" Family Feud winners the "E.S.B.L." team from Medicine (L-R): Tara Townsend; Kelsey Handziuk; Brittany Wilson; Jennifer Godin; Kawaljeet Nagra.

Toronto Grace Hospital

The tree is the pledge of all staff commitment to IPAC and the 2nd poster of prize winners is one of our staff's little two year old with PPE.

Lorraine Le'count, RN, BScN
Toronto Grace Hospital



University Health Network

This year at the UHN, as Canadian Patient Safety Week took place around the same time as National Infection Control Week, it was decided to roll the two initiatives together. IPAC teamed up with Risk Management and Public Affairs to highlight what IPAC does in contributing to patient safety.

Along with roaming carts to engage staff, patients and visitors across the organization in the initiatives taken to increase hand hygiene and therefore create a safer environment; we published articles to create awareness of some lesser-known roles IPAC takes with the organization.

The first initiative was called "Life Cycle of an Incident." It was sent out as a daily email announcement to all staff to describe the constructive nature of reporting an incident (this one involving a patient who acquired C. difficile and due to it, needed surgical intervention). It went over all the processes and how it is intended to affect positive change within the organization.

The second initiative was entitled "Day in the Life of an ICP," which was published in the UHN News. This described the day-to-day duties of an ICP; which are varied, less overt, and continue well past the point when an ICP has left their unit. We also celebrated our large and varied team with different backgrounds.

Erica Susky
University Health Network, Toronto

Infection Control Practitioners Nicole Kirby and Erica Susky pose for a quick photo in between answering their pages. Erica covers all of the inpatient and outpatient units of the E.W. Bickle Centre at Toronto Rehab. Nicole covers BMT inpatient units, a Malignant Hematology unit and associated ambulatory clinics.

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For NICW 2014, Surface Medical Inc./ CleanPatch developed an original rap and video about the importance of intact surfaces in healthcare.

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Contributed by Mark Heller

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*Safer Healthcare Now! Campaign, Prevent Ventilator Associated Pneumonia: Getting Started Kit, p. 6, June 2012.

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2015 Champions of Infection Prevention and Control

In collaboration with 3M Canada, IPAC Canada has developed the prestigious Champions of Infection Prevention and Control Award. Applications are being accepted for the 2015 Champions of Infection Prevention and Control award. This award will acknowledge the dedicated accomplishments of the front line Champions of Infection Prevention and Control. The award will recognize IPAC Canada members who daily work tirelessly, and creatively, to reduce infection, raise awareness and improve the health of Canadians. They have shown extraordinary results in their area, and should be recognized for their efforts. Awards will be presented at the 2015 National Education Conference in Victoria. Award criteria and nomination form will be posted to *www.ipac-canada.org* by November 1, 2014. The deadline for 2015 nominations is March 1, 2015.

"This award will acknowledge the dedicated accomplishments of the front line Champions of Infection Prevention and Control."

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[2] As of April 2012, STERRAD® 100NX and NX are cleared to process 10 stainless steel lumens per load. V-PRO maX is cleared to process 20 stainless steel lumens per load.

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SEPTEMBER 2015-JUNE 2016

In September 2015, IPAC Canada will once again be offering the Novice Infection Prevention and Control (IP&C) course.

Preference for admission to this interactive online distance education course will be given to the novice infection prevention and control practitioner (less than two years' experience) currently working in IP&C. Applications will also be considered from others working in healthcare and/or exploring opportunities in IP&C.

The course consists of six modules and a 12-hour practicum. The duration of each module is approximately one month with a week break between modules. There is a longer break scheduled over the December holiday period. The course will run from September 2015-June 2016.

Student evaluation consists of online discussions, a final take-home exam, and may include assignments. Graduates will receive a certificate of completion from IPAC Canada on successful completion of the six modules (with a minimum grade 65% in each module) and successful completion of the practicum.

Students must be able to dedicate 12-15 hours per week to read course material, participate in discussions, and complete assignments and exams.

Please refer to *http://www.ipac-canada.org* for a detailed description of course content, schedule, and tuition.

Tuition: Tuition is $1700.00 CDN for all six modules and the practicum. Tuition is paid in two installments of $850.00 due August 1, 2015 and $850.00 due February 2, 2016. Tuition can be paid through post-dated cheques or credit card (VISA, MasterCard or American Express).

Inquiries: Questions about the course should be directed to Heather Candon or Jane Van Toen, IPAC Canada Course Coordinators at *basicde@ipac-canada.org*

Application: Interested individuals should complete the application form located on the IPAC website and submit to *basicde@ipac-canada.org*. Completed application forms should be forwarded no later than **March 16, 2015.** Students will be notified of their acceptance by mid-June. A waitlist will be maintained and late applications may be accepted if space is available.

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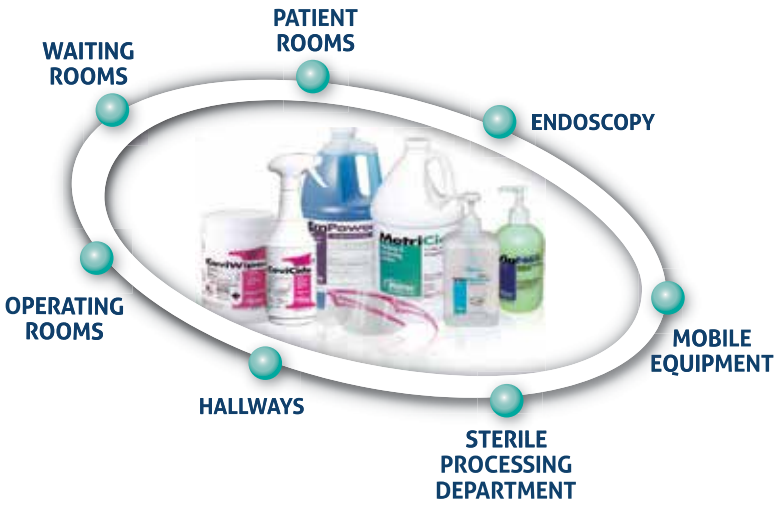

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AN-2014-02-0015

2015 Diversey **Bursary**

IPAC Canada and SealedAir Diversey Inc. have collaborated on the establishment of the Diversey Education Bursary. The objective of the Bursary is to provide financial assistance to eligible IPAC Canada members to attend continuing professional education programs. With the need for increased funding for IPAC Canada members to attend or participate in educational events, the sponsorship of this bursary by Diversey Inc. enhances IPAC Canada's ability to support its members in attendance at the annual conference, at a chapter educational event, or as a student at one of the distance education courses supported or endorsed by IPAC Canada.

"We are pleased to partner with IPAC Canada to provide this education bursary which advances our joint objective – promoting best practice in infection prevention and control to improve patient and staff safety," said Carolyn Cooke, Vice President, North America Healthcare Sector. "We see continuing education and shared knowledge as cornerstones to improving patient outcomes and program quality, and we are proud to partner with IPAC Canada to be able to provide an opportunity for increased learning and knowledge sharing."

> "With the need for increased funding for IPAC Canada members to attend or participate in educational events, the sponsorship of this bursary by Diversey Inc. enhances IPAC Canada's ability to support its members."

The 2015 Diversey Education Bursary will be online in November 2014. The deadline date for applications is January 31, 2015.

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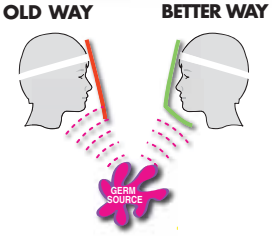

2015 Virox Technologies **Scholarship**

Through the financial support of Virox Technologies, 16 IPAC Canada members were awarded scholarships to attend the 2014 IPAC National Education conference in Halifax. IPAC Canada and its members thank Virox Technologies for their initiative to make the national education conference accessible to those who may not have otherwise been able to attend.

In partnership with IPAC Canada, Virox Technologies will again provide scholarships to assist IPAC Canada members with attending the 2015 National Education conference in Victoria (June 14-17, 2015). The 2015 Virox Technologies Scholarship online application will be launched in November 2014. The deadline for applications is January 31, 2015.

> "IPAC Canada and its members thank Virox Technologies for their initiative to make the national education conference accessible to those who may not have otherwise been able to attend."

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CIC **Graduates**

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First Time Certificants

Arla Altwasser, MLT, CIC..... Moose Jaw, SK
Alison M. Chant, BSN, RN, CON(c), CIC..... Vancouver, BC
Claudia A. Crusell-Balogh, CIC..... Oakville, ON
Terry J. Lauriks, BSc, CPHI, CIC.....Cold Lake, AB
Sandra A. MacIsaac, MA, MPH, CHES, CIC..... Athabasca, AB
Rhonda L. McLean, RN, CIC.....Surrey, BC
Sharon V. Pelletier, CIC ..... Edmonton, AB
Ivan Serunkuma, MD, CIC .....Prince Albert, SK
Jean Terhaar, RN, CIC ..... Belleville, ON

Renewed

Stacey L. Burns MacKinnon, CIC.....Charlottetown, PE
Yasmine A. Chagla, CIC..... London, ON
Catherine D. Egan, CIC ..... Toronto, ON
Jennifer L. Francella, CIC.....Sault Ste Marie, ON
Deanna Hembroff, RN, BSN, CIC ..... Prince Rupert, BC
Lisa Ann Holovach, HBSc, MLT, CIC ..... Moose Jaw, SK
Barbara Nancekivell, CIC ..... Dorchester, ON
Craig Lawrie, CIC.....Kingston, ON
Ruth E. Schertzberg, ART, CIC..... Kitchener, ON
Grace Volkening, MLT, CIC ..... Aurora, ON
Catherine E. Walker, CIC.....St. Thomas, ON

Bring in a **new member**

Win a complimentary 2015-2016 membership

Membership has its benefits. The IPAC Canada website (*www.ipac-canada.org*) has so much information on the benefits of being a member. The member resource guide for finding other IPAC Canada members, links to infection control sites, audit tools … the list is extensive. Tell another infection prevention and control professional (ICP), tell an ID physician, tell your Medical Laboratory Technologist, tell Environmental Services, tell EMS, tell your designate, and tell your director about the benefits of joining our national organization.

If that person joins IPAC by May 1, 2015, both you and the new IPAC Canada member will be eligible to win a complimentary 2015-2016 membership (value $202). You are eligible for the draw with every new IPAC Canada member that you get to sign up. Should the winning members have already paid their 2015-2016 membership, a refund will be made to the person or the institution which has paid the fee.

Send in this form no later than May 1, 2015. An announcement of the winners of this offer will be made at the 2014 conference. Membership applications can be found at *http://www.ipac-canada.org/about_join.php*.

New member name _____

Email address _____

Sponsoring member _____

Email address _____

Send this form by fax or email to:
IPAC Canada Membership Services Office | *info@ipac-canada.org* | Fax: 204-895-9595

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Moira Walker Memorial Award for International Service

About the International Service Award

This Award honors an individual or group that has demonstrated extraordinary efforts to bring about change or improvement related to infection prevention and control in parts of the world that are under developed or under resourced. The annual award is in honour of Moira Walker, RN, CIC, a Past President of IPAC Canada (formerly CHICA Canada) and Past Honourary Secretary of the International Federation of Infection Control. Moira's life was dedicated to enhancing the physical and spiritual health of her many friends and colleagues.

Nomination guidelines

- Who is eligible
  Preferred: Current IPAC Canada members in good standing. The award may be presented to individuals, prior nominees, or a group of individuals, but not past award recipients, who have demonstrated international cooperation in the field of Infection Prevention and Control or Public Health. Fundraising efforts alone will not be sufficient criteria for this award. Lifetime achievement in international service would be considered.
- Who may nominate
  Any member of IPAC Canada or a chapter of IPAC Canada may submit a nomination. The IPAC Canada Board of Directors (the Board) may also nominate candidates. The nomination form is available at *www.ipac-canada.org* (Opportunities).
- How to nominate
  A completed nomination form and covering letter outlining the nominee's projects that have resulted in this nomination must be forwarded to the Membership Services Office no later than March 31st of each year.
- Selection process
  The Board will select the recipient(s) through an evaluation process.

Award

Artwork with a First Nations and Inuit art theme. The accompanying engraved plate will announce the recipient's award. In addition, award winner(s) will be provided with a complete waived registration for the national education conference at which the award is presented. In the case of a group award, one representative of the group will be provided a complete waived registration.

DEADLINE:
The deadline for nominations is March 31, 2015.

Announcement and presentation

The award winner(s) will be advised by April 15th of each year. The award will be presented at the Opening Ceremonies of the IPAC Canada National Education Conference.

2015 ECOLAB® POSTER CONTEST

An annual poster contest is sponsored by Ecolab and supported by a chapter of IPAC Canada to give infection prevention and control professionals (ICPs) an opportunity to put their creative talents to work in developing a poster which visualizes the Infection Control Week theme.

YOU ARE INVITED to design a poster that will be used for Infection Control Week 2015 using the following theme:

Infection Prevention:

Prize: Waived registration to 2015 IPAC Canada National Education Conference or $500.

REMINDER: Posters should have meaning for patients and visitors as well as all levels of staff in acute care, long term care and community settings. The poster should be simple and uncluttered, with strong visual attraction and few if any additional words.

Judging will be on overall content. Artistic talent is helpful but not necessary. The winning entry will be submitted to a graphic designer for final production. Your entry will become the property of IPAC Canada.

HOST CHAPTER: IPAC CENTRAL SOUTH ONTARIO

Send submissions to:
Submissions will only be accepted by email.
Send submission to: *info@ipac-canada.org.*
Title email : 2015 Ecolab Poster Contest

DEADLINE: January 31, 2015

Submission format:
Electronic file in Word or PDF format only.
File size: must print out to 8.5"x11.0" paper
Name, address and telephone number must be included in the covering email. DO NOT include identifiers in the poster submission.

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Glo Germ	237	800-909-3507	www.germwise.com
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Medco Equipment	190	800-717-3626	www.medcoequipment.com
Medline Canada Corporation	213	800-396-6996	www.medline.ca
Metrex Corp.	240	800-841-1428	www.metrex.com
Process Cleaning Solutions	222	877-745-7277	www.processcleaningsolutions.com
Retractable Technologies, Inc.	202	888-703-1010	www.vanishpoint.com
Rubbermaid Commercial Products	201	800-998-7004	www.rubbermaidhygen.com
Sage Products, LLC	235	800-323-2220	www.sageproducts.com/preventinfection
Southmedic	242	800-463-7146	www.southmedic.com
STERIS Canada Inc.	238	800-661-3937	www.steris.com
The Clorox Company of Canada Ltd.	189,192	866-789-4973	www.cloroxprofessional.ca
The Stevens Company Limited	202,214	800-268-0184	www.stevens.ca
Vernacare Canada Inc.	219	800-268-2422	www.vernacare.com
Virox Technologies Inc.	IFC	800-387-7578	www.virox.com

To reach infection control professionals across Canada through the ***Canadian Journal of Infection Control*** and its targeted readership, please contact me at

Al Whalen, Marketing Manager 1-866-985-9782 *awhalen@kelman.ca*

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