



Bleach: Addressing the Myths and Sharing the Clinical Evidence

CAEM (Canadian Association of Environmental Management)
Return to Blue Conference and Trade Show

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Outline

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- II. How does Bleach Work?
- III. Common Bleach Myths
- IV. *A Clostridium difficile* Primer
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I. Why Use Bleach?

Rates of Hospital-Acquired Infections are Rising

*2003 Study → estimated 220,000 cases /year of HAIs in Canadian hospitals resulting in at least 8000 deaths annually.
(Special Report, Office of the Auditor General Ontario)*

<i>C. difficile</i>	<i>4.74 cases/1000 admissions</i>
<i>MRSA</i>	<i>8.04 cases/1000 admissions</i>
<i>VRE</i>	<i>1.32 cases/1000 admissions</i>

Ontario alone → nearly 4,900 deaths/year from infectious diseases (Institute for Clinical Evaluative Sciences, ICES, Dec. 2010)

I. Why Use Bleach?

In the US ...

- 2 million infections acquired in healthcare settings, resulting in about 90,000 deaths (CDC, 2006)
 - Direct medical costs of HAI to US hospitals > \$28.4 B (CDC 2009)
 - Benefits of prevention range from \$5.7 B (20% preventable infections) to 31.5 B (70% preventable infections) (CDC 2009)
- Sodium Hypochlorite Bleach is an effective disinfectant that is widely used to destroy bacteria, viruses, and fungi on surfaces in healthcare and daycare settings, schools and homes.

I. Why Use Bleach?

Advantages of Hypochlorite:

- Broad spectrum of antimicrobial activity
 - Bleach formulas \geq 1:10 concentration meet CDC Guidelines for Surface Disinfection and OSHA Bloodborne Pathogen Standards
- No toxic residues
- Unaffected by Water Hardness
- Inexpensive and Fast Acting
- Removes dried organisms & biofilms
- Low incidence of serious toxicity

I. Why Use Bleach?

Additional Advantages of Hypochlorite:

- Destroys Allergens
- Maintains Appearance – removes mold and stains
- Controls Odors
- Formulated RTU products reduce/eliminate need for other Cleaning Agents

I. Why Use Bleach?

Disadvantages of Bleach	Issue Addressed by Formulated Ready-to-Use (RTU) Products
At high concentrations skin, eye, or respiratory irritations possible	Low, but effective, concentrations used. See Product Labels.
Deactivated in presence of organic matter, degrades with time	Stabilizing agents may be added.
Caustic, tends to corrode metals	Anticorrosive agents may be added.
Discolors or “bleaches” fabrics	---
Incompatible with ammonia, acids, formaldehyde	---

II. How Does Bleach Work?

Antimicrobial Impact of Sodium Hypochlorite (NaOCl) Bleach ...

- Active species in bleach is Hypochlorous Acid, HOCl
- Strong oxidizing agent – reacts with enzymes, amino acids, proteins
- Rapid, non-specific destruction of proteins
- Since 1913, Bleach has been one of the most widely used disinfectant products due to its proven efficacy against hospital microorganisms. In spite of this long use, the mechanism has just recently elucidated (Winter, et. Al. 2008)

“the antimicrobial effects of bleach are largely based on HOCl's ability to cause aggregation of essential bacterial proteins”

Proteins rapidly lose structure via oxidative protein unfolding
Large protein aggregates form
Amino acids aggressively attacked

II. How Does Bleach Work?

Mode of Action: Bleach vs. Quats

Bleach

- Generally → broader range of microorganisms, lower contact times than QACs.
- Tears apart the microbe's cell walls and deactivates proteins required for bacterial growth by destroying the molecular structure.
- May be effective on spores.

Quaternary Ammonium Compounds (Quats, QACs)

- Act on cellular membranes and exhibit more variability in effectiveness by organism type.
- Must cross the microbe's cell membrane to inactivate it. Cell membranes vary by organism type and can inhibit the effects of QACs. Typically QACs take longer to affect the cell than bleach.
- Typically not effective on spores.

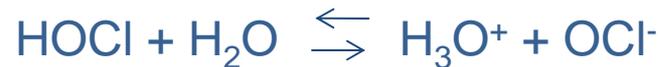


II. How Does Bleach Work?

Mode of Action: Bleach vs. Peroxide

Bleach

- Activity based on Hypochlorous Acid, HOCl → Strong Oxidizer.



- Tears apart the microbe's cell walls and deactivates proteins required for bacterial growth by destroying the molecular structure.
- Sporocidal depending on pH and concentration of available chlorine. During treatment, the spores lose the ability to germinate, the spore coat separates, and cell death occurs.

Hydrogen Peroxide

- Activity based on production of Hydroxyl free radicals, •OH → Strong Oxidizer.
- Attacks membrane lipids, DNA, and other essential cell components.
- Typically higher concentrations of H₂O₂ (10 to 30%) and longer contact times are required for sporocidal activity.

III. Common Bleach Myths

- #1 Bleach contains Chlorine Gas
- #2 Bleach use creates Dioxins
- #3 Bleach odor is Unacceptable
- #4 Bleach causes Respiratory Issues/Asthma
- #5 Bleach causes Cancer
- #6 Bleach can't be used -- it is a Pesticide
- #7 Bleach harms the Environment
- #8 Using bleach damages Equipment

III. Common Bleach Myths: #1 Bleach contains Chlorine Gas

Bleach is commonly referred to as chlorine bleach, but there is no molecular chlorine (Cl_2) in bleach.

- Bleach is manufactured from sodium chloride (common table salt) and water to produce sodium hypochlorite, the active ingredient in bleach.
- Bleach based disinfectants are water solutions of NaOCl that may contain additives for enhanced cleaning and stability.

III. Common Bleach Myths: #2 Bleach use creates Dioxins

No studies have connected household use of sodium hypochlorite bleach to dioxins.

Use of bleach as a disinfectant does not form dioxins.

- Bleach breaks down mainly into salt and water during or quickly after use.

III. Common Bleach Myths:

#3 Bleach Odor is Unacceptable...

The clean smell of bleach → a powerful, recognizable, and reassuring cue for patients and staff that they are in a clean and disinfected environment!

Studies have shown when exposed to bleach, little or no concern about the odor of bleach was expressed.

- **Mayo Clinic** study → only 8.8% of patients noticed the smell of bleach when it was used in their room; none found the odor bothersome. *APIC 2010 Abstract, K. Aronhalt, BSN, RN, Mayo Clinic.*
- At **Barnes-Jewish Hospital** → an 18-month study was conducted demonstrating 1:10 bleach's efficacy against *C. difficile* spores as part of a bundled program. The authors noted that "During the study, patients, family and staff did not complain about the odor of bleach." *J. L. Mayfield et al., Clinical Infectious Diseases 2000; 31:995-1000*

Bleach's odor is increased by the chemical reaction that occurs when bleach begins to break down proteins, such as those that make up HAI-causing pathogens. *K. Reddy, Infections Control Today, Sept. 30, 2010.*

- Follow label directions & ensure proper ventilation
- Bleach wipes reduce the dispersion of product in the air

III. Common Bleach Myths:

#4 Bleach causes Respiratory Issues/Asthma

The smell of Bleach ... should not raise health concerns.

- You can smell chlorine at very low levels -- well below levels recognized to cause potential respiratory irritation or overt health effects
- When used in accordance with the label directions, bleach disinfectants should not exceed the occupational exposure limits for chlorine.

Odor Threshold vs. Irritation for Chlorine	
	In Air
Odor Threshold for Cl ₂	0.002 ppm
Odor Threshold for -OCl	0.36 ppm
Perceivable Sensory Irritation Cl ₂	1.0 ppm*
Factor for Cl ₂	500

* EPA 1999. Cited from "Toxicology Profile for Chlorine", ASTDR, USDHHS, September 2007

III. Common Bleach Myths:

#4 Bleach causes Respiratory Issues/Asthma

- **Bleach is not on the AOEC list of recognized asthmagens.**

The Association of Occupational & Environmental Clinics AOEC Exposure Codes,

- **Bleach is not a recognized asthmagen by any regulatory agency.**
- **Bleach destroys allergens, it is not a cause of asthma.**

The Asthma and Allergy Foundation of America recommends “Cleaning and killing mold spores on hard, non-porous surfaces with an EPA-registered cleaning solution containing low concentrations of bleach” to prevent the growth of mold and mildew”.

The Asthma and Allergy Foundation of America , 2005

III. Common Bleach Myths: #5 Bleach causes Cancer

Bleach does not cause cancer

- The CDC, citing the International Agency for Research on Cancer (IARC), concluded that hypochlorite salts, including sodium hypochlorite (bleach), are not cancer-causing.

ToxFAQs™ for Calcium Hypochlorite/Sodium Hypochlorite, April 2002

- The European Commission Scientific Committee on Health and Environmental Risks (SCHER) also supports this conclusion, and adds that there is “no evidence for developmental or reproductive toxicity of sodium hypochlorite based on the available database on hypochloride and chlorine.”

•“Risk Assessment Report on Sodium Hypochlorite; Human Health Part”, SCHER, European Commission, 2008.

III. Common Bleach Myths:

#6 Bleach can't be used -- it is a Pesticide

ALL EPA registered disinfectants are classified as pesticides!!

- Public Health Disinfectants are NOT the same as traditional agricultural pesticides.
- Disinfectants are used to KILL microorganisms → that is their job! If they don't kill the pathogens, our hospitals and other facilities are not protected.
- EPA/Health Canada registration indicates that the product has proven efficacy against the microorganisms listed and that it complies with regulations regarding raw materials, processing, label requirements, usage safety and product efficacy. Check the registered product label to confirm disinfectant claims and micro-organism list.

EPA's Antimicrobial Division (EPA registration #)

Health Canada's Therapeutic Products Directorate, TPD (DIN #)

III. Common Bleach Myths:

#7 Bleach harms the Environment

Sodium Hypochlorite does not harm the environment

- Disappearance of hypochlorite is very rapid in the natural aquatic environment.
- Similarly, the impact of sodium hypochlorite on the air and soil was negligible
- Sodium and calcium hypochlorite do not accumulate in the food chain.
- The EPA has concluded that the “currently registered uses of the hypochlorites will not result in unreasonable adverse effects to the environment.”.

European Union Risk Assessment Report. 2007. Sodium Hypochlorite

CDC ToxFaq for Calcium Hypochlorite/Sodium Hypochlorite, April 2002.

EPA R.E.D. Facts Sodium and Calcium Hypochlorite Salts September 1991.

III. Common Bleach Myths:

#8 Using Bleach Damages Equipment

Fact: Bleach's effect on surfaces is caused by two factors:

- The oxidizing action of hypochlorite.
- The salt that is left behind.

These effects can be minimized by using

- RTU formulated bleach products that contain anticorrosive agents.
- A clean, damp cloth to wipe surfaces to prevent salt build up and damage.

Cleveland Veterans Affairs Medical Centers conducted a five-and-a-half month study involving routine use of 1:10 bleach

- “Although there were initially concerns that bleach might cause damage to surfaces in the rooms, no complaints regarding such damage have been reported. In addition, interviews with the housekeeping staff were conducted, and no complaints related to the application of bleach were reported.”

Eckstein et. Al. BMC, Infectious Diseases, 2007;7:61.

IV. *Clostridium difficile* Primer

What is *Clostridium difficile*?

- *C. difficile*, “*C. diff.*”
- *C. difficile* Infection (CDI), *C. difficile* associated diarrhea (CDAD)
- A naturally occurring gram-positive bacterium.
- Causes 3 million cases of diarrhea and colitis per year
- A major HAI → up to 40% of patients will acquire CDI
- NAP1 Strain → more toxin, highly resistant, severe disease with more relapses & higher mortality
- CDI caused by alterations in the bacteria in the colon associated with antibiotic treatment
- US CDI cases doubled from 2000 to 2003 (25,000 to 54,000)
- Huge Economic Burden for hospitals, \$580 M

ICT Webinar, “The *C. difficile* Battle in Healthcare Facilities” Infection Control Today , July 20, 2011, Lillian Burns
www.infectioncontrolday.com

IV. *Clostridium difficile* Primer

Recent Canadian OUTBREAKS → *Clostridium difficile*

- Calgary/Montreal 2003 → Hyper-virulent strain killed >100 , infected >1000 in 18 months.
- Quebec 2006 → outbreak killed 16.
- Ontario 2011 May- July → outbreak killed 21

***Clostridium difficile* is a Real Problem!!**

2004 CMAJ article "In many institutions, housekeeping staff has been reduced while nursing workloads have increased. *C. difficile* is particularly difficult to eradicate from surfaces and equipment. Compliance with hand hygiene has been shown to decrease as workloads increase. Decreased compliance with isolation protocols along with the increased environmental spore burden could have a synergistic effect in promoting *C. difficile* cross-infection"

IV. *Clostridium difficile* Primer

Key Issues

- Fecal-oral transmission → contaminated environment and hands of healthcare personnel
- Spores → survive outside of the body for 70 days
- Spores hard to kill with typical cleaning agents

Key Intervention

- Cleaning Alone is not Enough!
- Impose Strict Infection Prevention/Control:
 - Contact precautions for CDI patients
 - An environmental cleaning and disinfection strategy
 - Hand-washing with CDI patients

IV. *Clostridium difficile* Primer

The environmental cleaning and disinfection strategy should include ...

Terminal room disinfection with bleach solution

- Clean and remove gross soils FIRST.
- Use a different, clean cloth to disinfect → Wipes are handy!
- Use a 1:10 bleach solution for disinfection, as recommended by the CDC to kill *C. difficile* spores.
- If a product claims that it kills *C. difficile*, confirm that it has a DIN # and that the microorganism is listed on the TPD label. Follow all label instructions.
- Thoroughly disinfect high touch items.

Disinfection of patient care items with 1:10 bleach

Monitor Environment & Equipment Disinfection

Note: Alcohol sanitizers are not effective against *C. difficile* spores. Wash with Soap and Water.

V. Bleach & HAIs: Proven Results



To significantly decrease HAIs, APIC recommends implementing a multi-tiered approach.

- Staff education
- Antibiotic stewardship
- Surface disinfection using a 1:10 dilution of sodium hypochlorite bleach (consistent with CDC Guidelines)

Peer-reviewed, published studies have demonstrated success in controlling outbreaks involving Norovirus and VRE and significant decreases (up to 83%) involving CDI.

V. Bleach & HAIs: Proven Results



Clostridium difficile

- **Mayo Clinic (Rochester, MN)** Daily and terminal cleaning of all high touch surfaces in rooms on 2 units with high CDI incidence and colonization pressure with a protocol using germicidal bleach wipes resulted in a 92% decline in hospital acquired CDI, which was sustained over 12 months in the absence of any change in other measures including hand hygiene. *Orenstein, R. Infection Prevention and Control, Mayo Clinic, Rochester, MN, Study Presented at SHEA 2011*
- **UPMC (Pittsburgh)** Following implementation of the use of a protocol that included germicidal bleach wipes in all patient care areas and for shared patient care equipment, healthcare-associated *C.difficile* traditional (T) and expanded (E) rates per 1,000 patient days decreased 35% and 31% respectively *Muto, C.A. University of Pittsburgh Medical Center, Pittsburgh, PA, Study Presented at SHEA 2010*
- **Brigham & Women's Hospital (Boston)** Implementation of the SHEA-IDSA bundle – including use of 1:10 bleach for patient room cleaning/disinfection – reduced healthcare-associated CDI incidence by 40%. Results were sustained for 21 months after implementation of bundle. *S.K. Abbett et al., Infect. Control Hosp. Epidemiology 2009; 30:1062-1069*

V. Bleach & HAIs: Proven Results



Clostridium difficile

- **Cleveland Veterans Affairs Medical Center** Using 1:10 bleach solution for routine disinfection of high-touch surfaces as part a bundled infection prevention program reduced positive CDAD rates by 67%. Program was continued for 4 months and reduced contamination results were maintained. *B.D. Eckstein et al. BMC Infectious Diseases 2007, 7:61*
- **Barnes-Jewish Hospital (St. Louis)** When CDAD was noted in 2 intensive care units of a university-affiliated tertiary care facility, one unit instituted enhanced environmental cleaning with a hypochlorite solution in all rooms, whereas the other unit used hypochlorite solution only in rooms of patients with CDAD. The CDAD rates decreased in both units. *K.M. McMullen et al., Infect Control Hosp Epidemiol. 2007 Feb;28(2):205-7.*
- **Barnes-Jewish Hospital (Saint Louis)** When 1:10 bleach solution was used instead of quaternary-ammonium solutions, both in a bundled infection prevention program, CDAD decreased 61% (from 8.6 cases/1000 patient days to 3.3 cases/1000 patent days) in unit where *C.diff* infection was highly endemic. When quat-based solution was reintroduced, CDAD rate rose to 8.1 cases/1000 patent days. *J. L. Mayfield et al., Clinical Infectious Diseases 2000; 31:995-1000*



V. Bleach & HAIs: Proven Results

Norovirus

- **Johns Hopkins Hospital (Baltimore)** Norovirus outbreak with 355 individual cases affecting 90 patients and 265 health care workers in its coronary care unit. Extensive environmental decontamination – using 1:50 bleach solution as primary disinfectant for all surfaces – as part of an infection control bundle – terminated the outbreak. *Johnston et. al. 2007. Clinical Infectious Diseases 45: 534*

Vancomycin resistant Enterococcus (VRE)

- **Austin Health & U. of Melbourne (Australia)** Marked reductions in rates of vancomycin-resistant enterococci (VRE) colonization & disease associated with introduction of a routine hospital-wide bleach cleaning program. *M. L. Grayson et al., Presentation at International Conference on Prevention & Infection Control (ICPIC). BMC Proceedings 2011, 5(Suppl 6).*
- **Cleveland Veterans Affairs Medical Center** Using 1:10 bleach solution for routine disinfection of high-touch surfaces as part a bundled infection prevention program reduced positive VRE detection rates by 100%. Program was sustained for 4 months and reduced contamination results were maintained. *B.D. Eckstein et al. BMC Infectious Diseases 2007, 7:61*

VI. Summary

So ... Now you know ...

- Why Bleach should be used & how it works.
- The common myths about Bleach and the “real scoop”.
- A bit more about *Clostridium difficile* – what it is, what it causes, what some of the problems are, and what to use to disinfect areas that have been exposed to *C. difficile*.
- Bleach is not just for *C. difficile*, and not just for outbreaks – it provides proven protection against the spread of HAIs.



Part IIV. Q&A

