Chlorine and Chlorine Compounds:

Why is bleach used?

Situation:

With continued outbreaks of *Clostridium difficile* in healthcare facilities across Canada, the fact that neither Health Canada nor the U.S. Environmental Protection Agency have an approved testing method for sporocidal surface product and the resulting fact Canada does not currently have an DIN registered sporocidal surface disinfectant many chemical companies are jumping on the “Bleach” band wagon and introducing new, ready to use sodium hypochlorite products.

This document will provide a background on the use of chlorine and chlorine compounds, their history in healthcare and some limiting factors to the use of bleach as a disinfectant. Additionally, this document will address the potential concerns surrounding the introduction of new bleach-based products that have not gone through the Health Canada DIN registration process and therefore, provide limited to no support data with respect to disinfection contact times.

Background:

Hypochlorite has been used as a disinfectant for more than 100 years. It has many of the properties of an ideal disinfectant, including a broad antimicrobial activity, rapid bactericidal action, ease of use, solubility in water, relative non-toxicity at use concentrations, no poisonous residuals, no color, no staining, and low cost. The active species is undissociated hypochlorous acid (HOCl). Hypochlorites are lethal to most microbes, although viruses and vegetative bacteria are more susceptible than spore-forming bacteria, fungi, and protozoa. Germicidal activity is reduced by the presence of heavy metal ions, a biofilm, organic material, low temperature, low pH, or UV radiation. Clinical uses in health-care facilities include hyperchlorination of potable water to prevent Legionella colonization, chlorination of water distribution systems used in hemodialysis centers, disinfection of environmental surfaces, disinfection of laundry, local use to decontaminate blood spills, disinfection of equipment, decontamination of medical waste prior to disposal, and dental therapy.

Limitations of Bleach:

Use of bleach in hospitals is limited by their corrosiveness, inactivation by organic matter and relative instability. The stability of chlorine in solution depends largely on six factors: concentration of chlorine, presence and concentration of catalysts or reducing agents, pH of the solution, temperature of the solution, presence of organic material and ultraviolet irradiation. Any of these factors alone or in combination may greatly affect the stability. The most stable solutions are those with low chlorine concentration, high alkalinity, low temperature, absence of organic material and storage in dark, closed containers.
The antimicrobial activity of sodium hypochlorite is very dependent on pH. As pH increases the germicidal activity decreases. Additionally, contamination of organic material to a chlorine solution will consume the available chlorine which also reduces its capacity of germicidal activity. This is especially evident in solutions with low levels of chlorine. Organic materials such as body fluids and tissues when present in a chlorine solution will decrease the germicidal properties unless the chlorine dosage is adjusted to overcome the demand. Higher levels of chlorine with help to produce a safety reserve for performing the desired bactericidal action. Best practices with respect to the use of chlorine recommend that surfaces be cleaned before applying a chlorine solution for disinfection, however, the germicidal actively of chlorine is considerably diminished when chlorine is added to water containing ammonia or amino compounds (ie Quats). The user must then ensure that surfaces are dry before applying bleach for the disinfection step.

**Efficacy of Bleach:**

In 1881, German bacteriologist, Koch, demonstrated under controlled laboratory conditions that pure cultures of bacteria may be destroyed by the use of hypochlorites. Five years later, the American Public Health Association issues a favourable report on the use of hypochlorites as disinfectants. Many test methods have been devised since the early 1930s to demonstrate the antimicrobial activity of chlorine compounds. Today all chlorinated compounds may be evaluated using the AOAC available chlorine germicidal tests.

The antimicrobial of bleach, however, varies widely depending on concentration. Historical data for bleach using concentrations from ranging 50ppm to 5000ppm show microbicidal effectiveness against Mycobacteria, Viruses, Bacteria and Fungi in contact times of 15 seconds to 60 minutes. However, because hypochlorites are substantially inactivated in the presence of blood, the surface must be cleaned using a detergent prior to disinfection. Dilute solutions of hypochlorite have been suggested for disinfection carriage of in the rooms of patients with Clostridium difficile-associated diarrhea as a means of preventing the spread of the organism, however, studies suggest that asymptomatic patients constitute an important reservoir within the hospital and that person-to-person transmission, including transient carriage of C. difficile on the hands of hospital personnel, is the principal means of transmission between patients. Therefore, handwashing, barrier precautions and meticulous environmental cleaning may be equally effective in preventing the spread of this organism.

Robison et al reported that a commercial disinfectant containing 0.55% sodium hypochlorite with a 2-minute contact time at room temperature displayed poor tuberculocidal activity with the average time required for a 6-Log reduction in excess of 3-hours. The Centers for Disease Control (CDC) recommend
concentrations ranging from approximately 500 ppm (1:100 dilution of household bleach) sodium hypochlorite to 5,000 ppm (1:10 dilution of household bleach) for routine surface disinfection. However, specify that the effective concentration will depend on the amount of organic material (e.g., blood, mucus) present on the surface to be cleaned and disinfected. While Canadian Infection Control Guidelines recommend a 1000ppm (1:50 dilution of household bleach) for routine surface disinfection and a 5000ppm (1:10 dilution of household bleach) for disinfection of surfaces when sporicidal activity is required.

This differing of opinions between leading Infection Control regulating bodies combined with the fact that studies dating back to the 1930’s provide inconsistent data with respect to the concentration and contact time required for disinfection make it difficult of the end user to make an educated and informed decision.

What about the “New” products available for sale?

In an effort to reduce Occupation Health risks to exposure to concentrated household bleach, minimize the chance for improper dilutions and improve the shelf life stability many chemical manufactures have jumped on the “bleach” bandwagon and launched ready-to-use bleach solutions. These products can range from concentrations of 200 ppm to 5500 ppm. Many of these products are relying on the historical data available to the end user and are circumventing the disinfectant registration process by listing the products as Sodium Hypochlorite Cleaners which means they do not have a DIN number and the Use Instruction language on the label will not detail the contact times required to achieve disinfection.

Furthermore, to improve the shelf life stability some of these products are adding inerts to help stabilize the shelf life, however, while these inerts may help the shelf life stability there is no data registered with Health Canada to support that the inerts will not adversely affect the germicidal activity.

Conclusion:

Disinfectants based on chlorine and chlorine compounds have been around for well over 100 years and can be expected to be around for many years to come. There is no dispute that bleach is an effective disinfectant, however, allowing new products to be introduced into the market that contain bleach should be required to undergo the same testing requirements and registration process as disinfectants based on Quaternary Ammonium Compounds, Alcohol, Phenolics or Hydrogen Peroxide.

Canadian Infection Control Guidelines mandate that the disinfectants used within healthcare facilities have DIN registration from Health Canada. Facilities looking at some of these newer bleach solutions should refer to the Infection Control Guidelines and specify that all disinfectant products to be used in their facility carry a Drug Identification Number (DIN). The DIN number is an assurance that the product has been tested in accordance to the requirements specified by Health Canada under the Therapeutic Products Directorate as such will provide clear label use instructions detailing the appropriate concentration and contact time required to achieve disinfection.

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References: