How the United Kingdom Reduced *Clostridium difficile* Infection rates Without Bleach

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There is ample evidence demonstrating the link between the hospital environment and risk of hospital acquired infection (HAI)[1,2,3,5]. Despite this, there is little consensus on the appropriate cleaning and disinfection methods that should be used within hospitals to reduce infection transmission[6, 7, 8]. There is a general agreement that a combination of daily and terminal cleaning is required, however, the means and methods to be used are rarely specified in standards and guidelines. Another challenge is compliance. For example, studies indicate that less than 40% of high touch surfaces are cleaned as required, even if instructions state that all high touch surfaces must be cleaned and disinfected daily [9]. A number of implementation guides, such as the Association of Professionals in Infection Control (APIC) "Guide to Preventing *Clostridium difficile* Infections" 2013 recommend the use of commercial grade bleach diluted with water to produce a 5,250 ppm available chlorine solution[7]. However, these implementation guides do not reflect requirements from the Environmental Protection Agency (EPA) Federal Insecticide Rodenticide and Fungicide Act (FIFRA) 1974 et seq[10]. Since the introduction of the three part soil load to *Clostridium difficile* testing protocols there are no longer any liquid bleach concentrates on the EPA "K-List" that are registered as being effective against *Clostridium difficile* at 5,250 ppm available chlorine after testing in full soil load.

One of the many challenges faced by hospitals is the financial pressure to reduce overhead cost, particularly staffing costs. This has resulted in a reduction in the time allowed for housekeeping staff to clean a patient room. Despite several studies highlighting that improved terminal and daily cleaning reduces infection rates, the pressure is still mounting to reduce overhead costs[11, 12]. Bleach is not an effective cleaning agent and all surfaces to be disinfected using bleach must be precleaned prior to the application of the disinfectant[13.] Unfortunately with the time pressures placed on staff this step is often missed. Similarly, any EPA registered product making claims to kill *Clostridium difficile* must include standard language on its label per EPA www.epa.gov/pesticide-registration/methods-and-guidance-testing-efficacy-antimicrobial-products-against-spores#labeling:

Special Label Instructions for Cleaning Prior to Disinfection against *Clostridium difficile*

Include the following specific cleaning directions on all products bearing *Clostridium difficile* claims:

- Personal Protection: Refer to the product label for appropriate personal protective equipment.
- Cleaning Procedure: Special attention is needed for high-touch surfaces; cleaning in an appropriate manner and adherence to manufacturer's label instructions for use and contact/dwell times is necessary. Pre-clean surfaces to remove soil and filth. Wipe dry. Thoroughly wet pre-cleaned surface with product. Allow surface to remain wet for [contact time]. Surfaces in patient rooms are to be cleaned in an appropriate manner, such as from right to left or left to right, on horizontal surfaces, and top to bottom, on vertical surfaces, to minimize spreading of spores. Restrooms are to be cleaned last. Do not reuse soiled cloths.
- Infectious Waste Disposal: Materials used in the cleaning process that may contain feces/wastes are to be disposed of immediately in accordance with local regulations for disposal of infectious materials.

Therefore, a pre-clean must be carried out prior to disinfection in all cases where *C. difficile* is of concern.

When comparing the published data on *C. difficile* infection rates between the National Health Service (NHS) in the UK and the Centers for Disease Control and Prevention (CDC) in the US, two different patterns are observed. Both organizations highlighted an increase in *C. difficile* cases in the early 2000s. Although a greater increase in cases was initially observed in the UK, since 2008 there has been a dramatic decline in *C. difficile* rates in the UK, whereas the US rates have remained relatively steady (Fig 1).

Ministerial (cabinet) level action was commenced in the UK in 2008 to determine the cause of the elevated *C. difficile* rates and to focus on their reduction. Though the guidelines published by the NHS and CDC are very similar, there is a greater focus by the NHS on cleaning and disinfection of the environment. The CDC recommended the use of bleach, while in contrast, the NHS views bleach as being incompatible with health and safety requirements.

Bleach (sodium hypochlorite) is no longer used in most British hospitals for surface cleaning and disinfection, yet it has never been banned by the NHS. In the UK, COSHH (Control of Substances Hazardous to Health) regulations cover all hazards and all aspects of employment using a risk assessment approach. Fundamentally, every chemical used is reviewed and a determination is made whether there is an equally effective alternative that presents a lower health and safety risk. In evaluating disinfectants used in UK hospitals the NHS determined that Sodium Dichloroisocyanurate (NaDCC), an alternative to bleach, was just as effective a disinfectant[20] even when used as a sporicidal agent[21]. When compared to bleach, NaDCC had a lowered health risk and caused less damage to hospital equipment and the environment and had an excellent safety rating with a HMIS of 1/0/0. As early as 2003, published data indicated that NaDCC used as part of the daily disinfecting process could reduce infection rates[22].

NaDCC is presented in a fast dissolving tablet form, reducing transportation and storage costs compared to

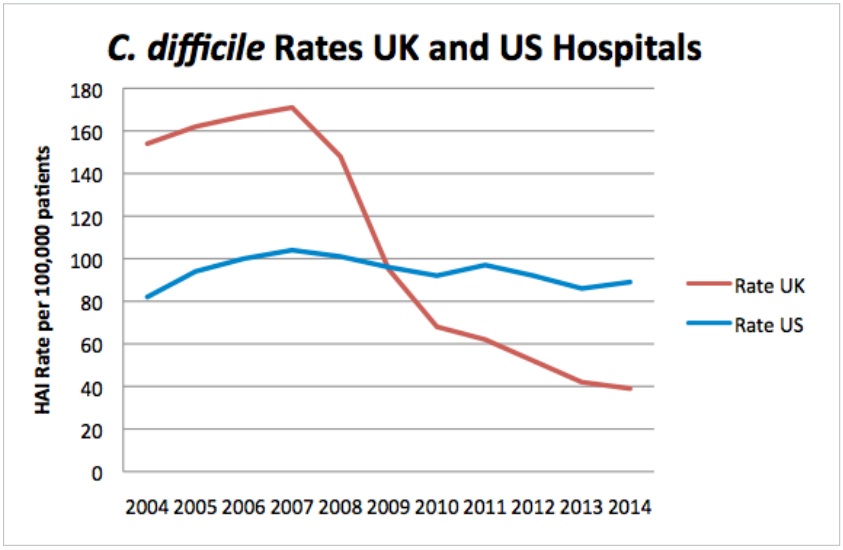

Fig. 1: Comparison of *C. difficile* rates in UK and US between 2004 and 2014[14, 15, 16, 17, 18, 19]

liquid products. Tablets are dissolved in water to produce a near neutral solution with a pH between 6 and 7. This reduces the potential damage to equipment and the environment. In addition, NaDCC presents a broad spectrum efficacy profile with EPA registered claims to address *C. difficile* spores, Norovirus, HIV, HBV, Gram negative bacteria, Gram positive bacteria and Mycobacterium turburculosis. The EPA has registered NaDCC for sporicidal *C. difficile* use at 4306 ppm, which is much lower than most bleach registrations which range between 8,500 - 13,000 ppm for sporicidal *C. difficile* in full soil load.

When cleaning and disinfecting a patient room it is vital that the process be completed in a thorough and repeatable fashion. Munoz-Price recently published a study[23] describing the "fecal patina" that should be anticipated on all surfaces in a room occupied by a patient with a *C. difficile* infection. Therefore, all surfaces should be cleaned and disinfected using a sporicidal product, not just high touch surfaces. Importantly, although soil may not be visible, *C. difficile* is often associated with a high organic load (fecal matter), therefore disinfectants should also be effective under such conditions.

The EPA registers products based on independent test data provided by the manufacturer demonstrating efficacy. Bleach, despite the significant health risks and corrosion issues associated with its use, was recognized as one of the most efficient antimicrobials, especially in relation to the hard to kill organisms such as *C. difficile* and Norovirus, with manufacturers gradually registering a number of bleach and bleach based products to address these challenging pathogens.

The current recommendation from the EPA to include a soil load in test protocols has resulted in a significant increase in the concentration of bleach required to ensure that *C. difficile* is eliminated from surfaces. The US EPA has registered a number of bleach-based products, which produce the active killing agent, hypochlorous acid, as sporicidal disinfectants for use on hard surfaces and two NaDCC based product that also uses the hypochlorous acid active. The list of registered products can be found at https://www.epa.gov/sites/production/files/2018-01/documents/2018.10.01.listk_.pdf.

From the EPA List K, it can be seen that NaDCC is effective at killing C. difficile at lower concentrations to bleach, possibly related to the lower pH of the solution formed by NaDCC. More specifically, if one is looking to kill *C. difficile* in a realistic time frame (<5 min vs. 10 min) then if starting with a 5.25% strength commercial bleach the dilution ratio is now 5:1 not 10:1. As the concentration of hypochlorous acid from a bleach solution is increased, there is a corresponding increase in sodium hydroxide (Caustic) concentration. The increased caustic concentration results in a more aggressive and potentially corrosive solution. From a practical perspective surfaces to be disinfected still require a pre-clean before the application of a disinfectant, as indicated by mandatory EPA instructions. If the disinfectant has a surfactant included in the formulation, then the same product can be used to pre-clean, though a new cloth/wipe is required for the disinfection step. When taking the pre-clean step into consideration, achieving daily clean (high touch surfaces) in 35 min and a terminal clean (all surfaces) in 45 min is extremely difficult.

In conclusion, to reduce *C. difficile* infection rates it is vital that the healthcare environment is maintained in a safe and sanitary fashion. To accomplish this, the employees engaged in housekeeping activities must be provided with adequate time, training and the correct materials to perform their tasks satisfactorily. All surfaces must be cleaned prior to disinfection, a task best accomplished by following a set protocol for cleaning a room: always clean to dirty, always high to low, always center to edge then perimeter in a uniform direction. Cleaning requires removal of soil, a task best accomplished using a microfiber cloth, either disposable or laundered, the cloth should be used in a linear motion, not a circular motion.

As with all good cleaning practice verification, continual monitoring of work practices is a vital part of overall compliance.

To reduce *C. difficile* infection rates we recommend the following:

- Provide adequate levels of staffing to perform the required tasks
- Ensure that staff are adequately trained and supervised
- Allow sufficient time for staff to complete the required daily and terminal cleans
- Ensure that all surfaces are pre-cleaned prior to disinfection
- Use a disinfecting product that is EPA registered as effective against C. difficile in accordance with the labeling instructions, preferably a product that does not present a health risk to your personnel or damage to equipment.
- Select a product from the EPA K list that has been tested as effective in the presence of soil load.

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