A Review of the U.S. Healthcare Wash Process for Hygienically-Clean Textiles

The following information and citations are provided in response to the publication of a recent article appearing in the journal of *Infection Control & Hospital Epidemiology* (October 2018) questioning the effectiveness of the wash process to remove Clostridium Difficile (C-Diff) from hospital textiles, which has raised concerns from United States (U.S.) laundry healthcare customers. A close look at this study reveals the United Kingdom (UK) approach to processing healthcare linen relies primarily on thermal applications.

In the U.S., laundry processors have long relied on the recommendations from the Centers for Disease Control and Prevention (CDC): "The antimicrobial action of the laundering process results from a combination of mechanical, thermal, and chemical factors. Dilution and agitation in water remove substantial quantities of microorganisms. Detergents and surfactants function to suspend soils, reduce water surface tension, and also exhibit some microbiocidal properties."[i]

In an attempt to help clarify the difference in U.S. practice from that of the article, the Association for Linen Management (ALM) has provided a crosswalk between the two methods. With this information, hospital leadership can engage their laundry processor in discussions to address any remaining concerns.

U.S. and UK Model Comparison

Stage	Purpose	Time	Temp.	Product in the wash stage (validation of effectiveness)	UK research[ii] Model comparison
1 – Flush	To remove gross soil from textile	3-5 minutes *Without use of water soluble bags*	90-110°F	High water level to provide an environment conducive to removal of fecal matter, gross soil, etc., before the wash process. Beginning pH levels of approximately 7+ on soiled textiles. Can serve as a prewash. Failure to adequately remove the gross soil will greatly inhibit the effectiveness of the disinfectant action in the later wash process as detergents/ disinfectants cannot reach the textile.	No flush utilized in sample provided. Ineffective removal of gross soil will inhibit the disinfectants from effectively rendering the textiles hygienically clean, as the U.S. model provides.
2 – Break		8-10 minutes	120-160°F	In a high/heavy soil wash formula, surfactants and/or alkalis are added to begin to raise the pH level of the textiles as an effective means of microbe destruction.[iii]	
3 – Suds Detergency	Detergent	5-8 minutes	120-160°F	To effectively remove soils and provide extended contact of the alkali and detergent for heavier soil removal. pH achieved here between 10.6 – 11.8.	UK formula – 1st step Wash temps are 104°F x 2 minutes – with detergent only & no alkali UK formula – 2nd step raises temperature to 167°F x 10 minutes.
4 – Carryover	Prepare for bleaching	3-5 minutes	May lower temps in preparation for chlorine bleach or retain temperatures needed for oxygen bleach stage.	A step to lower the water level in preparation for bleaching and to allow extended contact time for the textiles with chemicals from the wash process	UK formula – 3rd step is a drain.

Stage	Purpose	Time	Temperature	Product in the wash stage (validation of effectiveness)	UK research Model comparison
5 - Bleach	Oxidation	7-10 minutes for heavy soil; when used with peracetic acid is 10-12 minutes; very heavy soil 12-15 minutes	135-145°F for sodium hypochlorite/ chlorine bleach 160-170°F for oxygen bleach	The increased use of Chlorohexidine Gluconate (CHG) for its excellent efficacy, as noted by the CDC, has required U.S. laundries to move to oxygen bleach to avoid textile staining issues when sodium hypochlorite is used. Typically, U.S. laundries add peracetic acid to the oxygen bleach for improved disinfecting properties previously achieved with sodium hypochlorite. pH 10.2-10.8 for chlorine bleach / 10.8-11.2 for oxygen bleach.	UK formula – 4th step is a 5 minute exposure to chlorine bleach @ 140°F UK formula – 5th step is a drain
6 – Rinse	Flushing any remaining soil & reducing temp.	2-3 minutes		Removing residual detergents and chemicals and gradually lower water temperature. If sodium hypochlorite is used – an antichlor is often added at this stage to remove residual chlorine. Typically, at least 2 rinses are used.	UK formula – 6th step is a sour rinse of peracetic acid & hydrogen peroxide for *2 minutes* with cold water input (degrees not stated) Only one rinse was used.
7 – Sour - Softener - Sanitizer	Neutralize alkalinity	5-7 minutes	90-110°F	The increased use of oxygen bleach in the US has resulted addition of sanitizing agents to provide hygienically clean textiles in this final stage, in addition to souring agents utilized to neutralize the alkalinity of the wash process and provide for textiles most comparable to human skin. The ideal pH range of 5.5-6.8 is desired at the conclusion of the wash process, as the heat from drying/ironing process will further impact the pH.	

A Deeper Look at Variances in the U.S. Healthcare Laundering Practice

1. The wash process as demonstrated in Table 1 of the article differs from the processes practiced in the U.S. for use with healthcare textiles in washer extractors. The most significant are noted below:
    a. The U.S. process begins with a flush that removes the gross soil from the textile product. As in any cleaning process, removal of gross soil first allows the detergent and chemical disinfectants to remain fully effective when reaching the soil on the textile.
        i. The research study results revealed "the presence of C. difficile spores on cotton swatches after laundering was confirmed by SEM (Fig.3). The SEM images show clumps of *C. difficile* spores, potentially within the soiling with which they were inoculated" perhaps pointing to the lack of an initial flush, as practiced in the U.S., and the reduction/absence of surfactants in EU laundering practice resulted in a less effective wash process.
        ii. The CDC guidance for controlling *C. difficile* highlights the importance of routine cleaning before disinfection, "Surfaces should be kept clean, and

body substance spills should be managed promptly" as outlined in CDC's "Guidelines for Environmental Infection Control in Health-Care Facilities."[PDF 1.4 MB] "*Routine cleaning should be performed prior to disinfection.* EPA-registered disinfectants with a sporicidal claim have been used with success for environmental surface disinfection in those patient-care areas where surveillance and epidemiology indicate ongoing transmission of *Clostridium difficile*."

   b. Use of water-soluble bags for containing infectious linen is not a standard practice utilized in the U.S. Based on OSHA and CDC requirements, all healthcare textiles are treated as though they are contaminated by blood or other potentially infectious materials. One would strongly question the ability to dissolve these bags at 104°F *in only two minutes* producing a highly questionable ability for proper agitation and adequate exposure of the textiles to detergency necessary for producing hygienically-clean textiles.
   c. In the U.S., adherence to the CDC recommendations for a wash process that creates a "rapid shift in pH from approximately 12 to 5 is an effective means to inactivate some microorganisms."[iv] However, pH is not mentioned in the UK wash process as a variable to be monitored.
   d. Typical U.S. wash formulas utilizing peracetic acid and hydrogen peroxide as a bleach employ a 10-12 minute exposure, and when utilized as a sanitizing sour is applied in a 5-7 minute cycle, rather than the 2 minutes performed in the study.
   e. The simulated wash parameters depicted in the study do not indicate the use of any alkali products (beyond the bleach).

2. Previous studies, such as *Use of purified Clostridium difficile spores to facilitate evaluation of health care disinfection regimens*[v], surmised that exposure to a 10% hydrogen peroxide solution reduced viable spores to below their limit of detection (<2 CFU ml^{-1}).
   a. This study fails to report the percentage of hydrogen peroxide in the peracetic acid formulation used in the study. U.S. industrial/institutional wash products using this combination utilize between 11.2% - 23% hydrogen peroxide.
3. EU regulations on detergents and biocidal products vary from that in the U.S. (https://www.ecomundo.eu/en/blog/detergents-regulation-compliance) restricting use of surfactants that are utilized in the U.S.
   a. Surfactants are responsible for most of the cleaning performance in laundry detergent. They provide this by absorption and emulsification of soil into the water and also by reducing the water's surface tension to improve wetting. Laundry detergents contain mostly **anionic** and **non-ionic** surfactants.
   b. Surfactants may perform other important functions in cleaning, such as:
      i. Loosening, emulsifying, and holding soil in suspension until it can be rinsed away.
      ii. Providing alkalinity, which is useful in removing acidic soils and preparing cotton fibers for cleaning (swell fibers).
      iii. Enabling the cleaning solution to fully wet the surface being cleaned so that dirt can be readily loosened and removed.
      iv. Help to clean greasy, oily, particulate, protein, and carbohydrate-based stains.
      v. Being helpful in removing dirt and in keeping soils emulsified, suspended, and dispersed so they don't settle back onto the surface being cleaned.

[i] CDC Guidelines for Environmental Infection Control in Healthcare Facilities, Sehulster LM, Chinn RYW, Arduino MJ, Carpenter J, Donlan R, Ashford D, Besser R, Fields B, McNeil MM, Whitney C, Wong S, Juranek D, Cleveland J. Guidelines for environmental infection control in health-care facilities. Recommendations from CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). Chicago IL; American Society for Healthcare Engineering/American Hospital Association; 2004.

[ii] Tarrant Jenkins, Laird, From ward to washer: The survival of Clostridium difficile spores on hospital bed sheets through a commercial UK NHS healthcare laundry process, Infection Control & Hospital Epidemiology (2018)

[iii] "The rapid shift in pH from approximately 12 to 5 is an effective means to inactivate some microorganisms." CDC Guidelines for Environmental Infection Control in Healthcare Facilities"

[iv] CDC Guidelines for Environmental Infection Control in Healthcare Facilities, Sehulster LM, Chinn RYW, Arduino MJ, Carpenter J, Donlan R, Ashford D, Besser R, Fields B, McNeil MM, Whitney C, Wong S, Juranek D, Cleveland J. Guidelines for environmental infection control in health-care facilities. Recommendations from CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). Chicago IL; American Society for Healthcare Engineering/American Hospital Association; 2004.

[v] Lawley TD, Clare S, Deakin LJ, Goulding D, Yen JL, Raisen C, Brandt C, Lovell J, Cooke F, Clark TG, Dougan G Appl Environ Microbiol. 2010 Oct; 76(20):6895-900