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We experienced an undetected *Bacillus* pseudo-outbreak, which lasted more than one year after renovation work of a 602-bed hospital (1). We concluded that environmental contamination followed by contamination of linen was the major source of the pseudo-outbreak. Linen was highly contaminated with *Bacillus cereus* during the laundry process by contact with laundry clothes. *Bacillus cereus* is heat resistant and can survive in 80°C water for 10 minutes. Therefore, we increased the amount of sodium hypochlorite (NaOCl) solution (2), chlorine bleach, used in the rinsing process of laundry to stop this chain of cross-contamination during the laundry process.

Linen such as towels and soft gowns were washed in the in-house hospital laundry using four single-drum washing machines; the service was provided by an out-house commercial operation. The laundry process included one washing phase with a detergent for 15 minutes at 80°C and two rinsing phase with cold-water, then the laundries were moved into a dryer. Any kind of bleach had not been used in the process.

It is reported that low-temperature water formulations offered an effective alternative for significantly reducing bacterial counts and energy consumption (2). Therefore we added 12% NaOCl solution in the second rinsing phase with water. Amount of the 12% NaOCl solution was increased culturing cleaned linen by impression plates for bacteriological examination. Chloride concentration was measured by N, N diethyl-P-phenylenediamine colorimetric method (DPD method) in the hospital laboratory.

570 mL of 12% NaOCl solution against 135 L water (0.42 v/v %) was necessary to reduce *Bacillus cereus* colonies isolated from the laundries after the laundry process; the calculated concentration of chloride was 243 ppm and the measured concentration was 192 ppm (Table 1). We found smell of linen and damage of the clothes were acceptable.

There has been no recent recommendation on the appropriate chloride concentration

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to be used in the laundry process in hospitals except the 250 ppm recommended since 1980 or earlier by the Japanese Government for commercial hospital laundries. It is clear that more efficient disinfection will be attained when the higher chloride concentration is used, however, the linen would have an unpleasant smell and the clothes as well as the washing machines would be damaged. Usually, 50 to 150 ppm chloride concentration in the rinsing water after washing using an appropriate detergent at 80°C for 15 minutes should be sufficient to remove significant quantities of microorganisms from grossly contaminated linen. However, we found that 164 ppm was not enough to disinfect linen grossly contaminated with *Bacillus cereus* because *Bacillus* species are spore-forming and heat-resistant.

Barrie *et al.* reported contamination of hospital linen by *Bacillus cereus* in 1994 (3). They reported that linen introduced into the washing machine had a high *Bacillus cereus* spores content. The spores were not killed by either the 80°C disinfection stage of the laundry or the addition of detergent, hydrogen peroxide, phenolic disinfectant and an alkali solution, and were not removed by dilution in the process. The difference between their experience and ours is that they used a continuous-batch washing machine while we used single-drum washing machines. They descaled and steam cleaned inside the machine, and added hypochlorite to the water and left overnight. They increased the concentration of hydrogen peroxide to 25% for one month. However, NaOCl seems to be better than hydrogen peroxide bleach in terms of disinfecting pathogenic organism because the latter is not a disinfectant (4), although NaOCl can not sterilize the textiles.

Linen such as sheets and adult gowns were not grossly contaminated with *Bacillus cereus* after washing during our pseudo-outbreak. These laundries were washed using a continuous-batch washing machine and were pressed using a 200°C steam press in the out-hospital commercial laundry. We considered this 200°C steam press killed *Bacillus*

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cereus spores in the textiles.

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Table 1.

12% NaOCl*	v/v %	Cl calculated	Cl measured	BC colony
170 mL	0.13 %	73 ppm	not done	+++
320 mL	0.24 %	137 ppm	not done	++
340 mL	0.25 %	145 ppm	not done	++
360 mL	0.27 %	154 ppm	not done	+
380 mL	0.28 %	162 ppm	164 ppm	+
570 mL	0.42 %	243 ppm	192 ppm	-

*vs 135 L water. Cl calculated, calculated chloride concentration. Cl measured, measured chloride concentration. BC colony, *Bacillus cereus* colonies. +++; >1000, ++; 101-1000, +; 1-100, and -; no colonies were grown in 80 mm dish. Culture was done in triplicate.