

# Study on the effectiveness of disinfection with wipes against methicillin-resistant *Staphylococcus aureus* and implications for hospital hygiene

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**Background:** Environmental contamination with methicillin-resistant *Staphylococcus aureus* (MRSA) poses a significant risk in the epidemiology of infection. This study aimed to assess the effectiveness of disinfection in clinical areas by assessment of the wipe-rinse method to MRSA in the immediate patient environment, on both the bed rails and the cleaning wipes.

**Methods:** The environmental disinfection procedures of 8 MRSA-positive hospitalized patients in 2 orthopedic wards were evaluated. A total of 56 pre- and postdisinfection samples from the bed rails as well as pre- and postuse wipes samples were collected.

**Results:** The average MRSA loads on the bed rails before and after disinfections were 4.4 colony-forming units (cfu)/cm<sup>2</sup> and 0.4 cfu/cm<sup>2</sup>, respectively, the process reducing MRSA survival from a mean of  $-0.70$  log to  $-1.65$  log. The mean difference of MRSA survival detected on the wipes after each wiping ranged from 0.13 to 0.42 log.

**Conclusion:** The presence of MRSA in the proximity of the patient, ie, the bed rails as well as the cleaning tool (the wipe), was demonstrated in this study. If thorough rinsing was not conducted between wiping, bacteria accumulated on the wipes, which can result in cross transmission.

**Key Words:** Methicillin-resistant *Staphylococcus aureus*; MRSA; hospital; wipes.

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The control of hospital-acquired infection, particularly when caused by methicillin-resistant *Staphylococcus aureus* (MRSA), remains a major challenge for hospitals. Orthopedic patients carry a higher risk of progression from MRSA colonization to infection because of the presence of surgical wounds and pressure ulcers.<sup>1</sup> The orthopedic unit has been organized into MRSA cohort cubicles, and, because these patients are at risk of MRSA infection from colonization, it is advisable to determine the effectiveness of environmental decontamination so that effective disinfection guidelines can be developed for this area.

The risk of acquiring infection from environmental surfaces such as floors, walls, or surfaces of medical equipment or furniture has not been well established. Dancer<sup>2</sup> reviewed some case reports and outbreak investigations and concluded that there was a relationship between poor environmental hygiene and the transmission of MRSA causing nosocomial infections.

Boyce et al<sup>3</sup> demonstrated that MRSA-positive patients tended to shed their own strain of MRSA into the near-patient environment, as evidenced by molecular fingerprinting. The study revealed that 42% of personnel who had no direct contact with such patients but had touched side rails, linens, and infusion pump buttons contaminated their gloves with MRSA. This study provided evidence that environmental contamination of the room of a patient infected with MRSA was sufficient to contaminate the gloves of staff who had contact with the environment but no direct contact with the patient. The health care workers might not be aware of the environmental contamination and become a secondary reservoir and possibly a transmitter.

Rutala and Weber<sup>4</sup> criticized the effective use of disinfectant in environmental hygiene in hospital, concluding that the routine use of disinfectants to disinfect the hospital floors and other noncritical items was questionable, whereas frequently touched surfaces

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should be disinfected on a regular schedule to prevent the contaminated surfaces potential contribution of cross transmission by acquisition of transient hand carriage by health care personnel because of contact with a contaminated surface.

The study hospital is a tertiary care hospital in Hong Kong with approximately 1,850 beds, and it serves an effective population of approximately 900,000. This study was performed in the orthopedic unit, which contains 2 male and 2 female wards. The hospital used 2 types of wipe: disposable and nondisposable. The nondisposable wipes were 100% cotton and used in routine cleaning of the hospital environment. Because of resource limitations, disposable wipes are used only during an outbreak situation.

Those patients colonized or infected with MRSA were segregated into a cubicle, and contact precautions were implemented, together with designated medical equipment and more frequent environmental hygiene with 1,000 ppm hypochlorite, which is performed twice a day in the cohort cubicles compared with once a day in noncohort cubicles. The dedicated cleaning tools (ie, nondisposable wipes) were used in only the MRSA cohort cubicle and not mixed with those for other cubicles.

Westwood et al<sup>5</sup> recognized heavy microbial contamination of mops and the potential for spread of such contamination by such cleaning tool. Their study revealed that, if mops were not kept adequately cleaned and disinfected, and if the solution was not changed frequently enough in the buckets, the mopping procedure may spread heavy contamination through the hospital.

Because there is limited published research exploring this area, this study aim to determine whether the use of nondisposable wipes affects the risk of cross transmission of pathogens during the cleaning process. The results from this study may help in deciding the need for additional resources to eliminate environmental contamination and may ultimately help us to reduce the patient infection rate.

## METHODS

Eight MRSA-positive hospitalized patients in 2 orthopedic wards were recruited for the study. Fifty-six samples were collected on 14 occasions over a 7-day period, between June and July 2009. The environments of patients with MRSA colonization or infection were examined. One set of samples, including 1 predisinfection and 1 postdisinfection swab on each of the bed rails, and a 5 cm × 5 cm piece of the wipe trimmed before and after each disinfection, from each cubicle on each sampling occasion (Fig 1).

A predisinfection swab on the patient bed rails was collected to determine the baseline bacterial load in

the patient environment. By comparing this with the postdisinfection swab, the effectiveness of disinfection could be evaluated. The sample was taken using a sterile swab premoistened with sterile normal saline solution and swabbed over the patient bed rail. The postdisinfection swab was collected 5 minutes after the disinfection process to allow the surface to dry and the disinfectant to take action. The presence of bacteria in this sample implies failure of disinfection and the potential for bacterial transfer to a secondary environment. Swabs were cultured on MRSA select agar (Bio-Rad Laboratories, Redmond, WA).

Survival of bacteria on the wipes could allow cross contamination to secondary environments during further wiping. A 5 cm × 5 cm area was trimmed after wiping and placed into 20 mL Dey-Engley broth for neutralization of the disinfectant. To assess the quantity of MRSA carried in the wipe, the Dey-Engley (Sigma Chemical Co, St. Louis, MO) broth was filtered through a cellulose acetate filter and the filter transferred to MRSA Select (Bio-Rad Laboratories). All plates were incubated at 36°C for 24 hours, and the number of colonies displaying the characteristic red pigment of MRSA was counted.

## RESULTS

A total of 56 pre- and postdisinfection samples on bed rails as well as pre- and postuse wipes samples were collected. MRSA was isolated from 48 of 56 (pre-disinfection bed rails), 19 of 56 (postdisinfection bed rails), 29 of 56 (preuse wipe), and 38 of 56 (postuse wipe). Table 1 summarizes the descriptive data.

The mean log reduction of MRSA after disinfection on the bed rails ranged from -0.70 to -1.65 log. Although the disinfection process could significantly reduce the bacterial load in the patients' environment, survival of MRSA on the bed rails on 34% of occasions shows that the risk of cross infection had not been eliminated.

Culture of the wipes after each wiping revealed that the mean difference of surviving organisms ranged in number present from 0.13 to 0.42 log over the whole sequence of 4 beds. The wipes carried bacteria after the disinfection process, and the accumulated bacterial load on the wipes allows there to be cross contamination to the next patient environment during wiping.

The means of counts on post- and preuse wipes and post- and predisinfection bed rails were compared by the paired *t* test. The overall difference in means between MRSA counts on post- and preuse wipes was 3.02, the counts being generally increased on the wipes after use. The difference in means between counts on post- and predisinfection bed rails was -1.88 and indicated a reduction of MRSA count after disinfection.

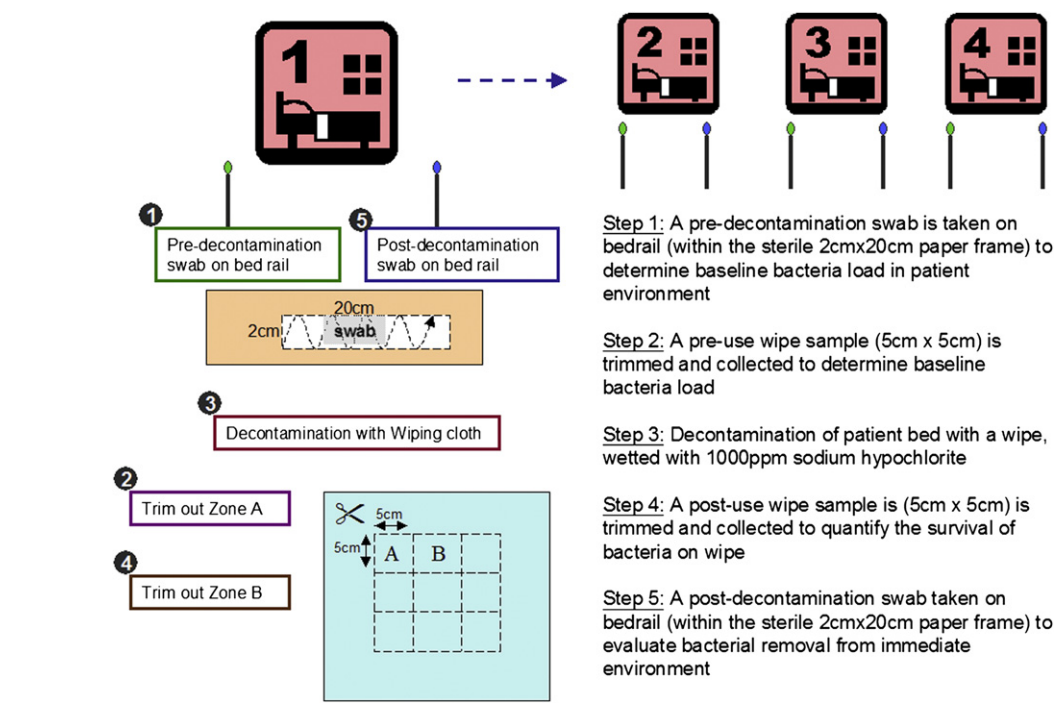


Fig 1. Description of sampling process.

Table 1. Descriptive statistics on the isolated count of MRSA

	No.	Minimum	Maximum	Mean	Standard deviation
Wipe (number of MRSA isolated on selective plate)					
MRSA prewipe	56	0	8	1.29	1.836
MRSA postwipe	56	0	50	5.93	9.798
MRSA wipe: post-pre	56	-5	50	4.64	10.091
Bed rails (number of MRSA isolated on selective plate)					
MRSA prerail	56	0	112	17.62	27.202
MRSA postrail	56	0	30	1.57	4.508
MRSA rail: post-pre	56	-112	25	-16.05	28.009
Valid No. (list wise)	56				

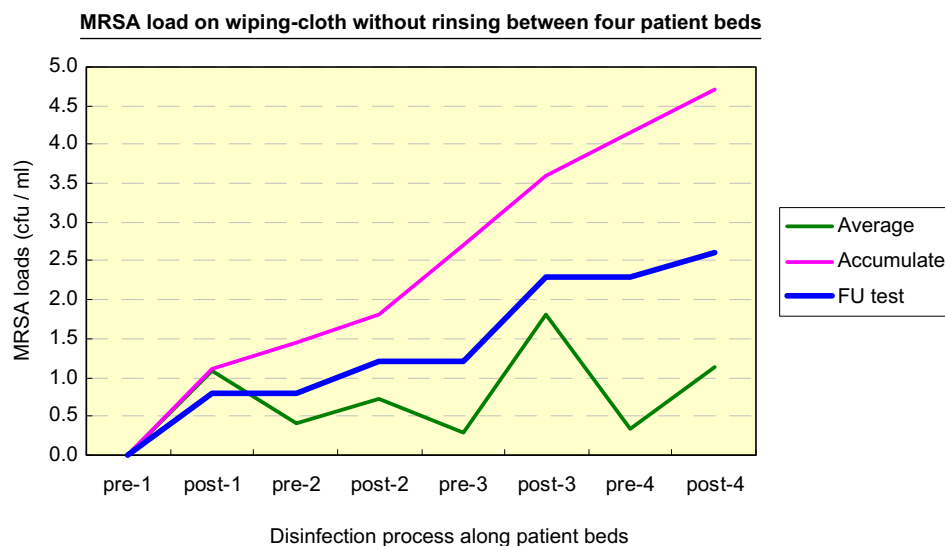
NOTE. Prewipe, sample of preuse wipe; postwipe, sample of postuse wipe; post-pre, postuse wipes subtracted preuse wipe; prerail, sample of predisinfection bed rails, postrail, postdisinfection bed rails; post-pre, postdisinfection subtracted predisinfection bed rails.

The association of bed sequence during disinfection was also examined. The difference in mean between counts on post- and preuse wipes over the wiping sequence ranged from 1.50 to 7.57. The difference in means between counts on post- and predisinfection bed rails along different sequences ranged from -1.21 to -31.29.

Analysis of covariance was performed to evaluate which of the factors affecting the MRSA count on the postdisinfection bed rails was statistically significant. The MRSA count on postdisinfection bed rails was anticipated to have a strong association with the MRSA count on the bed rails before disinfection. The results show a very strong correlation ( $P < .001$ ) between the MRSA count present on bed rails and the contamination of the postuse wipes.

It was demonstrated that the wipes could remove bacteria and trap them on the wipe. This suggests there is a consequential risk to the adjacent patient's environment, if there is insufficient intervention to manage the wipe, such as rinsing and disinfection of cleaning tools. A sharp reduction of MRSA load was detected in each wipe sample after rinsing with disinfectant and before applying to the next patient's bed.

Furthermore, an assumption was made on the likely numbers that could accumulate on the wipe if rinsing was not performed. The calculation of this was based on the results attained from the wipes, and the assumptive curve shown in Figure 2. If rinsing of the wipes is not performed between patient beds during the disinfection process, MRSA may accumulate on the wipes and may thus cause cross transmission.



**Fig 2.** MRSA load on wipes without rinsing among 4 patients. Note: average: the average value calculated is the mean of 14 tests; accumulate: the accumulate value calculated based on the mean of 14 tests after subtracting the effect of rinsing; FU (follow-up) test: the cumulative bacterial load calculated from the mean of 3 follow-up tests; Pre-1: preuse wipes sample of bed 1; post-1 and so on.

To investigate this assumption, a follow-up test was conducted to measure the MRSA load if no rinsing of wipes in between patient beds was performed. The follow-up test was performed using the identical procedures as the full-scale study except that no rinsing was conducted in between patient beds. The wipes samples were collected before and after the use, along the 4 patient beds, 24 samples were collected on 3 occasions. After each test, the 4 patient beds were disinfected again using the normal practices to prevent potential harm.

The mathematical model of the likely levels of contamination was confirmed by the follow-up experiments. However, the mean MRSA load along the 4 patient beds (shown in Fig 2) revealed the accumulation of bacteria on the wipes, although the levels were not as high as the assumptive value. It is likely that some of the MRSA load detached from the wipes and attached to the next patient bed. The accumulated MRSA on wipes may pose a potential risk to the next patient's environment during wiping.

## DISCUSSION

The association between environmental surfaces contaminated with MRSA and hospital infection rates is not fully understood because only a limited number of studies have addressed this association: the presence of MRSA in the proximity of the patient (the bed rails) as well as the cleaning tool (the wipe), were evidenced in this study.

If rinsing was not conducted between wiping, accumulations of bacteria on the wipes occurred and

increased the chance of cross transmission of MRSA. As numbers increased during this bed-to-bed wiping process, this strongly suggests that wipes can transmit organisms to surfaces if not adequately rinsed before each use.

As a consequence of the study results, the following recommendations were made to the hospital cleansing team: nondisposable wipes should be thoroughly rinsed immediately after use for each patient. Staff should be trained in the proper use of wiping cloths and immediate rinsing after each wiping. Patients under contact precautions should have separate cleaning tools from other patients by introducing color-coded wipes for patient group segregation. Disposable wipes are recommended for use in case of outbreak situations.

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