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Comparison of detergent-based cleaning, disinfectant-based cleaning, and detergent-based cleaning after enhanced domestic staff training within a source isolation facility

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Abstract

Source isolation facilities should be adequately cleaned to minimise the risk of cross-infection via the environment and fomites. The aim of this study was to compare the effectiveness of cleaning with detergent, cleaning with detergent followed by sodium hypochlorite and cleaning with detergent after enhanced training for domestic staff within isolation facilities in a district general hospital in southern England. Frequent 'hand touch' sites in two isolation rooms were sampled, using contact plates. A total of 567 plates were collected.

Bacterial total viable counts (TVCs) and environmental meticillin-resistant *Staphylococcus aureus* (MRSA) were used as surrogate markers to compare the efficacy of the cleaning methods.

The results indicate that cleaning with water and detergent followed by sodium hypochlorite achieved significantly lower TVCs for most sampling sites, but only significantly lower environmental MRSA detections from a minority of sample sites. No one method of cleaning consistently eliminated MRSA from the environment. These results provide some preliminary evidence for the use of detergent and hypochlorite cleaning within source isolation facilities.

Introduction

Patients posing a cross-infection risk are often nursed in source isolation, usually a single room. Source isolation aims to reduce the potential for cross-infection (The Hospital Infection Society Joint Working Group, 2001).

Adequate cleaning of source isolation facilities is important, in order to minimise the risk of transmitting nosocomial infection via the environment and fomites. While there is debate about the exact role of the environment in the spread of healthcare-associated infections (HAIs), it is largely accepted that it does play a role (Managan et al, 2001).

A number of studies have attempted to determine the most effective method of cleaning (Dharan et al, 1999; Wilcox et al, 2003; Barker et al, 2004), but it remains an unresolved issue. Much of the uncertainty relates to the multifactorial nature of nosocomial infection and the difficulties inherent in controlling the large number of variables that impact upon infection rates (Ayliffe, 2000).

In addition, conflicting national and international guidelines create further confusion. National recommendations for cleaning source isolation facilities indicate that hot water and neutral detergent is sufficient for most situations, but additional disinfection may be required if pathogens or harmful bacteria are present, as they can survive in the environment for prolonged periods of time, for example the spores of *Clostridium difficile* (The Hospital Infection Society Joint Working Group, 2001).

In contrast, international guidelines for environmental infection control in healthcare facilities indicate that cleaning should be a one-step process. It should combine detergent/disinfectant in patient care areas where either uncertainty exists around the type of soiling present, such as blood or body fluid contamination versus routine dust or dirt, or it is unclear whether multi-drug resistant micro-organisms are present on surfaces (Centres for Disease Control and Prevention, 2003).

Clearer guidance is required, not only to reduce cross-infection potential, but also to address public concern about poor standards of hospital hygiene.

Aim

The aim of this research was to determine the effectiveness of three cleaning methods by comparing bacterial total viable counts (TVCs) and recovery of environmental meticillin-resistant *Staphylococcus aureus* (MRSA) as surrogate markers of cleaning efficacy within source isolation facilities.

This study did not attempt to compare nosocomial infection rates, because of the difficulty in controlling the numerous variables that impact on HAIs.

Methods

Site code	Site
1	Armchair arm
2	Bedside table top
3	Locker top
4	Zimmer frame
5	Door handle
6	Bed frame
7	Wall-mounted patient drug box
8	Overhead lamp

This study was undertaken in a district general hospital with approximately 300 beds, in the south of England. Data collection took place over an 18-week period between 31 January 2005 and 3 June 2005.

Sampling was from two isolation rooms (rooms L and R) used for patients with a cross-infection risk, on a mixed sex orthopaedic ward. The ward has a total of 24 beds, two of which are in single rooms. The single rooms were occupied throughout the study by a variety of patients posing a cross-infection risk. The ward was fully refurbished in 2004 and was in a good state of repair.

The three cleaning methods, which were each undertaken for six weeks were cleaning with water and neutral detergent:

- A continuation of the routine cleaning practices (weeks one to six)
- This was followed by cleaning with sodium hypochlorite solution (Unichem, Chessington, Surrey). Domestic staff were instructed how to dilute the hypochlorite to achieve the appropriate in-use concentration – 1,000 ppm available chlorine (Ayliffe et al, 1993). A fresh dilution was made daily and for each room (weeks seven to 12)
- After the domestic staff received enhanced one-to-one training about cleaning in relation to the control of infection. This included the use of colour-coded cleaning equipment, hand hygiene, the importance of using fresh water and detergent for each room, as well as using a new cloth for each room and rinsing cleaning cloths frequently during the cleaning procedure to minimise the risk of cross-contamination from one surface to another (weeks 13 to 18).

A dedicated team of domestic staff provided the cleaning services during most of the study period. However, non-dedicated staff occasionally provided cover for sick leave and annual leave. The team comprised two staff – one who undertook damp dusting and general cleaning within rooms L and R, the other performed the floor cleaning duties.

There was no set order for cleaning rooms L and R – instead cleaning took place as each room became accessible. This was determined by whether the patients were receiving care when cleaning was due to take place.

Sampling

Sites frequently touched by hands have previously been identified

to pose the greatest cross-infection risk (Boyce et al, 1997; Cua and Lutwick, 2002).

The sampling sites chosen represent a combination of patient and/or staff frequent 'hand touch' sites (see Table 1). Samples were collected twice a week, from each site in each of the two source isolation rooms throughout the three cleaning phases. All samples were collected within three hours of cleaning.

Two types of contact plates were used for sampling each site – Tryptone Soya Agar (TSA) (Oxoid Ltd, Hampshire, UK) plates were collected to obtain a quantitative measurement of bacterial load, the TVCs. The use of contact plates in assessing bacterial load has been previously described (Dharan et al, 1999; Dancer, 2004). CHROMagar selective media (Bioconnections, Leeds, UK) supplied by the trust's department of medical microbiology was used to detect the presence or absence of MRSA.

Only the presence or absence of MRSA was recorded, as the use of selective media for the enumeration of MRSA is not generally recommended.

Data collection

Contact plates were collected following a written sampling protocol to ensure consistency. A total of 192 contact plates were to be collected during each six-week period however, on a few occasions sampling sites were unavailable and a total of 567 contact plates were collected throughout the 18-week study. This was sufficient to allow meaningful data analysis.

Following collection, plates were transported directly to the department of microbiology for laboratory analysis.

Microbiological methods

TVC: TSA contact plates were incubated aerobically at 37°C for 48 hours. TVCs were performed at 24 and 48 hours using a count monitor (Gallenkamp).

If colonies had merged at 48 hours causing confluent growth the 24 hour count was taken as the accepted count. Where large numbers of colonies were present, the plates were counted up to 1000 colony forming units (CFUs) and a count of greater than 1000 was recorded.

In some instances where growth swarmed and masked the TVC, a CFU of uncountable was recorded and the result excluded from the statistical analysis.

MRSA detection

The CHROMagar plates were incubated aerobically at 37°C for 24 hours. Plates were read at 24 hours and suspect colonies morphologically resembling *S. aureus* were confirmed to be MRSA according to laboratory standard operating procedures.

Ethical considerations

The study was approved by the relevant research ethics committee and the research and development committee. All data collection was anonymous.

Patients nursed in the single rooms were provided with an information leaflet informing them about the study and were happy for sampling to be undertaken.

Results

Statistical approach

The mean TVCs and standard deviations for each of the sample sites were calculated. Most of the distributions were skewed therefore a log base ten transformation was used.

A one-way ANOVA was used to compare the differences in the transformed mean TVCs for each sampling site (Anthony, 1999). As the ANOVA F ratio does not indicate which groups are significantly different to each other, Bonferroni post-hoc comparisons were made.

For the environmental MRSA detection data, a Kruskal-Wallis test was performed on the number of detections per site per cleaning

Table 2. Mean total viable bacterial counts and tests for differences for room L

Method of cleaning		Site							
		1	2	3	4	5	6	7	8
1	Mean	213.7 (2.1)	127.2 (1.9)	149.2 (1.9)	478.5 (2.6)	215.8 (2.2)	116.8 (2.0)	200.6 (2.2)	183.8 (2.1)
	SD	169.4 (0.5)	127.1 (0.5)	132.7 (0.5)	324.4 (0.3)	108.9 (0.4)	69.8 (0.3)	138.5 (0.3)	179.6 (0.5)
	N	12	12	12	11	12	12	12	12
2	Mean	160.7 (1.9)	51.3 (1.6)	69.9 (1.7)	403.6 (2.4)	107.8 (1.8)	50.3 (1.5)	68.3 (1.7)	80.7 (1.6)
	SD	183.7 (0.5)	40.6 (0.4)	52.5 (0.3)	295.8 (0.5)	109.4 (0.4)	46.4 (0.5)	55.8 (0.4)	112.8 (0.6)
	N	12	12	12	11	12	12	12	12
3	Mean	325.6 (2.3)	150.1 (2.0)	208.4 (2.3)	763.3 (2.8)	349.3 (2.3)	245.3 (2.1)	108.5 (1.8)	176.8 (2.1)
	SD	346.8 (0.4)	140.0 (0.4)	97.5 (0.3)	393.0 (0.4)	346.3 (0.6)	277.0 (0.6)	143.8 (0.5)	145.1 (0.3)
	N	12	12	12	10	12	12	12	12
Tests for differences									
One-way	F value	1.685	3.164	4.820*	1.591	3.045	4.829*	5.707*	4.944*
ANOVA	P value	0.201	0.055	0.015	0.221	0.061	0.014	0.007	0.013
Kruskal-Wallis	χ^2 value	2.641	5.527	10.386*	4.869	6.438*	7.711*	11.292*	6.947*
	P value	0.267	0.063	0.006	0.088	0.040	0.021	0.004	0.031

* P<0.05 Cleaning methods: 1=hot water and detergent; 2=water and detergent followed by sodium hypochlorite disinfectant; 3=hot water and detergent with enhanced training for domestic staff. Log base 10 transformations in brackets. One-way ANOVA conducted on transformed variables.

Table 3. Mean total viable bacterial counts and tests for differences for room R

Method of cleaning		Site							
		1	2	3	4	5	6	7	8
1	Mean	358.3 (2.4)	150.5 (1.9)	245.4 (2.2)	263.2 (2.3)	124.9 (1.8)	91.6 (1.9)	206.0 (2.2)	94.0 (2.3)
	SD	243.4 (0.4)	271.3 (0.5)	261.1 (0.4)	221.9 (0.3)	176.3 (0.6)	62.8 (0.3)	138.2 (0.4)	50.0 (1.9)
	N	12	12	12	11	11	12	12	12
2	Mean	138.3 (2.0)	28.3 (1.3)	81.0 (1.6)	106.9 (1.8)	98.3 (1.7)	166.0 (1.9)	59.3 (1.6)	72.3 (1.6)
	SD	130.6 (0.4)	23.4 (0.4)	98.9 (0.5)	115.8 (0.4)	151.7 (0.5)	161.5 (0.6)	53.5 (0.5)	89.7 (0.6)
	N	12	12	12	11	12	12	12	12
3	Mean	180.3 (1.9)	115.7 (1.8)	209.9 (2.1)	147.8 (2.0)	69.3 (1.7)	71.9 (1.5)	81.9 (1.7)	186.3 (1.9)
	SD	270.6 (0.6)	129.1 (0.6)	276.8 (0.5)	148.9 (0.5)	56.0 (0.4)	82.3 (0.6)	80.4 (0.5)	189.6 (0.7)
	N	12	12	12	10	12	12	12	12
Tests for differences									
One-way	F value	3.939*	4.226*	5.756*	3.448*	0.135	1.676	6.080*	1.975
ANOVA	P value	0.029	0.023	0.007	0.045	0.874	0.203	0.006	0.155
Kruskal-Wallis	χ^2 value	6.956*	8.102*	8.627*	6.377*	0.242	2.945	10.126*	3.824
	P value	0.031	0.017	0.013	0.041	0.886	0.229	0.006	0.148

* P<0.05 Cleaning methods: 1=hot water and detergent; 2=water and detergent followed by sodium hypochlorite disinfectant; 3=hot water and detergent with enhanced training for domestic staff. Log base 10 transformations in brackets. One-way ANOVA conducted on transformed variables.

method to detect any differences between the cleaning methods (Pett, 1997).

Total viable bacterial counts

Tables 2 and 3 show the raw and transformed mean and standard deviations for each of the sampling sites within rooms L and R respectively. In room L, method two produces the lowest TVCs in all eight sites, with method one producing the next lowest in six of the

eight sites.

In room R, the picture is more mixed with method two producing the lowest results, when examining the transformed data in five of the eight sites and method three, the lowest in the other three sites.

Method three was also the next lowest in four of the five sites, where method two produced the lowest results.

Statistical tests are indicated and several significant results identified. For all but one of the sites in room L, the ANOVA and

Table 4. MRSA detection

Method of cleaning		Site								
		Room L	1	2	3	4	5	6	7	8
1	#		4	2	0	3	4	1	2	0
	N		12	12	12	11	12	12	12	12
2	#		1	2	0	1	1	2	1	0
	N		12	12	12	11	12	12	12	12
3	#		7	3	3	6	3	6	4	2
	N		12	12	12	10	12	12	12	12
Kruskal-Wallis	χ^2		6.562*	0.345	6.364*	5.765	2.530	6.049*	2.414	4.118
	P		0.038	0.842	0.042	0.056	0.282	0.049	0.299	0.128
Room R			1	2	3	4	5	6	7	8
1	#		0	1	0	1	0	0	0	1
	N		12	12	12	11	11	12	12	12
2	#		4	1	3	3	3	0	3	0
	N		12	12	12	11	12	12	12	12
3	#		1	3	2	0	1	0	1	0
	N		12	12	12	10	12	12	12	12
Kruskal-Wallis	χ^2		0.871	1.806	3.161	3.862	3.828	0.000	3.828	2.000
	P		0.053	0.405	0.206	0.145	0.147	1.000	0.147	3.680

#=number of MRSA detections

* P<0.05 Cleaning methods: 1=hot water and detergent; 2=water and detergent followed by sodium hypochlorite disinfectant; 3=hot water and detergent with enhanced training for domestic staff

Kruskal-Wallis tests are consistent.

Bonferroni pairwise comparisons found significant differences between method two and method three for three out of the eight sampling sites in room L – these were the locker top, the bed frame and the overhead lamp, producing P values of 0.013, 0.021 and 0.023 respectively.

Significant differences were also found between method two and method one in room L for the wall mounted patient's drug box and the overhead lamp, producing P values of 0.008 and 0.042.

In room R, method two produced significant differences from method one for four sampling sites; the bedside table, locker top, zimmer frame and the bed frame producing P values of 0.028, 0.007, 0.049 and 0.007 respectively.

Significant differences between method one and method three were seen in two sites, the armchair arm and the bed frame, producing P values of 0.040 and 0.035 respectively.

Meticillin-resistant Staphylococcus aureus

Table 4 indicates the number of MRSA detections from the sampling sites in room L (upper panel) and room R (lower panel) for each cleaning method.

The Kruskal-Wallis test indicates significant differences between the cleaning methods from only three sample sites in room L (the armchair arm, locker top and bed frame) with method two producing the lowest number of detections at these sites.

There were no significant differences in room R. No one method of cleaning consistently eradicated MRSA from the environment.

Discussion

The TVC results obtained in the authors' study demonstrate that

cleaning with detergent followed by hypochlorite helped to achieve a greater reduction in the overall bioburden of several frequent hand touch sites in the isolation rooms, in comparison to cleaning with detergent alone or cleaning with detergent following enhanced training.

Similarly Dharan et al (1999) also compared the use of detergent versus disinfectant for cleaning environmental surfaces not contaminated with body fluids and found using detergent alone was associated with significantly higher bacterial colony counts.

However, the two studies are not directly comparable. Dharan et al (1999) also examined the impact on HAIs and found no commensurate change in the incidence of nosocomial infection in the 1117 patients observed during the study, concluding that enhanced disinfection does not impact HAIs.

This observation may possibly be a reflection of the difficulty in assessing the impact of cleaning on the acquisition and spread of HAIs given that infection control programs generally include multiple interventions, such as hand hygiene and source isolation precautions.

Dancer (2004) suggests that a quantitative assessment of microorganisms found within a specified area is a relevant measurement of bacteriological cleanliness, because a heavy burden of microbes (regardless of the type) on surfaces, such as frequent hand touch sites, may pose a cross-infection risk to vulnerable patients.

The environmental MRSA results indicate that neither hypochlorite nor detergent, with or without enhanced training of domestic staff, consistently eradicated MRSA from the sample sites, making the process of identifying the most appropriate cleaning method for isolation facilities inconclusive.

There are newer cleaning technologies available that have demonstrated greater efficacy, such as hydrogen peroxide vapour, found to

be effective in eliminating MRSA from the environment, achieving just 1.2% positive environmental swabs compared to 66% with conventional cleaning (French et al, 2004).

However, such advanced cleaning methods are expensive to purchase and therefore largely inaccessible to much of the NHS.

By comparison, cleaning agents such as detergent and hypochlorite are readily available, accessible and relatively cheap to purchase.

All of these factors require consideration when establishing cleaning protocols. It is possible that the results of the authors' study highlight the difficulty in using MRSA as a surrogate marker of cleaning efficacy, particularly where human dispersers are continually re-contaminating the environment (Dancer, 2002).

There are differing schools of thought about whether environmental MRSA is a cause or consequence of patients who have an MRSA colonisation or infection (Marshall et al, 2004).

Barakate et al (1999) found no difference in the rate of new MRSA cases in a newly-refurbished ward that included complete equipment cleaning.

In contrast Boyce et al (1997) suggests that environmental MRSA contamination can lead to contamination of healthcare workers' gloves and aprons, which can serve as indirect vectors for cross-colonisation of patients.

Furthermore Rampling et al (2001) demonstrated that during a prolonged outbreak of MRSA despite implementation of standard infection control precautions, the outbreak was only resolved following an increase in domestic cleaning hours, with an emphasis on dust removal.

Other studies that have used different indicator organisms have found the use of disinfectant cleaning more effective. For instance, Barker et al (2004) studied the effects of detergent versus disinfectant-based cleaning on environmental contamination with Norovirus and found that using combined detergent/hypochlorite with 5,000ppm available chlorine achieved a significant reduction in the levels of environmental contamination, while detergent-based cleaning alone consistently failed to remove Norovirus from the environment.

Similarly when the effect of detergent versus hypochlorite cleaning on environmental contamination and incidence of *Clostridium difficile* infection was considered in a crossover study, there was a significant reduction in infection using hypochlorite cleaning when compared to cleaning with detergent alone (Wilcox et al, 2003).

The use of disinfectants is not problem-free however, as disinfectant solutions may themselves become contaminated with bacteria that could actually seed the environment with potential pathogens (Dharan et al, 1999).

Hypochlorites may cause skin irritation and asthma in both patients and staff (Dettenkofer et al, 2004; Deschamps et al, 1994). Furthermore, regular use of disinfectants within a hospital environment may increase the pressure to select for greater microbial resistance.

It has been suggested that a more rigorous and scientific approach to assessing hospital hygiene is needed, using a combination of inspection and bacteriological sampling to detect specified indicator organisms such as *S. aureus*, Gram-negative bacilli and *Clostridium difficile* (Dancer, 2004).

Assessing microbiological risk is not an easy process, largely due to the lack of standardised methodologies and lack of microbiological standards for general hospital wards (Malik et al 2003).

These are necessary not only to facilitate objective and systematic assessment of hospital cleanliness, but also to help establish efficacy of cleaning protocols.

It is accepted that hand decontamination plays a crucial role in the control of nosocomial pathogens. Equally it is known that hands frequently become contaminated with bacterial pathogens, including MRSA and vancomycin-resistant enterococci (VRE), after contact with environmental surfaces that have already been cleaned (Bhalla et al, 2004).

Given that healthcare workers' hand hygiene compliance is often

poor (Pittet and Boyce, 2001; Voss and Widmer, 1997), there is an increasing emphasis on achieving better environmental cleanliness (Sexton et al, 2006).

Thus hand hygiene and environmental cleanliness should be regarded as sharing a symbiotic relationship.

Limitations of the study

There are a number of limitations to this study. Although there is general agreement that MRSA is a good indicator of overall hygiene standards (Dancer, 2002), the effect of cleaning on the control of MRSA remains uncertain (Blythe et al, 1998), particularly where human dispersers are continually re-contaminating the environment (Dancer, 2002).

Within the authors' study, the isolation rooms were frequently occupied by patients with MRSA – during cleaning method one, 58% in room L and 0% in room R (although it is important to note that while room R had no patients with MRSA during this phase, they were in isolation for other cross-infection risks, there were three occasions when MRSA was detected, from the bedside table top, zimmer frame and overhead lamp); during cleaning method two, 42% in room L and 83% in room R and during cleaning method three, 83% in room L and 83% in room R. Therefore re-contamination of the environment by patients or staff between cleaning and sampling was quite possible.

However, limited data was collected about the nature of the patients MRSA status during the three cleaning phases, limited to whether they were positive or negative.

There was no data collection around MRSA colonisation or infection, which site(s) were positive, whether the patients were on current skin suppression therapy to lower microbial load and information regarding dermatological skin conditions that may increase skin shedding and hence lead to increased environmental contamination.

Therefore it is difficult to say whether the patients' MRSA status was comparable during each cleaning phase

As samples were collected from only two isolation rooms in one ward, it is difficult to say whether similar results would have been obtained in other isolation rooms in different areas of the hospital.

This study was limited to TVCs and detection of environmental MRSA as the markers of cleaning efficacy and no evaluation was made against other indicator organisms, such as *Clostridium difficile*.

Furthermore samples were only collected post-cleaning, making it difficult to measure a reduction in these bio-markers during the three cleaning phases.

Further study around this topic should incorporate pre- and post-cleaning data collection in different areas of the hospital, using not only MRSA, but also other indicator organisms and more comprehensive data collection about the patients posing a cross-infection risk, in order to overcome these limitations.

Conclusion

The results of the study demonstrate that cleaning with water and detergent followed by cleaning with hypochlorite helps to achieve a greater reduction in the overall bacterial bio-burden on frequent hand touch sites within isolation facilities.

The results are less conclusive when considering environmental MRSA. Nevertheless, it is purported that by reducing the overall bacterial bio-burden on frequent hand touch sites, the potential for cross-contamination may be reduced. Nosocomial pathogens may contribute to this bio-burden and therefore these sites are likely to represent a greater risk of transmission.

Routine detergent and hypochlorite cleaning for source isolation facilities should be considered however, to test the efficacy a larger scale study involving a greater number of isolation facilities and incorporating a wider range of indicator organisms is recommended prior to the widespread adoption of such a cleaning protocol for source isolation facilities.

References

- Anthony D. (1999) *Understanding advanced statistics: a guide for nurses and healthcare researchers*. Churchill Livingstone: London.
- Ayliffe GAJ, Coates D, Hoffman PN. (1993) *Chemical disinfection in hospitals (second edition)*. Public Health Laboratory Service: London.
- Ayliffe GAJ, Fraise AP, Geddes AM, Mitchell K. (2000) *Control of hospital infection: a practical handbook (fourth edition)*. Arnold: London.
- Barakate MS, Harris JP, West RH, Vickery AM, Sharp CA, Macleod C, Benn RA. (1999) A prospective survey of current methicillin-resistant *Staphylococcus aureus* control measures. *Australian and New Zealand Journal of Surgery* **69**: 712-6.
- Barker J, Vipond IB, Bloomfield SF. (2004) Effects of cleaning and disinfection in reducing the spread of Norovirus contamination via environmental surfaces. *Journal of Hospital Infection* **58(1)**: 42-9.
- Bhalla A, Pultz NJ, Gries DM, Ray AJ, Eckstein EC, Aron DC, Donskey CJ. (2004) Acquisition of nosocomial pathogens on hands after contact with environmental surfaces near hospitalised patients. *Infection Control and Hospital Epidemiology* **25**: 164-7.
- Blythe D, Keenlyside D, Dawson SJ, Gallaway A. (1998) Environmental contamination due to methicillin-resistant *Staphylococcus aureus* (MRSA). *Journal of Hospital Infection* **38**: 67-9.
- Boyce JM, Potter-Bynoe G, Chenevert C, King T. (1997) Environmental contamination due to methicillin-resistant *Staphylococcus aureus*: possible infection control implications. *Infection Control and Hospital Epidemiology* **18(9)**: 622-7.
- Centres for Disease Control and Prevention. (2003) Guidelines of environmental infection control in healthcare facilities. Recommendations of Centres for Disease Control and the Healthcare Infection Control Practices Advisory Committee (HICPAC). *Morbidity and Mortality Weekly Report* **52**: RR-10.
- Cua A, Lutwick LI. (2002) The environment as a significant cofactor for multiply resistant nosocomial infections. *Seminar for Respiratory Infection* **17**: 246-9.
- Dancer SJ. (2002) Hospital-acquired infection: is cleaning the answer? *CPD Infection* **3(2)**: 40-6.
- Deschamps D, Soler P, Rosenberg N, Baud F, Gervais P. (1994) Persistent asthma after inhalation of a mixture of sodium hypochlorite and hydrochloric acid. *Chest* **105**: 1895-6.
- Dettenkofer M, Wenzler S, Amthor S, Antes G, Motschall E, Daschno FD. (2004) Does disinfection of environmental surfaces influence nosocomial infection rates? A systematic review. *American Journal of Infection Control* **32(2)**: 84-9.
- Dancer SJ. (2004) How do we assess hospital cleaning? A proposal for microbiological standards for surface hygiene in hospitals. *Journal of Hospital Infection* **56(1)**: 10-5.
- Dharan S, Mourouga P, Copin P, Bessmer G, Tschanz B, Pittet D. (1999) Routine disinfection of patients' environmental surfaces. Myth or reality? *Journal of Hospital Infection* **42(2)**: 113-7.
- French GL, Otter JA, Shannon KP, Adams NM, Watling D, Parks MJ. (2004) Tackling contamination of the hospital environment by methicillin-resistant *Staphylococcus aureus* (MRSA): a comparison between conventional terminal cleaning and hydrogen peroxide vapour decontamination. *Journal of Hospital Infection* **57**: 31-7.
- Malik RE, Cooper RA, Griffith CJ. (2003) Use of audit tools to evaluate the efficacy of cleaning systems in hospitals. *American Journal of Infection Control* **31**: 181-7.
- Managan LP, Pugliese G, Jackson M, Lynch P, Sohn AH, Sinkowitz-Cochran RL, Jarvis WR. (2001) Infection control dogma: top ten suspects. *Infection Control and Hospital Epidemiology* **22**: 243-7.
- Marshall C, Wesselingh S, McDonald M, Spelman D. (2004) Control of endemic MRSA – what is the evidence? A personal view. *Journal of Hospital Infection* **56**: 253-68.
- Pett MA. (1997) *Nonparametric statistics for healthcare researchers: statistics for small samples and unusual distributions*. Sage: London.
- Pittet D, Boyce JM. (2001) Hand hygiene and patient care: pursuing the Semmelweis legacy. *Lancet Infectious Diseases* **April**: 9-20.
- Sexton T, Clarke P, O'Neill E, Dillane T, Humphreys H. (2006) Environmental reservoirs of methicillin-resistant *Staphylococcus aureus* in isolation rooms: correlation with patient isolates and implications for hospital hygiene. *Journal of Hospital Infection* **62**: 187-94.
- The Hospital Infection Society. (2001) Report of the Joint Working Group (AMM, PHLS, ICNA, HIS, BIS, RCN): review of hospital isolation and infection control related precautions. The Hospital Infection Society: London.
- Voss A, Widmer AF. (1997) No time for handwashing? Handwashing versus alcoholic rub: can we afford 100% compliance? *Infection Control and Hospital Epidemiology* **18**: 205-08.
- Wilcox MH, Fawley WN, Wigglesworth N, Parnell P, Verity P, Freeman J. (2003) Comparison of the effect of detergent versus hypochlorite cleaning on environmental contamination and incidence of *Clostridium difficile* infection. *Journal of Hospital Infection* **54(2)**: 109-14.

Editor's comment

Re: Patel et al. (2007) Comparison of detergent-based cleaning, disinfectant-based cleaning, and detergent-based cleaning after enhanced domestic staff training within a source isolation facility. *British Journal of Infection Control* **8(3)**: 20-25.
This paper demonstrates the difficulty

in performing robust studies of cleaning technology and processes within busy clinical environments.

In particular, it highlights the uncertainty created by frequently changing variables including the MRSA status of the various patients in isolation and

their propensity (or not) to shed MRSA into the environment.

Nevertheless, this paper does add to published work and the debate over cleaning methods and the technology involved.