An evaluation of the antimicrobial properties of healthcare fomites (furnishings and equipment) made of copper alloys

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1. Introduction

- Pathogens, such as meticillin-resistant *Staphylococcus aureus,* colonise the healthcare environment and survive on surfaces for extended periods. [1]
- Following cleaning, the surfaces become rapidly re-contaminated due to lack of residual antimicrobial activity of many cleaning agents. [2-3]
- Furthermore, the hands of healthcare workers become readily contaminated with pathogens, when touching surfaces or patients. [4-5]
- Environmental contamination has been implicated in the transmission of microorganisms in healthcare settings.[6] This has consequently stimulated interest in antimicrobial surfaces.
- It has been demonstrated in both laboratory and clinical studies that copper surfaces reduce the survival of common pathogens. [7-11]
- The use of copper may therefore play a part in reducing healthcare-associated infections.

2. Objective

- The aim of this study was to evaluate the ability of copper to reduce environmental microbial contamination in the clinical setting.

3. Methods

- A 19-bedded acute medical ward at a University Hospital was fitted with copper- containing furnishings and equipment (Table 1 and Figure 1).
- The surfaces of the items were sampled once weekly for 24 weeks by swabbing.[6] In brief, the surfaces were sampled with a sterile template and a cotton swab moistened in 0.9% (w/v) sodium chloride. After sampling, the tip of the swab was placed into 2 mL of BBL Dey/ Engley neutralising broth (BD, UK). The samples were vortexed and 200 μL inoculated onto blood and selective agar. The plates were incubated as previously described.[6] Samples were taken in duplicate, except for toilet flush handles, light and socket switches and light pull cords. In these instances the whole surface area was sampled.
- The surfaces were sampled (in rotation) each Monday afternoon (between 14.00- 17.00) during visiting hours.
- Routine ward cleaning took place in the morning before 12.30 and in the evening after 17.00.
- Following 12 weeks of sampling, the copper and non-copper items were interchanged to exclude the possibility of preferential use of items from either group based on location.
- The total aerobic colony count was determined and the number of microorganisms on the copper surfaces was compared against the number on equivalent standard items on the same ward.
- The presence of vancomycin-resistant enterococci (VRE), meticillin-sensitive and-resistant *Staphylococcus aureus* (MSSA and MRSA respectively), coliform bacteria and *Clostridium difficile* on the areas sampled was also determined.

Table 1. The composition of study items.

Item	Standard item composition	Copper item composition (%Cu)
Door push plates	Aluminium	CuZn37 (63%) CuZn30 (70%) CuOF (99.95%)
Door pull handles	Aluminium	CuSn8 (92%) CuZn39Pb3 (58%)
Door lever handles	Aluminium	CuSn8 (92%)
Grab rails	Painted steel	CuZn30 (70%)
Toilet seats	Plastic	CuOF composite/ sprayed coating (approx.70%)
Toilet flush lever handles	Chrome	Copper plated (99.95%)
Commodes	Plastic	CuOF composite/ sprayed coating (approx.70%)
Patient over-bed tables	Plastic laminated	CuDHP (99.9%) CuOF composite/sprayed coating (approx.70%)
Dressing trolleys	Stainless steel	CuZn30 (70%)
Sockets (switches)	Plastic	CuZn15 (85%)
Light switches	Plastic	CuZn15 (85%)
Light pull cords (toggle)	Plastic	CuDHP (99.9%)
Sink waste fittings	Chrome	CuZn40Pb2 (58%)
Tap handles	Chrome	CuZn39Pb1 (60%)

Figure 1. Examples of copper items (door push plate, toilet seat, tap handles, grab rails, door pull handle, light switch, socket)

4. Results

- Eight out of 14 types of copper items had significantly fewer microorganisms on their surfaces as compared to standard surfaces. These included door push plates, door pull handles, tap handles, toilet flush lever handles, patient over-bed tables, dressing trolleys, socket switches and light pull cords (toggles). All other items demonstrated a trend towards a reduction in microbial numbers on the copper surfaces compared to standard surfaces, but did not reach significance (Figure 2).
- Indicator microorganisms were recovered from both the copper and non-copper surfaces, however significantly fewer surfaces were colonised with VRE, MSSA and coliform bacteria in the copper group (Table 2).

Figure 2. The median total aerobic counts on copper and standard items (Mann-Whitney p values).

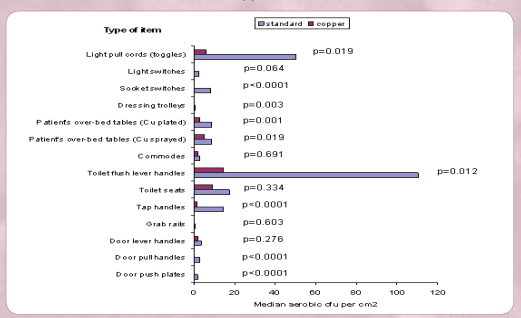

Table 2. The number of copper and standard surfaces contaminated with indicator micro-organisms (excludes results from sink waste fittings)

Indicator microorganism	Copper surfaces (n=559)	Standard surfaces (n=542)	Fisher's Exact Test (p value)
VRE	1	10	0.005
MSSA	7	25	0.001
MRSA	13	20	0.217
Coliforms	19	44	0.001
C.difficile	8	2	0.108

5. Discussion & conclusion

- On a busy medical ward, during continuous challenges from staff, patients and visitors, copper frequent-touch surfaces and other hospital furnishings, were associated with a lower microbial load than standard equivalent items.
- VRE, MSSA and coliform bacteria were also recovered less frequently on the copper containing surfaces compared to standard surfaces.
- These results demonstrate that copper offers the potential to significantly reduce the numbers of microorganisms in the clinical environment.
- The use of copper in combination with optimal infection prevention strategies may therefore reduce further the risk of patients acquiring infections in hospital and other healthcare environments.

References

1. Dancer SJ. Importance of the environment in meticillin-resistant *Staphylococcus aureus* acquisition: the case for hospital cleaning. *Lancet Infect Dis.* 2008;**8**(2):101-13.
2. Hardy KJ, Gossain S, Henderson N, Drugan C, Oppenheim BA, Gao F, Hawkey PM. Rapid recontamination with MRSA of the environment of an intensive care unit after decontamination with hydrogen peroxide vapour. *J Hosp Infect* 2007;**66**(4):360-8.
3. Kramer A, Schwebke I, Kampf G. How long do nosocomial pathogens persist on inanimate surfaces? A systematic review. *BMC Infect Dis* 2006;**6**:130.
4. Duckro AN, Blom DW, Lyle EA, Weinstein RA, Hayden MK. Transfer of vancomycin-resistant enterococci via health care worker hands. *Arch Intern Med* 2005;**165**(3):302-7.
5. Hayden MK, Blom DW, Lyle EA, Moore CG, Weinstein RA. Risk of hand or glove contamination after contact with patients colonized with vancomycin-resistant *enterococcus* or the colonized patients' environment. *Infect Control Hosp Epidemiol* 2008;**29**(2):149-54.
6. Boyce JM, Potter-Bynoe G, Chenevert C, King T. Environmental contamination due to methicillin-resistant *Staphylococcus aureus*: possible infection control implications. *Infect Control Hosp Epidemiol* 1997;**18**(9):622-7.
7. Wheeldon LJ, Worthington T, Lambert PA, Hilton AC, Lowden CJ, Elliott TS. Antimicrobial efficacy of copper surfaces against spores and vegetative cells of *Clostridium difficile*: the germination theory. *J Antimicrob Chemother* 2008;**62**(3):522-5.
8. Weaver L, Michels HT, Keevil CW. Survival of *Clostridium difficile* on copper and steel: futuristic options for hospital hygiene. *J Hosp Infect* 2008;**68**:145-151.
9. Casey AL, Adams D, Karpanen TJ, Lambert PA, Cookson BD, Nightingale P, Miruszenko L, Shillam R, Christian P, Elliott TSJ. Role of copper in reducing hospital environment contamination. *J Hosp Infect* 2010;**74**(1):72-77.
10. Marais F, Mehtar S, Chalkley L. Antimicrobial efficacy of copper touch surfaces in reducing environmental bioburden in a South African community healthcare facility. *J Hosp Infect* 2010;**74**(1):80-2.
11. Mikolay A, Huggett S, Tikana L, Grass G, Braun J, Nies DH. Survival of bacteria on metallic copper surfaces in a hospital trial. *Appl Microbiol Biotechnol* 2010;**87**(5):1875-9.

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