A comparative study to evaluate surface microbial contamination associated with copper-containing and stainless steel pens used by nurses in the critical care unit

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A clinical study was undertaken to compare the surface microbial contamination associated with pens constructed of either a copper alloy or stainless steel used by nurses on intensive care units. A significantly lower level of microbial contamination was found on the copper alloy pens.

Key Words: Copper; microbial contamination; writing pens.

Pens are used by health care workers (HCWs) on a daily basis, shared between users and only rarely decontaminated between activities. Pens are known to be readily contaminated with various microorganisms in the clinical environment.[1-3] Contaminated pens may subsequently reinoculate HCWs' hands after hand decontamination.

Copper and its alloys have antibacterial activity against a range of pathogens.[4,5] The present study was conducted to compare the surface microbial contamination associated with metal-barrel ball point pens constructed of either a copper alloy or stainless steel.

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METHODS

This study was approved by the Black Country Research Ethics Committee. Assuming a 92.9% contamination rate for the stainless steel pens (as determined in a previous study)[1] and a 50% reduction in contamination rate for copper-containing pens, a minimum of 23 pens were required in each arm of this study to give 90% power to detect a difference at the 5% significance level.

Accordingly, 25 copper-containing pens (CuZn15; 85% copper, 15% zinc) and 25 stainless steel pens (Parker Pens, Newell Rubbermaid Office Products, Boulogne-Billancourt, France) were evaluated. The pens, which had not been used previously, were disinfected by wiping a swab impregnated with 70% isopropyl alcohol (Alcotip swabs; Universal Hosital Supplies, London, UK) over the external surface of each pen for 30 seconds and allowing it to dry for 2 minutes. The pens were then distributed to nurses on 2 critical care units at the University Hospitals Birmingham National Health Service Foundation Trust. Pens were allocated (using a computer-generated randomization table) at the start of a 12.5-hour shift for use in place of the standard black pens. Nurses were entered into the study only once, and all were actively caring for patients. Each nurse cared for a maximum of 2 adjacent patients. Nurses caring for a colonized or infected patient did not care for any other patients simultaneously. At the end of each 12.5-hour shift, the pens were collected and immediately transported

Table 1. Number of copper-containing and stainless steel pens contaminated with microorganisms after 12.5 hours of use by nurses on critical care units

Time of microbiological sampling	Stainless steel pens contaminated (%)	Copper-containing pens contaminated (%)	*P* value, Fisher's exact test
Immediately postcollection	17/25 (68)	12/25 (48)	.25
After storage for 11 hours at room temperature	18/25 (72)	5/25 (20)	.0005

Table 2. Number of cfu recovered from the copper-containing and stainless steel pens after 12.5 hours of use by nurses on critical care units

Time of microbiological sampling	Median number of cfu isolated (lower and upper quartiles)		Total reduction in cfu, %	*P* value (Mann-Whitney *U* statistic)
	Stainless steel pens	Copper-containing pens		
Immediately postcollection	12 (0 and 20)	0 (0 and 4)	87.3	.04 (212.5)
After storage for 11 hours at room temperature	8 (0 and 80)	0 (0 and 0)	94.8	.0002 (135.5)

to the laboratory for microbiological sampling. These pens were sampled immediately upon receipt at the laboratory.

Another 50 pens (25 copper-containing and 25 stainless steel) were distributed and collected in the same manner as above, but were stored at room temperature for 11 hours to emulate nonuse between shifts (the period dictated by the European Working Time Directive)[6] before microbiological sampling.

Each pen was sampled with a sterile swab moistened with sterile 0.9% (w/v) saline solution. The swab was applied over the entire length of the pen barrels from top to base a total of 10 times. The distal 2 cm of each swab was then cut and placed into 2 mL of neutralizing solution (D/E neutralizing broth; BD, Franklin Lakes, NJ) and vortexed for 60 seconds. Then 500 μL of this solution was inoculated onto the surface of a blood agar plate and incubated aerobically at 37°C for 48 hours, giving a lower detection limit of 4 cfu (colony forming units) per pen. All microorganisms were enumerated and identified using standard microbiological techniques.

RESULTS

The 100 pens distributed included 4 pens (3 stainless steel and 1 copper) used by nurses caring for patients known to be infected or colonized with *Staphylococcus aureus*, 4 (stainless steel) used by nurses caring for patients with enterococci, 4 (1 stainless steel, 3 copper) used by nurses caring for patients with *Escherichia coli*, 3 (stainless steel) used by nurses caring for patients with *Candida* spp, 2 (1 stainless steel, 1 copper) used by nurses caring for patients with *Pseudomonas aeruginosa*, 2 (copper) used by nurses caring for patients with *Aspergillus* spp, 1 (copper) used by nurses caring for patients with *Klebsiella pneumoniae*, and 1 (stainless steel) used by nurses caring for patients with *Stenotrophomonas maltophilia*. None of these microorganisms was recovered from any of the pens.

The number of pens contaminated with microorganisms and the number of cfu recovered are presented in Tables 1 and 2, respectively. With regard to the pens sampled immediately postcollection, there was no significant difference in the rate of contamination between pens fabricated of stainless steel and those containing copper. However, significantly lower numbers of cfu were recovered from the copper-containing pens compared with the stainless steel pens.

Of the pens sampled after storage for 11 hours at room temperature, significantly fewer copper-containing pens were contaminated with microorganisms compared with stainless steel pens. In addition, significantly lower numbers of cfu were recovered from the copper-containing pens compared with the stainless steel pens.

Of the 17 contaminated copper-containing pens, coagulase-negative staphylococci were isolated from 14 (82.4%) and *Micrococcus* spp were isolated from 4 (23.5%). Of the 35 contaminated stainless steel pens, coagulase-negative staphylococci were isolated from 29 (82.9%), *Micrococcus* spp were isolated from 10 (28.6%), and the following microorganisms were isolated from 1 (2.9%) pen each: *Bacillus* sp, *Rhizobium radiobacter*, *Sphingomonas paucimobilis*, *Streptococcus oralis*, and *Acinetobacter iwoffii*.

Our data indicate that the copper pens used by nurses in a busy clinical environment followed by immediate microbial sampling demonstrated a lower microbial load compared with the stainless steel pens. The copper-containing pens exhibited significant

antimicrobial activity following use during a full clinical shift and then storage for 11 hours at room temperature.[4] This time period represents the typical period between shifts, when the pen is unlikely to be used but during which the copper continues to be active.

Our findings clearly demonstrate that the use of copper-containing pens significantly reduces the level of microbial contamination on writing instruments. Thus, copper pens may provide a tool to prevent reinoculation of decontaminated hands. The use of copper also may be applied to other surfaces in the health care setting. Indeed, this area is currently under investigation.[7-9] The role of copper in the possible reduction of infection rates has not been confirmed, however, and further studies are needed to assess this.

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