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Major article

Copper surfaces are associated with significantly lower concentrations of bacteria on selected surfaces within a pediatric intensive care unit

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Background: Health care–associated infections result in significant patient morbidity and mortality. Although cleaning can remove pathogens present on hospital surfaces, those surfaces may be inadequately cleaned or recontaminated within minutes. Because of copper's inherent and continuous antimicrobial properties, copper surfaces offer a solution to complement cleaning. The objective of this study was to quantitatively assess the bacterial microbial burden coincident with an assessment of the ability of antimicrobial copper to limit the microbial burden associated with 3 surfaces in a pediatric intensive care unit.

Methods: A pragmatic trial was conducted enrolling 1,012 patients from 2 high acuity care units within a 249-bed tertiary care pediatric hospital over 12 months. The microbial burden was determined from 3 frequently encountered surfaces, regardless of room occupancy, twice monthly, from 16 rooms, 8 outfitted normally and 8 outfitted with antimicrobial copper.

Results: Copper surfaces were found to be equivalently antimicrobial in pediatric settings to activities reported for adult medical intensive care units. The log10 reduction to the microbial burden from antimicrobial copper surfaced bed rails was 1.996 (99%). Surprisingly, introduction of copper objects to 8 study rooms was found to suppress the microbial burden recovered from objects assessed in control rooms by log10 of 1.863 (73%).

Conclusion: Copper surfaces warrant serious consideration when contemplating the introduction of no-touch disinfection technologies for reducing burden to limit acquisition of HAIs.

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INTRODUCTION

Hospital-associated infections (HAIs) continue to be one of the most common and significant complications associated with hospitalization across the globe. Patients admitted to intensive care units (ICUs) are at an increased risk of being colonized or of developing an infection from microbes that are resident within the clinical environment. These increased risks result from the contribution of many factors, such as underlying disease of the patient, medical circumstance requiring hospitalization, use of invasive

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medical devices, stochastic and frequent contact with health care workers, exposure to antimicrobial agents, emergence and increased frequency of the presence of antibiotic-resistant microbes in the clinical environment, prolonged lengths of hospitalization, and lack of compliance with existing infection control guidelines.[1] Less than 10% of hospitalized patients require ICU treatment.[2] However, care in the ICU accounts for >20% of HAIs acquired by hospitalized patients.[3] Additionally, pediatric intensive care units (PICUs) and neonatal ICUs have higher documented HAI acquisition rates than those seen for adult populations.[4-6]

Most HAIs are thought to occur via transmission from the microbiome of the patient. However, there is ever increasing evidence suggesting significant transmission of microbes from personnel and the clinical environment to patients.[7,8] Otter et al have delineated the complex, continuous, and omnidirectionality of the movement of microbes within the clinical space.[9] Investigators have also shown that the gloves of nurses frequently collect viable methicillin-resistant *Staphylococcus aureus* (MRSA) after touching objects near MRSA-colonized patients.[10] Further, studies have found that controlling the contamination of common hospital touch surfaces from hand to surface contact and visa versa can be an effective strategy to limit burden and control infections.[7,11,12] In one such study in a pediatric environment, mandatory use of gloves was found to limit the incidence of central line–associated bloodstream infections in the PICU during respiratory syncytial virus season.[13] Finally, in concert with hand hygiene compliance, recommendations concerning in-hospital infection control practices are increasingly directing attention toward the disinfection of patient care surfaces, especially those surfaces associated with high-touch objects, as an element of an effective, systems-based approach toward infection prevention and control.[14]

Recently, we have witnessed an increased incorporation of no-touch technologies as a component in systematic approaches for infection control. Ultraviolet light and the introduction of vapor phase oxygen radicals (hydrogen peroxide vapors [HPVs]) into the hospital environment exert their antimicrobial activity passively through an episodic introduction into the care space. Both technologies have been found to reduce the bacterial burden by at least 4 log10 within the clinical environment.[15] In one 30-month study evaluating the environmental and clinical impact of the episodic use of HPVs involving 6 high-risk units in a large tertiary care hospital, it was learned that patients admitted to rooms decontaminated with HPV were 64% less likely ($P < .001$) to accrue any multidrug-resistant microbe and were 80% less likely to acquire vancomycin-resistant enterococci (VRE).[8] These 2 systems require skilled labor to place and initiate the episodic application of their use and the exclusion of patients and health care workers from the environment.

Solid copper and its alloys have been used as an antimicrobial agent for millennia. They intrinsically display strong antibacterial activities in aquatic systems[16,17] and dry surfaces.[18-23] Controlled studies within the clinical environment have evaluated the effects that antimicrobial copper surfaces have on the microbial burden and acquisition of HAIs.[7,11,24] In 2008, the U.S. Environmental Protection Agency registered 5 families of copper-containing alloys as antimicrobial, therefore offering that products manufactured-surfaced from one of these alloys can kill 99.9% (log10 2.0) of bacteria within 2 hours of exposure.[25] Casey et al[26] observed a median microbial reduction of between 90% and 100% (log10 1.95-2.0) on copper-surfaced push plates, faucet handles, and toilet seats, whereas Schmidt et al demonstrated significantly lower bacterial burdens on 6 frequently touched clinical surfaces, averaging an 83% (log10 1.93) reduction for all of the objects over the course of a 43-month multicenter trial.[11] In the conduct of the same multicenter trial, it was learned that concomitant with a reduction to microbial burden, antimicrobial copper surfaces were found to significantly lower the rate of HAI acquisition by 58% from 8.1% to 3.4% ($P = .013$).[7] Analysis of the quartile distribution of infection acquisition stratified by microbial burden established a significant association ($P = .038$), establishing linkage between microbial burden and infection acquisition. Specifically, of the HAIs acquired, 89% were found to occur in rooms where the microbial burden was >500 aerobic colony forming units (ACC).[7]

In this study we expanded these observations by characterizing the microbial burden associated with commonly touched objects surfaced with and without copper in PICUs to understand whether or not a significant reduction to microbial burden and HAI acquisition observed within adult ICUs would be duplicated within a pediatric setting housing multiple patients within each room.

MATERIALS AND METHODS

Study environment

The study was conducted at a 249-bed tertiary care facility, Hospital de Niños Roberto del Río, which is located in Santiago, Chile. Two, high acuity pediatric units were selected for the intervention; 8 rooms from the ICU (PICU) and 8 rooms from the intermediate care unit (PIMCU). Eligible participants were patients admitted to one of the study units based on their respective medical needs to be housed in either the PICU or PIMCU. On admission, patients were sequentially assigned to an intervened (copper) or control room. Patient occupancy of the beds and cradles was noted at the time the samples were collected. Informed consent was not required to collect burden from the objects.

The PICU has six 2-bed rooms and 2 additional rooms containing a single bed. The PIMCU has one 4-bed room, 5 rooms with 3 beds, and 2 rooms containing a single bed (Fig. 1, Panels A and B). Eight rooms were furnished with copper surfaced items, and 8 rooms remained unchanged (Fig. 1, Panel AC). Intervened rooms were located in an alternate fashion. The copper surfaced items were bed rails, bed rail levers, intravenous poles, faucet handles, and the surface of the health care workstation. The copper alloys used to surface the objects were among those registered with the U.S. Environmental Protection Agency as being antimicrobial and are principally brass (C27200 and C23000 [bed rails, bed lever (DUAM S.A., Santiago, Chile), faucet (Chase Brass, Montpelier, OH), and work surface]) or Eco Brass (C69300 [faucet, faucet handles]). Prestudy handwashing procedures and cleaning routines were maintained and remained unchanged through the study period. The hand hygiene compliance rate of health care workers was assessed quarterly by staff not affiliated with the trial. Compliance was monitored and reported quarterly as a measure of health care worker adherence to the established protocol for hand hygiene before and after patient contact. For the period of the trial, the mean compliance rate for the health care workers observed in the units (N = 153), expressed as a percentage of individuals that complied entirely with the hospital standards for the PIMCU and PICU wards, was 93% (range, 80%-100%).

Sampling plan

The microbial burden resident in the built clinical environment is not normally distributed on surfaces because of individualized care provided to patients, variations to room occupancy, individualized shedding of microbes by patients, and health care workers and visitors with subsequent deposition and retention of viable microbes onto surfaces. Given the nonparametric distribution of the microbial burden resident on the surfaces sampled, the Mann-

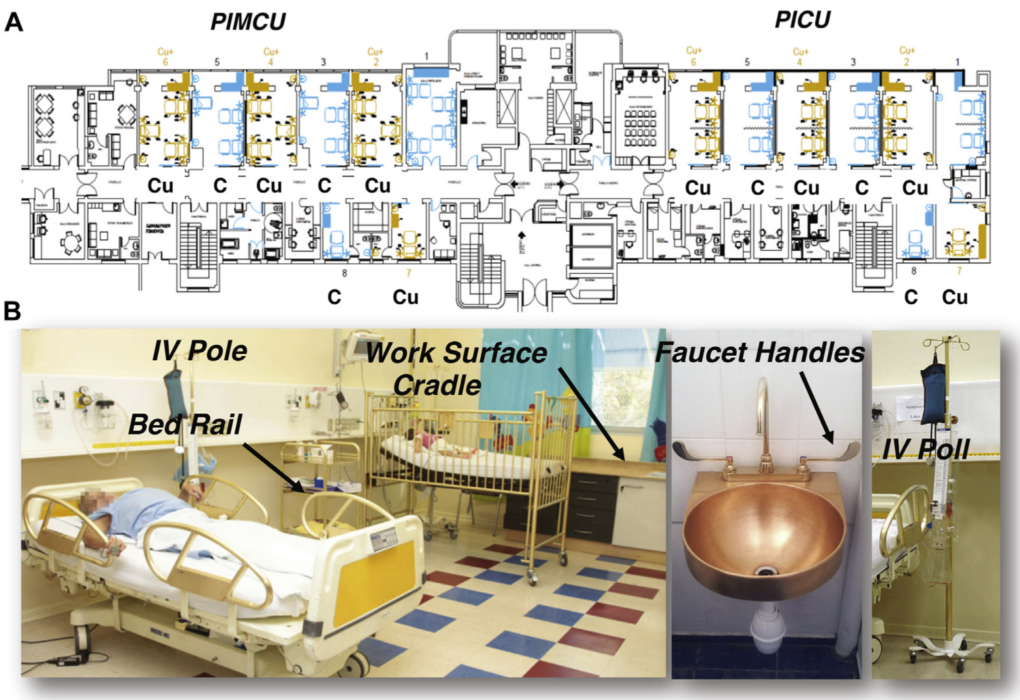

Fig 1. Sampling locations and item placement within the PICU and PIMCU. (A) Locations of the rooms sampled in the PICU and PIMCU rooms containing antimicrobial copper objects or control items are indicated on the diagram. (B) Particular placement of the 5 interventional surfaces: beds, cradles, faucet handles, intravenous pole, and work surfaces. Three objects (bed rails, cradles, and faucet handles) were sampled twice each month for the duration of the study. *C*, control rooms; *Cu*, copper rooms; *PICU*, pediatric intensive care unit; *PIMCU*, intermediate intensive care unit.

Whitney test, Wilcoxon 2-sample test, or Kruskal-Wallis test (Epi Info; Centers for Disease Control and Prevention, Atlanta, GA) was used to compare differences between microbial burden collected from control and intervention surfaces. Sample size was estimated on the basis of available local data collected during a preintervention period. It was anticipated that there might be some seasonal variation; the study was statistically powered to test for differences on a monthly basis. Fifty samples per group per month were found to yield an approximate 90% statistical power to show a 90% reduction of the bacterial burden in the intervention group compared with the control group, with a 2-sided type I error of 0.05. Having sufficient power to compare means enabled sufficient power to test differences between the medians observed using the Mann-Whitney test, Wilcoxon 2-sample test, or Kruskal-Wallis test (Epi Info; Centers for Disease Control and Prevention, Atlanta, GA).

Rooms were sampled on alternating weeks for the length of the trial. A total of 734 samples were collected during the preintervention phase as delineated in Table 1, and 1,230 samples were collected during the intervention (Table 2). Each of the surfaces monitored (Fig. 1) was assessed for total ACC, expressed as viable colony forming units (CFU) per 100 cm^2, and the presence of indicator microbes, staphylococci, MRSA, VRE, and gram-negative microbes as previously described.[11]

Statistical methods

The mean and median microbial burden of each item assessed during the interventional period was determined, and the significance of the data was assessed using the Kruskal-Wallis test to compare the microbial burden associated with objects and rooms (Epi Info; CDC, Atlanta, GA). A *P* value of <.05 was considered statistically significant.

Table 1
Common surfaces within the PICU harbor significant concentrations of bacteria

	Preintervention period		
	Aerobic colony counts (CFU/100 cm^2)		
Objects evaluated	n	Mean	Median
Bed rails	281	4,800	2,910
Faucet handles	135	5,200	1,126
IV poles	97	530	65
HCW workstation	136	550	120
Nurse pad	85	980	540
Overall	734	3,080	810

NOTE. Mean and median values of bacterial burden (aerobic colony forming units/100 cm^2) were associated with samples recovered from surfaces assessed prior to commencing the intervention as described in the Materials and methods section and according to the protocol of Attaway et al.[34]
CFU, colony forming units; *HCW*, health care worker; *IV*, intravenous; *PICU*, pediatric intensive care unit.

RESULTS

Baseline microbial burden found within the PICU on commonly touched objects

Before the intervention, we assessed the microbial burden associated with the rails of pediatric beds, faucet handles of the faucets used for hand hygiene, intravenous poles, health care workstation, and nurses pad and learned that the PICU and PIMCU were similarly burdened to the concentrations found for bed rails in adult ICUs.[11] Collectively, the average baseline burden was found to be 4,800 CFU/100 cm^2 for bed rails and 5,200 CFU/100 cm^2 for

Table 2
Copper alloyed surfaces limited the concentration of bacteria resident on frequently touched surfaces in the PICU

	Standard objects							Copper objects							
	Patient occupied			Unoccupied			Kruskal-Wallis	Patient occupied			Unoccupied			Kruskal-Wallis	
	n	Mean	Median	n	Mean	Median	pO/U	n	Mean	Median	Nn	Mean	Median	pO/U	pS/C
Bed rails	136	1451	1,020	84	766	484	0.0000	186	43	0	139	26	8	0.0000	0.0000
Cradle rails	91	1,806	1,170	78	979	640	0.0004	50	97	0	21	289	0	0.3165	0.0000
Faucet handles	NA	NA	NA	221	1,412	165	NA	NA	NA	NA	224	373	0	NA	0.0000

NOTE. Mean and median values of bacterial burden (aerobic colony forming units/100 cm^2) were recovered from surfaces assessed as described in the Materials and methods section and according to the protocol of Attaway et al[34]; samples collected during the first month were excluded from analysis because occupancy status was not recorded. *NA*, not applicable; *PICU*, pediatric intensive care unit; *pO/U*, Kruskal-Wallis test for significance of medians observed between occupied beds and cradles and unoccupied beds and cradles for the standard or copper arms during the intervention; *pS/C*, Kruskal-Wallis test for significance of median values observed between standard objects and objects surfaced with copper during the intervention.

faucet handles (Table 1). Given the concentrations associated with all of the frequently touched objects sampled were well above the postulated risk threshold of 500 CFU,[7] we hypothesized that the microbial burden found within the pediatric setting represented an equivalent risk to that found in adult care settings and that this concentration, and therefore risk, might be ameliorated through an introduction of a limited number of continuously active antimicrobial copper-copper alloyed surfaces.

Copper surfaces limited the concentration of bacteria associated with the intervention objects within the PICU and PIMCU

In total, 1,320 objects were sampled during the intervention phase from the 16 study rooms; 668 objects were surfaced with antimicrobial copper, and 652 were fabricated from polypropylene (bed rails) or stainless steel (faucet handles). A total of 1,012 patients were admitted to both units (PICU or PMICU) during the intervention. The mean bed occupancy rate during the study period was 70% (monthly range, 14%-121%) for the PICU and 43% (monthly range, 12%-94%) for the PMICU. For a period of 2 months (July and August; winter season) room occupancy exceeded 100% of capacity as a consequence of clinical need: 22 days in July and 14 days in August or 58% of the aforementioned period. To accommodate the clinical surge, control objects (beds and cradles) were introduced into the intervention-copper arm of the study. This accounted for an estimated deviation from protocol of 12% over the 868 patient days associated with the surge months.

The presence of copper alloyed surfaces were collectively found to be significantly lower than the microbial burden on the sampled objects in the pediatric units by 88% (log^{10} 1.94; P = .0000), regardless of whether or not the bed or cradle was occupied at the time of sampling. The average concentration for all of the objects sampled in the room with standard objects was 1,381 CFU/100 cm^2 (n = 652; median concentration, 574 CFU/100 cm^2), whereas the average concentration observed for copper surfaced objects was 172 CFU/100 cm^2 (n = 668; median concentration, 0 CFU/100 cm^2). The microbial burden recovered from the sampled copper objects was well below the postulated environmental risk threshold for HAI acquisition of 500 CFU.[7]

The average concentration observed for copper surfaced rails from occupied beds was 43 CFU/cm^2 and 97 CFU/cm^2 for copper cradles. The antimicrobial effectiveness of copper rails for the occupied copper beds was approximately 34-fold less than the equivalent mean concentration of bacteria recovered from occupied control beds (1,451 CFU/100 cm^2) (Table 2). The observed mean difference between the cradles, although less, was still significantly lower, with copper surfaced cradles harboring 19-fold fewer microbes than the controls (97 vs 1,806 CFU/100 cm^2 for copper vs control cradles, respectively).

Similarly, the concentration of bacteria recovered from unoccupied beds with copper surfaced rails and copper cradles was found to be significantly different than the control surfaces (P = .0000) (Table 2). Evaluation of the microbial burden recovered from occupied and unoccupied groups found that the average concentration from unoccupied control objects was 47% (bed rails) and 46% (cradles) lower than the concentration of ACC recovered from occupied objects. The average concentration between unoccupied and occupied copper surfaced bed rails was also significantly lower than unoccupied beds, having approximately 40% fewer bacteria than their occupied counterparts. However, the concentration observed for the unoccupied copper cradles did not significantly differ.

DISCUSSION

The role that the built environment serves in the transmission of pathogens has received increased attention from the infection control community. The data reported here established that antimicrobial copper surfaces are equivalently effective for their ability to control the environmental microbial burden in a pediatric setting. Collectively, an 88% reduction (log10 1.944) was observed when considering the values from the 3 objects sampled, whereas an 83% reduction (log10 1.919) was reported from a comparable study where the efficacy of 6 antimicrobial copper surfaces were evaluated from adult Medical Intensive Care Units.[11]

This study represents the first comprehensive evaluation of the effectiveness of copper to limit bacterial contamination on surfaces within multibed rooms. Substantial variability was seen among samples collected from within the control and intervention (copper) groups (Fig. 2). This observation well illustrates the nonparametric distribution of bacterial contamination associated with surfaces within the built environment. Similar to the adult study, such variation encountered in the pediatric setting was attributed to the stochastic nature of care common to the PICU and PIMCU and the level and extent to which patients and health care workers shed his or her respective flora. However, in this trial additional confounding variables could have impacted the nonparametric distribution of microbes within the built environment. Unlike adults in the MICU trial, where there was only 1 patient per room,[11] in our study each room could host multiple patients with variable rates of occupancy. On discharge, the formerly occupied bed and immediate area associated with the care area of the discharged patient was terminally cleaned and not terminally cleaned again until subsequent patient occupancy and discharge. This resulted in the observation that occupied beds and occupied cradles had higher concentrations of bacteria than the unoccupied beds or unoccupied cradles (Fig. 2). During 2 of the 12 months of the trial (July and August 2013), occupancy exceeded 100% for 36 days. During the clinical surge, noncopper objects were

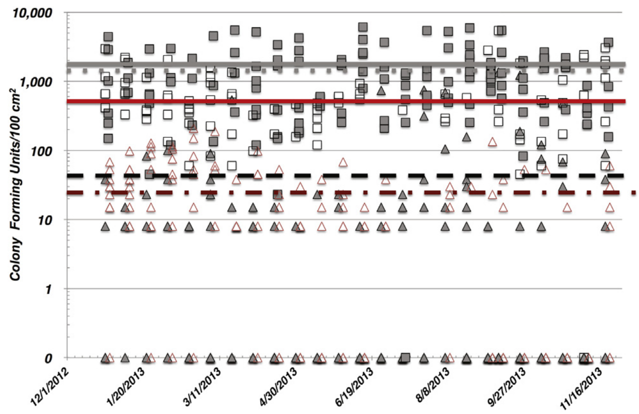

Fig 2. Copper surfaces limited the concentration of bacteria associated with the intervention objects within the PICU and PIMCU. Bed rails, cradles, and faucet handles were sampled twice each month as described in the Materials and methods section. The concentrations recovered for the rails are plotted against the date of collection and whether or not the bed was occupied (filled squares: control rails; filled triangles: copper rails) or unoccupied (open squares: control rails; open triangles: copper rails) at the time of sampling. The solid grey line denotes the average concentration of occupied control beds. The dashed grey line represents the average concentration found on unoccupied control rails. The dashed black line denotes the average concentration for unoccupied copper beds. The dashed-dotted line denotes the average concentration for occupied copper beds. The solid red line drawn at 500 CFU/cm^2 suggests an average concentration at which the risk of microbial transference may increase. *CFU*, colony forming units; *PICU*, pediatric intensive care unit; *PIMCU*, intermediate intensive care unit.

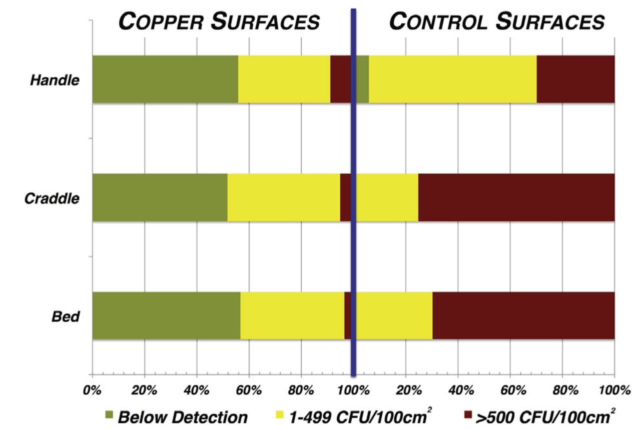

Fig 3. Copper surfaces were consistently able to limit the concentration of bacteria associated with commonly touched surfaces within the PICU and PIMCU. The antimicrobial consistency of copper surfaced objects was assessed by determining the frequency at which bed rails, cradles, or faucet handles fabricated from U.S. Environmental Protection Agency—registered antimicrobial copper alloys were able to limit the concentration of bacteria associated with those surfaces to <500 CFU/100 cm^2. The frequency that the microbial burden was below the limit of detection (green bars), above the limit of detection but less than the risk threshold (<500 CFU/cm^2; yellow bars), or exceeded the risk threshold (>5 CFU/cm^2; red bars) was determined by scoring the number of occasions that the ACC for individual samples from both the PICU and PIMCU was observed (N = 460 copper arm; N = 446). The limit of detection for the bed rails was 30 CFU/100 cm^2; cradles, 30 CFU/100 cm^2; and faucet handles, 30 CFU/100 cm^2. *ACC*, aerobic colony forming units; *CFU*, colony forming units; *PICU*, pediatric intensive care unit; *PIMCU*, intermediate intensive care unit.

introduced into the copper rooms as a consequence of the increased clinical need. Therefore, the likelihood of introducing additional microbial burden into the patient care setting, irrespective of cause, was increased. However, in spite of increased opportunities to introduce additional burden into the patient care setting, the antimicrobial efficacy of the copper surfaces monitored was consistently <500 CFU/100 cm^2 for most of the samples evaluated regardless of occupancy status (Fig. 2). Although it was observed that health care staff caring for patients made no distinction as to whether they were assigned patients in an intervention or control group, there is still a formal possibility that bias might be introduced into the unblinded study. The antimicrobial activity of the copper surfaces is continuous and requires no intervention on the part of the study or health care teams to exert its ability to disinfect the surfaces to which it was applied.

Presently, regulatory agencies assessing the antimicrobial efficacy of surface disinfectants require that products under evaluation reduce the microbial burden, using a defined in vitro protocol by a factor between 2 and 4 logs (eg, from 1×10^7 CFU viable cells to 1×10^5 or 1×10^3 CFU viable cells). Using the same in vitro conditions, the antimicrobial efficacy of copper is generally between 5 and 7 logs within the prescribed time period. The rate observed here during active clinical care was log10 1.99, was extremely close to the required in vitro disinfection standard, and was nearly equivalent to the rate observed in previous clinical evaluations of copper surfaces.[11] These observations prompted us to consider an alternative method for assessing the value that continuously active antimicrobial copper surfaces might offer in mitigating the risk that the microbial burden plays in HAI acquisition. The approach was based on a comparison of the frequencies with which individual samples from control and copper groups harbored concentrations of bacteria above which the risk of HAI acquisition and microbial transference was thought to increase. Salgado et al reported when the microbial burden for environmental surfaces collectively exceeded 500 CFU in an adult MICU, the rate with which HAI was acquired significantly increased.[7] Here, we learned that collectively only 3% of the copper bed rails, 6% of the cradles, and 9% of the faucet handles from the pediatric sites were found to harbor concentrations above the postulated HAI risk threshold of 500 CFU/100 cm^2, whereas 68% of the polypropylene bed rails, 80% of the cradles, and 30% of the faucet handles from the control groups were found above this concentration (Fig. 3). However, more remarkably were the number of occasions when the microbial burden associated with copper surfaces fell below the limit of detection for our sampling protocol. Here 62% of the copper rails, 56% of the cradles, and 56% of the faucet handles failed to yield any microbial burden when sampled, whereas this was only the case for 1% of the control rails and 6% of the faucet handles (Fig. 3).

Interestingly, when the mean microbial burden of preintervention phase control objects was contrasted with the intervention phase control objects, the concentration observed was significantly lower; the mean ACC observed for the rails was reduced from 4,800 to 1,313 CFU/100 cm^2 and from 5,200 to 1,412 CFU/100 cm^2 for the faucet handles. This represented an almost 2 log10 reduction (log10 1.86; 73%) to the microbial burden resident on these critical surfaces in the control rooms (Table 3). A similar result was seen in the trial conducted in adult MICUs. Here, in a similar log10 reduction, 1.80 (63%) was observed for the microbial burden associated with bed rails from the preintervention phase when contrasted against the mean observed for the control beds, suggesting that an introduction of a continuously active, no-touch antimicrobial solution, such as copper surfaces, could have an ability to suppress the microbial burden in rooms located in close proximity to those containing an active antimicrobial agent, such as copper surfaces. Given that the study design was similar for both trials and the antimicrobial effect observed between the copper arms was nearly equivalent (log10 1.99 adult MICU vs log10 2.0 PICU), these data offer insight into future trial designs that will evaluate the utility of no-touch disinfection strategies for mitigating risk from the intangible microbial burden present in the patient care setting.

Table 3
Presence of limited antimicrobial copper surfaces in adjoining rooms suppressed the microbial burden in rooms without copper

	Resident burden on bed rails in standard and control rooms				Resident burden on bed rails in rooms with copper objects		
	Mean preintervention burden	Mean intervention burden	Burden reduction (log10) preintervention-intervention	% Burden reduction preintervention-intervention	Mean	Burden reduction (log10) preintervention-intervention	% Burden reduction preintervention-intervention
MICU	17,336	6,471	1.80	63	366	1.99	98
PICU	4,800	1,313	1.86	73	43	2.00	99

NOTE. An assessment with which the bacterial burden was reduced in control rooms as a consequence of a limited introduction of antimicrobial copper surfaces in adjoining rooms was conducted by comparing the mean values (total aerobic colony forming units/100 cm^2) recovered from the bed rails prior to the intervention with the mean values observed during the intervention in the care of adults in the MICUs reported by Schmidt et al[11] with those observed here for pediatric bed rails.
MICU, medical intensive care units; *PICU*, pediatric intensive care unit.

More than 45 years ago Spaulding suggested a predicted degree of risk associated with inanimate objects.[27] Unfortunately, many of the objects found in the setting of patient care were relegated to the category of noncritical items, leading the infection control community to consider them unlikely to be responsible for significant transmission of infectious agents to patients given adherence to accepted hand hygiene practices and routine cleaning.[27] However, it is now recognized that the bacteria responsible for many of the severe and debilitating hospital-acquired infections can survive for days, weeks, or months on these surfaces in spite of the best efforts of the health care team to keep the bacterial burden within limits considered safe for patient care.[28-31] Several publications have argued that terminal cleaning must achieve a threshold where <250 CFU/100 cm^2 of aerobic bacteria are detectable immediately after cleaning on commonly touched surfaces to lower the microbial burden to a concentration where it only represents a minimal risk that the microbes resident on those surfaces might be transferred to health care workers or patients, with others linking microbial burden to HAI risk.[32,33] However, the frequency and efficacy with which cleaning may occur, especially in multibed rooms, represent a substantial challenge to the infection control community. Schmidt[24], Attaway[34], and colleagues established that in spite of the best cleaning and disinfection efforts, microbes easily re-establish themselves on frequently encountered surfaces within the patient care setting, such as the rails of beds. Copper-alloyed surfaces such as the ones used here offer a continuous way to limit and control the environmental burden. Hospital and environmental services need not perform additional steps, follow complex treatment protocols, or require additional training, oversight, or support from other workers for copper to manifest its antimicrobial activity.

It is intuitive to argue that to minimize the risk of HAI acquisition among the pediatric population, any method that can augment the effectiveness of hand hygiene and routine cleaning will likely translate into lower rates of HAIs and hospital-acquired colonization by MRSA, VRE, and other potential pathogens, such as extended spectrum β-lactamase and New Delhi metallo-β-lactamase-1−producing gram-negative microbes. The demonstration here that the antimicrobial activity of copper surfaces was equivalent to the levels witnessed for adult care settings encouraged us to address this very issue in a companion study. This study showed that through a reduction to burden, through this intervention in the PICU, the HAI rates decreased from 13.0 per 1,000 patient days for patients treated in the control settings to 10.6 per 1,000 patient days for patients treated in rooms with a limited number of copper objects (Dessauer BV, Navarrete MS, Benadof D, Schmidt MG. Unpublished data). Although the relative risk reduction failed to achieve statistical significance, we are encouraged that through reducing burden with copper surfaces, we were able to observe fewer infections among patients within the PICU. Given the pragmatic manner with which the trial was conducted, copper surfaces warrant serious consideration involving any systematic approach for reducing HAI acquisition in adult and pediatric settings.

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