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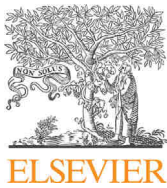
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## Original Study

# Copper for the Prevention of Outbreaks of Health Care–Associated Infections in a Long-term Care Facility for Elders

## ABSTRACT

**Keywords:**  
Cross infection  
copper  
disease outbreaks

**Objective:** We aimed to study the efficacy of copper as an antimicrobial agent by comparing incidence rates during outbreaks in areas equipped vs not equipped with copper surfaces in a long-term facility for dependent elderly persons (nursing home).

**Design:** Prospective observational pilot study in a nursing home.

**Setting and participant:** All persons resident in the nursing home belonging to a University Hospital, from February 1, 2015, to June 30, 2016, were included.

**Methods:** Incidence rates for health care–related infections during outbreaks occurring during the study period were compared between the wing that was equipped and the wing that was not equipped with copper surfaces. Results are expressed as relative risks (RRs) and 95% confidence intervals (95% CIs).

**Results:** During the study period, 556 residents were included; average age was  $85.4 \pm 9.2$  years, 76% were women. Four outbreaks occurred during the study period: 1 influenza, 1 keratoconjunctivitis, and 2 gastroenteritis outbreaks. The risk of hand-transmitted health care–associated infection was significantly lower in the area equipped with copper surfaces (RR 0.3, 95% CI 0.1–0.5).

**Conclusion:** and implication: In our study, copper was shown to reduce the incidence of hand-transmitted health care–associated infections and could represent a relatively simple measure to help prevent HAIs in nursing homes.

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The antimicrobial properties of copper have been used for thousands of years and by many human civilizations, for a variety of uses, from the sterilization of drinking water to the topical treatment of leg ulcers.<sup>1</sup>

In more recent times, copper has been used to control nosocomial infections.<sup>2</sup> It has been suggested that copper should be used to coat contact surfaces.<sup>3–20</sup> Indeed, solid surfaces can act as a reservoir for pathogens, thereby participating in the transmission of infections by hand contact. In vitro, copper surfaces show effectiveness against a large variety of pathogens (ie, bacteria, virus, and fungi).<sup>20</sup>

Few studies have investigated the efficacy of copper as a contact surface in reducing health care–associated infections (HAIs) from a

clinical point of view, and fewer were interventional studies.<sup>6,8,9,11,12</sup> A randomized, multicenter study in the intensive care unit by Salgado et al<sup>7</sup> showed that patients cared for in areas with copper alloy surfaces had a significantly lower risk of nosocomial infection. A quasi-experimental study by Von Dessauer et al<sup>8</sup> showed a numerical, although not statistically significant, reduction in HAIs in patients assigned to rooms with copper surfaces.

Therefore, the role of copper in the prevention of HAIs remains to be clarified, with conflicting results existing in the literature. Furthermore, existing studies were mainly performed in intensive care units in the hospital setting. To our knowledge, no study to date was performed in the setting of a long-term care facility for dependent elderly persons (nursing home). Indeed, elderly populations (older than 65 years) are at risk for susceptibility to HAIs, with a 15-fold increase in infections in patients hospitalized for more than 30 days, compared to those whose hospital stay lasts only 2 to 7 days.<sup>21</sup>

Against this background, we aimed to investigate the efficacy of copper as an antimicrobial agent by comparing incidence rates of

The authors declare no conflicts of interest.

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infection during outbreaks between an area equipped and an area not equipped with copper surfaces in a nursing home setting.

## Methods

We performed a prospective, longitudinal, observational pilot study in a nursing home operating under the auspices of a University Hospital.

### Study Population

All patients residing in the nursing home during the period from February 1, 2015, to June 30, 2016, were included in the study.

### Study Intervention

The nursing home had a capacity of 362 beds in total. The buildings of the nursing home comprise 2 distinct wings (AB wing and CD wing), each with 3 floors. Units A and B occupy the right wing, and Units C and D occupy the left wing. On each floor, there are areas that are common to both wings, such as dining rooms, game rooms and outdoor areas (patio, depending on the floor) ([Supplementary Material](#)).

The CD wing was randomly chosen to be equipped with antimicrobial copper surfaces. The premises were equipped from April 2014 onwards with 438 door handles, 322 m of handrails, and 10 grab-bars in copper alloy (containing from 80% to 90% copper).

### Data Recorded

During the study period, the outbreaks that occurred were recorded by noting the start date of symptoms for each individual. Outbreaks were defined as the onset of grouped cases with similar symptoms, that is, the occurrence of at least 5 cases in 4 days.<sup>22</sup>

All diagnoses were made by the physician in the nursing home.

All biological samples were analyzed in the Virology and Bacteriology Laboratory of a University Hospital for identification of the causal pathogen.

For each patient, we also recorded, sex, age, length of stay before inclusion in the study, occurrence of infection (yes/no) and, if yes, the type of infection.

### Statistical Analysis

Incidence rates of HAIs with 95% confidence intervals (CIs) were calculated in each wing, for each outbreak individually, and overall for all outbreaks observed during the study period, and also grouping only outbreaks caused by hand-transmitted pathogens. When the causal germ was not identified, we recorded the average incubation period for the germ most frequently encountered in that type of outbreak.<sup>23,24</sup>

For the calculation of incidence rates, the numerator was the number of new cases for each outbreak and the denominator was the theoretical duration of exposure to the infection expressed in person-days. The start of the exposure period for noninfected residents was the date of the first case minus the duration of incubation of the causal

germ. The end of the exposure period was the date of the last case plus the duration of incubation of the causal germ.<sup>23–25</sup> For cases, the duration of exposure was from the date of the first case minus the duration of incubation of the causal germ up to the date of onset of symptoms.

The relative risk was calculated as the ratio of the incidence of outbreaks in the wing equipped with copper surfaces to the incidence of outbreaks in the wing not thus equipped. The 95% confidence intervals of the relative risk were calculated according to Katz's method.<sup>26</sup> When the incidence rate in a wing was equal to zero (ie, no cases), we estimated the relative risk by calculating the incidence rate with a single case as the numerator.

Quantitative variables were described as mean  $\pm$  standard deviation, and qualitative variables as number (percentage). Qualitative variables were compared using the chi-square test, with Yates correction when necessary according to the conditions of application. A *P* value  $<.05$  was considered statistically significant. All analyses were performed with SAS version 9.4 (SAS Institute, Inc, Cary, NC).

The evaluation presented here was conducted independently by members of the Research Center of a University Hospital, after having warned a priori the company of the realization of this project.

## Results

During the study period, 556 residents were included in the study; 289 in the AB wing, 72% of whom were women, and 267 in the CD wing, among whom 79% were women. The mean age of the AB wing was  $85.4 \pm 9.6$  years vs  $85.4 \pm 8.8$  in the CD wing. The average length of stay prior to inclusion was  $2.8 \pm 3.2$  years in the AB wing vs  $3.1 \pm 5.4$  in the CD wing. For all these characteristics, the differences between the 2 wings appeared nonsignificant.

Overall, during the study period, there were 4 documented outbreaks: flu in February 2015, keratoconjunctivitis in November 2015, gastroenteritis in March 2016, and gastroenteritis again in June 2016 (characteristics of the outbreaks detailed in [Table 1](#)).

The pathogens identified were Influenza A virus for outbreak 1, and Norovirus for outbreak 4. No germ could be positively identified for outbreaks 2 (keratoconjunctivitis) and 3 (gastroenteritis). It was thus assumed that the responsible pathogens were those most frequently encountered in these infections, namely, Adenovirus and Norovirus, respectively.

For outbreak 1 (flu), the risk of infection was significantly increased among patients residing in the wing equipped with copper surfaces ([Table 2](#)). For outbreaks 2 and 3 (keratoconjunctivitis and gastroenteritis), the risk of infection was significantly lower in the wing equipped with copper surfaces ([Table 2](#)).

Finally, for outbreak 4 (gastroenteritis), there was no significant difference in the risk of infection between the wing equipped vs the wing not equipped with copper surfaces ([Table 2](#)).

Considering all 4 outbreaks together, there was no significant difference in the risk of infection between wings. Conversely, when considering only the 3 outbreaks caused by hand-transmitted pathogens, there was a significant decrease in the risk of infection in the wing equipped with copper surfaces (relative risk 0.3, 95% confidence interval 0.1–0.5) ([Table 2](#)).

**Table 1**  
Description of Outbreaks Occurring During the Study Period

Outbreak	Disease	Causal Pathogen	Number of Cases	Number of Samples	Number of Samples Positive	Duration, d
1	Flu	Influenza A	18	11	4	6
2	Keratoconjunctivitis	Non identified	19	6	0	12
3	Gastroenteritis	Non identified	10	2	0	3
4	Gastroenteritis	Norovirus	26	4	1	8

**Table 2**  
Incidence Rates and Relative Risks for Infection in the Wing Equipped (CD Wing) vs the Wing Nonequipped (AB Wing) With Copper Surfaces

No.	Outbreak	AB Wing (Not Equipped)		CD Wing (Equipped)		RR (95% CI)	P
		Cases	IR* (95% CI)	Cases	IR* (95% CI)		
1	Influenza A	1	0.1 (0-0.2)	17	1.1 (0.6-1.7)	21.0 (2.8-158.2)	<.001
2	Adenovirus	19	0.3 (0.2-0.5)	0	–	0.1 (0.01-0.5) <sup>†</sup>	<.001
3	Norovirus	10	1.0 (0.4-1.7)	0	–	0.1 (0.02-0.9) <sup>†</sup>	.03
4	Norovirus	15	0.7 (0.4-1.1)	11	0.6 (0.3-1.0)	0.9 (0.4-1.9)	.88
1, 2, 3, 4	All outbreaks	45	0.04 (0.03-0.06)	28	0.03 (0.02-0.04)	0.7 (0.4-1.1)	.14
2, 3, 4	Hand-transmitted only	44	0.09 (0.06-0.12)	11	0.02 (0.01-0.04)	0.3 (0.1-0.5)	<.001

IR, incidence rate; CI, confidence interval; RR, relative risk.

\*Incidence rates are expressed per 100 person-days.

<sup>†</sup>The RR was calculated on the basis of a single case in the wing nonequipped with copper surfaces.

## Discussion

Our study shows a protective effect of copper surfaces against the risk of HAIs, but only (and quite logically) those caused by hand-transmitted pathogens (gastroenteritis and keratoconjunctivitis).

Regarding the flu outbreak, the results not only show that there is no protective effect of copper surfaces but actually suggest the opposite. Although copper has been shown to be efficacious against the Influenza A virus *in vitro*,<sup>27</sup> transmission of the flu is predominantly airborne.<sup>28</sup> It is therefore unsurprising that copper surfaces should afford no protection, especially given that the point source was the wing that was equipped with copper surfaces.

As for the second (keratoconjunctivitis) and third outbreaks (gastroenteritis), the risk of infection was significantly lower in the wing equipped with the copper surfaces, with all infections occurring exclusively in the other wing. Indeed, it has previously been reported that biocidal surfaces made of, or containing, copper can reduce the microbiological burden, including efficacy against Adenovirus<sup>20,27,29</sup> and Norovirus.<sup>30</sup>

The last outbreak (gastroenteritis), confirmed by to be caused by Norovirus, occurred simultaneously in both wings, with 15 cases in the wing nonequipped with copper surfaces vs 11 in the equipped wing, yielding a non-statistically significant difference.

When we analyzed all outbreaks together, there was no significant difference between copper-equipped and nonequipped wings in terms of risk of infection, which is likely driven by the inclusion of the airborne infection (flu), where the majority of cases occurred in the copper-equipped wing. Conversely, when the risk of infection was analyzed only for outbreaks caused by hand-transmitted pathogens, there was a clear and significant reduction in risk in the copper-equipped wing, confirming the protective effect of copper surfaces against hand-transmitted infections.

The results of our study are coherent with the largest interventional study to date to investigate the effectiveness of copper-impregnated composite hard surfaces and linens in an acute care hospital to reduce HAIs. In that study, Sifri et al<sup>9</sup> assessed the development of HAIs due to multidrug-resistant organisms, and in particular *Clostridium difficile*, in acute care units of a community hospital. No change was observed in the rate of infections in the nonequipped wing, whereas there was a significant, 78% reduction in the rate of HAIs in the copper-equipped wing.

Salgado et al reported similar findings,<sup>6</sup> but in a multicenter study of 3 intensive care units in the United States, the authors reported a significant reduction in the rate of HAIs, from 8.1% in nonequipped rooms to 3.4% in equipped rooms ( $P < .02$ ).

In our study, the geographical structure of the nursing home, with 2 distinct wings that shared certain common areas, presented the advantage of being able to investigate the spread of outbreaks in each wing separately. In addition, to our knowledge, this is the only study to have been performed in a nursing home, which offers an opportunity

to study other pathogens than those commonly observed in interventional studies performed in intensive care units. Indeed, in hospital-based studies, the majority of infections were bacterial, particularly methicillin-resistant *Staphylococcus aureus*, vancomycin-resistant *Enterococcus* or *Clostridium difficile*.<sup>6,8,9</sup> In our study, the outbreaks were of viral origin, and copper has also been shown to be efficacious against viruses.<sup>20</sup>

A further strongpoint of our study is that it directly assessed HAIs, and not simply bacterial samples for culture. Indeed, the majority of studies on the utility of copper contact surfaces in the health care environment used a biological endpoint that measured bioburden as assessed by colony-forming units, without taking clinical criteria into account.<sup>4,5,7,10,13–19,29</sup>

Nonetheless, our study has some limitations. We do not have data relating to comorbidities or nutritional status in the residents of the nursing home at the time of the study, which may have been potential risk factors favoring the onset of infection in these subjects.<sup>31</sup> Consequently, this may have introduced bias in the analysis of the rate of infection. We also lack data in this study about potential confounders due to the health care personnel, such as the number of staff assigned to each wing, and the frequency with which the staff could switch wings, or whether the staff scrupulously respected the standardized precautions and hygiene measures to limit the spread of infection. In case of outbreaks, hygiene recommendations, information to visitors and cleaning protocols are identical for both wings.

A further limitation of this study is the absence of microbiological confirmation of the causal agent for all outbreaks. Indeed, in practice, patients did not systematically undergo sampling for identification of the germ responsible for infection, and only a low number of the samples that were taken actually returned a positive result.

Finally, another potential limitation for results extension could be the cost of copper equipment. To get an idea, the price of a copper handrail is €200/m vs €40/m for a standard stainless steel handrail and €75 for copper door handles vs €20 for a standard stainless steel door handle.

## Conclusion and Implication

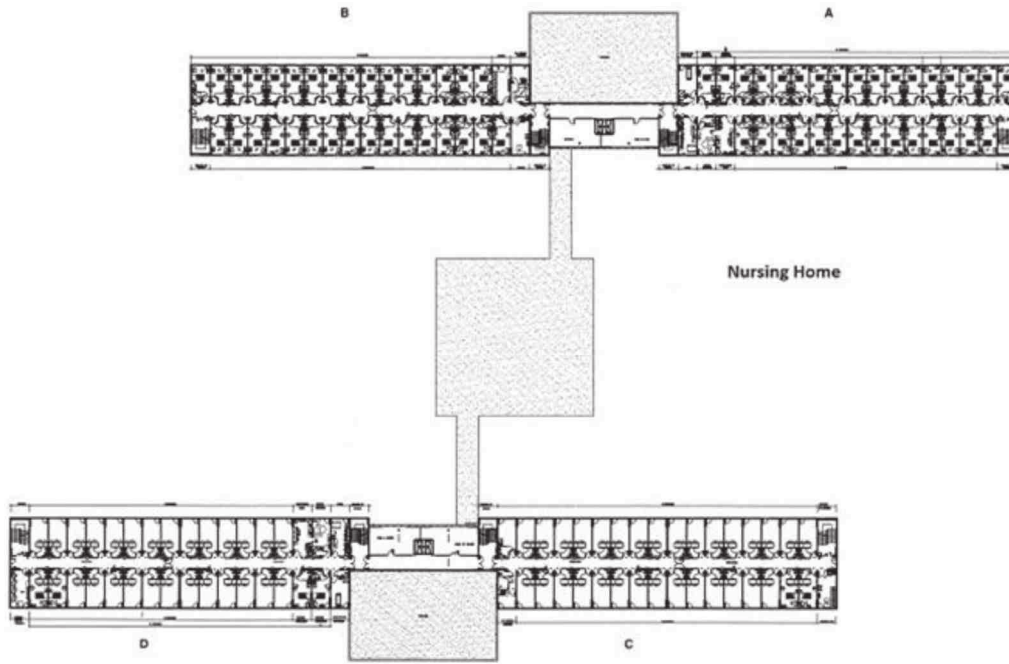
In conclusion, our study shows that copper surfaces help to reduce the incidence rate of infection during outbreaks caused by hand-transmitted pathogens. The installation of antimicrobial copper or copper-containing surfaces (such as door handles, support bars, and handrails) could represent a relatively simple measure to help to prevent HAIs in nursing homes.

## References

1. O'Gorman J, Humphreys H. Application of copper to prevent and control infection. Where are we now? *J Hosp Infect* 2012;81:217–223.

2. Grass G, Rensing C, Solioz M. Metallic copper as an antimicrobial surface. *Appl Environ Microbiol* 2011;77:1541–1547.
3. 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.
4. Souli M, Antoniadou A, Katsarolis I, et al. Reduction of environmental contamination with multidrug-resistant bacteria by copper-alloy coating of surfaces in a highly endemic setting. *Infect Control Hosp Epidemiol* 2017;38:765–771.
5. Hinsia-Leasure SM, Nartey Q, Vaverka J, et al. Copper alloy surfaces sustain terminal cleaning levels in a rural hospital. *Am J Infect Control* 2016;44:e195–e203.
6. Salgado CD, Sepkowitz KA, John JF, et al. Copper surfaces reduce the rate of healthcare-acquired infections in the intensive care unit. *Infect Control Hosp Epidemiol* 2013;34:479–486.
7. Schmidt MG, von Dessauer B, Benavente C, et al. Copper surfaces are associated with significantly lower concentrations of bacteria on selected surfaces within a pediatric intensive care unit. *Am J Infect Control* 2016;44:203–209.
8. Von Dessauer B, Navarrete MS, Benadof D, et al. Potential effectiveness of copper surfaces in reducing health care-associated infection rates in a pediatric intensive and intermediate care unit: A nonrandomized controlled trial. *Am J Infect Control* 2016;44:e133–e139.
9. Sifri CD, Burke GH, Enfield KB. Reduced health care-associated infections in an acute care community hospital using a combination of self-disinfecting copper-impregnated composite hard surfaces and linens. *Am J Infect Control* 2016;44:1565–1571.
10. Schmidt MG, Tuuri RE, Dharsee A, et al. Antimicrobial copper alloys decreased bacteria on stethoscope surfaces. *Am J Infect Control* 2017;45:642–647.
11. Lazary A, Weinberg I, Vatine J-J, et al. Reduction of healthcare-associated infections in a long-term care brain injury ward by replacing regular linens with biocidal copper oxide impregnated linens. *Int J Infect Dis* 2014;24:23–29.
12. Marcus E-L, Yosef H, Borkow G, et al. Reduction of health care-associated infection indicators by copper oxide-impregnated textiles: Crossover, double-blind controlled study in chronic ventilator-dependent patients. *Am J Infect Control* 2017;45:401–403.
13. Schmidt MG, Attaway HH Iii, Fairey SE, et al. Copper continuously limits the concentration of bacteria resident on bed rails within the intensive care unit. *Infect Control Hosp Epidemiol* 2013;34:530–533.
14. Schmidt MG, Attaway HH, Sharpe PA, et al. Sustained reduction of microbial burden on common hospital surfaces through introduction of copper. *J Clin Microbiol* 2012;50:2217–2223.
15. Karpanen TJ, Casey AL, Lambert PA, et al. The antimicrobial efficacy of copper alloy furnishing in the clinical environment: A crossover study. *Infect Control Hosp Epidemiol* 2012;33:3–9.
16. Casey AL, Karpanen TJ, Adams D, et al. A comparative study to evaluate surface microbial contamination associated with copper-containing and stainless steel pens used by nurses in the critical care unit. *Am J Infect Control* 2011;39:e52–e54.
17. Casey AL, Adams D, Karpanen TJ, et al. Role of copper in reducing hospital environment contamination. *J Hosp Infect* 2010;74:72–77.
18. Mikolay A, Huggett S, Tikana L, et al. Survival of bacteria on metallic copper surfaces in a hospital trial. *Appl Microbiol Biotechnol* 2010;87:1875–1879.
19. 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;74:80–82.
20. Borkow G, Monk A. Fighting nosocomial infections with biocidal non-intrusive hard and soft surfaces. *World J Clin Infect Dis* 2012;2:77–90.
21. INSERM. Infections nosocomiales. Available at: <https://www.inserm.fr/thematiques/immunologie-inflammation-infectiologie-et-microbiologie/dossiers-d-information/infections-nosocomiales>. Accessed November 6, 2017.
22. ARS (Agence Régionale de Santé). Surveiller et gérer les épidémies dans les établissements médico-sociaux. Available at: <http://www.grand-est.ars.sante.fr/surveiller-et-gerer-les-epidemies-dans-les-etablissements-medico-sociaux>. Accessed October 18, 2018.
23. ANSES (Agence Nationale de Sécurité Sanitaire de l'alimentation, de l'environnement et du travail). Norovirus. Available at: <https://www.anses.fr/fr/system/files/MIC2011sa0036Fi>. Accessed October 25, 2017.
24. Renard G. Kératoconjunctivites à adénovirus. *J Fr Ophtalmol* 2010;33:586–592.
25. OMS (Organisation Mondiale de la Santé). Grippe (saisonnière). Available at: <http://www.who.int/mediacentre/factsheets/fs211/fr/>. Accessed November 6, 2017.
26. NCCS. Confidence intervals for two proportions. Available at: [https://www.ncss.com/wpcontent/themes/ncss/pdf/Procedures/PASS/Confidence\\_Intervals\\_for\\_Two\\_Proportions.pdf](https://www.ncss.com/wpcontent/themes/ncss/pdf/Procedures/PASS/Confidence_Intervals_for_Two_Proportions.pdf). Accessed October 28, 2018.
27. Borkow G, Sidwell RW, Smee DF, et al. Neutralizing viruses in suspensions by copper oxide-based filters. *Antimicrob Agents Chemother* 2007;51:2605–2607.
28. Institut Pasteur. Grippe. Available at: <https://www.pasteur.fr/fr/centre-medical/fiches-maladies/grippe>. Accessed November 6, 2017.
29. Lewis A. The hygienic benefits of antimicrobial copper alloy surfaces in healthcare settings. Available at: [https://cuverro.com/sites/default/files/oem\\_files/ip010lewis-2009.pdf](https://cuverro.com/sites/default/files/oem_files/ip010lewis-2009.pdf). Accessed October 28, 2018.
30. Warnes SL, Keevil CW. Inactivation of norovirus on dry copper alloy surfaces. *PLoS One* 2013;8:e75017.
31. Laurent M, Bastuji-Garin S, Plonquet A, et al. Interrelations of immunological parameters, nutrition, and healthcare-associated infections: Prospective study in elderly in-patients. *Clin Nutr Edinb Scotl* 2015;34:79–85.

Appendix



Supplementary Material. Plan of Nursing Home.

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