

## Copper's mode of action and preventing the spread of antibiotic resistance

Copper is an essential nutrient for humans as well as bacteria but, in high doses, copper ions can cause a series of negative events in bacterial cells. The exact mechanism by which copper kills bacteria is still unknown, however several theories exist and are being studied by groups around the world. They include:

- Causing leakage of potassium or glutamate through the outer membrane of bacteria
- Disturbing osmotic balance
- Binding to proteins that do not require copper
- Causing oxidative stress by generating hydrogen peroxide.

Professor Bill Keevil, Director of Environmental Healthcare at the University of Southampton, UK, leads a research group looking at the antimicrobial properties of copper. In his laboratory, he has demonstrated copper's efficacy against antibiotic-resistant organisms, including MRSA and VRE.

"Bacteria such as MRSA can survive on ordinary surfaces like door handles, taps and grab rails for days, even months, and be transferred on hands, spreading bacteria to other surfaces or to patients," explains Professor Keevil. "As more resistant bacteria emerge, we're running out of drugs to treat the infections they cause, so we need to do everything practicable to prevent their spread. Copper is a powerful antimicrobial, which quickly and continuously reduces the number of bacteria on its surface. We've demonstrated it in the lab, and it's also been shown to be effective in busy clinical environments as part of a set of infection control procedures.

"Changing common touch surfaces in hospitals to copper can help break the chain of infection, leading to a more hygienic environment, which must have a positive impact on the well-being of patients, even in the face of antibiotic-resistant bacteria."

Microbiologists and clinicians worldwide witnessed tens of thousands of MRSA bacteria perishing rapidly on copper, yet surviving on stainless steel in a live experiment in Professor Keevil's laboratory. This demonstration was organised to mark 2011 World Health Day, the theme of which was 'Antimicrobial Resistance and its Global Spread'.

To see the video demonstration visit: [www.antimicrobialcopper.com/uk](http://www.antimicrobialcopper.com/uk)

### Antimicrobial copper in figures

- 99.9** percent of the bacteria that cause HCAs is eliminated by antimicrobial copper alloys
- 100** percent: the recyclability of copper
- 97** percent: the reduction in contamination on copper surfaces compared to other materials
- 355** alloys are registered by the US Environmental Protection Agency as public health products
- 10** years of laboratory and clinical research support copper's antimicrobial efficacy
- 1** global network of non-profit organisations and commercial companies advising on the use of copper for combatting infections, united behind the industry stewardship scheme 'Antimicrobial Copper Cu+'

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## Reducing the risk of Healthcare-Associated Infections

### Deployment of antimicrobial copper touch surfaces in hospital ICUs

The evidence of the efficacy of copper as an effective measure against healthcare-associated infections is growing; copper and copper alloy surfaces are being introduced in healthcare facilities around the world to help mitigate the 7 million infections and over 365,000 deaths that occur each year<sup>i</sup>. These infections cost over \$80 billion globally, according to the World Health Organization<sup>ii</sup>.

A number of peer-reviewed and published laboratory and clinical studies support the replacement of frequently-touched equipment and fittings with copper and copper alloy surfaces in the healthcare environment.

The same evidence suggests incorporating copper can reduce microbial burden and therefore reduce the risk of infection. In the laboratory, when challenged with over 10 million disease-causing microbes per cm<sup>2</sup>, copper and copper alloys demonstrate a continuous and rapid kill of greater than 99.9%. Independent laboratory testing<sup>iii</sup> supported the US Environmental Protection Agency's decision to approve the registration of more than 350 copper alloys as materials protective of human health. No other material has this approval.

Results from a US clinical trial, funded by the Department of Defense, take this evidence to a new level by evaluating the connection between contamination on frequently-touched surfaces and patient acquisition of infections. The findings demonstrate that patients treated in ICU rooms with copper and copper alloy products have a significantly lower risk of acquiring an infection.

Antimicrobial  
Copper **Cu<sup>+</sup>**

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<sup>i</sup> bioMérieux Corp, First World Forum on HCAs, 2007.  
<sup>ii</sup> World Health Organization, The Burden of Health Care-Associated Infection Worldwide, 2010  
<sup>iii</sup> H.T. Michels, and D. Anderson "Antimicrobial regulatory efficacy testing of solid copper alloy surfaces in the USA". Metal Ions in Biology and Medicine 2008: Vol. 10. 185-190, Eds Ph. Collery, I. Maynard, T. Theophanides, L. Khassanova, T. Collery. John Libbey Eurotext, Paris  
<sup>iv</sup> C.D. Salgado et al "Microbial Burden of Objects in ICU Rooms". Poster presentation, Interscience Conference for Antimicrobial Agents in Chemotherapy (ICAAC), October 25-28, 2008, Washington D.C., USA  
<sup>v</sup> M.G. Schmidt et al "Copper Surfaces in the ICU Reduced the Relative Risk of Acquiring an Infection While Hospitalized". Oral presentation, 1st International Conference on Prevention and Infection Control, June 29-July 2, 2011, Geneva, Switzerland

## Scientific evidence: Copper reduces bacterial burden between cleans



Three world-class medical centres – The Medical University of South Carolina, Charleston (MUSC), The Ralph H Johnson Veterans Administration Medical Center, Charleston, South Carolina and The Memorial Sloan Kettering Cancer Center in New York City – participated in a clinical trial assessing copper's antimicrobial efficacy in intensive care units (ICUs). The institutions replaced stainless steel, aluminium and plastic touch surfaces with antimicrobial copper alloys, hereafter referred to as 'copper', on the following frequently-touched objects within selected rooms in each of the ICUs: nurses' call devices, monitor bezels, bed rails, chairs, IV poles, data input devices (computer mice, laptop keyboard bases), arms of the patient visitor's chair and tray-tables. The surfaces shown to be most contaminated and, not surprisingly, in closest proximity to patients and visitors, were replaced with copper components. During the trial, the level of bacterial contamination on an equivalent number of the selected copper and non-copper surfaces was determined weekly. No changes were made to clinical practices or cleaning regimes in the study rooms.

The trial, conducted by renowned infectious disease clinicians and led by Dr Michael Schmidt, Professor and Vice Chair of the Microbiology and Immunology Department at MUSC, was executed in three stages.

The first stage established the baseline microbial burden on the frequently-touched objects in ICU rooms before installation of the copper products. The average microbial burden of the rooms was found to be 16,885 colony forming units (cfu) per 100 cm<sup>2</sup> iv.

The second stage was the replacement of the most contaminated touch surfaces with copper and subsequent comparison of the microbial burden on these and non-copper equivalent surfaces over a period of 135 weeks. The median bioburden observed on copper surfaces was 97% less than on the non-copper surfaces.

The third stage, reported at ICPIC 2011<sup>v</sup>, assessed the incidence of hospital-acquired infections in ICU rooms with and without copper products. Results to date show that there is a significant reduction in the risk of acquiring an infection in rooms where copper products are installed.

"Hospital-acquired infections are the invisible problem of healthcare facilities; bacteria are present at significant levels despite routine cleaning. The antimicrobial activity of copper has been proven in clinical trials," explains Dr Schmidt. The results of the trials indicate:

- bioburden on environmental objects matters when it comes to acquisition of infections;
- copper's antimicrobial effect is continuous and it works around the clock, non-stop;
- acquisition of infections is mitigated by copper.



## Trials over 4 years in 3 hospitals

- Non-copper touch surfaces in regularly-cleaned ICUs serve as significant microbial reservoirs that could transfer microbes to patients, healthcare workers and visitors<sup>iv</sup>.
- Objects made of plastics, stainless steel and other conventional materials, closest to patients had a higher microbial burden<sup>iv</sup>:
  - Average microbial burden of the rooms was 16,885 cfu/100 cm<sup>2</sup>
  - Bed rails averaged the highest concentrations
    - Total bioburden: 14,287 cfu/100 cm<sup>2</sup>
    - MRSA: 123 cfu/100 cm<sup>2</sup>
    - VRE: 500 cfu/100 cm<sup>2</sup>

## Copper provides clinical benefits to patients

The results to date suggest that replacement of key frequently-touched surfaces with copper components reduces microbial burden which results in a significant and consistent reduction in infection rates.

- Copper reduces the median amount of microbes by 97%.
- Virtually no MRSA or VRE were found on the copper surfaces.
- Microbial burden reduction on copper surfaces continuously achieves the same levels as terminal cleaning.
- Copper's antimicrobial activity is continuous – it works non-stop and around the clock.

For more information on clinical trials,  
scientific references, case studies and products,  
visit [www.antimicrobialcopper.com](http://www.antimicrobialcopper.com)

