



Reducing the Risk of Healthcare-Acquired Infections

Antimicrobial Copper - The Scientific Evidence

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There is now substantial scientific evidence to support the replacement of frequently touched equipment and fittings in the clinical environment with those incorporating copper to reduce contamination and therefore reduce the risk of infection.

Well before micro-organisms were discovered, the Egyptians, Greeks, Romans and Aztecs used copper-based preparations to treat sore throats, skin rashes and wound infections. In the 19th century, Louis Pasteur developed his germ theory of disease and scientists began to investigate copper's antimicrobial properties.

A solid body of scientific evidence now exists which shows that copper has a broad spectrum of antimicrobial efficacy and can inhibit the most important pathogens challenging public health today, including meticillin-resistant *Staphylococcus aureus* (MRSA) *Clostridium difficile*, *Escherichia coli*, Vancomycin-resistant enterococcus, *Legionella pneumophila* and Influenza A virus.

Today, copper's natural antimicrobial properties are exploited in applications ranging from antiseptics and anti-fungal products to medical devices and oral hygiene products. Results from ongoing trials now indicate a role for copper in reducing contamination in clinical environments and therefore lowering the risk of healthcare-acquired infections.



Copper and its alloys are easy to form into long-lasting equipment and fittings suitable for service in the healthcare environment. Whole life product costs are comparable with other materials and, at the end of their service life, products are fully recyclable and therefore contribute to sustainable design.

This leaflet provides an overview of the scientific evidence, from published laboratory and clinical studies, to support copper's role as an additional weapon in the fight against infection.



For comprehensive information on copper's antimicrobial properties, including scientific papers, webcasts, details of products and suppliers, and to join the Interest Group for announcements of updates and events, visit:

www.copperinfo.co.uk/antimicrobial

Incidence and Cost of Healthcare-Acquired Infections

Healthcare-acquired infections (HAIs) affect 9 out of every 100 patients admitted to hospitals in the UK, causing 300,000 infections and 5,000 deaths and costing the NHS upwards of £1 billion per year¹. Among the micro-organisms most frequently identified in healthcare-acquired infections are MRSA, *E. coli*, *Klebsiella pneumoniae* and *Clostridium difficile*. A single case of *Clostridium difficile* is estimated to cost somewhere between £1,100 and £6,200 to treat. Across Europe, *Clostridium difficile* cases cost an estimated €3 billion per annum.

Approximately 80% of infectious diseases are transmitted by contact and there is a growing body of literature which suggests that the environment may act as a reservoir for the organisms causing HAIs.

While not all HAIs are preventable, it is estimated that 15 to 30% could be avoided by compliance with infection prevention practices including appropriate hygiene measures, including hand hygiene. In a ward situation, surfaces could act as reservoirs of infection where healthcare workers, patients and visitors can come into contact with infectious germs. Frequently touched items, such as door handles, light switches, trolleys, bed rails, over-bed tables, bedside cabinets, grab rails, commodes and taps are typical examples of such surfaces.

Surfaces made from or incorporating copper are antimicrobial and can provide an additional hygiene measure which works away in the background without the need for any additional prompts or procedures. The following sections look at the published scientific evidence of copper's antimicrobial efficacy.

¹ Improving patient care by reducing the risk of hospital acquired infection: A progress report. London: National Audit Office, 2004.

Antimicrobial Efficacy of Copper - Laboratory Studies

Professor Bill Keevil's team at the University of Southampton has studied the survival rates of MRSA and other organisms on stainless steel (the metal most commonly used in healthcare institutions) and copper, brass (copper and zinc) and bronze (copper and tin). In these tests, carried out under ambient temperature and humidity conditions, 10 million bacteria were dried onto a 1cm² coupon of test material and the number of surviving organisms determined by both cell culture and microscopy techniques. The results show that:

- ◆ Bacteria survive on stainless steel for days
- ◆ Bacteria are eliminated from pure copper (99.9%) in less than 90 minutes at room temperature (20°C)
- ◆ Copper is efficacious at refrigeration temperature (4°C), though kill times are longer than at room temperature
- ◆ Copper eliminates a lower dose of a thousand organisms, a more typical clinical level, in as little as 15 minutes
- ◆ Copper content of >60-65% gives the greatest efficacy.

Work carried out at Southampton and other independent laboratories, and published in peer-reviewed journals, has shown copper to be effective against a broad range of organisms including:

Acinetobacter baumannii

Adenovirus

Aspergillus niger

Candida albicans

Campylobacter jejuni

*Clostridium difficile*²

Enterobacter aerogenes

Escherichia coli O157:H7³

Helicobacter pylori

Influenza A (H1N1)⁴

Legionella pneumophila

Listeria monocytogenes

Meticillin-resistant *Staphylococcus aureus* (MRSA)⁵

Poliovirus

Pseudomonas aeruginosa

Salmonella enteritidis

Staphylococcus aureus

Tubercle bacillus

Vancomycin-resistant enterococcus (VRE)

This work has led Professor Keevil to the important conclusion that 'the use of copper alloys in applications, such as door handles, trolleys, or any other work surface, could considerably reduce the presence of MRSA in hospitals and thus reduce the risk of cross-contamination between employees and patients in intensive care units'. Some key references are given below.

² Survival of *Clostridium difficile* on copper and steel: Futuristic options for hospital hygiene, Weaver L et al., J Hosp Infect (2008), doi:10.1016/j.jhin.2007.11.011.

³ Use of copper cast alloys to control *Escherichia coli* O157 cross-contamination during food processing. Noyce J O, Michels H T and Keevil C W, Applied and Environmental Microbiology 72:4239-44 (2006).

⁴ Inactivation of Influenza A virus on copper versus stainless steel surfaces. Noyce J O, Michels H T, Keevil C W, Applied and Environmental Microbiology, Apr. 2007, p. 2748-2750.

⁵ Potential use of copper surfaces to reduce survival of epidemic methicillin-resistant *Staphylococcus aureus* in the healthcare environment. Noyce J O, Michels H T and Keevil C W, Journal of Hospital Infection 62:289-97 (2006).



Antimicrobial Efficacy of Copper - Clinical Studies

Clinical trials are under way at hospitals around the world, providing a variety of ward types (geriatric, intensive care and general medical), local clinical strains of organisms and national healthcare settings to put copper to the test.

In the UK, Professor Tom Elliott, Consultant Microbiologist and Deputy Medical Director at University Hospitals Birmingham NHS Foundation Trust, leads a trial at Selly Oak Hospital, Birmingham. The trial is taking place in a general medical ward fitted with both copper and standard components. It aims to demonstrate copper's ability to reduce environmental contamination and improve patient outcomes as part of a 'care bundle' – a package of measures to fight infection.

The first results from the trial⁶, following sampling of three products - taps, push plates and toilet seats - were presented at the Interscience Conference on Antimicrobial Agents and Chemotherapy (ICAAC) in Washington DC, USA, in October 2008. These results show that surfaces made from materials that contain copper kill a wide range of potentially harmful micro-organisms, significantly reducing the number of these organisms that can come into contact with patients, visitors and staff. Data from the three products sampled over a ten-week period showed that items made from copper had 90 - 100% fewer micro-organisms on them, compared with the same items made from standard materials (chrome-plated brass, aluminium and plastic).

Professor Elliott said: "What this must mean is that the risk of picking up an infection is reduced, because we know that one of the vehicles where organisms can spread from one surface to another is by touching them. So the results are very exciting.

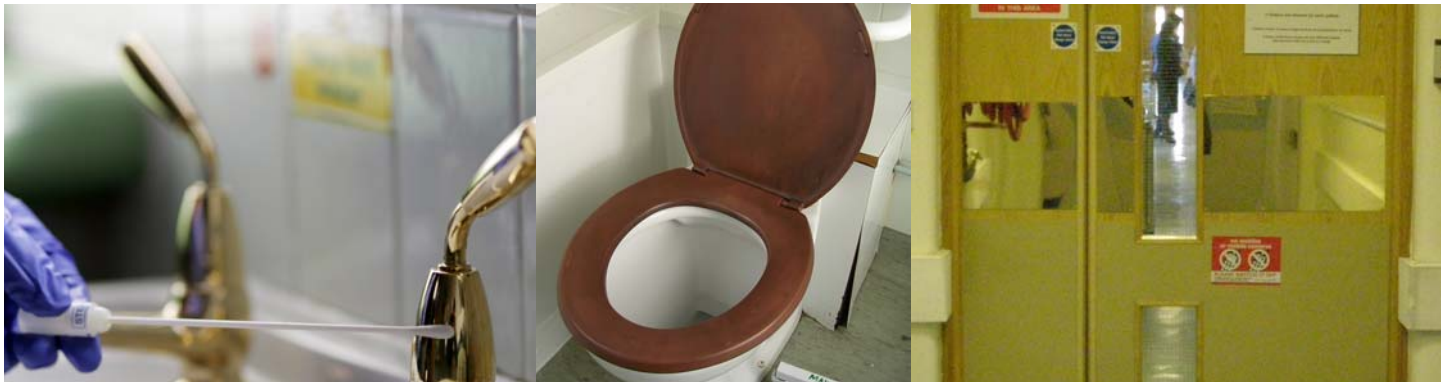
"The findings of a 90 to 100% killing of those organisms, even after a busy day on a medical ward with items being touched by numerous people, is remarkable. So it may well offer us another mechanism for trying to defeat the spread of infection."

The copper products installed for the clinical trial - door furniture, bathroom fittings, trolleys and overbed tables, have all been subject to the standard NHS cleaning protocols and formulations, including toilet and spillage cleaning. During the 12-18 months since installation, only some mild surface oxidation has taken place. With their copper, gold and bronze tones, the copper components appear markedly different to the standard components but have been widely accepted by staff, patients and visitors.

The next phase of the Selly Oak trial will see the full range of copper surfaces and their controls tested over a longer period to gather more data.



Professor Tom Elliott



In the Asklepios Clinic, Wandsbek, in Hamburg, Germany, aluminium door handles and plastic light switches in a geriatric ward and its adjacent bathrooms have been replaced by copper alloy equivalents. The patients in the control and trial wards have similar profiles. The results generated in the first three months of the trial (May – July 2008), have focused on the total level of contamination in a 'summer' situation and, more specifically on the MRSA bug, reinforce the UK findings. The trial resumed later in 2008 to investigate a 'winter' scenario. The German trial is expected to run for a total of 12 to 18 months.

In the USA, a 3-centre Department of Defense-funded clinical trial has published findings on environmental contamination in intensive care units. This study shows that objects in closest proximity to the (immobile) patients, such as bed rails, nurse call buttons and chairs, have the highest levels of staphylococci, meticillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant enterococci (VRE). This suggests that touch surfaces in these wards serve as reservoirs that could transfer bacteria to patients, healthcare workers and visitors. The next stage of these trials will be the installation and sampling of copper alloy components.

In addition to the trials in the UK, Germany and the US, testing of copper's potential to fight pathogens is also under way in South Africa and Japan.

⁶ Copper for Preventing Microbial Environmental Contamination, A L Casey, P A Lambert, L Miruszenko, T S J Elliott. Poster presented at the Interscience Conference on Antimicrobial Agents and Chemotherapy (ICAAC), October 2008.

United States Environmental Protection Agency Approval

In March 2008, following a year of comprehensive testing in an independent US laboratory⁷, the USA Environmental Protection Agency (EPA) approved the registration of copper as an antimicrobial agent to reduce specific⁸ harmful bacteria linked to potentially deadly microbial infections. There are 275 copper alloys which can now be marketed in the US as antimicrobial. The tests showed that 99.9% of the bacteria on copper alloy surfaces (with 65% or greater copper content) were eliminated within 2 hours of exposure.

Copper and its alloys are the first and only solid materials to acquire this status. Typically, this type of registration has been granted to liquids (or aerosols) and gases under the categories of sanitisers and disinfectants.

It should be noted, nevertheless, that the use of copper alloy surfaces is additional to, rather than a substitute for, standard infection control practices. For further information see the USA Copper Development Association website: www.copper.org/antimicrobial.

⁷ Antimicrobial regulatory efficacy testing of solid copper alloy surfaces in the USA, H T Michels and D G Anderson. pp 185-190, Metal Ions in Biology and Medicine: Vol. 10, Eds Ph. Collery, I Maynard, T Theophanides, L Khassanova, T Collery. John Libbey Eurotext, Paris © 2008.

⁸ Meticillin-resistant *Staphylococcus aureus*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Enterobacter aerogenes* and *Escherichia coli* O157:H7.

Copper Components - Practical Considerations

Copper forms alloys freely with a wide range of alloying elements, such as zinc, tin, nickel and aluminium, providing a practical family of alloys with a range of material characteristics suited to different applications and environments. The alloys exhibit a range of colours, allowing expression of design as well as practicality. Because they are notably different, they potentially provide a highly visual mark of change and innovation in healthcare.

Copper alloys, especially brass (copper + zinc), are industrial standby materials due to their ease of use. Much equipment is currently manufactured in these materials and subsequently lacquered or chrome or nickel-plated. Brass is readily cast, is considered the 'gold standard' in terms of machining and is easy to manipulate by bending and pressing. Moreover the alloys are very malleable, which, again, has the potential to allow designers to provide interesting as well as practicable equipment.

Cost

Copper is sometimes perceived as an expensive material but is used throughout industry because it offers good value. Most of the component cost comes from a combination of fabrication and fitting costs and not from the intrinsic material value. The fitting costs are broadly the same for any given component – unless it fails and has to be replaced. Copper alloys are widely used for complex components, like a tap or a lock, because they are so easy to fabricate, by casting, rolling, machining and then polishing. They therefore represent a comparable capital cost to other widely used materials⁹. Furthermore, installation of a key 'ward set' is straightforward and can be accomplished quickly and with minimum disruption to normal ward activities.

Cleaning

Copper and copper alloy products can be cleaned with the standard materials and protocols used in hospitals. When bleach-containing solutions are used, items should be washed down afterwards as described in the current NHS cleaning guidelines.

Sustainability

Copper is 100% recyclable without loss of properties. Scrap from manufacturing has value and there is a very well developed infrastructure for collecting and recycling this and end-of-life products. In Europe, over 40% of copper needs are met through the recycling route and almost all the brass produced comes from recycling.

Availability

Copper alloys are widely available throughout the UK from both primary manufacturers and stockists. Manufacturers of components have access to a wide variety of material forms and good selection advice from these sources, as well as the support of Copper Development Association and its global network of sister offices. Globally, there are thousands of suppliers of both raw materials and semi-finished products.

⁹ Specifier Costs, Peter Mayer, Building LifePlans, Building Magazine 2006.

Antimicrobial Copper Interest Group

The Antimicrobial Copper Interest Group has been formed for designers, architects, healthcare professionals, facilities managers, product manufacturers and material suppliers who wish to keep up with the latest developments and research on antimicrobial copper from around the world. The prime aims of the group are information dissemination and networking. To apply to join please email your expression of interest to:

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