
Reducing the Risk of Healthcare Associated Infections

The Role of Antimicrobial Copper Touch Surfaces

CDA Publication 196

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Antimicrobial
Copper



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Contents

| | |
|--|---|
| 1. Executive Summary..... | 2 |
| 2. Introduction..... | 2 |
| 3. Recent Scientific Evidence..... | 2 |
| Laboratory Studies..... | |
| Protocol..... | |
| Results (MRSA data)..... | |
| Efficacy testing..... | |
| Conclusions..... | |
| US EPA Registration..... | |
| Key features..... | |
| Registered claims..... | |
| Conclusions..... | |
| Mode of Action..... | |
| Clinical Research..... | |
| Dermatology and neonatal ICU study, Kitasato University Hospital study, Japan..... | |
| General medical ward study, Selly Oak Hospital, UK..... | |
| ICU pen audit, Selly Oak Hospital, UK..... | |
| Outpatient clinic study, US..... | |
| Nursing home study, Finland..... | |
| ICU clinical trial, multi-site, US..... | |
| Other trials..... | |
| Conclusions..... | |
| 4. Practical Aspects of Implementation..... | 7 |
| Range of Alloys..... | |
| Fabricability, Durability and Appearance..... | |
| Cleaning..... | |
| Reactions from HCW, Patients and Visitors..... | |
| Cost..... | |
| Sustainability..... | |
| Design..... | |
| Availability..... | |
| Conclusions..... | |
| 5. Accelerating Adoption..... | 8 |
| Acceptance..... | |
| Specifying Copper and Copper Alloy Products..... | |
| Learning More..... | |
| 6. Background Information..... | 9 |
| Copper Voluntary Risk Assessment..... | |
| About CDA..... | |
| 7. Key Recent References..... | 9 |
| Efficacy - Laboratory Studies..... | |
| Efficacy - EPA Registration..... | |
| Efficacy Clinical Studies..... | |
| Mode of Action..... | |
| Copper Voluntary Risk Assessment..... | |

1. Executive Summary

There is now substantial laboratory and clinical evidence to support the replacement of frequently-touched equipment, furniture and fittings in the healthcare environment with those incorporating antimicrobial copper to reduce bioburden and therefore reduce the risk of transmission of infection.

Copper and its alloys are easy to form into long-lasting products, suitable for service in the healthcare environment. Whole-life costs are comparable with other materials and products are fully recyclable and therefore contribute to sustainable design. Alloys that look like stainless steel are available, although the distinctive golds and bronzes can provide a highly visible statement that an additional measure is being taken to reduce the risk of HCAs. A wide range of products is available and, as industry responds to the growing demand, this is set to become more extensive.

The use of copper for touch surfaces is not a substitute for standard hygiene practices and products should be cleaned according to standard procedures, using standard agents. Some surface change will take place but this does not affect efficacy. Feedback from clinical trials is that all users found this acceptable.

The UK clinical trial at Selly Oak Hospital was the first in the world to publish results demonstrating copper's efficacy in reducing microbial contamination in a clinical setting by >90%. This has since been confirmed by other trials around the world, including the US, where preliminary results show an associated reduction in HCAs of >40% with a minimal and cost-effective intervention. This study also highlights the role of the patient environment in the transmission of infection.

Information, training and support is available to all stakeholders, on the supply and demand side, for the manufacture and specification of copper and copper alloy products. An industry stewardship scheme has been established to approve efficacious alloys and applications based on the latest scientific evidence.

Adoption of antimicrobial copper touch surfaces as an additional measure in the fight against HCAs has already started in hospitals and care homes around the world.

2. Introduction

Well before micro-organisms were discovered, the Egyptians, Greeks, Romans and Aztecs used copper-based preparations to treat sore throats and skin rashes, as well as for day-to-day hygiene. Copper was also used to ward off infection in battlefield wounds.

In the 19th century, with the discovery of the cause-and-effect relationship between germs and the development of disease, scientific evidence started to be gathered. In the last few decades, work has been done on the antimicrobial properties of copper and its alloys against a range of micro-organisms threatening public health in food processing, healthcare and air conditioning applications. A summary of the main results is presented here and references are provided.

3. Recent Scientific Evidence

Laboratory Studies

Research has been carried out to determine the survival of different micro-organisms on copper and copper alloy surfaces. Much of this work since 1994 has been carried out by Prof Bill Keevil, Director of the Environmental Healthcare Unit at University of Southampton and the results have been repeated in laboratories around the world. Efficacy against the following key organisms has been shown:

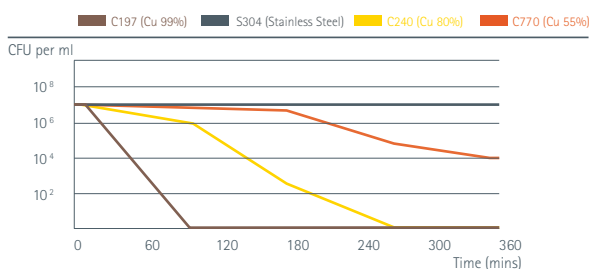
- *Acinetobacter baumannii*
- Adenovirus
- *Aspergillus niger*
- *Candida albicans*
- *Campylobacter jejuni*
- *Clostridium difficile* (including spores)
- *Enterobacter aerogenes*
- *Escherichia coli* O157:H7
- *Helicobacter pylori*
- Influenza A (H1N1)
- *Klebsiella pneumoniae*
- *Legionella pneumophila*
- *Listeria monocytogenes*
- Meticillin-resistant *Staphylococcus aureus* (MRSA, including E-MRSA)
- Poliovirus
- *Pseudomonas aeruginosa*
- *Salmonella enteritidis*
- *Staphylococcus aureus*
- Tubercle bacillus
- Vancomycin-resistant enterococcus (VRE)

Protocol

Small coupons of each alloy were inoculated with bacteria and incubated at either 20°C or 4°C for various time periods. Standard microbiological techniques were used to culture, recover and enumerate the viable bacteria and *in situ* microscopy methods were used to assess membrane integrity and respiration.

This protocol simulates a 'wet' contamination incident, such as a sneeze or wipe. The test has recently been developed to simulate a 'dry' contamination incident (using a lower volume but higher concentration of inoculum).

MRSA viability on copper alloys and stainless steel at 20°C

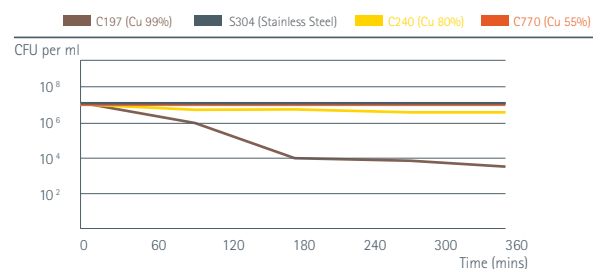


Indicates $p < 0.05$ compared to zero time controls

Results

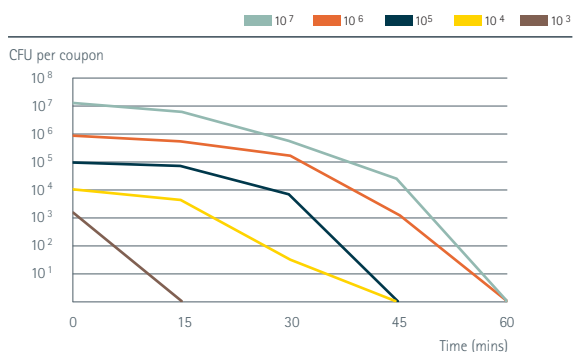
The following graphs show sample data for efficacy of different materials (copper, copper alloys and silver-containing materials) against MRSA. Stainless steel is used as the control. General conclusions for all organisms tested are summarised below.

MRSA viability on copper alloys and stainless steel at 4°C



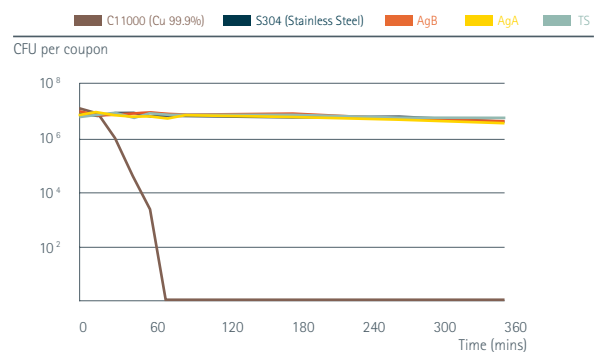
Indicates $p < 0.05$ compared to zero time controls

MRSA viability on copper at 20°C - reduced inoculum



At reduced inoculum challenges, more typical of clinical environments, copper rapidly eliminated MRSA e.g. 10³ CFU in 15 minutes.

MRSA viability on copper and other materials at room temperature and humidity



Under typical indoor conditions, silver coatings (AgA, AgB) and the triclosan coating (TS) behave as the stainless steel control (S30400) - i.e. they show no antimicrobial activity. Copper (C1100) is effective under these conditions, eliminating 10⁷ MRSA in less than 90 mins.

- Results show that bacteria survive on stainless steel for days and are eliminated on 99% copper in less than 90 minutes (10⁷ cfu/coupon) at room temperature.
- The effect is slower at 4°C but still significant.
- Greatest efficacy is seen in alloys with copper contents >60%.
- Reduced inoculum testing shows that, at levels of bacterial challenge typically encountered in the clinical environment (10³ cfu/cm²), kill times were as rapid as 15 minutes.
- Silver- and triclosan-containing coatings behaved as the stainless steel control i.e. showed no antimicrobial efficacy at room temperature and humidity.
- In the 'dry' contamination simulation protocol, under typical indoor conditions, the speed of efficacy is even greater with log 6 reductions of VRE in less than 10 minutes.

Efficacy testing

ISO 22196, based on the Japanese standard JIS Z2801, is most commonly used in the certification of antimicrobial efficacy of hard surfaces, yet this test is carried out at elevated temperature and humidity and so is not an appropriate indicator of efficacy under typical indoor conditions for touch surface applications. The more appropriate US Environmental Protection Agency approved test, carried out at room temperature and humidity, is being developed into a standard by ASTM and also as a British Standard.

Conclusions

Laboratory research on the antimicrobial efficacy of copper has been carried out and verified at institutions around the world, including the UK (Aston University, University of Southampton, Kingston University), US, South Africa, Germany, China and Japan. Results have been peer-reviewed and published.

Kill times vary according to organism, strain, level of challenge, copper content of alloy and temperature - being more rapid at 20°C but still with a considerable effect at 4°C.

Copper exhibits efficacy under typical indoor conditions (humidity and temperature). Silver-containing materials (from two manufacturers) and triclosan behaved as the stainless steel control i.e. showed no antimicrobial efficacy under these conditions.

There is now a solid body of laboratory and clinical evidence to demonstrate rapid, broad spectrum antimicrobial efficacy of copper against the most important pathogens challenging public health. It has been demonstrated that bacteria, viruses and fungi cannot survive on copper surfaces.

US EPA Registration

The Keevil efficacy test was adapted for a US Environmental Protection Agency (EPA)-approved protocol to substantiate claims on antimicrobial efficacy to allow marketing of antimicrobial copper products in the US. Tests were conducted at an EPA-approved GLP (Good Laboratory Practice) Laboratory.

Key features

Three test protocols were established to assess:

- efficacy as a sanitiser
- residual self-sanitising activity
- continuous reduction of bacterial contaminants.

Staphylococcus aureus, *Enterobacter aerogenes*, *Escherichia coli* O157:H7, *Pseudomonas aeruginosa*, MRSA and Vancomycin-resistant *Enterococcus faecalis* (VRE) were deposited on alloys ranging from 60% to 100% copper from two or three separately manufactured batches of each alloy.

Registered claims

Laboratory testing has shown that when cleaned regularly (bacterial claims relate specifically to the organisms tested and to 350 specified alloys with copper content >60%):

- Antimicrobial copper alloys continuously reduce bacterial contamination, achieving 99.9% reduction within two hours of exposure.
- Antimicrobial copper alloy surfaces kill greater than 99.9% of Gram-negative and Gram-positive bacteria within two hours of exposure.
- Antimicrobial copper alloy surfaces deliver continuous and ongoing antibacterial action, remaining effective in killing greater than 99.9% of bacteria within two hours, even after repeated wet and dry abrasion and re-contamination.
- When cleaned regularly, antimicrobial copper alloy surfaces kill greater than 99.9% of bacteria within two hours, and continue to kill more than 99% of bacteria even after repeated contamination.
- Antimicrobial copper alloy surfaces help inhibit the build up and growth of bacteria within two hours of exposure between routine cleaning and sanitising steps.

The EPA requires that the following statement be included when making public health claims in the US related to the use of antimicrobial copper alloys:

The use of a Copper Alloy surface is a supplement to, and not a substitute for, standard infection control practices; users must continue to follow all current infection control practices, including those practices related to cleaning and disinfection of environmental surfaces. The Copper Alloy surface material has been shown to reduce microbial contamination, but it does not necessarily prevent cross contamination.

Conclusions

In the US, antimicrobial products marketed with public health claims must be registered with the EPA. Copper is the first solid material to be registered. Outside of the US, this registration represents an independent, official recognition of the laboratory data presented and provides the quantified efficacy claims applicable to all registered alloys for the organisms tested.

Mode of Action

There are several theories for the mechanism by which copper kills bacteria, including:

- 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
- Degradation of bacterial DNA.

Clinical Research

In 1983, a US physician, Dr Phyllis Kuhn, published a hospital study showing copper's effectiveness in lowering the *E. coli* count on brass doorknobs.

In December 2005, Keevil presented his laboratory findings to the Department of Health and the conclusion was that the evidence was compelling and the next step should be a trial to demonstrate efficacy in a clinical environment. Copper Development Association (CDA) provided an education grant to University Hospitals Birmingham NHS Foundation Trust where Prof Tom Elliott developed a copper clinical trial. CDA worked with the supply chain to provide copper products for the trial and also provided liaison with other clinical trial groups around the world.

Dermatology and neonatal ICU study, Kitasato University Hospital study, Japan

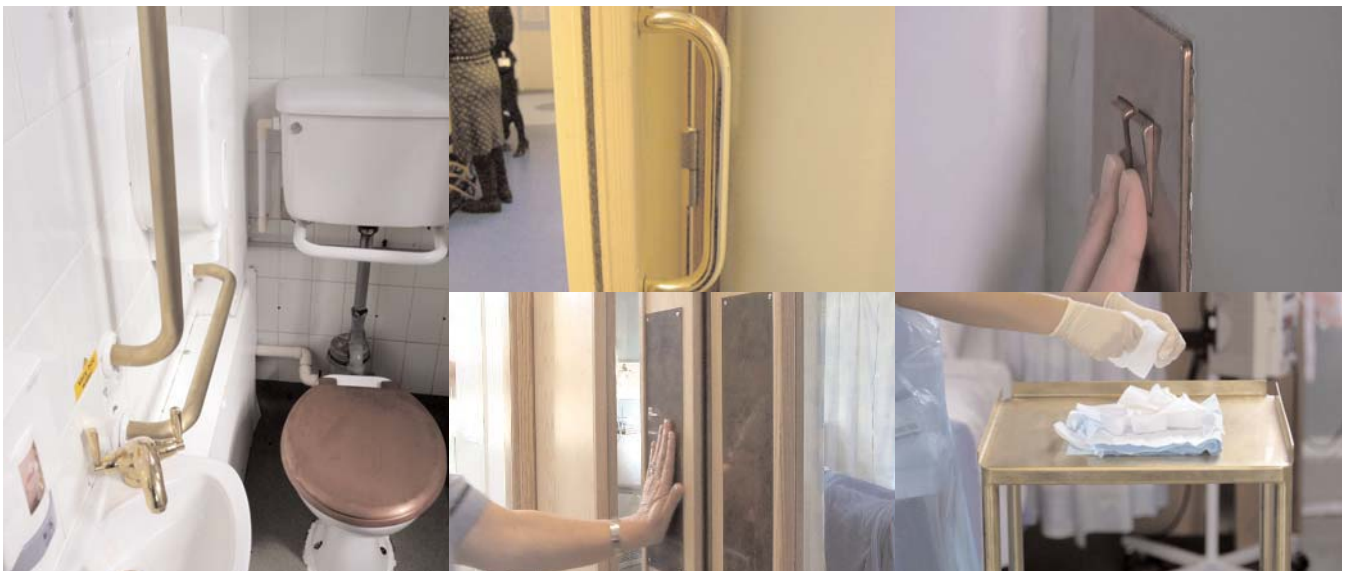
In 2005, selected surfaces on a dermatology ward and the neonatal intensive care unit (NICU) at Kitasato University Hospital in Tokyo were wrapped with copper or brass foil and levels of contamination were monitored on these and control surfaces. It was found that copper alloys had a superior sanitising effect in the hospital environment.

General medical ward study, Selly Oak Hospital, UK

From March 2007 onwards, surfaces identified as 'frequently touched' on a general medical ward were replaced with copper-containing items and the contamination on their surfaces compared to control items on the same ward.

The copper-containing items introduced included grab rails, door handles, door push plates, light switches, taps, over-bed tables, sink traps and toilet seats (see images below and table of components and alloy compositions in Table 1 on page 7).

Below: Installed copper products at Selly Oak Hospital, Ward B4



In the first phase of this study, three items were sampled - taps, door push plates and toilet seats. Sampling took place once a week for five weeks and then copper and control products were swapped over to compensate for any bias of use and sampling continued for a further five weeks. The results show that there was a reduction in contamination of between 90 and 100% on the copper-containing items compared to the controls.

In the second, extended, phase, further products were introduced (including trolleys, light pulls, flush handles, over-bed tables, dressing trolleys and commode chairs) and these were sampled for two three-month periods, with a crossover at the midway point. Results demonstrated lower levels of micro-organisms on the copper compared to the standard surfaces - 8 out of the 14 copper surfaces had significantly reduced bacterial load compared to controls and the other 6 copper surfaces demonstrated a trend towards reduction without reaching statistical significance. Furthermore, copper items were less frequently colonised with VRE, MSSA, MRSA and coliform bacteria compared to control items (significance was not reached with MRSA).

ICU pen audit, Selly Oak Hospital, UK

Two smaller-scale trials were set up to compare the contamination on copper vs stainless steel pens used by healthcare workers at different time points at the end of their shift. The results show that copper pens have significantly reduced contamination compared to the controls.

Outpatient clinic study, US

A study in a US outpatient clinic compared the microbial contamination on phlebotomy chair arms and an associated tray. Results showed the copper significantly reduced the total median burden by 90% on the top surface of the arms and by 88% on the trays.

A 'halo' effect was also observed: a 70% reduction in bioburden on adjacent, non-copper, touch surfaces. The calculated ratio of patients

to the median burden led to the conclusion that the chair with the copper arm tops resulted in a 17-fold lower risk of exposure to environmental microbes than when patients used the standard chair. Similarly, the patients and healthcare workers who used the chairs with copper trays were subjected to a 15-fold lower risk than the patients using chairs with composite trays.

Nursing home study, Finland

A trial conducted at a nursing home, in conjunction with the Helsinki University Department of Public Health, compared contamination on copper vs standard items in patient rooms, bathrooms and communal areas. Copper components included dressing trolleys, door handles, grab rails, handrails, shower drains and push buttons. Results showed higher levels of contamination on the non-copper items and presence of faecal and urinary bacteria, (*Staphylococcus aureus*, *E. coli* and *Candida albicans*) only on stainless steel, plastic and chromium components. On copper and copper alloy surfaces, only Gram-positive bacilli and cocci and normal environmental and skin flora were found.

ICU clinical trial, multi-site, US

The US Department of Defense funded a large-scale 3-centre trial, conducted at 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.

The aim of the study was to assess 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 over-bed 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 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 cm².

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 assessed the incidence of healthcare associated infections in ICU rooms with and without copper products.

The number of copper components in the individual rooms was recorded throughout each patient's stay, e.g. whether or not the patient was in a bed with copper rails (bariatric patients needed special beds which were not available with copper rails).

The preliminary results show that where patients were in a room with 75% of the copper components present (by surface area), they had a 40.4% lower risk of acquiring an infection (N=651, p=0.039). This percentage increased to 61% if the patients were in a 'copper' bed in a copper room (N=541, p=0.006). For patients in a copper room with all copper components present throughout their stay, the risk reduction was 69.1% (N=642, p=0.008).

In summary:

- Non-copper touch surfaces in regularly-cleaned ICUs serve as significant microbial reservoirs that could transfer microbes to patients, healthcare workers and visitors.
- Objects surfaced with copper consistently had bacterial burdens ~97% less than equivalent objects - below the recommended (terminal cleaning) value of 2.5 cfu/cm².
- Virtually no MRSA or VRE were found on the copper surfaces.
- Limited placement of copper surfaces significantly reduced the rates of HCAI in the ICU (by at least 40.4% and up to 69.1%).
- Rate of infection reduction was linked to exposure frequency.
- Built environment is likely to account for at least 50% of ICU HCAs.
- Use of copper surfaces represents the first instance where a 'no-touch', but continuously active antimicrobial material was able to significantly reduce the rate at which infections were contracted by patients.
- Incorporation of copper into essential items within the built environment of hospitals offers a unique solution to control and limit HCAs in an efficient and cost-effective manner.

Other trials

Trials have taken place/are under way in South Africa (led by Prof Shaheen Mehtar, University of Stellenbosch), Greece and also in Chile.

Conclusions

Teams around the world have led clinical trials to assess copper's role in reducing bioburden in the clinical environment and any associated improvement in patient outcomes.

The first published results from the Selly Oak clinical trial show a 90-100% reduction in the contamination on the copper vs control surfaces. The continuous antimicrobial activity of copper surfaces in challenging clinical environments has been confirmed by trials in other parts of the world.

Preliminary data from the first study to assess the impact of replacing key touch surfaces in ICUs with copper, shows an associated reduction in the risk of acquiring an HCAI of >40%.

Table 1: Selly Oak Clinical Trial - Installed Copper and Copper Alloy Components

| Area/fixture | Item/comment | Material | % Copper |
|----------------------------------|------------------------------------|----------------|------------|
| Commode chair | Seat and arm pads, sprayed coating | CuOF composite | 70 approx. |
| Dressing trolley | Frame and trays | CuZn30 | 70 |
| Electrical socket | Back plate | CuZn15 | 85 |
| Grab rails | Brass handle, steel plates | CuZn30 | 70 |
| Light switch | Back plate/switch | CuZn15/CuDHP | 85/99.9 |
| Main door handle | Lever handle | CuSn8 | 92 |
| Main door handle | Back plate and lock | CuETP | 99.95 |
| Overbed table | Work surface | CuDHP | 99.9 |
| Pens | All metal ballpoint | CuZn15 | 85 |
| Pull handle | Long: x 420 mm | CuSn8 | 92 |
| Pull handle | Short: x 230 mm | CuZn39Pb3 | 58 |
| Push plate - main ward door | Large push/kick plates | CuZn30 | 70 |
| Push plate - vertical/horizontal | Small: 75 x 300 mm | CuOF | 99.95 |
| Push plates - cohort ward | Large push/kick plates | CuZn37 | 63 |
| Sinks | All mixer taps | CuZn39Pb1Al | 60 |
| Sluice | Single hot and cold taps | CuZn39Pb1Al | 60 |
| Toilet seat | Sprayed coating | CuOF composite | 70 approx. |
| Toilet cistern lever | Electroplated | CuOF | 99.95 |

4. Practical Aspects of Implementation

Range of Alloys

The materials chosen for clinical trials are those already in common use for other purposes and are readily available to equipment manufacturers supplying healthcare components. They represent a range of compositions based on the US EPA-registered alloys.

Fabricability, Durability and Appearance

Copper alloys, especially brass, have become an industrial standby due to their ease of use and durability. Much equipment is 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 has the potential to allow designers to provide hygienic as well as practicable equipment. Components are familiar, easy to install and have long service lives.

Copper forms an alloy with a number of other elements such as iron, zinc, nickel and aluminium, providing a practical family of alloys with material characteristics that are readily understood by engineering designers. The alloys exhibit a range of colours, again allowing expression of design as well as practicality. Because they are notably different they can potentially provide a mark of change and innovation in healthcare.

Cleaning

The alloys installed for the clinical trials have been subject to the normal day-to-day range of cleaning processes and formulations used throughout the hospitals, including toilet and spillage cleaning. In the case of Selly Oak, apart from the expected mild surface oxidation, there was no severe corrosion observed over the course of 24-36 months.

It has been observed that, if a component is left uncleaned for more than a week, under certain conditions, the surface will change appearance, allowing a visual assessment of cleanliness to be made.

Deep cleaning, with hydrogen peroxide techniques, merely accelerates the usual patination of the alloys, leaving a slight oxide 'bloom' on newly installed equipment.

From recent observations of long-installed brass hardware elsewhere (especially taps and wastes, which have seen the most aggressive environments and cleaning regimes) the brass showed greater longevity than chrome or nickel plating.

Reactions from HCW, Patients and Visitors

From interviews at Selly Oak, the nursing staff were interested and very willing to explain to patients why the ward had copper alloy fittings; they say they were proud to be associated with the trial. Likewise the patients readily accepted that the fittings should be considered and treated as normal. There was no evidence of changed behaviour from these individuals.

Cost

Copper and its alloys are used throughout industry because they offer good value. Most of a component cost comes not from the intrinsic material value, but a combination of fabrication and fitting costs. 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 materials. Installation of a 'ward set' of key touch surface components is relatively easy and can be accomplished without major disruption on the ward.

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 it. In Europe, over 40% of copper needs are met through the recycling route and almost all the brass produced comes from recycled stock.

Design

Copper alloys are considered by many designers as traditional, and component designs often reflect a focus on a nostalgic market. In fact, they provide a great opportunity to design out infection through the use of modern manufacturing technology. The UK still plays an important part in the global industry, providing designs that can best be made using skills and equipment relevant to any country's supply chain. The clean, straight stainless steel design forms that have become so ubiquitous have arisen largely because the early steels were difficult to fabricate.

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 corresponding offices. Globally, there are thousands of suppliers of both raw materials and semi-finished products.

Conclusions

Copper and its alloys are easy to form into durable equipment and fittings suitable for service in the healthcare environment. Components are familiar, easy to install and have long service lives. Products made from solid materials will remain effective in killing germs throughout their lives, even if scratched.

Alloys are available which look like stainless steel, as well as the distinctive golds and bronzes which can provide a highly visible statement that an additional measure is being taken to reduce the risk of HCAs.

Whole life costs are comparable with other materials and products are fully recyclable and therefore contribute to sustainable design. A wide range of products is available and, as industry responds to the growing demand, this is set to become more extensive.

5. Accelerating Adoption

Acceptance

The Department of Health's (DH) fast track initiatives for HCAI control measures are aimed at individual products but not appropriate for endorsing an inherent property of a material. A suite of products (the 'ward set'), with individual components produced by different manufacturers, also falls outside of scope. However, each advancement in scientific evidence has been presented to DH by the lead researchers and there is acceptance that copper can reduce contamination on touch surfaces in a clinical setting. CDA is working with DH to progress the evaluation of copper's potential in healthcare, based on the latest available data on associated reductions in HCAs for the multi-site ICU study.

Since the publication of the bioburden reduction results from the Selly Oak trial, hospitals and care homes in the UK and the rest of the world have started to install antimicrobial copper touch surfaces in small-scale refurbishment projects.

These include a cystic fibrosis unit for young adults at Northern General Hospital, Sheffield, an ICU at Trafford General, Manchester, a care home in Mullingar, Ireland and a multi-generational care home in Laval, France.

Specifying Copper and Copper Alloy Products

As the global industry representative, the International Copper Association (ICA) has developed the Antimicrobial Copper name and Cu+ mark to ensure it addresses its stewardship with regard to the deployment of copper and copper alloys in the field. The use of the Antimicrobial Copper brand and Cu+ mark by an organisation indicates that a Copper Centre, on behalf of the International Copper Association, has granted permission to do so based upon adherence to strict usage rules. These rules guide that organisation's understanding of the underlying technology and the way they promote, advise and deploy it in line with existing research, regulatory and legislative requirements.

Antimicrobial Copper is the umbrella term for all copper alloys with antimicrobial efficacy.

Learning More

CDA is able to offer support by providing speakers and advisors for team meetings, seminars and other events, covering both the science and practical application of antimicrobial copper. All information resources are also accessible online. See back cover for contact and website details.

6. Background Information

Copper Voluntary Risk Assessment

The copper industry initiated a Voluntary Risk Assessment for copper. The assessment process was agreed with the Italian Government's Istituto Superiore di Sanità, acting as the review country on behalf of the European Commission and the EU Member States. The risk assessment has now been completed and one of the main conclusions, accepted by the European Commission and EU Member State experts, is 'the use of copper products is in general safe for Europe's environment and the health of its citizens.'

About Copper Development Association (CDA)

CDA is a not-for-profit, membership-based organisation which supports and promotes the correct and efficient use of copper and its alloys through the provision of technical support and impartial information to professionals, end users and students. CDA is part of a global network of 28 Copper Centres with a regional office in Brussels, European Copper Institute, and headquarters in New York, International Copper Association, Ltd. (funder of the University of Southampton research on antimicrobial copper).

CDA provided an education grant to University Hospitals Birmingham NHS Foundation Trust where Prof Tom Elliott developed a clinical trial. CDA worked with the supply chain to provide copper products for the Selly Oak trial and also provides liaison with other clinical trial groups around the world.

7. Key Recent References

Efficacy – Laboratory Studies

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