Antimicrobial Copper

Making a material difference to Healthcare

HEI, London

02/12/2015
Agenda

- Prevalence & Cost of HCAIs
- The role of the environment in acquisition of infection
- High-priority (high risk) touch surface items
- Why copper? What is Antimicrobial Copper?
- Research and Evidence
- Cost / Benefit
HCAIs / HAIs - Healthcare-Associated Infections

Average HCAI Prevalence 2011

Up to 51% prevalence in ICUs within EU countries

WHO - European Health for All Database (HFA-DB)
HCAIs in **Europe** – the grim facts

Per annum...

- Over **4.1 million** patients affected
- **16 million** extra days in hospital
- Additional **€7 billion** direct costs
- **37,000** deaths directly caused by HCAIs
- Additional **110,000 deaths** where HCAIs a contributory factor

WHO - European Health for All Database (HFA-DB)
HCAIs / HAIs / Nosocomial Infections: in the US

35m US patients hospitalised per annum:

- ~ 1 in 20 acquire infection
- ~ 1 in 20 infected die from that infection

Approx 1 in 400 risk of death from HAI in US
350 US patients die every day from HCAIs
The Role of the Environment

Current thinking: **touch surfaces play major role** in spread of infection:

- Pathogens can survive for a long time on standard surfaces
- A contaminated hand spreads pathogens to the next seven surfaces touched
- A single contaminated doorknob or elevator button can spread virus rapidly through entire office buildings, hotels or hospitals
- Increased bed occupancy rates influence HCAI incidence in ICUs
- Patients admitted to a room where an infected patient stayed face greater risk of acquiring that infection.
- There is a correlation between HCAI rates and microbial bioburden in ICU rooms
- Microbial Bioburden → environmental 'Reservoirs of infection' ...but also contributes to development of Antimicrobial Resistance
Cleaning is Not Enough

- Even after cleaning, a surface may not be microbiologically clean
- Inert surfaces give no protection against recontamination after cleaning
- Dirty hands contaminate cleaned surfaces, and vice-versa.

Wilks et al, 2006; Barker et al, 2004; Boone & Gerba, 2007
Copper touch surfaces are an additional infection prevention measure
### High-Risk Touch Surfaces

<table>
<thead>
<tr>
<th>Hospital beds</th>
<th>Door handles</th>
<th>Sinks</th>
<th>Toilets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over-bed tables</td>
<td>Push plates</td>
<td>Taps</td>
<td>Dispensers</td>
</tr>
<tr>
<td>IV poles</td>
<td>Visitor chairs</td>
<td>Counters</td>
<td>Trolleys</td>
</tr>
<tr>
<td>Grab rails</td>
<td>Patient chairs</td>
<td>Light switches &amp; sockets</td>
<td>Laundry bins</td>
</tr>
<tr>
<td>Computer input devices</td>
<td>Bedside tables</td>
<td>Call buttons &amp; pull cords</td>
<td>Bins</td>
</tr>
</tbody>
</table>

“Antimicrobial Copper” includes Cu alloys

<table>
<thead>
<tr>
<th>Copper</th>
<th>Admiralty Brass</th>
<th>Aluminum Bronze</th>
<th>Copper Nickel</th>
</tr>
</thead>
<tbody>
<tr>
<td>CW024A</td>
<td>CW706R</td>
<td>CW307G</td>
<td>CW352H</td>
</tr>
<tr>
<td>Red Brass (90/10)</td>
<td>Phosphor Bronze</td>
<td>Silicon Aluminum</td>
<td>Copper Nickel</td>
</tr>
<tr>
<td>CW501L</td>
<td>CW452K</td>
<td>CW115C</td>
<td>CW354H</td>
</tr>
<tr>
<td>Brass (85/15)</td>
<td>Phosphor Bronze</td>
<td>Silicon Bronze</td>
<td>Nickel Silver</td>
</tr>
<tr>
<td>CW502L</td>
<td>CW453K</td>
<td>CW116C</td>
<td>CW409J</td>
</tr>
<tr>
<td>Brass (80/20)</td>
<td>Aluminum Bronze</td>
<td>Silicon Bronze</td>
<td>Nickel Silver</td>
</tr>
<tr>
<td>CW503L</td>
<td>CW303G</td>
<td>CW65500</td>
<td>C76500</td>
</tr>
<tr>
<td>Cartridge Brass</td>
<td>Aluminum Bronze</td>
<td>Silicon Manganese</td>
<td>Tin Bronze</td>
</tr>
<tr>
<td>CW505L</td>
<td>CW62400</td>
<td>Aluminum Brass</td>
<td>CB480K</td>
</tr>
<tr>
<td>Yellow Brass</td>
<td>Aluminum Bronze</td>
<td>Manganese Bronze</td>
<td>Aluminum Bronze</td>
</tr>
<tr>
<td>CW507L</td>
<td>CW62500</td>
<td>CW67500</td>
<td>CB331G</td>
</tr>
</tbody>
</table>

The range of self-coloured alloys enables good variety of aesthetics: *does not have to “look like copper”*
“Antimicrobial Copper” alloys are....

- **Solid materials** - the antimicrobial properties last the lifetime of the product, unlike coatings.
- **Continuously active**, rapidly reducing pathogens.
- **Completely safe** for humans.
- **Easy to clean**, compatible with standard hospital cleaning.
- **Very durable**.
- **100% recyclable**.
- **Familiar every-day materials**, used for centuries.
- **Available in a range of colours** including copper, gold, silver and bronze.
Proof

Lab Testing:
• over 30 years of research
• ~200 published papers showing copper's efficacy:
  ✓ Rapid kill
  ✓ Broad-spectrum
  ✓ Multi-modal, complete kill – including DNA/RNA & plasmids

Clinical Trials
• ~40 clinical studies in differing healthcare settings
• >80% microbial bioburden reduction on copper items

ICUs in 3 medical centres, copper vs standard control rooms
• 83% bioburden reduction
• 58% reduction of HCAIs
Research conducted around the world

Jörg Braun  
Prof. Dr. med.

J. Robert Cantey  
M.D.

Panos Efstathiou  
M.D.

Tom Elliott  
M.D.

Bruce E. Hirsch  
M.D.

Shaheen Mehtar  
M.D.

Cassandra Salgado  
M.D.

Takeshi Sasahara  
Ph.D

Michael G. Schmidt  
Ph.D.

Bill Keevil  
Ph.D.
1983: first results from a modest study

Brass Lockset

72 hours after inoculation with E. coli: Little bacterial contamination

Stainless Steel Lockset

72 hours after inoculation with E. coli: Heavy bacterial contamination

Source: Doorknobs: A Source of Nosocomial Infection? by P. J. Kuhn, Diagnostic Medicine
Nov/Dec 1983
MRSA “wet touch” test: rapid kill on copper

Note: Inoculum was approximately 10 million CFUs. This graph simulates a wet contamination incident such as a sneeze. Research simulating a dry touch shows a much faster kill.

MRSA on C110 and S304: 8 Inoculations Over 24 Hours

CFU

25,000,000

20,000,000

15,000,000

10,000,000

5,000,000

0

0

3

6

9

12

15

18

21

24

Time (hours)

C110

Stainless Steel

‘Moist’ recontamination test: copper continues to kill bacteria at the same rate

Note: Each inoculum was approximately 1 million CFUs, suspended in a 20 microlitre droplet.

Source: www.epa.gov/pesticides/factsheets/copper-alloy-products.htm
No other material comes close to Antimicrobial Copper’s performance

$10^7$ challenge of MRSA on Copper, Silver-ion containing Material, and Stainless Steel at $20^\circ$C and 50% RH

Subsequent *dry contamination* testing against bacteria show even faster kill rates\(^1\)

Rapid kill of Vancomycin-resistant Enterococcus faecalis - VRE

[Graph showing the decline in cfu per coupon over time for Copper and Stainless steel.]  

**Source:** Mechanism of Copper Surface Toxicity in Vancomycin-Resistant Enterococci following Wet or Dry Surface Contact. S. L. Warnes and C. W. Keevil. APPLIED AND ENVIRONMENTAL MICROBIOLOGY, Sept. 2011.
Laboratory studies around the world confirm rapid and broad-spectrum efficacy

<table>
<thead>
<tr>
<th>Year</th>
<th>Highlight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>Legionella</td>
</tr>
<tr>
<td>2000</td>
<td>E. coli</td>
</tr>
<tr>
<td>2006</td>
<td>MRSA</td>
</tr>
<tr>
<td>2007</td>
<td>C. difficile (including spores)</td>
</tr>
<tr>
<td>2007</td>
<td>Influenza A (H1N1)</td>
</tr>
<tr>
<td>2008</td>
<td>USA EPA registration of &gt;300 alloys against 6 bacteria</td>
</tr>
<tr>
<td>2009</td>
<td>Vancomycin-resistant Enterococci</td>
</tr>
<tr>
<td>2011</td>
<td>Rapid dry kill – MRSA/VRE</td>
</tr>
<tr>
<td>2012</td>
<td>Prevention of horizontal gene transfer</td>
</tr>
<tr>
<td>2013</td>
<td>Norovirus</td>
</tr>
<tr>
<td>2015</td>
<td>Coronavirus</td>
</tr>
</tbody>
</table>

Organisms tested:
1. Acinetobacter baumannii
2. Adenovirus
3. Candida albicans
4. Campylobacter jejuni
5. Clostridium difficile
6. Enterobacter aerogenes
7. Escherichia coli O157:H7
8. Helicobacter pylori
9. Influenza A (H1N1)
10. Legionella pneumophila
11. Listeria monocytogenes
12. Klebsiella pneumoniae
13. MRSA
14. Mycobacterium tuberculosis
15. Poliovirus
16. Pseudomonas aeruginosa
17. Salmonella enteritidis
18. Staphylococcus aureus
19. Tubercle bacillus
20. Vancomycin-resistant enterococcus (VRE)
   + many more

Source: www.antimicrobialcopper.com/uk/scientific-proof.aspx
Rapid action mechanisms mean bacteria unlikely to develop resistance to copper touch surfaces

Mode of action

A: Copper dissolves from the copper surface and causes cell damage

B: The cell membrane ruptures, and cell contents “leak out” onto the copper surface

C: Copper ions induce the generation of oxidative stress, which causes further cell damage

D: Bacterial DNA is degraded, making it highly unlikely that resistance can develop

Note: multi-modal MOA means bacteria are highly unlikely to develop resistance to copper

Independent clinical trials conducted at multiple locations around the world

Source: www.antimicrobialcopper.com/uk/scientific-proof/clinical-trials.aspx
Department of Defense study, 3 US hospitals

Components upgraded to Antimicrobial Copper:

1. Bed rails
2. Over bed Tables
3. IV Poles
4. Nurse Call buttons
5. Arms of visitor chairs
6. Computer input devices

Copper components *in situ* at Memorial Sloan Kettering Cancer Center

Other sites: Medical University of South Carolina, Ralph H Johnson VA Medical Center
US Clinical trial results showed 83% reduction of bioburden on copper objects.

Sustained reduction of microbial burden on hospital surfaces through introduction of copper.

Copper surfaces reduced the rate of HCAIs in the ICU by 58%

Rooms without copper surfaces

Rooms with copper surfaces

HCAIs: 8.43%

58.1% reduction ($p=0.013$)

HCAIs: 3.4%

Link between environmental bioburden and acquisition of HCAIs reported

89% of HCAIs occurred among patients in rooms with a bioburden > 500 cfu/100cm²

The Business Case for Copper

An Economic Evaluation of the use of Copper in Reducing the Rate of Healthcare Associated Infections in the UK
Model Inputs

The purpose of this sheet is to set up the model for the appropriate hospital setting. The typical number of patients entered in the cells shaded in green. Whether or not copper items will be introduced to general wards, ICU or a specific pathogen in the model can be entered in the appropriate green shaded cell.

<table>
<thead>
<tr>
<th>Model Input</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of beds in unit</td>
<td>20</td>
</tr>
<tr>
<td>Average length of stay in ICU (days)</td>
<td>5.7</td>
</tr>
<tr>
<td>Average length of stay ward/single room (days)</td>
<td>3.0</td>
</tr>
<tr>
<td>Calculated number of patients per year (Cohort)</td>
<td>1,200</td>
</tr>
<tr>
<td>Yearly change in number of patients</td>
<td>0%</td>
</tr>
</tbody>
</table>

Setting: ICU

Infection to be included in the model: All Healthcare Associated Infections

Currency: Euro (€)
## Example: 20 bed ICU, new build, UK

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of beds</td>
<td>20</td>
<td>Single room configuration.</td>
</tr>
<tr>
<td>Number of patients per annum</td>
<td>1,200</td>
<td>Based on an average stay of 6 days (Edbrooke 2011).</td>
</tr>
<tr>
<td>Infection rate (all HCAIs)</td>
<td>25%</td>
<td>27.1% in Cairns 2010. 23.4% in English National Point Prevalence Survey on Healthcare, Health Protection Agency (2012).</td>
</tr>
<tr>
<td>Cost per HCAI</td>
<td>£6,000</td>
<td>Negriini (2006) reported the average cost per patient-day over 75 UK ICUs was $1,512 (£1,000) and an HCAI results in an additional 6 days. While the model allows for costs of subsequent outpatient and GP visits to be taken into account, these are not considered here.</td>
</tr>
<tr>
<td>Items to be upgraded to copper (or antimicrobial copper alloy)</td>
<td>6 critical items: IV drip pole, Bed rails, Computer input device, Nurse call button, Over-bed table, Visitor chair</td>
<td>Schmidt MG. Copper Touch Surface Initiative. Microbiology and Immunology. Medical University of South Carolina, Charleston, USA, BMC Proceedings 2011, 5(Suppl 6):053 (Oral presentation delivered at 1st International Conference on Prevention and Infection Control, June 29-July 2, 2011, Geneva, Switzerland). Sustained Reduction of Microbial Burden on Common Hospital Surfaces through Introduction of Copper, Michael G Schmidt et al, Journal of Clinical Microbiology, July 2012, Vol 50, No 7. This study was conducted in single-room ICUs. Other key touch surface replacements are also available - such as door handles, push plates, taps - that comply with current hospital regulatory requirements, and have been identified as high risk touch surfaces in other clinical areas.</td>
</tr>
<tr>
<td>Cost of intervention</td>
<td>£30,600</td>
<td>This is the cost difference between copper and standard, non-antimicrobial components, using early market prices. As this example is based on a new build or planned renovation, installation costs would be similar and have therefore not been considered.</td>
</tr>
<tr>
<td>Reduction in HCAIs post intervention</td>
<td>20%</td>
<td>Copper Surfaces Reduce the Rate of Healthcare-Acquired Infections in the Intensive Care Unit, Cassandra D Salgado et al, Infection Control and Hospital Epidemiology, May 2013, Vol 34, No 5. This study demonstrated a 58% reduction in infections in ICU rooms equipped with copper. The example below uses a conservative figure of 20%.</td>
</tr>
</tbody>
</table>
## Example: 20 bed ICU, new build, UK

5 Year Results

Using the above inputs, the model yields a return on investment of less than two months. The cost of copper components is £105,000 compared to £74,400 for standard items. There were 1,200 infections in the copper group and 1,500 in the baseline. This results in a cost per infection averted of £102.00. The model calculates additional benefits including bed days freed and Quality-Adjusted Life Years. To download the model visit [www.antimicrobialcopper.com/uk/why-antimicrobial-copper/the-business-case.aspx](http://www.antimicrobialcopper.com/uk/why-antimicrobial-copper/the-business-case.aspx) or email info@copperalliance.org.uk.

<table>
<thead>
<tr>
<th></th>
<th>Copper</th>
<th>Baseline</th>
<th>Incremental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cost (excluding cost of infections)*</td>
<td>£105,000</td>
<td>£74,400</td>
<td>£30,600</td>
</tr>
<tr>
<td>Number of infections</td>
<td>1,200</td>
<td>1,500</td>
<td>300</td>
</tr>
<tr>
<td>Cost per infection averted (excluding cost of infections)</td>
<td></td>
<td></td>
<td>£102.00</td>
</tr>
<tr>
<td>Total QALYS gained</td>
<td></td>
<td></td>
<td>107.40</td>
</tr>
<tr>
<td>Cost per QALY</td>
<td></td>
<td></td>
<td>£284.92</td>
</tr>
<tr>
<td>Cost of infections*</td>
<td>£7,200,000</td>
<td>£9,000,000</td>
<td>-£1,800,000</td>
</tr>
<tr>
<td>Total cost of intervention*</td>
<td>£7,305,000</td>
<td>£9,074,400</td>
<td>-£1,769,400</td>
</tr>
<tr>
<td>Cost per infection averted</td>
<td></td>
<td></td>
<td>Dominant *</td>
</tr>
</tbody>
</table>

*These are direct costs to the hospital (no GP costs or societal costs have been included in the model)

<table>
<thead>
<tr>
<th>Number of bed days saved per year</th>
<th>360</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost per bed day saved per year</td>
<td>£85.00</td>
</tr>
</tbody>
</table>

The number of bed days saved per year is 360, which would allow an increased capacity in the ICU of 63 beds with a typical length of stay of 5.7 days.

**Return on investment**

- *< 2 months*

The cost of the copper upgrade is £105,000 compared to £74,400 for installation of non-copper items. There were 1,200 infections in the copper group over the period and 1,500 in the baseline. This results in a cost per infection averted of £102.00.

[www.antimicrobialcopper.org](http://www.antimicrobialcopper.org)
After the initial two months, ongoing cost savings will accrue from the reduction in blocked beds and better-directed staff resources.’

Dr Matthew Taylor
YHEC Director
Antimicrobial Copper has been nominated as an ‘emerging technology to watch’ by key healthcare “watchdogs”

**UK:**
- **EPIC3:** National Evidence-Based Guidelines for Preventing Healthcare-Associated Infections in NHS Hospitals in England
- **SHTG:** Scottish Health Technologies Group

**US:**
- **ECRI:** Top 10 Technology Watch List for the Hospital C-Suite
- **AHRQ:** Understanding the Role of Facility Design in the Acquisition and Prevention of Healthcare-Associated Infections

**Canada:**
- **CNESH:** Top 10 New & Emerging Health Technology Watch List: 2014
Implementation is simple

Many different levels of installation taking place
...from basic handles & switches to large-scale upgrades

Example:
Asklepios Hospital, Germany: a lower patient infection rate observed in wards fitted with copper handles.

“This clinical effect has surpassed my expectations”
- Prof Jörg Braun MD, Chief Physician of Internal Medicine at Asklepios Clinic Wandsbek, Germany.
Benefits & role of Copper in healthcare

- Reduces pathogens on touch surfaces
- Reduces infections
- Saves lives
- Saves £££
- Frees-up beds

= improves efficiency of healthcare

..self disinfecting surfaces, especially copper coated [sic] surfaces, show promise for reducing the bioburden on hospital surfaces and decreasing healthcare-associated infections.” (Weber DJ, 2013)


Further references available www.antimicrobialcopper.com/uk/scientific-proof/scientific-references.aspx
Thank you

Next steps? www.antimicrobialcopper.org

Questions? andrew@act-surfaces.co.uk