Can the use of copper help to prevent infection?

Infection Prevention 2013
1st October 2013, London

Professor Tom Elliott
Consultant Microbiologist / Deputy Medical Director
University Hospitals Birmingham NHS Trust
1.0 Introduction
   ▪ why copper?
   ▪ what is the role of the environment?
2.0 Clinical trials - review and update
   ▪ environmental contamination
   ▪ healthcare associated infections
3.0 Conclusions
Introduction – why copper?
Laboratory studies around the world have confirmed rapid and broad spectrum efficacy

Key reports:

1994  Southampton University: verifying efficacy of copper and copper alloys against Legionella spp

2000  against Escherichia coli

2006  against MRSA

2007  against Clostridium difficile (including spores)

2007  against Influenza A (H1N1)

2008  USA Environmental Protection Agency Registration of about 350 alloys

2009  against Vancomycin-resistant Enterococci (VRE)

2011  against MRSA & VRE to show rapid kill

2012  showing copper stops gene transfer

2013  against norovirus
Microorganisms tested:

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

+ many more
HCAIs – Influence of the environment

There has been limited evidence of the role of environmental microbial contamination in HCAI acquisition

– but that is changing:

- proposals for acceptable levels of microorganisms in the clean environment have been proposed – transferred from the food industry (Mulvey et al., J Hosp Infection 77(2011) 25-30)

- there is an increasing awareness of the role of touch surfaces in transmitting infection, evidenced by an increasing number of research papers on the topic

- Infection Control and Hospital Epidemiology (ICHE) published a Special Topic Issue in May 2013: The Role of the Environment in Infection Prevention
Doorknobs: A Source of Nosocomial Infection?

Kuhn, P. Diagnostic Medicine, Dec 1983. Hamot Hospital, Pennsylvania, USA
cultures from brass door knobs

stainless steel door knobs
From the conclusion:

“If your hospital is being renovated, try to retain old brass hardware or have it repeated; if you have stainless steel hardware, make certain that it is disinfected daily, especially in critical-care areas.

We have known for years that certain metals are toxic to bacteria. It is the application of this knowledge to better infection control that warrants further attention.”
Independent clinical trials have been conducted at multiple locations around the world
Clinical Trials at University Hospitals Birmingham NHS Foundation Trust - UK
Role of copper in reducing hospital environment contamination

A.L. Casey a, D. Adams a, T.J. Karpanen a, P.A. Lambert b, B.D. Cookson c, P. Nightingale d, L. Miruszenko a, R. Shillam a, P. Christian a, T.S.J. Elliott a,

a University Hospitals Birmingham NHS Foundation Trust, The Queen Elizabeth Hospital, Birmingham, UK
b Life and Health Sciences, Aston University, Aston Triangle, Birmingham, UK
c Laboratory of Healthcare-Associated Infection, Centre for Infections, Health Protection England, London, UK

Received 20 March 2009; accepted 28 August 2009

KEYWORDS

The environment may act as a reservoir for pathogens.

The Antimicrobial Efficacy of Copper Alloy Furnishing in the Clinical Environment: A Crossover Study

T.J. Karpanen, PhD∗, A.L. Casey, PhD∗, P.A. Lambert, DSc∗, B.D. Cookson, FRCPath, PhD∗, L. Miruszenko, RGN, T.S.J. Elliott, DSc∗

Objective. To determine whether copper incorporated into hospital ward furnishings and equipment can reduce their surface microbial load.

Design. A crossover study.

Setting. Acute care medical ward with 19 beds at a large university hospital.

Methods. Fourteen types of frequent-touch items made of copper alloy were installed in various locations on an acute care medical ward. These included door handles and push plates, toilet seats and flush handles, grab rails, light switches and pull cord toggles, sockets, overbed tables, dressing trolleys, communodes, taps, and sink fittings. Their surfaces and those of equivalent standard items on the same ward were sampled once weekly for 24 weeks. The copper and standard items were switched over after 12 weeks of sampling to reduce bias in usage patterns. The total aerobic microbial counts and the presence of indicator microorganisms were determined.

Results. Eight of the 14 copper item types had microbial counts on their surfaces that were significantly lower than counts on standard items, but the reduction did not reach statistical significance. Indicator microorganisms were recovered from both types of surfaces; however, significantly lower copper surfaces were contaminated with vancomycin-resistant enterococci, methicillin-susceptible Staphylococcus aureus, and coliforms, compared with standard surfaces.

Conclusions. Copper alloys (greater than or equal to 50% copper), when incorporated into various hospital furnishings and fittings, reduce the surface microorganisms. The use of copper in combination with optimal infection-prevention strategies may therefore further reduce the risk that patients will acquire infection in healthcare environments.
UHB trial environment:

- busy 19 bed acute care “nightingale” ward
- standard cleaning protocols applied throughout the study

Research designed to evaluate:

- reduced contamination levels
- development of resistance to copper
## Results

<table>
<thead>
<tr>
<th>Phase 1</th>
<th>Duration</th>
<th>Sample taken</th>
<th>Primary results</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 items</td>
<td>6+6 weeks</td>
<td>duplicates at 7 am and 5 pm (before first and last</td>
<td>90 – 100% less microbes on copper than controls</td>
<td>9 out of 10 areas</td>
</tr>
<tr>
<td>with crossover</td>
<td></td>
<td>scheduled cleaning)</td>
<td></td>
<td>sampled</td>
</tr>
<tr>
<td>Phase 2</td>
<td>12+12 weeks</td>
<td>duplicates between 2pm and 5 pm (during visiting</td>
<td>all copper items had a lower microbe count than controls</td>
<td>8 out of 14 areas</td>
</tr>
<tr>
<td>14 items</td>
<td></td>
<td>time and before afternoon cleaning)</td>
<td>no resistance to copper was found in MRSA, MSSA, VRE or</td>
<td>sampled</td>
</tr>
<tr>
<td>with crossover</td>
<td></td>
<td></td>
<td>coliform strains recovered from the ward</td>
<td></td>
</tr>
</tbody>
</table>
Contamination or ‘Microbial Burden’ results in Chile

- **Calama, Chile – 2010** (very low daily relative humidity ~8%)
- 180 single rooms in an ICU – 30 weeks

- 49 - 92% less microorganisms on copper items
- Average microbial count was significantly lower in rooms with copper **1,851 vs. 11,620 cfu / 100 cm²**: (p = < 0.00001)

Effectiveness of Copper Contact Surfaces in Reducing the Microbial Burden in the ICU of Hospital del Cobre, Calama, Chile
Contamination or ‘Microbial Burden’ results in USA

- Medical University of South Carolina, USA – 2010
- 59 single bed ICU rooms – 9 weeks
  - 38 – 100% less microorganisms on copper surfaces
  - MRSA and VRE were never isolated from copper objects
  - >87% reduction in total mean bioburden (better than terminal clean)

A Pilot Study to Determine the Effectiveness of Copper in Reducing the Microbial Burden of Objects in Rooms of ICU Patients
Salgado CD et al. Poster 183, 5th Decennial International Conference on Healthcare-Associated Infections, Atlanta, March 29, 2010
Use of copper to prevent spread of MRSA in a dermatology ward in Japan

- Investigated use of bed sheets with a copper coated film
  - tested with heavily MRSA colonised patient
  - standard sheets had 6,600 to 11,000 CFU of MRSA compared to 20 to 130 CFU

Concluded ‘Copper sheets may prevent spread of MRSA contamination in hospital wards’

Use of copper alloy for preventing transmission of MRSA in the dermatology ward.
Clinical studies in USA in three ICUs

- 3 centre study
- Copper items put in eight single rooms and compared to 8 non-copper rooms
- Six items replaced: bed rails, over bed tables, chairs, call buttons, data devices and IV poles
- Patients randomised

**Outcome measures:**
- number of bacteria on surfaces
- patient colonisation by MRSA & VRE
- HCAI rates
Microbial Burden on the three ICU study

- Sampled 6 objects in 16 rooms over 43 months
- After 23 months introduced copper items in 8 rooms
  - Copper objects had a 83% reduction in average microbial burden
    \[ (465 \, \text{v} \, 2,674 \, \text{cfu/100 cm}^2 \, p = <0.0001) \]
- Also sampled copper bed rail for 6.5 hours post cleaning
  - Achieved sustained antimicrobial effect with copper compared to control
    \[ (\text{at 6.5 hours} \, 434 \, \text{v} \, 5198 \, \text{cfu/100 cm}^2 \, p = 0.002) \]

Concluded ‘copper provides a potentially safer environment for patients’


Copper Continuously Limits the Concentration of Bacteria Resident on Bed Rails within the ICU
Schmidt et al. Infect Control Hosp Epidemiol 2013;34(5):000-000
Copper surfaces and HCAIs in the three ICU study

- 294 patients in copper rooms v 320 in standard rooms
- Determined HCAI – including blood stream infections, UTI, pneumonia
- Trend to reduction in HCAI infections
  - 17 (5.7%) v 29 (9.0%) (p= 0.13)
  - reduction in blood stream infections: 3 v 11 (p=0.057)
  - no reduction in pneumonia nor UTI
- On further analysis, a link between microbial burden and HCAI was suggested

Copper Surfaces Reduce the Rate of Healthcare-Acquired Infections in the Intensive Care Unit. Salgado C et al.
ICHE, Vol. 34, No. 5, Special Topic Issue: The Role of the Environment in Infection Prevention (May 2013), pp. 479-486
Significant association between contamination level and HCAI risk \((p=0.038)\) with 89% of HCAI occurring among patients cared for in a room with a burden >500 cfu/100cm\(^2\).
Conclusions of Copper surfaces and HCAI in the ICU study

First clinical study to show possible link between prevention of HCAIs and use of copper in the healthcare environment.

Further studies, appropriately powered, are needed to study the effect of designated copper fomites on specific types of HCAI (e.g. Bloodstream infections)
Conclusions
Overall conclusions of studies - 1

- Results demonstrate that copper offers the potential to significantly reduce the numbers of microorganisms both in *vitro* and in the clinical environment.

- There appears to be a quantifiable link between contamination of the built environment and the risk of HCAIs.
Overall conclusions of studies - 2

- Incorporation of copper into essential items within the built environment of hospitals may offer a unique solution to control and limit HCAIs in an efficient and cost effective manner.

- Additional studies evaluating the critical and optimal placement of antimicrobial copper touch surfaces within the built environment are warranted.
‘We firmly believe that self-disinfecting surfaces such as copper are a significant step forward to reduce infection causing microbial bioloads on clinical surfaces.’

‘We should now ask the question why select a non antimicrobial surface when we now know that naturally occurring metals have this intrinsic antimicrobial activity?’

Worthington et al., Infection Cont Hosp Epidemiology 33; 2012.
Can the use of copper help to prevent infection?

Thank you

QUESTIONS?

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