Antimicrobial Copper Touch Surfaces for Infection Prevention and Control

Copper Development Association
Copper Alliance

Antimicrobial Copper

Content

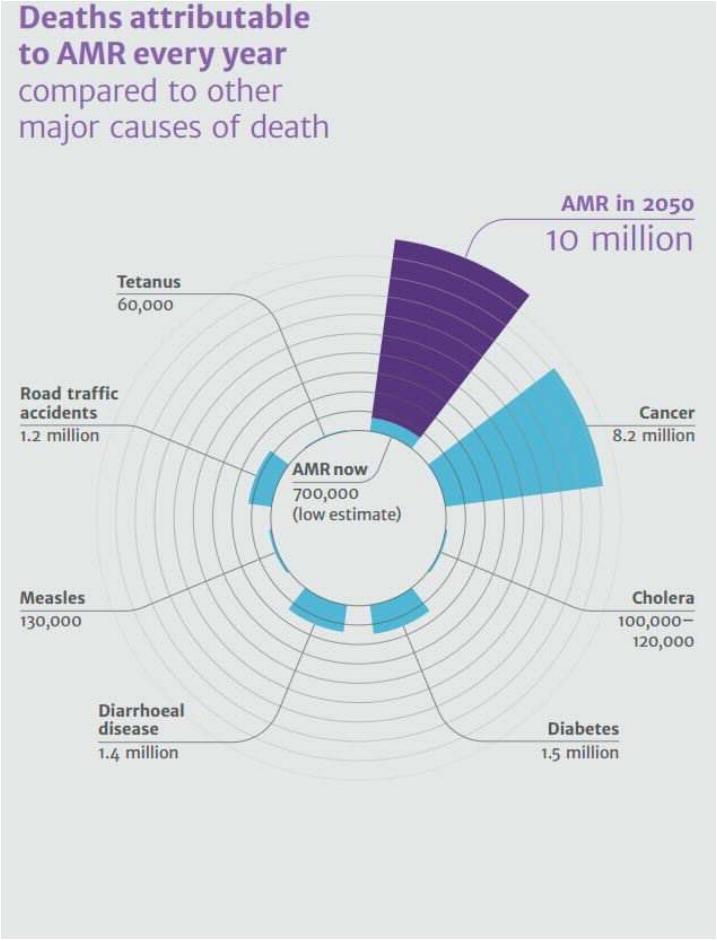
01.00 Introduction

Healthcare-associated infections in Europe

- 7.1% overall prevalence rate – over 4.1 million patients affected
- Up to 51% prevalence in Intensive Care Units (ICUs)
- 16 million extra days in hospital
- Direct costs: €7 billion
- 37,000 deaths directly caused by HCAIs
- Additional 110,000 deaths where HCAIs contributory factor

Source: WHO - The Burden of Health Care-Associated Infection Worldwide – A Summary. 2011
WHO - European Health for All Database (HFA-DB)

Antimicrobial resistance (AMR): a global threat



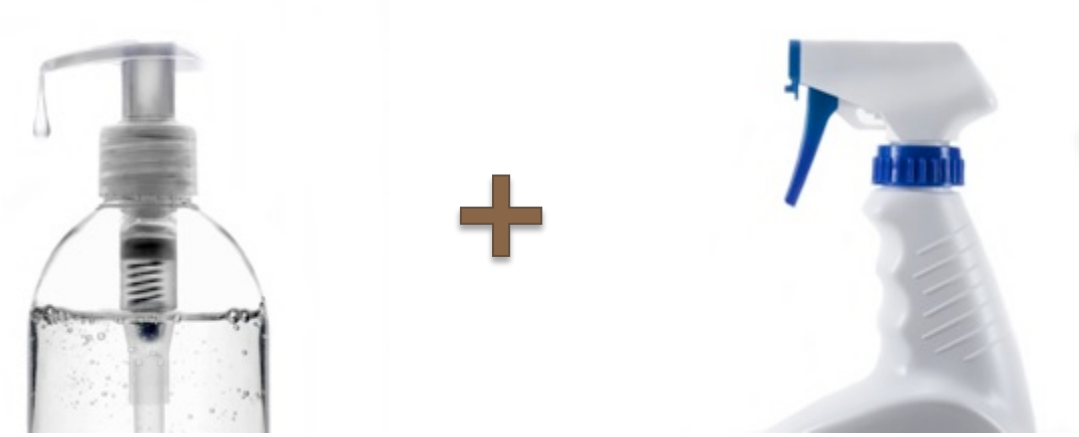
Review on Antimicrobial Resistance. Antimicrobial Resistance: Tackling a Crisis for the Health and Wealth of Nations. 2014.

Tackling the global threat of antimicrobial resistance

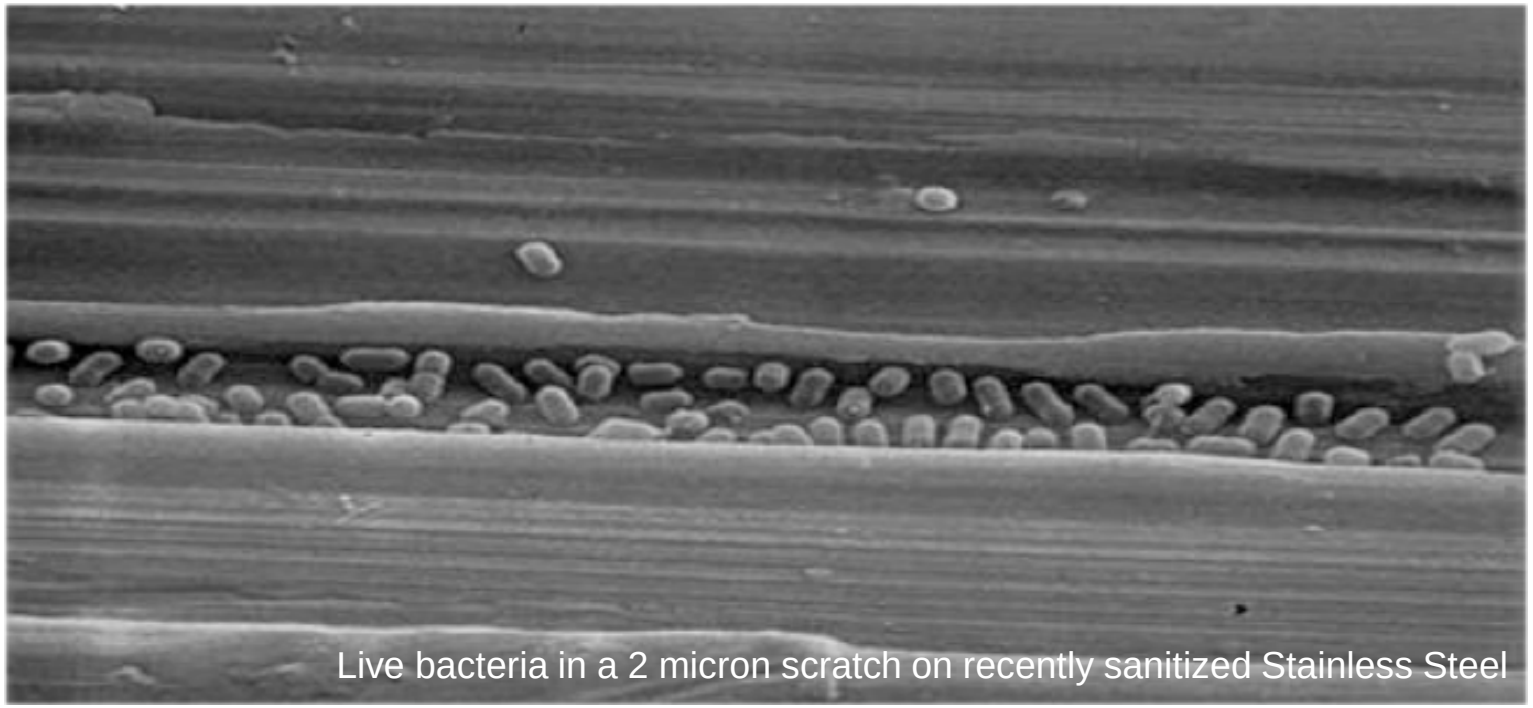
- WHO endorsed a Global Action Plan for tackling antimicrobial resistance
- Preventing infectious disease is one of 5 strategic objectives
- The plan urges assessment of new technologies
- Infection prevention and control is the foundation of preventing AMR according to the CDC

Global Action Plan on Antimicrobial Resistance. (2015.) World Health Organization.

Additional measures are needed



80% of all infectious illnesses are transmitted by touch [1]



Live bacteria in a 2 micron scratch on recently sanitized Stainless Steel

As shown above, even recently-cleaned touch surfaces may not really be clean. Additionally, as a contaminated hand will spread germs to the next seven surfaces touched [2], having an inactive surface offers no protection against recontamination and the spread of microbes.

[1] Tierno, 2001 [2] Barker et al, 2004

Research has been conducted around the world

Jörg Braun
Prof Dr med.

J. Robert Cantey
MD

Panos Efstathiou
MD

Tom Elliott
MD

Bruce E. Hirsch
MD

Bill Keevil
PhD

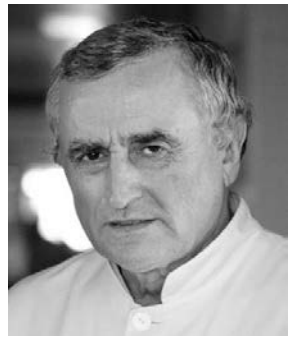
Shaheen Mehtar
MD

Cassandra Salgado
MD

Takeshi Sasahara
PhD

Michael G. Schmidt
PhD

Mark Solioz
PhD



Wojciech Witkiewicz
MD

02.00 Laboratory Science

In 1983 the results of a modest study gave first results

Brass Lockset

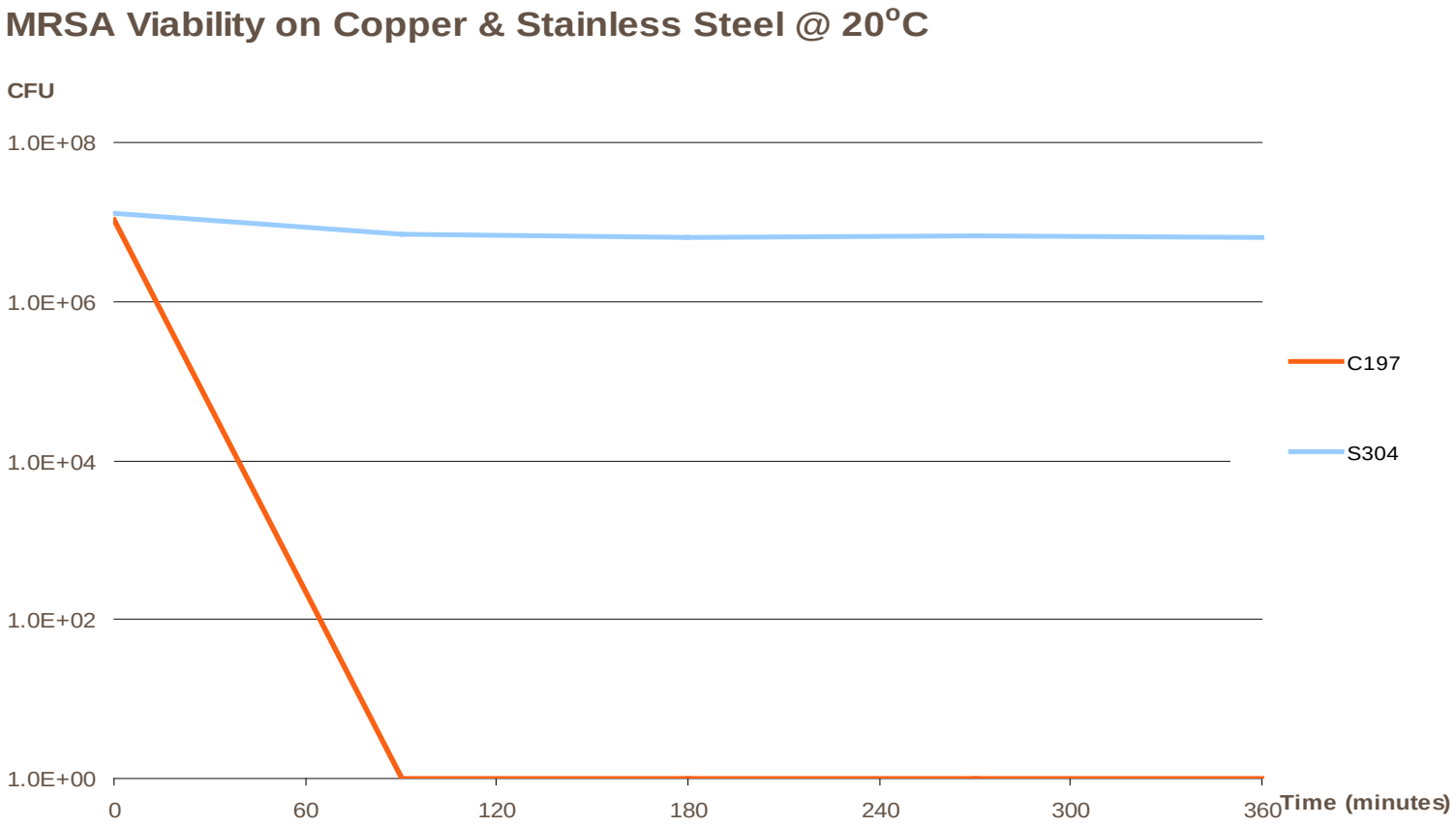
72 hours after inoculation with E. coli:
Little bacterial contamination

Stainless Steel Lockset

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

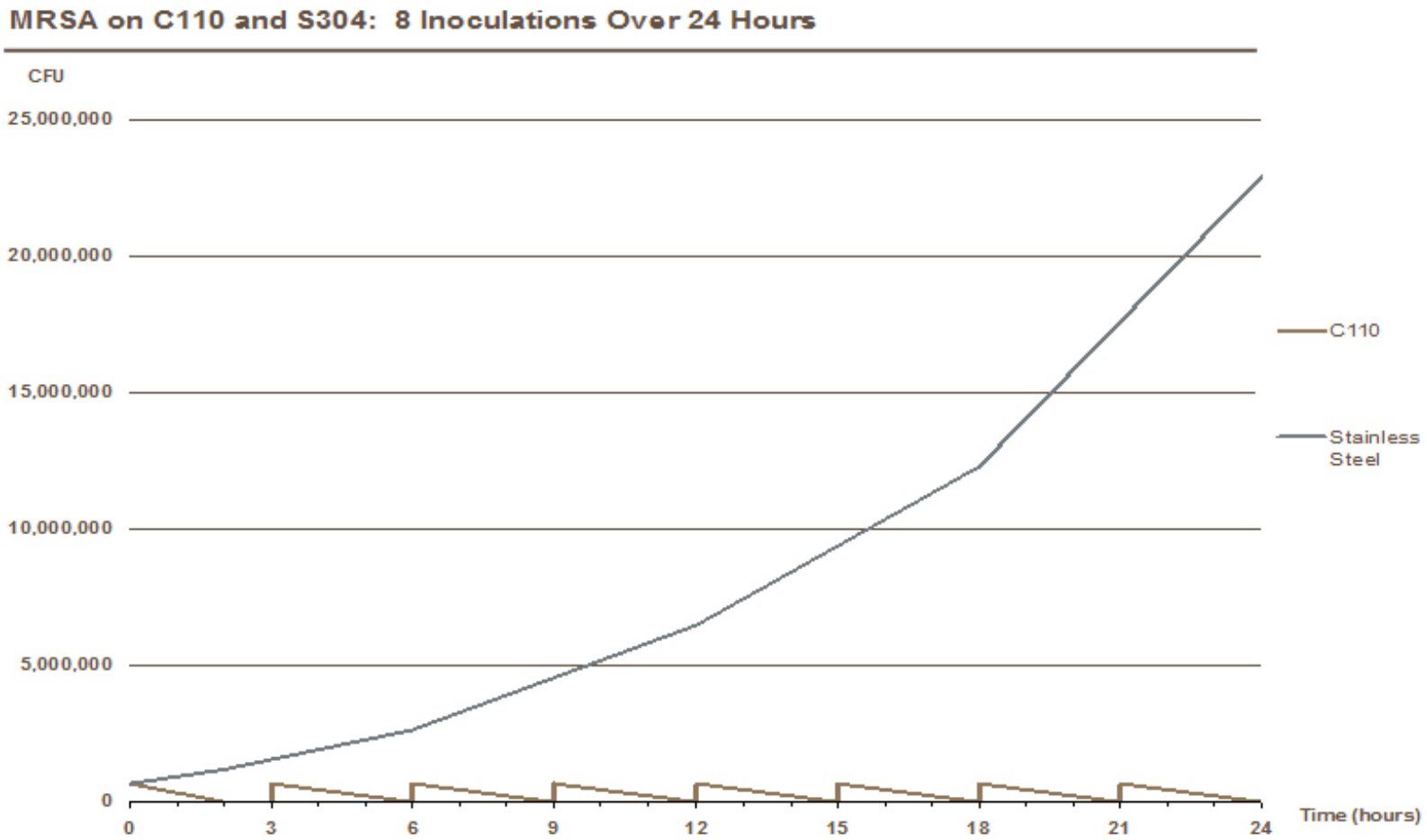
Source: Doorknobs: A Source of Nosocomial Infection? by P. J. Kuhn, Diagnostic Medicine, Nov/Dec 1983

Initial “wet touch” contamination tests showed rapid kill of a high challenge of MRSA by copper



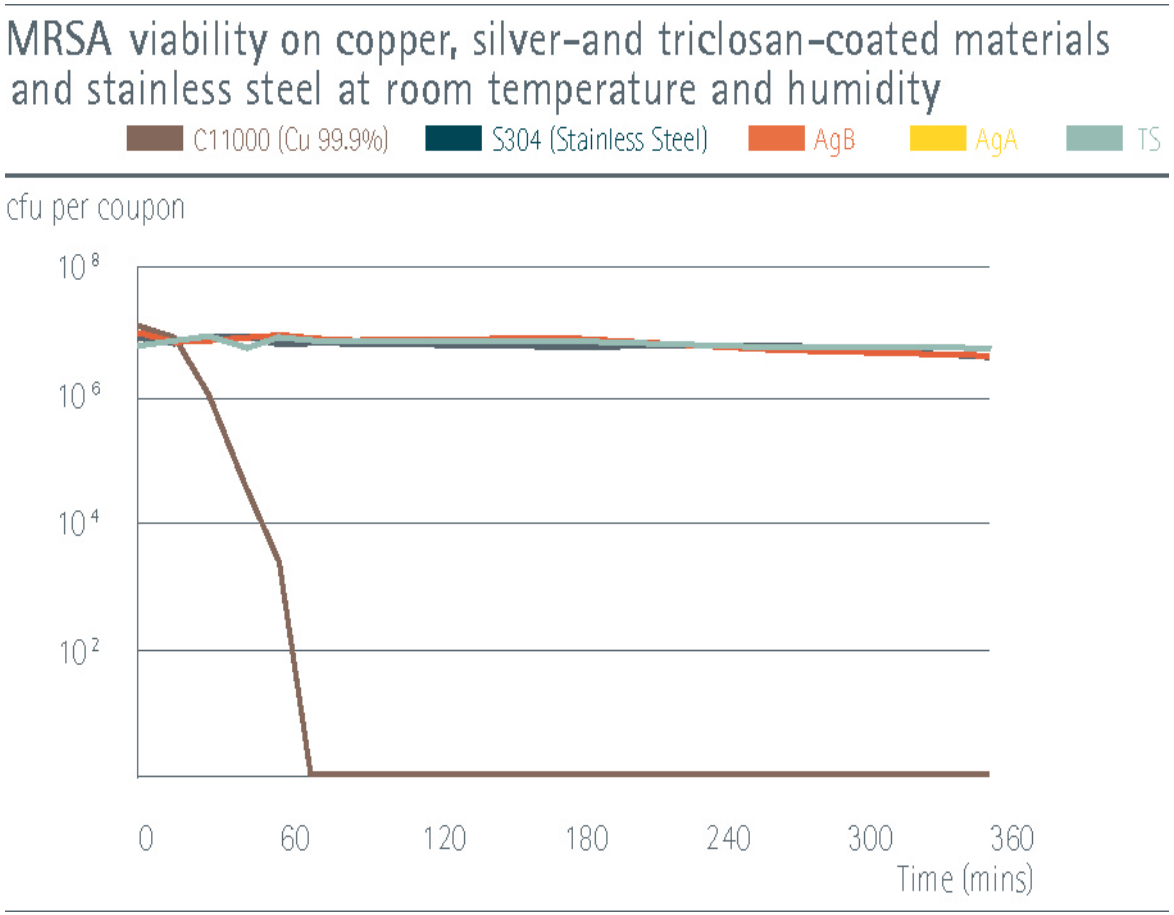
Note: This graph simulates a wet contamination incident such as a splash. Latest research simulating a dry touch shows a much faster kill.

Tests showed that copper continues to kill bacteria at the same rate even after constant re-inoculation



Note: Each inoculum was approximately 1,000,000 CFUs

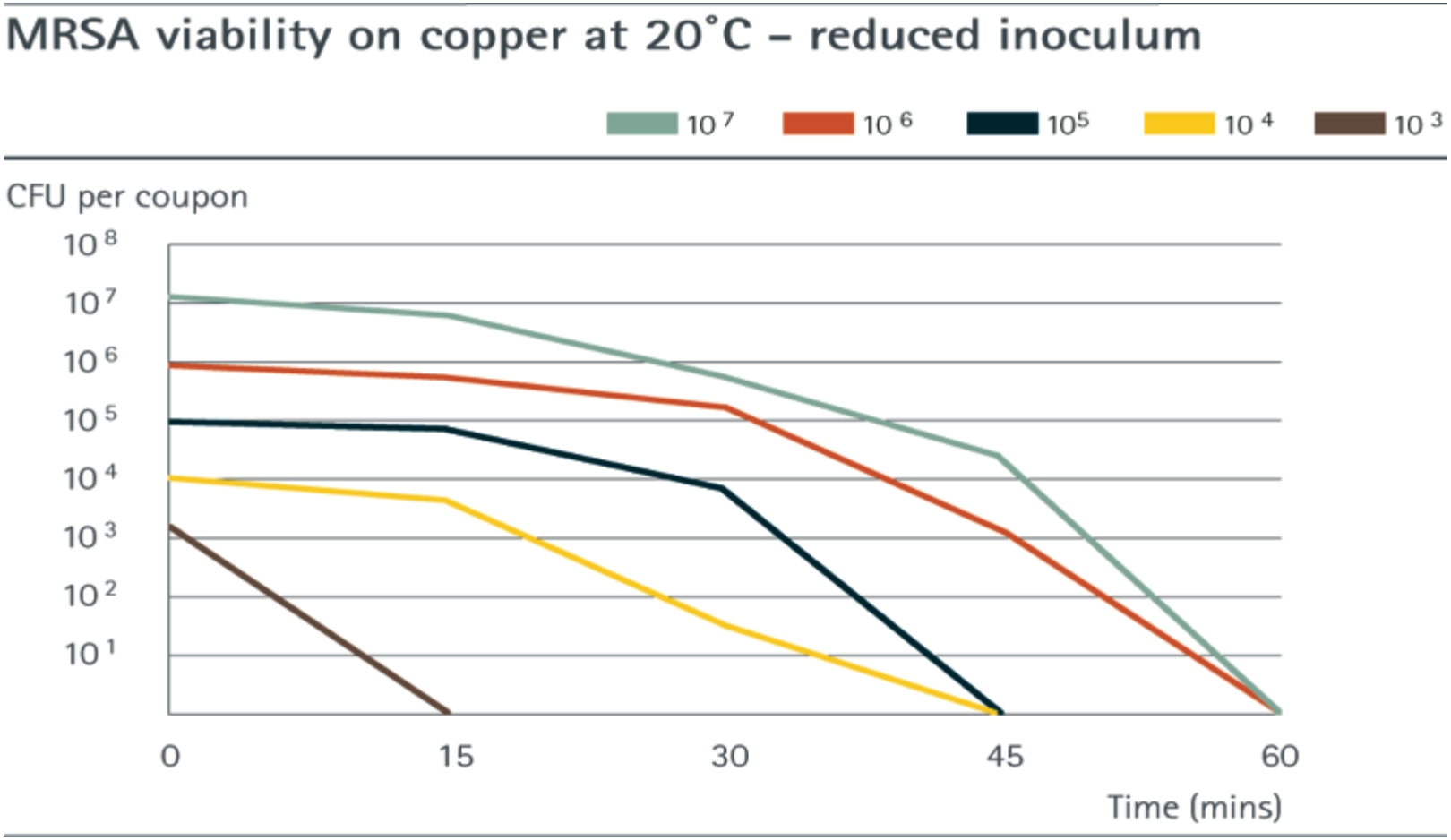
No other material comes even close to Antimicrobial Copper's performance



Antimicrobial Copper is the name given to the range of copper alloys scientifically proven to kill greater than 99.9% of bacteria within two hours.

Antimicrobial Copper Cu+

Kill time depends on the number of organisms that inoculate the surface

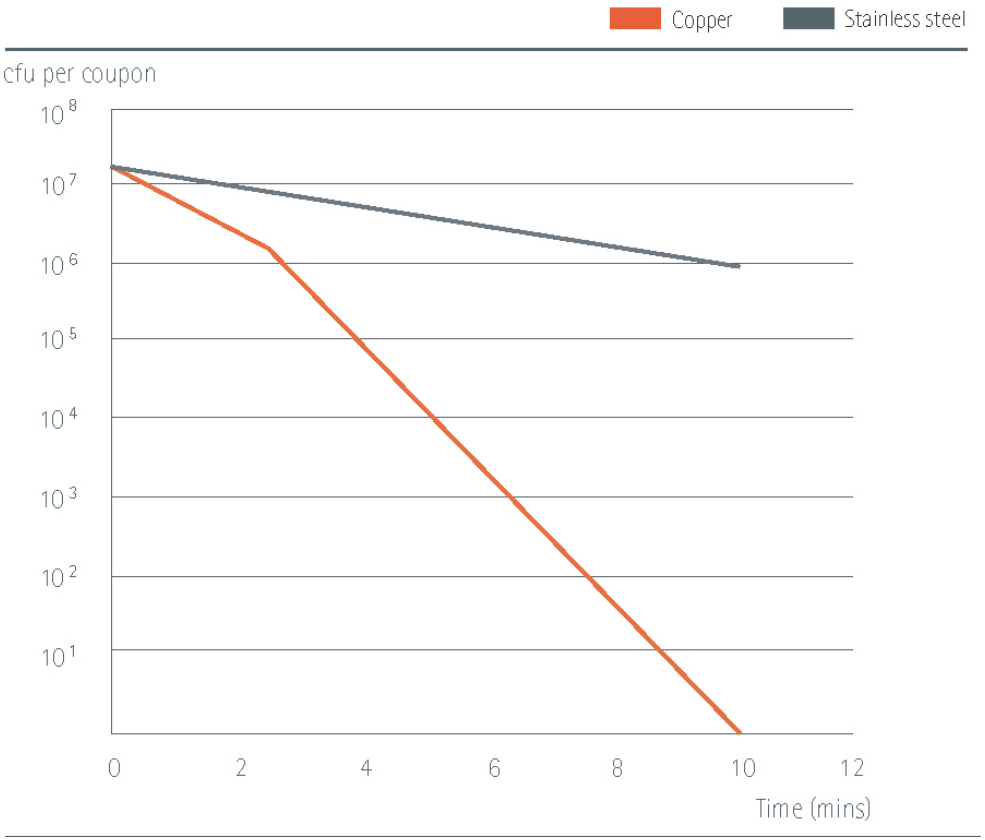


Note: This graph simulates a wet contamination incident. Latest research simulating a dry touch show a much faster kill.

Antimicrobial Copper Cu+

Subsequent dry contamination testing against bacteria have shown even faster kill rates

Rapid kill of Vancomycin-resistant Enterococcus faecalis - VRE



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.

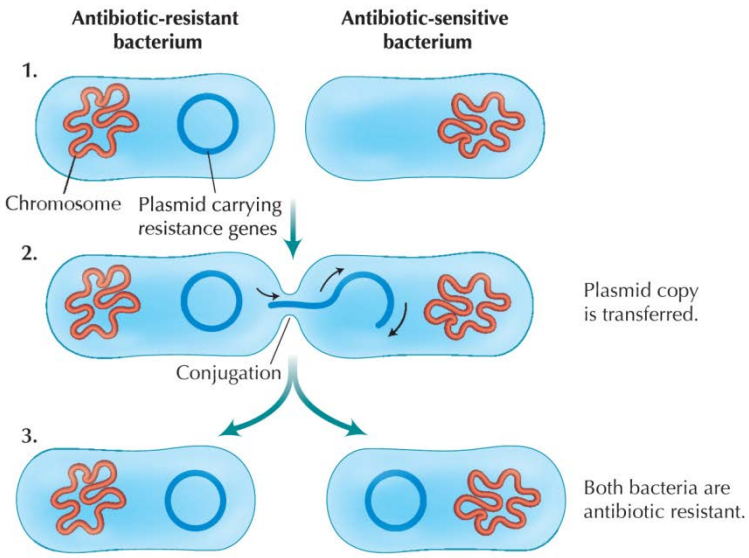
Laboratory studies around the world have confirmed rapid and broad spectrum efficacy

Year	Highlight
1994	Legionella
2000	*E. coli*
2006	MRSA
2007	*C. difficile* (including spores)
2007	Influenza A (H1N1)
2008	USA EPA registration of >300 alloys against 6 bacteria
2009	Vancomycin-resistant *Enterococci*
2011	Rapid dry kill – VRE
2012	Prevention of horizontal gene transfer
2013	Norovirus (murine)
2014	Bacterial and viral biothreats
2015	Coronavirus (human) & Norovirus (human)
2016	Rapid dry kill - MRSA

Organisms tested:

Acinetobacter baumannii
Adenovirus
Candida albicans
Campylobacter jejuni
Carbapenem-resistant Enterobacteriaceae
Clostridium difficile (including spores)
Coronavirus (Human 229E)
Enterobacter aerogenes
Escherichia coli O157:H7
Helicobacter pylori
Influenza A (H1N1)
Klebsiella pneumoniae
Legionella pneumophila
Listeria monocytogenes
Mycobacterium tuberculosis
Norovirus or Norwalk-like virus
Penicilliium chrysogenum
Poliovirus
Pseudomonas aeruginosa
Rhinovirus
Rotavirus
Salmonella enterica
Staphylococcus aureus MRSA/EMRSA/MSSA)
Tubercle bacillus
Vancomycin-resistant enterococcus (VRE)
Vibrio cholerae *+ many more*

Copper prevents spread of antibiotic resistance by horizontal gene transfer



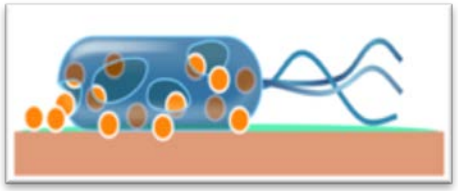
- HGT can take place in the environment, on frequently-touched surfaces such as door handles, trolleys and tables from stainless steel.
- Copper prevents this process from occurring by rapidly killing bacteria on contact and destruction of plasmid and genomic nucleic acid

adapted from Collignon P.J., *Med. J. Australia* **177:** 325–329, © 2002 Australasian Medical Publishing Co.

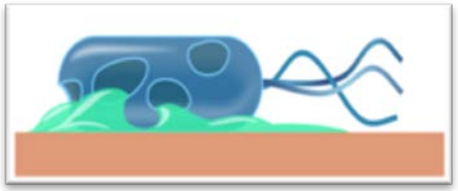
Source: Horizontal Transfer of Antibiotic Resistance Genes on Abiotic Touch Surfaces: Implications for Public Health. SL Warnes, CJ Highmore and CW Keevil. mBio 2012, Vol. 3 No. 6 e00489-12.

Copper's rapid 'contact kill' mechanism makes it unlikely bacteria will ever develop a resistance to copper*

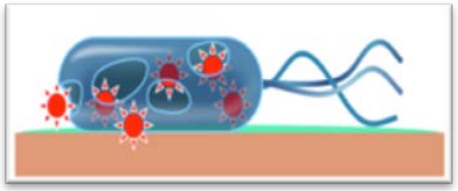
Mode of action



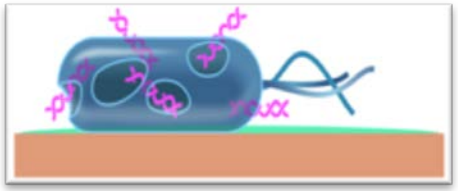
A: Copper dissolves from the copper surface and causes cell damage



B: The cell membrane ruptures, and "leaks out" onto the copper surface



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



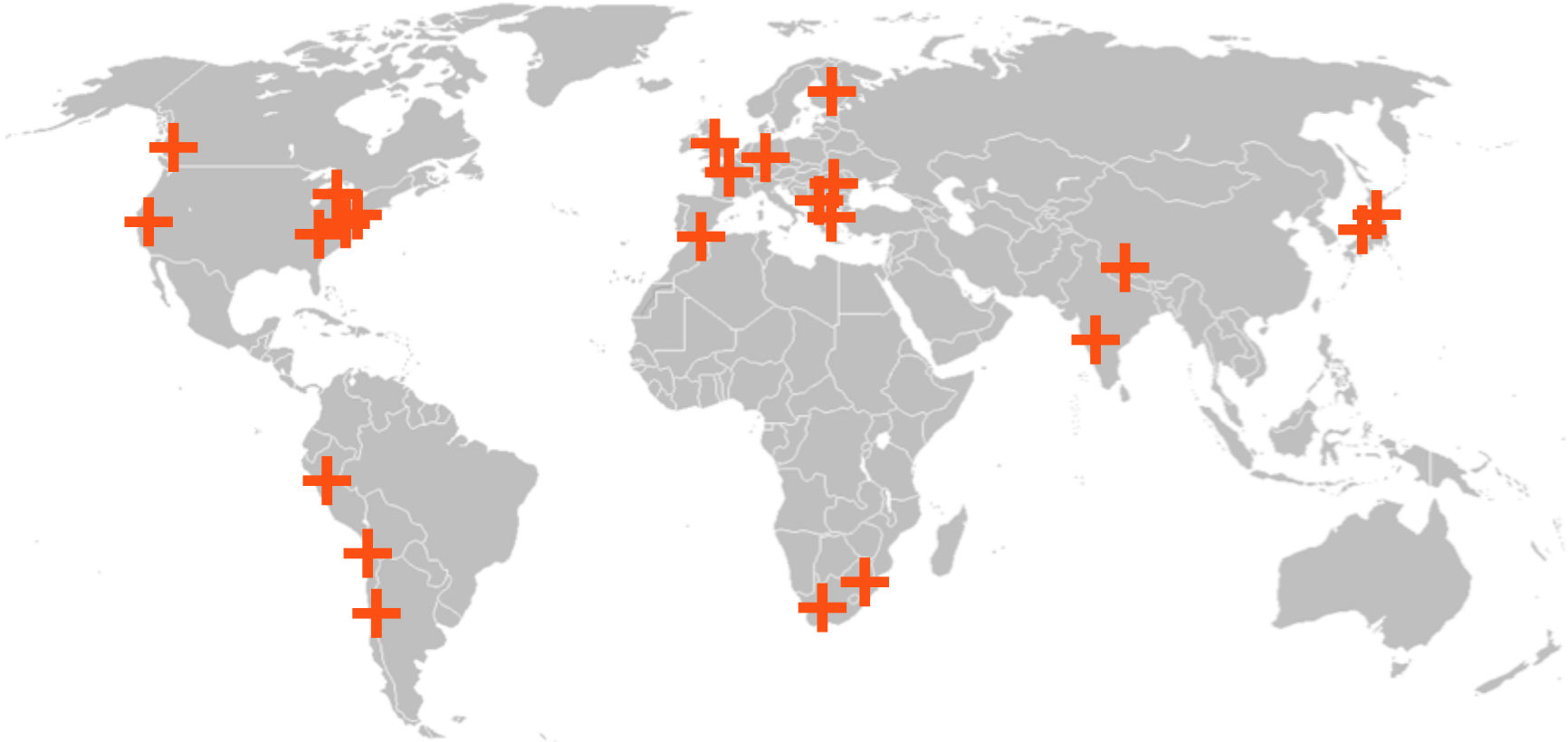
D: Bacterial DNA is degraded making it highly unlikely that resistance can develop

*Dr. Grass, Dr. Keevil, Dr. Rensing & Dr. Solioz

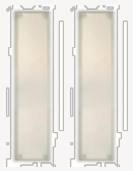
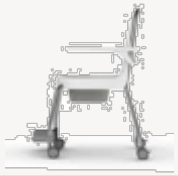
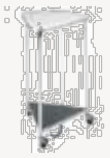
Note: It's important to Note: Mechanism is multi-modal, thus it's highly unlikely that bacteria will ever develop a resistance to copper

03.00 Clinical Evidence

Independent clinical trials have been conducted at multiple locations around the world



The products shown below represent those assessed as high-risk during the trials

Hospital beds *		Door knobs		Sinks		Dispensers	
Over-bed tables *		Door Push Plates		Taps		Toilets	
IV poles *		Visitor chairs *		Counter tops		Trolleys & Carts	
Grab bars		Patient chairs		Computer input devices *		Linen hampers	
Light switches & sockets		Bedside tables		Call buttons & pull cords *		Bins	

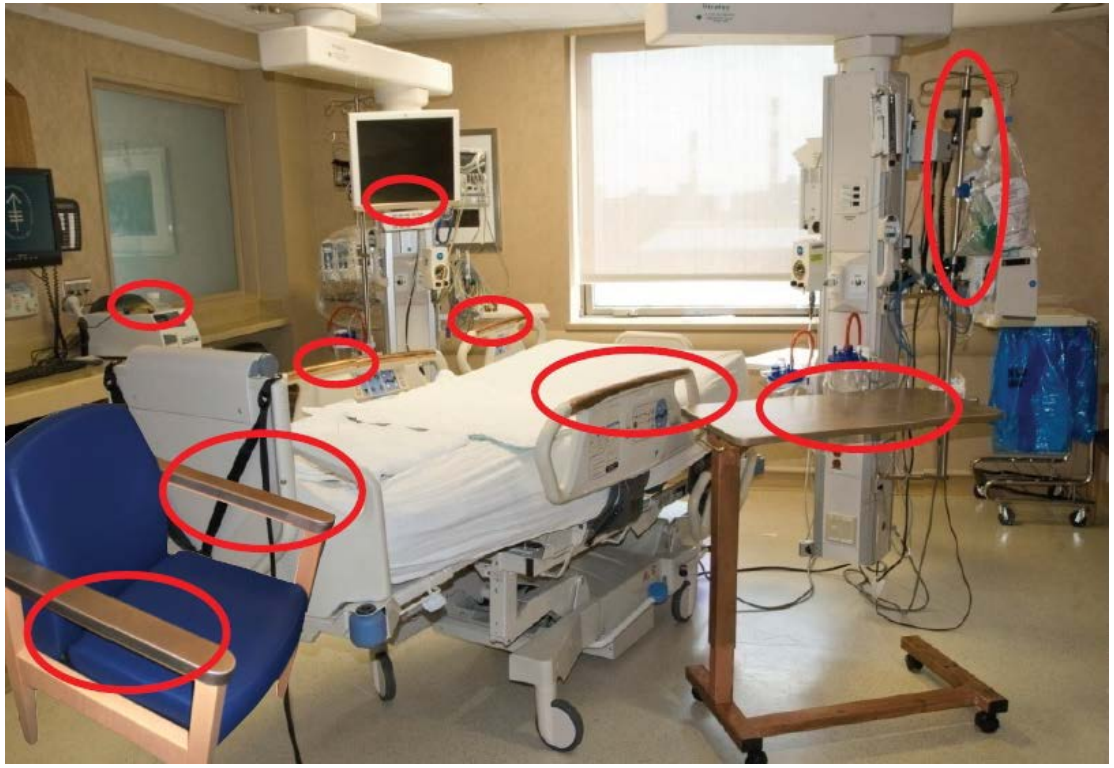
Note: The products shown represent those measured with the highest bioburden during initial trials
Those with * were components upgraded to Antimicrobial Copper in “infection reduction” clinical trials

Selly Oak, Birmingham, UK

- 20 bed “nightingale” general medical ward
- All copper items harboured 90–100% fewer microorganisms (median values) than their control equivalents

Source: Casey AL et al., Role of Copper in reducing hospital environment contamination. J of Hospital Infection 2010; 74, 72 -77

Department of Defense funded study, 3 hospitals, US

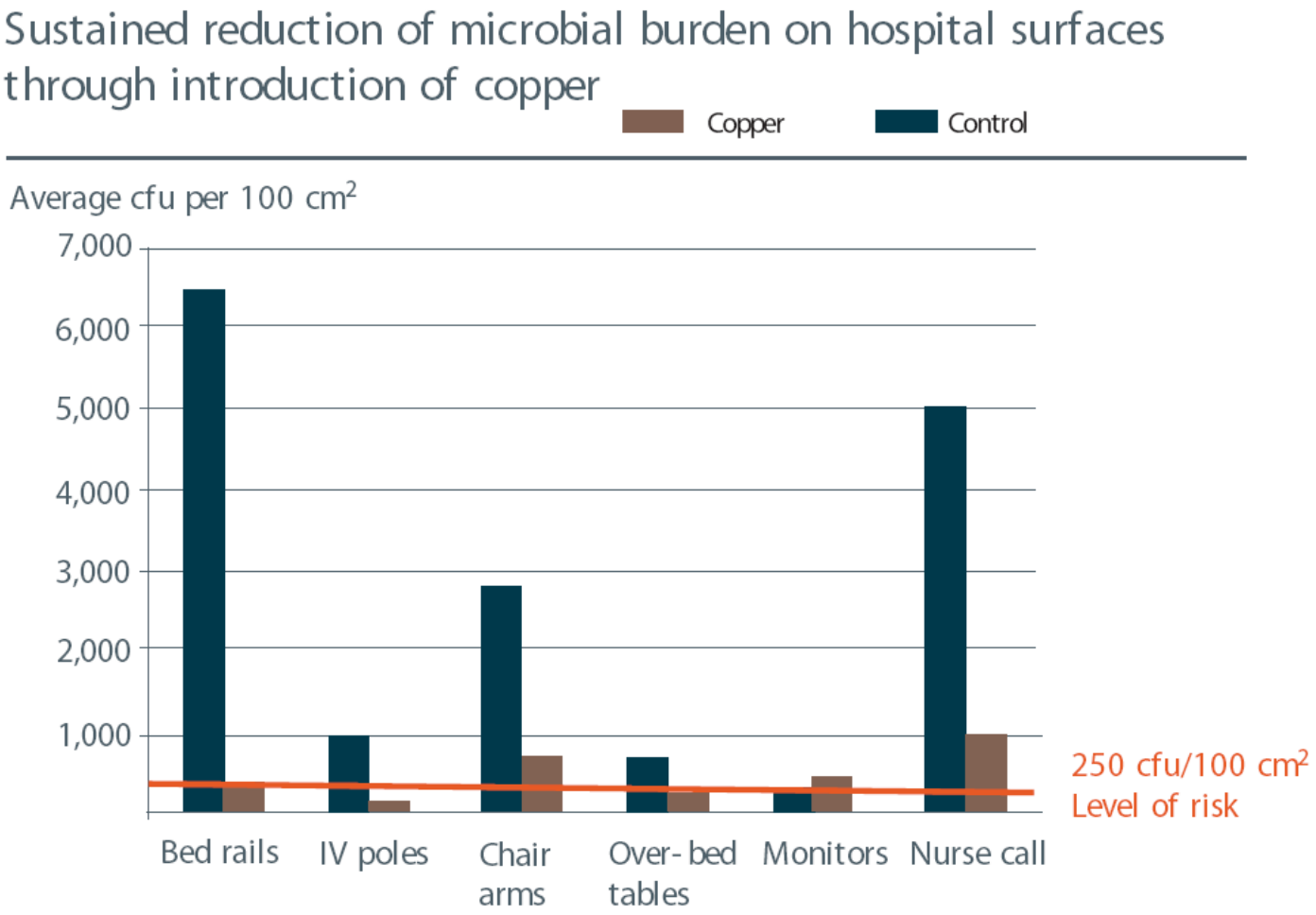


Copper components *in situ*:
Memorial Sloan Kettering Cancer Center

Components upgraded to Antimicrobial Copper:

1. Bed rails
2. Over bed table
3. IV pole
4. Nurse call button
5. Arms of visitor chair
6. Computer input devices

Clinical trial results from the US have shown 83% reduction in bioburden on copper objects*



16 rooms sampled weekly for 21 months, n= 1012 rooms.

Note: virtually no MRSA or VRE were found on any of the copper surfaces

*Schmidt et al ,J Clin. Microbiol. 2012, 50(7):2217

Antimicrobial Copper Cu+

Copper surfaces reduced the rate of healthcare-associated infections in the ICU by 58%

Rooms without copper surfaces

Rooms with copper surfaces

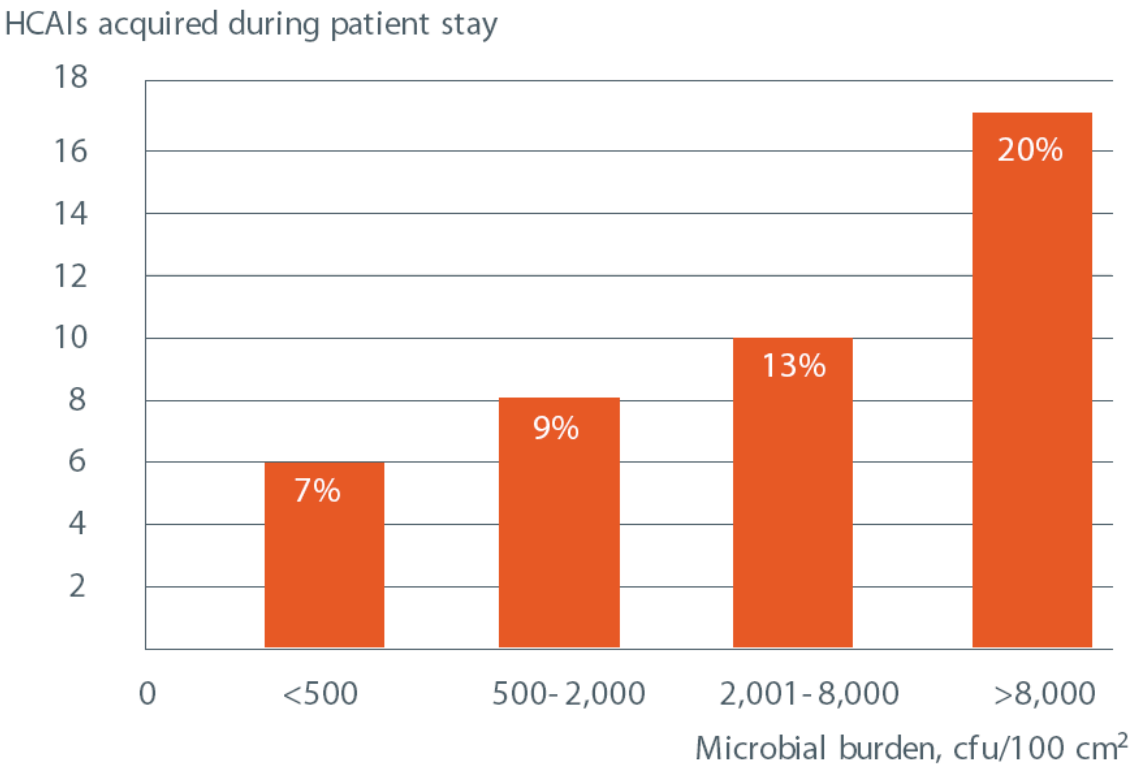
HCAIs: 8.43%

58.1% reduction
(*p*= 0.013)

HCAIs: 3.4%

Link between environmental burden and acquisition of HCAIs reported

Quartile distribution of HCAIs stratified by microbial burden in all rooms (copper and controls)



89% of HCAI occurred among patients in rooms with a bioburden >5 cfu/cm²

Study Conclusions

- In the test ICUs, touch surfaces were shown to serve as significant microbial reservoirs that could transfer microbes between patients, healthcare workers and visitors, despite regular cleaning.
- Objects upgraded with copper or copper alloys consistently had bacterial burdens >80% less than equivalent objects – and below the proposed safe value of 2.5 cfu/cm^2.
- During the course of the two year study, the minimal observed oxidation did not reduce the efficacy of the copper.
- Limited placement of copper surfaces significantly reduced the rates of HCAI (by greater than 50%).
- The copper surfaces were shown to work in tandem with standard infection prevention practices to significantly reduce burden and HCAIs.
- Infection reduction was linked to exposure frequency.
- Use of copper surfaces represents the first instance where an intervention designed to reduce burden has had a clinical impact among ICU patients.

Antimicrobial copper can supplement current practices

- Antimicrobial Copper needs to be seen as a supplement to, not a substitute for, standard infection control practices.
- One must continue to follow all current practices, including those practices related to cleaning and disinfection of environmental surfaces.
- Antimicrobial Copper is compatible with hospital cleaning agents.
- Antimicrobial Copper alloy surfaces must not be waxed, painted, lacquered, varnished, or otherwise coated. The alloys tarnish to varying degrees, which does not impair their antimicrobial efficacy.

04.00 Recognition in Guidelines and Rating Systems

Infection control guidance

Antimicrobial Copper nominated as an emerging ‘technology to watch’ in key healthcare guidelines:

- ***UK:***
  - ***EPIC3****: National Evidence-Based Guidelines for Preventing Healthcare-Associated Infections in NHS Hospitals in England , 2014*
- ***US:***
  - ***ECRI:*** *Top 10 Technology Watch List for the Hospital C-Suite, 2014*
  - ***AHRQ:*** *Understanding the Role of Facility Design in the Acquisition and Prevention of Healthcare-Associated Infections, 2013*
- ***Canada***
  - ***CNESH:*** *Top 10 New & Emerging Health Technology Watch List: 2014*

HPS/NHS Scotland Recommendation

Health Protection Scotland, Literature Review and Practice Recommendations: Existing and emerging technologies used for decontamination of the healthcare environment - Antimicrobial Copper Surfaces, 2017

- Recommendation: ‘Copper alloy environmental and equipment surfaces may be considered for high-touch sites (e.g. bed rails) as an additional measure to supplement existing procedures for routine cleaning but does not replace the requirement for routine cleaning to be performed.’

Health Protection Scotland

NHS National Services Scotland

Healthcare accreditation scheme

Polish Healthcare Quality Monitoring Centre (CMJ, 2016)

- Antimicrobial copper (“copper, brass and bronze”) are specifically mentioned as antimicrobial materials and a higher accreditation score awarded to healthcare facilities installing touch surfaces made from these.

Centrum
Monitorowania
Jakości w Ochronie Zdrowia

WHO Collaborating Centre for Development
of Quality and Safety in Health Systems

US Centers for Disease Control (CDC) checklist of key environmental surfaces

Medical Equipment & Furniture	Fixtures & Fittings	
Bed rails*	Cabinet handles*	Light switches*
Chairs*	Counter tops	Push plates*
Dressings trolleys	Dispensers	Sinks*
Input devices/ nurse call buttons*	Door handles*	Switched sockets
IV poles*	Grab rails*	Taps
Over-bed or tray tables*	Hand rails	Toilet seats and flush handles*

* Included in the CDC Environmental Checklist for Monitoring Terminal Cleaning.

Green, hygienic and well building design guidance

- Indian Green Building Council Green Healthcare Rating System Reference Guidelines, Pilot Version (October 2016)
  - Copper surfaces comply with SH Credit 1: Sanitisation and Hygiene: Infection Control within the Spaces: Antibacterial Surfaces.

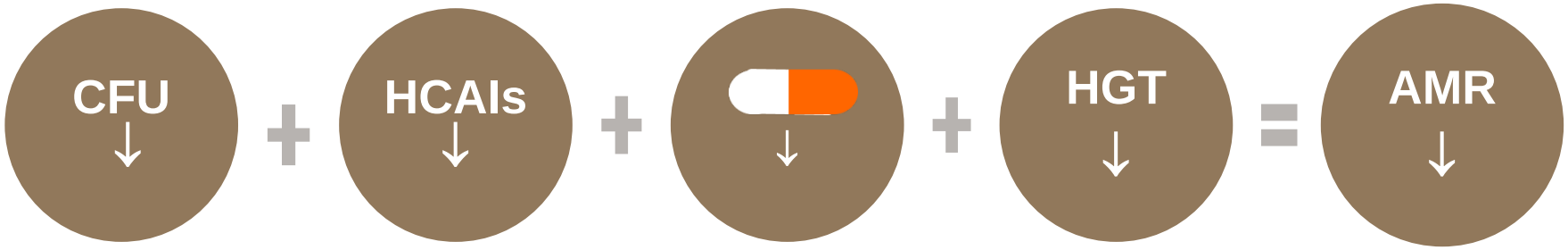
- Finnish Building Information Foundation Indoor Hygiene Environment General Criteria: RT1 – (February 2017)
  - 4. Infection Control Indoors; 4.1 Surfaces, Fixtures and Fittings; 4.1.1 Antimicrobial Materials.

- International WELL Building Certification (2016)
  - Optimisation option for Gold and Platinum level certification: 27 Antimicrobial Activity For Surfaces - Part 1: High Touch Surfaces.
    - High touch surfaces from an abrasion-resistant, non-leaching material that meets EPA testing requirements for antimicrobial activity.

05.00 Tackling Antimicrobial Resistance

Copper's role in tackling antimicrobial resistance

- Copper can help reduce the bacterial load on surfaces
- Copper can help reduce healthcare-associated infections
- Fewer infections means less antibiotic usage
- Copper can prevent the spread of resistance between bacteria by HGT



06.00 Practical Implementation

Many different levels of installation are taking place, from basic handles and switches to larger scale replacement

Example: On wards equipped with copper handles a lowered infection rate in patients was observed in Asklepios Hospital. ‘This clinical effect has surpassed my expectations’ said Professor Jörg Braun MD, Chief Physician of the I. Medical Department at Asklepios Clinic Wandsbek, Germany. The reduction raises hopes that copper based fittings may be a reasonable supplement to existing hygiene measures.

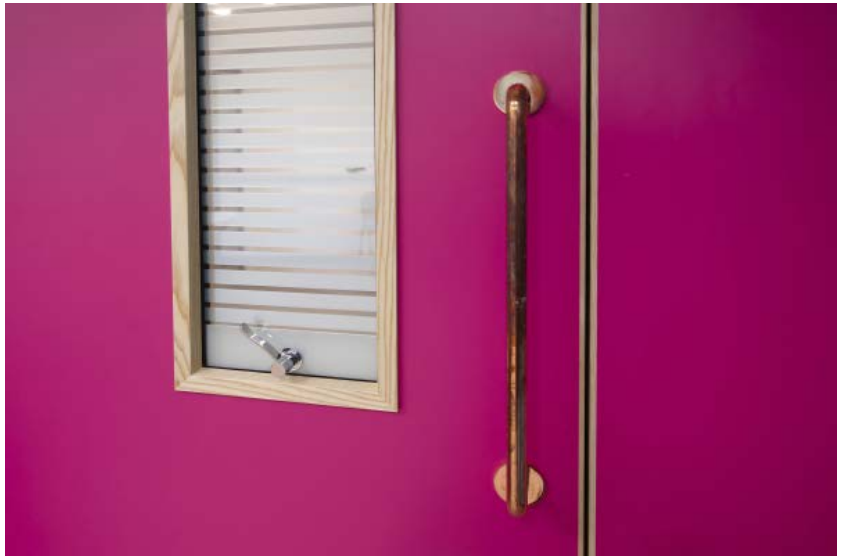
Sir Robert Ogden Macmillan Cancer Centre, Harrogate, UK

Bostonian Clinic, Lincolnshire, UK

- Sleep Clinic Bedroom

Northern General NHS, Sheffield, UK

- Young Adult Cystic Fibrosis Unit



Craigavon Area Hospital, N. Ireland, UK

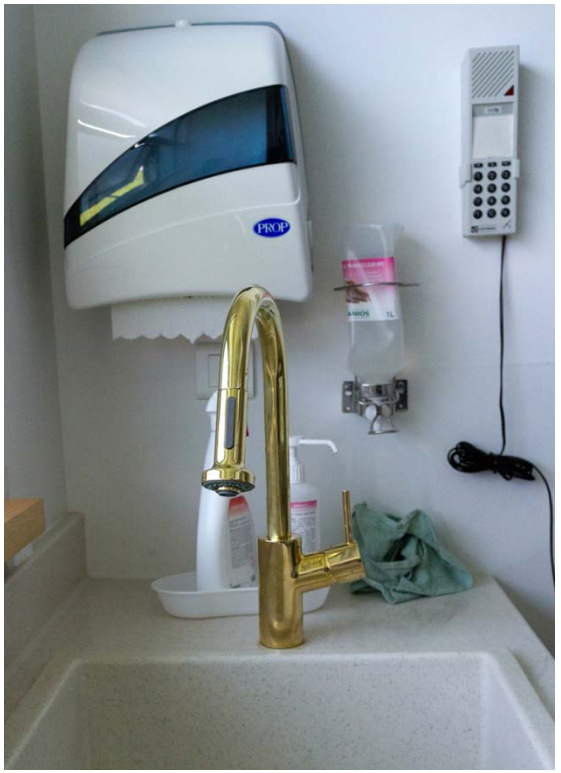
- Maternity and Surgery

CIGMA Centre Inter Générationnel Multi Accueil, France

- Care Home
- Nursery

Rambouillet Hospital, France

- Various departments



Isku-Yhtymä Healthcare Centre, Finland

- Company Medical Centre

Attikon Hospital, Athens

- ICU

Ochiai Clinic, Japan

- Fever Clinic

Ronald MacDonald House of Charleston, USA

Grinnell Regional Medical Center, USA

- Patient bedrooms and bathrooms

Calama Hospital, Chile

- ICU

Roberto del Río Children's Hospital, Chile

- Paediatric ICU

Francis Crick Institute, UK

Industry Stewardship Programme: Cu+ Mark

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 cleanin.g
- Excellent durability.
- 100% recyclable.
- Familiar materials, used for centuries.
- Available in a range of colours including copper, gold, silver and bronze.

07.00 The Business Case

Cost vs Benefit: Return on Investment

The Business Case for Copper

- YHEC - Global leader in healthcare associated modelling
- Model developed to calculate payback for upgrading to copper
- Allows input of local HCAI rates/costs
- Fully referenced model

Example: 20-bed ICU, New build, UK

	Copper	Standard	Copper impact 5 years
Cost of key touch surfaces*	£105,000	£74,400	+£30,600
# HCAIs over 5 years	1,200	1,500	-300
Cost of HCAIs over 5 years	£7,200,000	£9,000,000	-£1,800,000
Cost per infection averted			£102.00
Payback			< 2 months

'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

YHEC
York Health Economics Consortium

US DoD ICU Trial: Time Needed to Recoup the Cost of Antimicrobial Copper Components

Savings achieved by installing copper

Over 338 days:

14 infections prevented @ $28,400 = $397,600

= $1,176 saved per day

Cost of intervention

Additional cost of copper components = $52,000

Payback

= 52,000/1,176

= **44.2 days**

Note: This figure was reached independently of the YHEC Business Case Model and confirms rapid payback.

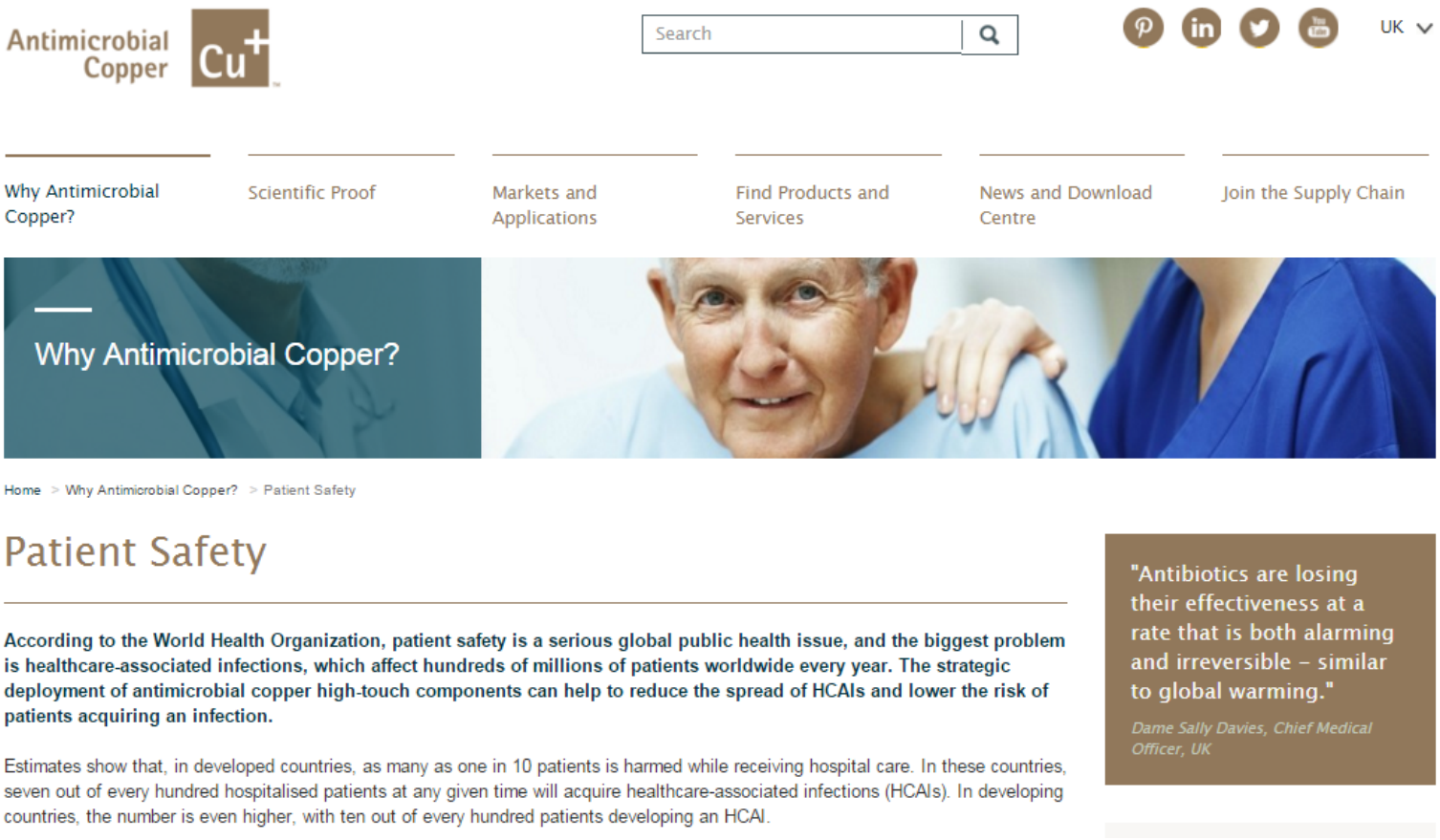
08.00 Conclusions and Further Information

5 Reasons to Install Antimicrobial Copper

- Continuous and significant bioburden reduction
- Improved patient outcomes
- A supplement to standard hygiene practices
- Simple, cost-effective intervention
- Payback in less than one year

Further information

- Visit www.antimicrobialcopper.org



Thank you

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