

<p>Institution: ASTON UNIVERSITY</p>
<p>Unit of Assessment: 3: ALLIED HEALTH PROFESSIONS, DENTISTRY, NURSING AND PHARMACY</p>
<p>Title of case study: 2) ASTON UNIVERSITY'S RESEARCH IMPACTS ON THE CONTROL OF HEALTHCARE-ASSOCIATED INFECTIONS</p>
<p>1. Summary of the impact (indicative maximum 100 words) Research into healthcare associated infections (HAI) at Aston University is led by Professor Lambert, Dr Worthington and Professor Hilton. New strategies to prevent and reduce HAI through a cleaner healthcare environment (antimicrobial surfaces and disinfection) and improved pre-surgical skin antisepsis have been founded on Aston's research in this field since 2007. This work has delivered significant impact on commerce, health and welfare and policy by:</p> <ol style="list-style-type: none"> 1. Influencing practice within the healthcare setting and sales of copper surfaces. 2. Influencing policy changes within healthcare. 3. Prevention of infection rates and improved patient health within the clinical setting. 4. Improving product awareness and licencing within the commercial sector.
<p>2. Underpinning research (indicative maximum 500 words) The following research was undertaken from 2007 by Lambert (Aston, 1980 - date), Worthington (Aston, 2000 - date) and Hilton (Aston, 2000 - date), and was supported by third stream funding and competitively awarded grants through TSB, EPSRC-CASE and the Copper Development Agency. HAI are a significant cause of morbidity and mortality in the UK with a cost to the NHS in excess of £1billion per annum. Strategies to prevent and reduce HAI must target the clinical environment (A), the healthcare worker and the patient (B and C).</p> <p>A. First world-wide clinical trial to assess the efficacy of antimicrobial copper surfaces in infection control Aston University led the first world-wide clinical trial to assess the antimicrobial effects of copper surfaces, carried out on a General Medical Ward at Birmingham's Selly Oak Hospital (2009 - present) (S3.1; S3.2). Touch surfaces e.g. grab rails, door handles, door push plates, light switches, taps, over-bed tables, sink traps, and toilet seats were replaced with those containing antimicrobial copper. With normal cleaning, the copper surfaces achieved a greater than 90% reduction in environmental bioburden compared with standard, non-copper surfaces (S3.1).</p> <p>B. Novel formulation for enhanced pre-surgical skin antisepsis. Approximately 5% of patients develop surgical site infection (SSI) following surgery, mainly due to inappropriate skin antisepsis. Prior to Aston's research, there was no consensus as to which antiseptic formulation should be used in clinical practice. Hence there was a lack of antiseptic standardisation. Laboratory based research at Aston coupled with a 6-hospital multicentre trial (2008 - 2010), focused upon the development and assessment of a novel antiseptic formulation comprising 2% chlorhexidine in 70% isopropyl alcohol (ChloraPrep®). Aston's research investigated the efficacy of ChloraPrep® compared to 10% povidone iodine antiseptic for pre-surgical skin antisepsis and prevention of SSI. The results from Aston's research demonstrated the significantly superior efficacy of ChloraPrep®</p>

Impact case study (REF3b)

in reducing the overall incidence of post-surgical site infection ($p=0.004$). ChlorPrep[®] was significantly more protective than povidone-iodine against both superficial incisional infections (4.2% vs. 8.6%, $p=0.008$) and deep incisional infections (1% vs. 3%, $p=0.05$) (S3.3).

C. Development of novel hard surface disinfectants and biocides for elimination of pathogens from the clinical environment. *In vitro* findings demonstrated that eucalyptus oil contributes to enhanced antimicrobial activity and significantly improves delivery of chlorhexidine into human skin and bacterial biofilms (S3.4). Aston has further developed this novel concept and produced a hard surface disposable disinfectant wipe (2008 - present) for use within the clinical setting. Research on Aston's wipes (EuClean[®]) demonstrates superior antimicrobial killing and penetration into bacterial biofilms compared to wipes currently used within clinical practice (S3.5). *Clostridium difficile* produces resistant spores which contaminate the environment; strategies to control its spread must therefore target the spore. The microbiology team at Aston University is the first group to undertake research (2008 - present) on developing unique strategies to germinate resistant spores of *C. difficile* thus rendering them sensitive to common antimicrobials including alcohol, benzalkonium chloride, tea tree oil and copper (S3.6).

3. References to the research (indicative maximum of six references)

1. Karpanen TJ, Casey AL, Lambert PA, Cookson BD, Nightingale P, Miruszenko L, Elliott TS. (2012) The antimicrobial efficacy of copper alloy furnishing in the clinical environment: a crossover study. *Infect Control Hosp. Epidemiol.* 33(1):3-9. doi: 10.1086/663644, citations 9.
Grant: £60,000; Awarded by Copper Development Agency; Awarded to Lambert (PI); 2010-2012.
2. Casey AL, Adams D, Karpanen TJ, Lambert PA, Cookson BD, Nightingale P, Miruszenko L, Shillam R, Christian P, Elliott TS (2010) Role of copper in reducing hospital environment contamination. *J. Hosp. Infect.* 74(1):72-7. doi: 10.1016/j.jhin.2009.08.018, citations 49.
Grant: £60,000; Awarded by Copper Development Agency; Awarded to Lambert (PI); 2010-2012.
3. Small H, Adams D, Casey AL, Crosby CT, Lambert PA, Elliott T. (2008) Efficacy of adding 2% (w/v) chlorhexidine gluconate to 70% (v/v) isopropyl alcohol for skin disinfection prior to peripheral venous cannulation. *Infect Control Hosp. Epidemiol.* 29(10):963-5. doi:10.1086/590664, citations 10.
4. Karpanen TJ, Worthington T, Hendry ER, Conway BR and Lambert PA. (2008). Antimicrobial efficacy of chlorhexidine digluconate alone and in combination with eucalyptus oil, tea tree oil and thymol against planktonic and biofilm cultures of *Staphylococcus epidermidis*. *J Antimicrob Chemother*, 62 (5), 1031-1036. doi: 10.1093/jac/dkn325, citations 32.
Grant: Formulation engineering strategies to enhance skin antiseptics and delivery of chlorhexidine £98,000, EPSRC/CASE with industrial partner-Insight Health Ltd, UK.
5. Karpanen TJ, Conway BR, Worthington T, Hilton AC, Elliott T, Lambert PA (2010). Enhanced chlorhexidine skin penetration with eucalyptus oil. *BMC Infectious Disease*; 10: 278 doi 10.1186/1471-2334-10-278, citations 5.
Grant: Formulation engineering strategies to enhance skin antiseptics and delivery of chlorhexidine £98,000 EPSRC/CASE with industrial partner-Insight Health Ltd, UK.
6. Wheeldon L, Worthington T, Lambert PA, Hilton AC, Lowden C, Elliott TSJ (2008) Antimicrobial efficacy of copper surfaces against spores and vegetative cells of *Clostridium difficile*: the germination theory. *J Antimicrob Chemother*; 62(3):522-5. doi:1093/jac/dkn219, citations 31.

Impact case study (REF3b)

Grant: Development of a commercial formulation of a cleaning product to be used in the elimination of Hospital Acquired Infections, particularly *Clostridium difficile*. £168,000 KTP-industrial partner-Insight Health Ltd, UK.

Refs 1 and 2 are publications arising from the first world-wide clinical trial which evaluated the antimicrobial efficacy of copper surfaces. Ref 3 is the first manuscript to report on the efficacy of the skin antiseptic, Chloraprep,[®] in reducing the number of microbial contaminated or colonised central venous catheters. Refs 4 and 5 are the first manuscripts to describe the enhanced antimicrobial efficacy and permeation of chlorhexidine when used in combination with eucalyptus oil (patented). Ref 6 is the first manuscript to describe Aston's *germination theory* and the elimination of *C. difficile* spores.

4. Details of the impact (indicative maximum 750 words)**IMPACT: Influencing practice within the healthcare setting, reducing environmental microbial contamination and commercial sales of copper surfaces (2008 - date)**

Data generated from the world's first clinical assessment of antimicrobial copper surfaces, undertaken by Aston, at Selly Oak Hospital, Birmingham raised awareness, nationally and internationally (S5.1; S5.2; S5.3). As a result of this seminal research, the sales of copper surfaces have increased significantly within the UK and many healthcare establishments, nationally and internationally, are now using copper touch surfaces on their wards as a measure to reduce infections. Director of the Copper Development Association quotes: "*It is remarkable to note that the first results from Selly Oak were announced as recently as 2008 and just over 4 years later, there are more than 50 healthcare facilities around the world where copper has been installed. In the UK, 5 NHS hospitals have deployed copper as part of their infection control bundle.*" (S5.2). Aston's contribution to copper research has helped lay the cornerstone of the evidence of copper's clinical efficacy, translating clinical and laboratory findings into practical, potentially life-saving applications (S5.2; S5.3). In addition, raising awareness of copper's contribution to reduce HAI has been achieved through practitioner (Healthcare Supply Chain) engagement conferences within the UK (e.g. Clarendon Suites, Birmingham, 24th April, 2012).

IMPACT: Reducing post-surgical skin site infection and influencing policy change (2007 - date)

Data generated from our published research into improved skin antisepsis has influenced practice within the NHS and also policy within the UK National EPIC 2 guidelines (Evidence-based guidelines for preventing healthcare-associated infections in NHS). Indeed, Chloraprep[®] (Carefusion), following recommendation in EPIC 2 guidelines in 2007, is widely used in clinical practice and is recommended as the standard first choice antiseptic for pre-surgical skin antisepsis nationally and internationally (<http://www.chloraprep.co.uk/evidenceBasedGuidelines.html>). The use of Chloraprep[®] for pre-surgical skin antisepsis has impacted upon improved patient health within healthcare as the formulation significantly reduces the number of both superficial and deep post-surgical infections (S5.4; S5.5).

IMPACT: Development and Marketing of Novel Disinfectants and Biocides (2008 - date)

Aston's novel disinfectant, EuClean[®], was evaluated in the clinical setting, thus raising awareness within the NHS (Birmingham Children's Hospital user feedback trial, 2009) and the data is now in the public domain. A full European patent is now held (S5.6; S5.9) (granted 5th July 2013) allowing Insight Health Ltd (Industrial partner on KTP/EPSRC grants) to licence the product, potentially in a variety of formats (wipes, solution, spray). Following feedback from the Birmingham Children's Hospital regarding the 'strong' smell of the wipes, a decision was made to modify the disinfectant formulation without loss of efficacy to satisfy customer need, thus demonstrating impact on company decisions and product development. The first production run of EuClean[®] has now been made and used as samples within the healthcare setting to engage potential customers. Sales of EuClean[®] into the NHS and other establishments (care facilities/hospices/schools) are expected by 2014 (S5.6). Furthermore, Aston's publications (S3.4 and 5) have had a significant impact on raising awareness of the product and has led to a raised number of enquires by potential customers and Pharma companies at Insight Health in 2012-2013 (S5.6).

Through collaboration with Insight Health Ltd, we have also developed a novel germination biocide (2011) which eliminates the spores of *C. difficile*. Based on the novel mechanism of our formulation a patent has been filed (S3.6; S5.10). This research has now been adopted by Insight Health Ltd thus generating commercial awareness and activity through increased enquires by manufacturing and Pharma. In addition, Insight Health is now in a position to licence the product. This aspect of Aston's research was peer reviewed by a KTP project assessment panel and awarded a significance and impact grade of 'outstanding' (S5.7; S5.8).

5. Sources to corroborate the impact (indicative maximum of 10 references)

1. Letter from the Consultant Microbiologist / Deputy Medical Director. Queen Elizabeth Hospital, Edgbaston, Birmingham, B15 2TH.
2. Letter from the Director, Copper Development Agency (CDA), 5 Grovelands Business Centre - Boundary Way - Hemel Hempstead - HP2 7TE - United Kingdom
3. www.antimicrobialcopper.org
4. Contact details: Vice President, Global Medical Affairs at CareFusion. Great Falls, Montana, USA
5. <http://www.nejm.org/doi/pdf/10.1056/NEJMoa0810988>
6. Letter from the Managing Director, Insight Health Ltd, PO Box 520, Wembley, HA9 7YN
7. Aston Website. <http://www1.aston.ac.uk/business/links-to-business/previous-news-stories/2011/october/aston-ktp-rated-outstanding-by-panel/>
8. Certificate of Outstanding Achievement: Knowledge Transfer Partnership (KTP); Development of a germination biocide for elimination of *Clostridium difficile* spores.
9. Eucalyptus oil / chlorhexidine patent European Patent Application No. 08788396.3
10. Germination patent
<http://worldwide.espacenet.com/publicationDetails/biblio?CC=WO&NR=2011101661A1&KC=A1&FT=D>