Comparison of cleaning disinfectant agents against Methicillin resistant Staphylococcus aureus

Hospital study conducted in the Southern General Hospital and the Victoria Infirmary Glasgow between January 2010 and February 2011

Supported by:

DuoMax was supplied for this study.

Authors: Dr Chris Woodall BSc(Hons) PhD, Dr Penelope Redding, MBBS, FRCPath, Professor Chris Robertson, BSc(Hons) PhD and Professor Alistair Leanord, MBChB, MD, FRCPath.

TWELVE MONTH HOSPITAL TRIAL

Contents

1.1. The Study Team:

1.1.1. **Dr Penelope Redding, MBBS, FRCPath**

Senior Consultant Microbiologist (South Glasgow), NHS Greater Glasgow and Clyde Health Board (GG + C). Dr Redding has over 20 years experience of Infection Control. Clinical Director for GG + C laboratory directorate.

1.1.2. **Professor Alistair Leanord, MBChB, MD, FRCPath**

Consultant Microbiologist, clinical duties involved: Managing patients by providing a routine diagnostic service and on-call. Founder and Director of the Scottish Infection Research Network.

1.1.3. **Mary Anne Kane. Senior Manager Health Facilities Scotland, a division of NHS National Services, Scotland.**

Responsible for the appropriate delivery of cleaning services nationally to the Scottish NHS and a member of the Scottish hospital acquired infection task force.

1.1.4. **Professor Chris Robertson, BSc (Hons) PhD.**

Professor of Statistics at the University of Strathclyde, Department of Statistics & Modelling Science and Chief Statistician for Health Protection Scotland.

1.1.5. **Suzanne Gardner, BSc (Hons).**

Hospital Trial project manager, BluTest Laboratories Limited.

1.1.6. **Katie Forrest, BSc.**

Hospital Trial specialist, BluTest Laboratories Limited.

1.1.7. **Diane Mulvey, BSc (Hons).**

Support scientist, BluTest Laboratories Limited.

1.1.8. **Dr Chris Woodall BSc (Hons) PhD.**

Director of BluTest Laboratories. Disinfectant and antiseptic specialist microbiologist. Member of BSI CH216 (London), CEN TC216 (Rome), CEN TC 216 WG2 (London), CEN TC 216 Virus Task Group (Rome), Chairman of CEN TC216 sporicidal task group (Paris).

1.2. Acknowledgement.

1.2.1. The organizers of this study wish to acknowledge the excellent contributions and cooperation from David Bedwell and Richard McManus of Health Facilities, Scotland, The Greater Glasgow and Clyde NHS, Hospital management, the infection control nurses, clinicians, ward sisters, nurses, microbiology staff, domestic staff management and domestic staff without whom this project would not have been possible. The cooperation of the patients is also greatly appreciated.

1.3. Introduction. There is little evidence to support the current national hospital cleaning regimes. Hospital-acquired infections (HAI) have been linked with contamination within the hospital environment, but the role of cleaning in the control of infection still remains to be determined.[1] Effective cleaning in this study was defined as aerobic colony counts (ACC) on hand-touch sites. Previous studies in the same environment have shown that visual assessment of cleanliness is not a good indicator and ATP bioluminescent technology is limited as a measure of a microbiologically clean environment.[2] Several studies have chosen both *Staphylococcus aureus* (MSSA) and methicillin-resistant *Staphylococcus. aureus* (MRSA) as indicator organisms.[3-6] In this study we specifically monitored MRSA in addition to ACC. Staphylococci, including MRSA, can survive for months in the hospital environment.[1,7] They were found on floors, furniture and clinical equipment,[8,9-11] and particularly on curtains, beds, bedside lockers and overbed tables.[5,6] These sites were usually situated beside the patient.[5,6,12] It is possible that staphylococci are transmitted between patients via the hands of health care workers after touching a contaminated surface.[10,13] Sites nearest the patient pose a greater risk to the patient than sites far distant in a clinical area.[5,6,13,14]. Therefore effective removal of these pathogens from surfaces adjacent to the patient would be expected to reduce the transmission of HAI.

1.4. The purpose of this study was to measure the levels of microbial and MRSA contamination on environmental surfaces surrounding patients with MRSA before and after cleaning. The rate of re-contamination of surfaces and air contamination by MRSA were also measured.

1.5. Measurement of the efficacy of present cleaning regimes using the chlorine-releasing agent Actichlor+ compared with DuoMax was performed.

1.6. The central questions being asked by the study were:

1.6.1. Is the current cleaning regime effective?

1.6.2. What is the rate of recontamination of the environment?

1.6.3. Are the currently used cleaning frequencies adequate?

1.6.4. Can the currently used cleaning agent be replaced with agents of equivalent or superior effectiveness? Potentially these agents cause less damage to equipment than chlorine based agents, in addition to a reduction in staff hypersensitivity reactions.

1.7. The study was conducted within NHS Greater Glasgow and Clyde Health Board (GG + C), predominantly located at the Southern General Hospital and the Victoria Infirmary hospitals.

1.8. The study was supported by Health Facilities Scotland, a division of the Scottish NHS and two private sponsors, who also supplied the cleaning products A and B used in the study.

1.9. The study was designed to make 25 two day observations for each test agent that was balanced for selection of the agent (the cleaning agent selected was randomised for a group of every six observations as they arose) and the hospital site in which observations were made.

1.10. Observations were made between January 2010 and February 2011.

1.11. Observations were set up on the day following the reporting of an MRSA positive patient. This allowed at least 16 hours for environmental contamination to have occurred.

1.12. Observations were excluded if no MRSA was detected in environmental sample sites on the day 1 pre-cleaning session.

1.13. The final number of observations made that satisfied the statistical design criteria were 23 for DuoMax, and 22 for Actichlor+.

1.14. The following terms and conditions applied for admission of cleaning agents to the study.

1.14.1. Cleaning agents had demonstrated *in vitro* capacity to be effective against micro-organisms to include bacteria, fungi, some classes of viruses and if possible to demonstrate capability against bacterial endospores.

1.14.2. Cleaning agents must have had low human toxicity and low ecotoxicty, preferably demonstrated by laboratory testing. They should not be corrosive or capable of otherwise damaging medical instruments.

1.14.3. Cleaning agents must have been designed to have good utility as effective cleaning agents in addition to any biocidal properties.

1.14.4. Cleaning agents were provided to the study free of charge in sufficient quantities for the duration of the study. The formulation or the concentration of the cleaning agent was not changed for the duration of the study.

1.14.5. Cleaning agents were accompanied by appropriate instructions and training for their use and used in the study at their intended concentrations. Cleaning agents, if provided as concentrates will be diluted accordingly in untreated tap water as available according to manufacturer's instructions.

1.14.6. Withdrawal of a sponsor from the study was not permitted after 3 months from the start of the study.

1.14.7. The objectivity of the study was retained, by remaining independent of intervention by the sponsors, which will not be permitted for the duration of the study.

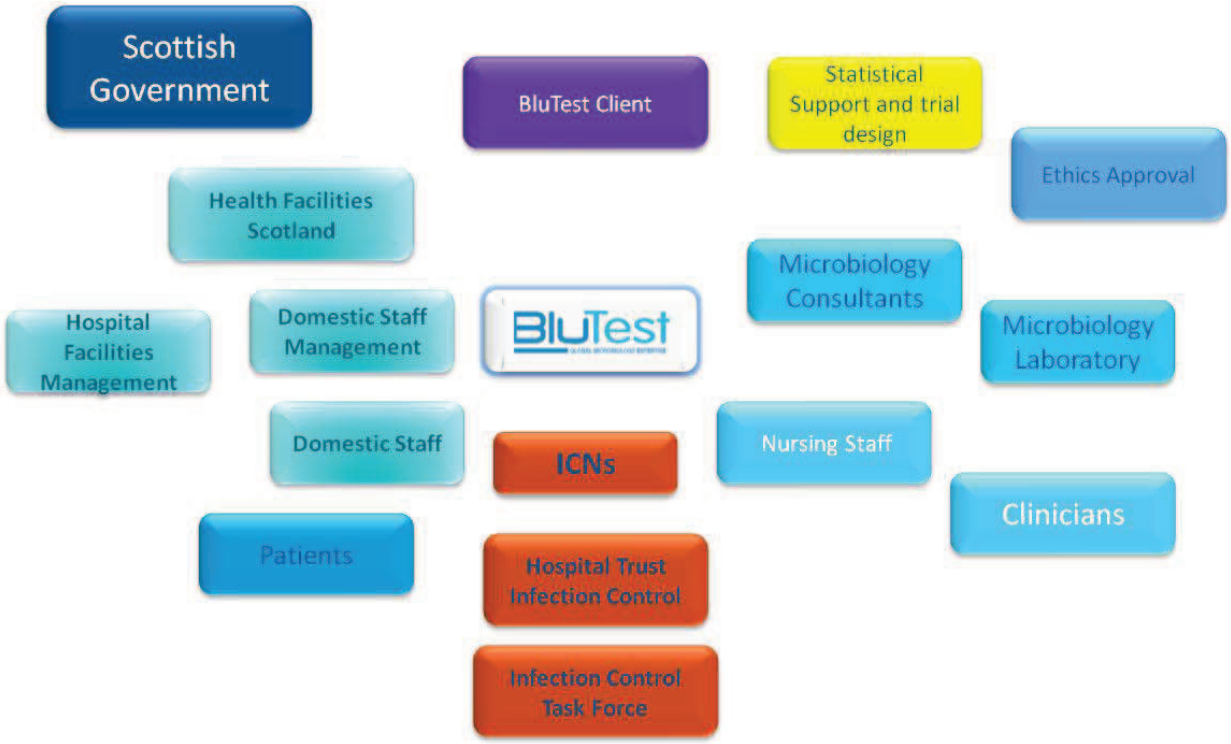
1.14.8. The study team will not make any claim on the intellectual property rights of the agents participating in the trial.

1.15. No data on patients was retained by the study.

1.16. Staff were appropriately trained and accredited to perform procedures as set down in the standard operating procedures for this project by BluTest Laboratories Limited and in accordance with local and national NHS procedures.

1.17. The day to day project management of the study was conducted by BluTest laboratories with the prior permission and contribution of the stakeholders, as described in Figure A1.

Figure A1.



1.18. Infection control informed the trial scientists of MRSA patients, generally the day before an observation was made.

1.18.1. MRSA patients were nursed following infection control procedures in single room, if available, or on an open ward.

1.19. For each patient samples were collected from 4 sites

1.19.1. These are all within the remit of the domestic staff

1.19.1.1. (A1) Top of the bedside locker.

1.19.1.2. (A2) Over bed table.

1.19.1.3. (A3) Floor.

1.19.1.4. (A4) Rail at the foot of the bed.

1.19.1.5. (A5) Air sample taken from floor level.

1.19.2. Hand touch sites excluded:

1.19.3. Where the cleaning site is the responsibility of nursing staff for clinical reasons.

1.19.4. Bed control and locker door because these were not always present.

2. Statistical Methods

2.1.1. This was a 3 arm randomised study with three agents – A, B, C. Randomisation of agents was performed, each for a group of six patients at a time, where only one agent

was used with a specific patient, but each group of six patients was treated with each agent twice in a random sequence.

2.1.2. There are 8 sampling times per site on Days 1 and 2, Morning and Afternoon with readings Pre and Post Cleaning. These times are labelled as:

PrMD1	Day 1	Pre Cleaning	Morning (AM)
PoMD1	Day 1	Post Cleaning	Morning (AM)
PrAD1	Day 1	Pre Cleaning	Afternoon (PM)
PoAD1	Day 1	Post Cleaning	Afternoon (PM)
PrMD2	Day 2	Pre Cleaning	Morning (AM)
PoMD2	Day 2	Post Cleaning	Morning (AM)
PrAD2	Day 2	Pre Cleaning	Afternoon (PM)
PoAD2	Day 2	Post Cleaning	Afternoon (PM)

2.1.3. Within these 8 time points there are two sets of contrasts to estimate. Within each set, which are orthogonal to each other, there are contrasts which are more important than the others

Set 1	First 3 are more important	
Name	Times in the contrast	Interpretation
R-O.AM	(D1PoAM- D1PrAM) +(D2PoAM- D2PrAM)	The direct effect of cleaning in the morning cleaning session
R-O.PM	(D1PoPM - D1PrPM) +(D2PoPM - D2PrPM)	The direct effect of cleaning in the afternoon cleaning session
D1-D2	D1PrAM+ D1PoAM+ D1PrPM+ D1PoPM – (D2PrAM+ D2PoAM+ D2PrPM+ D2PoPM)	Day 1 average – Day 2 average
D.R-O.AM	(D1PoAM- D1PrAM) -(D2PoAM- D2PrAM)	The direct effect of cleaning in the morning cleaning session on Day 1 compared to the direct effect of cleaning in the morning cleaning session on Day 2
D.R-O.PM	(D1PoPM - D1PrPM) - (D2PoPM - D2PrPM)	The direct effect of cleaning in the afternoon cleaning session on Day 1 compared to the direct effect of cleaning in the afternoon cleaning session on Day 2
Set 2	The first 2 are the more important	
Name	Times in the contrast	Interpretation
O.AM-R.PM	(D1PoAM- D1PrPM) +(D2PoAM- D2PrPM)	The change from the morning cleaning session up to just before the afternoon session
D1.OAM-D2RAM	D1PoPM - D2PrAM	Post cleaning in the afternoon of Day 1 to Pre cleaning in the morning of Day 2
D1.OARP-D2.OARP	D1PoAM+D1PrPM –(D2PoAM+D2PrPM)	The average of the post morning and pre afternoon on Day 1 compared to the same average on Day 2
D1OMRA-D2OMRA	(D1PoAM- D1PrPM) -(D2PoAM- D2PrPM)	The contrast of the change from the morning cleaning session up to just before the afternoon session on Day 1 compared to Day 2

2.1.4. There are 5 important contrasts the remaining 4 are of lesser importance. These two sets of contrasts are all identifiable and within each set are uncorrelated and together with another 2 or 3 contrasts, respectively, explain all the differences between the 8 time periods.

2.1.5. Statistical modelling was performed using linear and generalised linear mixed effect models to take into account the repeated observations from sampling sites associated with the same patient

3. Microbiological Methods

3.1. Dip Slides for determination of aerobic colony counts (ACC)

3.1.1. The Oxoid Dip Slide is made of disposable plastic. Its raised edges ensure an even thickness of culture medium. It has a moulded grid, which makes colony counting easier. The surface area of the agar layer on each side is 1000 sq.mm. The bottle cap forms a convenient handle by which the dip slide may be held without risk of touching the culture medium. Contamination with unwanted organisms that can increase the final count is therefore less likely. The dipslide contains TTC Red Spot Medium which is yellow in colour and transparent. Developing bacterial colonies alter the TTC and they appear as red spots.

3.2. MRSA selection medium

3.2.1. The improved formulation of the new Oxoid Brilliance MRSA Agar utilises the same novel chromogen to yield a demin blue colour as a result of phosphatase activity. This enzyme is present in all MRSA. To allow the medium to differentiate MRSA accurately, it contains a combination of antibacterial compounds designed to inhibit the growth of a wide variety of competitor organisms and MSSAs. This combination includes a new surrogate marker for meticillin resistance which replaces cefoxitin. Also included are compounds that encourage the production of MRSA pathogenicity marker, ensuring expression of the phosphatase enzyme and so providing enhanced sensitivity and specificity. They are also used routinely by the Scottish NHS microbiology laboratories as part of the nationwide MRSA screening programme.

3.2.2. Oxoid Brilliance MRSA contact plates are typically used for environmental monitoring within clean room facilities as well as forming a crucial part of drug research and development. Contact plates are filled so that the media forms a dome.

3.3. Sampling technique for ACC

3.3.1. Sampling sites were selected to be adjacent. One side of the dip slide was brought into contact with the surface of the site to be investigated and pressed flat on the surface whilst applying enough pressure to bend the stem slightly (25g/cm^2) for 5 seconds. It was carefully replaced back into it's container. Dip slides were incubated at 35–37°C for 48 hours. Aerobic colony counts were estimated according to the manufacturers guide (Figure A2)

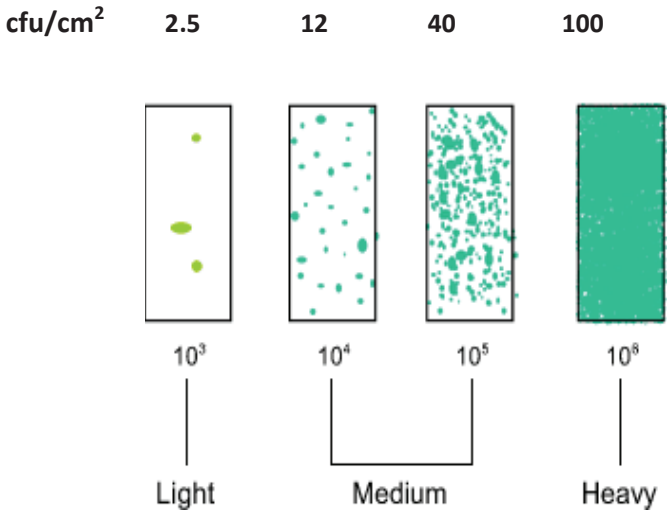


Figure A2. Estimating of Aerobic colony counts on dipslides according to the manufacturers guide.

3.3.2. **Sampling technique for MRSA**

3.3.2.1. Sample sites were those adjacent to those used for dip slides. The lid was removed from contact plate and the domed surface of the agar gently rolled onto the area to be tested. The surface area of the contact plate was exposed to the test surface for 5 seconds and the lid replaced. Contact plates were incubated at 37^0C for 18-24 hours.

3.3.3.**Air sampling technique for MRSA**

3.3.3.1. The MAS-100 Eco™ unit draws air through a perforated plate, using a high-performance suction device. The particle-bearing airflow is directed on to a standard petri dish containing Oxoid brilliance MRSA agar. Pre-programmed air volume settings of 4.0 litres were used to give reproducible results.

3.3.4.**Identification of MRSA**

3.3.4.1. The number of denim blue colonies on each Oxoid brilliance MRSA agar plate was recorded. Blue colonies are presumptive MRSA confirmed by selecting 4 single blue colonies for testing.

3.3.4.2. The identification of denim blue colonies was confirmed as MRSA to genus level by gram staining and a positive reaction coagulase testing (ProLab Prolex Staphxtra).

3.3.4.3. Coagulase negative Staphylococci appear as white colonies and *Bacillus sp*. were identified as large flat blue colonies, which are gram positive rods, coagulase negative on Oxoid brilliance MRSA agar [MSSA does not grow on this medium].

3.3.4.4. Typical example of the result on Oxoid brilliance MRSA agar (Figure A3)

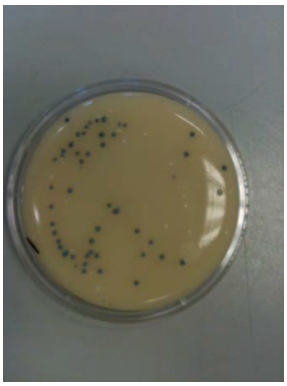


Figure A3. A typical randomly selected Oxoid Brilliance MRSA plate showing denim blue and white colonies.

4. Definition of an observation

4.1. An MRSA case was defined as confirmed MRSA isolated from inpatient on a medical ward.

4.2. An observation was initiated the day after the case can be confirmed.

4.3. The clean the day before the observation period was made with detergent only to remove residual effects of previously used agents.

4.4. This allows at least 16 hours for the room to be potentially colonised with shed microbial agents.

4.5. The selected test cleaning agent is then applied and the environment audited for microbial contamination for 48 hours.

4.6. One test cleaning agent only is applied for each case.

4.7. Each surface hand-touch site was sampled before and after a morning clean and before and after an afternoon clean for ACC and MRSA.

4.8. Air samples were taken for MRSA only

4.9. *An observation is defined as one case, monitored over a 48 hour period.*

TIME (24 HR)	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00
CLEANING											
TIMELINE			-1	0	1	2	3	4	5	6	7
SAMPLING											
SURFACE SAMPLE			ACC MRSA		ACC MRSA		ACC MRSA		ACC MRSA		
AIR SAMPLE			MRSA		MRSA		MRSA		MRSA		

5. Recording data

5.1. Data was recorded in standard format as shown in Figure A4.

5.2. Each sample was given a pre-determined unique identifier and processed on the same day.

5.3. Ward, bed position, information on the history of MRSA screening and antibiotic treatment were recorded only for each patient. No patient identifying data was collected.

6. Quality Assurance.

6.1. Data management and standard operating procedures were performed in accordance with the BluTest Quality Manual and the Southern General Hospital Microbiology Department.

Date		Ward		Bed Position			
Patient No.	3			MRSA Antibiotics:			
Agent				MRSA Screen:			
Day 1	Nutrient Agar Dipslide		MRSA Chromogenic Agar Plate				
Site/Sample	Lab No.	ACC cfu/cm^2	Lab No.	Results	No. Of Colonies	Coag +ve	
A1 Morning Pre	M0301		M0317				
A1 Morning Post	M0302		M0318				
A1 Afternoon Pre	M0303		M0319				
A1 Afternoon Post	M0304		M0320				
A2 Morning Pre	M0305		M0321				
A2 Morning Post	M0306		M0322				
A2 Afternoon Pre	M0307		M0323				
A2 Afternoon Post	M0308		M0324				
A3 Morning Pre	M0309		M0325				
A3 Morning Post	M0310		M0326				
A3 Afternoon Pre	M0311		M0327				
A3 Afternoon Post	M0312		M0328				
A4 Morning Pre	M0313		M0329				
A4 Morning Post	M0314		M0330				
A4 Afternoon Pre	M0315		M0331				
A4 Afternoon Post	M0316		M0332				
Air Sample							
Morning Pre			M0333				
Morning Post			M0334				
Afternoon Pre			M0335				
Afternoon Post			M0336				

ACC; Aerobic Colony Count (site sampled with Nutrient Agar Dipslide) MRSA; Methicillin resistant *Staphylococcus aureus*

NG; No Growth, VSG; Very Slight Growth, SG; Slight Growth, MG; Medium Growth, HG; Heavy Growth

A1; Locker, A2; Table, A3; Floor, A4; Bed rail,

Blue colonies on MRSA Chromogenic plate are only presumtive for MRSA, and therefore confirmed with a Staph Latex reagent.

Date		Ward		Bed Position			
Patient No.	3			MRSA Antibiotics:			
Agent				MRSA Screen:			
Day 2	Nutrient Agar Dipslide		MRSA Chromogenic Agar Plate				
Site/Sample	Lab No.	ACC cfu/cm^2	Lab No.	Results	No. Of Colonies	Coag +ve	
A1 Morning Pre	M0337		M0353				
A1 Morning Post	M0338		M0354				
A1 Afternoon Pre	M0339		M0355				
A1 Afternoon Post	M0340		M0356				
A2 Morning Pre	M0341		M0357				
A2 Morning Post	M0342		M0358				
A2 Afternoon Pre	M0343		M0359				
A2 Afternoon Post	M0344		M0360				
A3 Morning Pre	M0345		M0361				
A3 Morning Post	M0346		M0362				
A3 Afternoon Pre	M0347		M0363				
A3 Afternoon Post	M0348		M0364				
A4 Morning Pre	M0349		M0365				
A4 Morning Post	M0350		M0366				
A4 Afternoon Pre	M0351		M0367				
A4 Afternoon Post	M0352		M0368				
Air Sample							
Morning Pre			M0369				
Morning Post			M0370				
Afternoon Pre			M0371				
Afternoon Post			M0372				

ACC; Aerobic Colony Count (site sampled with Nutrient Agar Dipslide) MRSA; Methicillin resistant *Staphylococcus aureus*

NG; No Growth, VSG; Very Slight Growth, SG; Slight Growth, MG; Medium Growth, HG; Heavy Growth

A1; Locker, A2; Table, A3; Floor, A4; Bed rail,

Blue colonies on MRSA Chromogenic plate are only presumtive for MRSA, and therefore confirmed with a Staph Latex reagent.

Figure A4. Standard data recording sheet. Each observation has a unique sheet for an observation over a two day period. Each sample has a pre-determined unique identifier

Results

7.1. ACC

7.1.1. Both DuoMax and Actichlor+ are equally efficacious at removing environmental contamination from the four surface sample sites.

7.1.2. Of the four surface sites, the floor has much higher ACC compared to the other sites which have similar levels of contamination. The floor has 2.17 (95% CI 1.95, 2.42) times greater mean ACC than the reference site A1 (Locker).

7.1.3. There are large differences among the time periods in a predictable fashion, $P < 0.0001$. The morning clean (R-O.AM) is associated with a 28% (95% CI 24%, 31%) reduction in mean ACC, while the afternoon clean (R-O.PM) is associated with a 20% (95% CI 15%, 24%) reduction in ACC.

7.1.4. There was no difference between Day 1 and Day 2 (D1-D2), $p = 0.067$.

7.1.5. There is a 7.1% (95% CI 1.4% to 13.0%) increase in ACC from the end of the morning cleaning session to the beginning of the afternoon cleaning session, $p = 0.013$.There is a much greater increase in ACC from the end of the afternoon cleaning session to the beginning of the morning cleaning session the next day – a 47.0% increase (95% CI 36.2%, 58.8%).

7.2. MRSA as measured by the counts on surfaces.

7.2.1. The floor has 2.17 (95% CI 1.94, 2.43) times greater mean number of MRSA counts than the reference A1 locker.

7.2.2. Cleaning in the morning session was associated with a 9.5% reduction in mean MRSA colony counts and the afternoon session with a 9.9% reduction in mean MRSA colony counts.

7.2.3. A significant reduction ($p=0.001$) of 6.9% was observed in MRSA colony counts between day 1 and day 2 of cleaning (difference between the day 1 and day 2 average counts).

7.3. MRSA as measured by the percentage of patients with an environmental surface positive for MRSA.

7.3.1. From post morning clean to pre afternoon clean the odds of a sample being MRSA positive increased by 13.6% (95% CI 9.77, 32.1 %), $p = 0.098$.

7.3.2. From post afternoon clean to pre morning clean on the subsequent day the odds of a sample being MRSA positive increased by 57.4% (95% CI 26.5, 95.8%). MRSA was most commonly isolated from the floor. MRSA was less likely to be isolated from the bed rail than the locker.

7.3.3. **Relationship between where MRSA was isolated on a patient and environmental contamination**.

7.3.4. Irrespective of the site on the patient which was screened positive for MRSA, environmental contamination with MRSA is higher on the floor compared to the other three surface sites – Locker, Table, Bed Rail.

7.3.5. Patients who have MRSA isolated in the groin and multiple other sites are more likely to be associated with MRSA in the environment (42% of environmental sites) than

those with MRSA isolated from nasal and other sites, excluding the groin (around 30% of environmental sites).

7.4. Air sampling

7.4.1. Air sampling appeared to be of no additional benefit in assessing environmental contamination

8. Summary of findings

8.1. DuoMax was compared to Actichlor+, a chlorine releasing agent and the currently (and widely) used agent. Both agents have cleaning and antimicrobial capabilities *in vitro*. During this study, no differences in cleaning efficiency was seen between the agents on the basis of mean ACC, mean MRSA colony counts or percent detection of MRSA on environmental sample sites.

8.2. This is an important finding, because chlorine releasing agents have been associated with hypersensitivity reactions in staff. Free chlorine, being a strong oxidising agent, is also a contributor to damage of the environment, including medical devices. This study therefore provides evidence that DuoMax, introduced during this study, can effectively replace chlorine releasing agents without a loss of cleaning efficiency.

8.3. Data combined for all sampled surfaces and for DuoMax and Actichlor+, showed that cleaning reduced contamination by 28% in mean ACC in the morning session and by 20% in mean ACC in the afternoon session, quantitating the beneficial effect of cleaning.

8.4. Measurement was made of the recontamination rate following cleaning, where the time period between the end of the morning cleaning session to the beginning of the afternoon cleaning session is about 4 hours while the difference overnight is about 16 hours.

8.4.1. A 47% increase in ACC was observed in the overnight 16 hour period and a 7% over the 4 hours from the morning to the afternoon.

8.4.2. If the afternoon cleaning session was removed, we estimate that from the end of the morning session to the beginning of the morning session the next day there would be a 57% increase in growth over the 20 hour period.

8.4.3. These data estimate, assuming a constant rate of recontamination of the hospital surfaces, a 10% increase in bacterial load every 4 hours after cleaning.

8.5. Each morning and afternoon cleaning session resulted in approximately a 10% reduction on MRSA counts on surfaces.

8.6. There is also evidence for a reduction in MRSA surface counts of 7.0% from day 1 to day 2 on all environmental sample sites.

8.7. Quantitative MRSA air contamination was not a useful measurement in this study. This was because of the low numbers of MRSA isolated from the air for this particular sampling design.

8.8. The odds of detecting an MRSA positive sample on all environmental sites, increased by approximately 13% from the end of the morning to the beginning of the afternoon cleaning session and increased by 57% from the end of the afternoon cleaning session on day 1 to the beginning of the morning cleaning session on day 2.

8.9. The relationship between the site where MRSA was isolated and environmental contamination was an interesting finding of this study.

8.9.1. We retrospectively divided patients into two groups on the basis of screening:

8.9.1.1. Nasal – patients with MRSA isolated from a nose swab and another site (not groin)

8.9.1.2. Groin – patients with MRSA isolated from groin, wound and nose.

8.9.2. The majority of patients where MRSA was isolated from the groin were also found to have MRSA isolated in other sites, while few patients without an MRSA groin isolate were found to have MRSA in multiple sites.

8.9.3. Using this definition, the study found that patients with MRSA in the groin and multiple other sites are more likely to be associated with MRSA in the environment (42% of environmental sites) compared to those screened for nasal and other screening sites (30% of environmental sites).

8.9.4. This is particularly associated with the locker, table and bed rail sites, but not the floor. The patients with MRSA isolated from groin, wound and nose also showed a significantly higher level of contamination in the day 1 and day 2 pre-morning cleaning session samples.

8.9.5. These data indicate that some patients appear to contribute more to MRSA environmental contamination than others and a positive groin swab was associated with increased risk of contamination of the environment by that patient.

9. Further work.

9.1. Questions which have not been addressed by this study and need to be answered using one cleaning agent in a series of further studies.

9.1.1.Cleaning Frequency

9.1.1.1. Do we need to measure the rate of environmental contamination between afternoon and morning cleaning?

9.1.1.2. Does just cleaning the floor reduce the 'recontamination rate'?

9.1.1.3. Is there a difference between sample sites. Can contamination hotspots be identified?

9.1.2.Distance of MRSA dispersal

9.1.2.1. How far is the environment around a patient contaminated?

9.1.2.2. Measure sideways spread as well as from the end of the bed.

9.1.2.3. Measure (airborne) contamination during bed making.

9.1.3.Can the source of MRSA contamination be isolated more clearly? Patient and environmental strains of MRSA would need to be typed in order to achieve this

9.1.4.Type of Patient

9.1.4.1. Do some patients present a higher risk of shedding MRSA than others?

9.1.4.2. Do colonised and infected patients have the same risk of shedding MRSA?
9.1.4.3. Are patients on a decolonisation regime less likely to shed MRSA?
9.1.4.4. Are patients on MRSA antibiotic therapy less likely to shed MRSA?
9.1.4.5. Is the patient confined to bed or not?

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Signed

Dr Chris Woodall
CEO, BluTest Laboratories Limited
Glasgow, UK

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Robertson Incubator, Level 4, Robertson Building, 56 Dumbarton Road, Glasgow, G11 6NU
Tel: +44 (0)141 330 7340 Fax: +44 (0)141 330 7342 Email: info@blutest.com Website: www.blutest.com
Company Registration Number: SC364409 VAT Registration Number: GB 979 1131 96