Calderdale and Huddersfield NHS
NHS Foundation Trust

Showcase Hospitals Local Technology Review Report number 5

Bio-Cav40 Ultrasonic Cleaning

The Healthcare Associated Infections (HCAI) Technology Innovation Programme

The basic ways of preventing and reducing healthcare associated infections (HCAIs) are largely unchanging. The principal strategies for combating HCAIs are those associated with hand hygiene / aseptic techniques, prudent antibiotic prescribing and good clinical practice. However, new technologies and equipment can support these strategies by helping get things done differently, more swiftly or more reliably.

The Department of Health is funding the HCAI Technology Innovation Programme[1]. The Programme aims to

- Speed up the development and adoption of technologies to further help combat HCAIs
- Identify which new technologies provide the best value and will have the most impact

The Showcase Hospitals Programme

As part of the HCAI Technology Innovation Programme, Showcase Hospitals are undertaking local technology reviews of infection related products or technologies in which they have a specific interest. These are service evaluations, as defined by the National Patient Safety Agency's National Research Ethics Service, and do not therefore require Research Ethics Committee review.[2] This service evaluation was undertaken by Calderdale and Huddersfield NHS Foundation Trust.

[1] For further information on the Programme see http://www.hcai.dh.gov.uk
[2] See leaflet on defining research at http://www.nres.npsa.nhs.uk/news-and-publications/publications/nres-research-leaflets/

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Bio-Cav40 Ultrasonic Cleaning

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Executive summary

As part of the Department of Health's Healthcare Associated Infections (HCAI) Technology Innovation Programme, Showcase Hospitals have undertaken local technology reviews of infection related products or technologies in which they have a specific interest. This is with the objective to help Directors of Infection Prevention and Control and other stakeholders to decide whether they should consider any of these products or technologies as part of their Trust's strategy to reduce healthcare associated infections.

Bio-Cav40 Ultrasonic Cleaning is a cleaning technology that has been used in industry such as automotive, sporting, printing, marine, medical, pharmaceutical, electro-plating, engineering and weapons industries. The process involves the use of a generator or transducer in a water tank which transmits high frequencies to create millions of bubbles. These small bubbles expand and eventually implode and the force of this gently removes dirt from equipment by accelerating the detergency of the cleaning agent. This process is known as biological cavitation.

The system was used at Calderdale and Huddersfield NHS Foundation Trust for an initial period of three months, which was extended to six months.

Introduction

This report sets out the findings from an evaluation in Calderdale and Huddersfield NHS Foundation Trust, one of eight Showcase Hospitals, of the in-use and features and adoption characteristics of the Bio-Cav40 Ultrasonic Cleaning.

The objective of this document is to help Directors of Infection Prevention and Control and other stakeholders to decide whether they should consider Bio-Cav40 Ultrasonic Cleaning as part of their trust's strategy to reduce healthcare associated infections.

The problem

Equipment contamination

Ultrasonics cleaning has been shown to be more consistent and as effective, if not more so, than thorough hand-scrubbing. One exception is that ultrasonic cleaning may not remove some types of very adherent materials (such as wax or dental cement) or tissues impaled on individual instruments.[(1)] Special solvent solutions are available from manufacturers for removing these types of materials.

Visual cleanliness

The validation of ultrasonics cleaning relies primarily upon 'visual' cleanliness, which is complex and involves the person assessing the surface as being free from debris and soil without sampling aids. As well as freedom from soil, visual cleanliness should also establish freedom from any other hazards attributed to the cleaning programme, primarily cleaning fluids and foreign bodies. Cleaning fluids may be a hazard in their own right, particularly in their concentrated form and, when diluted, may become a nutrient or selective medium to aid residual microbial growth. [(2)]

Free from soil

Visual assessment may not be sufficient if small amounts of soiling present a risk when using the equipment. The assessment of a marker, which could be present in many types of soiling, can be used: such markers include adenosine triphosphate (ATP) (Adenosine-5'-triphosphate (ATP) is a multifunctional nucleotide, and plays an important role in cell biology as a coenzyme that is the "molecular unit of currency" of intracellular energy transfer [(3)]). It is very difficult to suggest what an acceptable level of soil residue remaining on a surface is following cleaning and relate this to the risks associated with the equipment.

Due to the difficulty in setting external standards, it is best to set internal standards such as what can be achieved by a given cleaning programme.

The product

Bio-Cav40 Ultrasonic Cleaning

Ultrasonics (Sonication) is based on a cavitation process – the creation and collapse of multitudes of micro-bubbles in liquid. In ultrasonication high-frequency vibration leads to strong formation of very small bubbles that hit the surface at high speed, which in turn causes detachment of surface-bound micro-organisms and biofilms.

The equipment itself comprises a 680 litre, stainless steel tank, filled with an optional cleaning agent and an ultrasonic generator or transducer to impart energy into the cleaning liquid. The tank capacity is 680 litres. The cleaning agent is appropriately specified according to the precise nature of the intended cleaning task. The water is heated to 46 degree centigrade and this temperature is maintained during the cleaning process. This temperature should not be exceeded due to the possibility of proteins being fixed onto the item.

It must be noted that not all adherent materials can be removed using this process such as wax and dental cement.

It is marketed as an environmental alternative to solvents, which may have an impact on the ozone. Environmentally friendly to employees and offering a consistent and non-destructive method of cleaning due to it's ability to penetrate screw threads and hinges and inaccessible spaces on equipment. The time cycle is approximately 3-minutes, providing a quick and effective way to clean equipment.

The Bio-Cav40 is classed as a mobile unit for general purpose cleaning such as the removal of a range of bacterial contaminants. Before use, the water within the tank must be degassed. It is a process, which can take 2-12 hours dependant upon the volume of water.

A team of trained personnel carry out the procedure with the aid of a lifting rack within the tank. When a piece of equipment is lowered into the tank sliding plates cover the tank. This is to help prevent aerosolisation of any bacteria and dispersion into the cleaning environment.

The recommended equipment for cleaning are:

Wheelchairs	Commodes
IV stands	Cabinets
Tables	Chairs
Trolleys	Electrical fans
Toys	Sac bins

The Bio-Cav40 ultrasonics technology should be used in addition to standard cleaning, not as a substitute for it. The technology can be deployed in two ways:

- The manufacturer's trained team of engineers can provide a fully managed service (as in this evaluation); or

- The hospital can purchase Bio-Cav40 Ultrasonic technology (pictured below) and use either CK Group staff or Trust staff to undertake the cleaning of equipment.

Figure 1 – Bio-Cav40 ultrasonics technology

The knowledge base

What was known before this evaluation

Ultrasonic technology is good at accessing inaccessible areas that normal cleaning cannot reach, for example screw threads and hinges. It is good at cleaning hard substrates.

It has been found by researchers to be even more effective than thorough hand scrubbing, often observed in busy work areas[4,5,6] It involves less exposure to cleaning agents and, therefore, contributes to a reduction in skin damage.

Ultrasonic technology is known for cleaning equipment damaged by smoke but equally used to remove bacterial contamination.

The evaluation

How the evaluation was done

As part of the Showcase Hospitals Programme Bio-Cav 40 SMF Ultrasonic Technology was introduced for three months between two hospital sites within Calderdale and Huddersfield NHS Foundation Trust with the aim of establishing:

1a if the use of the ultrasonics service improves the cleaning of hospital equipment
1b to what extent the use of the ultrasonics service improves the cleanliness of hospital equipment
2a is suited to hospital routines and fits in with ward and department needs
2b can be assigned to provide an overnight collection / delivery service to wards for the cleaning of specified hospital wide equipment e.g. drip stands on Monday, commodes on Tuesday etc.
2c can be assigned to offer a ward based cleaning service using a side room or storeroom to clean equipment either overnight or during the day
2d can be used as an on demand service within the hospital
2e is required as a full-time or part-time basis

Meetings were held between October 2008 and February 2009 with the involvement of the Estates Department, Matrons and Showcase Lead. Each site has a complementary but separate facilities management system in place for managing estates, buildings and processes.

The proposal outlined the requirements and processes needed for implementation. Information was sent to Ward and Department Managers, as well as portering staff to notify them of the forthcoming cleaning process and the types of equipment to be cleaned. Therapy staff were asked to identify equipment to be cleaned.

On both sites, a room which had space, electrical and water supply as well as drainage was required. At the Huddersfield site, the reprographics room situated in sub basement was moved to accommodate the deep clean area. This room was used for the ultrasonic bath as it met all the requirements. At the Calderdale site the old CSSD room was used.

The service was run from 0830 until 1700hrs Monday to Friday by a trained team of technicians familiar with working in hospital environments from CK Group. It involved the following process:

- collection of the equipment from wards or departments
- swabbing
- placing into and removing from the tank
- swabbing
- drying with a paper towel
- cleaning with micro fibre cloth then disinfecting with Difficil-S

- swabbing
- tagging and dating
- returning to the ward / department

Photographs were taken of several pieces of equipment but not all. Reflective light unit measurements were taken pre-clean, after the paper towel clean and following the microfibre clean.

Electronic weekly reports were generated from CK Group to depict the following:

- How many pieces of equipment had been subject to the cleaning process
- What type of equipment had been cleaned and the correlating ATP swabbing results from all the items cleaned
- Which location the equipment was from
- The average turnaround time from collection to return to the ward
- How many hours the contractors staff had been employed to be available for work
- How many hours the tank had been in use
- The aqua trace results from the water testing

All items of equipment were subject to ATP testing which had to be taken before it was cleaned using the ultrasonic technology and after cleaning with ultra micro fibre. Swabs had to be consistently taken from the same place on the same pieces of equipment. The equipment to be swabbed was pre-assigned:

Commodes
Drip stand,
Portering chairs
Dressing trolleys
Over bed tables

Concerns were raised due to research data showing high levels of bacterial contamination of the water. Water sampling occurred three times per day at the start, 1400hrs, and at the end of the day. To minimise risk to patients, equipment was cleaned with the microfibre cloth, then disinfected with a solution of chlorine dioxide (Difficil-S).

Many of the items of equipment had their own set of instructions for cleaning drawn up in order to maximise the effectiveness of the process and to protect staff handling them. A water risk schedule was drawn up to highlight areas of very high risk such as intensive care unit, to low risk areas such as the catering department.

The Bio-Cav 40 Ultrasonics technology cleaning system was not intended to, and did not replace, standard cleaning. All equipment continued to be cleaned in the usual way. Wards and departments decided on what equipment required cleaning from the list available. Staff from CK Group transported, cleaned and returned the items to the wards and departments.

Information on the views of staff and patients on a range of issues, including those relating to suitability, accessibility and the usability of Bio-Cav 40 Ultrasonics technology system was collected through questionnaires.

It was agreed that five weeks would be spent on each site with a two-week evaluation period following completion of the cleaning programme. It was originally hoped to commence on 02 March 2009, but started week commencing 30 March 2009 at Calderdale Royal Hospital.

Results of microbiological testing (water sampling and random swabbing)

The evaluation was not designed to assess the effectiveness of ultrasonics in reducing infection, but was it more effective than normal routine cleaning.

Of the equipment swabbed, three bedside tables were presumptive of MRSA. The HPA lab, however, found no C. *difficile* on the swabs.

RLU measurements were recorded pre-clean, post-paper towel clean and then following microfibre and Difficil-S. All results following pre-clean reflected a huge decrease in readings (see Appendix 1).

A further investigation was requested due to initial finding's using the ultrasonic pre-clean. It was agreed that the water would be sampled twice weekly and results were reported back as shown below. The water within the bath was found to become contaminated with bacteria from the equipment. The investigation was to help identify the extent of the contamination.

Requested by :
Site reference :

Reported to :

medipure
Innovations in Infection Control

Results of Water Samples from Ultrasonic Bath.

In the event of any query please quote Report No. R 7737

Sample Reference	Additional information	Date sampled	Date tested	pH	Conductivity µS cm^{-1}	Hardness (mg/l)	TVC 48h @ 35°C
4054	Sample 1	17/06/09	17/06/09	9.4	273	0-10	>500
4055	Sample 2	17/06/09	17/06/09	7.4	119	10-50	0

Summary

Reported By Checked by

Date 19/06/09

Figure 2 – Example of the Water Sample Results

Questionnaire feedback from staff highlighted how visually clean the equipment looked and photographic evidence demonstrates this. Below are before and after photographs of the base of a drip stand:

Figure 3 – Drip stand base before cleaning

Figure 4 – Drip stand base after cleaning

Results of ATP Testing

Over the ten-week testing period, the completed ATP testing returns from both hospital sites contain 1025 records. A number of these records (160) contained incomplete data sets (missing RLU values at various stages of the process) and consequently this analysis is based on the data contained in the remaining 865 complete records.

An analysis of the cleaning results shows an average of a 98% change in the RLU reading when the average Pre-Clean reading is compared with the average Post-Clean 2 reading.

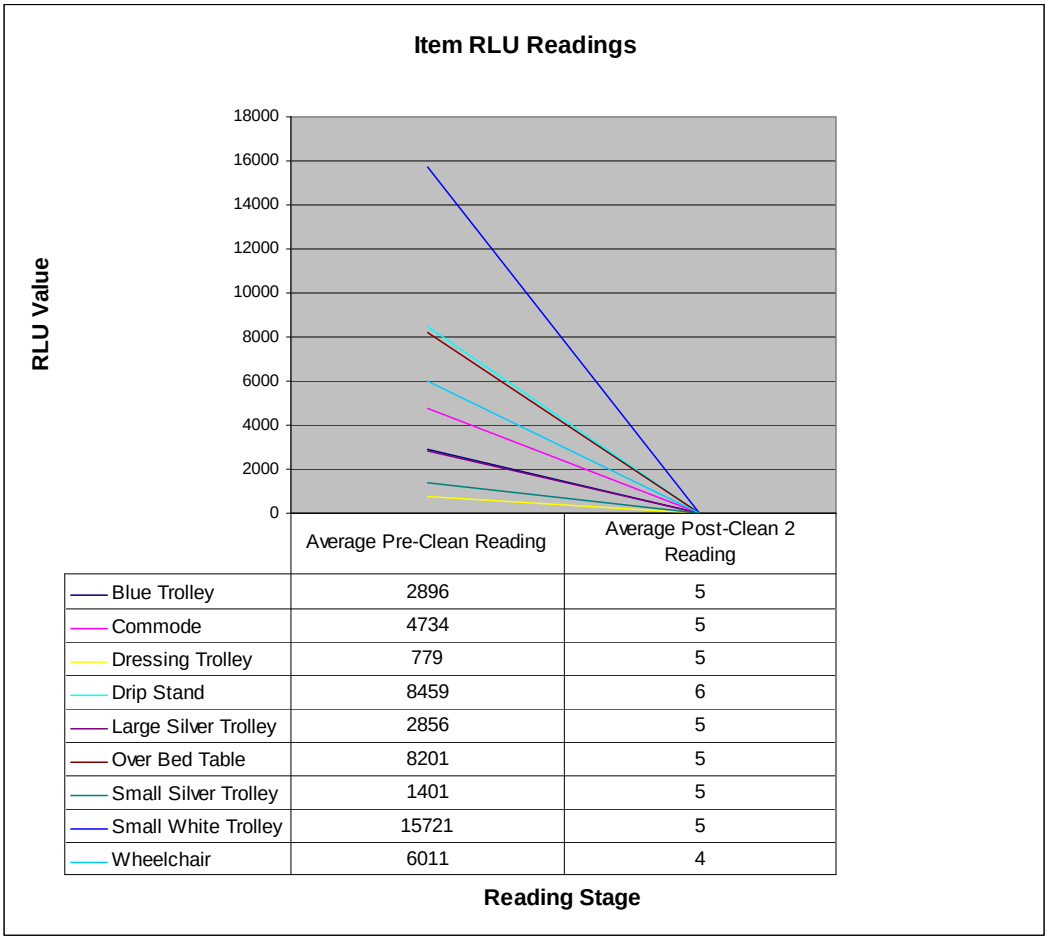

Figure 5 – RLU readings for each item tested

The above chart shows how the RLU Values taken on selected equipment dramatically drops from the point of Pre-Clean to the point of Post-Clean 2. The items that are included in this chart have been chosen as they represent the most commonly cleaned equipment:

- *Blue Trolley – 13 cleaned*
- *Large Silver Trolley – 64 cleaned*
- *Small Silver Trolley – 63 cleaned*
- *Commode – 77 cleaned*
- *Dressing Trolley – 20 cleaned*
- *Drip Stand – 118 cleaned*
- *Over Bed Table – 244 cleaned*
- *Small White Trolley – 26 cleaned*
- *Wheelchair – 19 cleaned*

An analysis of the ATP results for the above selected items indicates the Small White Trolley as having the highest RLU average value at the Pre-Clean stage. This should however be countered by one of the readings in Week 11 which records a significantly higher comparative RLU value of 380405. This figure may represent a data entry error.

The Drip Stand recorded the second highest average RLU Pre-Clean value (8459).

The Dressing Trolley recorded the lowest average RLU Pre-Clean value of 779.

All items cleaned gave an RLU reading at Post-Clean 2 stage that fell within the minimal detectable levels (0-50 RLUs) with the highest reading showing an RLU level of 24 (Dressing Trolley).

When comparing the Post Clean 1 stage data with the Post Clean 2 stage data, we see an average RLU reading of 8.38 at Post Clean 1 and an average RLU reading of 5.23 at Post Clean 2 (*readings based on data from the 865 items cleaned*). The average reading at Pre-Clean stage is 6522.

An analysis of the percentage change in the RLU reading recorded at Post Clean 1 and the reading at Post Clean 2 shows an average of a 25.72% change.

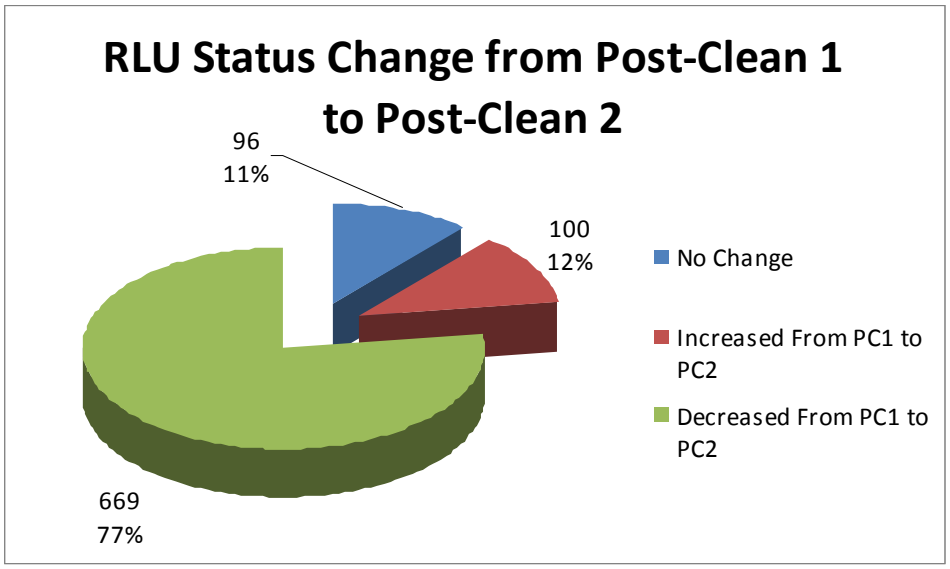

Figure 6 – RLU status change from Post-Clean 1 to Post-Clean 2

The above chart illustrates the change in the RLU reading when the reading at Post-Clean 1 is compared to the reading at Post-Clean 2.

The analysis of the change between the RLU readings at Post-Clean 1 and Post-Clean 2 need to take into consideration the significant decrease in the RLU reading from Pre-Clean stage to Post-Clean 1 stage (see chart below).

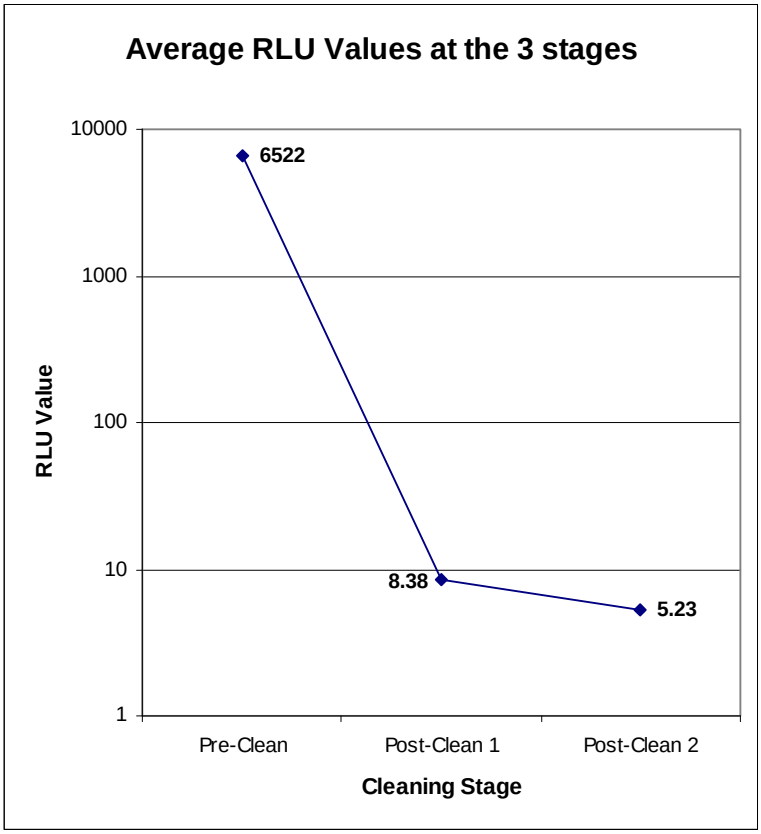

Figure 7 – Average RLU values

How acceptable was the product to staff?

When asked "Did the introduction of the ultrasonic cleaning affect your daily duties?"

- 59 staff gave an answer of "No"
- 12 gave an answer of "Yes"
- One "No" Response

In comparing the responses of the staff from the two testing sites, a higher percentage of staff at CRH (26%) remarked that the introduction of Ultrasonic cleaning affected their cleaning duties compared to three per cent at HRI.

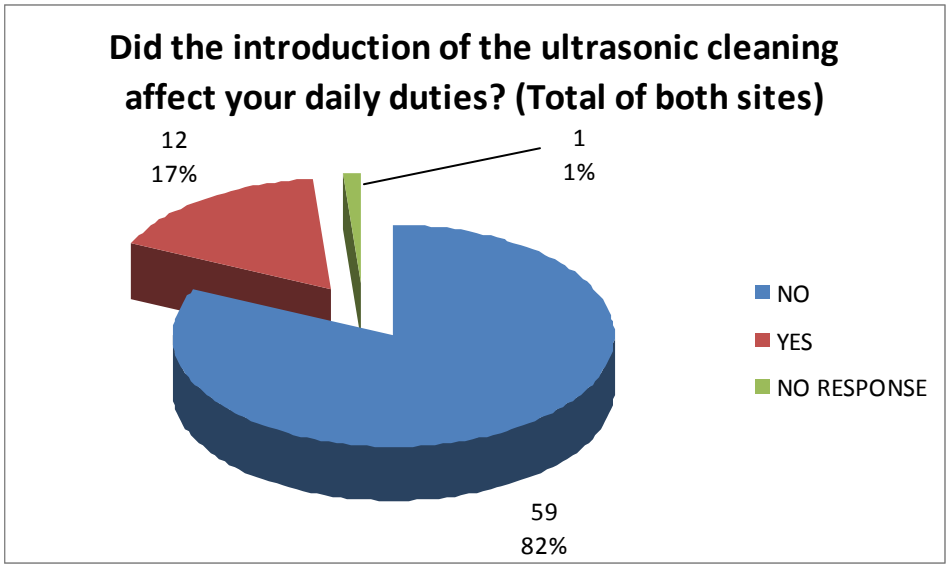

Figure 8 – Proportion of staff affected by ultrasonic cleaning

When asked "Would you recommend this system to other colleagues?" 72 positive responses recorded - 100% (some conditions were noted in the responses, for example, it would have been beneficial to have been given more notice at ward level to get equipment ready for ultrasonic cleaning)

Most responses (90%) report a 1-3 hours turnaround time from initial contact with the team to the return of the equipment. CK Group quoted that they could turn around specialist equipment in 30-minutes but it should be noted that there wasn't an option on the survey to indicate a turnaround time of less than an hour. The one response showing as less than an hour was written in the additional comments.

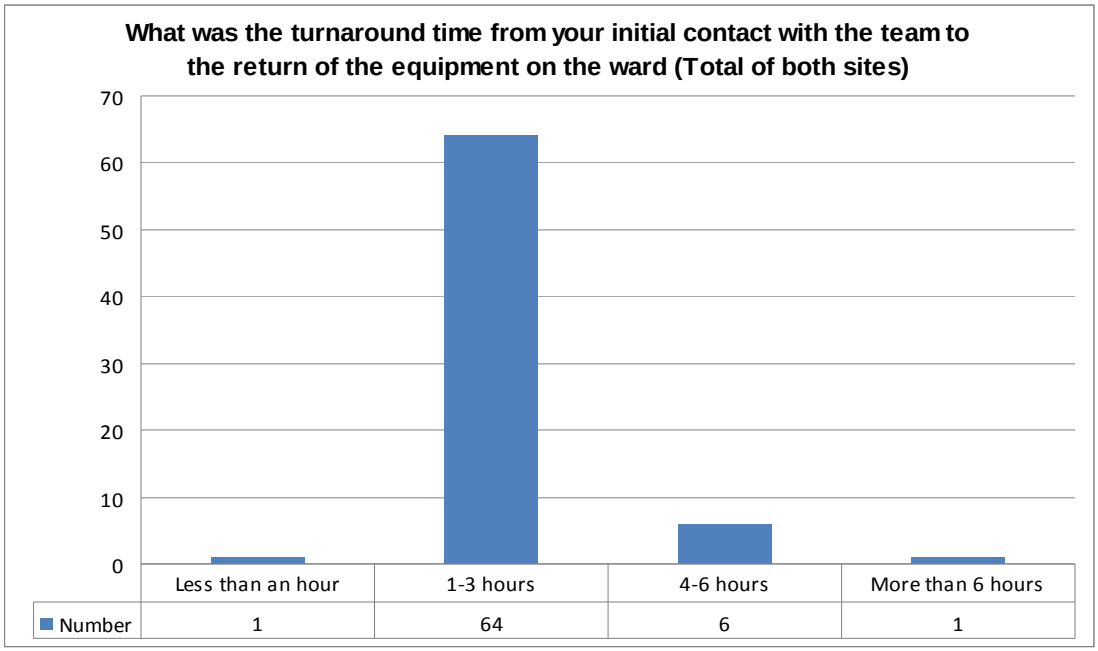

Figure 9 – Turnaround of equipment return

How acceptable was the product to patients?

From five patient responses, two patients were aware of the Ultrasonic cleaning process taking place and three were unaware.

Four patients remarked that they had noticed a visible difference to the cleanliness of the ward whilst one had not noticed any change.

Other comments from patients remarked on the friendliness of the Ultrasonic staff whilst positive remarks include “gleaming”, “cleaner” and “fresher”.

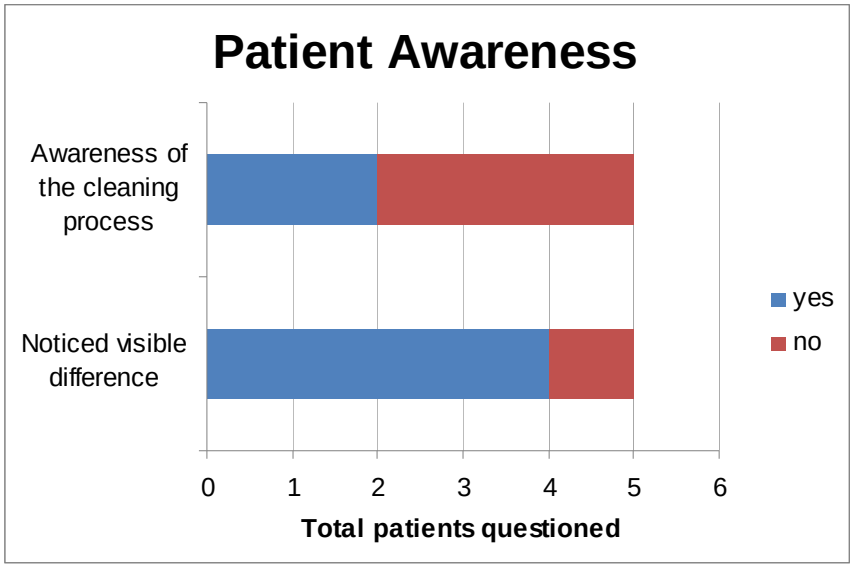

Figure 10 – Patient awareness

What issues arose in relation to implementation and adoption?

There appeared to be overall support for the use of Bio-Cav 40 ultrasonic technology.

Finding a suitable room, which had all the requirements for the running of the ultrasonics tank and space for the staff to work within was challenging. Although Calderdale Royal Hospital and Huddersfield Royal Infirmary are part of the same Trust, there were issues dealing with different facilities management systems and health and safety teams. The tank also had to be moved after five weeks to the other site. This may have also had an impact upon staff who were delivering the service as they had to become familiar with two hospital layouts.

Prior to implementing, there was a study of cross contamination issues that could potentially arise from reuse of the water in the tank after each piece of equipment, as well as the subsequent disposal of the potentially contaminated water. A week’s trial was completed to test the water three times a day. To minimise the risk to patients all pre-cleaned equipment was wiped with a microfibre cloth and disinfected with Difficil-S.

Advice and tools for Trusts considering introducing Bio-Cav40 Ultrasonic Cleaning

Important points to consider

The Bio-Cav 40 ultrasonic system can be used without disruption to staff or patients so long as there is a plan in place to ensure equipment that may be required frequently through the day is cleaned at an appropriate time to allow it to be returned before being required again. The clean appearance of the equipment returned had a lot of support from staff and the RLU values post pre clean proves equipment was less contaminated.

It would be in a Trust's best interest to decide which contract would be more applicable to them. If choosing to employ the CK Group team on a weekly basis, they must ensure that they keep the team from being idle as this idle time costs money. The more equipment cleaned per week the more cost effective.

Raising awareness of what equipment should be cleaned can be done through posters, leaflets, and local training.

Assigning a staff member of the Trust to ensure that when the City & Kent staff visit the wards that they can be proactive in choosing items to be cleaned if the ward or department staff are too busy.

If the Bio-Cav 40 ultrasonics technology is introduced as an aid to cleaning equipment:

- patients should be informed of the process
- communication increased to reduce idle time and the numbers of equipment missed
- ward and department managers and the Matrons should be encouraged to cease the opportunity of reducing the contamination levels of equipment and improving the overall visual cleanliness.

Costs and Benefits

Bio-Cav40 Ultrasonic Cleaning is not available through the NHS Supply Chain catalogue and for this evaluation was purchased directly from the manufacturer at a cost of £4,595.40 per week for a managed service (excluding electric and water costs).

Cost of cleaning per item

In this evaluation, the cost of the Bio-Cav Ultrasonic technology system was a fixed rate for the hours of service set out. Under this form of contract, payment is unaffected by the proportion of idle time during which City and Kent staff were not actively busy. Less idle time and volume of equipment cleaned per week, the more cost effective the service is.

CK Group quoted £4,595.40 per week to cover staff, chemicals, materials, machinery, vehicles, ATP swabs, audit tags and ultra micro fibre.

• Week 1	45 items cleaned	£102.12 per item
• Week 2	76	£60.46
• Week 3	89	£51.63
• Week 4	151	£30.43
• Week 5	50	£91.90
• Week 6	51	£90.10
• Week 7	107	£42.94
• Week 8	116	£39.61
• Week 9	193	£23.81
• Week 10	149	£30.84

Where a maximum of 193 items were cleaned in a week the cost for individual items was £23.81. When there were only 45 items cleaned in the week then the cost rose to £102.12 per item. These figures are not inclusive of electrical and water costs, or costs relating to processing the swabs.

All swabs taken to test the cleaning process cost £18 each. Each item swabbed required pre and post swab. Forty swabs were taken per day and sent to the HPA laboratory in Leeds and 200 swabs were processed at a cost of £18.00 each, thus costing £3,600.00.

Water within the steel tank required testing three times a day for the purpose of this evaluation. Fifteen samples to be analysed at £11.40 each, therefore costing £171.00.

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Appendix 1 – RLU Results Week 1

Medisonics Equipment Trials
Huddersfield Hospital
31/3/2009 - 3/4/2009

using Medisonics Bio-Cav 40 Equipment

Results based on Mean Values

Results Based on Mean Values per Item

	Date	Item No	Description	Pre Clean (RLU)	Post Clean 1 Paper Towel(RLU)	Post Clean 2 MicroFibre(RLU)	Photo
Week 1	31/03/2009	3	Bin	460	16	13	N
Week 1							
Week 1	03/04/2009	135	Blue Dressing Trolley	5474	11	3	N
Week 1							
Week 1	01/04/2009	29	Blue Patients Table	1202	6	7	Y
Week 1							
Week 1	31/03/2009	11	Commode	536	11	7	Y
Week 1			**Mean Value**	**536**	**11**	**7**	
Week 1							
Week 1	03/04/2009	116	Cot	237	8	5	N

Week 1	03/04/2009	127	Cot	1295	18	6	N
Week 1	03/04/2009	134	Cot	1364	9	6	N
Week 1	01/04/2009	38	Dressing Trolley	65	3	3	N
Week 1	01/04/2009	42	Dressing Trolley	97	3	3	N
Week 1	01/04/2009	58	Dressing Trolley	32	3	3	N
Week 1	01/04/2009	59	Dressing Trolley	229	37	24	N
Week 1	02/04/2009	84	Dressing Trolley	47	9	7	N
Week 1	02/04/2009	85	Dressing Trolley	40	7	4	N
Week 1			**Mean Value**	**85**	**10**	**7**	
Week 1	31/03/2009	1	Drip Stand	44	3	5	Y
Week 1	31/03/2009	18	Drip Stand	1107	18	20	Y
Week 1	31/03/2009	19	Drip Stand	390	7	3	Y
Week 1	01/04/2009	53	Drip Stand	13	4	4	N
Week 1	02/04/2009	79	Drip Stand	188	13	9	N
Week 1	03/04/2009	109	Drip Stand	2035	11	8	N
Week 1	03/04/2009	110	Drip Stand	204	6	5	N
Week 1	03/04/2009	111	Drip Stand	106	3	4	N
Week 1	03/04/2009	133	Drip Stand	833	26	15	N
Week 1			**Mean Value**	**547**	**10**	**8**	
Week 1	03/04/2009	126	Extra Large Silver Trolley	1203	4	3	N
Week 1	02/04/2009	106	Large Bin	148	4	3	N
Week 1	02/04/2009	108	Large Bin	1718	5	6	N
Week 1	01/04/2009	52	Large Silver Trolley	282	6	4	N
Week 1	02/04/2009	90	Large Silver Trolley	1607	4	3	N
Week 1	02/04/2009	92	Large Silver Trolley	1893	7	4	N
Week 1	03/04/2009	114	Large Silver Trolley	80	5	4	N
Week 1	03/04/2009	115	Large Silver Trolley	15158	6	4	N
Week 1			**Mean Value**	**3804**	**6**	**4**	
Week 1	31/03/2009	26	Large Trolley	1293	11	8	N
Week 1							
Week 1	03/04/2009	117	Laundry Trolley	1129	6	5	N

Week 1	03/04/2009	118	Laundry Trolley	112	4	4	N
Week 1	03/04/2009	136	Laundry Trolley	93	4	5	N
Week 1							
Week 1	01/04/2009	56	Nurses Trolley	5898	12	10	N
Week 1	01/04/2009	57	Nurses Trolley	467	9	7	N
Week 1							
Week 1	01/04/2009	69	Patients Trolley	520	5	6	N
Week 1							
Week 1	02/04/2009	88	Silver & Glass Trolley	419	6	4	N
Week 1	02/04/2009	89	Silver & Glass Trolley	653	4	6	N
Week 1							
Week 1	01/04/2009	60	Silver Trolley	18	3	3	N
Week 1	01/04/2009	61	Silver Trolley	21	5	4	N
Week 1							
Week 1	01/04/2009	45	Small Silver Trolley	142	4	3	N
Week 1							
Week 1	03/04/2009	112	White Dressing Trolley	334	8	5	N
Week 1							
Week 1	01/04/2009	54	White Patient Trolley	70	6	4	N
Week 1			**Mean Value**	**70**	**6**	**4**	
Week 1							
Week 1	01/04/2009	34	White Patients Table	31718	7	6	Y