

# In-use evaluation of the “Germ Genie” ultra-violet lamp for bio-decontamination of computer keyboards on four wards at North Middlesex University Hospital

## Pre-publication Report

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## 1. Introduction

This report is on the performance of the Germ Genie ultraviolet lamp for computer keyboard decontamination as trialled on four wards at North Middlesex University Hospital NHS Trust in July-August 2011.

Details of the trial proposal which was approved by a London Research Ethics Committee and the North Middlesex University Hospital NHS Trust Research & Development Committee are given in the appendices. Information on any deviation in practice from the approved trial proposal will be given as needed for clarification. Since full details of the product, study design (both quantitative for keyboard sampling and qualitative for staff interviews about the product) and justification for this are given in the appendices, this report will focus on the methods actually employed, study findings and the conclusions which can be drawn.

The main questions under consideration for this trial are:

1. Does “Germ Genie” provide a significant reduction in the level of bacterial load on high-use computer keyboards?
2. How is “Germ Genie” viewed by computer users on wards?

The answers to these questions will then enable the investigators to form views on whether “Germ Genie” might be of value in reducing contamination of high-risk computer keyboards in a hospital setting.

## 2. Rationale

*(Please see the protocol section of the appendix for further discussion and references)*

The prevention and control of hospital-acquired Infections (also called nosocomial infections) continues to be a NHS and worldwide priority. Whilst the role of the environment in the causation of hospital-acquired infection continues to be debated, increasing evidence suggests that environmental contamination does play a role in the spread of MRSA, *Vancomycin-resistant enterococci* (VRE) and also *Clostridium difficile*. A number of investigators have focussed on the role of high-touch surfaces in the transmission of infection. In this regard, computer keyboards have been cited as a potential environmental source for organisms (pathogens) which can cause nosocomial infections.

The structure (with multiple gaps) and electrical nature of a computer keyboard is such that standard, liquid-based decontamination methods, such as washing and wiping, often cannot be used for effective cleaning /decontamination and ultraviolet (UV) radiation has been considered for use in this context. Radiation of this type has a broad spectrum of activity against commonly encountered viruses and bacteria in a hospital setting. A recent investigation of the activity of a UV light decontamination system found limited activity as compared to decontamination using wet wipes when used on computer keyboards. In that study a hand-held UV light source was used and was moved over the keyboards for 5 second periods. This may have been insufficient time for biocidal activity on a particular area of a given keyboard.

The present study was designed to evaluate the “Germ Genie” which is a stand-alone, UV desk-type lamp source which can be fixed permanently to a keyboard or the surface on which both the lamp and the keyboard are placed, or left free-standing (moveable) at the back of computer keyboards.

The lamp is designed to emit UV light at a biocidal wavelength (254nm) from a bulb approximately 15cm above the keyboard within an area that covers the surface of said keyboard (standard size PC keyboard). The light is triggered either by someone using the keyboard and then finishing (moving away) or by a period of inactivity of 30 minutes. The levels and types of bacteria found on keyboards in a number of locations including North Middlesex hospital has been evaluated by co-investigators at the University of Reading (data on file). The activity of the device in a laboratory setting against standard pathogens *that might be found in a hospital setting* has also been evaluated by co-investigators at the University of Hertfordshire. The purpose of this evaluation is to determine the efficacy of “Germ Genie” as a UV light decontamination system *in the hospital setting itself*. The findings from these three studies will then be combined to give a comprehensive evaluation of the performance of the Germ Genie device.

### 3. Methods

The wards selected for the study at North Middlesex University Hospital were:

- Oncology/ Chemotherapy Day Unit
- Intensive Care
- Acute Stroke Unit
- Michael Bates

Ward staff were briefed about the study by the chief investigator at general ward meetings and other visits prior to and during the study period (July-August 2011). In these briefings it was emphasised that staff should not change their behaviour as regards the way they would normally use ward keyboards because of the trial.

Four heavily used keyboards per ward were used for the study (total of 16 keyboards in the study). On each ward, two keyboards were chosen as control keyboards, and two were chosen to have Germ Genies installed. Whilst the manufacturer recommends a permanent attachment to the keyboard, for the purposes of the study, the Germ Genies were attached to each keyboard with a small piece of Velcro. This was in the approved (London REC and NNUH R&D Committee) trial protocol in order to allow ward staff to remove the Germ Genie if they did not wish to participate in the trial.

Fig. 1 gives the wards and keyboard designations used in the study.

**Fig 1. Study wards and keyboards at North Middlesex University Hospital July/Aug 2011**

Ward	Keyboard	ID
Chemo Day Unit	CHEMO-DAY Key-board IT9548	CDU 1 - Test
Chemo Day Unit	CHEMO-DAY Key-board IT9205	CDU 2 - Test
Chemo Day Unit	ONC Front Key-board IT8300	CDU 3 - Control
Chemo Day Unit	ONC Doc's Office Key-board IT9292	CDU 4 - Control
ICU	ICU Key-board IT116 Test	ICU 1 - Test
ICU	ICU Key-board IT117	ICU 2 - Control
ICU	ICU Key-board IT1118 Test	ICU 3 - Test
ICU	ICU Key-board IT119	ICU 4 - Control
ASU	ASU MR Key-board IT10982	ASU 1 - Control
ASU	ASU MR Key-board IT10983 Test	ASU 2 - Test
ASU	ASU Front Key-board IT9342 Test	ASU 3 - Test
ASU	ASU Front Key-board IT8301	ASU 4 - Control
Michael Bates	M/B MR Key-board IT10986 Test	MB 1 - Test
Michael Bates	M/B MR Key-board IT10858	MB 2 - Control
Michael Bates	M/B Front Key-board IT18100 Test	MB 3 - Test
Michael Bates	M/B Front Key-board IT10779	MB 4 - Control

### 3.1. Quantitative Methods

All of the keyboards on each ward were swabbed for culture before the installation of the Germ Genie (GG).

#### Swabbing method for keyboards

Baseline screening swabs were taken on the Monday of the first week of the study. Sterile cotton-tipped swabs were pre-moistened with sterile water and used to swab keys as given below.

Once the initial swabs were taken from the keyboards, the Germ Genie devices were positioned with the base tucked behind and underneath the keyboard as recommended by the manufacturer.

A Germ Genie was left on each "test" keyboard for 2 weeks of the study with sampling of all keyboards on the Monday, Wednesday and Friday of each week.

#### Details of Swabbing:

Two swabs were used per keyboard.

- Swab 1 was used to swab keys on one half of the keyboard with direct plating of that swab onto blood agar. For direct plating of a swab, that swab was rolled onto a plate area of about 3cm diameter and then parallel streaks were done with a single streak method using a sterile loop each time (as described below). This swab was then placed into a sterile bijou containing 2ml of nutrient broth and then vortexed. The swab was then removed aseptically and discarded. After swab removal, the bijou with broth was incubated for 24 hours at 37 °C in air.
- Swab 2 was used for the other half of the keys and that swab was placed into 2ml PBS buffer and then vortexed. The swab was then removed aseptically and discarded. 100 µl aliquots (neat and dilutions) were dropped onto blood agar plates to be incubated for enumeration

of bacterial growth from the original 2ml samples (Miles & Misra technique). Counting was done after 24h incubation at 37 °C in 5% CO<sub>2</sub>.

Single Streaking Method Used (see Fig. 2)

The swab was rolled onto the blood plate onto an area of about 3cm diameter (a) and then parallel streaks were done with a single loop (b). When about 30% of the plate was covered by the first streaking phase, the loop was sterilised by flaming. This procedure was then repeated for the second phase (c), but this time picking up some inoculum by crossing the first phase once and then not passing into it again. This was then repeated for the third phase (d), flame sterilizing the loop between streaking phases before setting it down

Fig 2. Streaking before and after incubation



**3.2. Qualitative Methods**

Semi-structured interviews were conducted with 15 members of staff on the trial wards. These were staff members who had used a keyboard which had had a Germ Genie placed and who gave consent to be interviewed. All questions were initially “open” and depending on responses, clarification was then sought with specific queries. By example, an open question was:

“What do you think about the lamp?”

A specific question was:

“Did it affect the visibility of the keys?”

Further questions employed are given in the approved trial protocol (Appendix 1)

## 4. Findings

### 4.1. Quantitative Findings

#### CDU

CDU- the control keyboards (CDU 3, CDU 4) showed consistent high positivity for the period of the trial. Before Germ Genie was installed, the two test keyboards showed growth by all three methods. After Germ Genie was installed both test keyboards showed no growth by any of the three enumeration methods by any method. Germ Genie was well positioned throughout the trial period.

For test keyboard (CDU 1), there were 7 samples in total where Germ Genie had been installed. All of them showed no growth by any of the three enumeration methods. Germ Genie was well positioned throughout the trial period.

For test keyboard (CDU 2), there were 7 samples in total where Germ Genie had been installed. All of them showed no growth by any of the three enumeration methods. Germ Genie was well positioned throughout the trial period.

#### ICU

ICU - the control keyboards (ICU 2, ICU 4) showed consistent high positivity for the period of the trial. Before Germ Genie was installed, the two test keyboards showed growth by all three methods. After Germ Genie was installed both test keyboards showed no growth by any of the three enumeration methods by any method. Germ Genie was well positioned throughout the trial period.

For test keyboard (ICU 1), there were 7 samples in total where Germ Genie had been installed. All of them showed no growth by any of the three enumeration methods. Germ Genie was well positioned throughout the trial period.

For test keyboard (ICU 3), there were 7 samples in total where Germ Genie had been installed. All of them showed no growth by any of the three enumeration methods. Germ Genie was well positioned throughout the trial period.

#### ASU

ASU- the control keyboards (ASU 1, ASU 4) showed consistent high positivity for the period of the trial. Before Germ Genie was installed, the two test keyboards showed growth by all three methods. After Germ Genie was installed both test keyboards showed significant reduction in bacterial numbers with no growth by any method on the sampling days when Germ Genie was correctly positioned.

For test keyboard (ASU 2), there were 7 samples in total where Germ Genie had been installed. 5 showed no growth and 2 showed some levels of growth. In each case where there was some growth, Germ Genie was noted to be out of position at the time of sampling.

For test keyboard (ASU 3), there were 7 samples in total where Germ Genie had been installed. 4 showed no growth and 3 showed some levels of growth. In the each case where there was some growth, Germ Genie was noted to be out of position at the time of sampling.

### **Michael Bates**

Michael Bates - the control keyboards (MB 1, MB 3) showed consistent high positivity for the period of the trial. Before Germ Genie was installed, the two test keyboards showed growth by all three methods. The results from the two test keyboards suggest that when Germ Genie is moved out of position, bacterial contamination can quickly return.

For test keyboard (MB 1), there were 8 samples in total where Germ Genie had been installed. 2 showed no growth by any of the three enumeration methods and 6 showed some levels of growth. In each case where there was some growth, Germ Genie was noted to be out of position at the time of sampling. It was observed that the Germ Genie at this keyboard was moved around a lot by the staff so that it was either not in the correct position or not switched on most of the time.

For test keyboard (MB 3), there were 7 samples in total where Germ Genie had been installed. All of them showed no growth by any of the three enumeration methods, and the Germ Genie was well positioned throughout the trial period.

Detailed findings in tabular format are given in Appendix 1

### **Summary points**

- In all cases where Germ Genie was correctly positioned (40 samples), no bacteria were recovered by any of the three enumeration methods.
- Where the Germ Genie was not installed at all (67 samples), significant levels of bacteria were found by all three enumeration methods.
- Where the Germ Genie was moved away periodically from the keyboard (15 samples), bacteria were often found, but generally in much reduced levels compared with the control keyboards.
- The control sampling showed that the flora found on keyboards were as expected for regular skin contact and exposure to the wider environment. These were predominantly Coagulase-negative staphylococci, *Corynebacteria spp*, and *Bacillus spp*. with a few isolates of *Staphylococcus aureus* and *Aspergillus spp*. (see Appendix 2)
- The three sampling and enumeration methods often showed concordance. For example, where there was a high count from direct plating, the broth result was very turbid, and the PBS dilution method also showed a high count.
- The hospital keyboards tested showed varying levels of contamination with up to 10<sup>3</sup> organisms per keyboard detectable by the sampling methods used.

## 4.2. Qualitative findings

The key responses from each staff member are listed below which each person being identified by a number only.

- Staff 1- Likes lamp; no issues with use; was a suitable height and did not block vision in any way (asked if NMUH owned the device since thought it was so innovative)
- Staff 2- Likes lamp; was not sure at times if lamp was “on” or not ( i.e. when there was no light on)
- Staff 3- Likes lamp; thought that design was very good; did hear a background high-pitched noise all the time when near lamp that was plugged in to socket; wondered about the noise ( was lamp working properly?), but felt that it did not affect work; did not hear comments from any member of staff about a similar experience with noise.
- Staff 4- likes lamp; thought that it promoted hand-hygiene by being a visible reminder of our efforts at NMUH to prevent and control infections; felt that this was a very suitable device for NHS use.
- Staff 5- could not see back keys (F keys) as well so asked if height of lamp could be adjusted/adjustable; otherwise favourable towards use of lamp on wards.
- Staff 6- Likes lamp; thought that keyboard decontamination was important; was aware of other attempts/devices (at other hospitals) which try to accomplish this; wondered if lamp light actually covered all of keyboard and in particular thought that it should be wider ( width in position) to cover the far left and far right keys.
- Staff 7- felt that palm-rest was as important as keys and this did not seem to be covered by keyboard light; otherwise favourable towards lamp use on wards for decontamination of keyboards
- Staff 8- noted buzzing when lamp was plugged into socket which stopped when lamp was disconnected; felt a bit nauseated and, in discussion with this person (medical), we both wondered about an impact on the vestibular system; staff was not concerned about ill effects as such as the fact that it affected (her) ability to work at the keyboard concerned ( and in the room with a Germ Genie plugged in) ; because of this finding which was on the very first day of use with the keyboard in question, the Germ Genie was removed from that room and placed elsewhere on the ward concerned.
- Staff 9- did not know about the trial initially since had been away so thought that summary information about the lamp should be on a sticker on the top of the lamp since staff move in and out of wards all the time; thought that lamp was a “good idea”.
- Staff 9- liked lamp but thought that it was too easy to move away even accidentally; felt that lamp should be fixed in some way to ensure correct positioning of light.

- Staff 10- liked lamp; wondered if it could be modified to use with movable keyboards on trolleys which are retractable ( current design would preclude this since keyboard would go under the back part of the trolley top as it is retracted).
- Staff 11- likes lamp; thought it should be taller to give more visibility of keys (tall person)
- Staff 12- thought that Germ Genie gave confidence that keyboard was “clean” and wondered if there was a way of knowing that the lamp was working when light was not visible.
- Staff 13- was a bit confused by the different light colours- what did they mean?
- Staff 14- commented that I ( Dr I Hosein- Chief Investigator) had said (at a ward staff briefing on the trial) that, “if UV light was on, lamp would switch off as the hands approached the keyboard”.. when in fact hands ( this person said) have to be in the UV light area before the lamp switched off; liked the product otherwise; wondered if lamp could detect counterfeit £20 notes...
- Staff 15- asked about cost of the lamp (would pay £50-£100 pounds) ; did think it was a useful addition in our efforts to prevent hospital infections.

### **4.3. Analysis of Findings**

#### **4.3.1. Quantitative**

The overall finding is that Germ Genie is a highly effective decontaminating device for computer keyboards in a hospital setting. Where the data was discrepant i.e. where there was a higher than expected count for test keyboards (where the Germ Genie had been installed), ward observations by investigating staff indicated that those were caused by the Germ Genie not being positioned correctly.

#### **4.3.2. Qualitative**

The overall finding was that staff thought that the Germ Genie was a worthwhile addition to our armamentarium to combat hospital acquired infections. Staff gave several helpful suggestions as to how the device could be improved and some which stand out are:

- height adjustability for staff who have difficulty with seeing the back keys
- placement of an LED light to indicate that the UV light beam is “on” or “off” but that the device is still switched on
- adjustment of the device to prevent it being sensed by those who can detect higher frequency sound wave

## 5. Discussion

The reduction of Hospital-acquired infections continues to be a major NHS priority despite significant improvements in rates for MRSA blood stream and *C. difficile* infections in recent years. Some of this reduction may have been as a result of adhoc campaigns such as the government initiated “deep clean” one for *C.difficile* control. With continuous improvement comes higher quality expectations from users in any service industry. However, quality improvement in any industry is best achieved by building control systems into daily work outputs and it is in this regard that the current trial of the Germ Genie UV lamp for continuous decontamination of computer keyboards on hospital wards was conceived. One previous trial using a hand held (moving) UV light source for this same end found limited activity of a lamp as compared to wet wipes. However, the Germ Genie is a standing desk-type lamp with a controlled UV dose not subject to user operational variation so the potential efficacy of the Germ Genie cannot be extrapolated from that previous trial. The questions investigated in the present trial were:

- 1 Does “Germ Genie” provide a significant reduction in the level of bacterial load on high-use computer keyboards?
- 2 How is “Germ Genie” viewed by computer users on wards?

The quantitative part of the trial indicated that computer keyboards can be highly contaminated with skin type flora (up to  $10^3$  organisms recovered) and that Germ Genie application resulted in very significant reductions in such contamination when Germ Genie was properly positioned and used (switched on and left on). The different enumeration techniques used have imperfect levels of precision and accuracy so the numbers of bacteria recovered demonstrate the *minimum* level of bacterial inoculation on the keyboards. Despite this limitation, since the enumeration methods employed were identical for control and test keyboards, and since sufficient interpretable data was obtained, we believe that valid conclusions about the efficacy of the device can be drawn.

There were 40 samples in the study where the Germ Genie was correctly positioned and switched on. There were 15 samples where the Germ Genie was moved away from the keyboard either fully or partially. There were 67 samples where Germ Genie was not installed at all, which included a mixture of the test keyboards (before Germ Genie was installed) and the control keyboards. In all cases where Germ Genie was positioned correctly there were no bacteria recovered by the methods employed. Where Germ Genie had been moved away or incorrectly positioned, whilst there was biomass reduction some bacteria were still recovered indicating that maintenance of correct positioning of the device is vital for maximal efficacy.

The staff interviews indicated an overall level of satisfaction with the Germ Genie, and significant interest in its potential future utilisation on hospital wards. On the whole staff members found that Germ Genie did not adversely affect their working at PC terminals in the usual way. Several helpful suggestions for improvements in the design of the Germ Genie were made and these will be passed on to the manufacturer.

## 6. Conclusion

Germ Genie was found to be highly effective in reducing computer keyboard contamination on four wards at North Middlesex University Hospital.

Staff members were very interested in the product and thought that it could be very beneficial to the NHS in our continuing efforts to prevent hospital acquired infections.

## Appendix 1 - Approved protocol

GCP Non CTIMP  
Protocol - UV version

## Appendix 2 – Bacterial isolates.

Bacteria isolates  
v0.1.xls

## Appendix 3- Results in Tabular format

### Wards Results Template: Chemo Day Unit / Oncology

Day	Date	CHEMO-DAY Key-board IT9548			CHEMO-DAY Key-board IT9205			ONC Front Key-board IT8300			ONC Doc's Office Key-board IT9292		
		Direct Plate inoculation on Area A cfu	Broth inoculation Broth A	PBS inoculation Areas BCD in PBS	Direct Plate inoculation on Area A cfu	Broth inoculation Broth A	PBS inoculation Areas BCD in PBS	Direct Plate inoculation on Area A cfu	Broth inoculation Broth A	PBS inoculation Areas BCD in PBS	Direct Plate inoculation on Area A cfu	Broth inoculation Broth A	PBS inoculation Areas BCD in PBS
Monday	18-Jul-11												
Wednesday	20-Jul-11	46	TURBID +	0	12	TURBID +/-	0	224	TURBID +++	133.3333333	108	TURBID ++	80
Friday	22-Jul-11	0	CLEAR	0	0	CLEAR	0	100	TURBID +++	40	36	TURBID ++	40
Monday	25-Jul-11	0	CLEAR	0	0	CLEAR	0	160	TURBID +++	160	62	TURBID ++	200
Wednesday	27-Jul-11	0	CLEAR	0	0	CLEAR	0	134	TURBID +++	400	32	TURBID ++	240
Friday	29-Jul-11	0	CLEAR	0	0	CLEAR	0	110	TURBID +++	320	210	TURBID ++	480
Monday	01-Aug-11	0	CLEAR	0	0	CLEAR	0	110	TURBID +++	160	32	TURBID ++	240
Wednesday	03-Aug-11	0	CLEAR	0	0	CLEAR	0	40	TURBID +	80	50	TURBID ++	400
Friday	05-Aug-11	0	CLEAR	0	0	CLEAR	0						

### Wards Results Template: ICU

Day	Date	ICU Key-board IT116			ICU Key-board IT117			ICU Key-board IT1118			ICU Key-board IT1119		
		Direct Plate inoculation on Area A cfu/keyboard	Broth inoculation Broth A cfu	PBS inoculation Areas BCD in PBS	Direct Plate inoculation on Area A cfu	Broth inoculation Broth A	PBS inoculation Areas BCD in PBS	Direct Plate inoculation on Area A cfu	Broth inoculation Broth A	PBS inoculation Areas BCD in PBS	Direct Plate inoculation on Area A cfu	Broth inoculation Broth A	PBS inoculation Areas BCD in PBS
Monday	18-Jul-11	48	TURBID +	133.3333333	96	TURBID +	26.66666667	112	TURBID +	26.66666667	80	TURBID +	26.66666667
Wednesday	20-Jul-11	0	CLEAR	0	10	TURBID +	0	0	CLEAR	0	28	TURBID +	0
Friday	22-Jul-11	0	CLEAR	0	66	TURBID +	320	0	CLEAR	0	56	TURBID +/-	560
Monday	25-Jul-11	0	CLEAR	0	46	TURBID +	40	0	CLEAR	0	14	TURBID +	0
Wednesday	27-Jul-11	0	CLEAR	0	10	TURBID +	120	0	CLEAR	0	28	TURBID +	80
Friday	29-Jul-11	0	CLEAR	0	10	TURBID +	80	0	CLEAR	0	12	TURBID +/-	40
Monday	01-Aug-11	0	CLEAR	0	60	TURBID +	280	0	CLEAR	0	12	TURBID +/-	0
Wednesday	03-Aug-11	0	CLEAR	0									

### Wards Results Template: ASU

Day	Date	ASU MR Key-board IT10982			ASU MR Key-board IT10983 Test			ASU Front Key-board IT9342 Test			ASU Front Key-board IT8301		
		Direct Plate inoculation on Area A cfu	Broth inoculation Broth A	PBS inoculation Areas BCD in PBS	Direct Plate inoculation on Area A	Broth inoculation Broth A	PBS inoculation Areas BCD in PBS	Direct Plate inoculation on Area A cfu	Broth inoculation Broth A	PBS inoculation Areas BCD in PBS	Direct Plate inoculation on Area A cfu	Broth inoculation Broth A	PBS inoculation Areas BCD in PBS
Monday	18-Jul-11	356	TURBID ++	160	200	TURBID +	160	400	TURBID ++	160	176	TURBID ++	186.6666667
Wednesday	20-Jul-11	102	TURBID ++	80	44	TURBID ++	40	8	TURBID ++	0	44	TURBID ++	40
Friday	22-Jul-11	44	TURBID +	0	0	CLEAR	0	0	CLEAR	0	110	TURBID ++	160
Monday	25-Jul-11	64	TURBID ++	160	62	TURBID +	0	0	CLEAR	0	68	TURBID ++	160
Wednesday	27-Jul-11	2	TURBID ++	40	0	CLEAR	0	10	TURBID +	40	186	TURBID ++	1320
Friday	29-Jul-11	22	TURBID +	40	0	CLEAR	0	10	TURBID +	40	68	TURBID ++	160
Monday	01-Aug-11	40	TURBID +	80	0	CLEAR	0	0	CLEAR	0	Not Sampled	Not Sampled	Not Sampled
Wednesday	03-Aug-11	44	TURBID +	160	0	CLEAR	0	0	CLEAR	0	Not Sampled	Not Sampled	Not Sampled

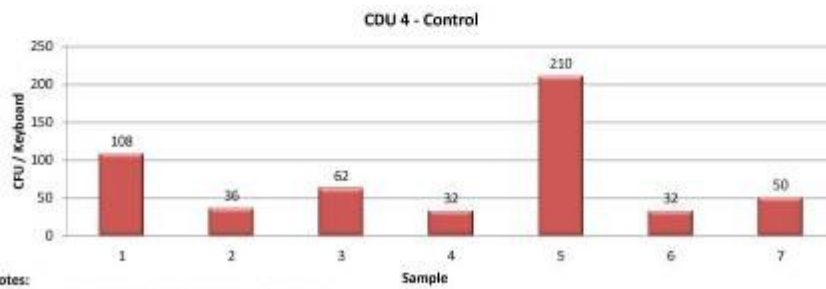
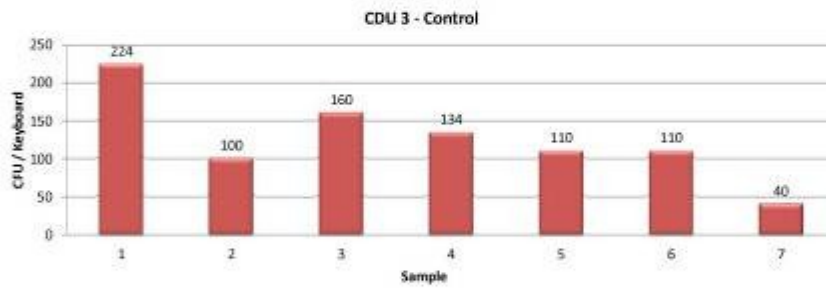
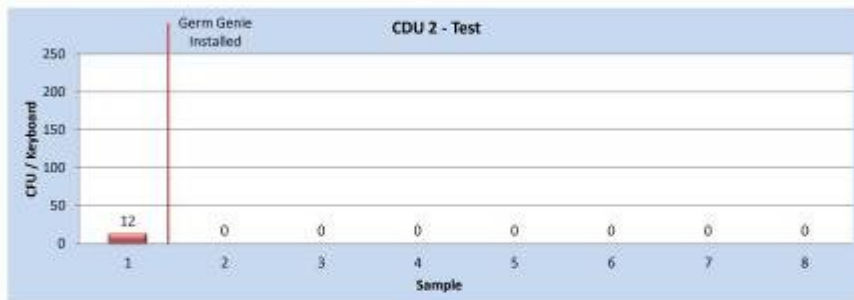
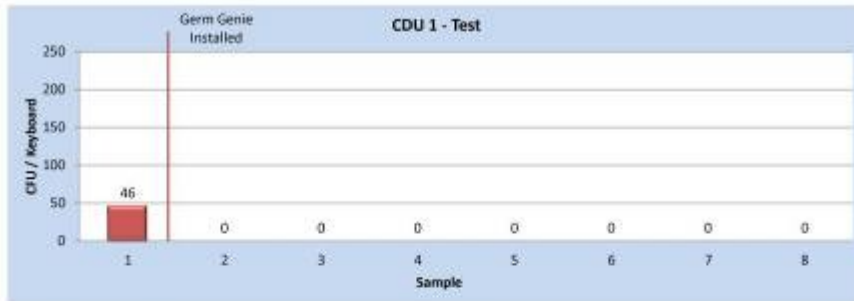
## Wards Results Template: Michael Bates

Day	Date	M/B MR Key-board IT10986 Test			M/B MR Key-board IT10858			M/B Front Key-board IT18100 Test			M/B Front Key-board IT10779		
		Alternate Sampling and plate reading	Direct Plate inoculation on Area A cfu	Broth inoculation Broth A	PBS inoculation Areas BCD in PBS	Direct Plate inoculation on Area A cfu	Broth inoculation Broth A	PBS inoculation Areas BCD in PBS	Direct Plate inoculation on Area A cfu	Broth inoculation Broth A	PBS inoculation Areas BCD in PBS	Direct Plate inoculation on Area A cfu	Broth inoculation Broth A
Monday	18-Jul-11	80	TURBID +	26.66666667	240	TURBID +++	80	320	TURBID +++	133.3333333	160	TURBID ++	106.6666667
Wednesday	20-Jul-11	0	CLEAR	0	84	TURBID +++	120	0	CLEAR	0	76	TURBID ++	120
Friday	22-Jul-11	10	TURBID +	0	50	TURBID +++	160	0	CLEAR	0	68	TURBID ++	120
Monday	25-Jul-11	22	TURBID +	160	34	TURBID +++	160	0	CLEAR	0	40	TURBID ++	160
Wednesday	27-Jul-11	0	CLEAR	0	32	TURBID +++	120	0	CLEAR	0	12	TURBID ++	120
Friday	29-Jul-11	0	TURBID +	0	14	TURBID +	0	0	CLEAR	0	12	TURBID ++	160
Monday	01-Aug-11	60	TURBID +	200	36	TURBID +	320	0	CLEAR	0	10	TURBID ++	40
Wednesday	03-Aug-11	30	TURBID +	200	30	TURBID +	280	Not sampled	Not sampled	Not sampled			
Friday	05-Aug-11	28	TURBID +	160	40	TURBID +	160	Not sampled	Not sampled	Not sampled			

## **Appendix 4- Results in graphical format (Direct Plates)**

## Chemo Day Unit - Direct

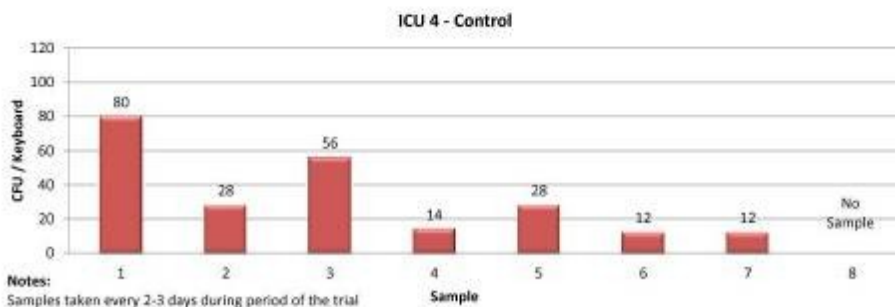
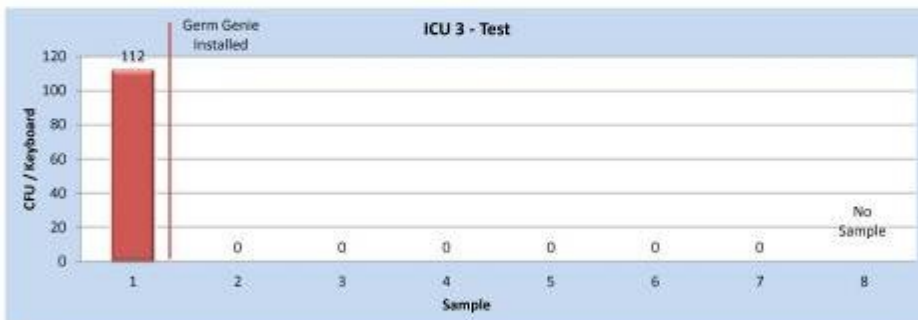
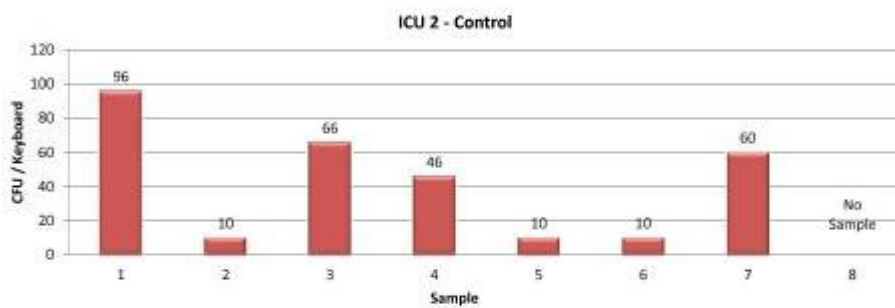
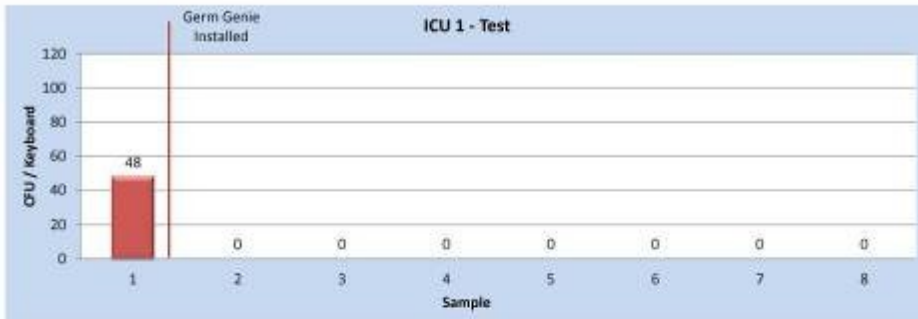
Max CFU - 224



**Notes:**  
 Samples taken every 2-3 days during period of the trial  
 Overall - Excellent compliance

## Intensive Care Unit - Direct

Max CFU - 112

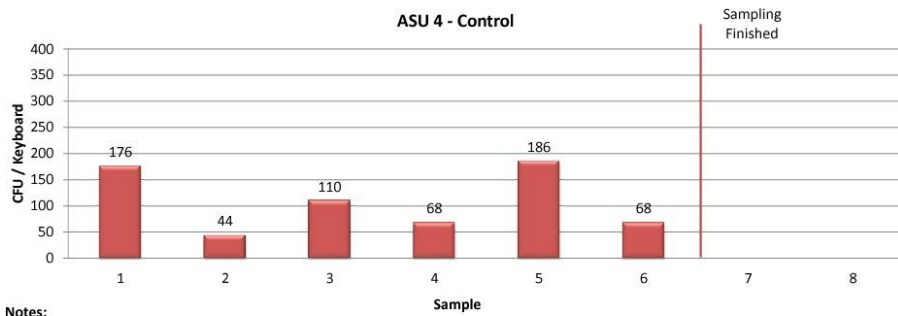
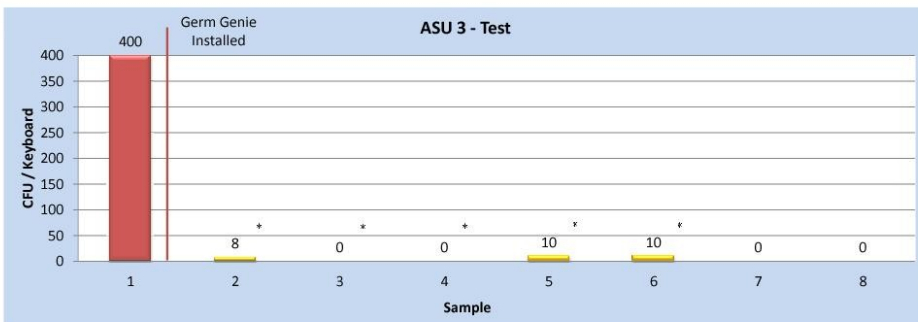
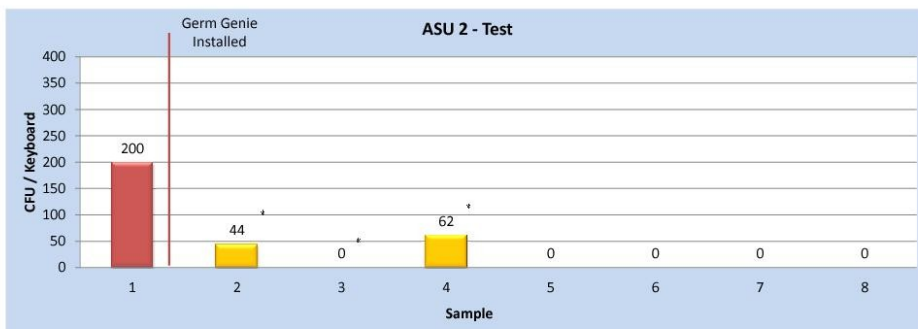
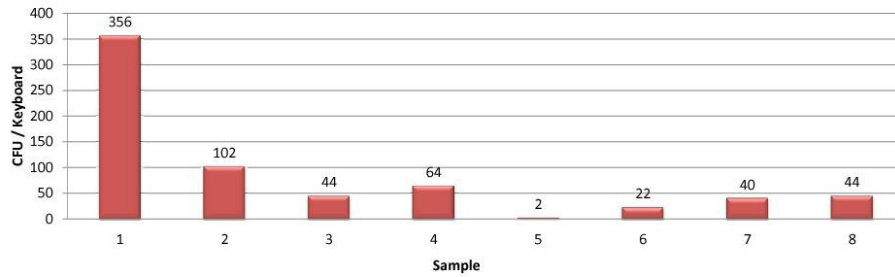


Notes:  
Samples taken every 2-3 days during period of the trial  
Overall - Excellent compliance

## Acute Stroke Unit - Direct

Max CFU - 400

**ASU 1 - Control**



**Notes:**

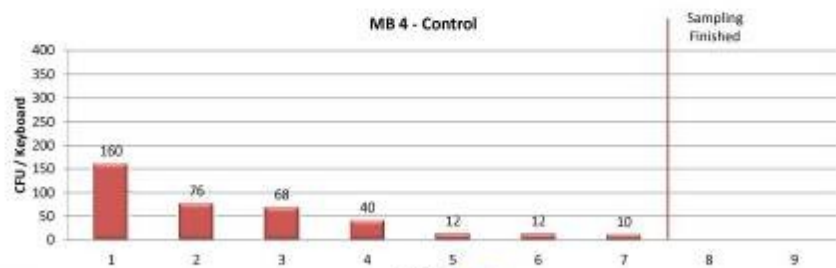
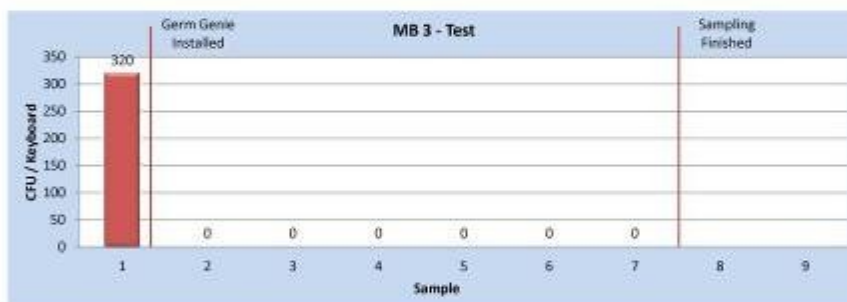
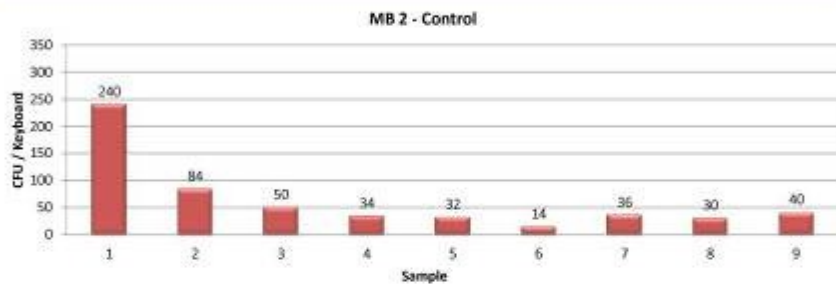
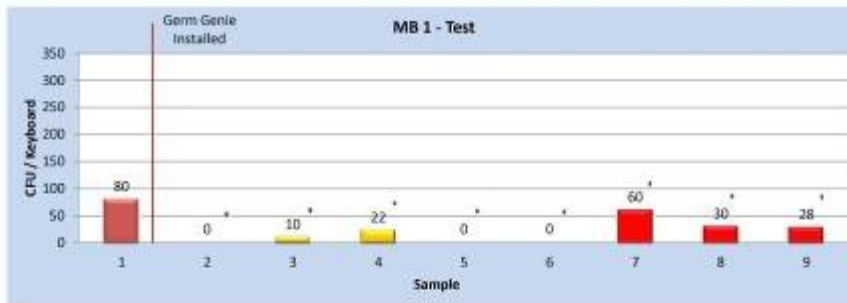
Samples taken every 2-3 days during period of the trial  
 Overall - Germ Genie positioning over keyboard inconsistent



\* Incorrect location of Germ Genie noted

## Michael Bates Ward - Direct

Max CFU - 320



**Notes:**

Samples taken every 2-3 days during period of the trial

Overall - Germ Genie positioning over keyboard inconsistent on MB1, good on MB3

Sample



\* Incorrect location of Germ Genie noted



\* Germ Genie Removed altogether