Application of new technologies in environmental infection control in a regional hospital in Hong Kong

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Commissioned Training on Disinfection and Sterilization

Environmental transmission of HCAI

- Increasing body of evidence showing the importance of environment in transmission of HCA pathogens from infected patients to susceptible patients:
  - Contamination of hosp env
  - Survival of pathogens on surface
  - Indirect transmission: acquisition on HCW hands after contact w/ contaminated env surfaces
  - Direct transmission: patient acquire pathogens after contact w/ env
  - Env cleaning reduces transmission of pathogens

Environmental transmission of HCAI

- Persistence of clinically relevant bacteria on dry inanimate surfaces
  - *Acinetobacter spp.*: 3 days – 5 months
  - *Clostridium difficile* (spores): 5 months
  - *Enterococcus spp.* including VRE and VSE: 5 days – 4 months
  - *Staphylococcus aureus*, including MRSA: 7 days – 7 months
  - Norovirus and feline calicivirus: 8 hours – 7 days
    - WHO Infection Control Toolkit (HA IDC)

Environmental transmission of HCAI

- Acquisition of MRSA on hands after contact w/ skin (40%) and env (45%)
  - *Stiefel U et al. SHEA 2010*
  - *Donskey CJ et al. NEJM 2009*

- No difference in skin & env contamination, and hand acquisition of MRSA after skin contact w/ MRSA carriers identified *clinically* Vs thru' *active surveillance*
  - *Chang S. et al. CID 2009*

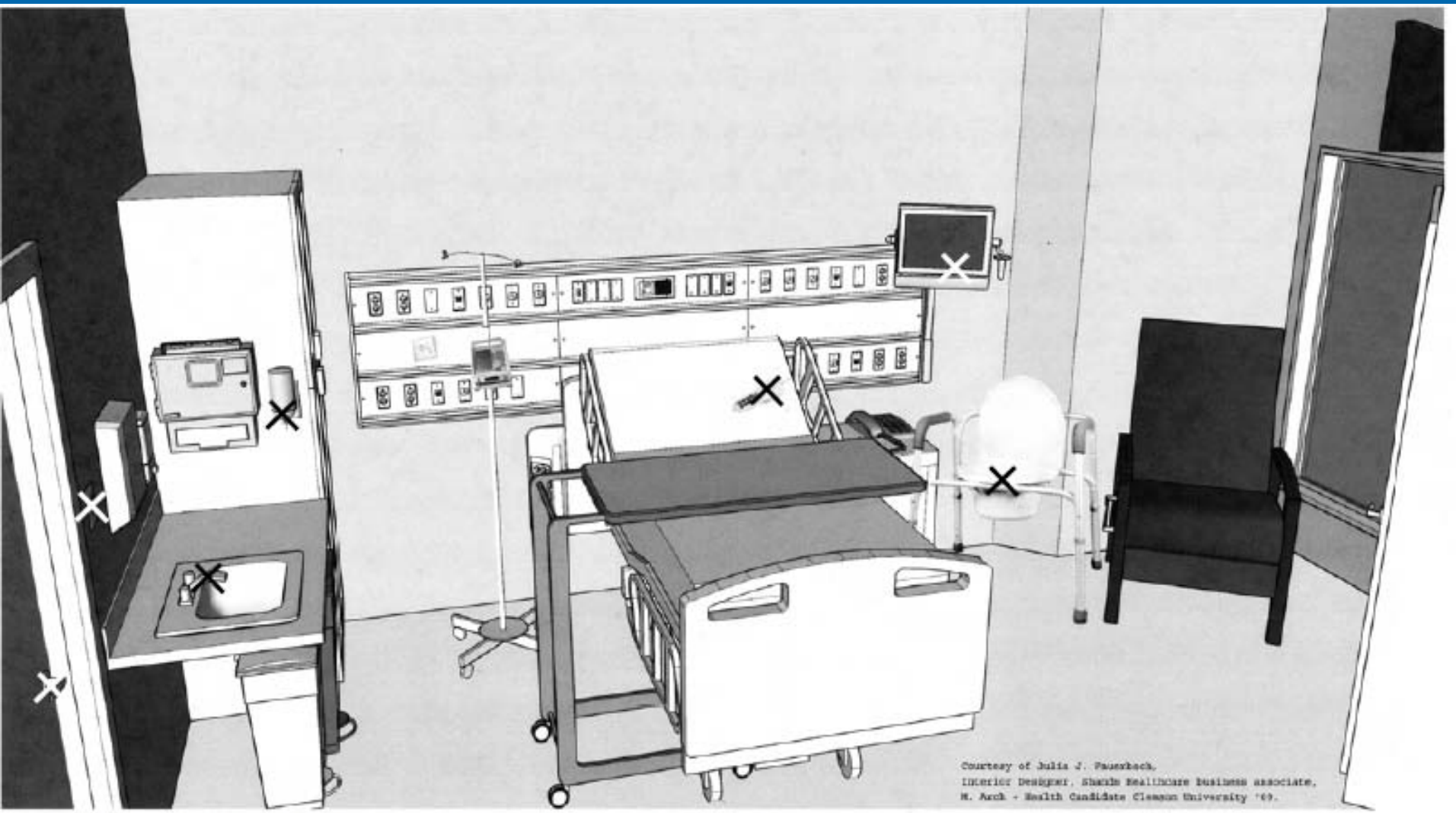
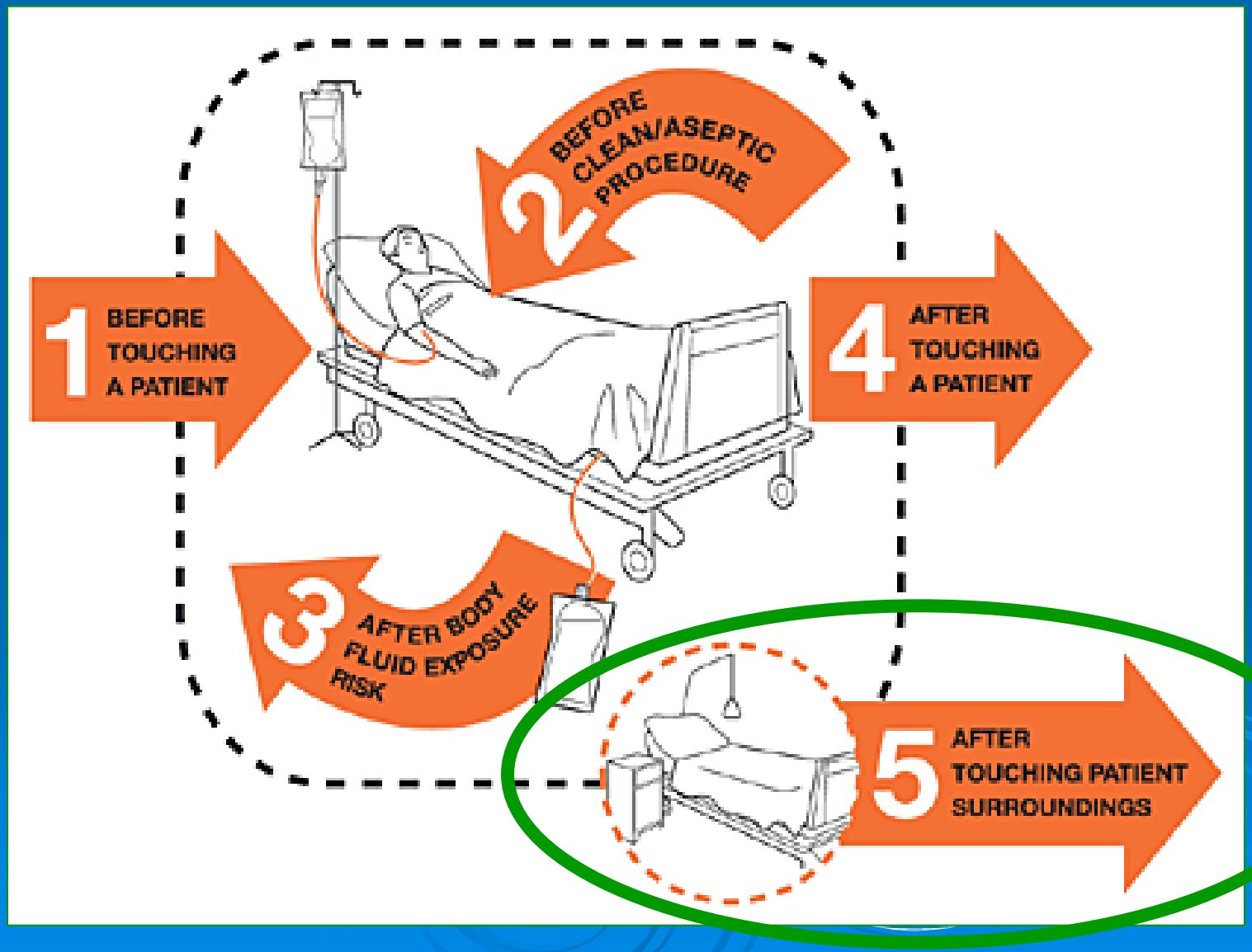


Figure 10.2. Picture of room noting some high touch surfaces and items.

5 Moments of Hand Hygiene (WHO)



Environmental transmission of HCAI

- Even with high compliance to HH, cross-transmission still occurs
  - Pittet D *et al. Ann Intern Med 1999;130: 126-30, 159:821-6*

Problems in manual cleansing in clinical wards: How clean are they?

Assign Responsibility for Cleaning Procedures

- Housekeepers and nursing staff often do not agree on who should clean what
- Housekeepers do not always understand
  - Which detergent/disinfectant to use
  - What concentration should be used
  - What contact times are recommended
  - How often to change cleaning cloths/mop heads
- Develop policies regarding who should clean what

Dumigan DG et al. AJIC 2010 (in press)

Hospital of Saint Raphael

Ways out

- To improve environmental surface manual cleaning
  - What items have been missed
  - How clean are they if not missed
- To look for better surface disinfectants

Ideal tools for checking surface cleanliness

- Sensitive
- Specific
- Quantitative Vs qualitative
- Objective
- Available interpretative standard
- Reproducible
- No Hawthorne effect
- User friendly
- Quick: real-time
- Cheap
- Safe

Checking surface cleanliness

- Indications: routine Vs ad hoc
  - Training
  - Quality assurance
  - Outbreak investigations

How to monitor the effectiveness of surface disinfection?

- Methods for assessing cleaning practices
  - Visual inspection of surfaces
  - Observation of housekeeper techniques
  - Aerobic colony count (ACC)
  - Fluorescent marker system
  - Adeosine triphosphate (ATP) bioluminescence

Improving cleaning & disinfection: How to monitor the effectiveness of surface disinfection?

- ACC
  - Moistened swab inoculated onto agar +/- broth enrichment
  - RODAC (replicate organism detection and counting) plates
  - ACC using cellulose sponges
  - No standard methods
  - No accepted criteria

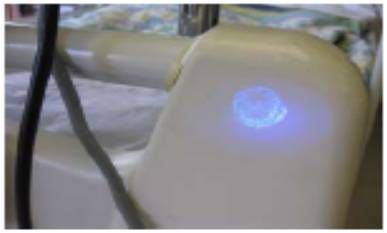
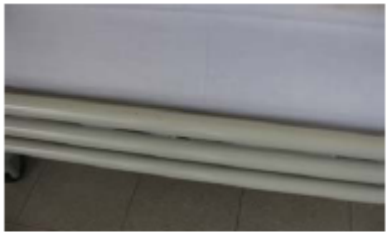
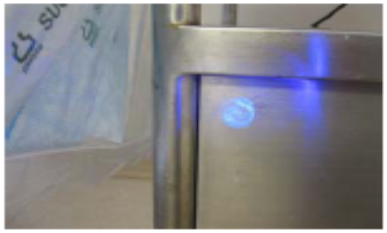
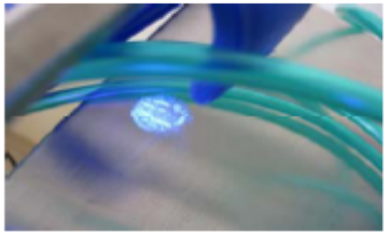
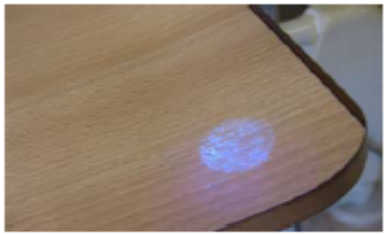
Fluorescent marker system

DAZO® Fluorescent Marking Gel (Ecolab)

Trials at PMH

清潔成績圖示

		
徹底清潔	部分清潔	未有清潔

Site of spot check	Uncleaned surfaces still stained by fluorescence	Site of spot check	Cleaned surfaces showed no fluorescence
Bed end		Bedside rail	
Bedside trolley drawer		Remote control (Bed 2)	
Bedside trolley surface			
Bedside table			

ic Infection Control

Appendix 6(B) 清潔能力評估表

日期:	時間:
部門:	病房:
清潔人員:	評估員:
病床被傳染病人使用：無 / 有 _____	

於清潔前選定檢查區域並以*黃光凝膠/標記*作記號
請於適當的方格加上(✓)

選定區域	標記位置	徹底清潔	部分清潔	未有清潔
可換鈴				
氧氣及抽吸器開關				
床頭位置				
病人枱				
床頭櫃：抽屜拉位及滑動枱枱面				
鍵水支桿：支桿位置				
床墊				

Collaboration with HKUST

- Secondary school project on fluorescent dye pen for hygiene monitoring

ATP bioluminescence

- surrogate marker of bacterial load
- quick, easy, sensitive
- recently proposed as one of the standards for surface hygiene in hospitals in UK

How clean in targeted wards – using 3M ATP Method

Date : 25 June 2009

Venue: G615

W C TANG

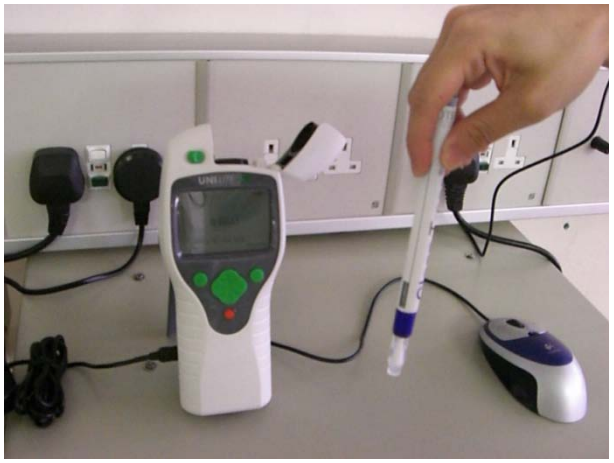
WM ICT&IDC

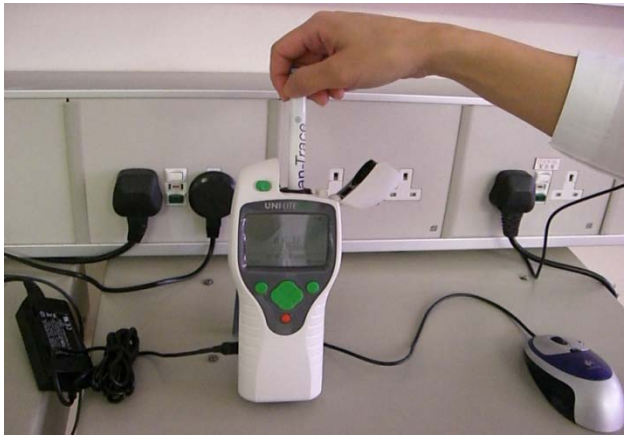
Infection Control Team

Method

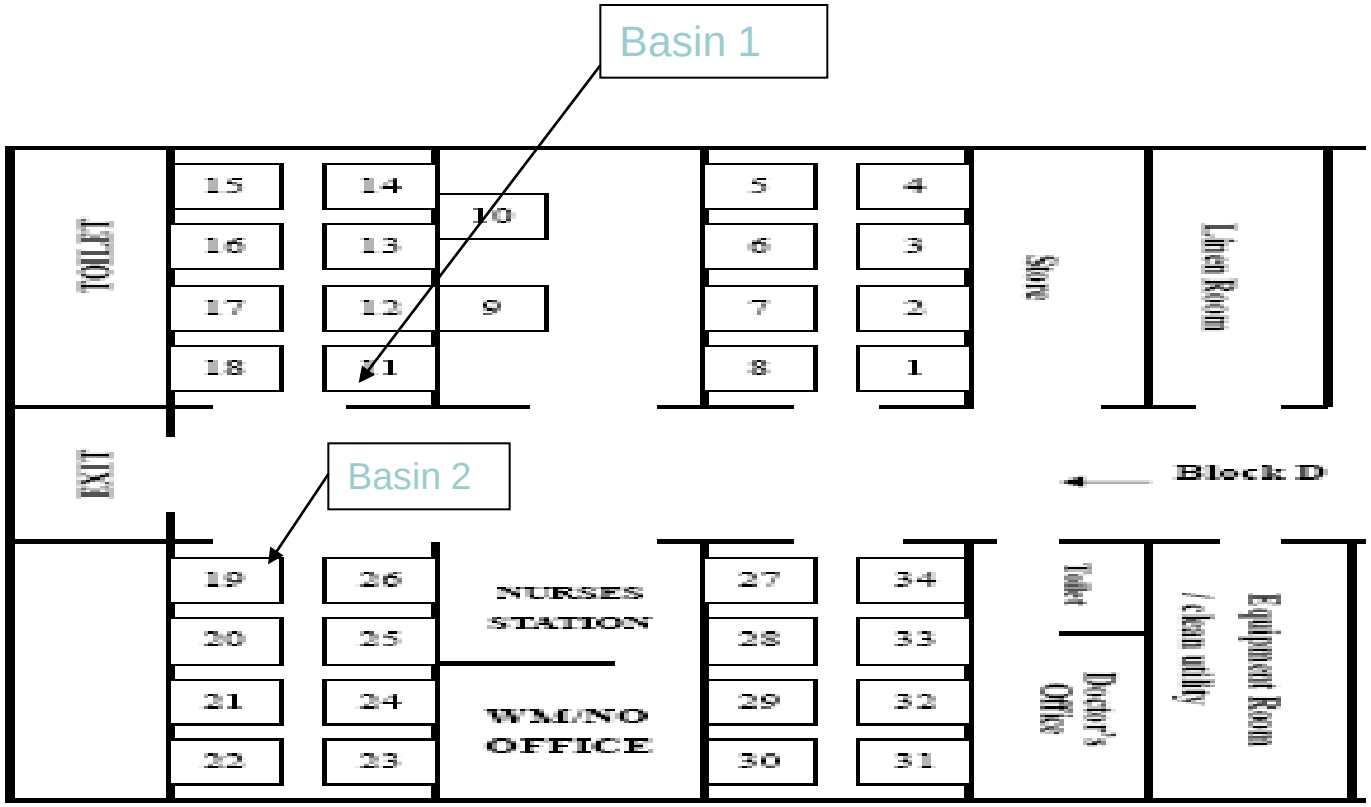
- Use 3M Clean-Trace ATP Surface Hygiene Test
- Swab all sampling areas, common touching area in ward setting
- Review the sampling result

Sampling

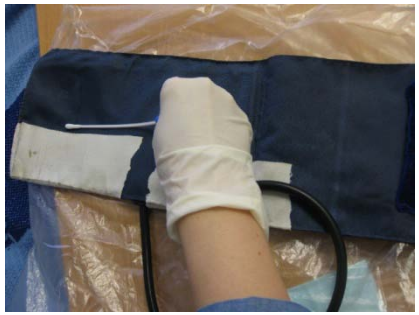




Floor Plan


Basin 1
TOILET
15
14
10
16
13
17
12
9
18
11
5
4
6
3
7
2
8
1
Store
Linen Room
EXIT
Basin 2
Block D
19
26
NURSES STATION
20
25
21
24
WM/NO OFFICE
22
23
27
34
28
33
29
32
30
31
Toilet
Doctor's Office
Equipment Room / clean utility

Sampling locations

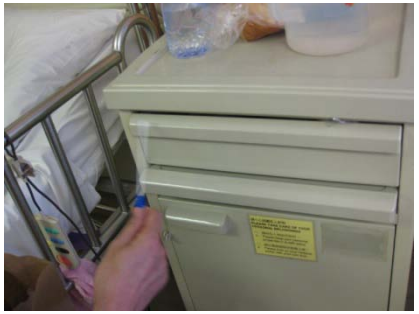


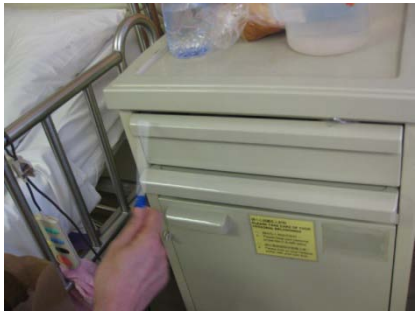
BP cuff

Bed side Basin 1

bedside rail

Call bell





locker

Dressing trolley

Dressing tray

Bottom shelf of dressing tray

Patient Toilet and shower head

Basin handle

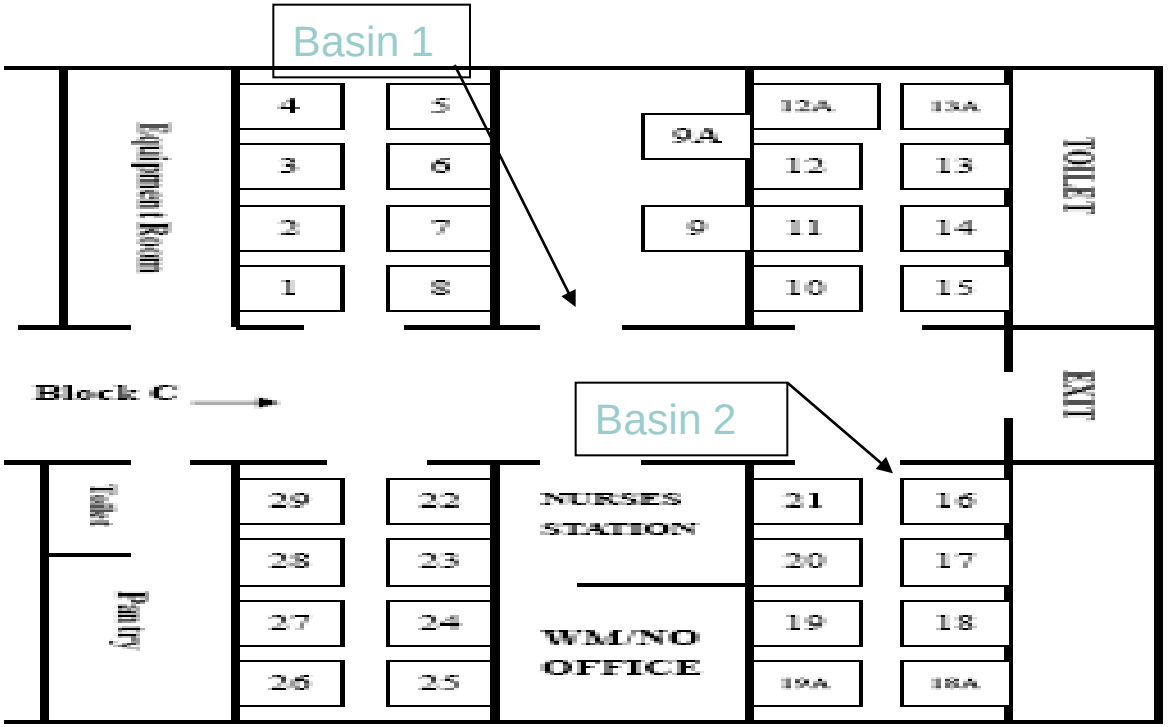
Shower tab

Bathroom handle

Toilet basins

- Patient toilet basin handle

Control ward



Control ward

- Patient toilet basin handle

Data review between two wards

3M Clean-Trace surface ATP Results - FMH

Ward / Swabbed sites	Ward 23/6/09 at 10am (RLU)	Ward 23/6/09 at 4pm (RLU)	Ward 24/6/09 at 11am After cleansing before patient use (RLU)	Ward 25/6/09 at 11am Cleansing under DH supervior's supervision (RLU)	(Control) 23/6/09 at 4pm (RLU)	(Control) 24/6/09 at 10am (RLU)	(Control) 24/6/09 at 10am After cleansing before patient use (RLU)
Basin 1	224	184		19	63	224	
Basin 2	283	69			513	1443 *	
Dr Tray	196	157			139	348	
Dr Trolley	590	53			12	19	
Pt toilet basin (Lt) handle	859	7056 * / 8007	31798 * / 159302 / 6067 / 501	25	3274		154
Pt toilet basin (Rt) handle	541 *	3224	45771 * / 26755 / 24541	42	9498		800
Pt toilet flush	*		3504	617			
Pt Bathroom shower tab	826		445	31	517		388
Pt Bathroom shower handle	3770 * / 2208		372	98	43		138
bed 23A bedside locker	376	219			1703		
bed 9A call bell	380			57			
bed 9A locker	348			30	122		
bed 10 side rail	382						
bed 10 BP cuff	441						
HO keyboard (Lt)	401						
HO keyboard (Rt)	289				319		125

Remarks:

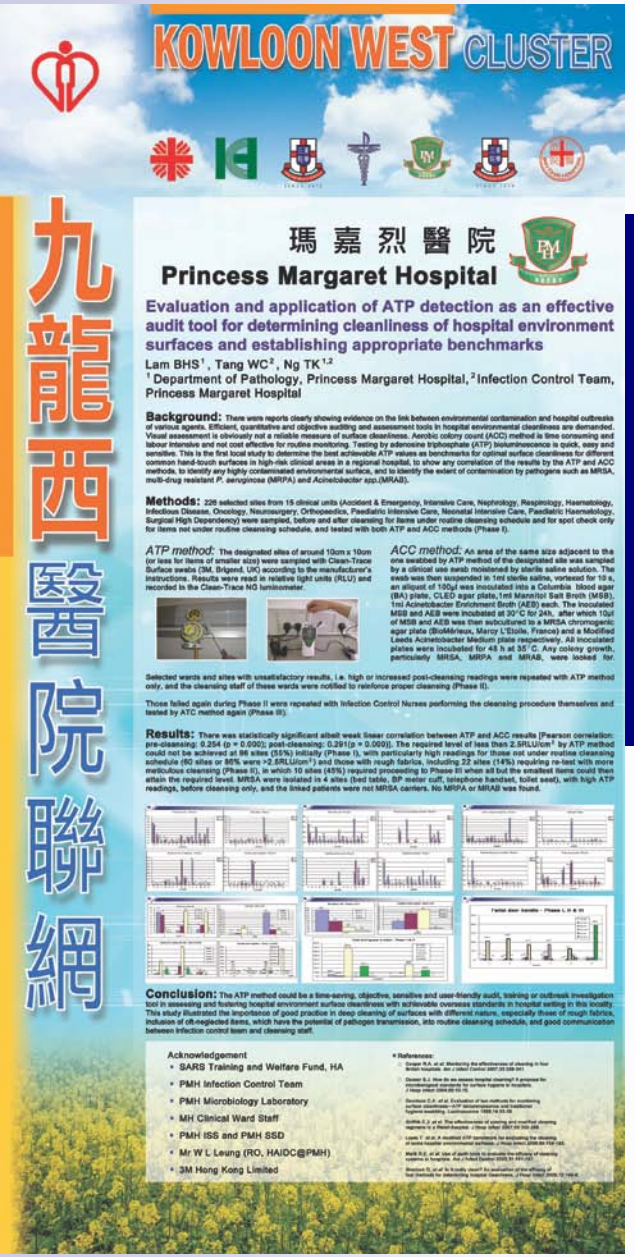
* swab taken for c/t

Post-cleansing means swabbed taken immediately after cleansing without any contact by patient

ATP passing result : less than 250

Comments

- Cleaning work should be reinforced in targeted wards
- Set basic standard
- Step up frequency of cleaning service for common touching surfaces
- Observe compliance
- Demo cleaning method to those staff with lapse practice ASAP
- Collect feedback from users



Clean-Trace Study at PMH: Evaluation and application of ATP detection as an effective audit tool for determining cleanliness of hospital environment surfaces and establishing appropriate benchmarks

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[1]Department of Pathology, Princess Margaret Hospital,
[2]Infection Control Team, Princess Margaret Hospital

Objectives

- To determine site-specific thresholds of ATP values as benchmarks for surface cleanliness by comparison of results of pre- and post-cleansing samples taken from common hand-touch surfaces in high-risk clinical areas.
- To show any correlation of the results by the ATP and ACC methods.
- To identify any highly contaminated environmental surface.
- To identify the extent of contamination by hospital pathogens such as MRSA and *Acinetobacter spp.*

Methods

- **Target areas**
  - Total **15** clinical areas
    - A&E
    - ONC-H4N
    - Renal-P2, P3
    - ICU-S6, F4
    - MID-S12
    - Resp-F3
    - Haem-C6
    - NSHDU-A6
    - O&T-D5
    - PICU-A1
    - PHaem-B1
    - NICU-D1
    - SHDU-D4

Methods

- **Phase I**
  - **Sampling sites**
    - sites under **routine cleansing schedule**: sampled twice for **pre-** and **post-cleansing** testing on the same day (Total: **156** sites)
    - The cleansing procedures on the site sampled are supposed to be the standard ones or under supervision
      - **Location 1: Bed unit**
        - Patient locker
        - Bed table
        - Bedside rail (or mattress for A&E)
        - Suction port regulator
        - BP meter cuff
        - Touch screen of bedside monitor (for ICU, NSHDU, SHDU)
        - Ventilator control panel (for Resp, ICU, NSHDU, SHDU)
      - **Location 2: Nursing station**
        - Telephone handset
        - CMS computer keyboard
      - **Location 3: Patient toilet**
        - Toilet seat
        - Toilet flushing lever or button
        - Toilet door handle

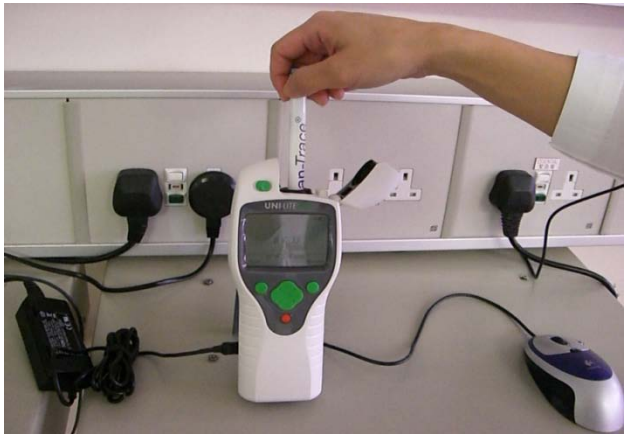
Methods

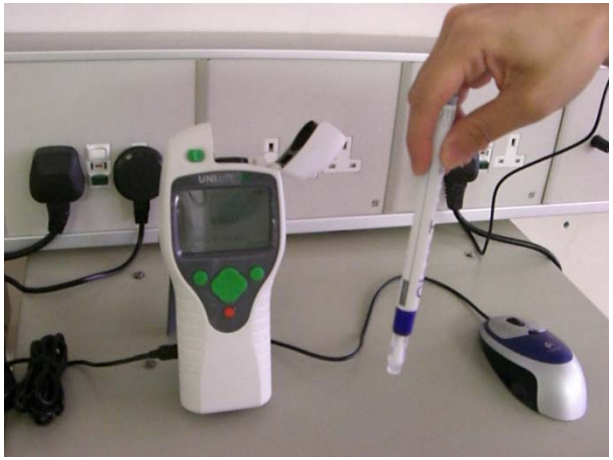
- The sites for **spot check** will be sampled once only (Total: **70** sites)
  - Infusion pump
  - BP meter control panel
  - Stethoscope diaphragm
  - Tympanic thermometer
  - Trolley (dressing or multi-purpose)

Methods

- **Sampling methods**
  - **ATP**
    - **Clean-Trace Surface swabs (3M, Brigend, UK) - according to the manufacturer's instructions: swab the designated site of ~10cm x 10cm (or less for items of smaller size**
    - **Results (in relative light units, RLU) were read and recorded in the Clean-Trace NG luminometer**

3M Clean-Trace - Sampling





Methods

- ACC
  - Clinical use dry swabs were moistened in sterile saline solution prior to use
  - An area adjacent to and of the same size as the one swabbed by ATP method of the designated site
  - swab suspended in 1ml sterile saline, vortexed for 10 s, 100µl on to a Columbia blood agar (BA) plate, CLED agar plate,1ml Mannitol Salt Broth (MSB), 1ml Acinetobacter Enrichment Broth (AEB) each
  - The inoculated MSB and AEB were incubated for 24h at 30°C
  - 10µl of MSB and AEB was then be subcultured to a MRSA chromogenic agar plate (BioMérieux, Marcy L'Etoile, France) and a Modified Leeds Acinetobacter Medium plate respectively
  - All inoculated plates were incubated for 48 h at 35°C
  - Any colony growth on the BA plates was counted (in colony forming units, CFU) and significant bacteria e.g. MRSA, *P. aeruginosa, Acinetobacter spp.* were looked for

Methods

- **Period for sampling**
  - 3 – 23 September 2009

Methods

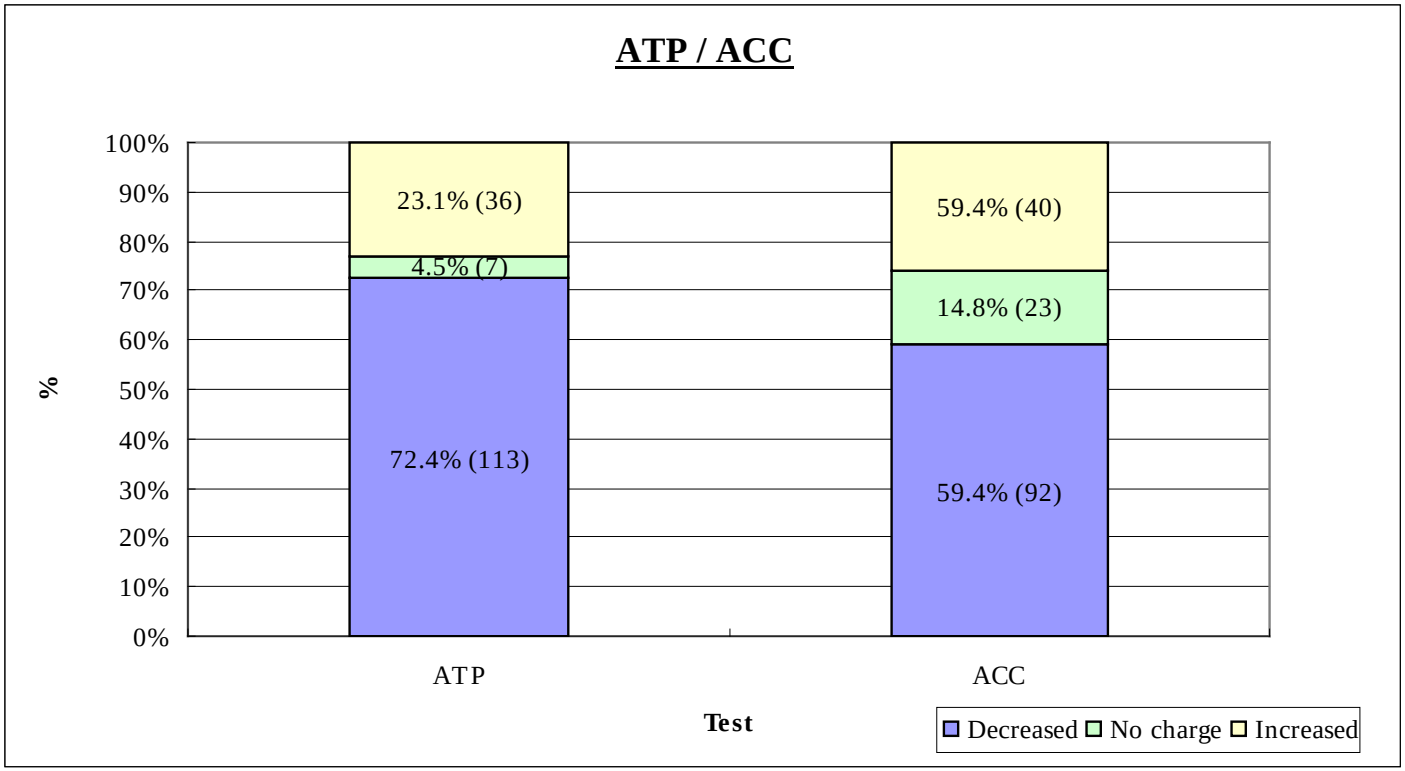
- Phase II
  - Selected wards and sites with unsatisfactory results, i.e. high or increased (as c.f. pre-cleansing) post-cleansing readings, were repeated with ATP method only
  - The cleansing staff of these wards were notified in advance to reinforce proper cleansing

Methods

- Phase III
  - Those failed again during Phase II were repeated with ICT performing the cleansing procedure themselves and tested by ATC method again

Results: Phase I

- Pre-/post-cleansing comparison



Results: Phase I

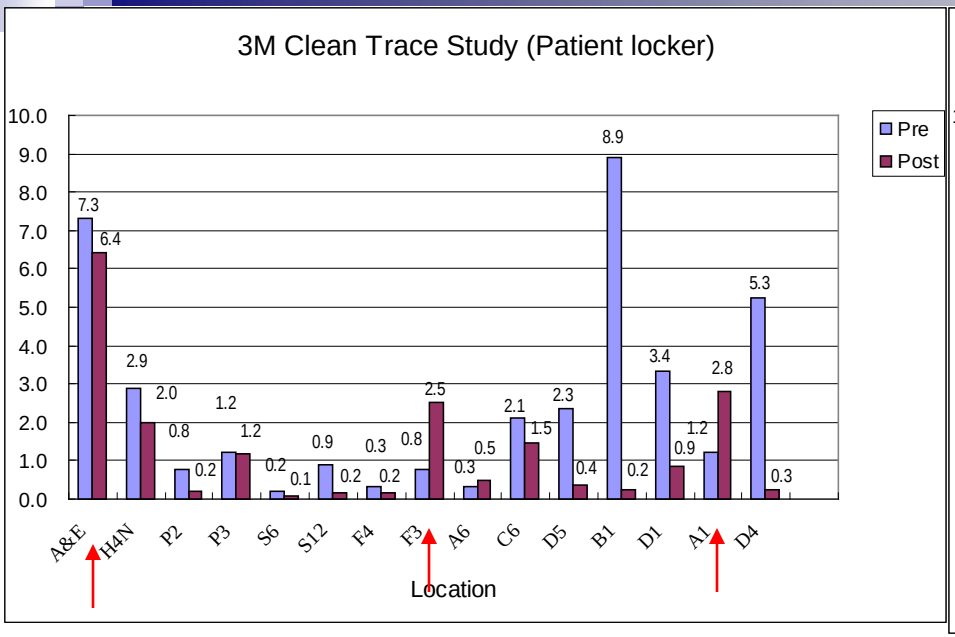
- Correlation between ATP & ACC
  - Pre-cleansing: Pearson correlation = 0.254 (p = 0.000)
  - Post-cleansing: Pearson correlation = 0.291 (p = 0.000)
  - Difference between pre-/post-cleansing: Pearson correlation = - 0.10 (p = 0.907)

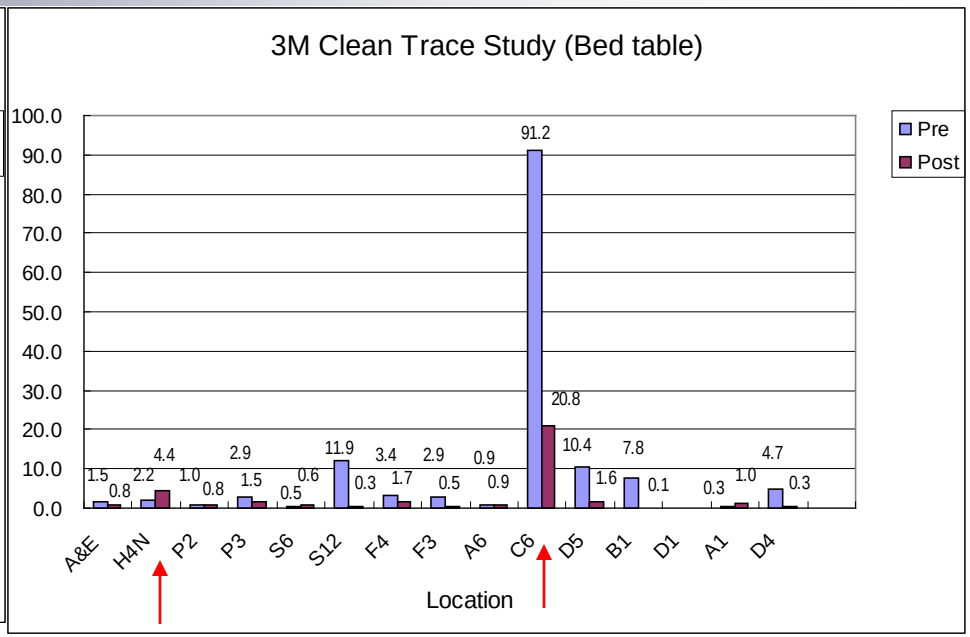
Results: Phase I

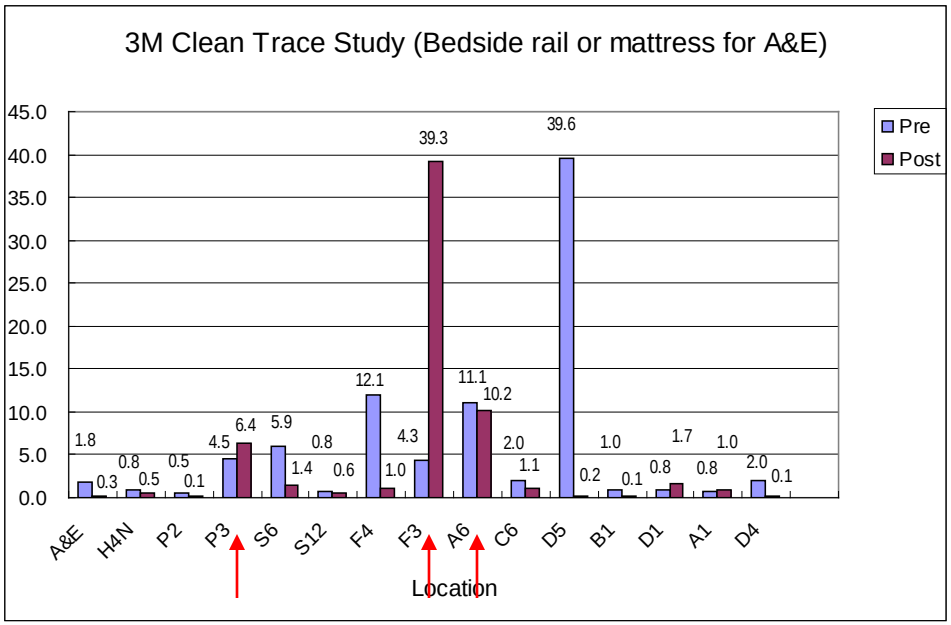
- Post-cleansing (all sites)
  - ATP > 2.5 RLU/cm^2: 86 (55%)
  - ACC > 10 CFU/cm^2: 39 (25%)
- 22 (14%) sites required Phase II

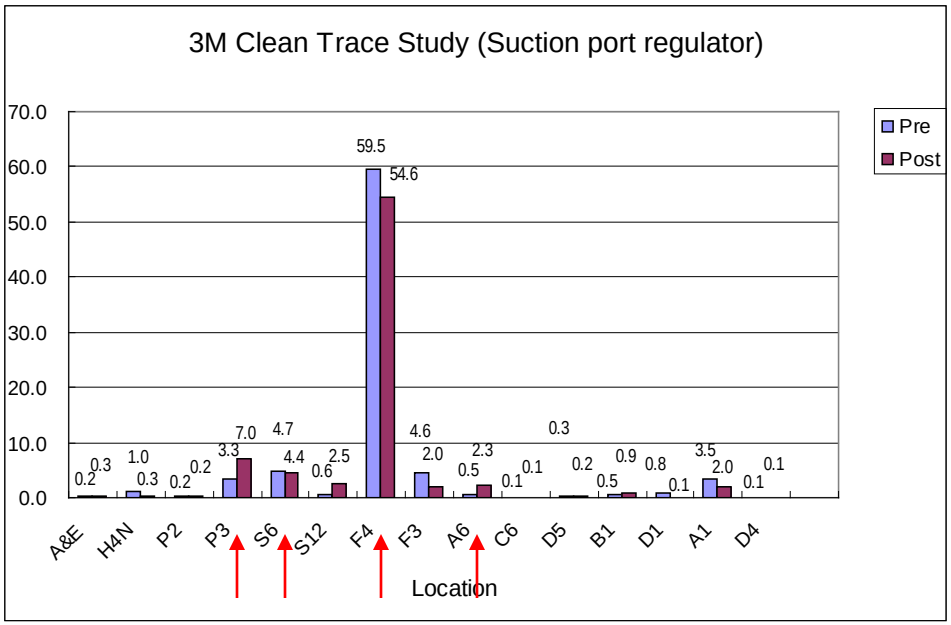
ATP Post-reading (sites with decreased readings only)			
Median		2.0000	
Std. Deviation		514.72309	No. of cases below the percentile
Percentiles	50	2.0000	*56 (out of 113)*
	60	5.1200	*68 (out of 113)*
	70	7.9000	*79 (out of 113)*
	75	11.6500	*85 (out of 113)*
	80	17.1200	*91 (out of 113)*
	85	21.9900	*96 (out of 113)*
	90	34.6200	*102 (out of 113)*
	95	138.3000	*108 (out of 113)*

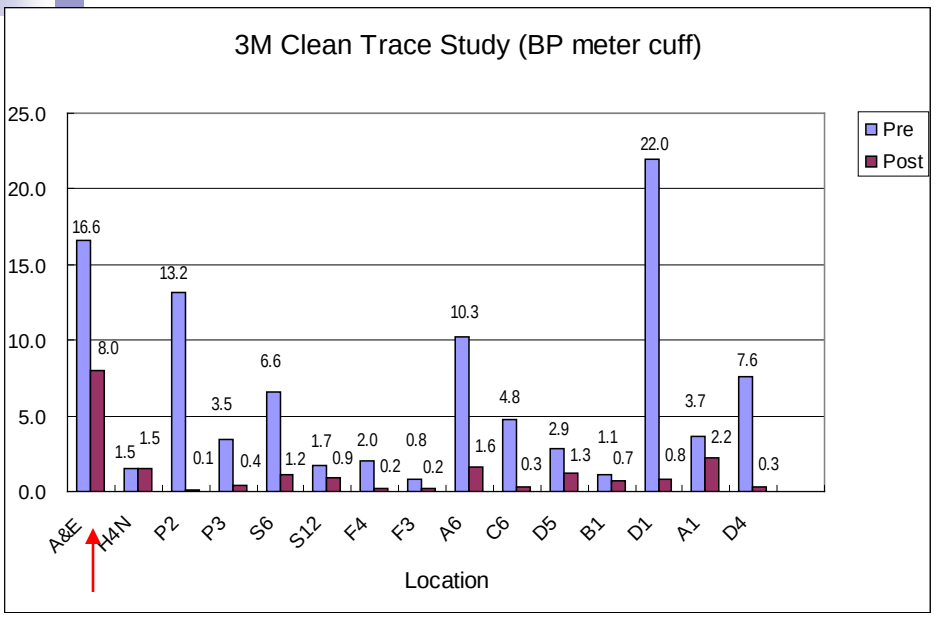
ACC Post-reading (sites with decreased counts only)			
Median		.1000	
Std. Deviation		13.47286	No. of cases below the percentile
Percentiles	50	.1000	*34 (ou of 93)*
	60	.2000	*47 (out of 93)*
	70	.9000	*64 (out of 93)*
	75	1.0000	*66 (out of 93)*
	80	1.0200	*75 (out of 93)*
	85	2.8200	*79 (out of 93)*
	90	6.6000	*84 (out of 93)*
	95	20.0000	*88 (out of 93)*

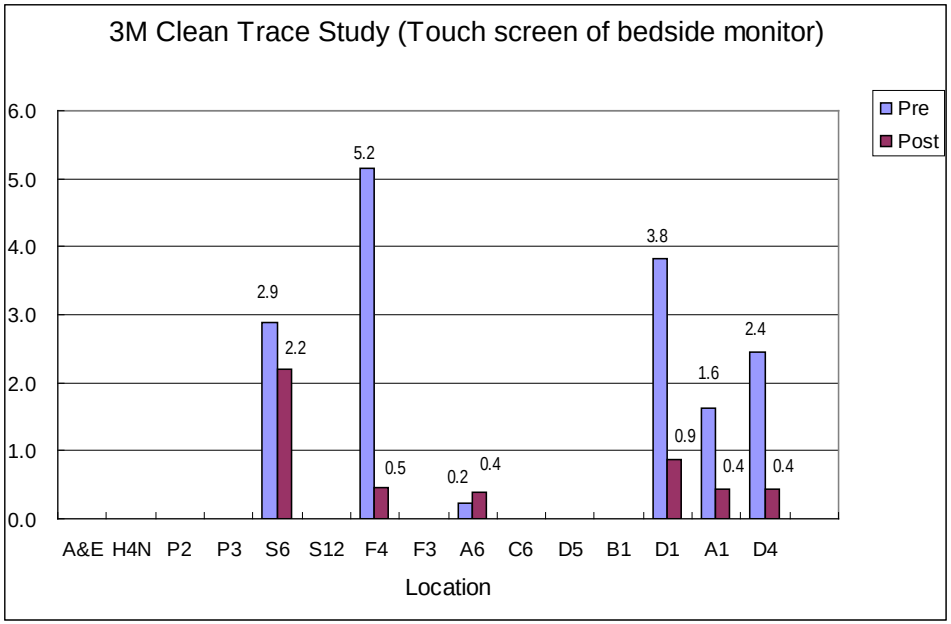

3M Clean Trace Study (Patient locker)
Pre
Post
Location
A&E
H4N
P2
P3
S6
S12
F4
F3
A6
C6
D5
B1
D1
A1
D4

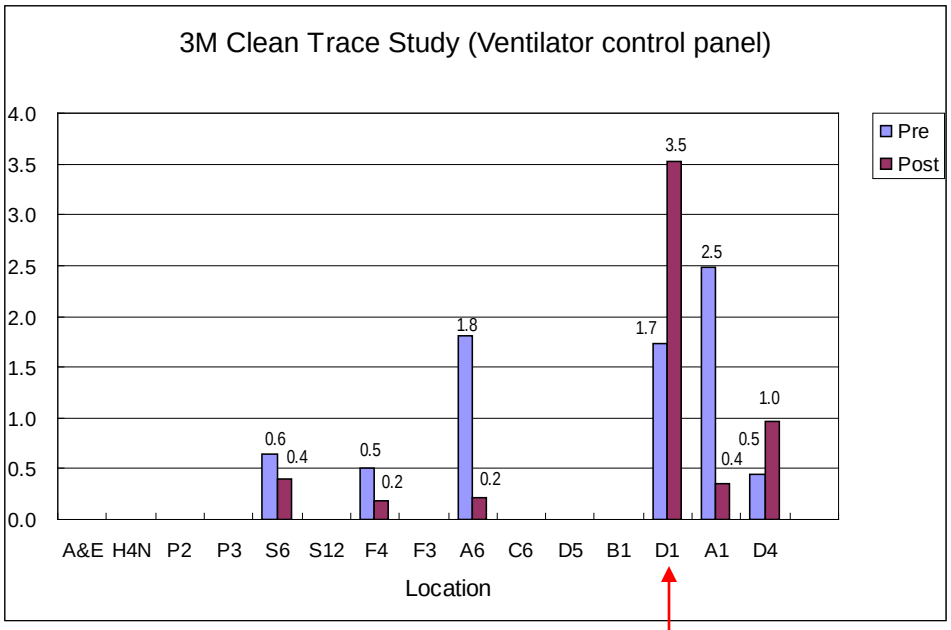

3M Clean Trace Study (Bed table)
Pre
Post
Location
A&E
H4N
P2
P3
S6
S12
F4
F3
A6
C6
D5
B1
D1
A1
D4

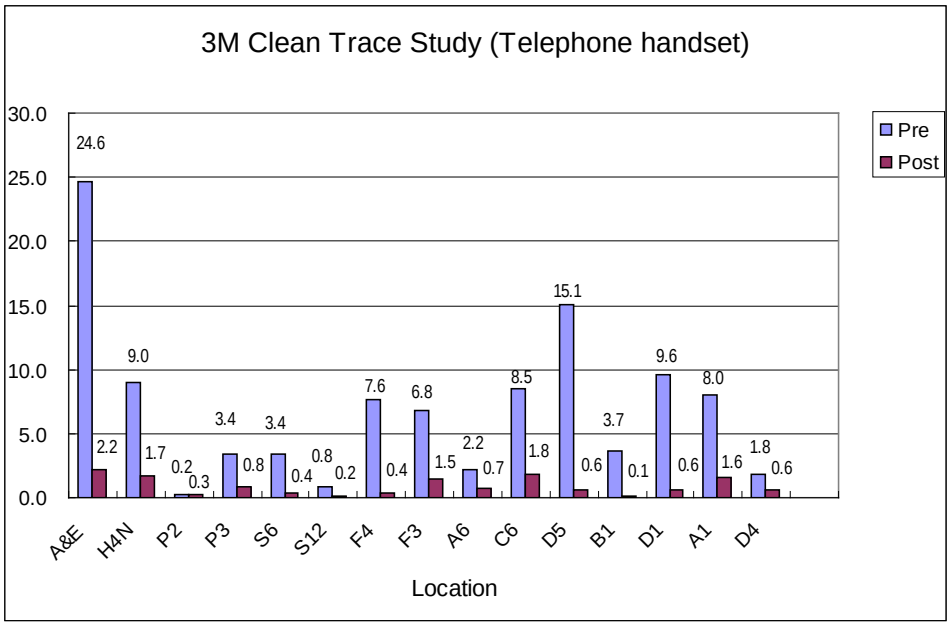

3M Clean Trace Study (Bedside rail or mattress for A&E)
Pre
Post
Location
A&E
H4N
P2
P3
S6
S12
F4
F3
A6
C6
D5
B1
D1
A1
D4

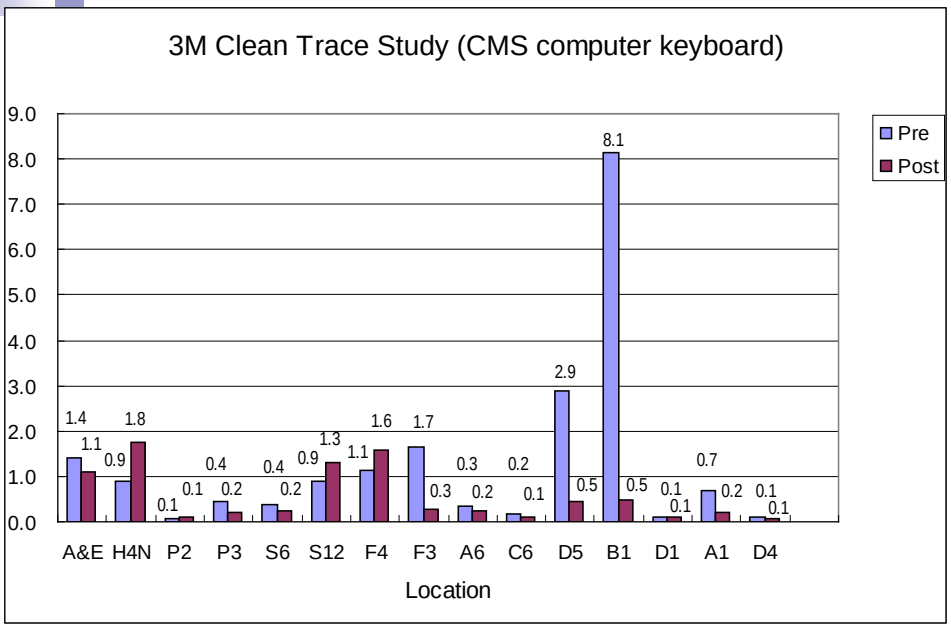

3M Clean Trace Study (Suction port regulator)
Pre
Post
Location
A&E
H4N
P2
P3
S6
S12
F4
F3
A6
C6
D5
B1
D1
A1
D4

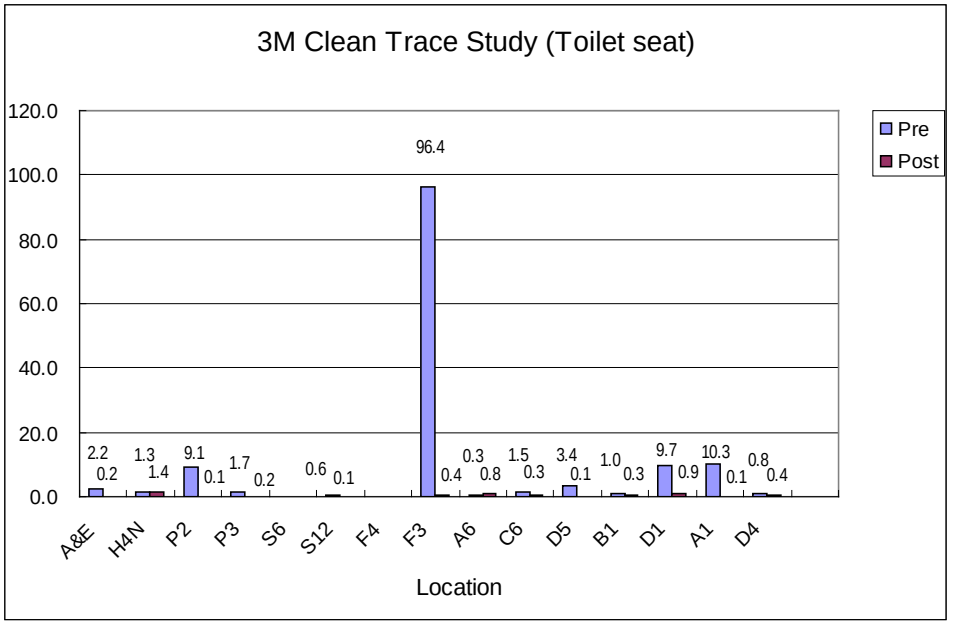

3M Clean Trace Study (BP meter cuff)
Pre
Post
Location
A&E H4N P2 P3 S6 S12 F4 F3 A6 C6 D5 B1 D1 A1 D4
16.6 8.0
1.5 1.5
13.2 0.1
3.5 0.4
6.6 1.2
1.7 0.9
2.0 0.2
0.8 0.2
10.3 1.6
4.8 0.3
2.9 1.3
1.1 0.7
22.0 0.8
3.7 2.2
7.6 0.3

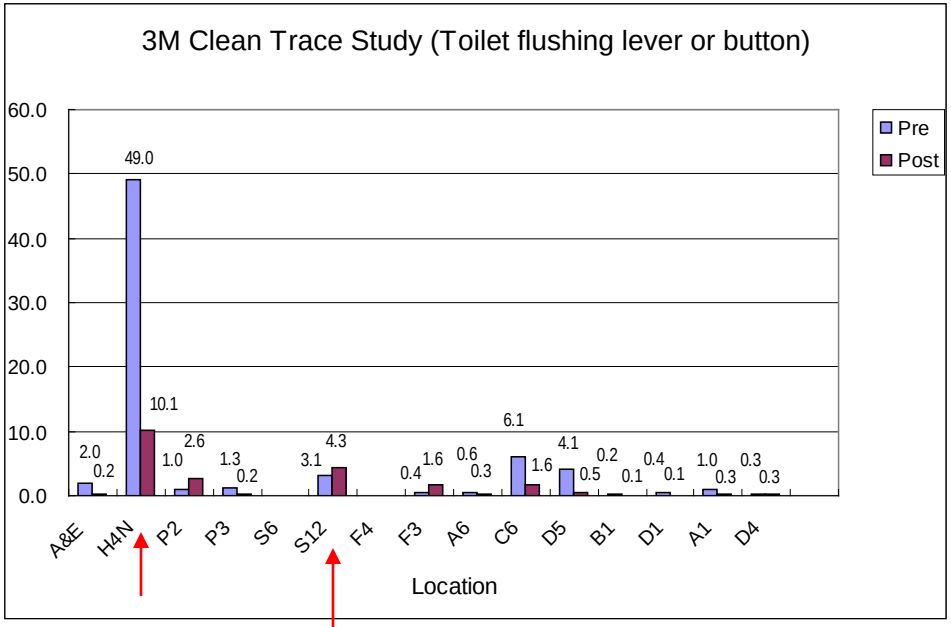

3M Clean Trace Study (Touch screen of bedside monitor)
Pre
Post
Location
A&E H4N P2 P3 S6 S12 F4 F3 A6 C6 D5 B1 D1 A1 D4
2.9 2.2
5.2 0.5
0.2 0.4
3.8 0.9
1.6 0.4
2.4 0.4

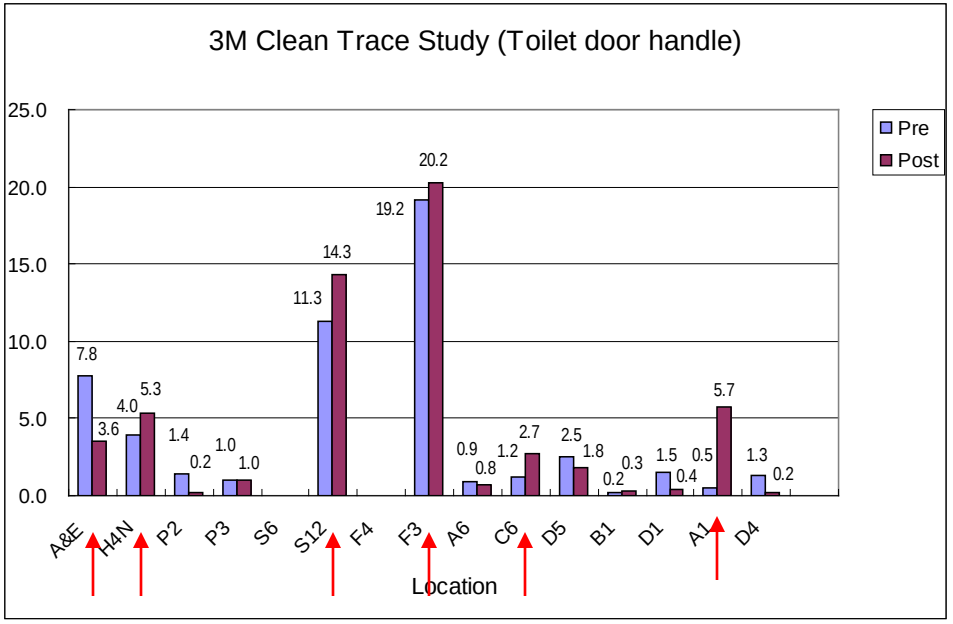

3M Clean Trace Study (Ventilator control panel)
Pre
Post
Location
A&E H4N P2 P3 S6 S12 F4 F3 A6 C6 D5 B1 D1 A1 D4
0.6 0.4
0.5 0.2
1.8 0.2
1.7 3.5
2.5 0.4
0.5 1.0


3M Clean Trace Study (Telephone handset)
Pre
Post
Location
A&E H4N P2 P3 S6 S12 F4 F3 A6 C6 D5 B1 D1 A1 D4
24.6 2.2
9.0 1.7
0.2 0.3
3.4 0.8
3.4 0.4
0.8 0.2
7.6 0.4
6.8 1.5
2.2 0.7
8.5 1.8
15.1 0.6
3.7 0.1
9.6 0.6
8.0 1.6
1.8 0.6


3M Clean Trace Study (CMS computer keyboard)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1.4 1.1 0.9 1.8 0.1 0.1 0.4 0.2 0.4 0.2 0.9 1.3 1.1 1.6 1.7 0.3 0.3 0.2 0.2 0.1 2.9 0.5 8.1 0.5 0.1 0.1 0.7 0.2 0.1 0.1
A&E H4N P2 P3 S6 S12 F4 F3 A6 C6 D5 B1 D1 A1 D4
Location
Pre
Post


3M Clean Trace Study (Toilet seat)
120.0
100.0
80.0
60.0
40.0
20.0
0.0
2.2 0.2 1.3 1.4 9.1 0.1 1.7 0.2 0.6 0.1 96.4 0.4 0.3 0.8 1.5 0.3 3.4 0.1 1.0 0.3 9.7 0.9 10.3 0.1 0.8 0.4
A&E H4N P2 P3 S6 S12 F4 F3 A6 C6 D5 B1 D1 A1 D4
Location
Pre
Post


3M Clean Trace Study (Toilet flushing lever or button)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
2.0 0.2 49.0 10.1 1.0 2.6 1.3 0.2 3.1 4.3 0.4 1.6 0.6 0.3 6.1 1.6 4.1 0.5 0.2 0.1 0.4 0.1 1.0 0.3 0.3 0.3
A&E H4N P2 P3 S6 S12 F4 F3 A6 C6 D5 B1 D1 A1 D4
Location
Pre
Post


3M Clean Trace Study (Toilet door handle)
25.0
20.0
15.0
10.0
5.0
0.0
7.8 3.6 4.0 5.3 1.4 0.2 1.0 1.0 11.3 14.3 19.2 20.2 0.9 0.8 1.2 2.7 2.5 1.8 0.2 0.3 1.5 0.4 0.5 5.7 1.3 0.2
A&E H4N P2 P3 S6 S12 F4 F3 A6 C6 D5 B1 D1 A1 D4
Location
Pre
Post

Results: Phase I

- Organisms:
  - 4 MRSA identified but the related patients were not MRSA carriers

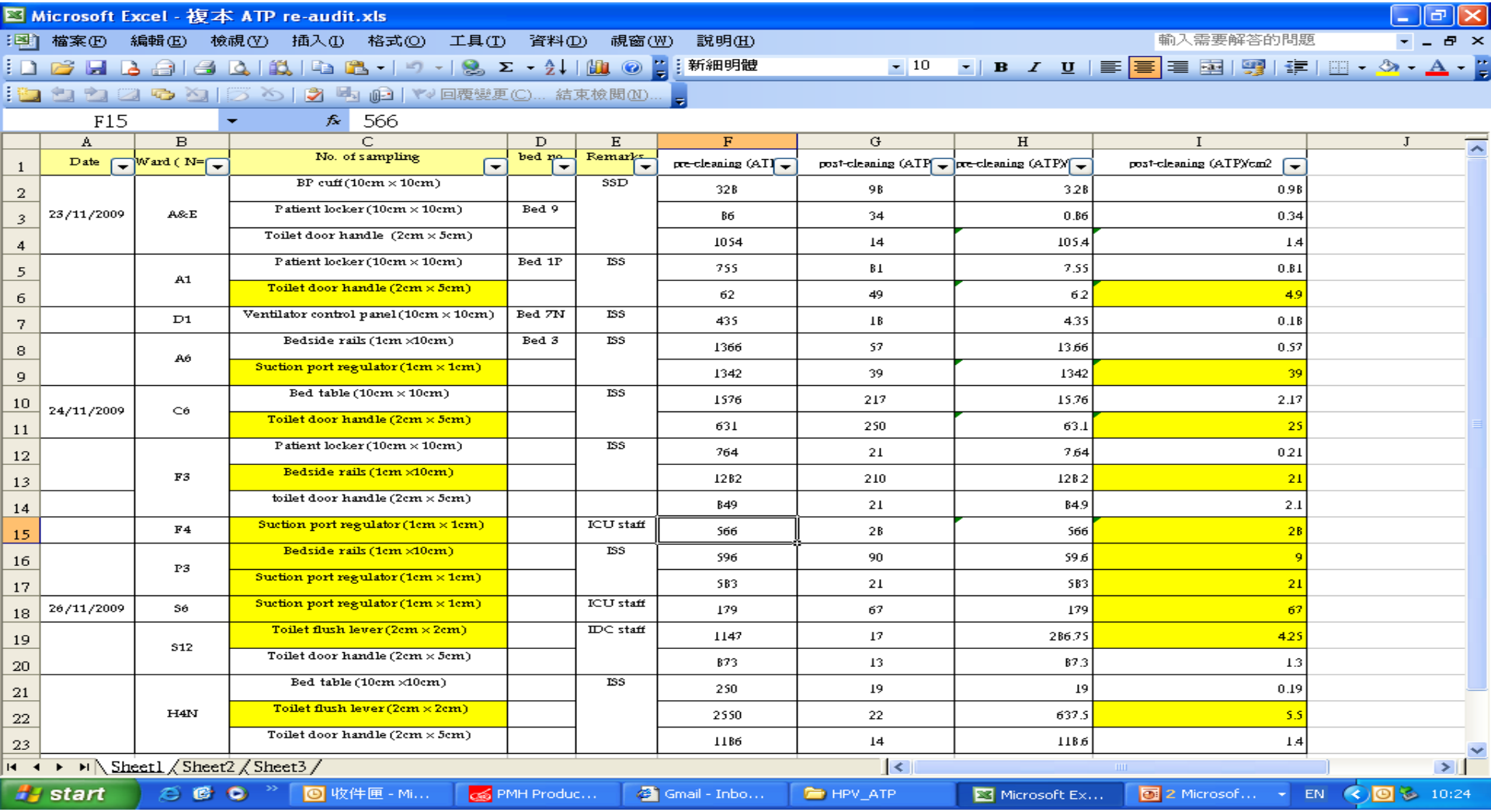
Ward	**Site**	**Pre-/Post-cleansing**	**ATP (RLU/cm^2)**	**ACC (CFU/cm^2)**
F4	Bed table	Pre	3.4	15
P2	BP meter cuff	Pre	13.2	15
F4	Telephone handset	Pre	76	11
C6	Toilet seat	Pre	1.9	37.5

  - *Pseudomonas spp.* and *Acinetobacter spp.* identified but not multi-drug resistant

Results: Phase I

- Spot check:
  - ATP > 2.5 RLU/cm^2: 60 (86%)
  - ACC > 10 CFU/cm^2: 16 (23%)

Results: Phase II


Microsoft Excel - 複本 ATP re-audit.xls

F15 566

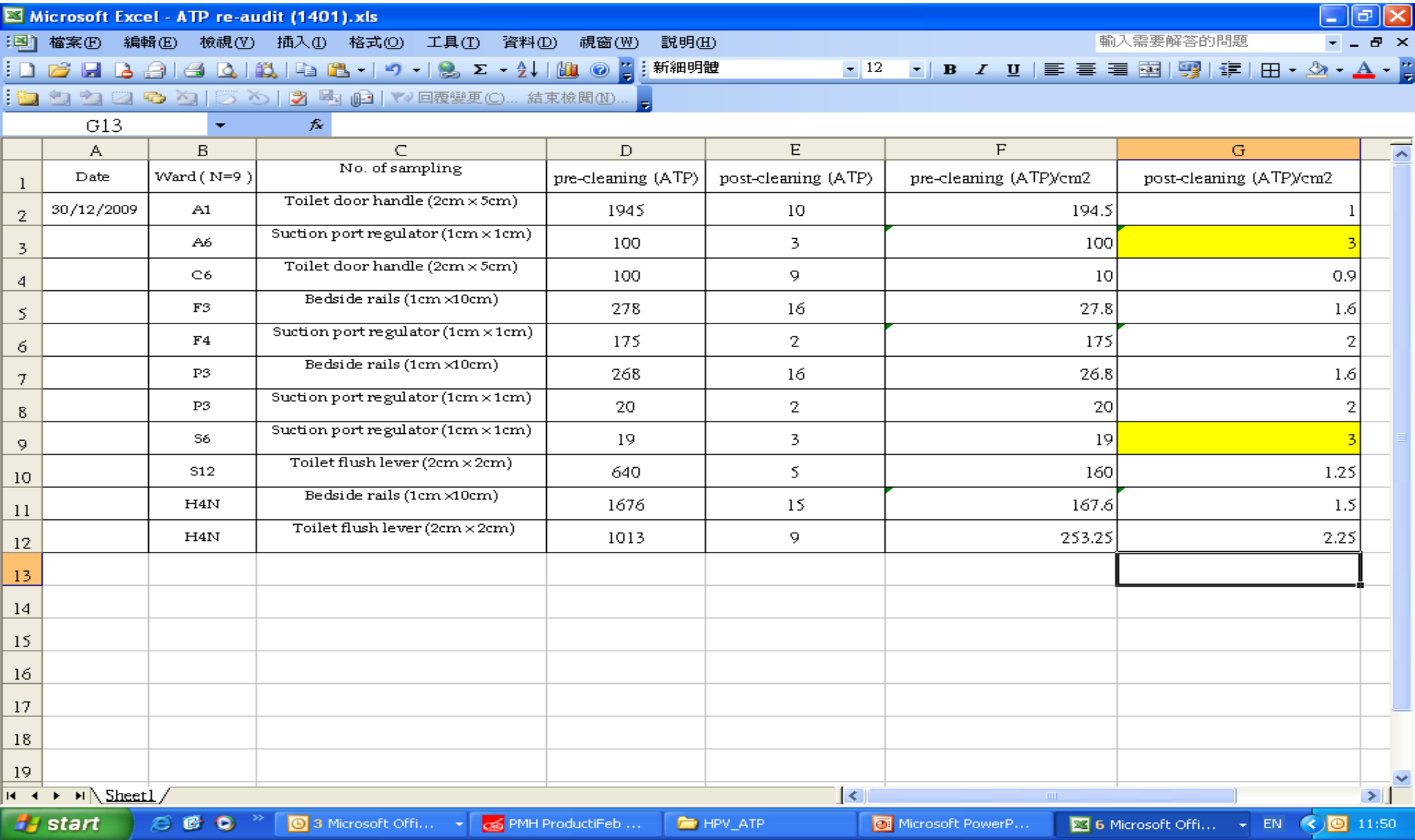
	A	B	C	D	E	F	G	H	I	J
1	Date	Ward (N=	No. of sampling	bed no.	Remarks	pre-cleaning (AT	post-cleaning (ATP	pre-cleaning (ATP)	post-cleaning (ATP)/cm2	
2	23/11/2009	A&E	BP cuff (10cm × 10cm)		SSD	328	98	3.28	0.98	
3			Patient locker (10cm × 10cm)	Bed 9		86	34	0.86	0.34	
4			Toilet door handle (2cm × 5cm)			1054	14	105.4	1.4	
5		A1	Patient locker (10cm × 10cm)	Bed 1P	ISS	755	81	7.55	0.81	
6			Toilet door handle (2cm × 5cm)			62	49	6.2	4.9	
7		D1	Ventilator control panel (10cm × 10cm)	Bed 7N	ISS	435	18	4.35	0.18	
8		A6	Bedside rails (1cm ×10cm)	Bed 3	ISS	1366	57	13.66	0.57	
9			Suction port regulator (1cm × 1cm)			1342	39	1342	39	
10	24/11/2009	C6	Bed table (10cm × 10cm)		ISS	1576	217	15.76	2.17	
11			Toilet door handle (2cm × 5cm)			631	250	63.1	25	
12		F3	Patient locker (10cm × 10cm)		ISS	764	21	7.64	0.21	
13			Bedside rails (1cm ×10cm)			1282	210	128.2	21	
14			toilet door handle (2cm × 5cm)			849	21	84.9	2.1	
15		F4	Suction port regulator (1cm × 1cm)		ICU staff	566	28	566	28	
16		P3	Bedside rails (1cm ×10cm)		ISS	596	90	59.6	9	
17			Suction port regulator (1cm × 1cm)			583	21	583	21	
18	26/11/2009	S6	Suction port regulator (1cm × 1cm)		ICU staff	179	67	179	67	
19		S12	Toilet flush lever (2cm × 2cm)		IDC staff	1147	17	286.75	4.25	
20			Toilet door handle (2cm × 5cm)			873	13	87.3	1.3	
21		H4N	Bed table (10cm ×10cm)		ISS	250	19	19	0.19	
22			Toilet flush lever (2cm × 2cm)			2550	22	637.5	5.5	
23			Toilet door handle (2cm × 5cm)			1186	14	118.6	1.4	

Sheet1 / Sheet2 / Sheet3

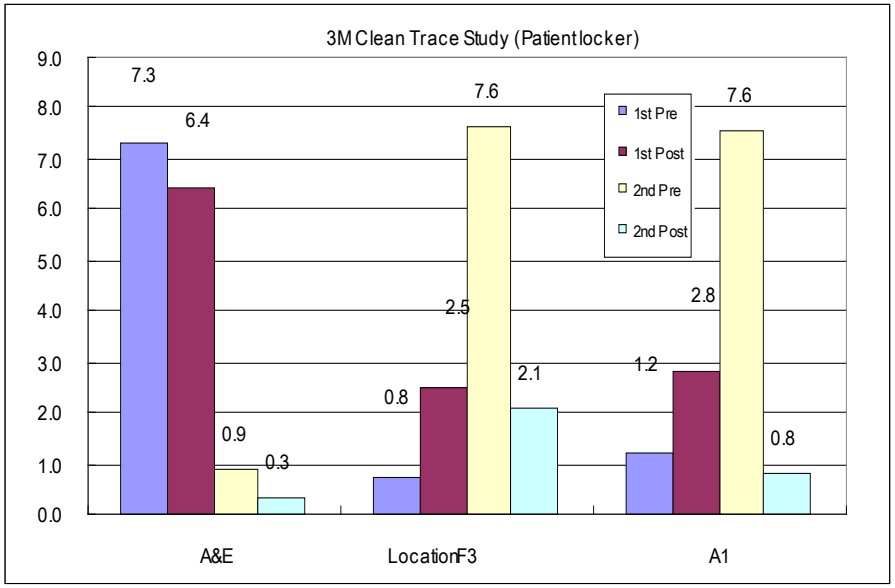
start | 收件匣 - Mi... | PMH Produc... | Gmail - Inbo... | HPV_ATP | Microsoft Ex... | 2 Microsof... | EN | 10:24

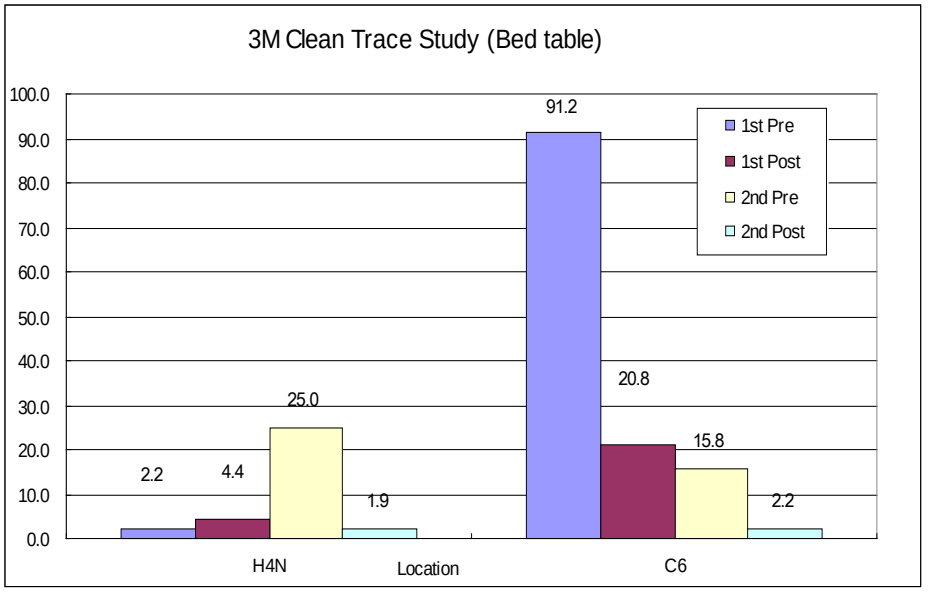
- 10 sites (45%) required Phase III

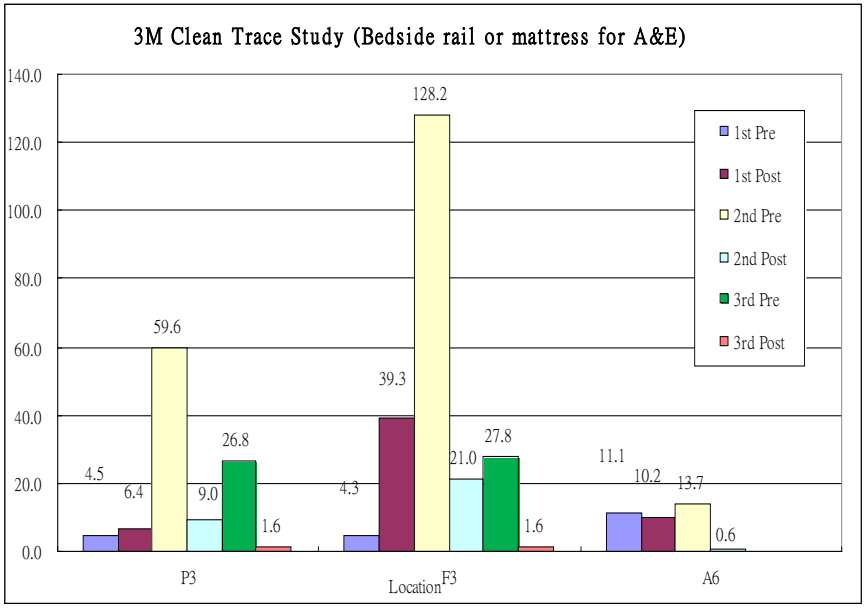
Results: Phase III

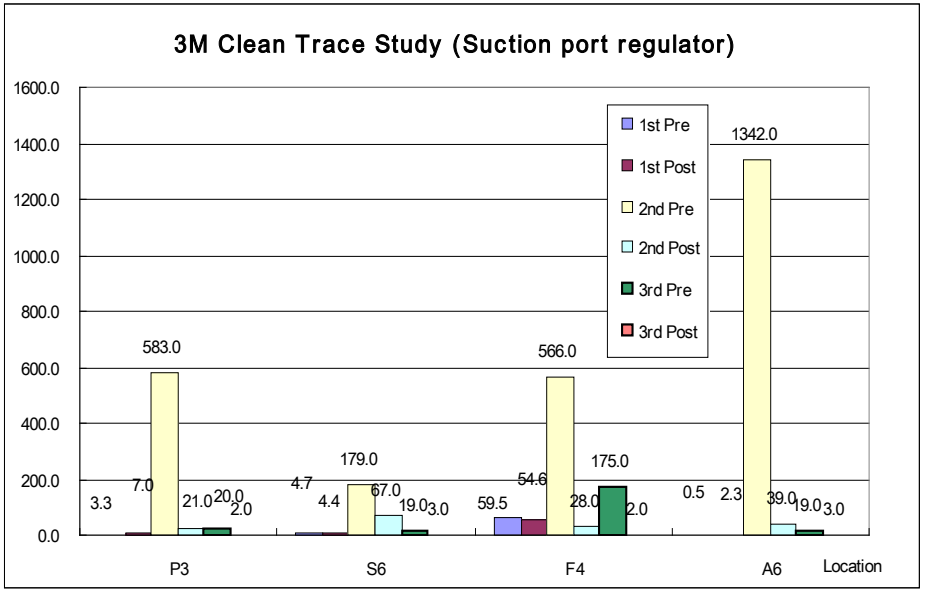


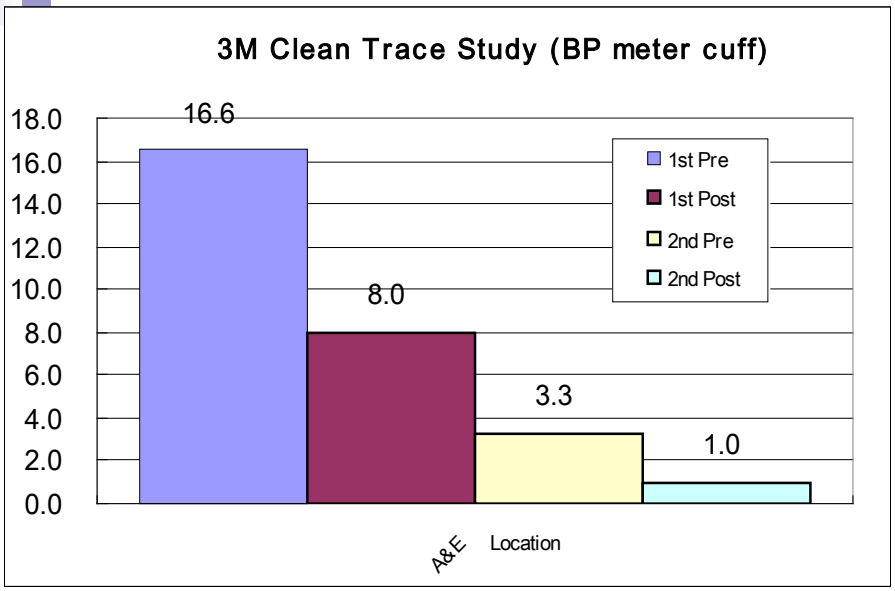
	A	B	C	D	E	F	G
1	Date	Ward (N=9)	No. of sampling	pre-cleaning (ATP)	post-cleaning (ATP)	pre-cleaning (ATP)/cm2	post-cleaning (ATP)/cm2
2	30/12/2009	A1	Toilet door handle (2cm × 5cm)	1945	10	194.5	1
3		A6	Suction port regulator (1cm × 1cm)	100	3	100	3
4		C6	Toilet door handle (2cm × 5cm)	100	9	10	0.9
5		F3	Bedside rails (1cm ×10cm)	278	16	27.8	1.6
6		F4	Suction port regulator (1cm × 1cm)	175	2	175	2
7		P3	Bedside rails (1cm ×10cm)	268	16	26.8	1.6
8		P3	Suction port regulator (1cm × 1cm)	20	2	20	2
9		S6	Suction port regulator (1cm × 1cm)	19	3	19	3
10		S12	Toilet flush lever (2cm × 2cm)	640	5	160	1.25
11		H4N	Bedside rails (1cm ×10cm)	1676	15	167.6	1.5
12		H4N	Toilet flush lever (2cm × 2cm)	1013	9	253.25	2.25
13							
14							
15							
16							
17							
18							
19							

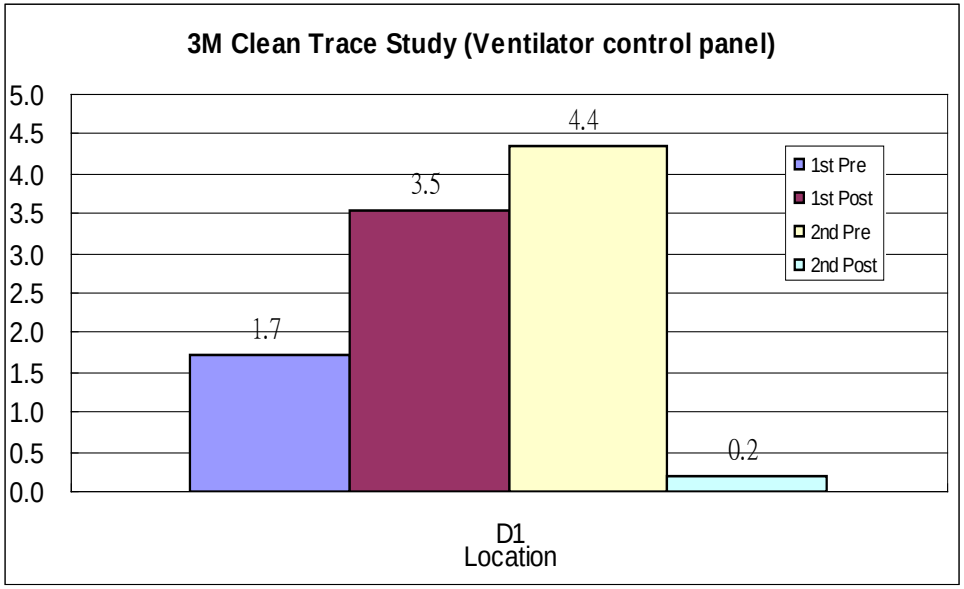

3M Clean Trace Study (Patientlocker)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
7.3
6.4
0.9
0.3
0.8
2.5
7.6
2.1
1.2
2.8
7.6
0.8
1st Pre
1st Post
2nd Pre
2nd Post
A&E
LocationF3
A1

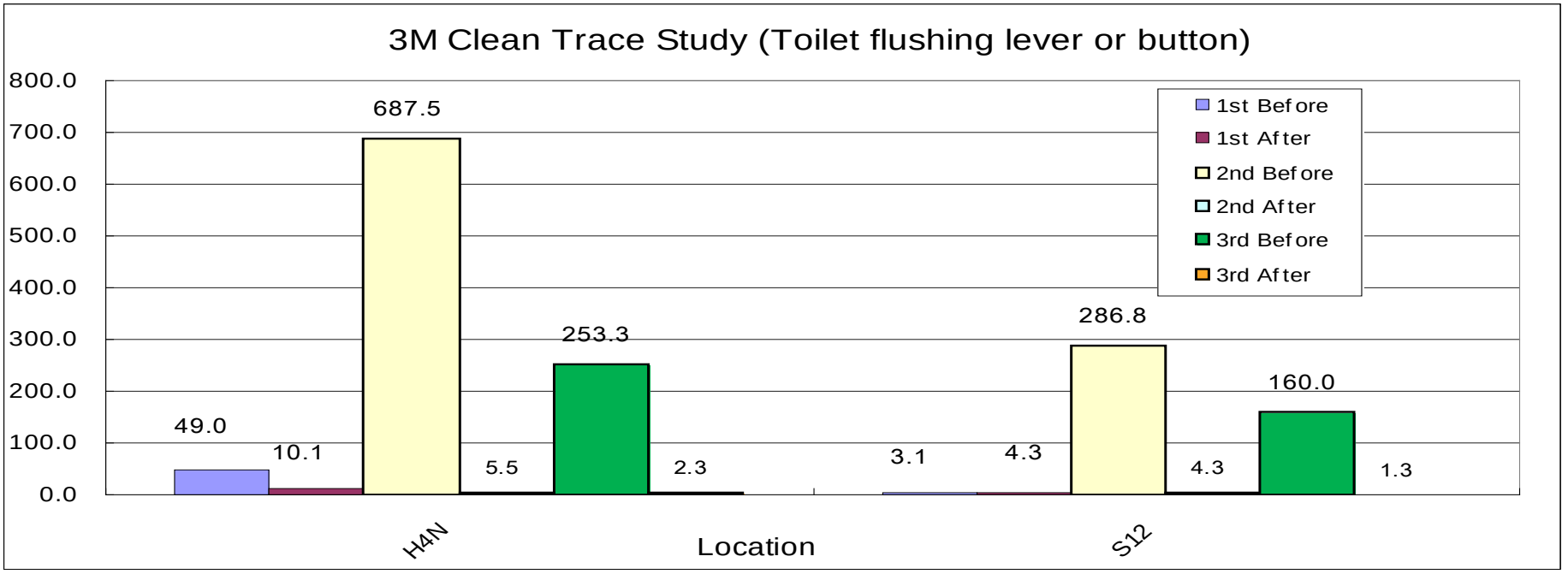

3M Clean Trace Study (Bed table)
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
2.2
4.4
25.0
1.9
91.2
20.8
15.8
2.2
1st Pre
1st Post
2nd Pre
2nd Post
H4N
Location
C6

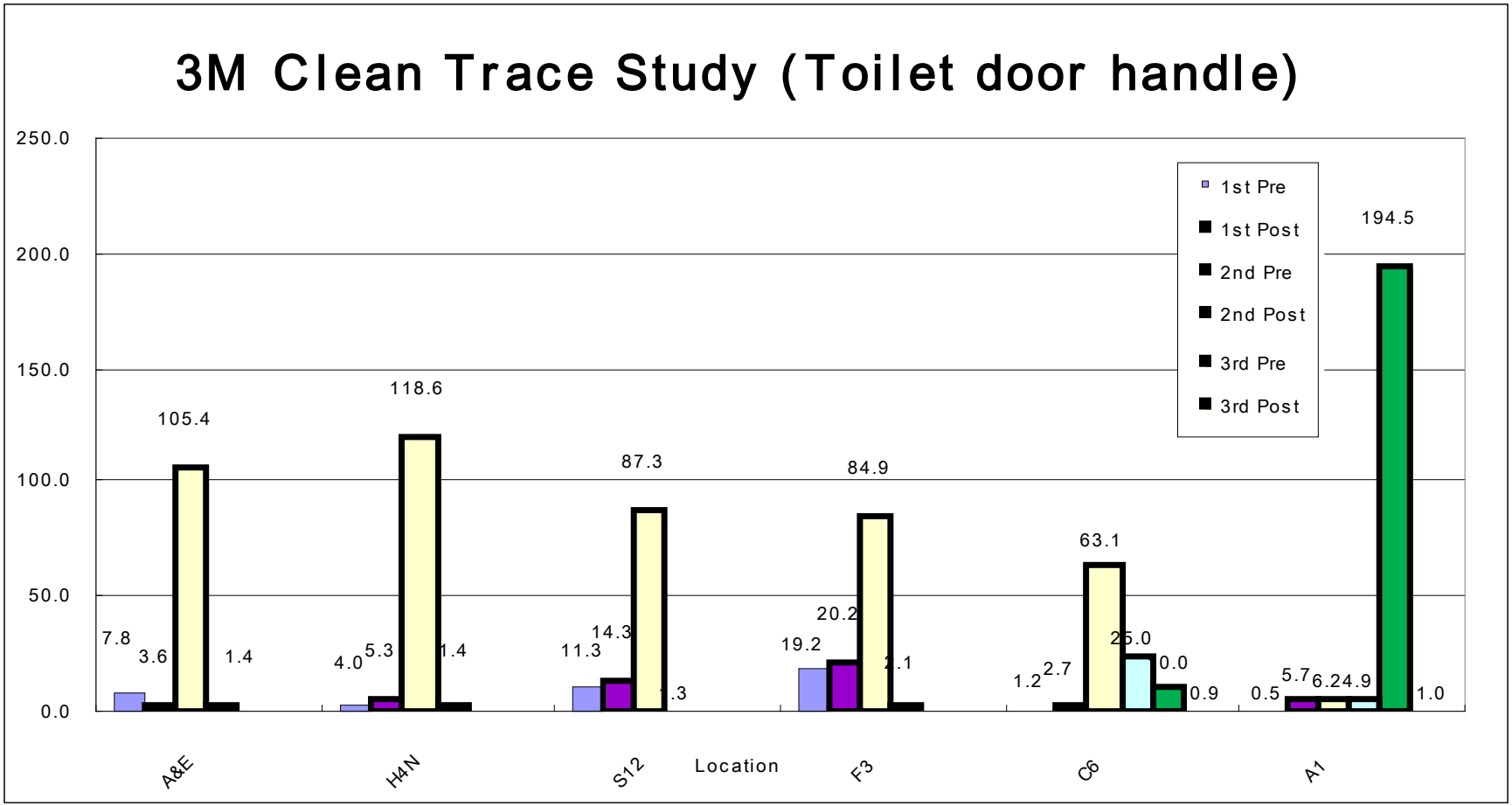

3M Clean Trace Study (Bedside rail or mattress for A&E)
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
4.5
6.4
59.6
9.0
26.8
1.6
4.3
39.3
128.2
21.0
27.8
1.6
11.1
10.2
13.7
0.6
1st Pre
1st Post
2nd Pre
2nd Post
3rd Pre
3rd Post
P3
LocationF3
A6


3M Clean Trace Study (Suction port regulator)
1600.0
1400.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
3.3
7.0
583.0
21.0
20.0
2.0
4.7
4.4
179.0
67.0
19.0
3.0
59.5
54.6
566.0
28.0
175.0
2.0
0.5
2.3
1342.0
39.0
19.0
3.0
1st Pre
1st Post
2nd Pre
2nd Post
3rd Pre
3rd Post
P3
S6
F4
A6
Location


3M Clean Trace Study (BP meter cuff)
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
16.6
8.0
3.3
1.0
1st Pre
1st Post
2nd Pre
2nd Post
A&E
Location


3M Clean Trace Study (Ventilator control panel)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1.7
3.5
4.4
0.2
1st Pre
1st Post
2nd Pre
2nd Post
D1
Location


3M Clean Trace Study (Toilet flushing lever or button)
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
49.0
10.1
687.5
5.5
253.3
2.3
3.1
4.3
286.8
4.3
160.0
1.3
1st Before
1st After
2nd Before
2nd After
3rd Before
3rd After
H4N
Location
S12


3M Clean Trace Study (Toilet door handle)
250.0
200.0
150.0
100.0
50.0
0.0
1st Pre
1st Post
2nd Pre
2nd Post
3rd Pre
3rd Post
7.8
3.6
105.4
1.4
4.0
5.3
118.6
1.4
11.3
14.3
87.3
1.3
19.2
20.2
84.9
2.1
1.2
2.7
63.1
25.0
10.0
0.9
0.5
5.7
6.2
4.9
194.5
1.0
A&E
H4N
S12
Location
F3
C6
A1

Discussion

- ATP method: rapid, objective, semi-quantitative, sensitive
- Linear correlation with ACC was not strong
  - different bacteria might release different amount of ATP
  - ATP can also be released from dust & organic matter but not viruses
  - Although not identifying specific microorganisms, its role could potentially be supplemented by ACC during outbreak investigation
- 2.5 RLU/cm^2 could generally be achievable and consistent with overseas standards except items with very small surface area (e.g. suction port regulator) for which 5 RLU/cm^2 should be reasonable
- Items with surface of rough fabrics were required to be cleaned more meticulously or microfibre cloth could be indicated though not tested in this study
- Items not under routine cleaning schedules showed highly unsatisfactory results
- Feedback to wards and cleansing staff of the results with reinforcement of proper cleansing showed improved results

Limitation

- Reproducibility was not tested (operator dependent)
- Tracking of MRSA isolated was not performed

Conclusion

- ATP method as a real-time, user-friendly, sensitive assessment or audit tool
- Comparable benchmarks could be established as with overseas standards
- Items with rough fabrics require special attention for deep cleaning
- Good cleaning practice cannot be overemphasized
- Regular cleaning schedule should be extended to other items with potential spread of microorganisms to patients and healthcare workers

What you see is NOT what you get!

Ideal environmental disinfectant

- Efficacious
  - Broad spectrum
  - Great log reduction
  - Long lasting with residual effect
  - Not operator-dependent
  - Not inducing microbial resistance
  - Not affected by organic matter
- Efficient, reliable, penetrative
- Stable, durable
- User friendly, non-odorous
- Non-interruptive to cleansing routine
- Compatible with various surface materials
- Safe
- Environmentally friendly
- Short TAT
- Inexpensive

Smart Anti-Microbial Coating

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[2]Division of Environment, [3]Health, Safety and Environment Office,
Hong Kong University of Science and Technology

[1]Tel.: 2358 7123, Fax: 2358 0054, E-mail: kekyeung@ust.hk

K.L. Yeung

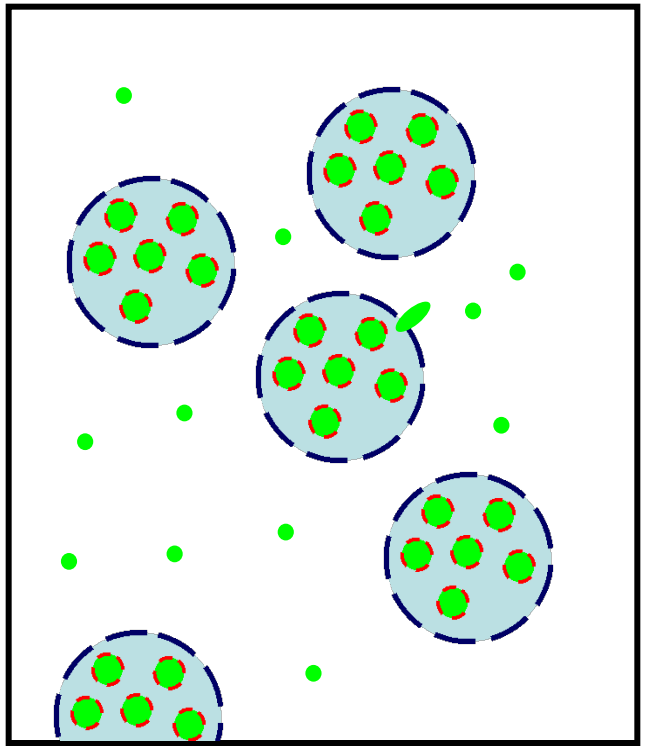
Joseph Kwan

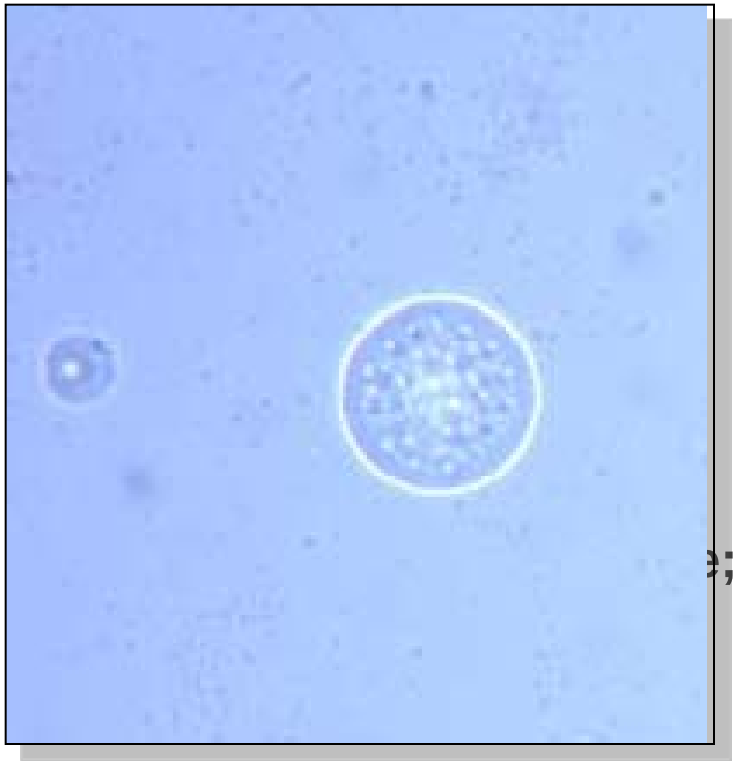
Arthur Lau

Courtesy of Prof. King L. Yeung, HKUST

Smart Anti-Microbial Coatings

Anatomy of the Multilevel Anti-Microbial Formulation





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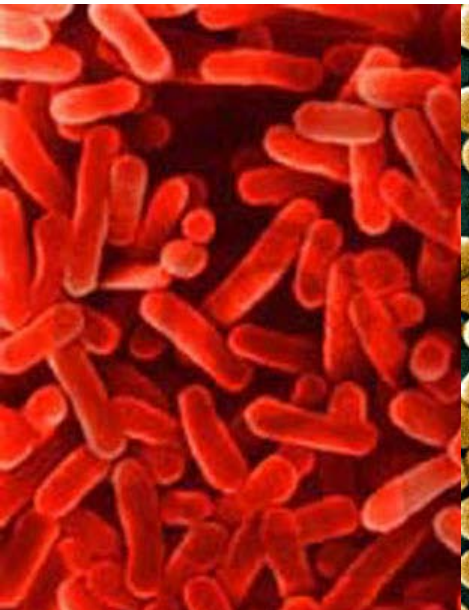
Fast and Effective

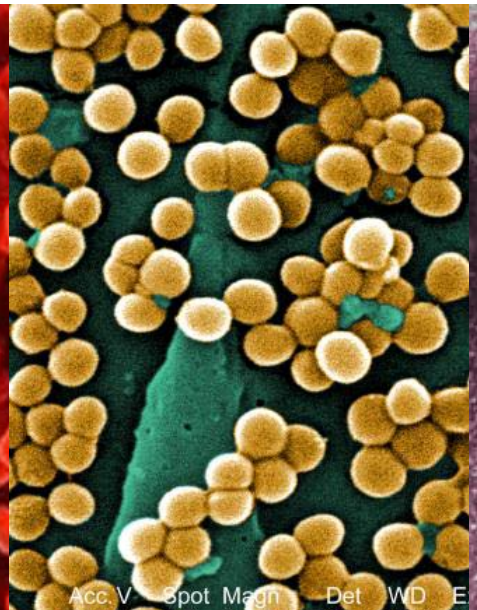
Sprayed-on Formulation

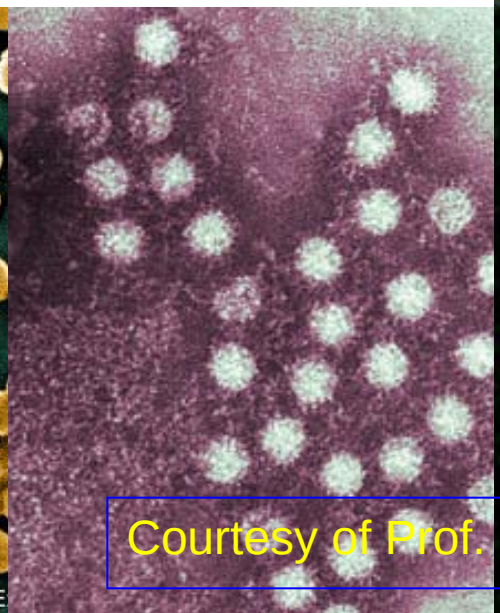
≥ 99.99 % within 1 min

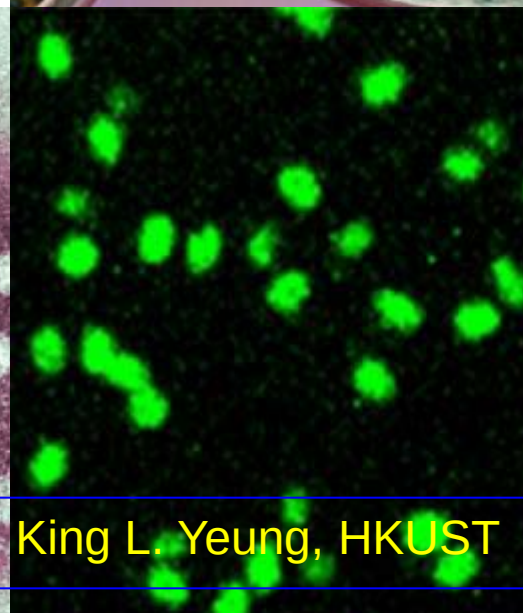
Coating on Surface

Bacteria: 99.9 % within 1 min
H1N1 human swine flu virus: 99 % within 3 min
***Bacillus* spores: 99 % within 30 min**









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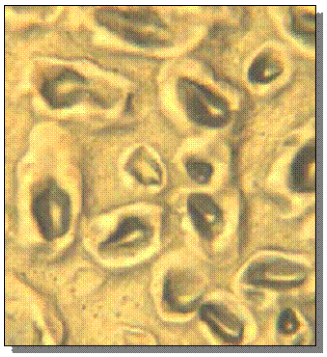
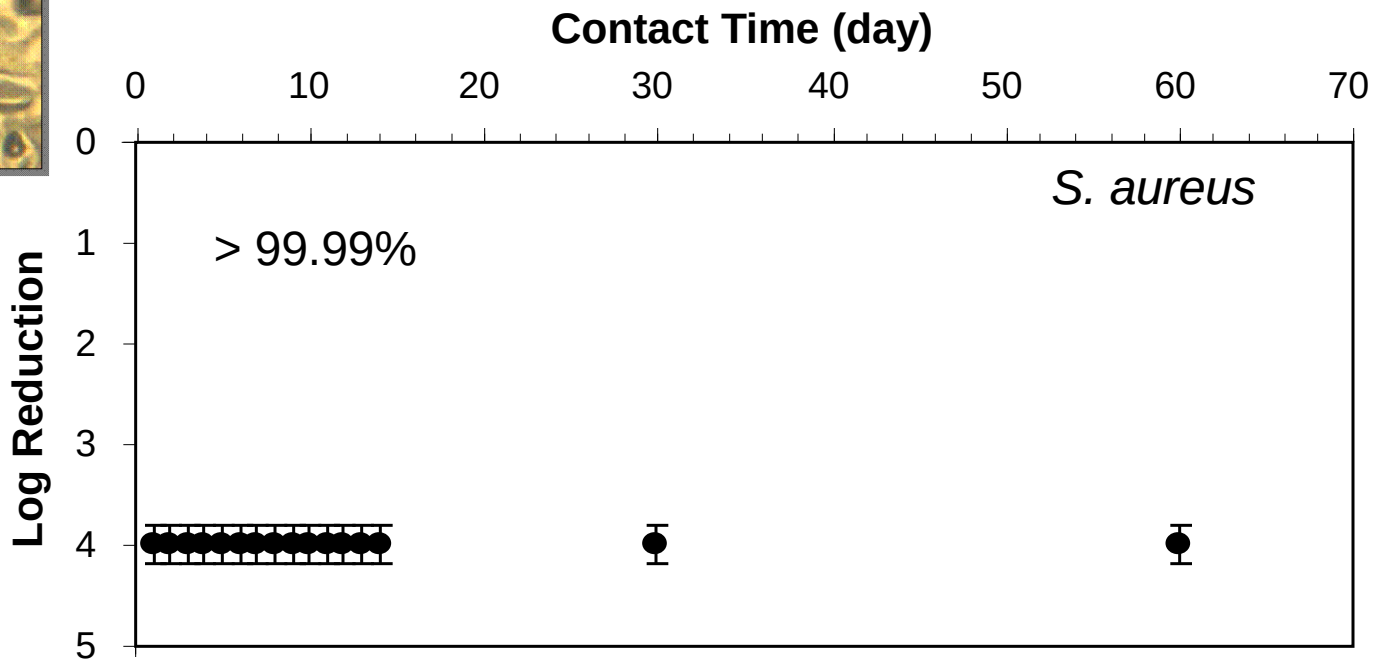
Long Lasting

Minimum 30 days in single application



Effectiveness can be maintained for at least 60 days after coating

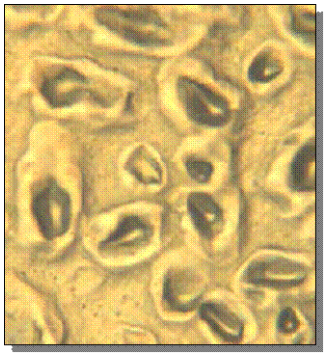


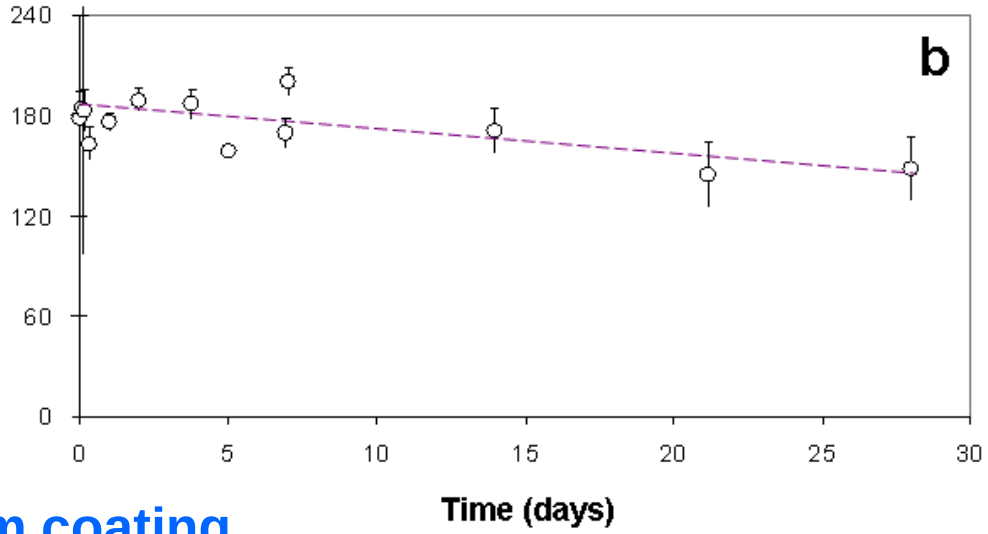
Courtesy of Prof. King L. Yeung, HKUST

SMART

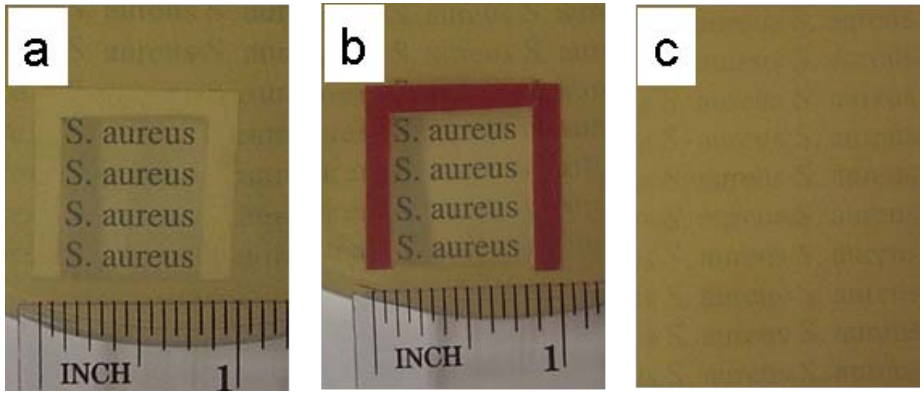
Courtesy of Prof. King L. Yeung, HKUST

Persistent Release of Biocides





Disinfect up to 3 mm from coating



1 mm **3 mm** **10 mm**

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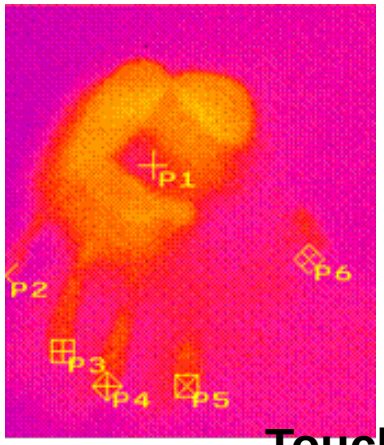
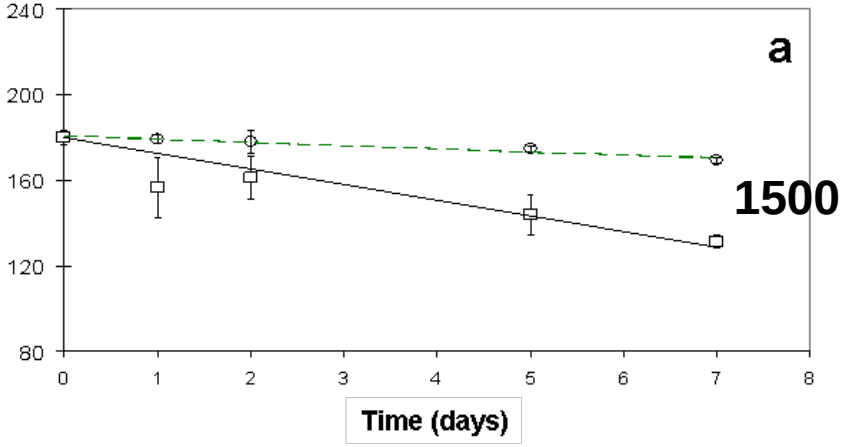
Rapid Self-disinfection

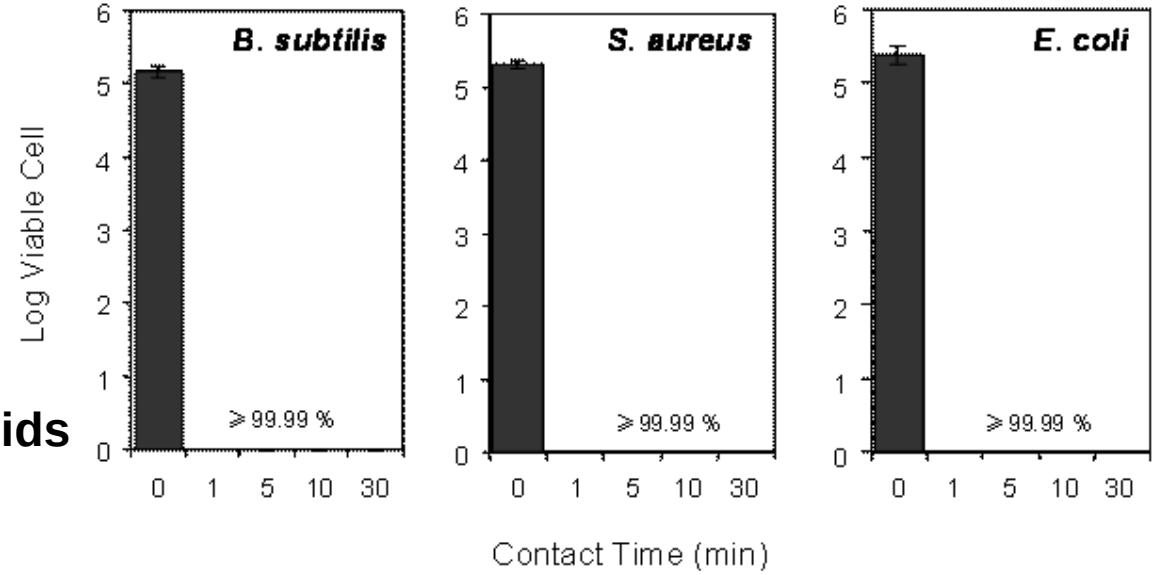


Touch



1500 μg/g/day

Body Fluids



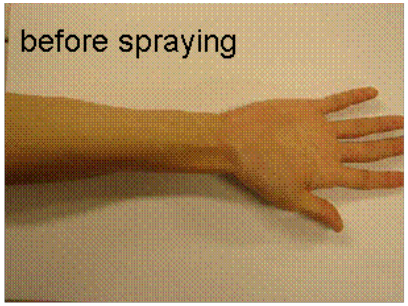
Safe and Environmentally Friendly

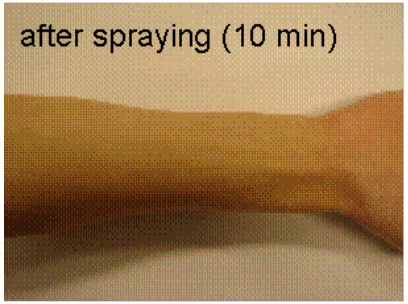
All active formulations are U.S. FDA and EPA approved;

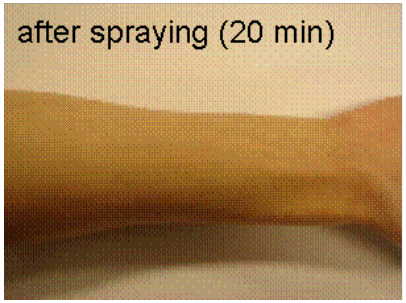
Smart dosing ensures long-term safety and prevents resistance in microorganisms;

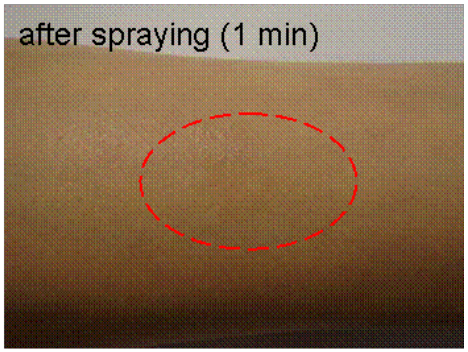
Environmentally friendly;

Biodegradable









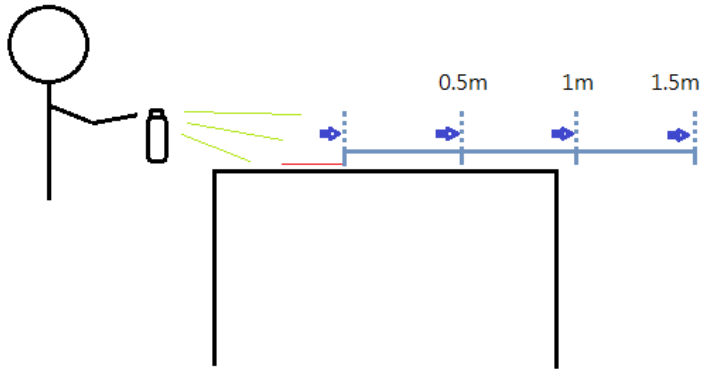
No skin reaction

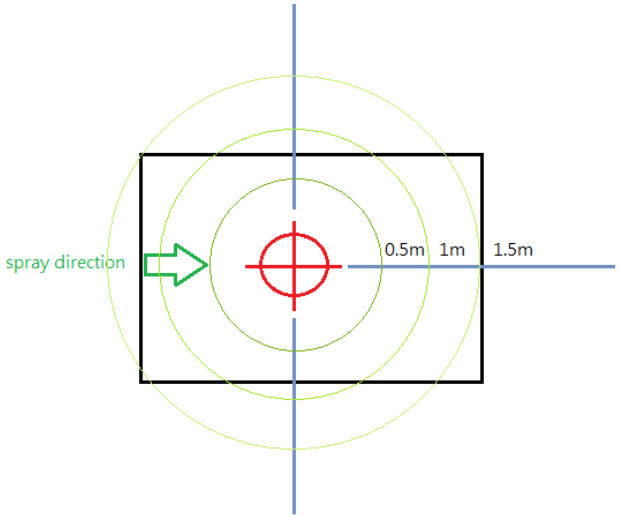
Courtesy of Prof. King L. Yeung, HKUST

Safe and Compatible

Courtesy of Prof. King L. Yeung, HKUST

A sample of the new anti-microbial coating spray.





No detectable ClO2 (i.e., < 0.01 ppm)

Safe and Compatible

Tested compatible with stainless steel, aluminum, plastics, paper, cotton…

Tested durable under repeated wiping with

- **Dry cotton cloth and napkin paper**
- **Wet cotton cloth with tap water**
- **Wet cotton cloth with 1:49 bleach solution**
- **Wet cotton cloth with Virkon disinfectant solution**

Courtesy of Prof. King L. Yeung, HKUST

Collaborative studies with HKUST

1. Provision of MRSA, multi-drug resistant *P. aeruginosa, Acinetobacter spp.,* enterococci strains for testing at HKUST lab (2010)
2. Testing with MRSA and *Acinetobacter spp.* (Efficacy Test, Persistent Test, Soiling Test, Coating Durability under Standard Cleaning) on bed table at PMH lab (Mar 2011)

PMH Field Test

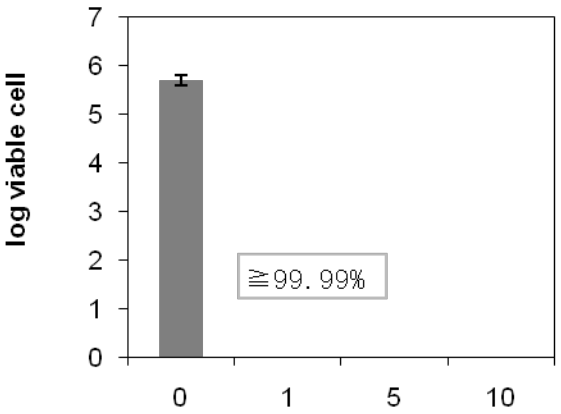
May 11 to 26, 2011

Dr. T K Ng
Dr. Bosco Lam

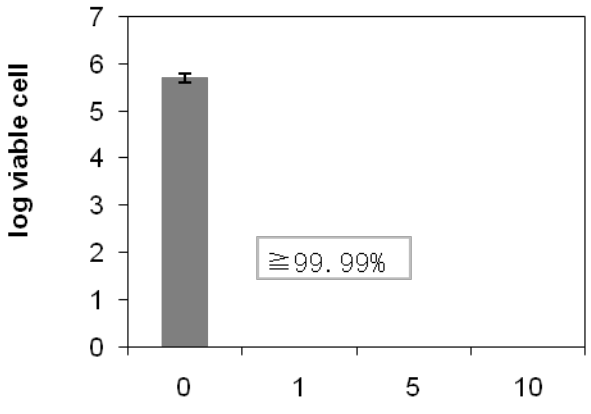
Princess Margaret Hospital

Objectives:
Coating efficacy and persistence against MDRO.

Lab tests against MDRO



MRSA

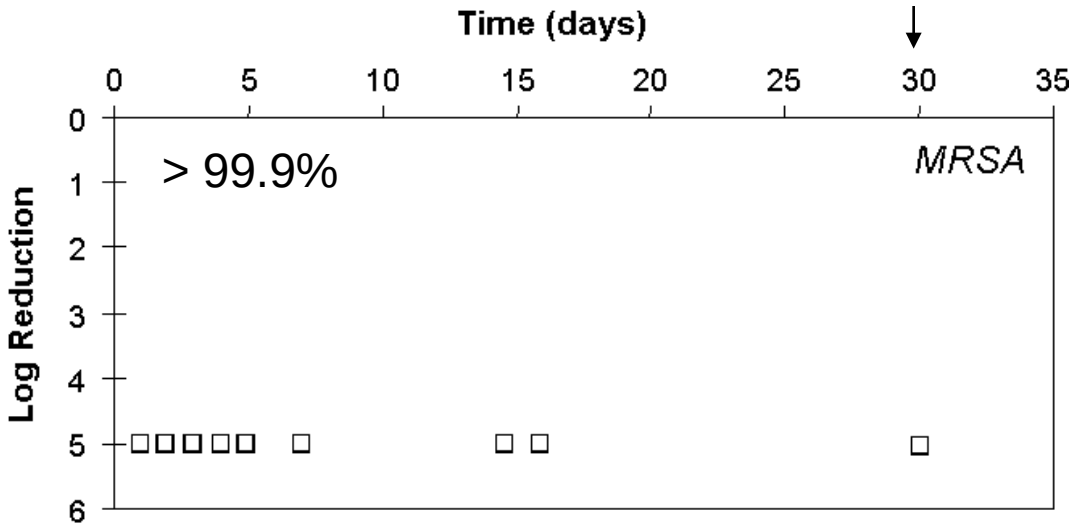


IMIpenem-Resistant ACInetobacter

Courtesy of Prof. King L. Yeung, HKUST *

Laboratory Test

Courtesy of Prof. King L. Yeung, HKUST



0.1ml of 10^6/ml of MRSA on glass with contact time of 10 min

Field Test

May 11 to 26, 2011

Objectives:
Coating efficacy and persistence against MDRO.

Coating applied by wiping, let dry 1 day

Challenged by drop test of 10^5 organisms / grid

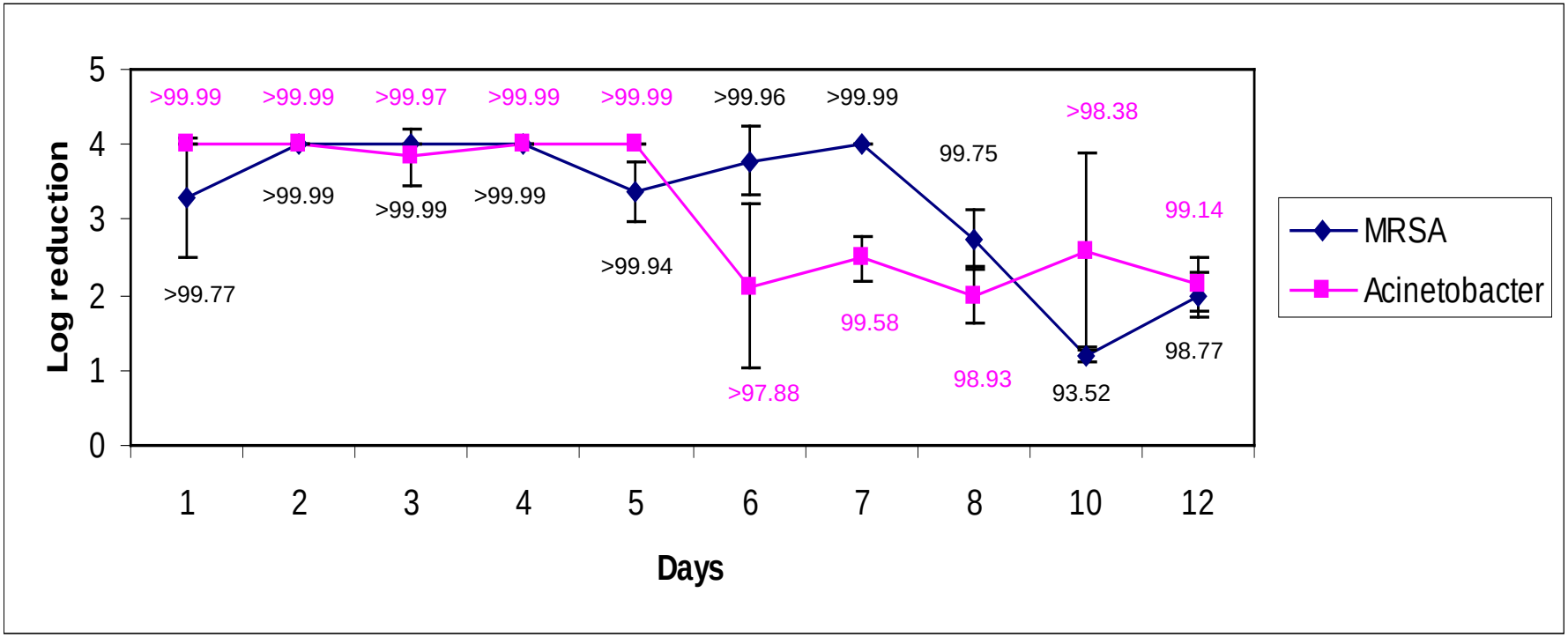
Sample 5 grids per day

140 2”x2” grids coated with 0.1 g coating each

Courtesy of Prof. King L. Yeung, HKUST

Coating Efficacy

Long-term Study of Coating Performance (12 days)

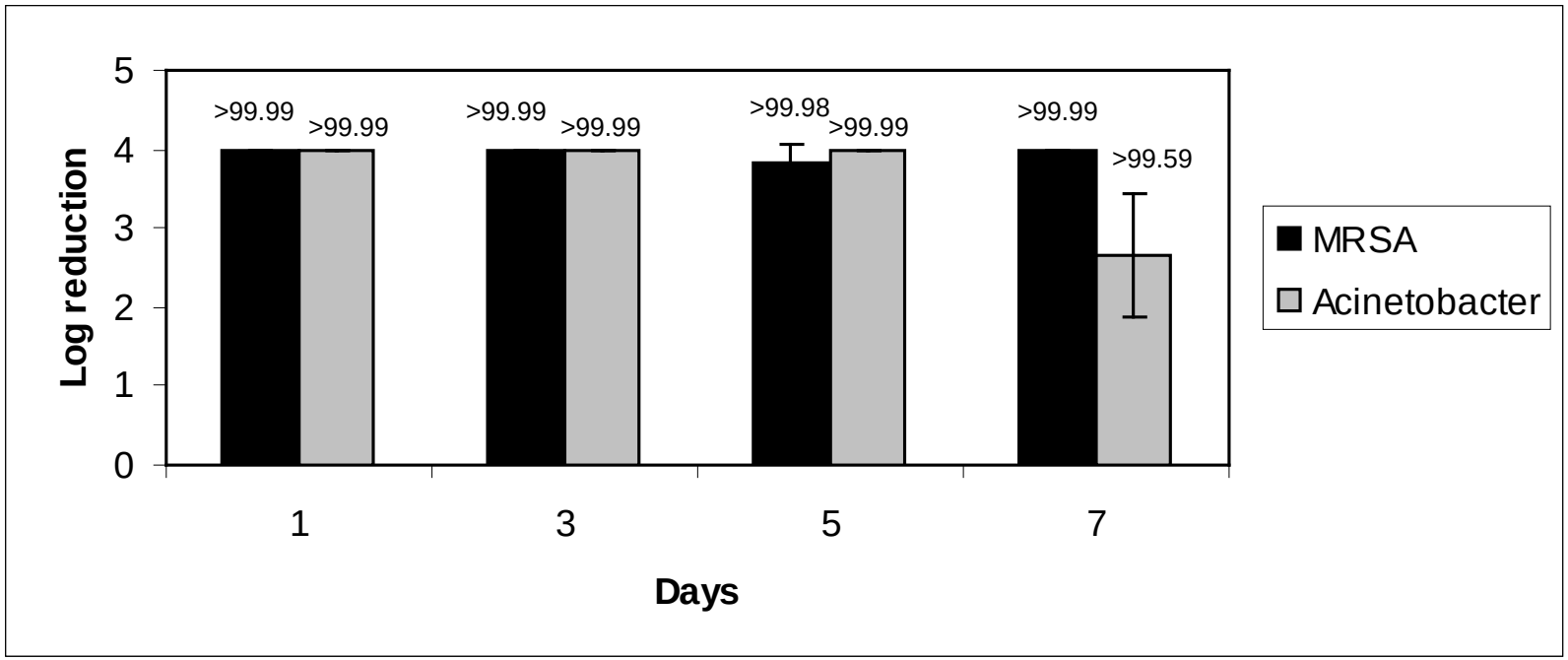


Challenged with 10^5 MDRO and sampling by swabbing after 10 min contact. Please note reduction is calculated against control surface without coating.

Courtesy of Prof. King L. Yeung, HKUST

Coating Efficacy

Repeated Challenge and Surface Soiling



Challenged with 10^5 MDRO twice daily and sampling by swabbing after 30 min contact. Please note reduction is calculated against control surface without coating.

Courtesy of Prof. King L. Yeung, HKUST

Collaborative studies with HKUST

3. Field tests at clinical surfaces (high-touch) and equipments at IDC simulation ward
4. Clinical trials on contamination / infection rates in general wards / LKB / ICU

Room Decontamination by Hydrogen Peroxide Vapor (HPV)

H_2O_2

- 10-30%: bactericidal, virucidal, sporicial
- Disinfectant for inanimate materials & inert surfaces free of catalase
- Solutions: for surgical implant components, temp.-sensitive plastic equipment, spacecraft hardware, hydrophilic soft contact lenses, commercial packing materials, water, milk
- HPV: for pharmaceuticals, foodstuffs, processing equipment, packaging materials, fermentors, dialyzers, incubators, lyophilizers, BSC, glove boxes, centrifuges

Types of HPV

- Micro-condensation
  - Bioquell, UK
  - Gas (fumigation), 30% H_2O_2, <1μm
  - High humidity
  - Broken down catalytically to water vapour & oxygen
  - Require sealing of all ventilation ducts, windows, doors
  - Need checking for leakage (safety monitoring)
  - Need biological indicators (spore strips)
- Dry mist
  - Sterinis (Gloster, France→Glosair, J&J, UK); VaproSure (Steris), USA
  - Aerosol (fogging), 5% H_2O_2, <50ppm phosphoric acid, <50ppm silver cations, 8-12μm
  - Low humidity
  - Decompose spontaneously
  - Room sealing not necessary
  - checking for leakage not needed (?)
  - No BI

- *Boyce. Infect Control Hosp Epidemiol 2009;30:515-7*
- *Otter et al. Infect Control Hosp Epidemiol 2010;31:1201-2*
- *Pottage et al. J Hosp Infect 2010;74:55-61*

Field tests at PMH (30 Mar – 1 Apr 2009)

- Challenge with Acinetobacter spp. and MRSA at 2.0 McFarland standard (~$6x10^8$CFU/ml) before HPV fumigation
- Comparing before and after by
  - ATP
  - Culture
- Location:
  - D2 (unused ICU)
  - S8 (isolation ward)
  - BSL3 Lab
  - Cold chamber at Mortuary

Step 1. Seal up the room exhaust to building corridor

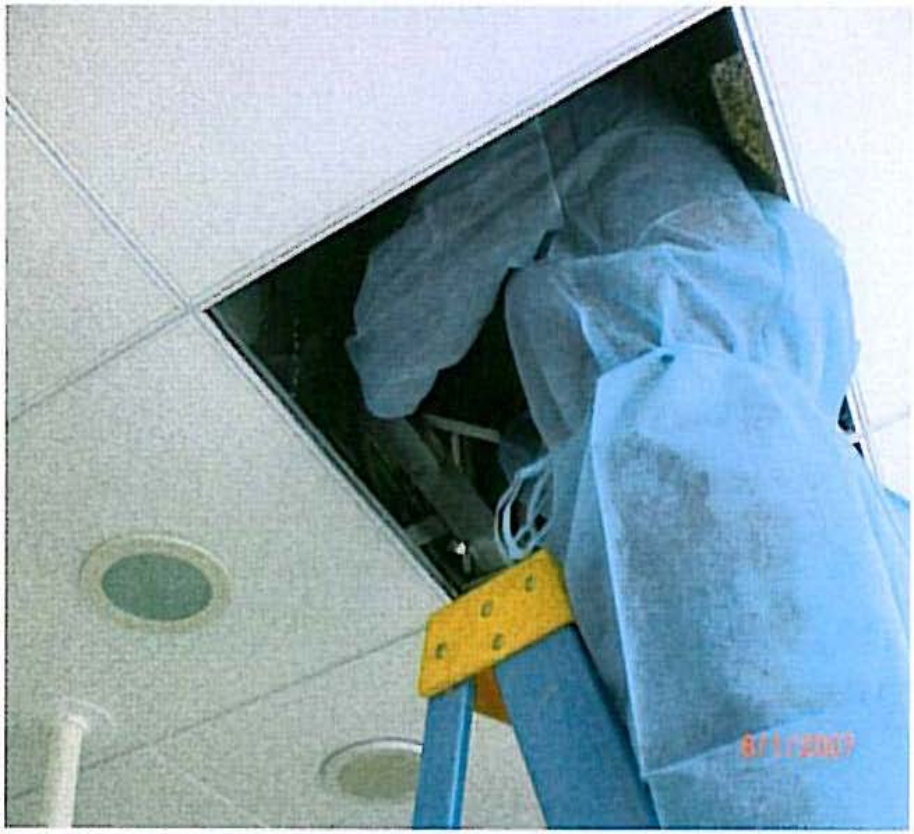
S8 Ward

No need to seal up the Air-In Filter

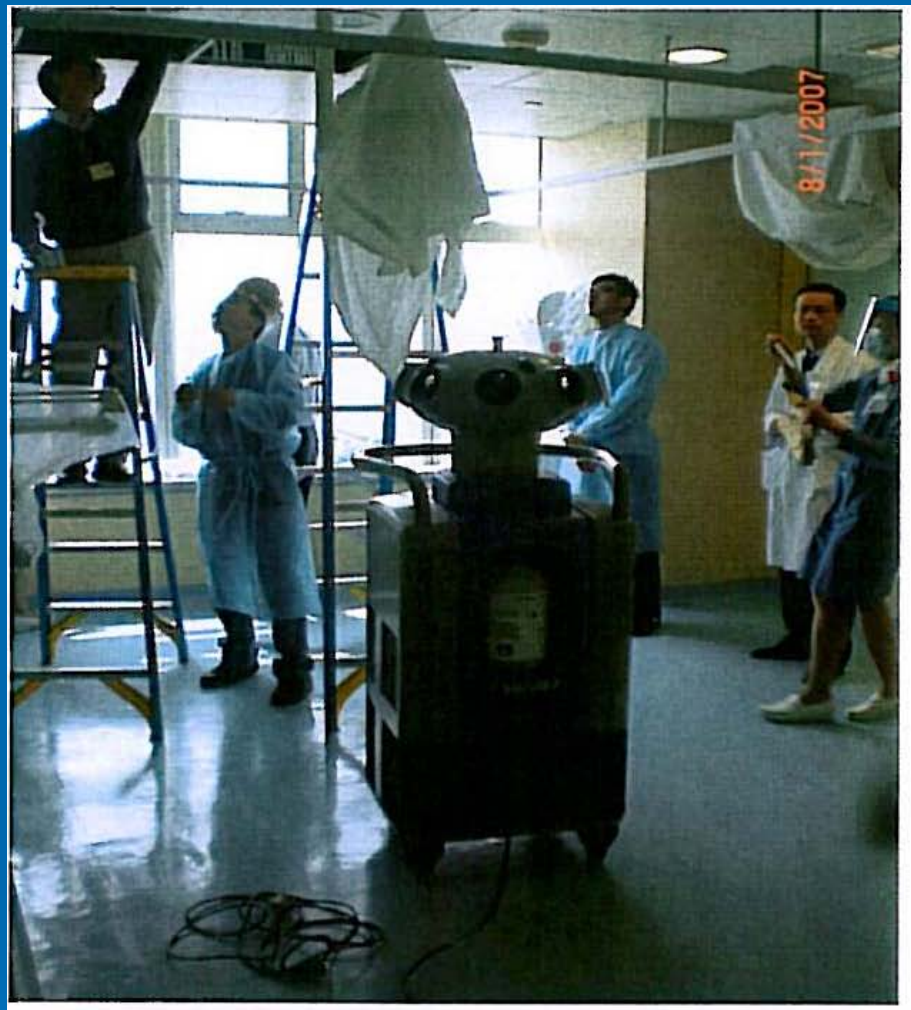
S8 Ward

S8 Ward

Step 2. Place the H2O2 Generator at the center of the Isolation Room.
Open the Pass Through Hatch door and place the fan blowing to the bathroom.



Step 3. Open the ceiling plates, prepare to disinfect the HEPA Filter



Step 4. Place the Control Panel at outside, set up program, insert H2O2 volume parameter and start cycle.

The H2O2 Vapour will fill up in the Isolation Room

The total Cycle time around 3-4 hours

Princess Margaret Hospital – General Ward D5

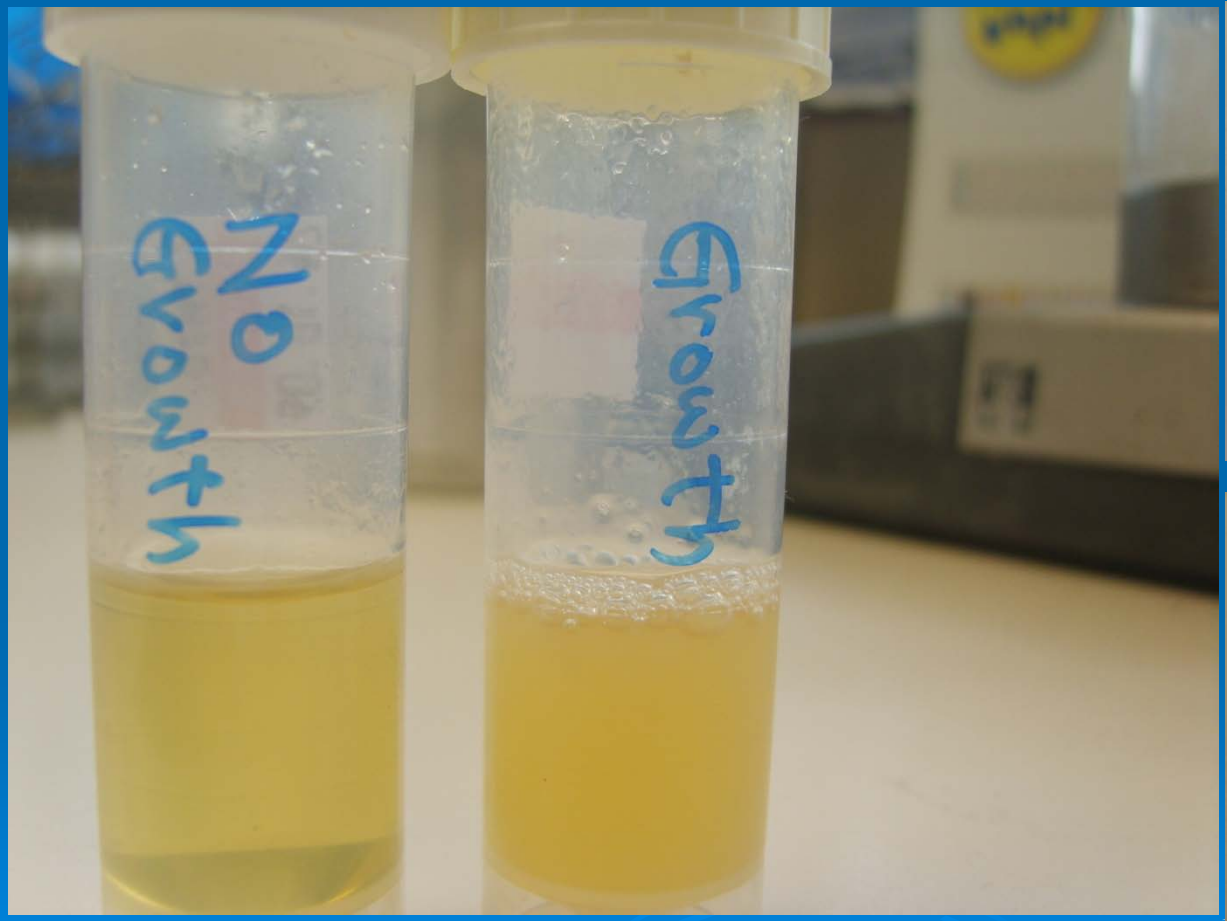
Step 1. Seal up the air-conditional exhaust and the gap between wall and false ceiling

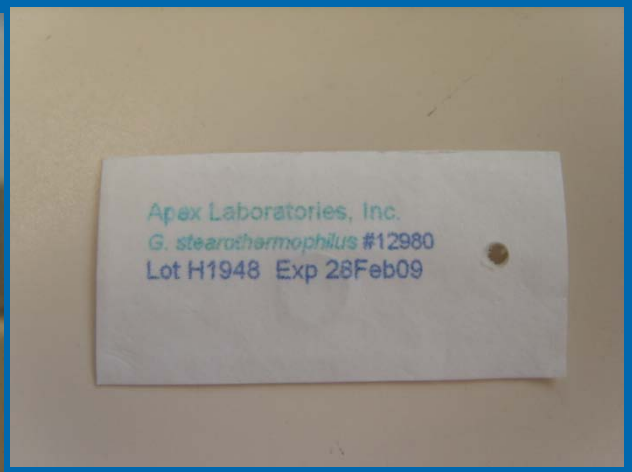
Step 2. Place the H2O2 Generator and R20 Aeraflow Aeration Module at the center of the General Ward

Step 3. Place the Control Panel at outside, set up program, insert H2O2 volume and start cycle

Total Cycle time around 3-4 hours

Biological Indicator (spore) – for gas sterilization





ATP Test & Swab culture pre and post fumigation at D2 (bed 10-13)

No	Location	Organism	ACIS 2.0			MRSA 2.0		
			ATP	Count on BA cfu	Count on MAC cfu	ATP	Count on BA cfu	Count on MAC cfu
1	Suction port regulator	Pre	939	30	40	727	NG	NG
		Post	4	NG	NG	3	NG	NG
2	Computer stand	Pre	285	30	36	1726	1	0
		Post	47	NG	NG	98	NG	NG
3	Monitor	Pre	672	26	62	1465	0	1
		Post	153	NG	NG	199	NG	NG
4	Wall bench	Pre	380	100-200	90	1472	NG	NG
		Post	11	1	NG	33	NG	NG
5	Window	Pre	172	NG	NG	1002	2	1
		Post	4	NG	NG	6	NG	NG
6	Fan	Pre	289	1	6	2059	1	2
		Post	33	NG	NG	637	NG	NG
7	Keyboard box	Pre	468	NG	NG	684	0	3
		Post	162	NG	NG	266	NG	NG
8	Keyboard	Pre	1098	100-200	100-200	879	4	4
		Post	132	NG	NG	92	NG	NG
9	Lamp switch	Pre	1173	2	5	1419	9	5
		Post	121	NG	NG	158	NG	NG
10	Tap under sink	Pre	567	2	5	618	15	14
		Post	81	NG	NG	320	NG	NG

ATP & Swab culture pre and post fumigation at S8 isolation room 1/4/2009

No	Location	Organism	ACIS 2.0			MRSA 2.0		
			ATP	Count on BA cfu	Count on MAC cfu	ATP	Count on BA cfu	Count on MAC cfu
1	Electricity socket	Pre	1701	60	~ 100	79	13	3
		Post	27	NG	NG	19	NG	NG
2	Suction port regulator	Pre	940	60	60	207	10	7
		Post	100	NG	NG	60	NG	NG
3	Call bell button	Pre	1617	50	50	148	15	8
		Post	53	NG	NG	20	1	NG
4	Low level air exhaust	Pre	1271	50	70	293	2	3
		Post	86	NG	NG	27	NG	NG
5	Toilet sink	Pre	3482	80	100-200	411	15	24
		Post	25	NG	NG	26	NG	NG
6	Toilet flush button	Pre	2648	60	60	453	70	60
		Post	118	NG	NG	13	NG	NG
7	Hatch	Pre	162	70	80	584	60	40
		Post	26	NG	NG	13	NG	NG
8	Toilet door handle	Pre	851	~ 100	~ 100	274	17	10
		Post	246	NG	NG	20	NG	NG
9	Curtain rail	Pre	570	27	23	352	40	10
		Post	20	NG	NG	22	NG	NG
10	Auto door sensor	Pre	4465	80	80	343	40	40
		Post	71	NG	NG	23	NG	NG

ATP Test pre and post fumigation

Date: 30/03/2009
Location: S16 BSL 3

No	Location	MRSA 2.0		ACIS 2.0	
		Pre	Post	Pre	Post
1	Incubator	875	22	471	17
2	Telephone	806	32	282	73
3	Cupboard under sank	600	105	291	171
4	Water tape on floor	710	18	111	18
5	Autoclaver	612	29	500	40
6	BSC	2128	22	90	19

Agar plate result **after fumigation**:

No	Agar plate location	Organisms	ATP count
1	Sank	PAER	39941
2	Incubator	ACIS	21013
3	BSC	MRSA	76994

ATP & Swab culture pre and post fumigation at Mortuary

Date: 1/4/2009
Location: Mortuary

No	Location	Organism	ACIS 2.0			MRSA 2.0		
			ATP	Count on BA cfu	Count on MAC cfu	ATP	Count on BA cfu	Count on MAC cfu
1	Inside the cold chamber	Pre	3172	60	60	225	11	4
		Post	15	NG	NG	14	NG	NG
2		Pre	1073	80	45	1068	29	22
		Post	126	NG	NG	14	NG	NG
3		Pre	1700	60	~ 100	642	28	23
		Post	22	NG	NG	14	NG	NG
4		Pre	2779	50	~ 100	145	10	20
		Post	45	NG	NG	23	NG	NG
5		Pre	656	100 - 200	~ 100	161	45	35
		Post	17	NG	NG	16	NG	NG

Applications at PMH

- Interim disinfection for cubicles or rooms with uncontrolled spread of MDRO (e.g. MRSA, MRAB) and problematic pathogens (e.g. C. difficile, Norovirus, VRE).
- Terminal disinfection for cubicles or rooms with highly pathogenic or bioterror agents (e.g. smallpox, plague).
- Post-renovation (with much dust generation) disinfection for wards housing immunocompromised or highly susceptible in-patients or with high prevalence of MDRO.

Points to note: need thorough planning

- what's the magnitude of the problem of your setting (incidence? Surveillance in place?)
- Environmentally hardy pathogens (higher priority than CRE)
- Not for routine terminal disinfection for endemic pathogens
  - may be considered for single room previously occupied by VRE, C. difficile ribotype 027 patient (?)
- Source control / removal
- Have all other IC measures / cleansing standard been optimized and adhered?
- Factors modifiable?
- Take any chance to vacate the room / cubicle / ward?

Points to note: need thorough planning

- Any ways to avoid re-contamination of the fumigated ward
  - MRSA:
    - Decolonize known MRSA carriers before moving them back to the ward or relocate them to other cohorted areas
    - Perform active screening and prompt isolation of newly identified MRSA carriers
- Take chance of decontamination of selected medical equipment (non-critical items; semi-critical items??), not limiting to those belong to the ward for fumigation
    - *French et al. J Hosp Infect 2004;57:31-7*
  - But decontamination of narrow-lumen items should be done by appropriate standard methods
    - Otter et al. *J Hosp Infect 2006;62:384-92*

Points to note: need thorough planning

- Give ample time (at least 2-4 weeks) for all relevant parties (EMSD, FM, ICT, dept & ward manager, lab technologist) for joint site inspection and planning if any special preparation / remedial work (renovation) is required & feasibility of setting up the venue
- Total cost largely depends on size of the area / no. of sessions applicable for HPV
- Pre-cleansing is mandatory

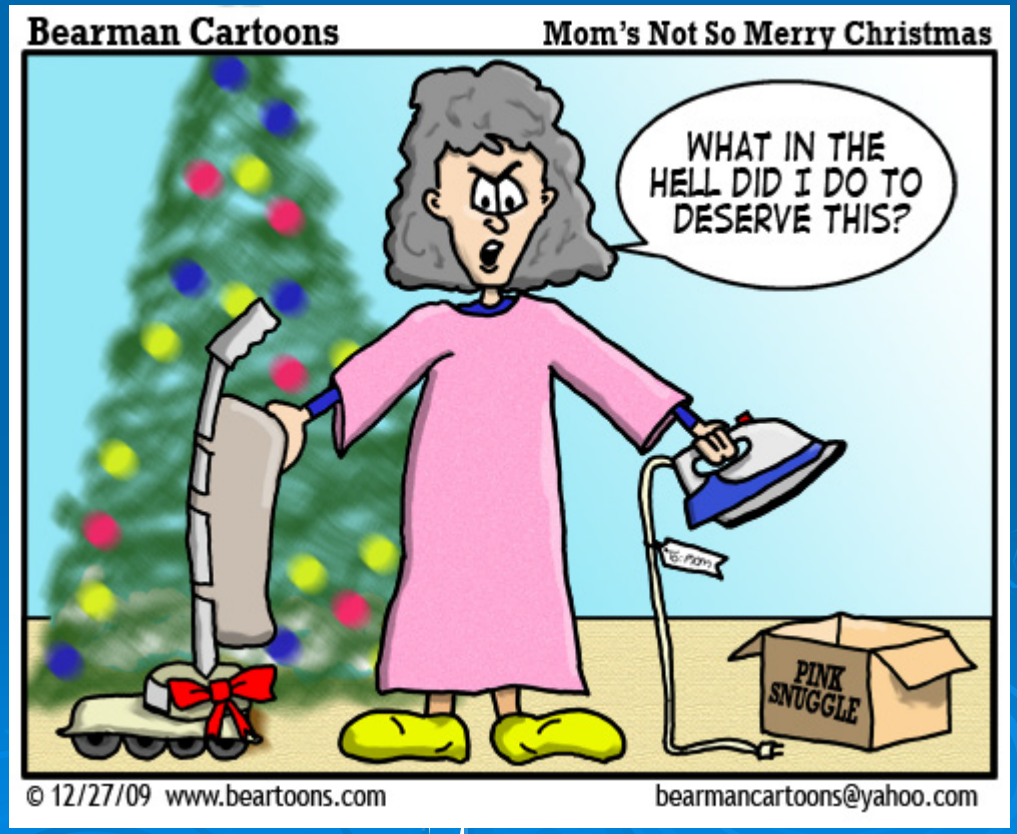
Points to note: need thorough planning

- How to measure effectiveness?
  - Environmental sampling, before and after
    - Specimens? Frequent hand-touch sites only?
    - Culture? ATP? But not fluorescent markings.
    - Typing (PFGE)
  - Clinical outcomes
    - e.g. MRSA infection / colonization rate; acquisition rate (admission screening and FU screens)
- Not to replace routine standard environmental decontamination

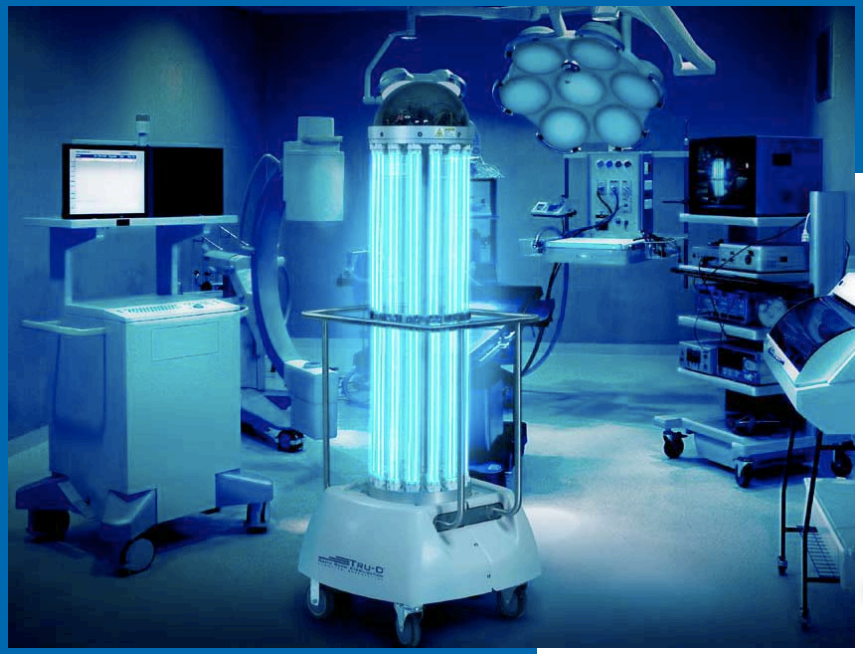
Other applications

- lab
  - BSC
  - Autopsy room / mortuary: cold chamber for dead bodies
  - Centrifuge (need injection port)
- Isolation ward
  - HEPA unit

To buy or not to buy…



More innovative products…



Thank you!