HEALTHCARE INFECTION SOCIETY

Operating Theatre Design: What do Guidelines Advise?

Dr Tim Boswell
Consultant Medical Microbiologist
Infection Control Doctor
Nottingham UK

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HIS Guidelines

Guidelines produced by HIS working parties and in collaboration with other Professional organisations.

- Guidelines on the facilities required for minor surgical procedures and minimal access interventions [2012, 153KB, PDF]
- Guidelines for prevention and control of group A streptococcal infection in acute healthcare and maternity settings in the UK [2012, 1.4 MB, PDF]
- Guidelines for the management of norovirus outbreaks in acute and community health and social care settings [2012, 2.6 MB, PDF]
- Guidelines for the control and prevention of meticillin-resistant Staphylococcus aureus (MRSA) in healthcare facilities* [HIS, 2006, PDF]
- Guidelines for the control of glycopeptide-resistant enterococci in hospitals [HIS, 2006, PDF]
- National Glycopeptide-Resistant Enterococcal Bacteraemia Surveillance Working Group Report to the Department of Health — August 2004 [HIS, 2004, PDF]
- National Clostridium difficile Standards Group: Report to the Department of Health [HIS, 2004, 459KB, PDF]
- Behaviours and rituals in the operating theatre [HIS, 2002, 184KB, PDF]
- Microbiological commissioning and monitoring of operating theatre suites [HIS, 2002, 292 KB, PDF]
- Rinse water for heat labile endoscopy equipment [HIS, May 2002, 130 KB, PDF]

Sources of information

- Microbiological commissioning and monitoring of operating theatres
- Also Behaviours and rituals in the operating theatre
- www.his.org.uk
- HTM 03-01 (updates HTM 2025)
  - Available free to NHS staff at Space for Health Website

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Guidance for facilities for providing primary and community care services

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The planning and design of sterile services departments

2 January 2004 DH Guidance

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/148490/HBN_26.pdf

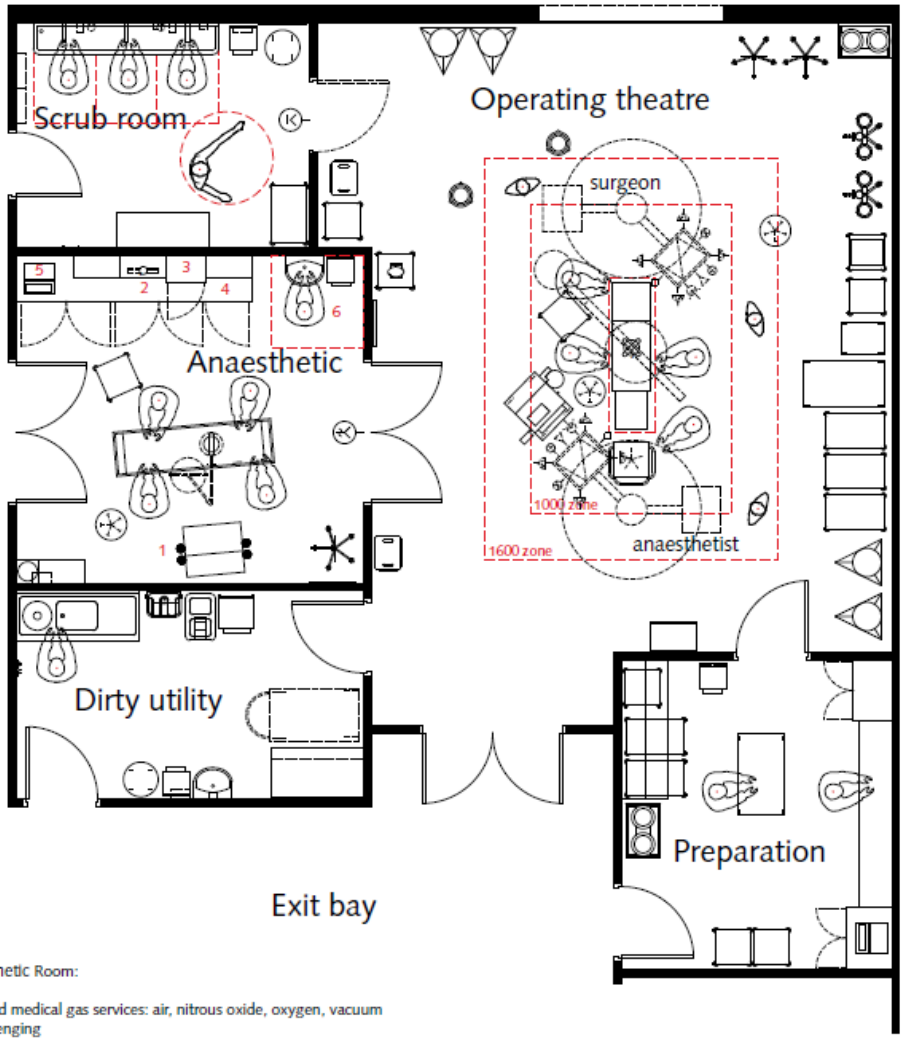
NHS Estates

HBN 26
Facilities for surgical procedures: Volume 1

Department of Health

Surgery

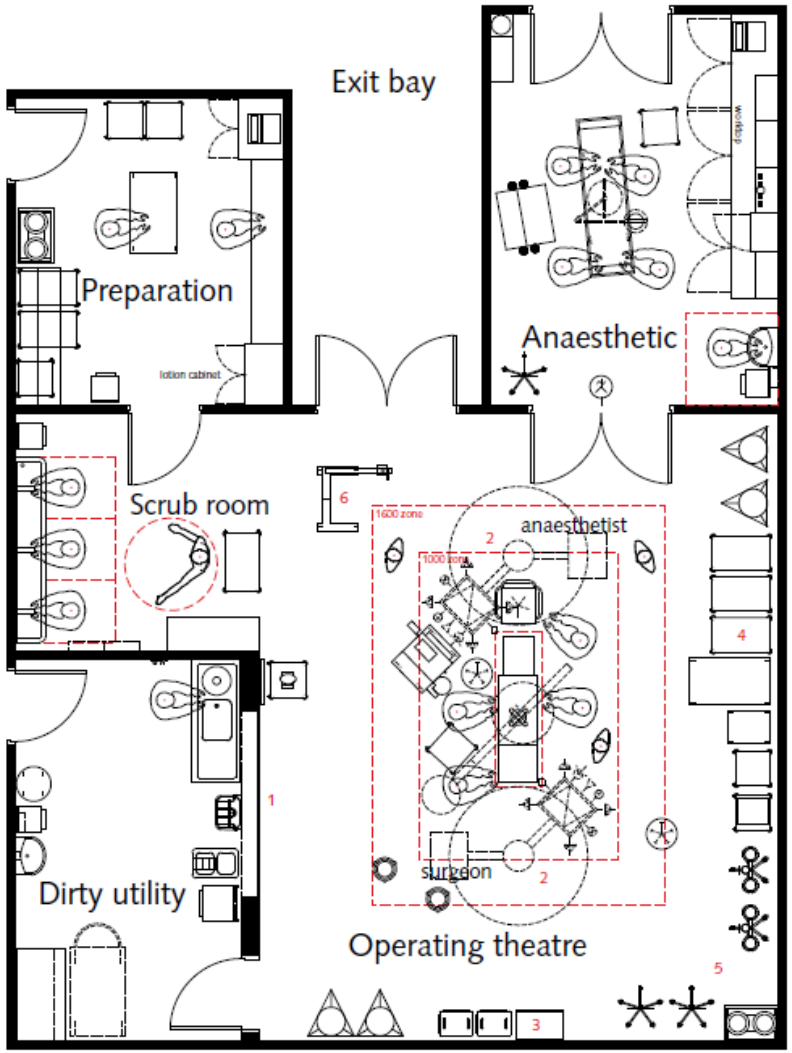
Health Building Note 10-02: Day surgery facilities



Key for Anaesthetic Room:

1. Wall-mounted medical gas services: air, nitrous oxide, oxygen, vacuum and gas scavenging
2. Lockable controlled drugs cupboard
3. Lockable drugs refrigerator
4. Work surface and storage units
5. Computer terminal
6. Clinical wash-hand basin with non-touch taps, soap and paper towel dispenser, clinical waste holder

0 1 2 3 4 5 m



Key to operating theatre:

1. Theatre control panel

0 1 2 3 4 5 m

Guidelines on the facilities required for minor surgical procedures and minimal access interventions

H. Humphreys [a,b,*], J.E. Coia [c], A. Stacey [d], M. Thomas [e], A.-M. Belli [f], P. Hoffman [g], P. Jenks [h], C.A. Mackintosh [i]

[a] *Department of Clinical Microbiology, Royal College of Surgeons in Ireland, Dublin, Ireland*
[b] *Department of Microbiology, Beaumont Hospital, Dublin, Ireland*
[c] *Department of Clinical Microbiology, Glasgow Royal Infirmary, Glasgow, UK*
[d] *Microbiology Department, Royal Berkshire NHS Foundation Trust, Reading, UK*
[e] *55 Long Row, Horsforth, Leeds, LS18 5AP, UK*
[f] *Department of Radiology, St George's Healthcare NHS Trust, London, UK*
[g] *Laboratory of Healthcare-associated Infection, Health Protection Agency, London, UK*
[h] *Department of Microbiology, Plymouth Hospitals NHS Trust, Plymouth, UK*
[i] *Infection Control Research, Clatterbridge General Hospital, Merseyside, UK*

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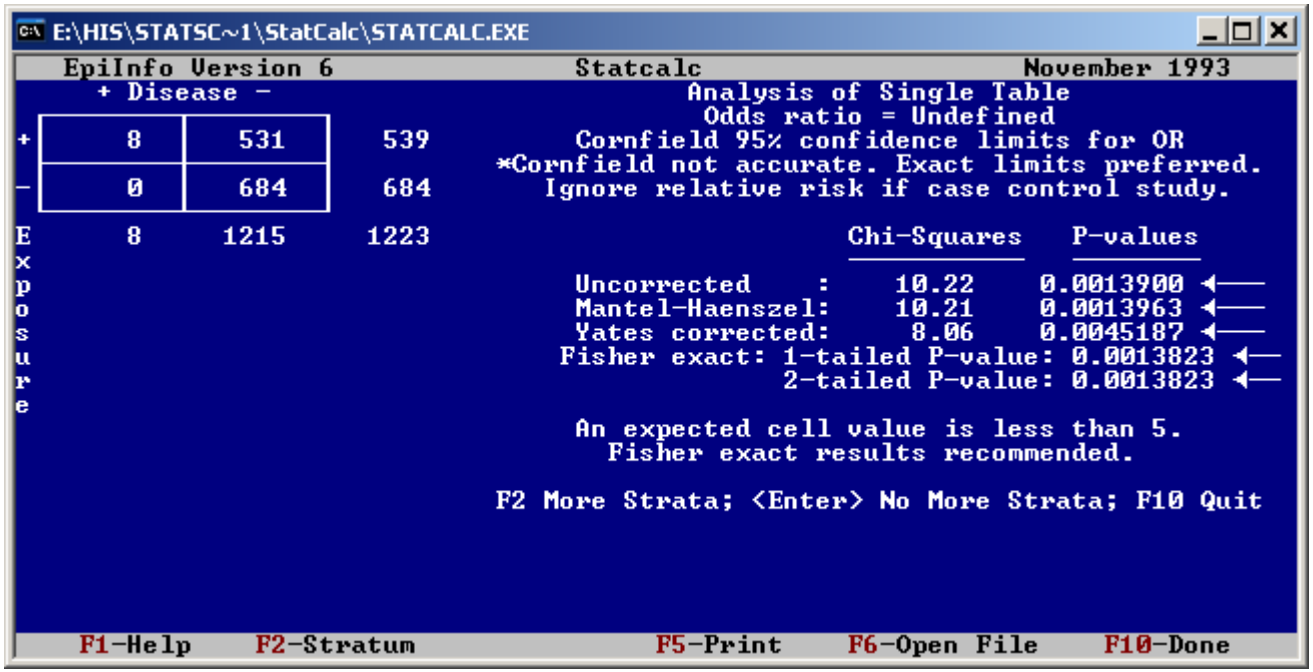
Surgical site infection
Ventilation

SUMMARY

There have been many changes in healthcare provision in recent years, including the delivery of some surgical services in primary care or in day surgery centres, which were previously provided by acute hospitals. Developments in the fields of interventional radiology and cardiology have further expanded the range and complexity of procedures undertaken in these settings. In the face of these changes there is a need to define from an infection prevention and control perspective the basic physical requirements for facilities in which such surgical procedures may be carried out. Under the auspices of the Healthcare Infection Society, we have developed the following recommendations for those designing new facilities or upgrading existing facilities. These draw upon best practice, available evidence, other guidelines where appropriate, and expert consensus to provide sensible and feasible advice. An attempt is also made to define minimal access interventions and minor surgical procedures. For minimal access interventions, including interventional radiology, new facilities should be mechanically ventilated to achieve 15 air changes per hour but natural ventilation is satisfactory for minor procedures. All procedures should involve a checklist and operators should be appropriately trained. There is also a need for prospective surveillance to accurately determine the post-procedure infection rate. Finally, there is a requirement for appropriate applied research to develop the evidence base required to support subsequent iterations of this guidance.

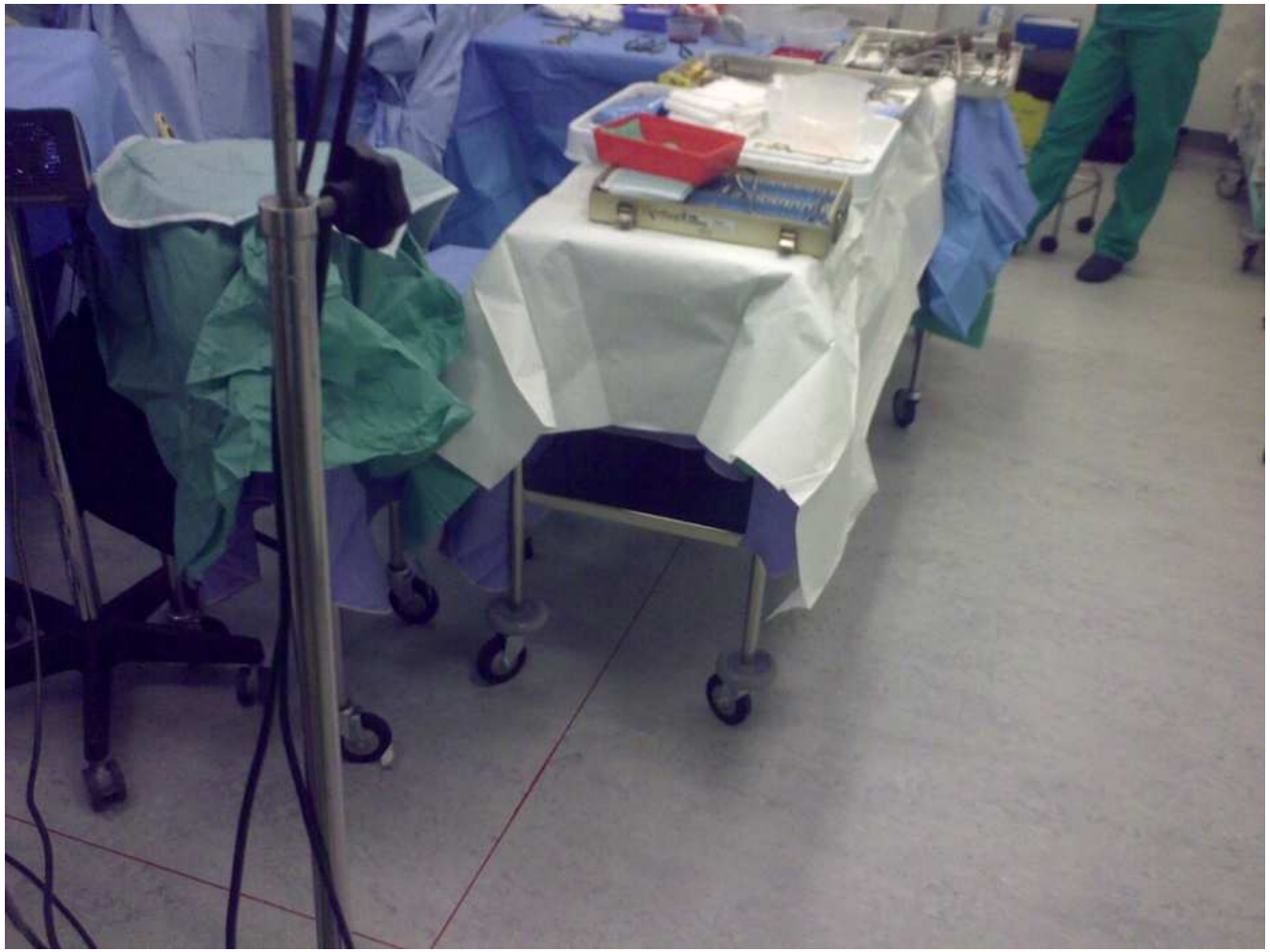
Recent increase in deep SSI after joint replacement surgery performed in temporary mobile UCV theatres



- S.aureus n=2
- CoNS n=4 (1 mixed with enterococcus)
- Pseudomonas n=1
- No organism identified n=1


Fire exit
Fire Action
Heylish


Fire Action
Valleylab



Journal of Hospital Infection 81 (2012) 71–72

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Leader

Surgical site infection, ultraclean ventilated operating theatres and prosthetic joint surgery: where now?

Recent years have seen a number of reviews and guidelines on the prevention of surgical site infection (SSI) which focus on pre-, peri- and postoperative factors.[1–3] However, these guidelines make very little reference to the physical circumstances or conditions under which the surgery takes place. Tradition and practice has been for most general surgical procedures to take place in a plenum ventilated operating theatre with about 20 air changes per hour and for much of prosthetic joint surgery to take place under laminar flow

respectively, there was a significant increase in the requirement for early revision for deep infection in those procedures performed with the use of a space suit and/or operations performed in ultraclean ventilated theatres compared with conventional theatres.[7] In this issue, P. Gastmeier and colleagues in Germany report on a systematic review of cohort studies of severe SSI following hip and knee prosthetic surgery. No individual study showed a significant benefit for ultraclean ventilated and three studies recorded higher SSI rates following hip prosthesis when the procedure was carried out in ultraclean ventilated theatres.[8]

It is unclear why the provision of such facilities may have resulted in increased SSI rates but this could relate to other issues such as surgical practice and not be a direct consequence of the ventilation. The use of ultraclean air with laminar air flow does not obviate the need for appropriate professional practice and compliance with other measures believed to be important in preventing SSI. Many of these have been reviewed and

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Review

Influence of laminar airflow on prosthetic joint infections: a systematic review

P. Gastmeier [a,*], A.-C. Breier [a], C. Brandt [b]

[a] Institute of Hygiene and Environmental Medicine, Charité-Universitätsmedizin Berlin, Germany
[b] Institute of Medical Microbiology and Infection Control, Goethe-University Frankfurt, Germany

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Hip prosthesis
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Ultraclean ventilation

SUMMARY

Background: Many hospitals use ultraclean ventilation (UVC), also known as laminar airflow systems (LAF), in their operating rooms to decrease rates of surgical site infections (SSIs). However, the evidence for these systems is limited and the additional expenses for LAF are substantial.

Aim: To determine the effectiveness of LAF to decrease SSI rates following hip and knee prosthesis.

Methods: Systematic review of cohort studies investigating the influence of LAF on SSIs following hip and knee prosthesis published during the last 10 years.

Findings: Four cohort studies using the endpoint severe SSI following knee prosthesis and four studies following hip prosthesis were included. No individual study showed a significant benefit for LAF following knee prosthesis but one small study showed a significant benefit following hip prosthesis. However, one individual study showed significantly higher severe SSI rates following knee prosthesis and three studies significantly higher SSI rates following hip prosthesis under LAF conditions. The summary odds ratio was 1.36 (95% confidence interval: 1.06–1.74) for knee prosthesis and 1.71 (1.21–2.41) for hip prosthesis.

Conclusions: It would be a waste of resources to establish new operating rooms with LAF, and questionable as to whether LAF systems in existing operating rooms should be replaced by conventional ventilation systems.

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journal homepage: www.elsevierhealth.com/journals/jhin

Laying-up of sterile instruments in the operating theatre: equal or superior protection by using a horizontal unidirectional air flow system

A.A.L. Traversari [a,*], C.A. Goedhart [b], E. Dusseldorp [c], A. Bode [a], F. Keuning [a], M.S.J. Pelk [d], M.C. Vos [e]

[a] TNO Dutch Centre for Health Assets, Soesterberg, The Netherlands
[b] Erasmus MC, University Medical Center Rotterdam, Expertise Group Corporate Real Estate, The Netherlands
[c] TNO Statistics Group, Leiden, The Netherlands
[d] Erasmus MC, University Medical Center, Rotterdam, Service Organisation Knowledge, Sector Patient Care, The Netherlands
[e] Erasmus MC, University Medical Center, Rotterdam, Department of Medical Microbiology and Infectious Diseases, The Netherlands

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Air quality
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Laying-up process
Operation theatre
Unidirectional flow system

SUMMARY

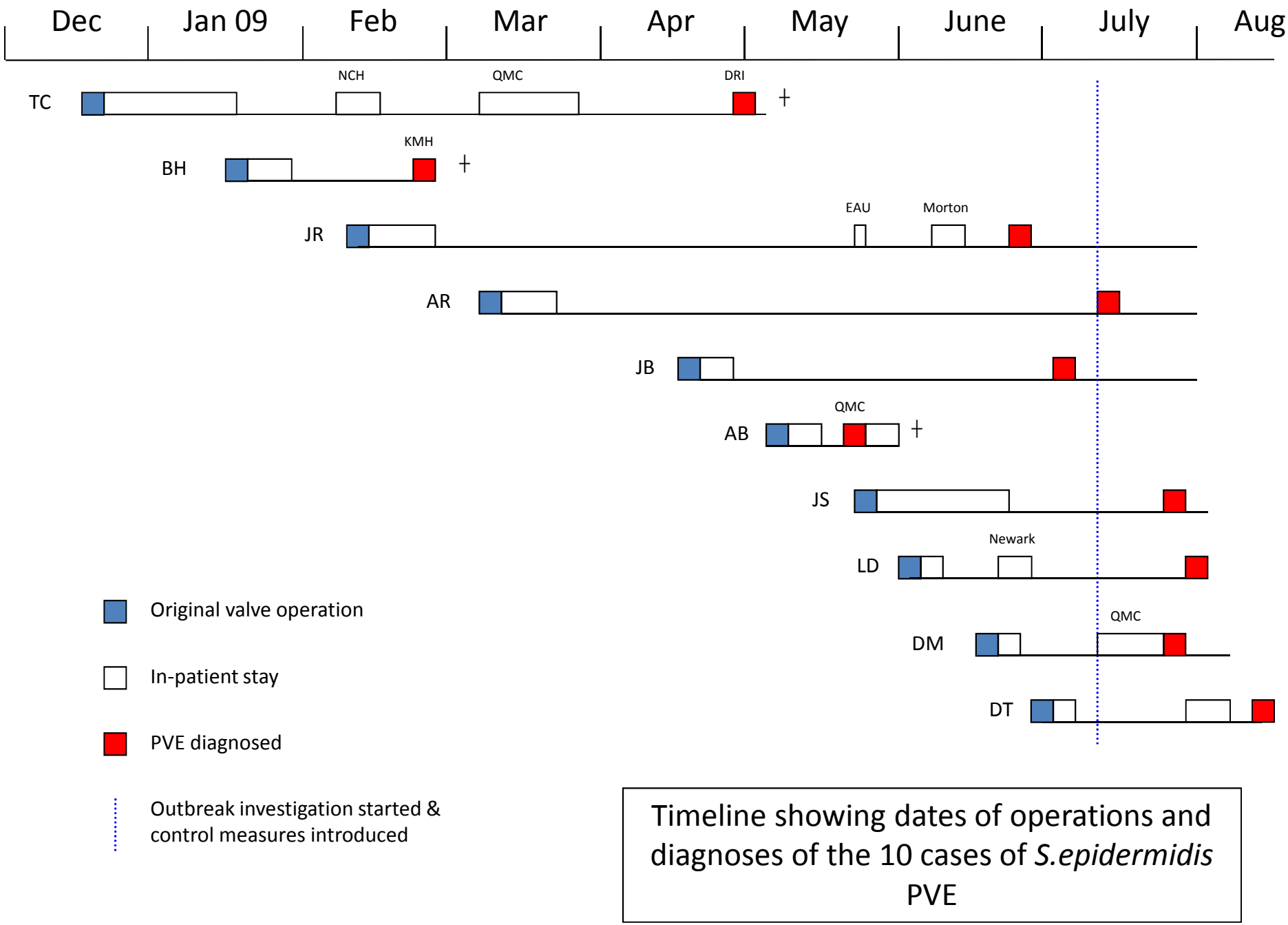
Background: A system for the preparation of sterilized instruments with unidirectional horizontal air flow (UDHF) has several advantages over a unidirectional down flow system (UDDF). The advantages are based on the installation of the system being more flexible and easier to use, no cooling of the air flow being necessary and less air being needed for circulation, resulting in reduced energy use.

Objectives: The objective of this study was to determine whether a system with UDHF performs equal or superior to a system with UDDF in terms of prevention of contamination of the air (the presence of particles and micro-organisms) during the laying-up process.

Methods: The degree of protection (DP) offered by two UDHF system variants and two UDDF system variants was determined for several static set-ups and a dynamic simulation of the process. In addition to determining the level of protection for several categories of particle size, colony-forming units (CFU) were also measured during process simulations.

Findings: When maximum protection (no particles present) is considered, the UDHF systems performed significantly better than the UDDF systems for particles $\geq$2.5 μm. When particles were present, there was no significant difference between systems for particles $\geq$0.3 and $\geq$0.5 μm. However, the performance of the UDHF system was superior to that of the UDDF system (DP) for particles $\geq$1.0 μm representing the bacteria-carrying particles. During the process measurements, no CFU were found with the UDDF system in 64% of the measurements, compared with 90% for the UDHF system ($P = 0.012$).

Conclusions: The UDHF system offers equal or superior protection to the UDDF system against contamination of the clean area within which the laying up takes place. Despite our finding that the differences did not always reach statistical significance (due to low background concentrations), there is a clear trend, from the small-sized particles



Timeline showing dates of operations and diagnoses of the 10 cases of *S.epidermidis* PVE

S.epidermidis

- Resistant to:
  - Flucloxacillin, erythromycin, gentamicin, ciprofloxacin, mupirocin (high level), fusidic acid
- Variable to:
  - Trimethoprim, teicoplanin, tetracycline, clindamycin
- Sensitive to:
  - Vancomycin, rifampicin, linezolid

Table 1. Summary of cases of *S.epidermidis* infections in cardiac surgery

Patient	Date of Operation	Operation Valve used	Infection (month/year diagnosed)	Organism	DNA typing	Outcome	Re-do surgery
Case 1	16/12/08	MVR St Jude Epic tissue	PVE (May 2009)	*S.epidermidis*	PFGE type a4	Died (06/05/09)	No
Case 2	21/01/09	AVR St Jude Epic Supra tissue	PVE (Feb 2009)	*S.epidermidis*	Not available	Died (23/02/09)	No
Case 3	10/02/09	AVR St Jude Epic Supra tissue	PVE (Jun 2009)	*S.epidermidis*	PFGE type a	Alive	Yes x 2
Case 4	10/03/09	MV repair, CABG Seguin annuloplasty ring	Deep sternal (Mar 2009)	*S.epidermidis*	Not available	Died (29/08/09)[1]	No
Case 5	11/03/09	AVR Sorin slimline mechanical	PVE (July 2009)	*S.epidermidis*	PFGE type a	Died (06/10/09)[2]	Yes x 2
Case 6	31/03/09	MVR	PVE (Nov 2009)	*S.epidermidis*	PFGE type a	Alive	Yes
Case 7	14/04/09	AVR + CABG x1 St Jude Epic Supra tissue	PVE (Jun 2009)	*S.epidermidis*	PFGE type a	Alive, residual VSD	Yes
Case 8	29/04/09	AVR St Jude Epic Supra tissue	PVE (May 2009)	*S.epidermidis*	PFGE type a	Died (30/05/09)	No[3]
Case 9	20/05/09	AVR St Jude Epic Supra tissue	PVE (July 2009)	*S.epidermidis*	PFGE type a	Alive	Yes x 2
Case 10	27/05/09	AVR St Jude Epic Supra tissue	PVE (July 2009)	*S.epidermidis*	PFGE type a	Alive	Yes
Case 11	10/06/09	AVR St Jude Epic Supra tissue	PVE (July 2009)	*S.epidermidis*	PFGE type a	Died (Nov 09)	Yes[4]
Case 12	16/06/09	MVR/AVR + closure PFO St Jude Epic tissue/St Jude Epic Supra tissue	Post-op bacteraemia (Jun 2009)	*S.epidermidis*	Not available	Alive	No
Case 13	23/06/09	AVR St Jude Epic Supra tissue	PVE (Aug 2009)	*S.epidermidis*	PFGE type a	Alive, has VSD	No
Case 14	07/07/09	AVR + CABG x1 St Jude Epic Supra tissue	Post-op bacteraemia (July 2009)	*S.epidermidis*	PFGE type a	Alive	No

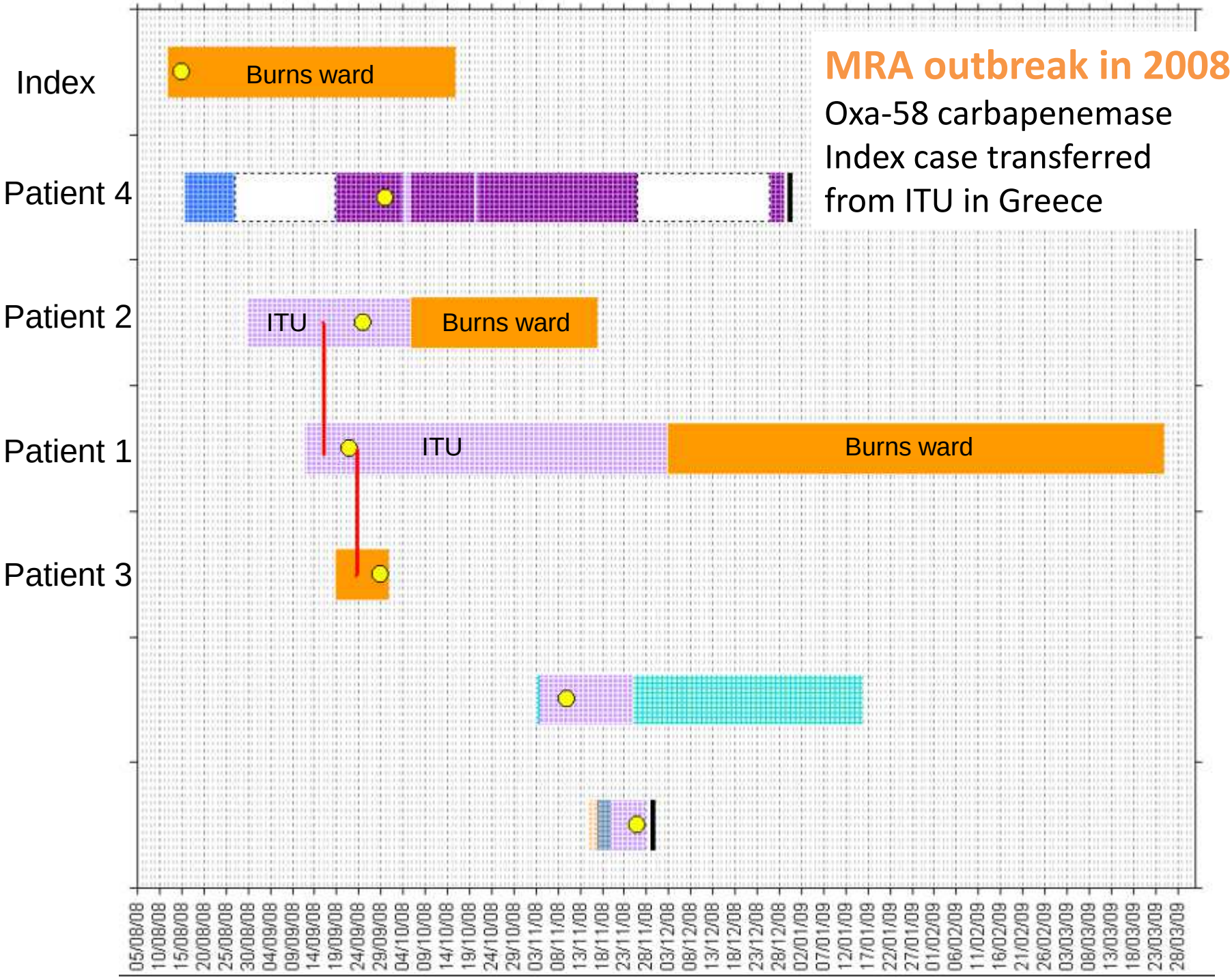
PFGE – pulsed field gel electrophoresis

1. Died of un-related cause (ischaemic bowel post reversal of ileostomy)
2. Died shortly after 2nd re-do AVR following recurrent *S.epidermidis* infection after 1st re-do AVR
3. Died shortly before planned re-do surgery
4. Further paravalvular leak plugged with percutaneously deployed device.

Outbreak summary

- 11 cases of PVE - all operated on by one surgeon
- No cases in other surgeons
  - 11/28 versus 0/105 ($p<0.0000001$)
- No other member of staff present at all 11 operations
- All caused by *S.epidermidis*. All but one were due to DNA fingerprint type "a"
- Surgeon was found to be carrying "a" on hands and elsewhere
- Strain "a" was not found on the hands of 23 other staff (surgeons, CICU nurses, theatre personnel)
- Infections were acquired in theatre

- This strain of *S.epidermidis* was resistant to the surgical antibiotic prophylaxis
- Route of transmission from surgeon not clear
  - Airborne
  - Micro-puncture of gloves
  - Contamination of gloves during glove changing


MRA outbreak in 2008
Oxa-58 carbapenemase
Index case transferred
from ITU in Greece
Index
Patient 4
Patient 2
Patient 1
Patient 3
Burns ward
ITU
Burns ward
ITU
Burns ward
05/08/08
10/08/08
15/08/08
20/08/08
25/08/08
30/08/08
04/09/08
09/09/08
14/09/08
19/09/08
24/09/08
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17/01/09
22/01/09
27/01/09
01/02/09
06/02/09
11/02/09
16/02/09
21/02/09
26/02/09
03/03/09
08/03/09
13/03/09
18/03/09
23/03/09
28/03/09

Detection of MRA in the burns operating theatre air

	Prep.Rm (2 stripes)		
Time /min	al Count /r	Aci	~Pseud.
0	62	4	0
10	33	6	2
20	20	6	2
30	30	10	3
40	45	3	2
50	59	3	0
60	83		0
90	40	1	0
110	18		0
130	15	1	0
180	37		0
210	41		0
220	54	1	0
230	28	2	0
240	18		1
250	17		0
260			0

	Main Theatre (plain lid)		
Time /min	al Count /r	Aci	~Pseud.
0	25	0	0
10	140	++	3
20	90	35	3
30	200	150	3
40	110	85	2
50	70	3	0
60	85	3	0
80	70	4	0
100	106	6	0
120	55	2	2
140	88	0	0
180	94	3	0
220	90	2	3
230	60	2	3
240	75	3	3
250	100	1	3
260	50	2	3

Case-control study

- Cases n=27
  - Burns patients between January ‘03 and September ’11 who were MRA positive
  - First MRA positive sample given at least 48 hours after admission
  - 4 clusters as well as sporadic infections
- Controls n=100
  - Same time period & admitted to the same wards (burns or intensive care)
  - No MRA positive samples

Case-control study

- Matched controls (n=100)
  - From time periods when MRA positive patients were on the burns ward
  - At least two days in-patient admission
  - At least one sample sent to microbiology that would have been capable of growing Acinetobacter – but didn't

Risk factors recorded

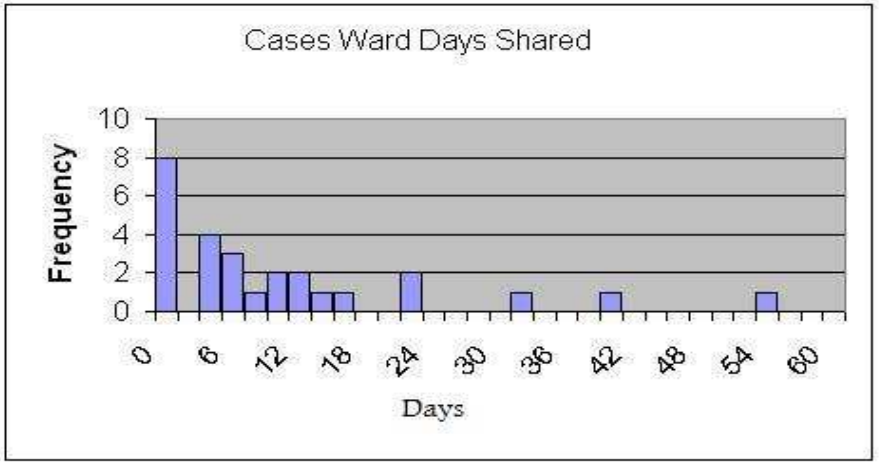
- Using a 30 day window for each patient
- Days on hospital
- Ward days shared
- Number of visits to burns theatre
- Total time in burns theatre
- If a patient went through the theatre, how close to the last MRA positive patient before

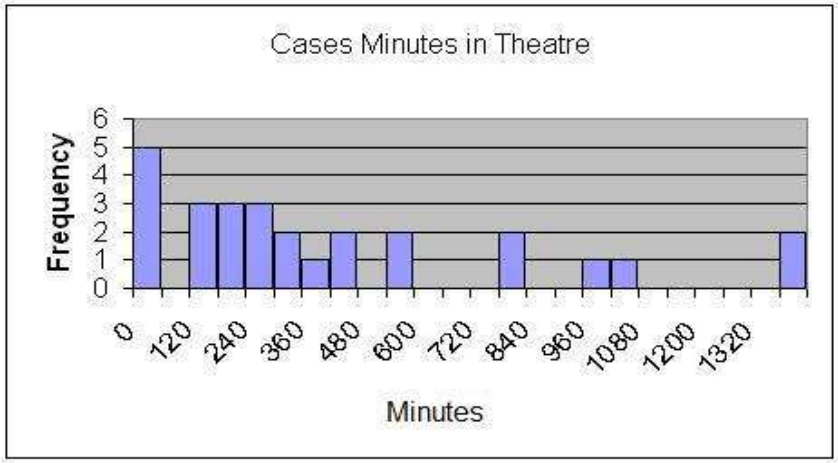
Table 5 – Results of analysis of risk factors in Case-Control study

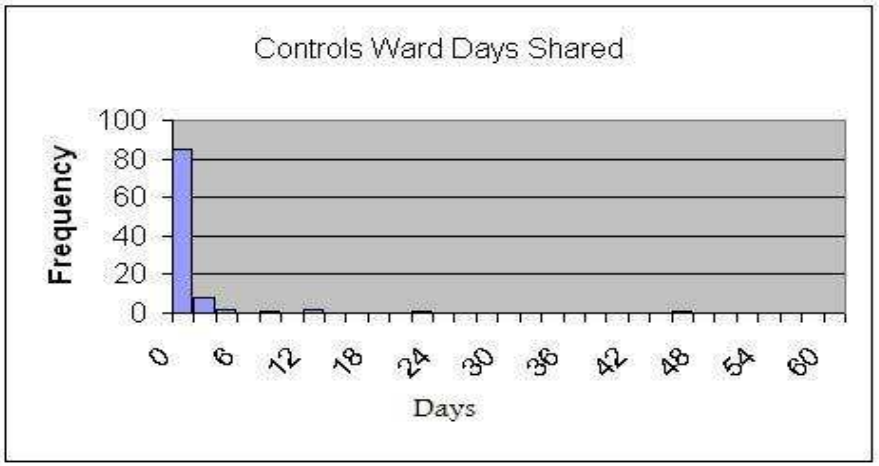
Measure		Cases (n=27)	Controls (n=100)	p value: case vs. control	Matched Controls (n=100)	p value: case vs. matched control
Male	%	59	82	0.025*	85	0.008*
Age	Median [range]	45 [20-92]	36 [0-91]	0.074**	47 [1-89]	0.60**
	mean	48.8	39.3		44.8	
Days in hospital	Median [range]	12 [3-30]	1 [0-30]	<0.001**	8 [2-30]	0.064**
	mean	14.4	3.8		11.4	
Ward days shared	Median [range]	6 [0-54]	0 [0-46]	<0.001**	5 [0-47]	0.815**
	mean	10.9	1.3		8.7	
Times in theatre	Median [range]	1 [0-10]	0 [0-8]	<0.001**	0 [0-4]	<0.001**
	mean	2	0.5		0.6	
Minutes in theatre	Median [range]	270 [0-1377]	0 [0-1118]	<0.001**	0 [0-446]	<0.001**
	mean	405	51		63	

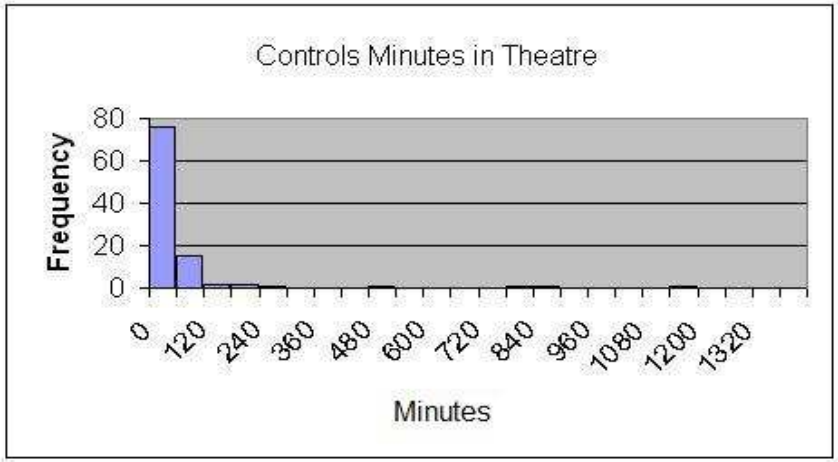
*Calculated using a chi-squared test with Yates's correction

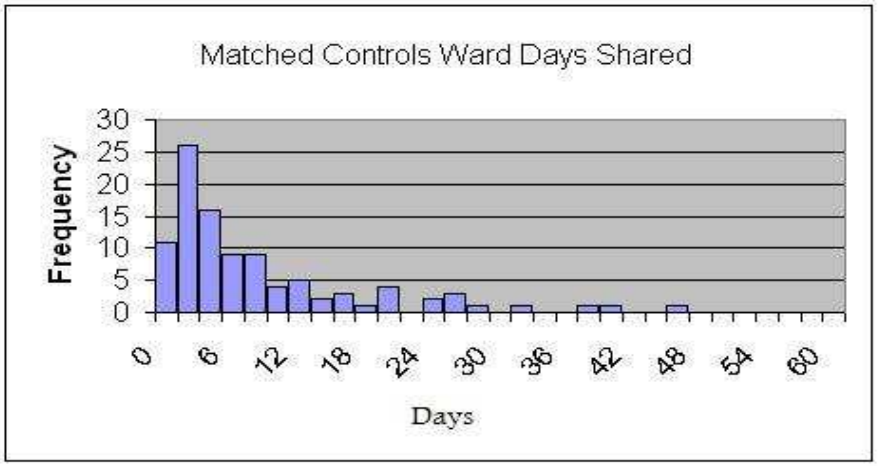
**Calculated using a Mann-Whitney U test


Cases Ward Days Shared
Frequency
0
2
4
6
8
10
0
6
12
18
24
30
36
42
48
54
60
Days


Cases Minutes in Theatre
Frequency
0
1
2
3
4
5
6
0
120
240
360
480
600
720
840
960
1080
1200
1320
Minutes


Controls Ward Days Shared
Frequency
0
20
40
60
80
100
0
6
12
18
24
30
36
42
48
54
60
Days


Controls Minutes in Theatre
Frequency
0
20
40
60
80
0
120
240
360
480
600
720
840
960
1080
1200
1320
Minutes


Matched Controls Ward Days Shared
Frequency
0
5
10
15
20
25
30
0
6
12
18
24
30
36
42
48
54
60
Days

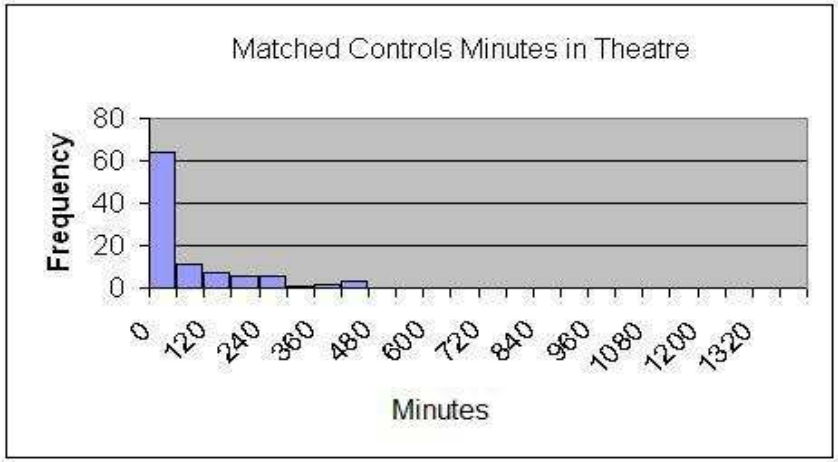

Matched Controls Minutes in Theatre
Frequency
0
20
40
60
80
0
120
240
360
480
600
720
840
960
1080
1200
1320
Minutes

Table 6 – Results of analysis of theatre visits for cases and matched controls

Time since previous positive patient	Cases	Matched Controls	Odds Ratio (95% confidence interval)	p value
Same Day	5/27	1/100	22.5 (2.5 – 202.29)	0.002
Within 48 hours	5/27	3/100	7.35 (1.63 – 33.08)	0.011
Within 1 week	13/27	20/100	3.71 (1.51 – 9.14)	0.007
Within 1 month	20/27	35/100	5.31 (2.04 – 13.77)	0.001
Any visit to theatre	22/27	37/100	7.49 (2.62 – 21.46)	<0.001

For the tests for same day exposure, and within 48 hours, at least one cell had an expected value of less than five, so Fisher exact one-tailed p values were taken. For the remaining tests, a Yates corrected p value was used.

Low concentration hydrogen peroxide area decontamination

- Whole burns theatre suite 1st decontaminated in Oct 2008, including burns bathroom
- Deployed after each known MRA patient theatre visit
- Used 6 times during 2009 and once during 2010
- Isolation rooms on Burns ward also decontaminated once in 2009 and once in 2010

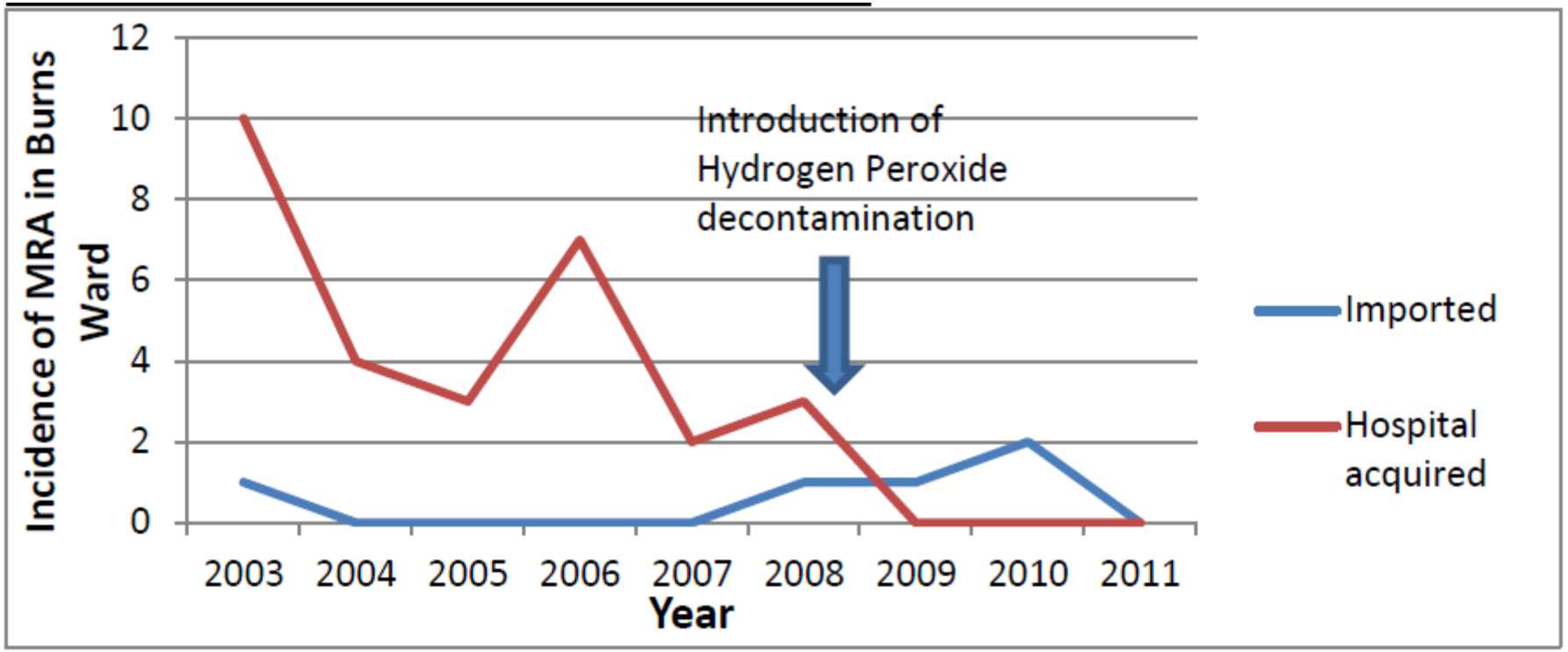


Figure 1: The incidence of both imported and hospital acquired MRA infections on the burns ward. Once hydrog peroxide decontamination was introduced for the ward and theatre, there were no subsequent hospital acquire infections despite infected patients being admitted.

Summary

- Cases of hospital acquired MRA occurred each year between 2003-8.
- Sporadic cases as well as clusters
- 2008 outbreak had an epidemiological association with the burns theatre
- Retrospective case control study showed a strong association with burns theatre as a risk factor for cases between 2003-8
- The control measure (H_2O_2 decontamination) seems to have eliminated MRA from the unit