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Environmental contamination

Public Health England, London,
United Kingdom

Derren Ready

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Environmental contamination

Reservoirs

- Patients
- Staff
- Food
- Animals
- Environment
- surfaces

Surfaces

Surface contamination

- Frequency of surface contamination
- Are levels of contamination sufficiently high to allow transmission
- Can pathogens remain viable on surfaces
- Are surfaces cleaned

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Survival on dry surfaces

Survival of hospital pathogens on dry hospital surfaces

Organism	Survival time
Clostridium difficile (spores)	>5 Months
Acinetobacter spp	3 Days to 11 months[79]
Enterococcus spp including VRE	5 Days to >46 months[32]
Pseudomonas aeruginosa	6 Hours to 16 months
Klebsiella spp	2 Hours to >30 months
Staphylococcus aureus, including MRSA	7 Days to >12 months[80]
Norovirus (and feline calicivirus)	8 Hours to >2 weeks[81]

NOTE. Adapted from Kramer et al.[31]

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Hands from surfaces

Transfer of pathogens from surfaces to the hands of health care personnel

Direct patient contact	Contact with environmental surfaces only
	52% of 44 HCP acquired VRE on their hands or gloves[10]
45% of 50 HCP acquired MRSA on their gloved hands[39]	40% of 50 HCP acquired MRSA on their gloved hands[39]
50% of 30 HCP acquired *Clostridium difficile* on their gloved hands[40]	50% of 30 HCP acquired *C difficile* on their gloved hands[40]
Compliance with hand hygiene: 80%[41]	Compliance with hand hygiene: 50%[41]

HCP, Health care personnel.

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Curtains

Two patients with laryngeal cancer developed iGAS infection with associated tracheostomy wound cellulitis within a 48h period.

The outbreak team - review of GAS cases, prospective case finding, healthcare worker screening and sampling of patient curtains.

Environmental sampling demonstrated that 10 out of 34 patient curtains on the ward were contaminated with GAS and all isolates were typed as emm-1.

Patient curtains as potential source for GAS cross-transmission, with implications in relation to hand hygiene and frequency of laundering.

Based on this report we recommend that during an outbreak of GAS infection all patient curtains should be changed as part of the enhanced decontamination procedures.

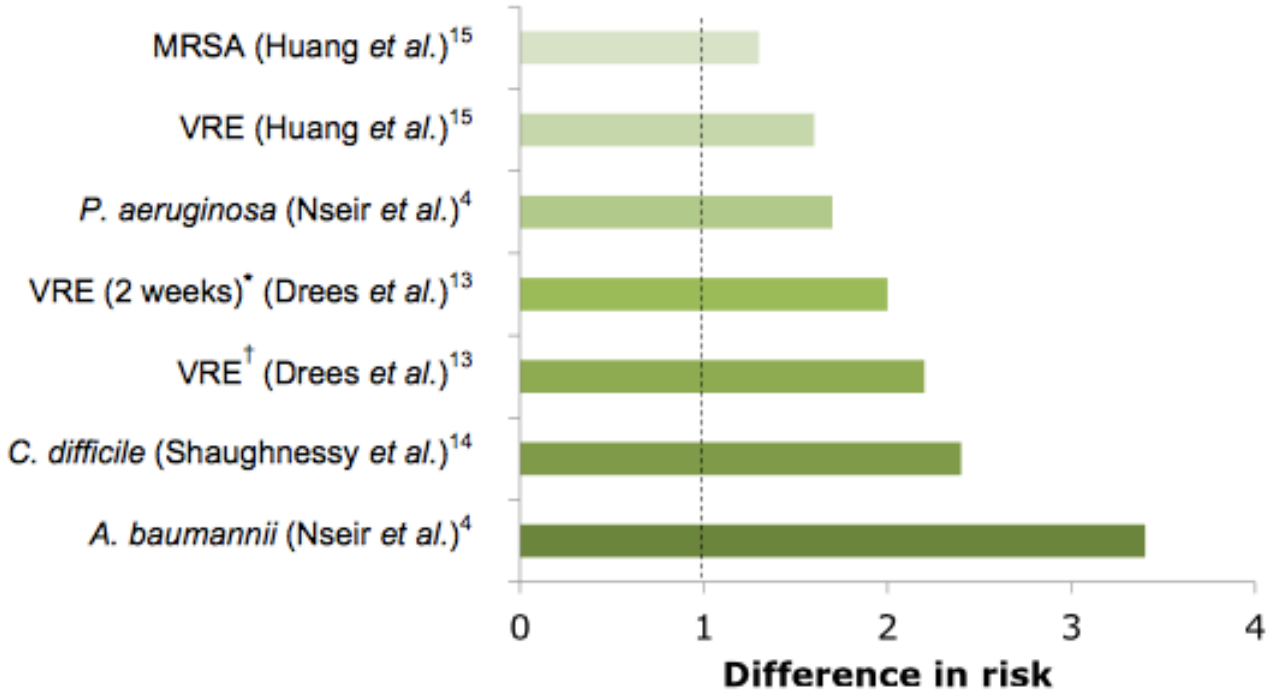

Fig 1. Chart showing the increased risk associated with the prior room occupant. The figures of difference in risk are unadjusted based on raw data. Several of the studies included adjusted measures of risk, but these were not included because of differences in study design. * Any patient infected or colonized with VRE in the two weeks prior to admission. † The immediate prior room occupant was known to be infected or colonized with VRE.

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C. difficile & MRSA in hospital setting

Table 1

Descriptive statistics of variables for MRSA and *C. difficile* contamination in patient rooms

	Unexposed rooms (n = 26)		MRSA exposed rooms (n = 10)		*C. difficile* exposed rooms (n = 3)		Overall Prevalence	
Variables[a]	**MRSA (%)**	***C. difficile* (%)**	**MRSA (%)**	***C. difficile* (%)**	**MRSA (%)**	***C. difficile* (%)**	**MRSA (%)**	***C. difficile* (%)**
General prevalence	6/149 (4.0)	9/149 (6.0)	1/52 (1.9)	1/52 (1.9)	0/17 (0)	4/17 (23.5)	7/218 (3.2)	14/218 (6.4)
Ward:								
Medicine A[b]	4/54 (7.4)	3/54 (5.6)	0/20 (0)	1/20 (5.0)	0/5 (0)	2/5 (40)	4/79 (5.1)	6/79 (7.6)
Medicine B[c]	0/35 (0)	3/35 (8.6)	1/16 (6.3)	0/16 (0)	No sampling	No sampling	1/51 (1.9)	3/51 (5.9)
Surgery[d]	2/60 (3.3)	3/60 (5.0)	0/16 (0)	0/16 (0)	0/12 (0)	2/12 (16.7)	2/88 (2.3)	5/88 (5.7)
Material type:								
Cork	0/23 (0)	3/23 (13)	0/7 (0)	1/7 (14.3)	0/3 (0)	2/3 (66.7)	0/33 (0)	6/33 (18.2)
Fabric	0/26 (0)	0/26 (0)	1/8 (12.5)	0/8 (0)	0/2 (0)	0/2 (0)	1/36 (2.8)	0/36 (0)
Laminate	1/26 (3.8)	1/26 (3.8)	0/9 (0)	0/9 (0)	0/3 (0)	1/3 (33.3)	1/38 (2.6)	2/38 (5.3)
Plastic	5/74 (6.8)	5/74 (6.8)	0/28 (0)	0/28 (0)	0/9 (0)	1/9 (11.1)	5/111 (4.5)	6/111 (5.4)

Fabric	0/26 (0)	0/26 (0)	1/8 (12.5)	0/8 (0)	0/2 (0)	0/2 (0)	1/36 (2.8)	0/36 (0)
Laminate	1/26 (3.8)	1/26 (3.8)	0/9 (0)	0/9 (0)	0/3 (0)	1/3 (33.3)	1/38 (2.6)	2/38 (5.3)
Plastic	5/74 (6.8)	5/74 (6.8)	0/28 (0)	0/28 (0)	0/9 (0)	1/9 (11.1)	5/111 (4.5)	6/111 (5.4)
Surface sampled:								
Bulletin board[e]	0/23 (0)	3/23 (13)	0/7 (0)	1/7 (14.3)	0/3 (0)	2/3 (66.7)	0/33 (0)	6/33 (18.2)
Chair back[e]	4/25 (16)	2/25 (8)	0/10 (0)	0/10 (0)	0/3 (0)	0/3 (0)	4/38 (10.5)	2/38 (5.3)
End of bed	1/26 (3.8)	1/26 (3.8)	0/10 (0)	0/10 (0)	0/3 (0)	1/3 (33.3)	1/39 (2.6)	2/39 (5.1)
Overbed table[e]	1/26 (3.8)	1/26 (3.8)	0/9 (0)	0/9 (0)	0/3 (0)	1/3 (33.3)	1/38 (2.6)	2/38 (5.3)
Privacy curtain[e]	0/26 (0)	0/26 (0)	1/8 (12.5)	0/8 (0)	0/2 (0)	0/2 (0)	1/36 (2.8)	0/36 (0)
Television[e]	0/23 (0)	2/23 (8.7)	0/8 (0)	0/8 (0)	0/3 (0)	0/3 (0)	0/34 (0)	2/34 (5.9)

n = number of rooms.

[a] Denominator is based on the number of surfaces in patient rooms that were tested.

[b] Total of 10 unexposed rooms, 4 MRSA exposed rooms, 1 *C. difficile* exposed room located in ward Medicine A.

[c] Total of 6 unexposed rooms, 3 MRSA exposed rooms, 0 *C. difficile* exposed rooms located in ward Medicine B.

[d] Total of 10 unexposed rooms, 3 MRSA exposed rooms, 2 *C. difficile* exposed rooms located in the surgical ward.

[e] Surfaces were not present in all patient rooms at the time of sampling.

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PLOS ONE

Environmental Contamination as a Risk Factor for Intra-Household *Staphylococcus aureus* Transmission

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Bivariate and multivariate analyses of risk factors for *S. aureus* transmission within households.

	Bivariate analyses[a,b]			Multivariate analyses[a]		
	aOR[2]	(95% CI)	*P*	aOR[3]	(95% CI)	*P*
Sociodemographics						
Income < $21,000	0.8	(0.4–1.4)	.38			
Child ≤5 present	2.4	(1.3–4.4)	.01	**2.3**	**(1.2–4.5)**	**.02**
Pet present	1.6	(0.9–2.9)	.13	1.8	(0.9–3.5)	.10
Travel to the Dominican Republic in the past 6 months	0.6	(0.3–1.2)	.14	0.6	(0.3–1.3)	.19
Health and hygiene risk factors						
Surgery in the past 6 months	1.9	(0.9–3.7)	.08	2.1	(1.0–4.5)	.07
Injects insulin in the past 6 months	0.3	(0.1–1.2)	.09	0.3	(0.1–1.1)	.07
Home healthcare attendant	0.8	(0.3–2.3)	.68			
Shares towels	1.4	(0.7–2.6)	.36			
Shares Razor	1.5	(0.6–3.4)	.36			
Crowding (>1 person per room)[c]	2.1	(0.9–4.5)	.07			
Contaminated environment with a colonizing or clinicalinfection strain	5.1	(2.8–9.4)	<.01	**5.4**	**(2.9–10.3)**	**<.01**
Drug use and other household level risk factors						
Illicit drug use in the past 6 months	2.5	(0.5–12.7)	.26			
HIV, IDU, MSM, Prison, STD	1.6	(0.5–4.8)	.41			

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Environmental contamination with a colonizing or clinical infection strain and intra-household transmission by case-control status.

	Case households (N =146)		Control households (N =145)				
	N	(%)	N	(%)	aOR[a]	(95% CI)	*P*
Environmental contamination with a colonizing or clinical infection strain							
Contaminated with a colonizing strain or the clinical infection strain	73	(50)	43	(30)	**2.4**	**(1.5–3.9)**	**<.01**
Contaminated with a colonizing strain	54	(37)	43	(30)	1.4	(0.9–2.3)	.17
Contaminated with the clinical infection strain	45	(31)					
Contaminated with a colonizing strain and the clinical infection strain	26	(18)					
Intra-household transmission							
≥2 household members colonized with identical strains or ≥1non-index household member colonized with the clinical infection strain	55	(38)	26	(18)	**3.1**	**(1.8–5.6)**	**<.01**
≥2 household members colonized with identical strains	35	(24)	26	(18)	1.5	(0.8–2.8)	.17
≥1 non-index household member colonized with theclinical infection strain	36	(25)					
≥2 household members colonized with identical strains and ≥1non-index household member colonized with the clinical infection strain	16	(11)					

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval.
a. Logistic regression was used to calculate adjusted OR's and 95% CI's, controlling for household size.

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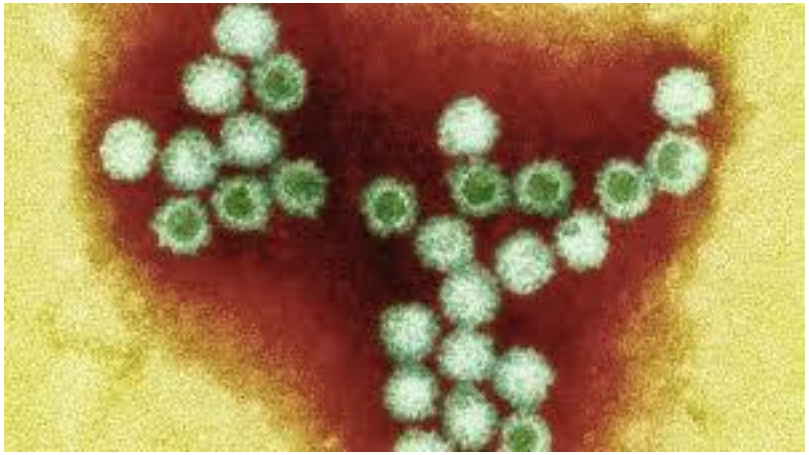
Case studies
Norovirus gastroenteritis



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Healthcare outbreak

- Outbreak monitored over a 4½ month period (December 2009 – May 2010)
- Affected 326 patients on 22 wards

- **Genotyping**
- GII-4 norovirus detected in all genotyped samples
- Diversity between strains was <4% at the nucleotide level

- **Strain Diversity**
- Eight distinct genetic clusters detected
- Up to 13% diversity was observed between genetic clusters

- **Epidemiology**
- Clusters affected 1 – 4 wards
- Clusters were detected for between 3 – 85 days

Data from: Morter et al (2011)

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Healthcare outbreak:

- 239 environmental swabs were taken during the outbreak from 5 wards
- 31.4% (75/239) were norovirus-positive (genotyped samples were all GII-4)

	After 1st Clean
Cleansers	4
Equipment	5
Nurses Station	4
Bedside	1
Furniture	5
Total	**19**

- Reduction in contaminated sites from ~40% to ~13%
- Sites remaining norovirus-positive after cleaning showed ≥1log reduction by qRT-PCR

Data from: Morter et al (2011)

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This is Bob

- Bob is 79
- Independently living, dementia, increasingly needing help
- Admitted to a care home in February 2015

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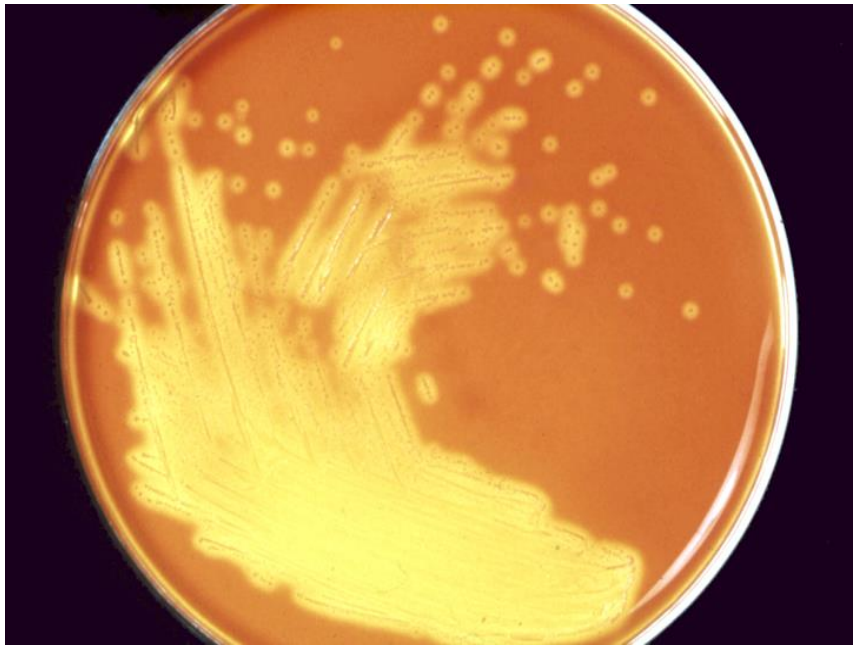
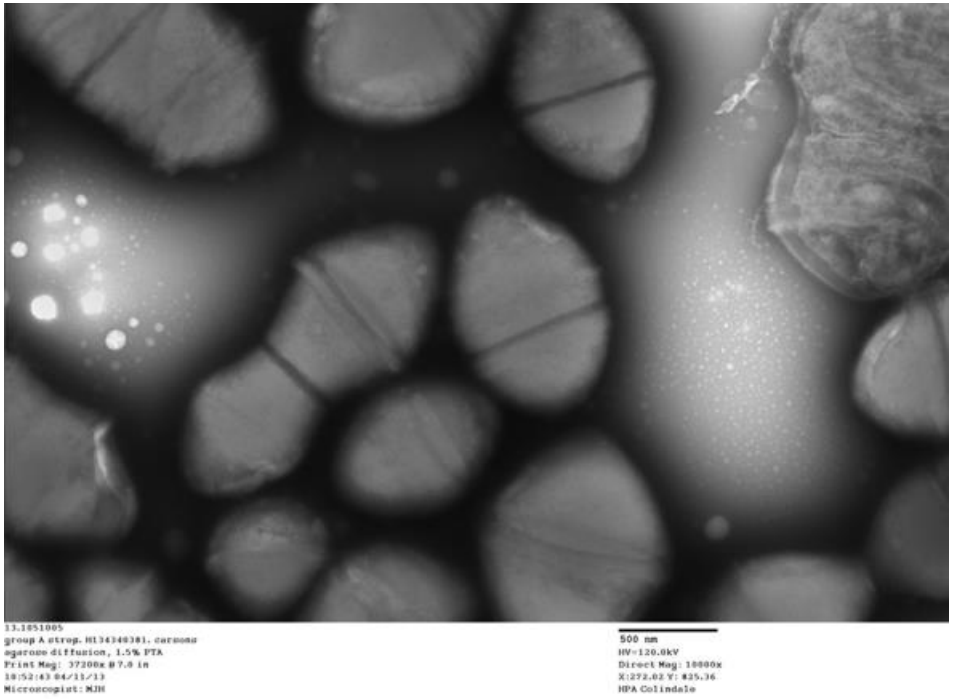
7 days post admission Bob died

His blood culture yielded a pure growth of *S. pyogenes* (Group A streptococci)





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Two weeks prior.....

- A long term resident in the same care home had died……
- Also - blood culture yielded a pure growth of *S pyogenes* (Group A streptococci)

? Are they linked ?

? Are other patients at risk ?

? Is it coincidental ?

Cluster analysis using bacterial discrimination

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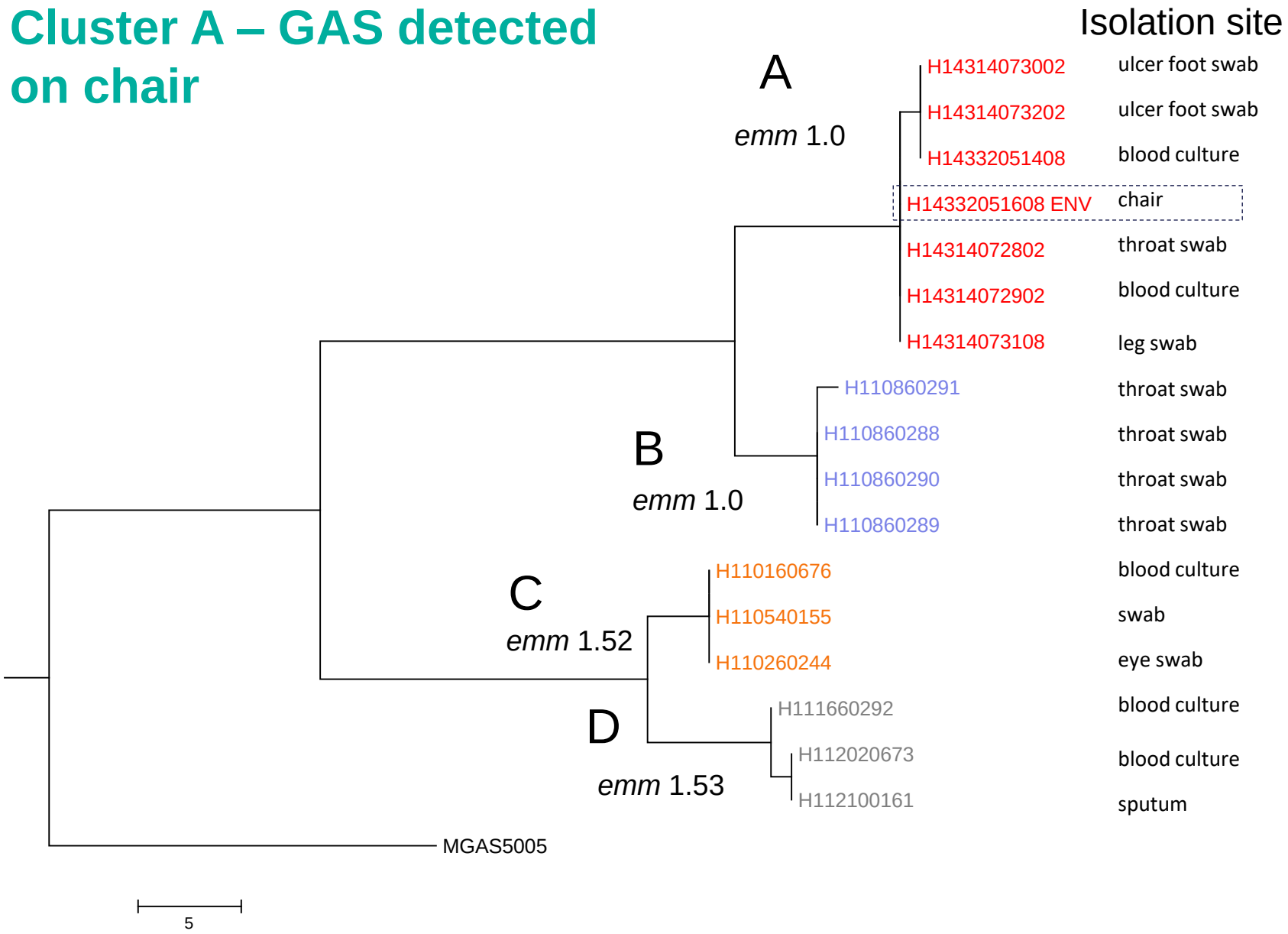
Cluster A – GAS detected on chair



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Bob…….

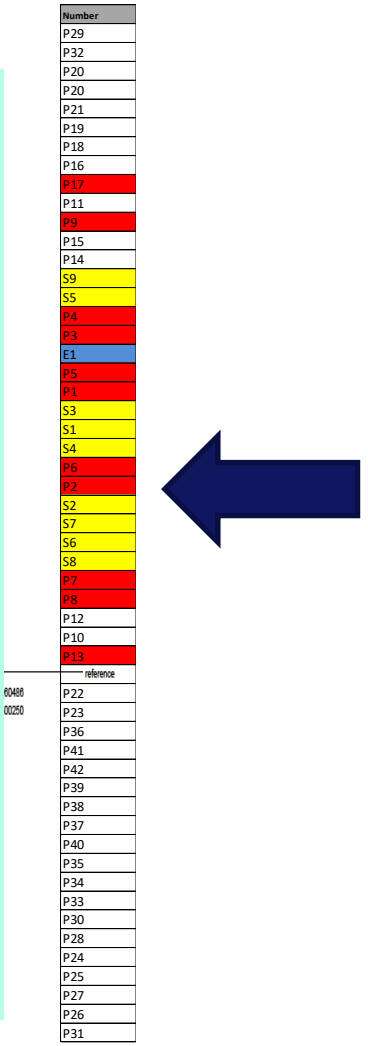
Environmental swab
Outbreak - patient
Outbreak - staff
Non-outbreak - patient

Infected with strain indistinguishable from first fatal case

Investigation revealed 9 additional infected/colonised patients

9 staff infected, asymptomatic

1 environmental swab positive with the cluster strain, indistinguishable from staff and patients – chair used for treatment



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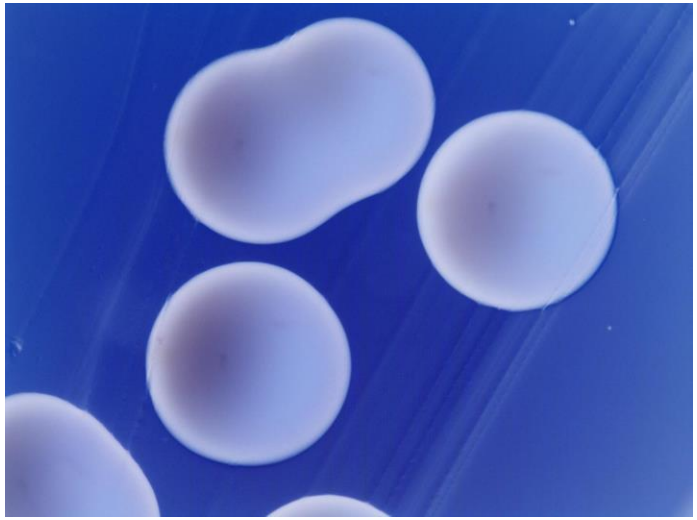
MRSA, dentistry and medicine

- MRSA on clinical & non-clinical surfaces
  - Clinical and non-clinical surfaces within dental practices including the reception areas

- Evidence suggests that prosthetic devices in the oral cavity may increase carriage of *Staphylococcus aureus*

- MRSA on removable devices
  - Dentures
  - Retainers



MRSA in hospitalized patients

	Viable microbiota	*S. aureus*	MRSA
No. of subjects harbouring	100	33	12
microorganisms (*%*)	(*100%*)	(*33%*)	(*12%*)
Median total viable count	6.93×10^7	9.8×10^3	1.99×10^4
CFU / sample (*range*)	($1 \times 10^7 - 2.9 \times 10^9$)	($1.4 \times 10^2 - 1.4 \times 10^7$)	($5 \times 10^2 - 9.35 \times 10^5$)
Median % of viable count	-	0.1%	0.04%
(*range*)		(*<0.001 - 89.7%*)	(*<0.001 – 11.7%*)

Will patients recolonise themselves with MRSA from dentures post-decontamination?

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Summary

- contaminated surfaces contribute to the transmission of pathogens.
- admission to a room previously occupied by a patient with a hospital pathogen increases the risk of acquiring that pathogen,
- intervention studies showing that this increased risk can be mitigated by improved environmental decontamination,
- more needs to be done to improve surface decontamination.
- reduce and contain the shedding of pathogens into the environment and improve cleaning and disinfection.