

# Challenges in the management of *Candida auris* : cases and hospital outbreaks

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# Disclosure

Honorarium/speaker fees: Gilead, Basilea, Astellas, Pfizer  
Specialist advisor/consultancy: Pfizer, Astellas

# Candida auris

## ORIGINAL ARTICLE

### ***Candida auris* sp. nov., a novel ascomycetous yeast isolated from the external ear canal of an inpatient in a Japanese hospital**

Kazuo Satoh<sup>1,2</sup>, Koichi Makimura<sup>1,3</sup>, Yayoi Hasumi<sup>1</sup>, Yayoi Nishiyama<sup>1</sup>, Katsuhisa Uchida<sup>1</sup> and Hideyo Yamaguchi<sup>1</sup>

<sup>1</sup>Teikyo University Institute of Medical Mycology, 359 Otsuka, Hachioji, Tokyo 192-0395, <sup>2</sup>Japan Health Sciences Foundation, 13-4 Nihonbashi-Kodenmacho, Chuo-ku, Tokyo 103-0001 and <sup>3</sup>Genome Research Center, Graduate School of Medicine and Faculty of Medicine, Teikyo University, Otsuka 359, Hachioji, Tokyo 192-0395, Japan

- 1<sup>st</sup> case report, Japan 2009<sup>1</sup>
- 1<sup>st</sup> candidaemia cases, Korea 2011<sup>2</sup>
- Retrospective 1<sup>st</sup> isolate 1996 <sup>2</sup>
- Multidrug-resistant (azoles, AmB, echino.)
- 28-70% mortality – candidaemia

### **Often not 'speciated' or misidentified<sup>3</sup>**

- Oval shape
- Growth at 37C and 42C
- No germtube/pseudo hyphae

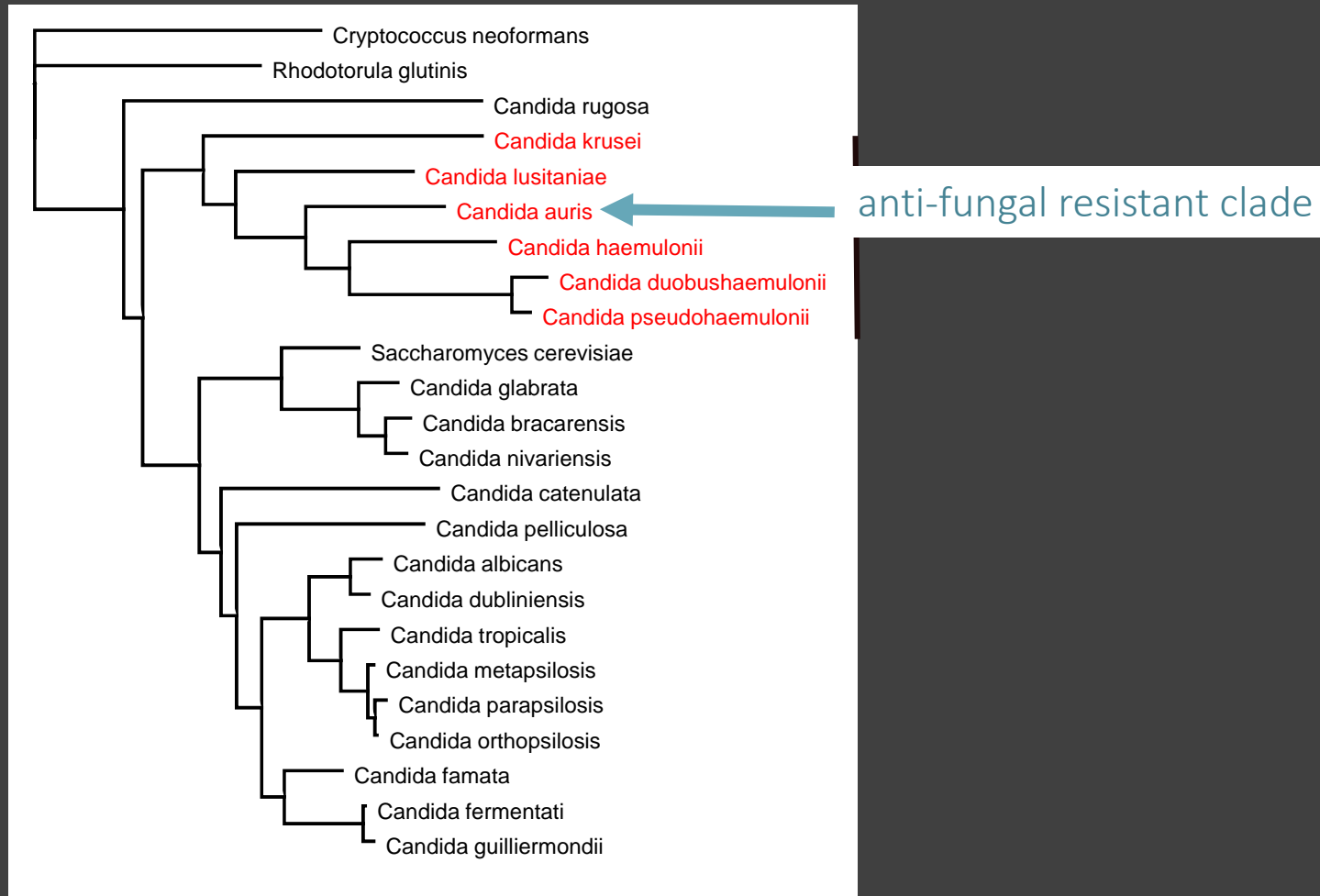


CHROMagar (Mast)

<sup>1</sup>Satoh K et al.. Microbiol Immunol. 2009;53(1):41-4

<sup>2</sup>Lee WG et al J Clin Microbiol 2011 <sup>3</sup>PHE (27 June 2016); <sup>4</sup>. Schelenz et al. Abstract: 5179; FIS/HIS 2016.

# Phylogenetic tree of *Candida* spp.



# Anti-fungal susceptibility: *C. auris*

Anti fungal drug	Resistance	Breakpoint MIC ug/ml
<b>Fluconazole</b> <sup>1,4</sup>	<b>88-98%</b>	<b>≥32</b>
<b>Echinocandins</b> <sup>1</sup>	<b>7%</b>	<b>≥8</b>
<b>5-flucytosine</b> <sup>2</sup>	<b>5%</b>	<b>≥32</b>
<b>Amphotericin B</b> <sup>1,4</sup>	<b>10-35%</b>	<b>&gt;2</b>
<b>Voriconazole</b> <sup>1</sup>	<b>54%</b>	<b>≥4</b>
<b>Posaconazole</b> <sup>2</sup>	<b>22%</b>	<b>≥8</b>
<b>Isavuconazole</b> <sup>3</sup>	<b>0%</b>	<b>&gt;(0.03 – 0.25)</b>

<b>MDR isolates</b> <sup>1</sup>	<b>41%</b>
<b>Resistant to all 4 major antifungal classes</b> <sup>1</sup>	<b>4%</b>

<sup>1</sup>Lockhart et al. CID 2017; 64,134, <sup>2</sup>Schelenz unpublished data, <sup>3</sup> Miranda-Cadena et al TIMM 2017

<sup>4</sup> Arendrup et al, AAC 2017;61:e00485

# Simultaneous Emergence of Multidrug-Resistant *Candida auris* on 3 Continents Confirmed by Whole-Genome Sequencing and Epidemiological Analyses

Shawn R. Lockhart,<sup>1</sup> Kizee A. Etienne,<sup>1</sup> Snigdha Vallabhaneni,<sup>1</sup> Joveria Farooqi,<sup>4</sup> Anuradha Chowdhary,<sup>6</sup> Nelesh P. Govender,<sup>7</sup> Arnaldo Lopes Colombo,<sup>8</sup> Belinda Calvo,<sup>9</sup> Christina A. Cuomo,<sup>2</sup> Christopher A. Desjardins,<sup>2</sup> Elizabeth L. Berkow,<sup>1</sup> Mariana Castanheira,<sup>3</sup> Rindidzani E. Magobo,<sup>1</sup> Kausar Jabeen,<sup>4</sup> Rana J. Asghar,<sup>5</sup> Jacques F. Meis,<sup>10,11</sup> Brendan Jackson,<sup>1</sup> Tom Chiller,<sup>1</sup> and Anastasia P. Litvintseva<sup>1</sup>

- 4 unique clads across the world
- Very different across regions  
(>40K-400K SNPs)
- Nearly identical within regions  
(<70 SNPs)

1,000

B11894 Israel  
B11892 Israel  
B11893 Israel  
B11897 Israel  
B11895 Israel  
B11896 Israel  
B12046 IL  
B11851 Colombia  
B11846 Colombia  
B11778 Colombia  
B11244 Venezuela  
B11247 Venezuela  
B11245 Venezuela

**Clade 4**  
South America

**Clade 2**  
East Asia

B12040 USA NY003  
B12043 USA NY003  
B11220 Japan  
B11808 Korea  
B1809 Korea

**Clade 3**  
South Africa

B11225 South Africa  
B11859 Germany  
B11230 South Africa  
B014730939 Canada

**Clade 1**  
South Asia

B11116 Pakistan  
B11858 USA NY003  
B11815 USA NY003  
B11811 USA NY003  
B11813 USA NY003  
B11812 USA NY003  
B11814 USA NY003  
B11810 USA MD001  
B12045 USA NY003  
B12044 USA NY003  
B12042 USA NY003  
B12041 USA NY003  
B11878 USA NY003  
B11201 India Hospital 2  
B11096 Pakistan  
B1210 India Hospital 2  
B1209 India Hospital 2  
B1214 India Hospital 2  
B11112 Pakistan

# Diagnostic challenge

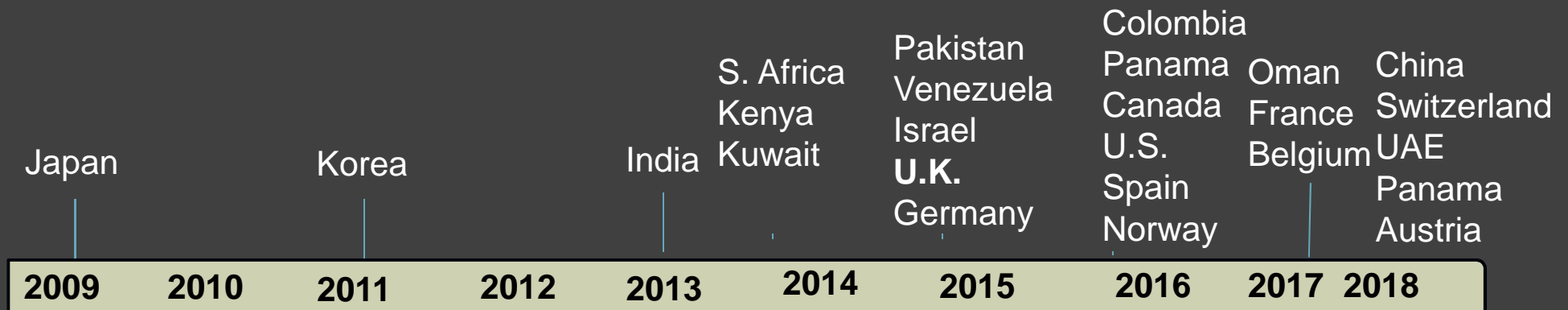
Commercial assays for Candida ID	<i>C. auris</i> Identified as:	Correct <i>C. auris</i> ID
API 20C-AUX bioMerieux	<i>C. sake</i> , <i>Rhodotorula glutinis</i> , <i>C. famata</i>	No
Vitek 2 Yst (Ver <8) bioMerieux	<i>C. haemulonii</i> , <i>C. famata</i> , <i>Rhodotorula glutinis</i> , <i>C. lusitanae</i>	No
MicroScan (Beckman Coulter)	<i>C. tropicalis</i> , <i>C. albicans</i> , <i>C. catenulate</i> <i>C. guilliermondii</i> , <i>C. lusitanae</i>	No
BD Phoenix yeast ID	<i>C. catenulata</i> , <i>C. haemulonii</i> ,	No
AuxaColor 2 (BioRad)	<i>Saccharomyces cerevisiae</i>	
Chromogenic media	Beige, white, pink (no ID)	No
Vitek 2 YST card version 8.01 software	<i>C. auris</i>	yes
ITS sequencing and D1D2 region 28sDNA	<i>C. auris</i>	yes
MALDI Bruker version 3.1	<i>C. auris</i>	yes
Vitek MS MALDI extended database	<i>C. auris</i>	yes
Whole genome sequencing	<i>C. auris</i>	yes

## National UK laboratory diagnostic survey 2017

<b>Candida auris species identification</b>	<b>Laboratories that identify to species level/respondents (%)</b>		
<b>Onsite</b>			
<b>MALDI</b>	<b>24/58 (41%)</b>		
<b>VITEK</b>	<b>2/58 (3%)</b>		
<b>API</b>	<b>0/58 (0%)</b>		
<b>Chromogenic Agar</b>	<b>0/58 (0%)</b>		
<b>PCR/Sequencing</b>	<b>0/58 (0%)</b>		



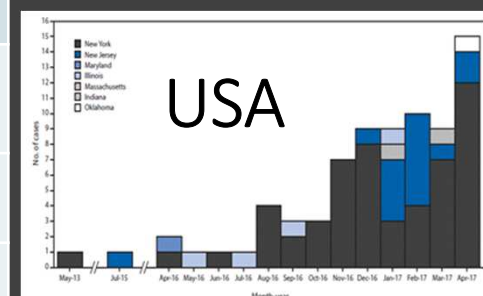
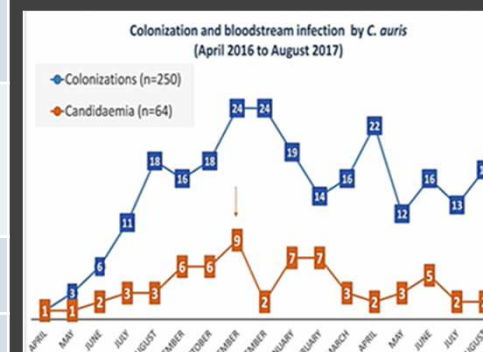
# Rapid global emergence of *C. auris*



CDC October 2017

# Propensity to transmit and cause hospital outbreaks

Country	year	Impact	Reference
India	2013	Mortality 44%, candidaemia ICU, NICU	Chowdhary A et al. 3013 Lockhart et al CID 2017
Pakistan	2013	Mortality 52%, candidaemia	Lockhart et al CID 2017, Mahmood TIMM 2017
Venezuela	2012	Mortality, candidaemia	Lockhart et al CID 2017, Calvo et al. 2016
Columbia	2015/16	candidaemia, high mortality, Hands HCW pos, environmental contamination	Escandón P et al CID 2018
South Africa	2013/14	Mortality 46%	Lockhart et al CID 2017
UK	2015/16	environmental contamination, ICU	Schelenz et al. 2015
Spain	2015/16	38.7% mortality, breakthrough candidaemia, ICU	Ruiz-Gaitan et al 2017
USA	2016	Long term care facilities	Vallabhaneni S et al MMWR 2016
Canada	2016	ICU	Schwartz et al 2017
Israel	2017	Travel S Africa, ICU,	Belkin A et al. Em Inf Dis. 2018



## What makes *C. auris* transmissible in health care settings?

	Impact	Reference
Survival in desiccated state > 4 weeks	Prolonged persistence in environment and increased risk of exposure	Abdolrasouli, A et al Mycoses 2017
Reduced susceptibility to environmental disinfectants	quaternary ammonium	Cadnum JL et al ICHE 2017
Persistence on linen	In vitro (7 days)	Biswal et al 2017
Biofilm formation	In vitro	Larkin et al., 2017; Sherry et al., 2017
Ability to shed from skin into environment	Environmental contamination	Schelenz et al 2015
Lack of effective skin decontamination products	Chlorhexidine	Abdolrasouli, A et al Mycoses 2017 Moore, G et al J. Hosp. Infect 2017
Delayed detection	Lack of surveillance, lack of identification and early treatment	

# *C. auris* in the UK

- 2013: first 3 isolates from B/C from unrelated patients.
- 2014: 1 isolate, pleural fluid
- **2015: First outbreak (Royal Brompton H.)**
- June 2018, 227 cases in UK  
(61 infections, 31 candidaemias, 160 colonisation, 6 unknown)
- Majority colonised, detected through enhanced surveillance.
- Large outbreaks in 3 hospital Trusts ICUs!
- Sequencing suggests 3 lineages (Indian, South African, Japan/Korea)

Courtesy of PHE

## Health

### Japanese fungus spreading in UK hospitals

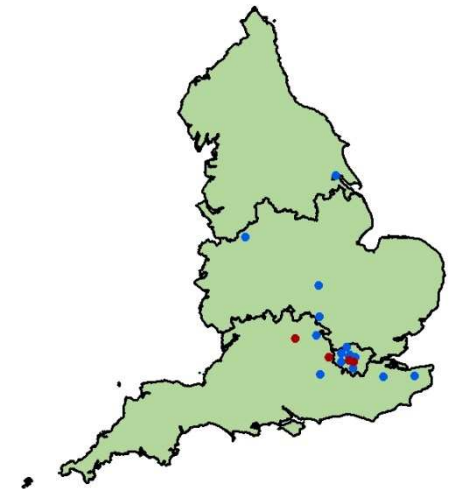
15 August 2017 | Health

f t b e Share

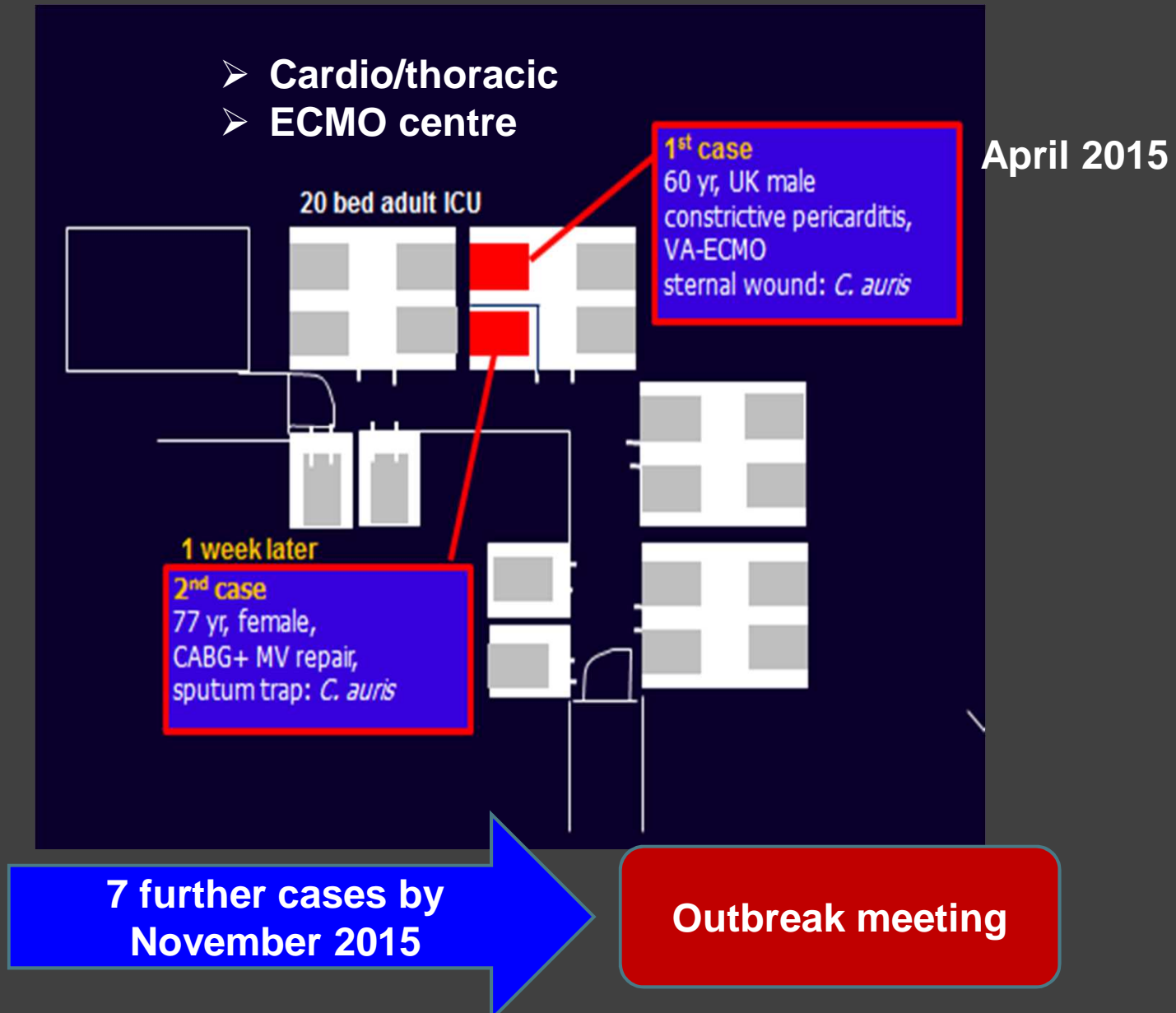


More than 200 patients in England have been infected or contaminated with a drug-res

Hospital:  
help con



# Brompton experience 2015 *C. auris* outbreak



# Initial Infection Prevention Control measure 2015



## Positive *C. auris* patients

Isolation/cohorting

skin 'decolonization'-chlorhexidine

## Patient contacts of *C. auris* cases

Isolation/cohorting

Screening (N, A, G, T, urine, rectal)

( 3 x negative, de-isolate)

## Contacts & positive patients

Gowns, aprons (as per CRE UK policy)

Terminal clean with chlorine products

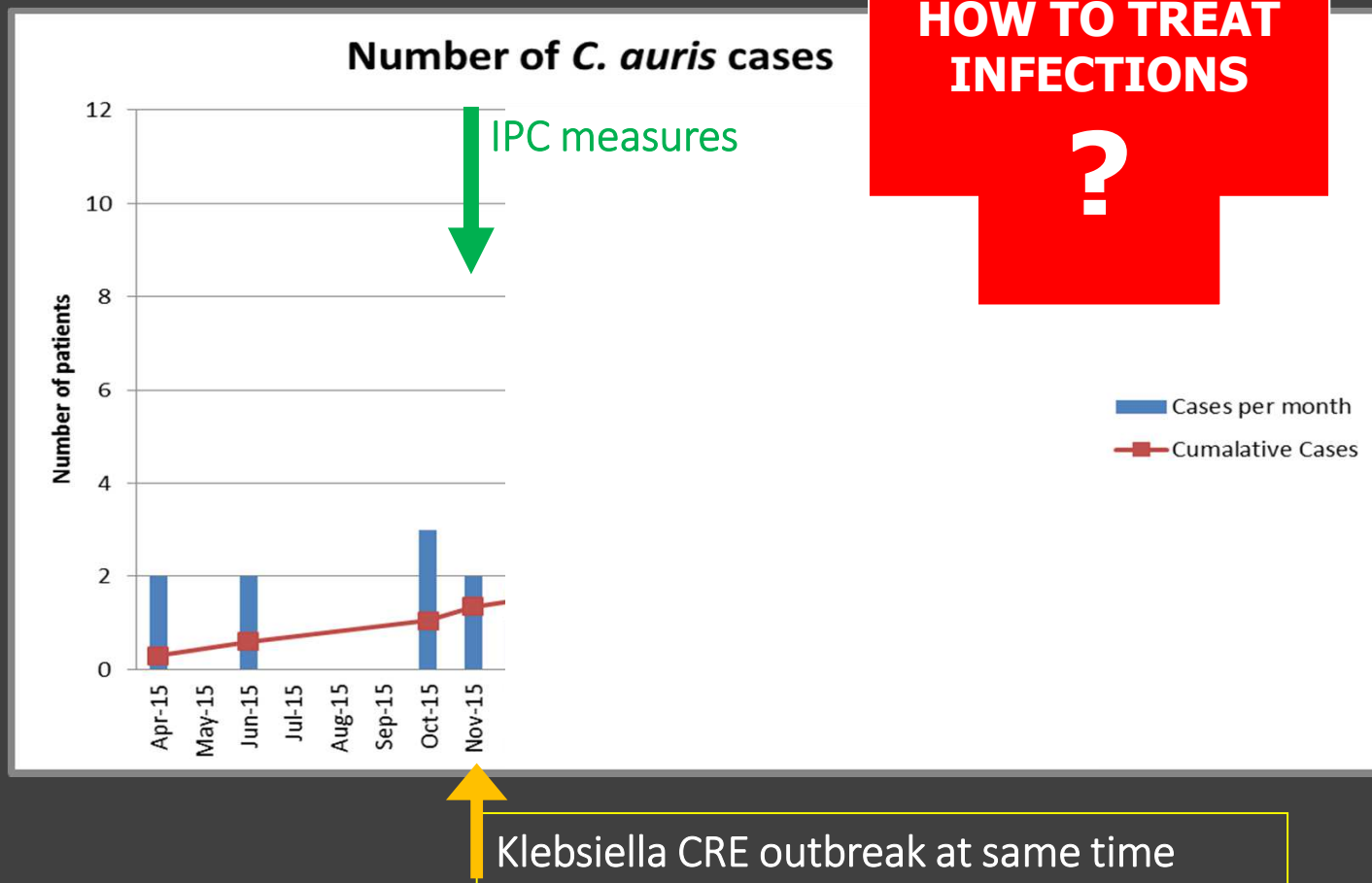


RESEARCH

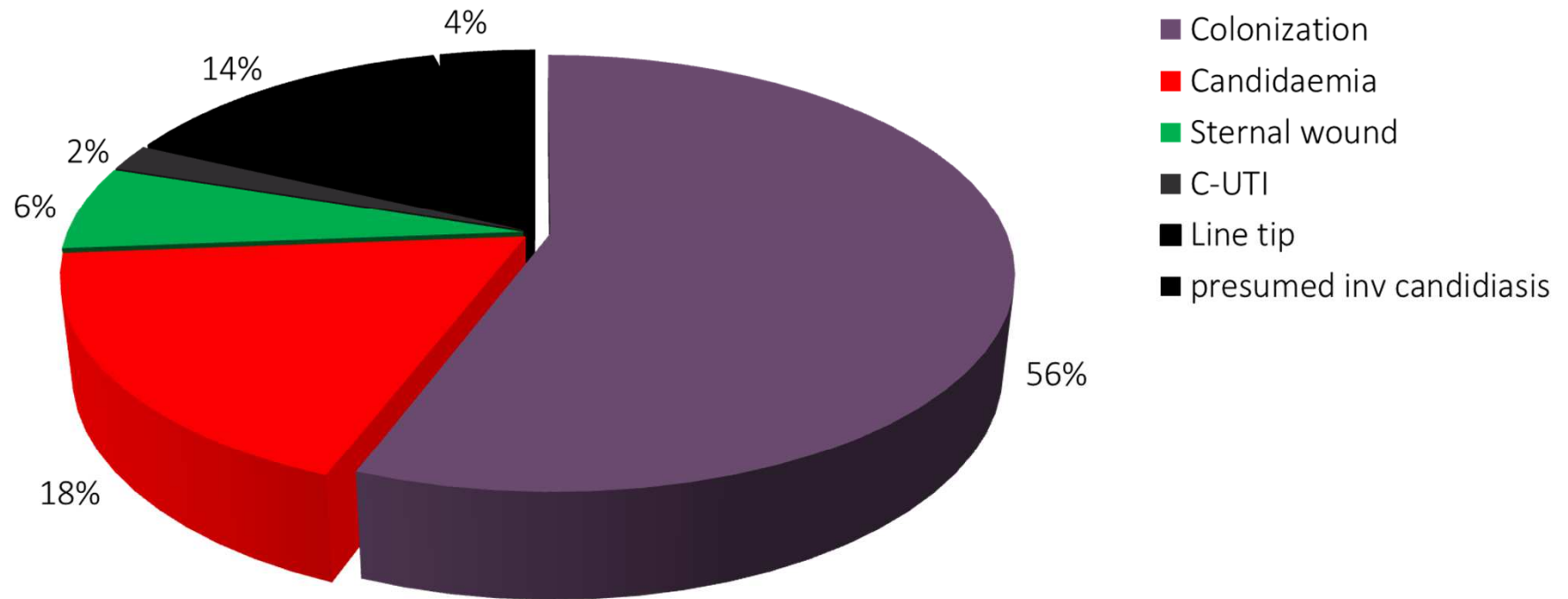
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# First hospital outbreak of the globally emerging *Candida auris* in a European hospital



# Clinical manifestations and management of *C. auris* patients (n=50)



External review of cases  
No direct attributable mortality



# Management of *C. auris* infection at RBH

- ▶ Candidaemia/deep seated infection
  - 1<sup>st</sup> line echinocandin (break through infections?)
  - 2<sup>nd</sup> line Amphotericin, +/- 5FC
  - (reserve 3<sup>rd</sup> generation triazole)
- ▶ Urinary tract infection, CNS infection
  - 1<sup>st</sup> line Amphotericin plus 5FC
  - (reserve 3<sup>rd</sup> generation triazole)
- ▶ Monitor serum B-D Glucan in at risk patients

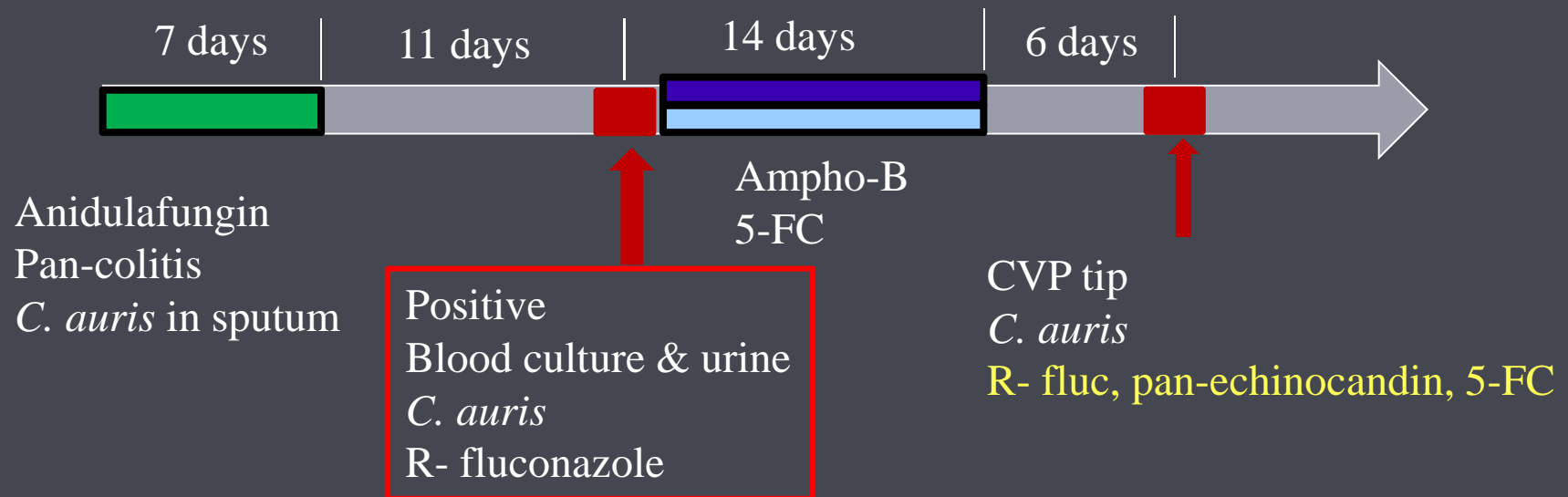
# Development of MDR *C. auris* case during treatment at RBH

50yr, male

Admitted with SOB, HAP

Placed on ECMO

*C. auris* sputum 26 d after admission to ICU

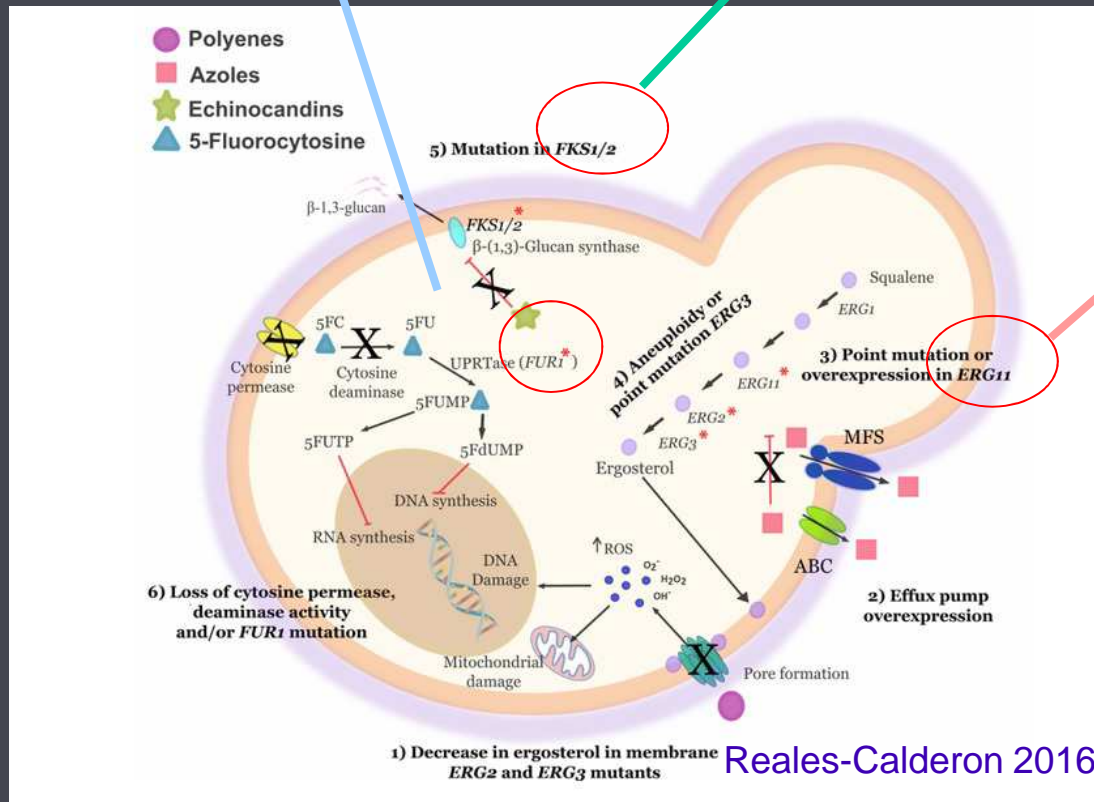


Rhodes J et al 2018

# *C. auris* Anti-fungal resistance mechanism

**Flucytosine R**  
**F211I FUR1**  
phenylalanine  
for isoleucine

**Echinocandin R**  
**S652Y FKS 1**  
serine for  
tyrosine



**Fluconazole R**  
**100% isolates**  
**Y132F ERG11**  
tyrosine for  
phenylalanine

(same India,  
Pakistan,  
Venezuela)

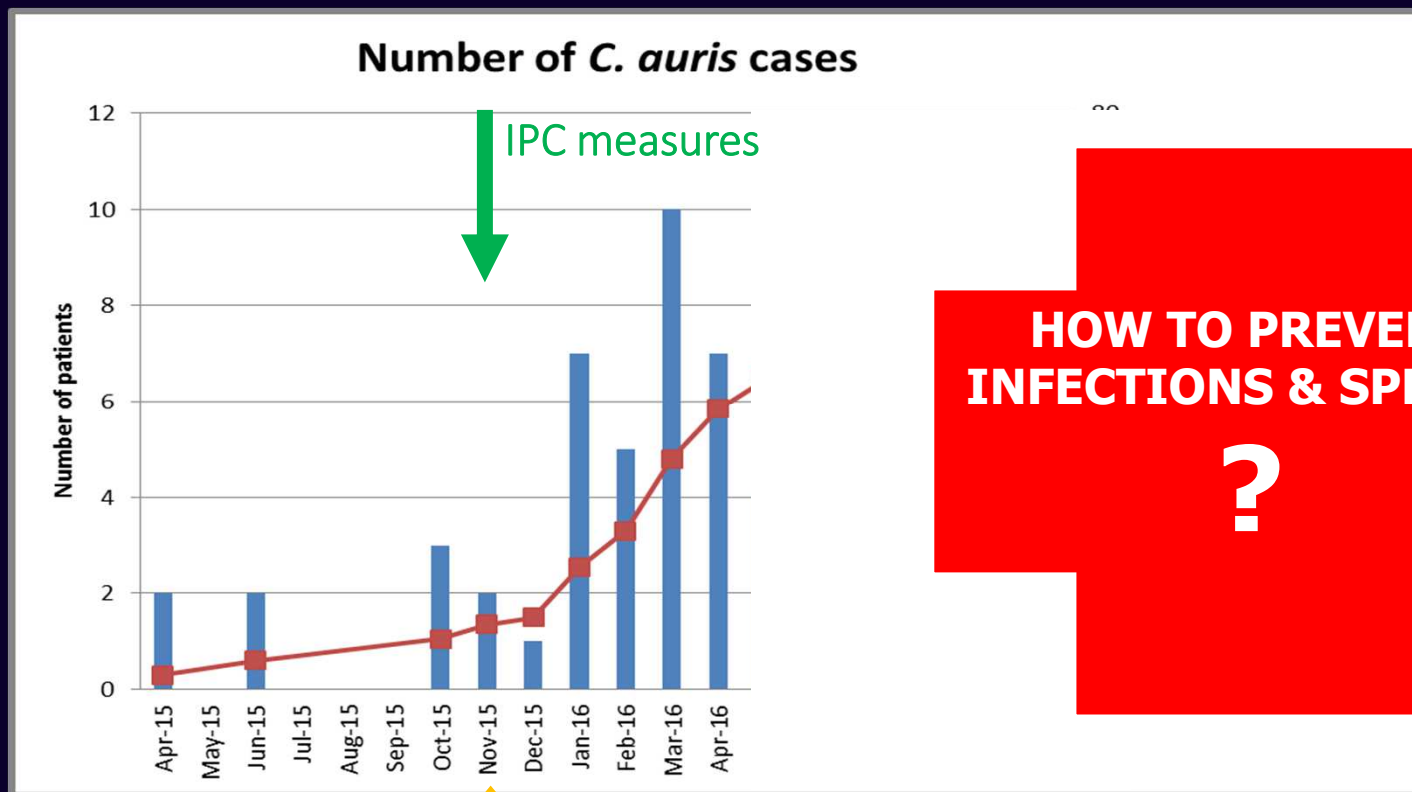
Rhodes J *et al* 2018

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# First hospital outbreak of the globally emerging *Candida auris* in a European hospital



HOW TO PREVENT  
INFECTIONS & SPREAD


?



## More Infection Prevention Control measures implemented...

- Route course analysis/each patient
- Screening of all patient on effected wards (2 x week )
- **AICU ward closure/refurbishment**
- Opening HDU as AICU on different floor, restricted access
- Disposing medicines/items on discharge
- Single use items: bronchoscope, pillows...
- Enhanced cleaning (3xday) & audit
- Enhance hygiene awareness, audits
- 2 x week formal outbreak meetings

# How to implement IC measures when there was no published evidence or guidance in 2015?

<b><i>C. auris</i> : Key questions 2015</b>	<b>Answers?</b>	
Clonal strains? What is reliable typing method?	No typing service in UK	
Cause/route of transmission?	Unknown, possible patient to patient via <ul style="list-style-type: none"> <li>▪ HCW?</li> <li>▪ Equipment, environment?</li> </ul>	
Effective agents for skin/gut decolonization?	Unknown	
How to screen 'contacts' and new admissions?	Best body sites ? unknown Best lab methods? unknown	
How to decontaminate equipment and environment?	Best products? unknown	
Lack of published evidence based guidance	Hospital management questioning validity and justified expense	

# High impact ICP interventions

Back to  
BASICS

Prevention of ventilator associated pneumonia

Prevention of infections associated with peripheral vascular access devices

Prevention of infections associated with central intravascular access devices

Prevention of surgical site infection

Prevention of infections in chronic wounds

Prevention of urinary catheter associated infections

Promotion of stewardship in antimicrobial prescribing

✓ Aseptic Non Touch -Technique

✓ Implementation of chlorhexidine 'biopatch' line exit site

✓ Training, implementation, recording and checking  
(monitoring compliance!)

# High impact ICP interventions

Back to  
BASICS

Prevention of ventilator associated pneumonia  
Prevention of infections associated with peripheral vascular access devices  
Prevention of infections associated with central intravascular access devices  
**Prevention of surgical site infection**  
**Prevention of infections in chronic wounds**  
Prevention of urinary catheter associated infections  
Promotion of stewardship in antimicrobial prescribing

- ✓ Not open wound dressings unless necessary
- ✓ Not to include dressed wounds in routine weekly *C. auris* screening



# High impact ICP interventions

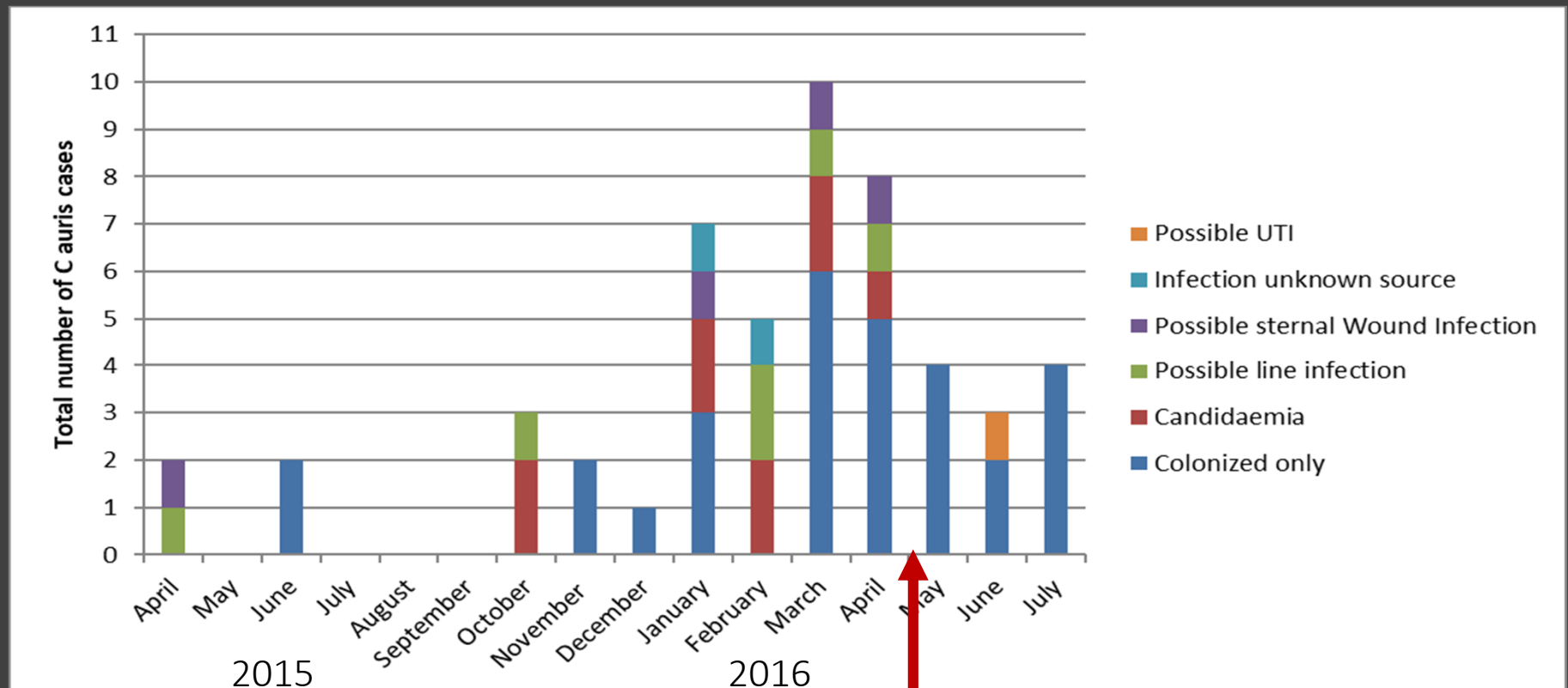
Back to  
BASICS

Prevention of ventilator associated pneumonia  
Prevention of infections associated with peripheral vascular access devices  
Prevention of infections associated with central intravascular access devices  
Prevention of surgical site infection  
Prevention of infections in chronic wounds  
Prevention of urinary catheter associated infections  
**Promotion of stewardship in antimicrobial prescribing**

- ✓ Reduce use of broad spectrum antibiotics
  - ✓ Reduce use of antifungals (azoles)
  - ✓ Monitor B D-glucan

3EPIC, Journal of Hospital Infection 86S1 (2014)  
S1–S70

# We managed to stop infections but ongoing transmission of *C. auris*



Implementation of High Impact prevention measures

## How to prevent transmission of *C. auris*?

- Isolation/co-horting *C.auris* positive patients crucial (Spain, Pakistan, India)
- Need for patient decolonization to reduce 'shedding'
- Cohort contacts until screen negative
- Control & prevent contamination of equipment and environment
- Increase and monitor hand hygiene

### Enhanced drastic IPC measures have impact on:

- day to day running of clinical services  
(bed closure, cancelled admissions and surgery)
- High cost (single use items, more cleaning staff, etc)
- Pressure on communication, commitment from senior management, HCW, doctors, cleaners etc.

# Management of *C. auris* Patient colonization

- reduce infection
- reduce shedding in environment/transmission



Product	concentration	Site/application
Chlorhexidine	2%	Wash cloth
Aqueous Chlorhexidine	4%	Body wash
Chlorhexidine	nk	Impregnated exit line patch
Chlorhexidine	0.2%	Mouth wash
Nystatin	1ml qds	Mouth
Chlorhexidine dental gel	1%	Trachy site

- Echinocandins had no effect on skin carriage
- Patient presumed long term carrier
- Persistent colonization on chlorhexidine

# Skin decontamination for *C. auris*

Skin decontamination	Strength/concentration	Proven Efficacy	Reference
Videne alcoholic tincture: w/w povidone-iodine	10% + 30% IMS		Moore <i>et al.</i> 2017
Iodinated povidone Videne antiseptic solution	10% w/w cutaneous solution		Abdolrasouli <i>et al.</i> 2017, Moore <i>et al.</i> 2017
Chlorhexidine gluconate HiBiScrub antimicrobial hand and body wash	2-4% w/v		Abdolrasouli <i>et al.</i> 2017, Moore <i>et al.</i> 2017
Chlorhexidine gluconate Clinell wash cloths/Sage pads	2% (20 mg/mL solution)		Abdolrasouli <i>et al.</i> 2017,
Terbinafine	Topical versus systemic	little data	

# Standard Principles of ICP

Back to BASICS



Available online at [www.sciencedirect.com](http://www.sciencedirect.com)

Journal of Hospital Infection

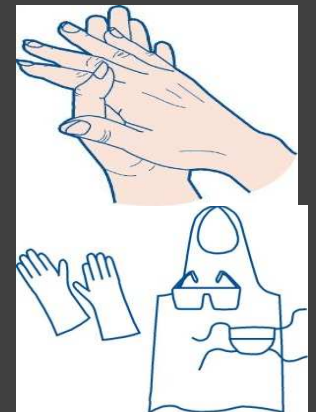
journal homepage: [www.elsevierhealth.com/journals/jhin](http://www.elsevierhealth.com/journals/jhin)



## epic3: National Evidence-Based Guidelines for Preventing Healthcare-Associated Infections in NHS Hospitals in England

H.P. Loveday<sup>a\*</sup>, J.A. Wilson<sup>a</sup>, R.J. Pratt<sup>a</sup>, M. Golsorkhi<sup>a</sup>, A. Tingle<sup>a</sup>, A. Bak<sup>a</sup>, J. Browne<sup>a</sup>, J. Prieto<sup>b</sup>, M. Wilcox<sup>c</sup>

- IV catheter and urinary catheter care
- Hand hygiene
- The use of personal protective equipment
- Hospital environmental hygiene



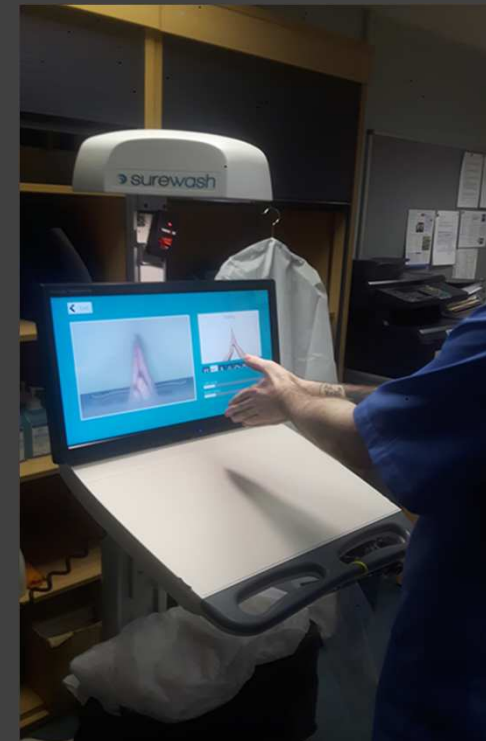
## ***C. auris* carriage by Health care workers**

Site positive for <i>C. auris</i>	Place	Reference
Nose of nurse	London	Schelenz et al.
Sole healthcare worker's shoe	Columbia	Escandón P et al   CID 2018
Hands HCW (doctors, nurses)	Columbia, India	Escandón P et al   CID 2018 Biswal et al 2017
Groin HCW	Columbia	Escandón P et al   CID 2018

# Standard Principles: Hand hygiene

- Improve Hand hygiene
- Mandatory training (Surewash)
- Monitored compliance (audit 3 x wk)
- Feed back: outbreak meeting
- Email from medical director to all doctors
- Staff screening

Your 5 moments for hand hygiene at the point of care\*



 surewash



# ***Standard Principles:*** **Personal & Protective Equipment**



## **Gloves**

- protect hands and patients
- training

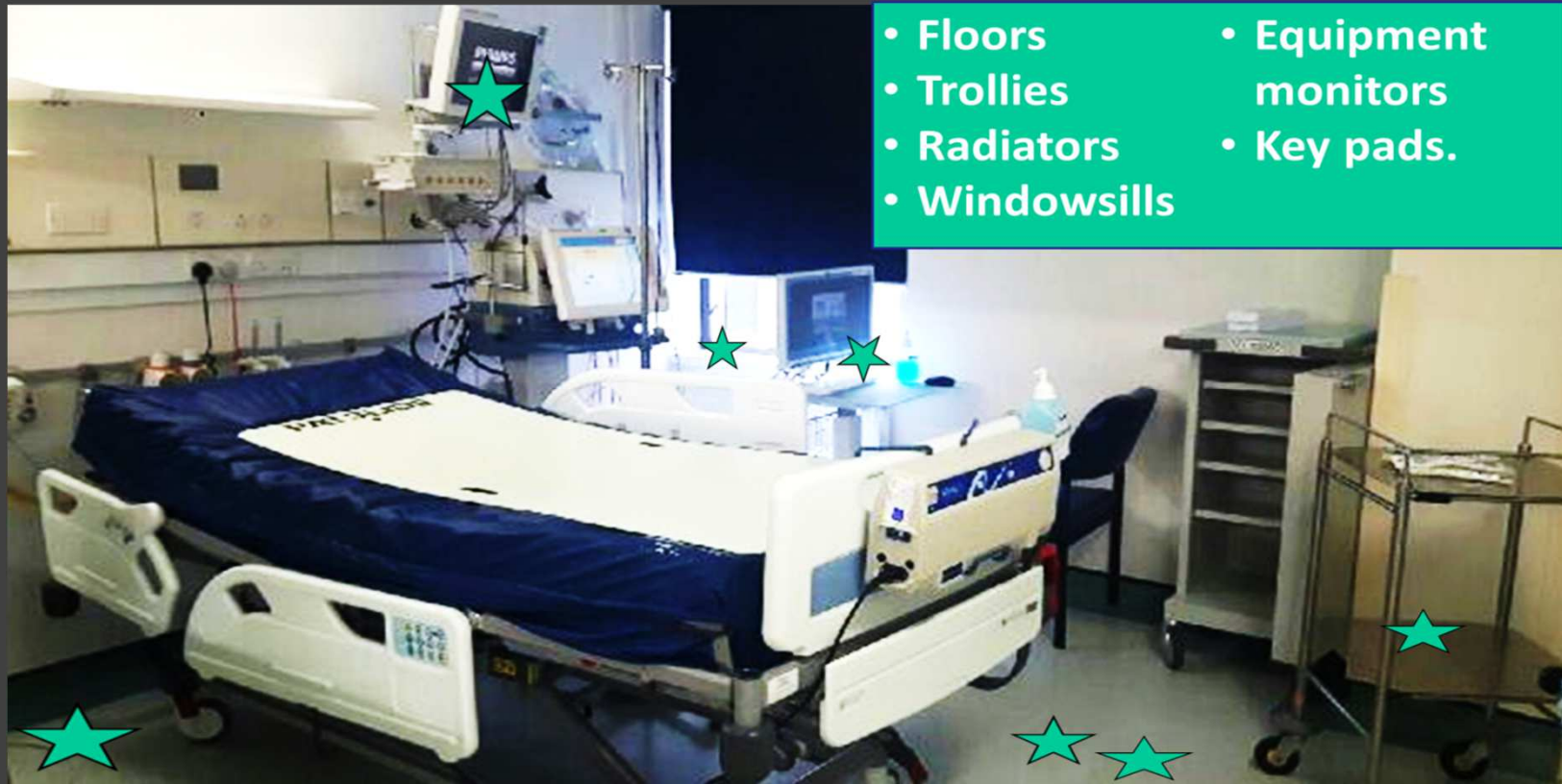
## **Long sleeved gowns**

- protect skin and/or clothing

## **Aprons**

- to be used in isolation bays when dealing with patient

# AICU Environmental *C. auris* contamination



Impact of Environmental Decontamination  
in a *Candida auris* Outbreak.  
Abstract: 5172; FIS/HIS 2016

# Contaminated environment: global experience

Site positive for <i>C. auris</i>	Place	Reference
Patient floor surface	London, Columbia	Schelenz et al. 2015, Escandón P eta I CID 2018
Air positive around bed spaces	Oxford	K Jeffrey <a href="https://doi.org/10.1101/149054">https://doi.org/10.1101/149054</a>
Bedrails, chairs, closet cabinets	Columbia	Escandón P eta I CID 2018
door handles,	Columbia	Escandón P eta I CID 2018
sink basins	Columbia	Escandón P eta I CID 2018

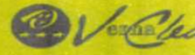
## Assure clean environment

- Engage with cleaning manager
- Training cleaners, share problems
- Right technique
- Right cleaning products
- Audit cleaning of
  - Equipment, floor, beds...
- Use fluorescent marker
- Use of 'I am cleaned stickers'
- With date, time, signature



This equipment was cleaned on  by  I am clean ☐

Vernacare  
A VERNA-CARE COMPANY

 Vernacare

## Intensive care Unit refurbishment of environment



Before



After

- More side rooms
- Removed wooded furnishing
- Smooth surfaces
- New floor
- Declutter
- Minimal equipment in corridor



# Contaminated Equipment: global experience

Equipment positive for <i>C. auris</i>	Place	Reference
Reusable temperature probes	Oxford	K Jeffrey <a href="https://doi.org/10.1101/149054">https://doi.org/10.1101/149054</a>
Pulse oximeter	Oxford	K Jeffrey <a href="https://doi.org/10.1101/149054">https://doi.org/10.1101/149054</a>
Blood culture cuffs	Valencia	A. Ruiz-Gaitan TIMM 2017
Dialysis syphon ICU	Valencia	A. Ruiz-Gaitan TIMM 2017
Infusion pump	Valencia	A. Ruiz-Gaitan TIMM 2017, Biswas et al 2017
non-disposable mop	Columbia	Escandón P eta I CID 2018
cellular phone	Columbia	Escandón P eta I CID 2018
alcohol gel dispensers	Columbia	Escandón P eta I CID 2018
bedpans, and mop buckets	Columbia	
Ventilator attachment	India	Biswal et al 2017



Courtesy of K.Jeffery



# *Standard Principles:* Decontamination & Re-processing of Equipment



**Back to BASICS**



## Equipment and devices: improve decontamination

- Assess risk of transmission through multiuse equipment
- Introduce single use devices such as bronchoscopes (expensive)
- Dispose of all materials in *C. auris* isolation room (empty trollies)
- Dispose all medicines that were in *C. auris* patient room
- Assess decontamination of medical devices
- Train cleaners, audit cleaning
- Exposure to Hydrogen peroxide vaporisation





# Focus on Environmental decontamination

## ➤ Enhanced cleaning

3x day 1,000 ppm (Chlor-clean)

## ➤ Equipment cleaning, assurance

3x day 1,000 ppm

or chlorine dioxide wipes

## ▶ Terminal cleaning 10,000ppm

Chlorine based (Haztab)

Followed by H<sub>2</sub>O<sub>2</sub> vaporization



## Revised Healthcare Cleaning Manual

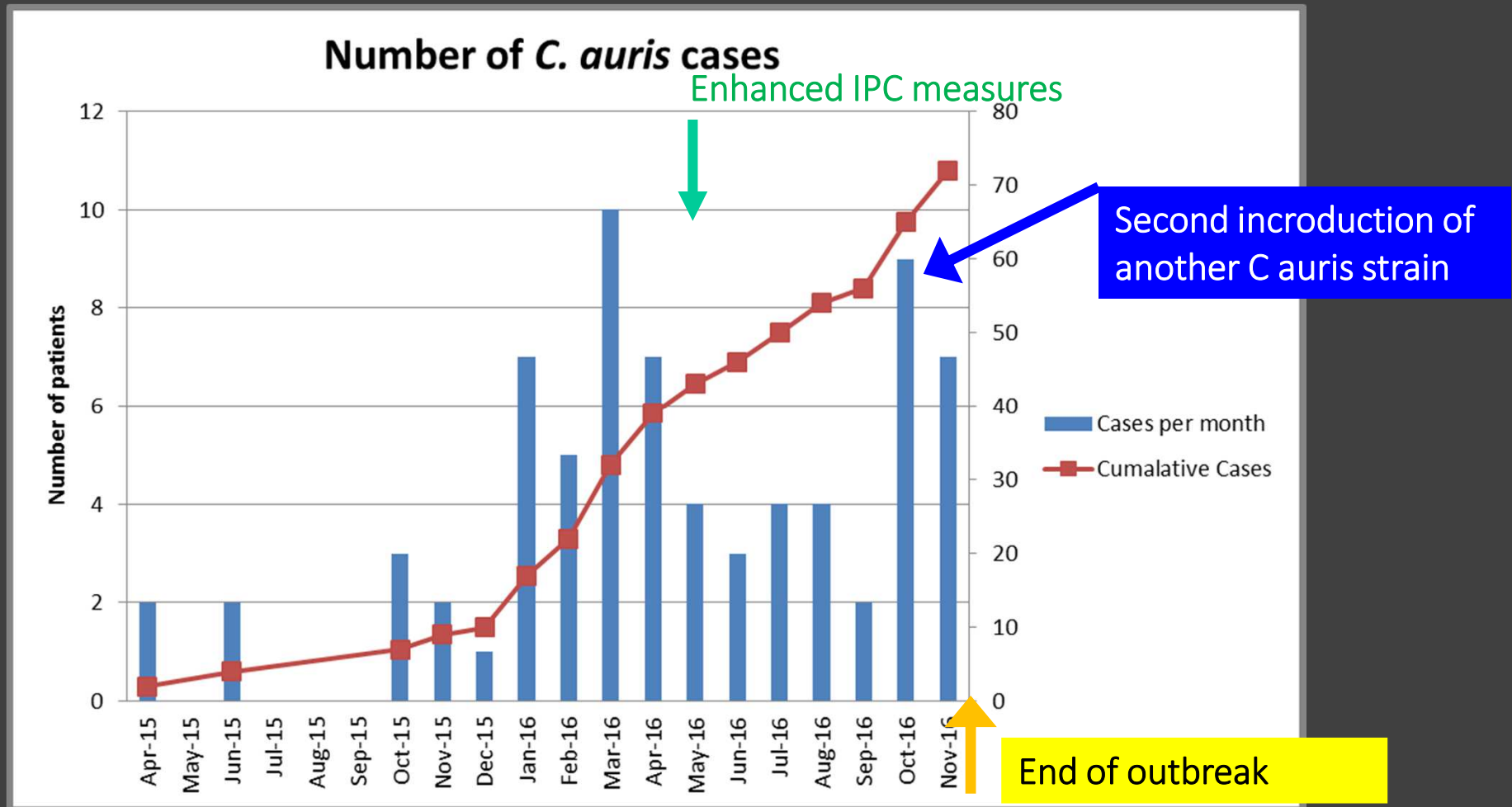
Published in June 2009, the Revised Healthcare Cleaning Manual is designed to be used across different healthcare settings, including acute care, mental health care, primary care and the ambulance service.

The Association of Healthcare Cleaning Professionals (AHCP) worked jointly with the

# Effective surface decontamination: *C. auris*

Surface decontamination	Strength/concentration	Proven Efficacy	Reference
Sodium hypochloride (Clorox, Chlor-clean, HazTab®)	≥ 1000 ppm 0.39-0.65%, 10%		Cadnum <i>et al.</i> 2017 Abdolrasouli <i>et al.</i> 2017, Moore <i>et al.</i> 2017
Quaternary ammonium (Lysol all, Virex II 256)			Cadnum <i>et al.</i> 2017
Peracetic acid hydrogen peroxide <1%, acetic acid (OxyCide)	1200ppm,		Cadnum <i>et al.</i> 2017
Ethyl alcohol 29.4% (Purell disinfectant)	29.4%		Cadnum <i>et al.</i> 2017
Acetic acid (White distilled vinegar)	>5% (pH 2.0)		Cadnum <i>et al.</i> 2017
Carbolic acid (phenol)	5%	?	?
Hydrogen peroxide (Oxivir Tb, Clorox)	0.5%, 1.4%		Cadnum <i>et al.</i> 2017
Vaporized hydrogen peroxide (BioQuell)	8g/peroxide/m <sup>3</sup>		Abdolrasouli <i>et al.</i> 2017
Ultra violet light	(D90 value of 515 J/m <sup>2</sup> )		Schelenz <i>et al.</i> unpublished

# Brompton: 72 cases over 20 months period 2015-16



Average *C. auris* acquisition from hospital admission 21 days

Average *C. auris* acquisition from admission to affected ward 17 days

# Post outbreak IC practice

- ▶ Continue 'high level' cleaning, hand hygiene
- ▶ Routine speciation of *Candida* from clinical sites
- ▶ *C. auris* admission screening (pooled N,A,G,T)
  - Hospital transfers from an HDU, ICU to our HDU/ICU
  - Known positive *C. auris* patient
  - Patients from another unit known to have *C.auris* cases
  - UK national prevalence low

## Conclusion: *C. auris* Infection control

- Transmissible within care setting
- Early detection/speciation of *C. auris* crucial
- Environment easily contaminated-poses major risk of transmission
- Isolation and screening
- Enhanced IPC measures & high impact interventions and cleaning is vital
- Outbreak: very costly, resource intensive
- Need for good communication and resource allocation during outbreaks

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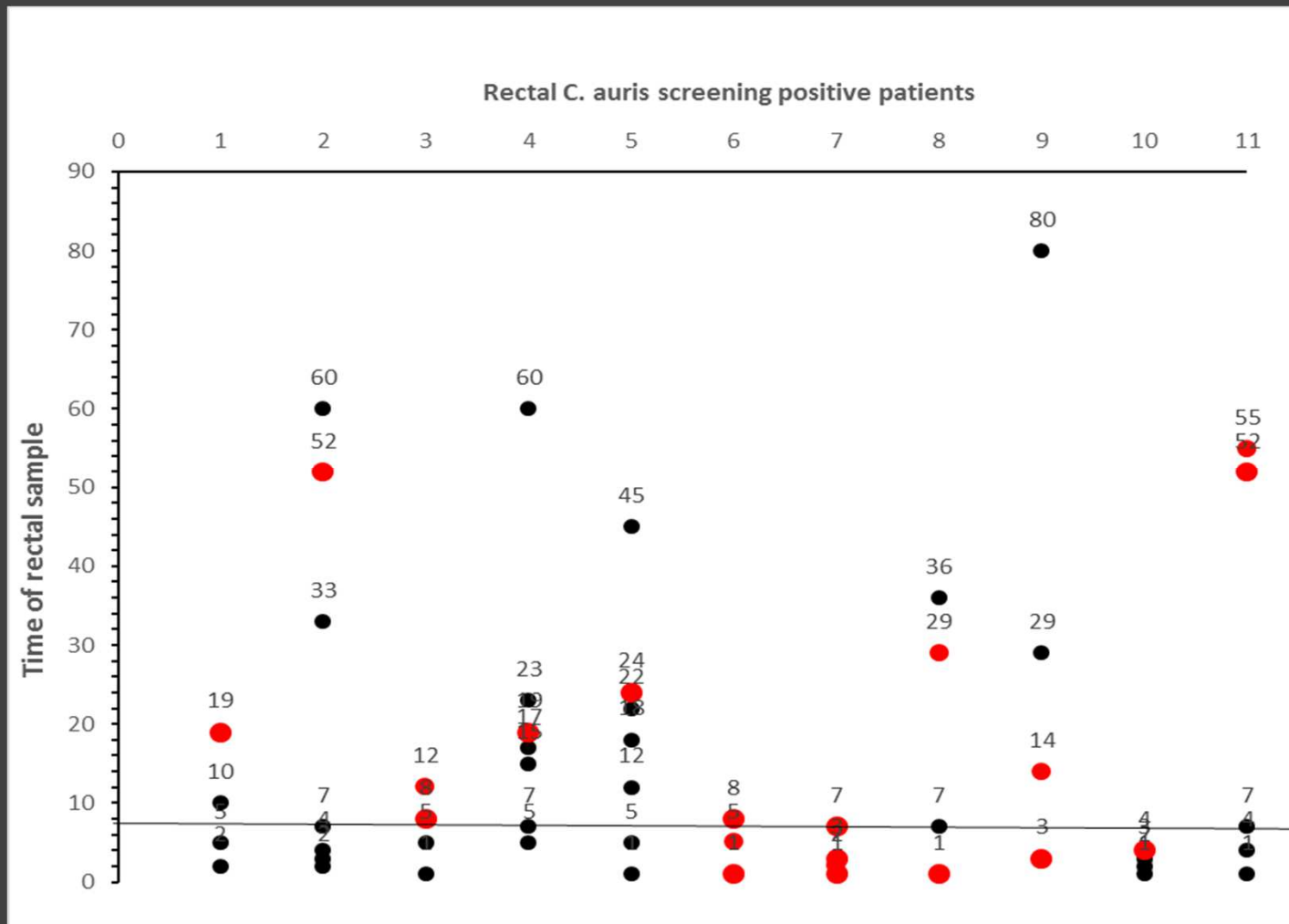
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And many, many, more people...

# Intermittent rectal carriage



8% (4/50) patients screened positive on their 1st rectal screen swab

55% of patients never tested rectum positive over time