Symposium on Advanced Infection Control 2019

Control of *Candida auris* in Hong Kong: Local perspective

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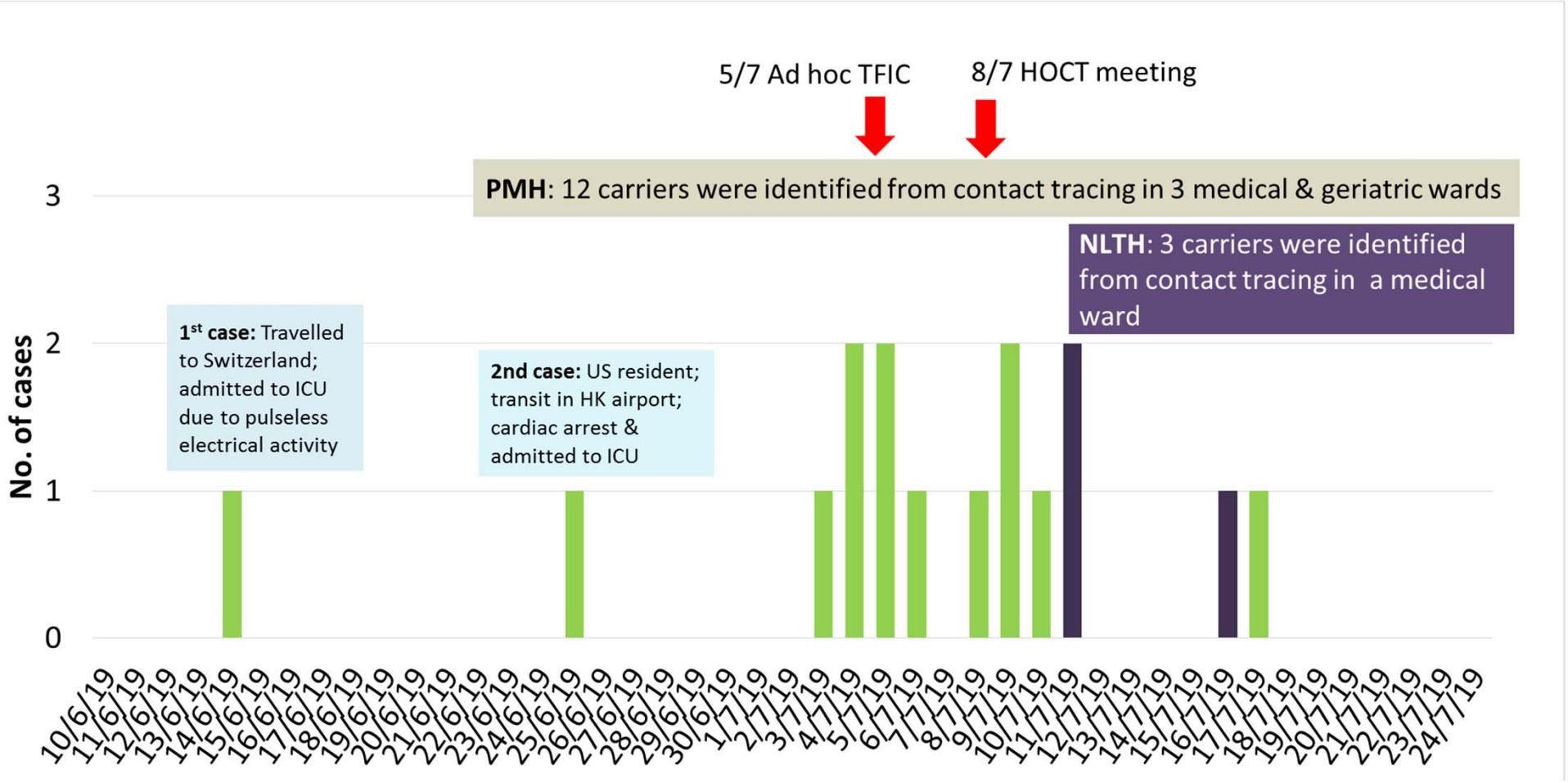
First local outbreak in HK

Local Outbreak

On 21 June 2019, PMH reported a suspected case of *C. auris* in the medical ward. The microorganism was subsequently confirmed by the PHLC on 24 June, which was the first case of *C. auris* reported in Hong Kong.

As of 24 July, a total of 16 *C. auris* cases were reported



Case 1 & 2 details:

Case 1:

- 48/M, HK resident (Chinese), banker. Travelled from Switzerland
- Admitted directly to ICU (after flight landing) due to pulmonary embolism on 19/5
- Transferred to a medical ward **F** on 31/5/19
- Had been on multiple antibiotics: *ceftriaxone, cefoperazone-sulbactam, cloxacillin, piperacillin-tazobactam, amoxycillin-clavulanic acid, levofloxacin, meropenem, vancomycin, ceftazidime*
- **ETA 14/6 fungal culture : *Candida auris* (confirmed by PHLC on 24/6)**
- 24/6: Pooled swab: Heavy growth of *C. auris*
- *C. auris* was considered as colonizer and no antifungal was given

Contact tracing (cubicle) →

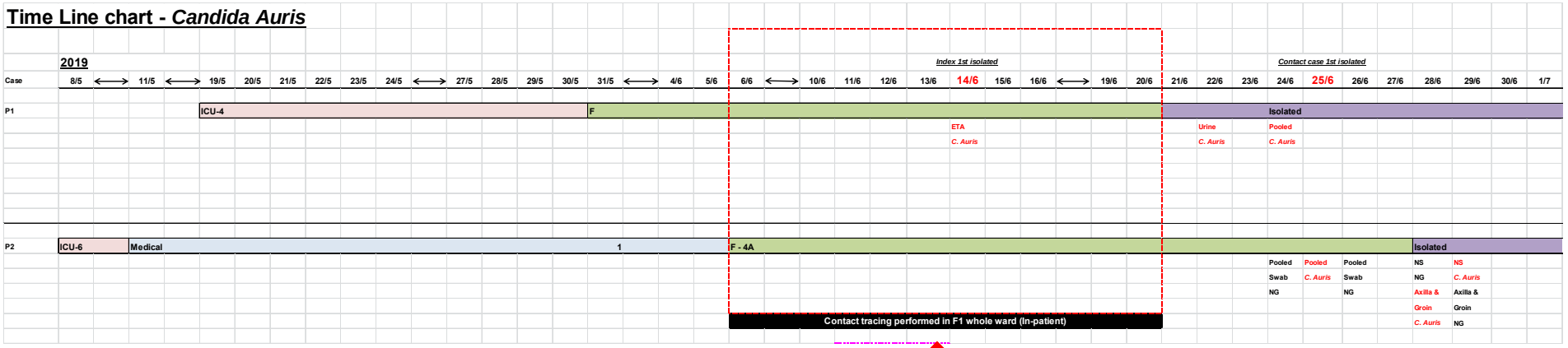
← ?Transmit

Case 2:

- 59/M US resident (Tennessee)
- Pre-existing coronary artery disease with CABG done (unknown place and time)
- **Transit** in HK airport (from Manila to USA)
- Admitted directly to ICU on 8/5 with diagnosis of acute coronary syndrome, post cardiac arrest
- Transferred to a medical ward on 11/5
- Further transferred to medical ward **F** on 6/6
- No antibiotic after 27/5
- Pooled swabs:
  - 24/6 : No growth
  - 25/6 : 1 colony of *C. auris*
  - 26/6 : no *C. auris*
  - 28/6 : 1 colony of *C. auris*
  - 29/6 : Few colonies of *C. auris*

Outbreak investigation

Time line chart of the 1st 2 cases



Overlap from 6/6 to 20/6 in same cubicle

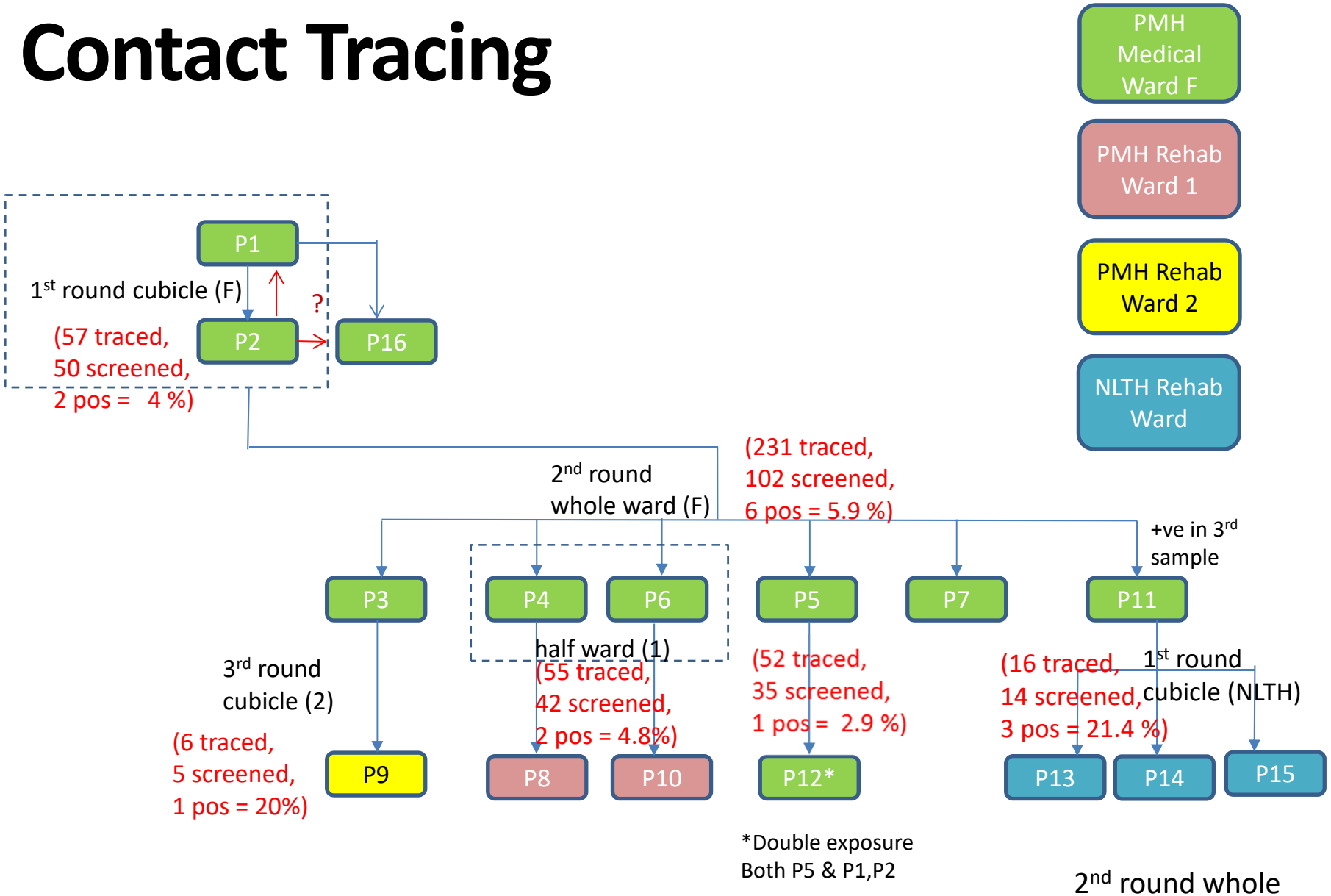
Contact Tracing

- Patients who shared the **same room** or **cubicle** as the infected or colonized patient **within the past one month**.

- Screening should be extended to whole ward in outbreak situation as advised by infection control team.

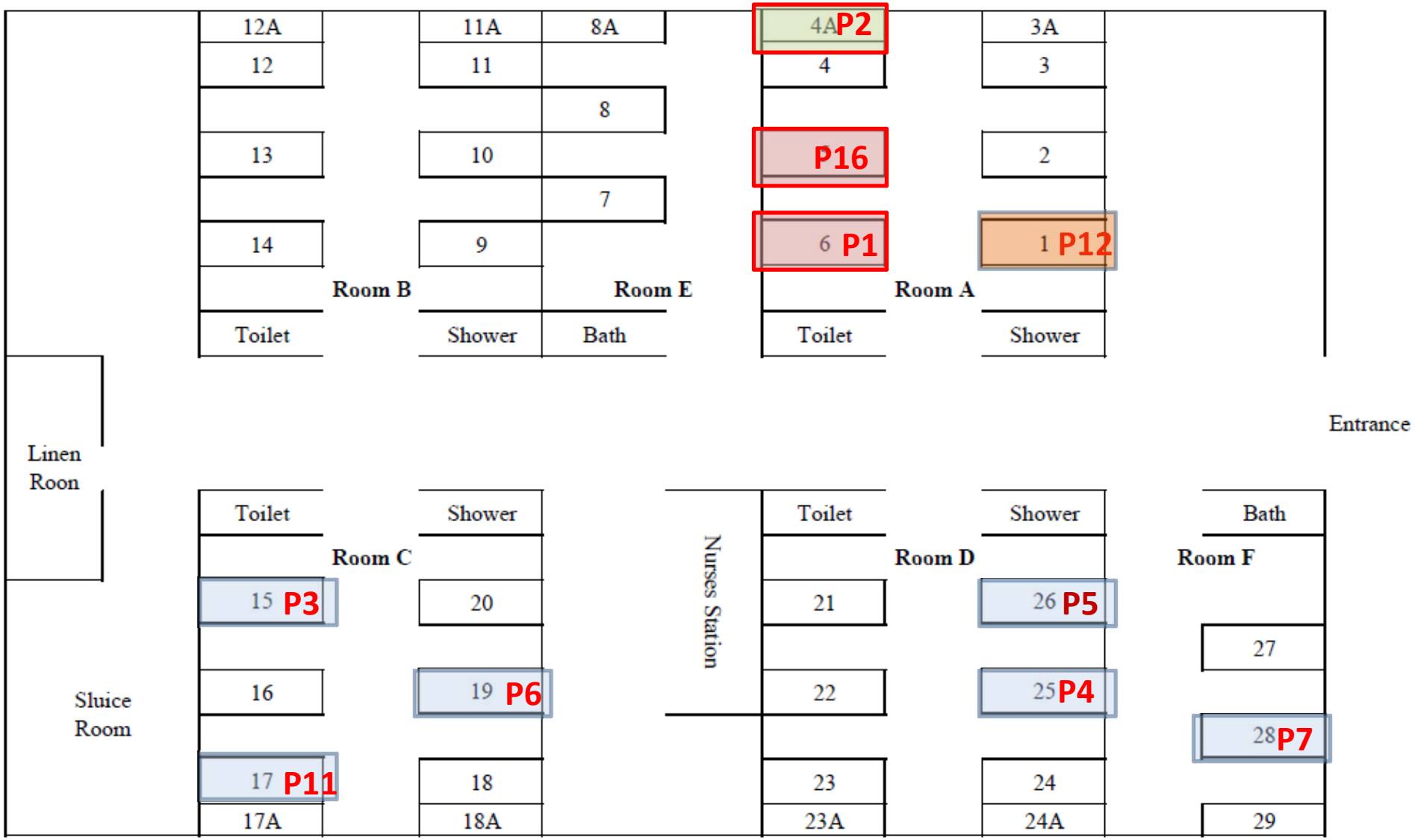
- **Screening for a close contact**:
  - Collect a pooled swab (nasal, axilla and groin)
  - Apply preemptive contact precautions until 3 consecutive screens at least 24 hours apart are negative

Contact Tracing



Total: 316 screened, 15 pos = 4.7%

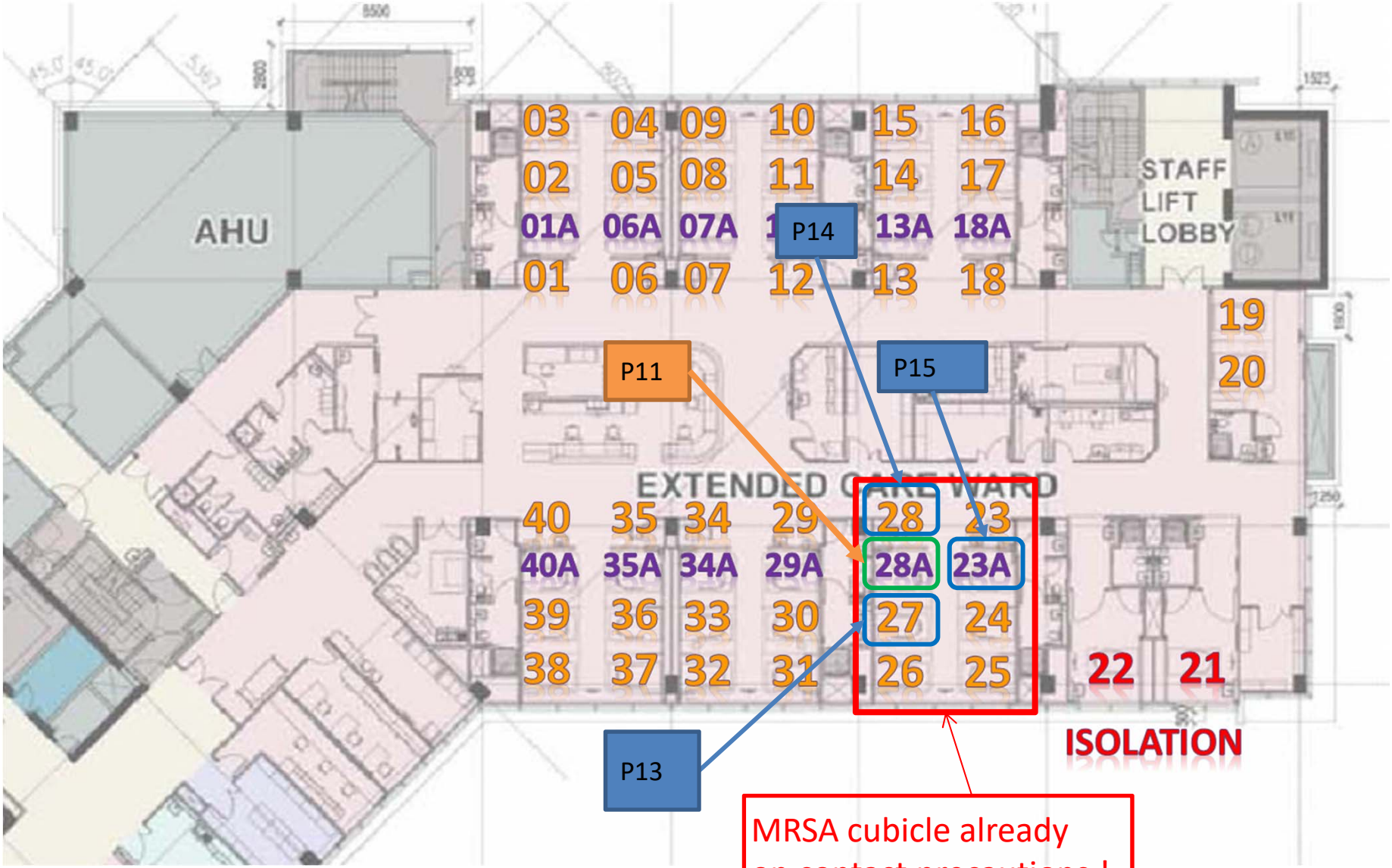
Medical Ward F



P5: Bed 25->26->other ward-> 13 ->5

NLTH/6B floor plan

Bed assign



Laboratory Testing

Infection Control
Princess Margaret Hospital

Surveillance culture of Contacts

- According to HA guidelines
- 3 sets of pooled nasal, axilla and groin swab, at least daily apart
- 2 swabs taken: Nasal & Axilla + Groin

Procedure for collecting swabs for *Candida Auris*

<table>
<tr>
<td>  </td>
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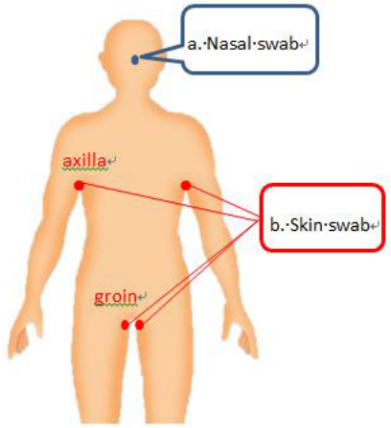
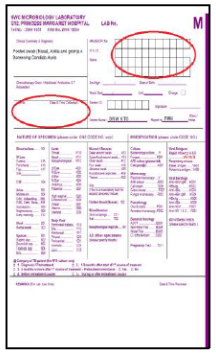
<tr>
<td>1. Perform hand hygiene and wear appropriate PPE.</td>
<td>2. Ensure the swab tip is moistened before taking specimen.</td>
</tr>
<tr>
<td> 
</td>
<td>a.  b.  </td>
</tr>
<tr>
<td>3. a) Take swab from both nostrils.
b) Use another swab, obtain skin swab from both sides of axilla and groin region</td>
<td>4. a) Indicate “nasal swab” and “skin swab” on the specimen
b) Indicate collection date and time using one lab form</td>
</tr>
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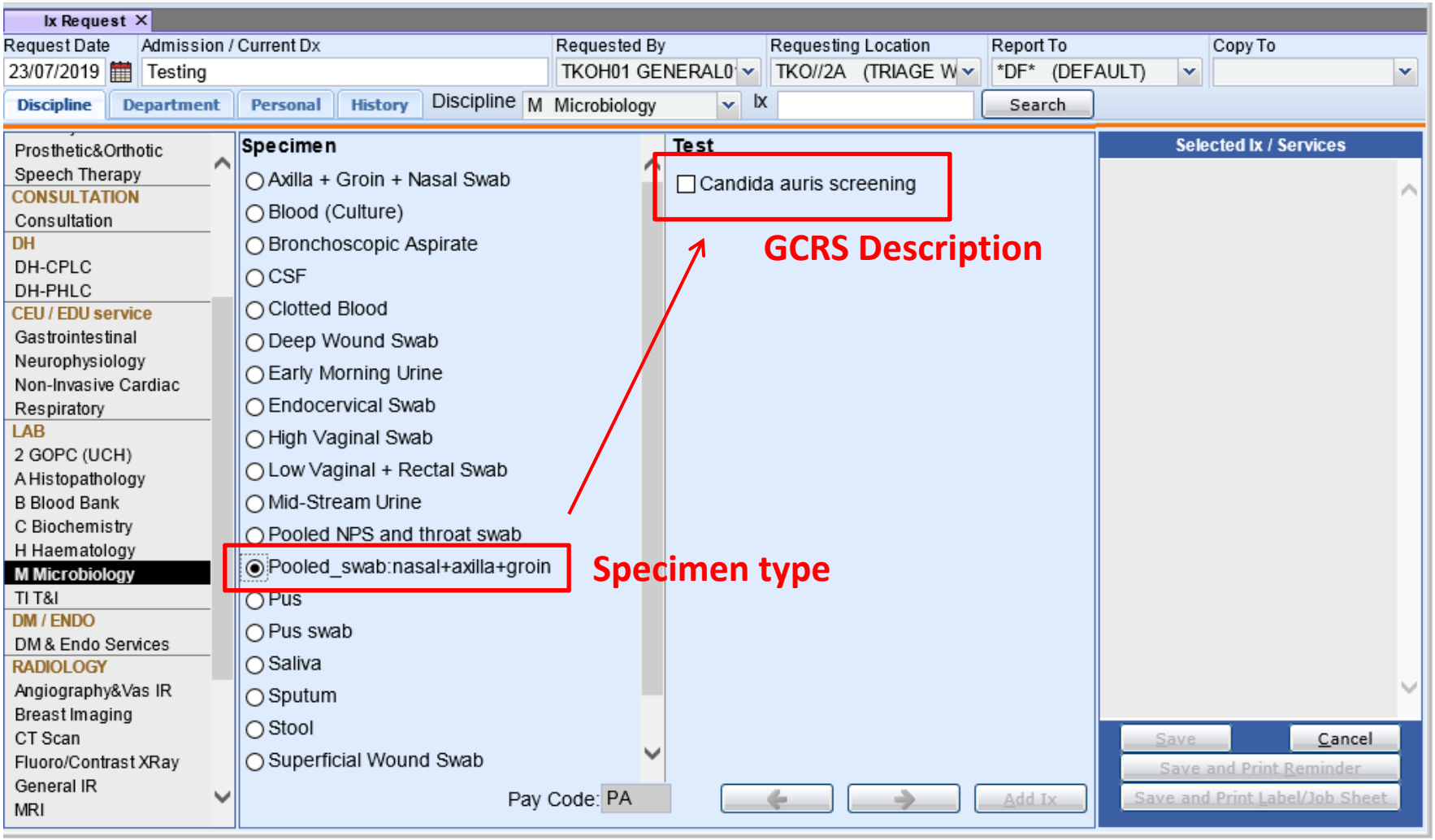
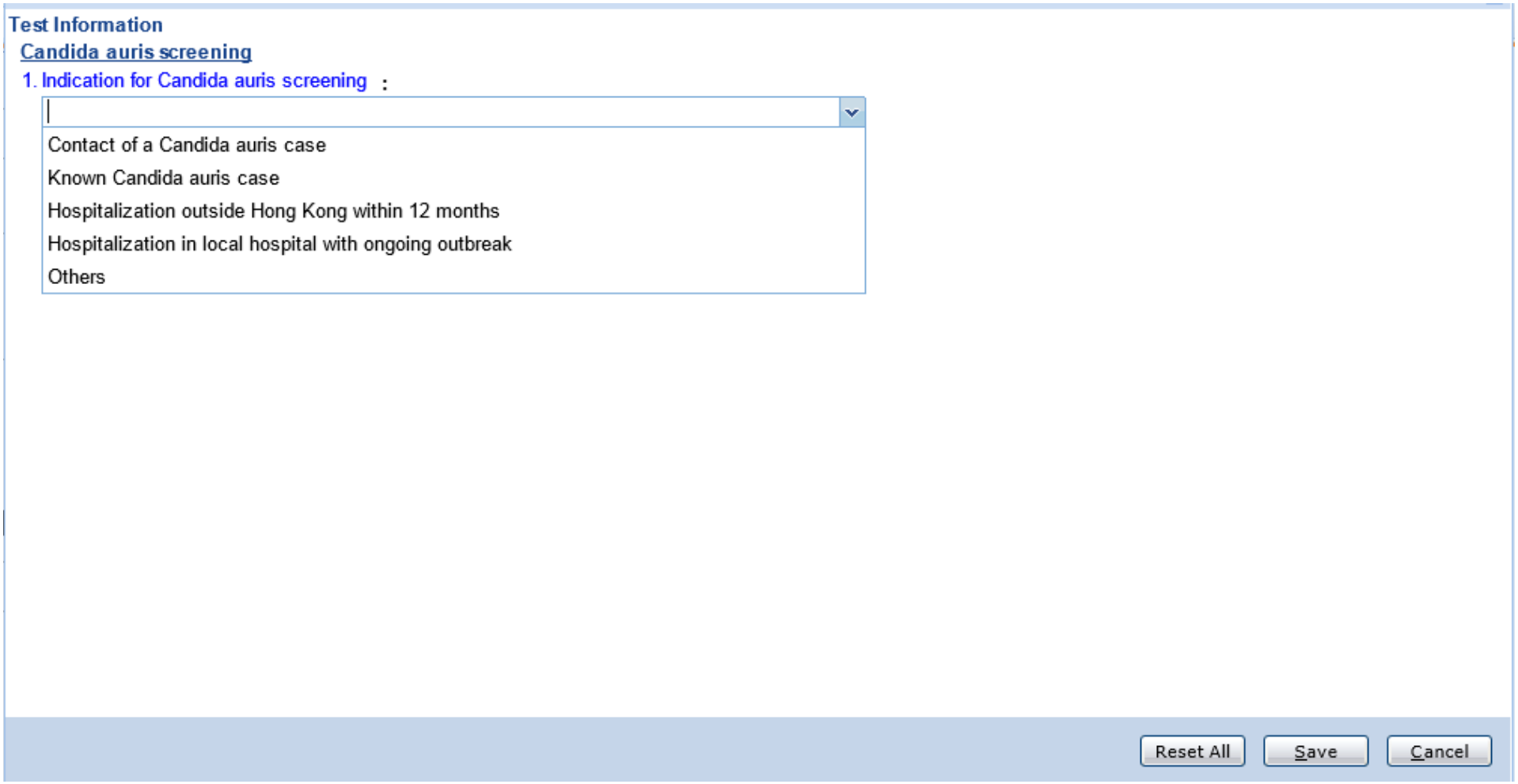
July 2019

GCRS – *C. auris* screening

Tentative date of roll out in all clusters: 8 Aug 2019 6:00pm



GCRS – *C. auris* screening



Patient screening

Specimen types

Pooled swab(Nasal, Axilla and Groin)

Reagents, Materials and Media

chromID® CAN2 agar (Biomerieux)

Sabouraud dextrose broth with 10% NaCl and 50mg/L Chloramphenicol and Colistin (20mg/L).

Samples Processing and Examination

Day 0 Put up

- Inoculate pooled Nasal swab and combined axilla and groin swab onto the same half plate (i.e. chromID CAN2) using the same laboratory number.
- Incubate the plate at ambient air at 35 ± 2°C.for 4 days.
- Check the plate daily.
- Perform MALDITOF identification *with full extraction* for any suspected colonies (white and pink colonies, EXCLUDE blue colonies)
- After that, inoculate the same nasal swab and Axilla and groin swab into the Sabouraud dextrose broth with 10% NaCl and 50mg/L Chloramphenicol and 20mg/L Colistin. Incubate the broth at ambient air at 40 ± 2°C.for 7 days.
- Check the broth daily for any turbidity.

Environmental screening

1. **Specimen type**

- Environment Sponge in a leak proof container

2. Reagents, Materials and Media

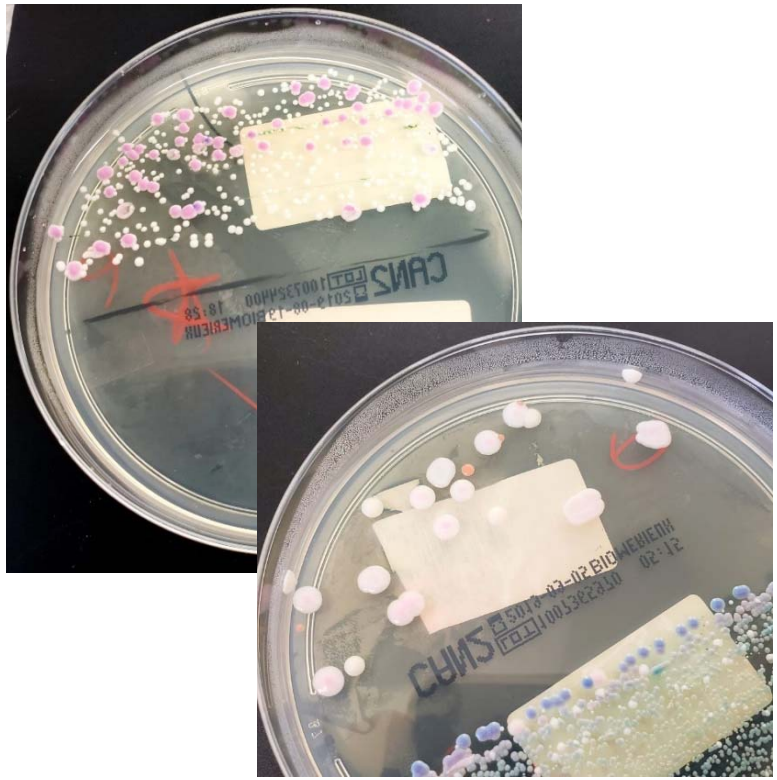
- Sabouraud dextrose broth (oxoid CM0147) with 10% NaCl and chloramphenicol (50mg/L) and colistin (20mg/L)

3. Specimen processing and examination

- Add 20 mL sabouraud dextrose salt antibiotic broth into the container.
- Mixing the broth content thoroughly with slow circular motion then incubated at 40℃±2℃ for 7 days.
- Inspect the broth daily for signs of growth or turbidity for up to 7 days.
- Slowly and gently invert every day, making certain paddle surfaces are coated with broth.
- If the broth is turbid, subculture onto ChromID CAN2 agar (half plate), incubated at 35℃±2 for 3 days
- Perform MALDITOF identification with full extraction for any suspected colonies.

Laboratory Testing

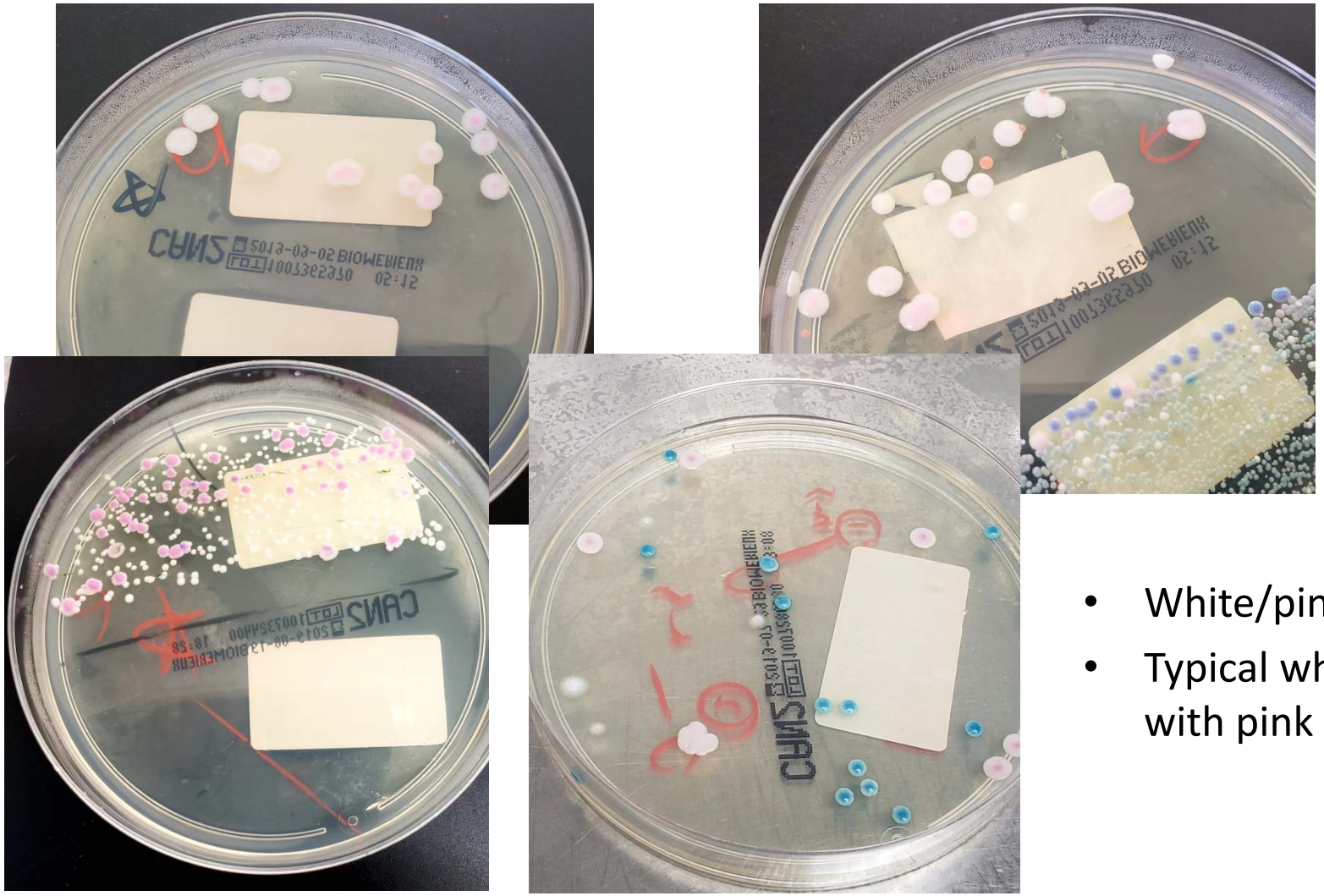
- *C. auris,* unlike most other Candida species, it grows well at 40–42°C.
- On CHROMagar™ *C. auris* colonies appear white, pink, or red, and some colonies cannot be distinguished from *C. glabrata*.
- Easily misidentification
- MALDI-TOF can differentiate *C. auris* from other Candida species:
  - Full extraction is needed in old database but not needed in new version
- Take time to growth. Need 7+ days to get Negative report.



chromID® CAN2 agar

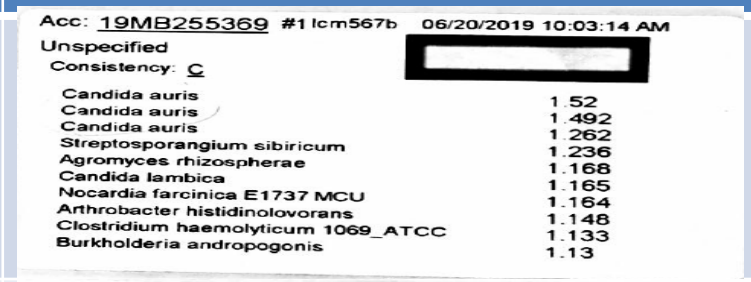
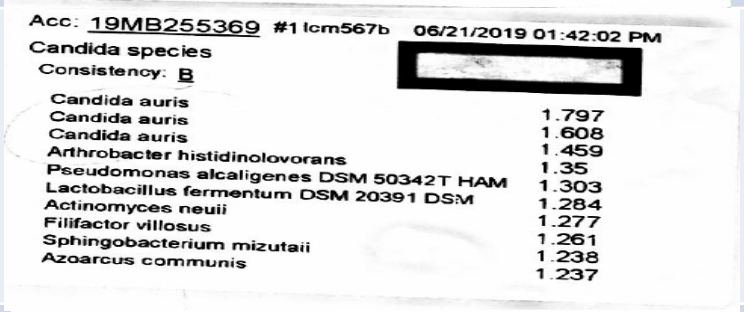
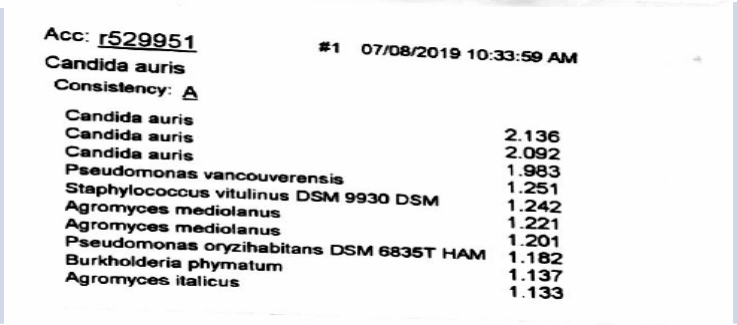
MALDI-TOF MS

Culture: Solid Medium: chromID CAN2 (bioMerieux)



- White/pink colony
- Typical white colony with pink center

Direct transfer or extended transfer method versus full extraction method

Method	Score	Label
Direct transfer method	Consistency C Score 1.52	
Extended transfer method	Consistency B Score 1.797	
Full extraction method	Consistency A Score 2.136	

Sensitivity

PMH Vitek AST card						E test by PMH	
Fluconazole	Voriconazole	Flucytosine	Amphotericin B	Caspofungin	Micafungin	Fluconazole	Voriconazole
16ug/ml	<=0.12ug/ml	<=1 ug/ml	2 ug/ml	0.25 ug/ml	0.12 ug/ml	>=256ug/ml	0.75ug/ml
CDC Tentative MIC breakpoint (ug/mL) ≥32	N/A	N/A	CDC Tentative MIC breakpoint (ug/mL) ≥2	CDC Tentative MIC breakpoint (ug/mL) ≥2	CDC Tentative MIC breakpoint (ug/mL) ≥4		

https://www.cdc.gov/fungal/candida-auris/c-auris-antifungal.html

Multi-resistant, echinocandin is probably the drug of choice if treatment is indicated

Types and Number of Samples Summary

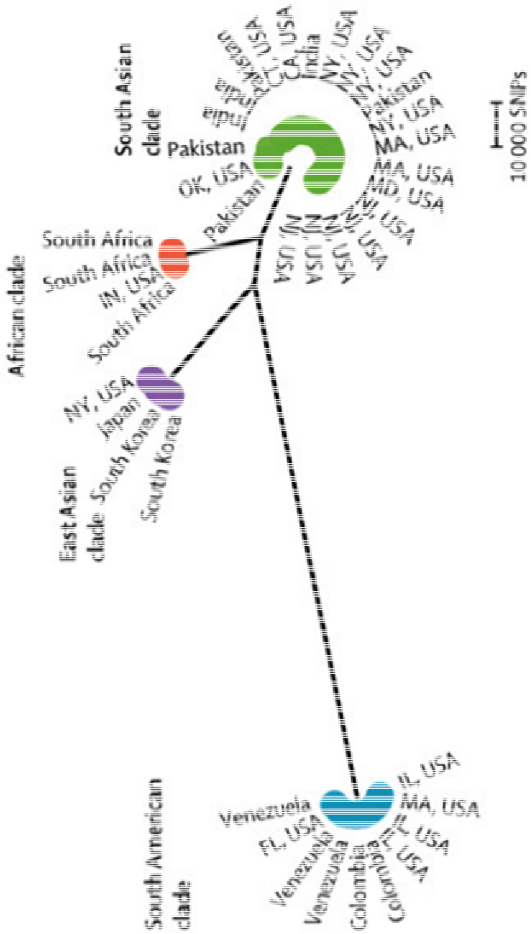
Case no	Nasal	Axilla/groin	Combine	Urine	Rectal	1st positive screening sample
1			Positive	Positive	Positive	Clinical specimen
2	Positive	Positive	Positive	NA	NA	2nd
3	Negative	Positive		Negative	Negative	1st
4	Negative	Positive		NA	NA	1st
5	Negative	Positive		Positive	Positive	2nd
6	Negative	Positive		Negative	Negative	1st
7	Negative	Positive		Positive	Positive	2nd
8	Negative	Positive		Negative	Negative	1st
9	Positive	Positive	Positive	Negative	Negative	1st
10	Positive	Positive	Positive	Negative	Negative	1st
11	Negative	Positive		NA	NA	3rd
12			Positive	NA	NA	6th (2 Exposure)
13			Positive	Negative	Negative	1st
14			Positive	Positive	Negative	1st

Whole Genome Sequencing WGS

- The seven local isolates were in the same clade as those from India and Pakistan (South Asian clade)
- They were closely related to one another, differing by ≤12 SNPs
- They are different from the rest of the isolates in this clade by >40 single nucleotide polymorphisms (SNPs).

Fig 1a. Phylogenetic tree showing the genetic relationships among isolates comprising 4 distinct clades. The isolates from the seven patients were indicated by different colors.

4 種演化支



Distribution of Candida auris clades in the United States.

Courtesy from PHLC

Outbreak Management (PMH)

1. All confirmed cases of inpatients are having room isolation with strict contact precautions.

2. With the help of ICB, CHP, known positive cases can be discharged to OAH after assessment and education.

3. Contact tracing (ward / cubicle)

4. Performed environmental sampling, **so far all negative**

5. Enhanced infection control measures in the affected wards:
   - terminal disinfection of wards and equipment
   - environmental disinfection at least twice daily
   - daily change of bedside curtains
   - reinforcement of hand hygiene
   - infection control patrol by infection control nurses
   - patient education

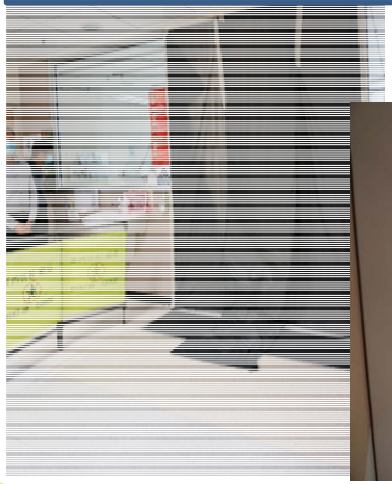
6. HOCT meeting was held on 5 July
   - ICB of CHP has suggested to continue the current control measures

Control of *C. auris* in NLTH

1. Single room isolation (if still not discharged) with strict contact precautions
2. Whole cubicle disinfection
3. Post-disinfection environmental sampling: 3 positive (bedrail of Bed 27, overbed table & patient locker of Bed 28A) / 148 = 2%
4. Contact tracing: affected cubicle → whole ward
5. Bed bath with CHG wipes for confirmed and contact in-patient cases
6. Change the conventional bath gel to CHG bath gel for other in-patients
7. Freeze admission to affected cubicle → freeze admission to ward from PMH Ward F
8. Enhanced environmental hygiene and hand hygiene
9. UVC room disinfection for affected cubicle

UVC Robot disinfection in NLTH

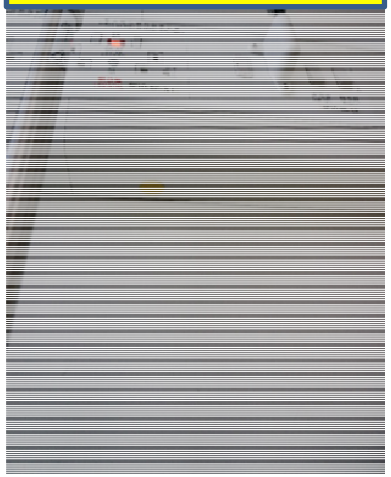
1 Environmental preparation after manual terminal cleansing



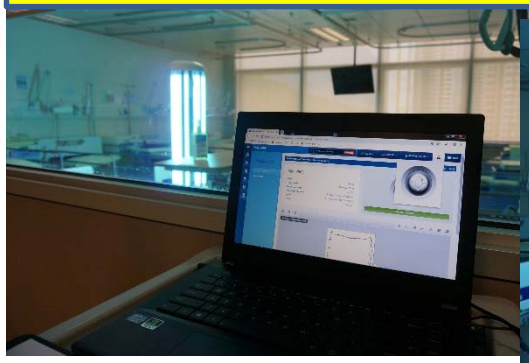
2 Apply *Candida albicans* (from 5.0 McFarland suspension) on designated site with marking and pre-environmental sampling

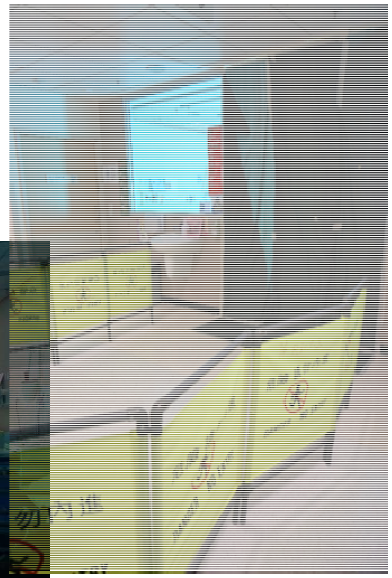
UVC Robot disinfection in NLTH

3 Apply test strip by manufacturer



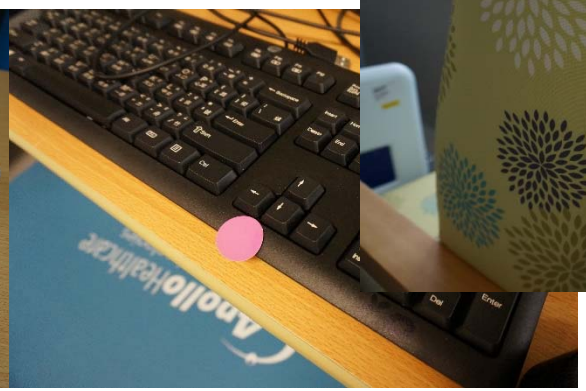
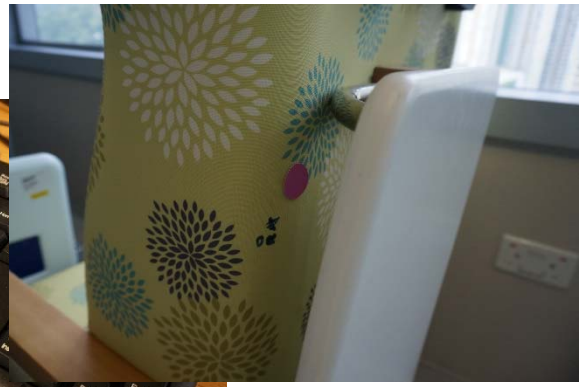
4 Starting UVD robot disinfection





UVC Robot disinfection in NLTH

5 Evaluate effectiveness – colour changed

6 Evaluate effectiveness – partial or no colour change



7 Post environmental sampling

UVC Robot disinfection video

https://youtu.be/v8P3CEUHcT4

Environmental sampling result (pre and post UVC robot disinfection)

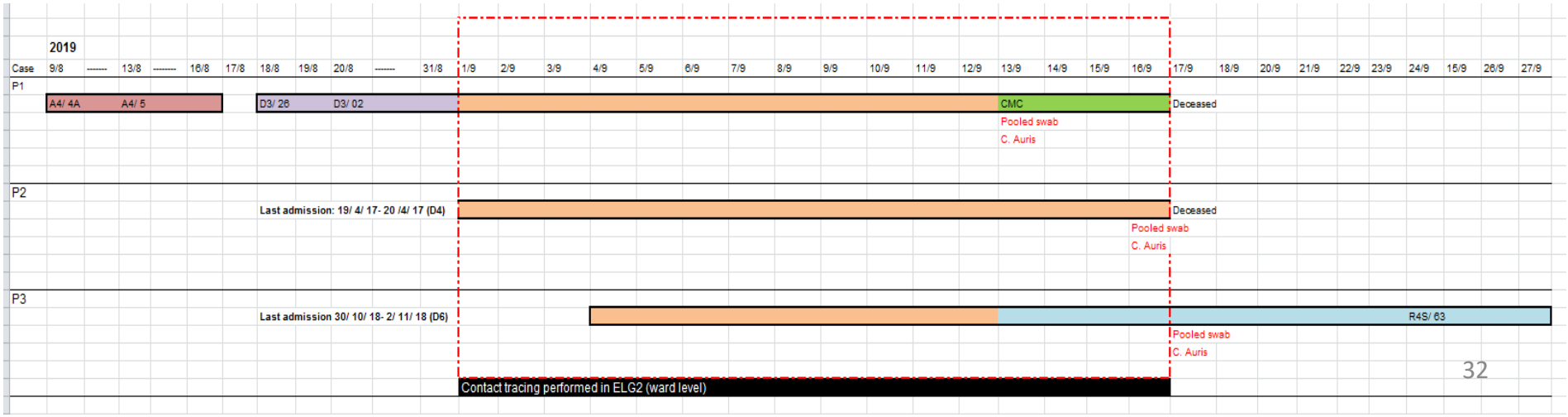
Location (cubicle 23-28)	***Candida albicans***	***Candida albicans***
	Pre-UVC	Post-UVC Positive : 4/21 Effectiveness : 81%
Bedrails (Bed 23)	positive	negative
Electronic Bed control (Bed 25)	positive	positive
Mattress (Bed 23A)	positive	negative
Over bed table (Surface) (Bed 28)	positive	negative
Call Bell (Bed 24)	positive	negative
IV pole (grab area) (Bed 28)	positive	negative
Monkey pull handle (Bed 28)	positive	negative
Suction switch (Bed 23)	positive	positive
Wall panel (Bed 26)	positive	negative
Arm Chair in cubicle	positive	positive
Alcohol hand gel dispensers (Pump top) (Bed 25)	positive	negative
Patient Locker (Inside) (Bed 24)	positive	negative
Blood pressure Machine	positive	negative
Ear thermometer (Handle)	positive	negative
Telephone	positive	negative
Keyboard	positive	negative
Over bed table (Bottom) (Bed 28)	positive	negative
Oxygen switch (Bed 26)	positive	negative
Patient Locker (Drawer) (Bed 24)	positive	negative
Over bed signage board	positive	negative
Walking frame	positive	positive

The story didn’t end here……

2nd outbreak in PMH

Case Summary

Case no	Exposure History	S/A	OAHR	Principle diagnosis	ADL	Duration of stay in ELG2	Positive date & site of C. Auris	Destination
P1	From **CMC admission** screening, unknown source, not a contact case from last outbreak	M/60	Yes	CA rectum	ADL-TD	1/9/19 – 13/9/19	13/9/2019 pooled swab	T/O to CMC on 13/9/2019 Passed away on 16/9/2019
P2	**Cubicle contact of P1 in Ward Y**	M/84	Yes	Chest infection	ADL-TD	1/9/19 – 16/9/19	16/9/2019 pooled swab **(1st specimen)**	Passed away on 16/9/2019
P3	**Cubicle contact of P1 in Ward Y**	M/75	Yes	Fever and vomiting	ADL-PD	4/9/19 – 13/9/19	17/9/2019 pooled swab **(2nd specimen)**	PMH Rehab Ward (single room)



Ward Y


Ward Pantry
Lifts
A/C Plant
Linen Room
Mini Station
Bed No 1-10
Bed No 11-20
Bed No 41-43
Mini Station
Emergency exit
Entrance & Exit
Male Staff Toilet
Sluice Room
Medical Store Room
Bed No 44-46
(P1)
(P2)
(P3)
Nursing Station
Mini Station
Bed No 31-40
Bed No 21-30
Accessible Toilet
Male Toilet
Shower
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Epidemiological Investigation for P1

- **No definite linkage of this case with previous case can be identified, though he had been in several medical wards in August and Sept (last outbreak was declared over on 29/7/19).**

Our Actions

Enhanced infection control measures:

- **Single room isolation with Contact Precautions**
- **Terminal disinfection** and enhanced disinfection with Actichlor Plus of involved wards (including patient beds, shared items, floor & change curtains)
- **Environmental sampling** to involved wards
- **IC patrol** to observe hand hygiene and Contact Precautions

Enhanced laboratory surveillance:

- Identify all yeasts from the involved wards into species level

Notification:

- CICO
- SEB and ICB of CHP

Tagging

- All patient contacts are tagged in CMS alert and MDRO Tagging System

Infection Control Measures for *C. auris*

Guideline on Infection Control for *Candida Auris*

Version	Effective Date
1	4 March 2019
1.1	22 October 2019

Document Number	CCIDER-Candida-001(v1.1)
Author	Task Force on Infection Control (TFIC)
Custodian	Central Committee on Infectious Diseases and Emergency Response (CCIDER)
Approved by	Central Committee on Infectious Diseases and Emergency Response (CCIDER)
Approval Date	22 October 2019
Next Review Date	4 March 2022

Reporting

1. Any patient with *C. auris:*
   a) Inform CICO with relevant epidemiology and clinical information
2. One or more patients identified *C. auris* from clinical specimen,
   a) Notify CHP & CICO
   b) Convene hospital outbreak control team (HOCT) meeting

Admission Screening

1. Admission screening should be performed for patients who had history of hospitalization outside Hong Kong in the last 12 months AND currently admitted to high risk units including intensive care units, clinical oncology wards, hematology wards and bone marrow units.

   (PMH M&G also participate as pilot with effect from 22 July 19)

2. Admission screening could be considered for patients who have history of hospitalization in local hospital with ongoing outbreak.

3. Apply preemptive contact precautions until **one** set of screening is negative.

Admission Screening – CMC/YCH

- **For patients who had history of hospitalization outside Hong Kong in the last 12 months AND currently admitted to intensive care units**
- **For patients who have history of hospitalization in PMH/NLTH M&G in the last 1 month until laboratory surveillance in PMH do not reveal new *C. auris* case for 1 month**

Standard and Contact Precautions

1. Isolate the patient in a **single room** preferably with ***ensuite*** facilities or cohort with *C. auris* cases
2. Emphasize **hand hygiene**
3. Wear gown and gloves when direct contact with patient or his/her immediate environment/ equipment
4. Dedicate non-critical equipment (e.g. thermometer probes, pulse oximeter, blood pressure cuff, stethoscope, tourniquet, etc.)

Patient Discharge

- Provide education and leaflet

出院須知

帶有耳念珠菌的患者對家人、同事或公眾的健康不會構成危險，因此無須在家中隔離，可參與正常社交生活，但仍須注意下列事項：

1. 保持良好的個人衛生，例如每天洗澡及更換衣服。衣服可與其他衣物按慣常方法一起清洗。
2. 注意手部衛生：經常用清水及梘液徹底清潔雙手，或用酒精搓手液揉搓雙手。
3. 傷口應用敷料妥善包紮，並於處理傷口前後清潔雙手。
4. 避免與別人共用個人物品，如毛巾、牙刷、剃鬚刀及衣物等。餐具可按慣常方法清洗。
5. 避免徒手直接接觸傷口、造口、引流或任何被身體分泌物污染之物件。如有需要，應先戴上手套，並於處理完畢後清潔雙手。
6. 保持環境衛生和物品清潔。例如可用 1 比 49 稀釋家用漂白水(即把 1 份 5.25% 漂白水與 49 份清水混和)定期消毒家具及環境設施。
7. 如出現感染徵狀，應立即找醫生診治。
8. 跟從醫生處方，正確使用抗生素 / 抗真菌素。

給病人及家屬指引

耳念珠菌

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總感染控制主任辦事處

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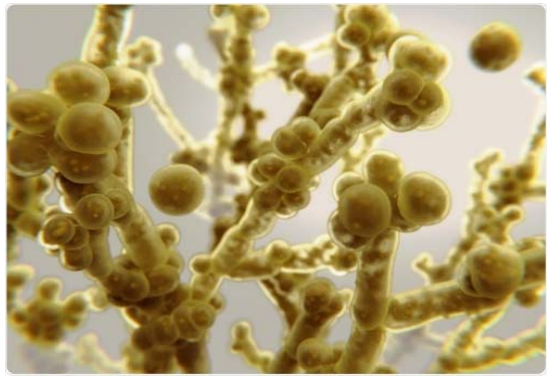
http://ha.home/visitor/view_content.asp?parent_id=32739&content_id=39730&language=ENG

Environmental Decontamination and Terminal Disinfection

- Quaternary ammonium compound disinfectants should be avoided.
- Frequently touched environmental surfaces should be cleaned and **disinfected at least twice daily using 1,000 ppm sodium hypochlorite solution** or other disinfectant recommended by ICT.
- Prefer to use of **disposable wipes**
- Upon patient discharge:
  - Change privacy curtain
  - Discard single use items

What is *Candida auris* ?



- *Candida*, is a family of fungi (yeasts), normally lives inside the body such as the mouth, throat, gut, and vagina and on the skin without causing any infection.

- *Candida auris* is an emerging fungus that presents a global health threat. It was first reported from external ear discharge of a patient in Japan in 2009. Since then, *C. auris* has been isolated on five continents, over 20 countries.

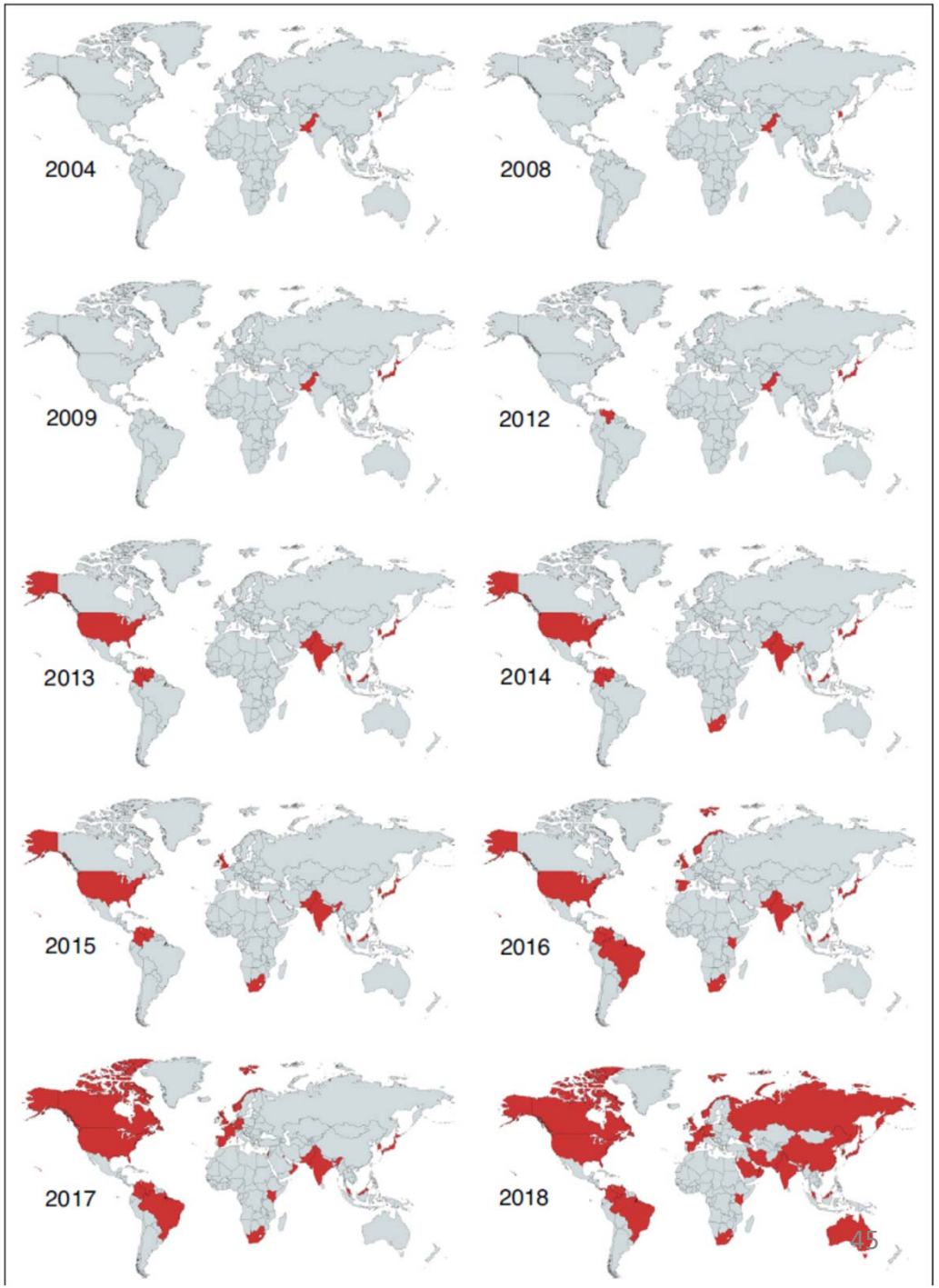
- It can colonize patients for several months, and cause invasive infections such as candidemia, pericarditis, pneumonia, severe urinary tract infection, especially in critically ill patients and immunocompromised patients.

- It can cause high mortality. According to the US CDC, about 30% - 60% of patients with an invasive *C. auris* infection have died.

Global Epidemiology

Timeline showing the expanding worldwide detection of *C. auris*

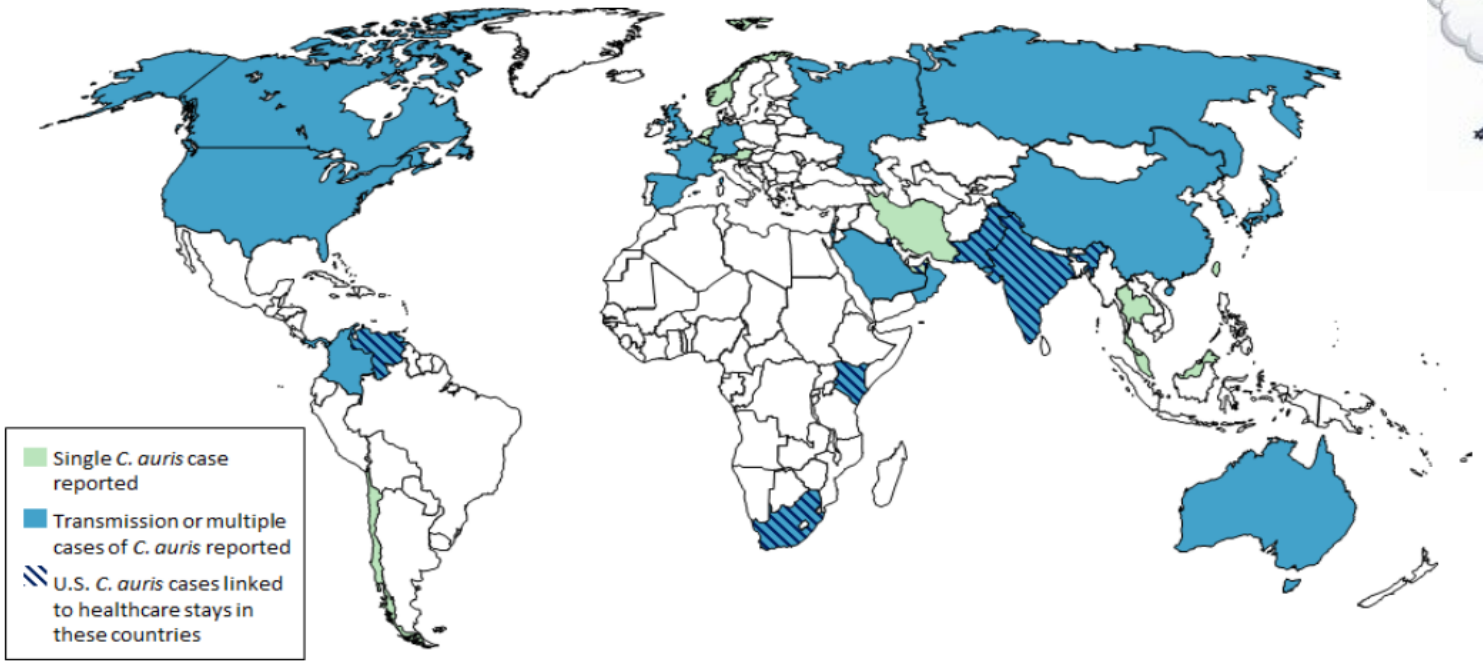
First described in 2009 after being isolated from external ear discharge of a patient in **Japan**



Source: Rhodes J, Fisher MC. Global epidemiology of emerging *Candida auris.* Curr Opin Microbiol. 2019 Jul 3;52:84-89.

Global Epidemiology

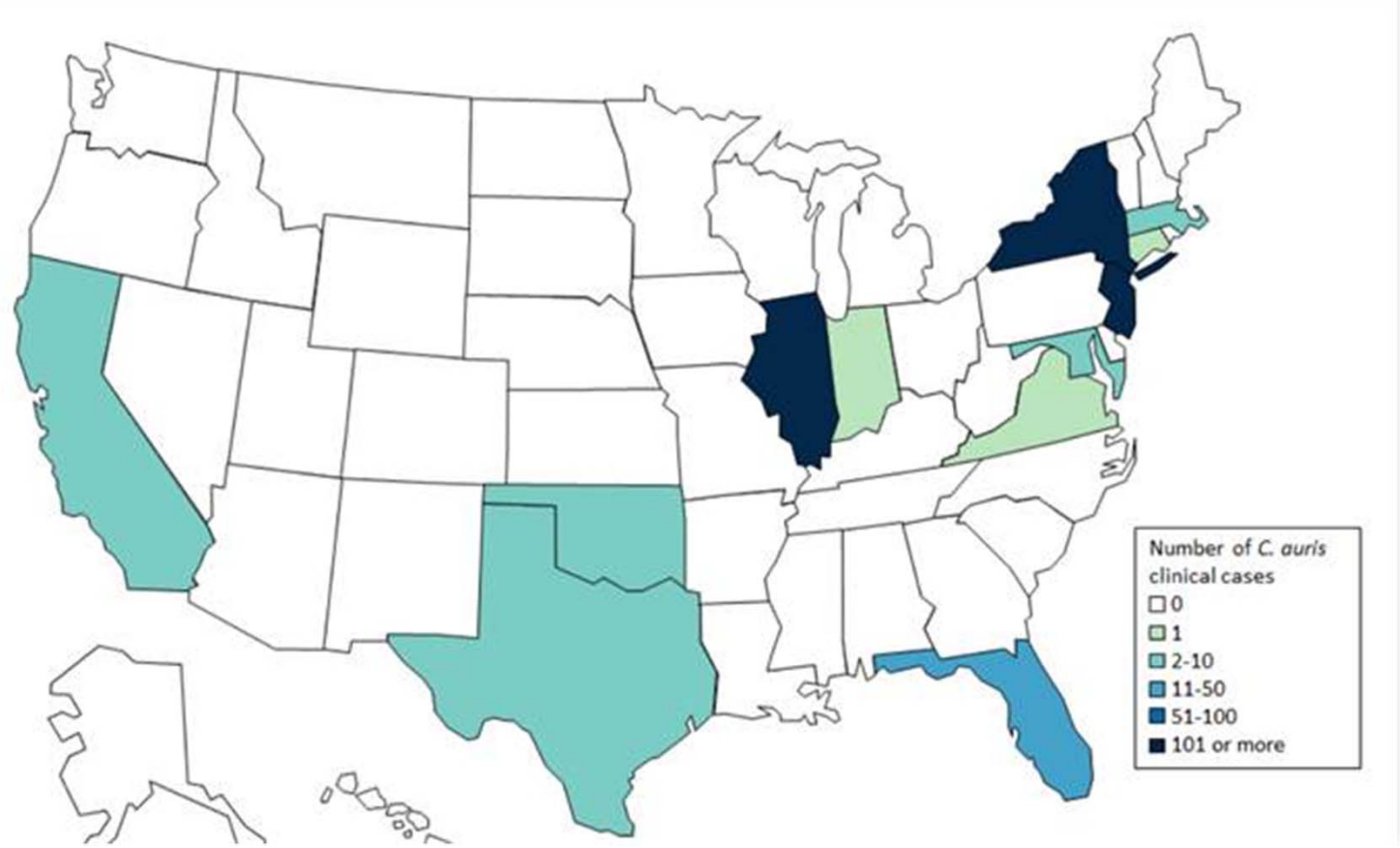
Countries from which *Candida auris* cases have been reported, as of April 30, 2019



- Single cases of *C. auris* have been reported from Austria, Belgium, Chile, Iran, Malaysia, the Netherlands, Norway, Switzerland, Taiwan, Thailand, and the United Arab Emirates.
- Multiple cases of *C. auris* have been reported from Australia, Canada, China, Colombia, France, Germany, India, Israel, Japan, Kenya, Kuwait, Oman, Pakistan, Panama, Russia, Saudi Arabia, Singapore, South Africa, South Korea, Spain, the United Kingdom, the United States (primarily from the New York City area, New Jersey, and the Chicago area) and Venezuela; in some of these countries, extensive transmission of *C. auris* has been documented in more than one hospital.
- U.S. cases of *C. auris* have been found in patients who had recent stays in healthcare facilities in India, Kenya, Kuwait, Pakistan, South Africa, the United Arab Emirates, and Venezuela, which also have documented cases.
- Other countries not highlighted on this map may also have undetected or unreported *C. auris* cases.

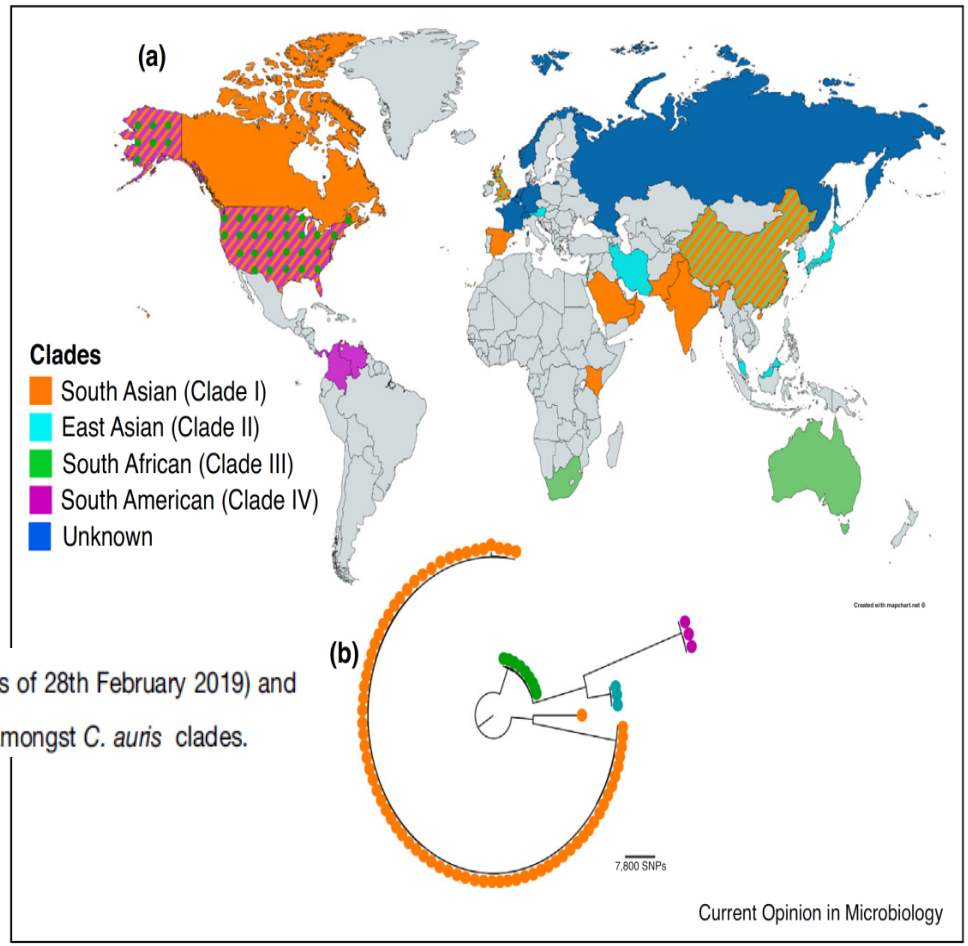
Source: CDC (30 April 2019). Tracking *Candida auris*. https://www.cdc.gov/fungal/candida-auris/tracking-c-auris.html#world

U.S. Map: Clinical cases of *Candida auris* reported by U.S. states, as of May 31, 2019



Genetic analysis of *C. auris*

- Widespread variation between geographic clades with thousands of single nucleotide polymorphism (SNP)
- Separated into 4 geographical clades with minimal genetic differences (<150 SNPs) within each clade
  1. South Asian
  2. South African
  3. South American
  4. East Asian



(a) Global distribution of *Candida auris* clades (as of 28th February 2019) and **(b)** RAxML phylogeny showing the relationship amongst *C. auris* clades.

Source: Rhodes J, Fisher MC. Global epidemiology of emerging *Candida auris.* Current Opinion in Microbiology. 2019 Jul 3;52:84-89.

Why are we concerned about *C. auris* infections?

1. **Resistant to multiple antifungal drugs**
   - In US, about 90% of *C. auris* isolates have been resistant to fluconazole, about 30% have been resistant to amphotericin B, and less than 5% have been resistant to echinocandins.

2. **Difficult to identify with standard laboratory methods**

3. **Transmission in healthcare settings**
   - Carriage healthcare workers' hands
   - Survive for weeks on hospital environment, including plastics, fabrics and nonporous surfaces
   - Withstand commonly used surface disinfectants
   - Cause nosocomial outbreaks in multiple countries

Nosocomial Outbreaks of *C. auris*

Reference	Location	Colonized/ Infected	Molecular Linkage	Outbreak Controlled
Ryan-Gaitan, 2018	Europe April 2016 to Jan 2017	140/41 BSI	Yes	No
Arauz, 2018	Panama	NA/9	No	NA
Biswal, 2017	India	Many/3 BSI	NA	Yes
Calvo, 2016	Venezuela Mar 2012 to July 2013	NA/18 BSI	Yes	NA
Schelenz, 2016	London April 2015 to July 2016	NA/50	Yes	No

Nosocomial Outbreak of *C. auris* in India

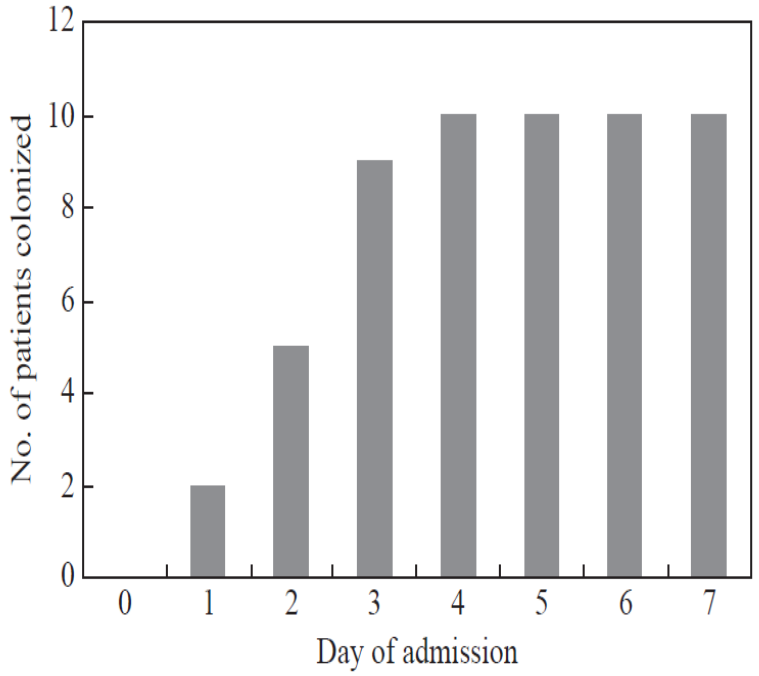


Figure 3. Time to *Candida auris* acquisition after intensive care unit admission.

Hand carriage of *C. auris* among healthcare workers

Table I
Contamination of *Candida auris* on environmental samples and carriage on healthcare workers' hands

Samples	MICU	CCU	Trauma ICU	NSW
Environmental				
No. of samples	68	10	189	37
C. auris-positive samples	7	0	17	0
Handwash samples (HCWs)				
No. of samples	41	13	79	12
C. auris-positive samples	2	0	2	0

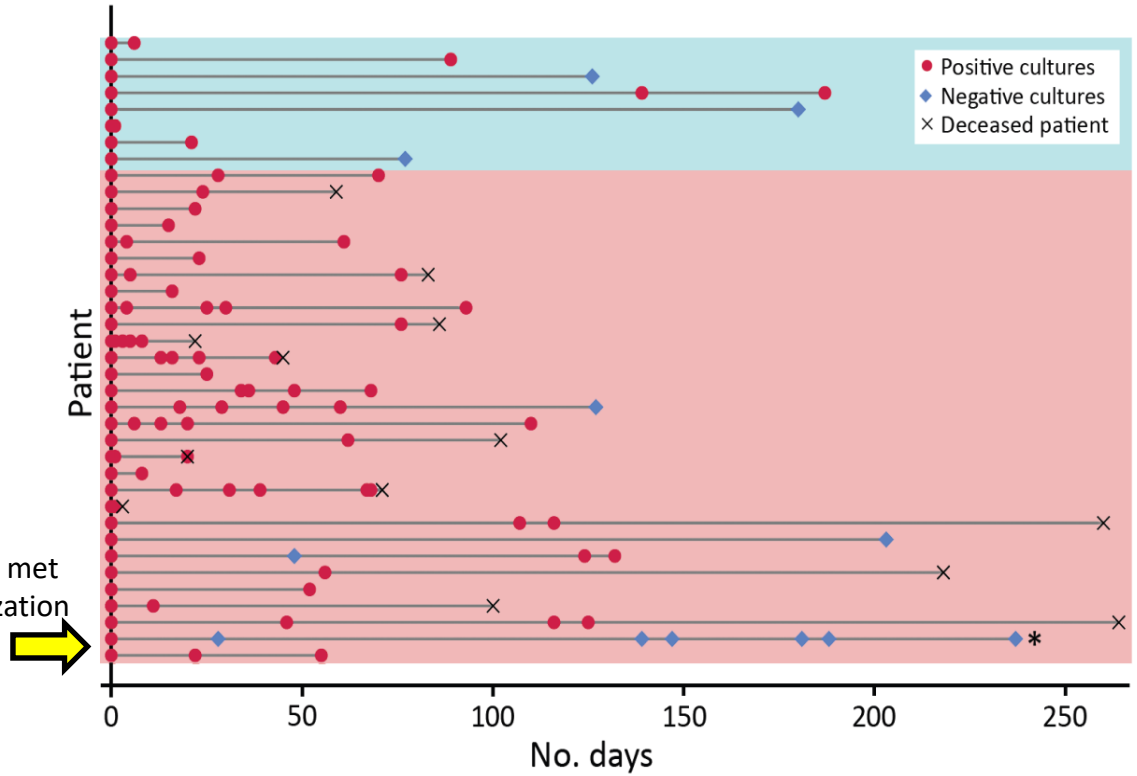
MICU, medical intensive care unit; CCU, cardiac care unit; ICU, intensive care unit; NSW, neurosurgical ward; HCW, healthcare worker.

By the fourth day, all ten patients acquired C auris

Source:
Biswal M, Rudramurthy SM, Jain N, et al. Controlling a possible outbreak of *Candida auris* infection: lessons learnt from multiple interventions. J Hosp Infect. 2017;97(4):363-370.

Prolonged Carriage

- Pink shading indicates clinical case patients and blue shading indicates screening case patients.
- Follow-up cultures were collected from a variety of sites, typically axilla and groin and often nares, rectum, urine, and wounds.
- Persons were considered free of colonization with *C. auris* and eligible for removal of contact precautions when 2 sets of surveillance cultures at multiple sites, taken at least 1 week apart, were negative.



Source: *Candida auris* in Healthcare Facilities, New York, USA, 2013–2017
https://wwwnc.cdc.gov/eid/article/24/10/pdfs/18-0649.pdf

Decolonization

- Currently no data on the efficacy of decolonization for patients with *C. auris.*
- May consider to use the following items for decolonization during outbreak situation as advised by infection control team:
  1. skin decontamination with chlorhexidine,
  2. mouth gargles with chlorhexidine,
  3. targeted topical management e.g. topical nystatin, chlorhexidine impregnated dressing at catheter exit sites

Information Sheet on the Use of 2% Chlorhexidine Gluconate (CHG) Solution for Bed Bathing

(Prepared by CICO office, 7 May 2012)

Disclaimer: The information provided in this information sheet is for reference only. Please follow nursing standards for patient care.

Equipment required for a bed bath

- 2% Chlorhexidine Gluconate antiseptic solution (rinse free)
- Disposable cloths/ wipes
- Disposable gowns and gloves
- Clean clothes
- Waste bag

Procedures for bed bathing a patient

1. Prepare the environment and equipment.
2. Follow the manufacturer's instructions of use. Prepare appropriate volume of 2% CHG antiseptic solution. The solution can be used at room temperature. Warming is allowed but the temperature should not exceed 40°C*.
3. Perform hand hygiene and wear disposable gloves and gown/ apron.
4. Assist the patient to remove clothing. Cover the body e.g. a bath towel or sheet to sustain body temperature when necessary.
5. Soak the disposable clothes/ wipes fully with antiseptic solution.
6. Rub the areas of the body according to the sequences#^ shown in Figure 1. No rinsing is required.
7. Care should be taken not to wet drains, dressings, and/or intravenous devices.
8. Change the disposable clothes/ wipes when visibly soiled, after cleaning armpits, buttock and groin area.
9. Remove gloves and perform hand hygiene.
10. Wear clean disposable gloves.
11. Assist patient to put on clean clothes.
12. Remove gloves and gown/ apron, and perform hand hygiene after procedures.

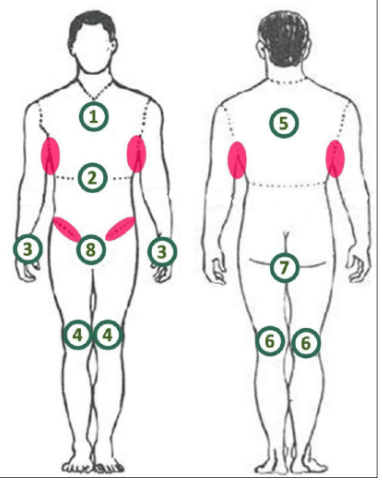
*The antiseptic agent may denature into other chemical components when excessive heat is applied (> 40°C).

#The sequences could be modified according to the posture or condition of patient.

^Avoid contact with the eyes and any mucosal membranes.

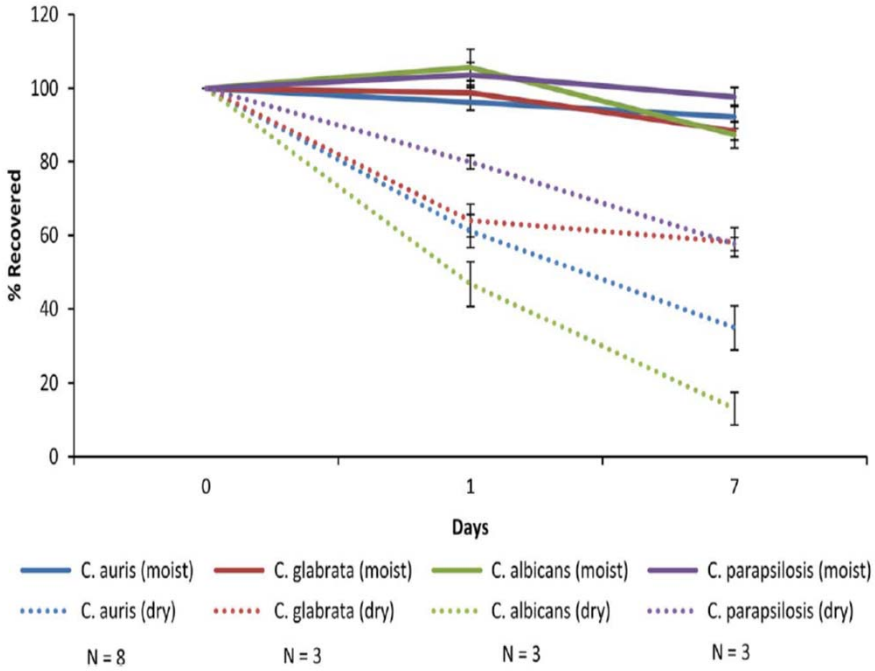
Figure 1. Sequences of cleaning

① FACE^, NECK, SHOULDERS AND CHEST
② ABDOMEN
③ BOTH ARMS AND HANDS
④ ANTERIOR LOWER LIMBS
⑤ BACK
⑥ POSTERIOR LOWER LIMBS
⑦ BUTTOCKS
⑧ GROIN
Shaded areas have higher density of bacterial count

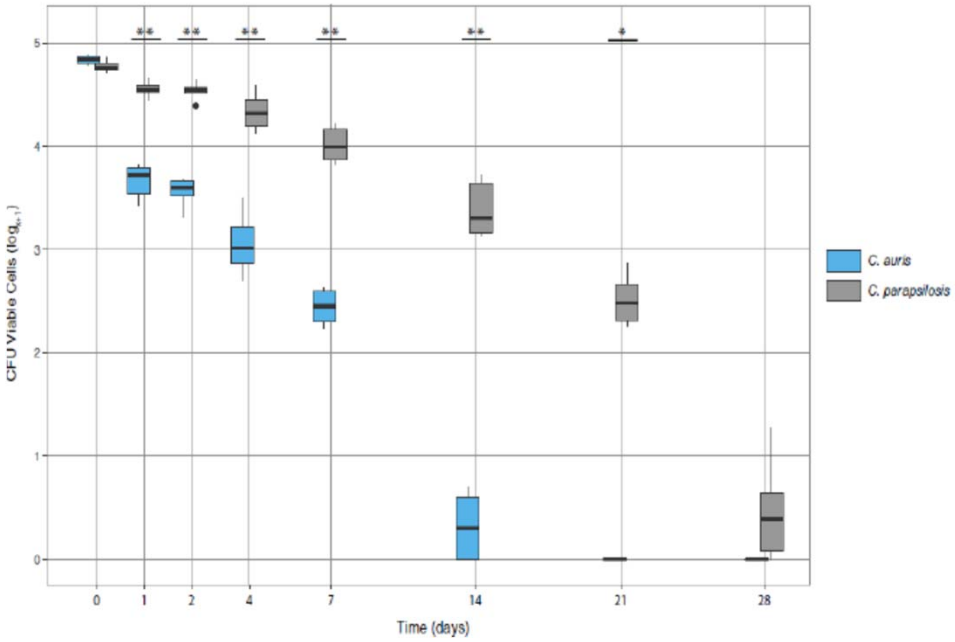


Prolonged Environmental Survival

- Prolonged environmental survival on environmental surfaces; > 14 days (Piedrahita 2017, Welsh 2017)
- Prolonged survival (>7 days) on contaminated bedding (Biswal 2017)



Piedrahita C, et al. ICHE 2017;38:1107-1109



Welsh RM, et al. J Clin Microbiol 2017;55:2996-3005

Environmental Contamination

- Of 660 environmental samples collected from surfaces, objects, and equipment in the rooms of *C. auris* case-patients and from mobile equipment outside the rooms on the affected nursing units, 79 (12%) were positive by culture or PCR.
- Contamination of surfaces and objects in *C. auris* case-patients' rooms and mobile equipment outside the rooms was common.
- High-yield items included bedrails, IV poles, beds, privacy and window curtains, windows, and floors.

Table 2. Environmental contamination with *Candida auris* in healthcare facilities, New York, USA, 2013–2017*

Category, object or surface	No. samples	Positive by culture, no. (%)	Positive by PCR and negative by culture, no. (%)	Negative by culture and PCR, no. (%)
Near-patient surfaces and objects in rooms				
Bedside/over bed table	44	2 (5)	2 (5)	40 (91)
Bed rail	49	7 (14)	5 (10)	37 (76)
TV remote/call button	36	2 (6)	2 (6)	32 (89)
IV poles	21	5 (24)	1 (5)	15 (71)
Bed	17	4 (24)	0	13 (77)
Privacy curtain	6	2 (33)	0	4 (67)
Miscellaneous other†	5	0	1 (20)	4 (80)
Total	178	22 (12)	11 (6)	145 (82)
Other surfaces and objects in rooms				
Door knob/handle	36	1 (3)	1 (3)	34 (94)
Sink	27	1 (4)	2 (7)	24 (89)
Window	22	3 (14)	1 (5)	18 (82)
Floor	17	4 (24)	0	13 (77)
Furniture	27	3 (11)	0	24 (89)
Window curtain	11	3 (27)	0	8 (73)
Light switch	9	0	0	9 (100)
Closet	6	0	0	6 (100)
Wall	4	1 (25)	0	3 (75)
Bathroom	4	1 (25)	0	3 (75)
Countertop	4	1 (25)	0	3 (75)
Toilet	4	0	0	4 (100)
Miscellaneous other‡	16	2 (13)	0	14 (88)
Total	187	20 (21)	4 (2)	163 (87)
Equipment in room				
Ventilator/respiratory equipment	12	1 (8)	0	11 (92)
Pump	4	0	0	4 (100)
Miscellaneous other§	19	4 (21)	0	15 (79)
Total	35	5 (14)	0	30 (86)
Equipment outside of room				
Clean supply cart	51	1 (2)	0	50 (98)
Ventilator/respiratory equipment	45	1 (2)	0	44 (98)
Vital sign machine	21	3 (14)	1 (5)	17 (81)
Normothermia system (e.g., Bair hugger)	20	1 (5)	0	19 (95)
Computer workstation	20	0	0	20 (100)
Thermometer	14	1 (7)	1 (7)	12 (86)
PPE/isolation cart/box	12	1 (8)	1 (8)	10 (83)
Lift/scale	11	2 (18)	0	9 (82)
Glucometer	11	0	0	11 (100)
Housekeeping cart	9	0	1 (11)	8 (89)
Dialysis equipment	7	1 (14)	0	6 (86)
Suction canister	6	1 (17)	0	5 (83)
Ultrasonography equipment	4	0	0	4 (100)
Miscellaneous other¶	29	1 (3)	0	28 (97)
Total	260	13 (5)	4 (2)	243 (94)

*A total of 660 samples were collected from surfaces, objects, and equipment in the rooms of *C. auris* case-patients and from mobile equipment outside the rooms on the affected nursing units. In addition, 62 samples from surfaces within the nursing units but outside the patient rooms and 23 samples from outside the affected nursing units were negative by culture and PCR. The location of 36 samples could not be ascertained; 2 were positive by culture.
PPE, personal protective equipment; TV, television.
†PCR positive from light cord.
‡Cultures positive from handrail and phone.
§Cultures positive from glucometers (n = 2), vital signs machine, and stretcher.
¶Culture positive from bedpan flusher.

Source: *Candida auris* in Healthcare Facilities, New York, USA, 2013–2017
https://wwwnc.cdc.gov/eid/article/24/10/pdfs/18-0649.pdf

Equipment Contamination

Reusable skin-surface axillary temperature probes as a source of *C. auris* outbreak in a neurosciences ICU (16 beds) of the Oxford University Hospitals, UK

Reusable skin-surface temperature probes

Photo from Philips

Source:
Eyre WD, Sheppard A E, Madder H, et al. A *Candida auris* outbreak and its control in an intensive care setting. N Engl J Med. 2018, 379:1322-1331

Surface Disinfectants Tested Against *C. auris*

Disinfectant	Concentrations tested (contact time in minutes)	Effective	Level of evidence	Comments	Reference
Chlorine	0.39% (1), 0.65% (1), 0.825% (1), 1% (10), 2% (10), 1000 ppm (3, 5, 180, 1800), 10000 ppm (3, 180, 1800)	Yes	Good	Most extensively studied. Can cause ocular irritation, or oropharyngeal, esophageal, and gastric burns. Can corrode metals at concentrations > 500 ppm.	Abdolrasouli et al., 2017; Biswal et al., 2017; Cadnum et al., 2017b; Moore et al., 2017
Hydrogen peroxide	8 g/m^3 (?), 1.4% (1)	Yes	Moderate		Abdolrasouli et al., 2017; Cadnum et al., 2017b
Hydrogen peroxide+silver nitrate	11% (60)	Yes	Low		Biswal et al., 2017
Phenolics	5% (?)	Yes	Low	Not FDA-approved for use as high-level disinfectant but can be used to preclean before terminal sterilization.	Biswal et al., 2017
Glutaraldehyde	2% (20)	Yes	Low	Expensive and toxic. Should be used for medical equipment cleaning.	Biswal et al., 2017
Alcohols	29.4% (0.5)	Yes	Low	Difficult to achieve prolonged contact time due to rapid evaporation. Flammable. May harden rubber and certain plastic tubing after prolonged and repeated use.	Cadnum et al., 2017b
Acetic acid	>5% (3)	No	Low		Cadnum et al., 2017b
Peracetic acid	2000 ppm (5, 10)	Yes	Low	For medical equipment cleaning. Can corrode certain metals.	Kean et al., 2018
Peracetic acid+hydrogen peroxide+acetic acid	1200 ppm/<1% (3)	Yes	Low		Cadnum et al., 2017b
Quaternary ammonium compounds	2% didecyldimethyl ammonium chloride (60), alkyl dimethyl ammonium chlorides (10), didecyldimethyl ammonium chloride/dimethylbenzyl ammonium chloride (10)	No	Low		Biswal et al., 2017; Cadnum et al., 2017b

Source: Ku TSN, et al. Frontiers in Microbiol 2018;9:726
https://www.frontiersin.org/articles/10.3389/fmicb.2018.00726/full

Terminal Room Disinfection

Hydrogen peroxide vapor or UV-C disinfector could be considered.

Hydrogen peroxide vapor

UV-C light

UV dose required for inactivation of viruses, bacteria, moulds, etc

Bacteria

Micro-organism (microbe)	UV light exposure (dose) in J/m² required to achieve 90% – 99.99% reduction of the specified micro-organism types			
	90% (1 log)	99% (2 log)	99.9% (3	99.99% (4
Bacillus anthracis – Anthrax	45.2	90.40	135.60	180.80
Bacillus anthracis spores – Anthrax spores	243.2	486.40	729.60	972.80
Bacillus magaterium sp. (spores)	27.3	54.60	81.90	109.20
Bacillus magaterium sp. (veg.)	13.0	26.0	39.0	52.0
Bacillus paratyphusus	32.0	64.0	96.0	128.0
Bacillus subtilis spores	116.0	232.0	348.0	464.0
Bacillus subtilis	58.0	116.0	174.0	232.0
Clostridium difficile (C. difficile or C. diff)	60.0	120.0	180.0	240.0
Clostridium tetani	130.0	260.0	390.0	520.0
Corynebacterium diphtheriae	33.7	67.4	101.1	134.80
Ebertelia typhosa	21.4	42.80	64.2	85.60
Escherichia coli	30.0	60.0	90.0	120.0
Leptospiracanicola – infectious Jaundice	31.5	63.0	94.5	126.0
Micrococcus candidus	60.5	121.0	181.5	242.0
Micrococcus sphaeroides	10.0	20.0	30.0	40.0
MRSA	32.0	64.0	96.0	128.0
Mycobacterium tuberculosis	62.0	124.0	186.0	248.0

Yeast

Micro-organism (microbe)	UV light exposure (dose) in J/m² required to achieve 90% – 99.99% reduction of the specified micro-organism types			
	90% 1 log	99% 2 log	99.9% 3 log	99.99% 4 log
Brewers yeast	33.0	66.0	99.0	132.0
Common yeast cake	60.0	120.0	180.0	240.0
Saccharomyces carevisiae	60.0	120.0	180.0	240.0
Saccharomyces ellipsoideus	60.0	120.0	180.0	240.0
Saccharomyces spores	80.0	160.0	240.0	320.0

Conclusion:

PMH's experiences have demonstrated the reasons why we are concerned about ***C. auris*** infections.

1. It is often resistant to multiple antifungal drugs commonly used to treat *Candida* infections.
   - In US, about 90% of *C. auris* isolates have been resistant to fluconazole, about 30% have been resistant to amphotericin B, and less than 5% have been resistant to echinocandins.

2. It is difficult to identify with standard laboratory methods.

3. It can transmit to patients on the hands of healthcare workers, persists in the environment, and can colonize people who then serve as a reservoir for outbreaks.
   - *C. auris* outbreak in a neonatal unit in Venezuela (2012)
   - *C. auris* outbreak with 372 colonization and 85 bloodstream infections in a 992-bed tertiary institution in Valencia, Spain (2016-2017)
   - *C. auris* outbreak with 72 cases in an ICU of the Royal Brompton Hospital in London; the ICU was closed for 11 days (2016)

Conclusion: NLTH experience

1. “Contact precautions” doesn’t necessarily mean *transmission-free* for *C. auris*
2. Isolation rooms are much better
3. Be meticulous on environmental cleansing and disinfection
4. Potential application and pitfalls of terminal disinfection by UVC

Thank You