Emerging Threats in IPC

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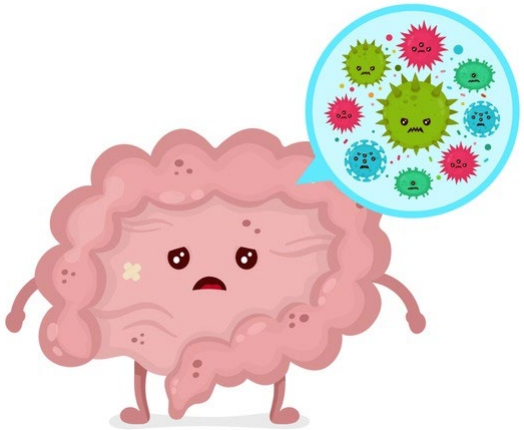


Western Diagnostic Pathology

Joondalup Health Campus
Part of Ramsay Health Care

PathWest
Laboratory Medicine WA

Conflicts of Interest Declaration

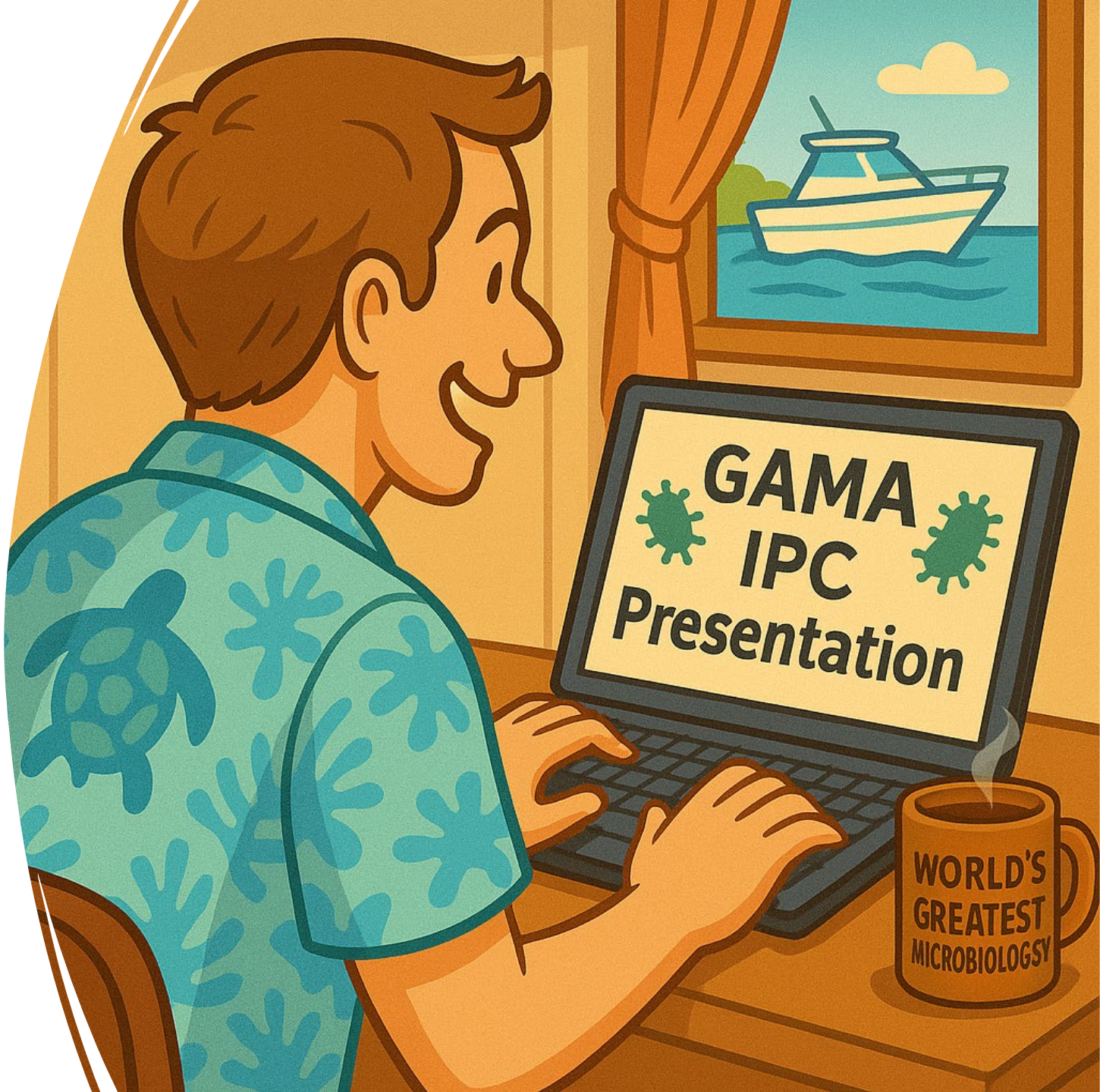
- I am employed by the Healius Group, Ramsay Health Care and PathWest
- I am an independently practicing private Infectious Diseases Physician
- I have been sponsored by Pfizer to attend conferences/talks and received honorariums for participation in committees etc
- I have not received any financial benefit from GAMA
- I am a member of the AMA council and sit as the pathologist representative.
- I have no other conflicts of interest to declare

Other declarations

- Views provided in the following presentation are based on my experience and expertise as a Clinical Microbiologist and Infectious Diseases Physician.
- The views and opinion expressed are my own and are not the views of the organisations (title page) I am associated with.
- ChatGPT has been used for editing and some entertaining cartoons

Emerging threats

- AMR : CRE, ESBLs and VRE
- USA – CDC + USAID
- Vaccination Hesitancy
- Candida auris
- Agricultural Antimicrobials



Review on Antimicrobial Resistance

Tackling drug-resistant infections globally

Antimicrobial Resistance: Tackling a crisis for the health and wealth of nations

The Review on Antimicrobial Resistance
Chaired by Jim O'Neill
December 2014

Health Insurance

- ~50% of Western Australian's have private hospital insurance
- 61% of all elective surgery is performed in private hospitals in WA (vs 45% in Australia)
- WA has the highest number of private hospital beds per capita in Australia
- Private patients admitted to public hospitals are guaranteed no out of pocket costs
- Medication costs ~ HBF $1,400 cap for non-pbs medications

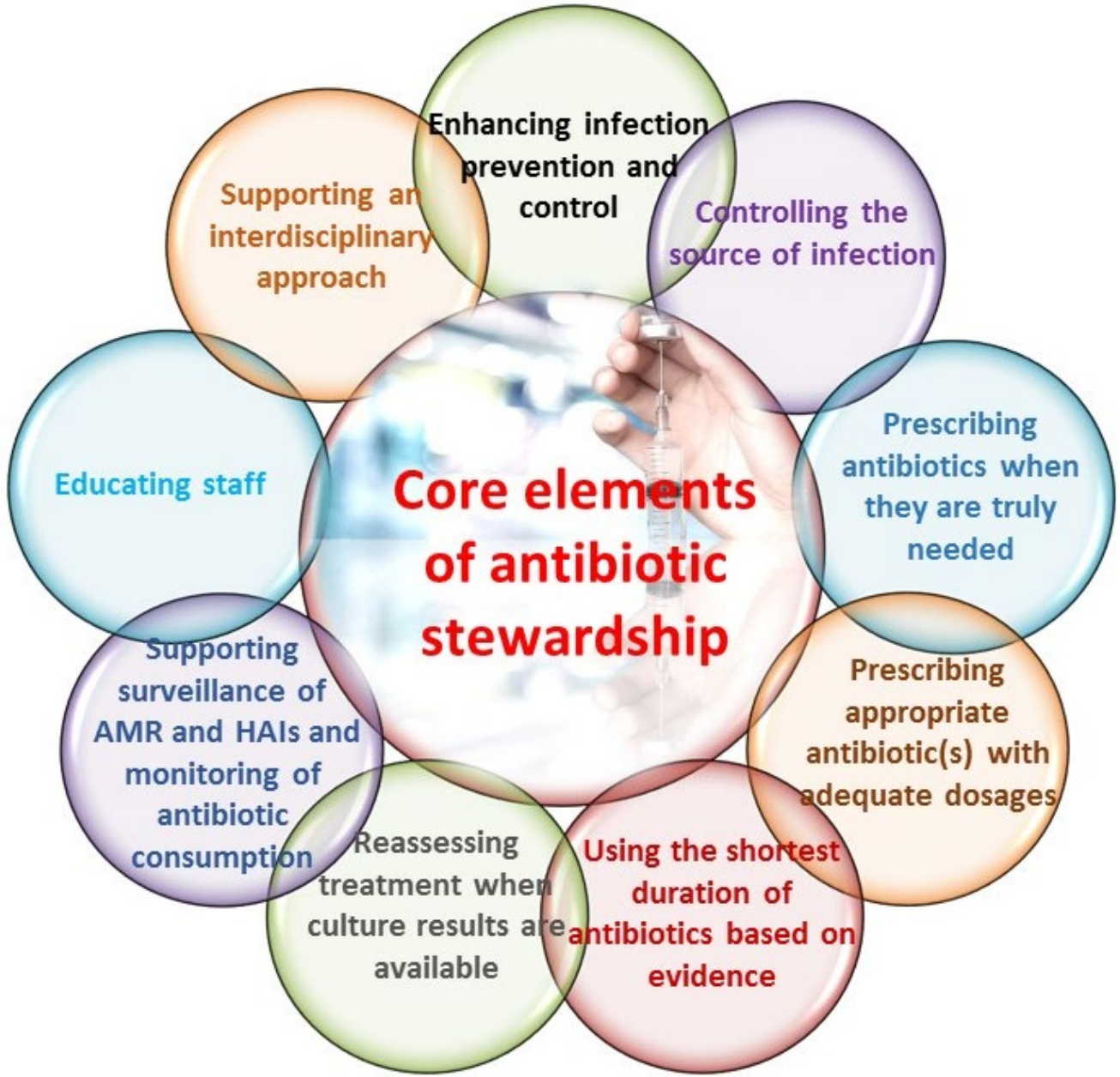
Non-PBS antibiotics/antifungals

- Tazocin
- IV Augmentin
- Meropenem
- Daptomycin
- Linezolid
- Teicoplanin
- Anidulafungin
- Liposomal amphotericin b
- Caspofungin
- Ceftazidime / Avibactam
- Ceftolozane/tazobactam
- Cefiderocol
- Aztreonam
- Pivmecillinam
- Moxifloxacin

AMR threat

- By 2050 AMR will kill more people than all forms of cancer combined
- **Any antibiotic use will increase resistance and make common infections less easily treated**
- The use of any antibiotic including broad spectrum antibiotics will accelerate the failure of surgical prophylaxis – leading to increased costs, complications and length of stay
- Not using antibiotics when indicated will lead to increased costs, complications and length of stay

Core elements of antibiotic stewardship



CRE/CPE: Carbapenemase-producing Enterobacterales

Enterobacterales = coliforms like E.coli, Klebsiella sp. , Citrobacter's etc

CRE/CPE = Meropenem our last good/safe drug doesn't work

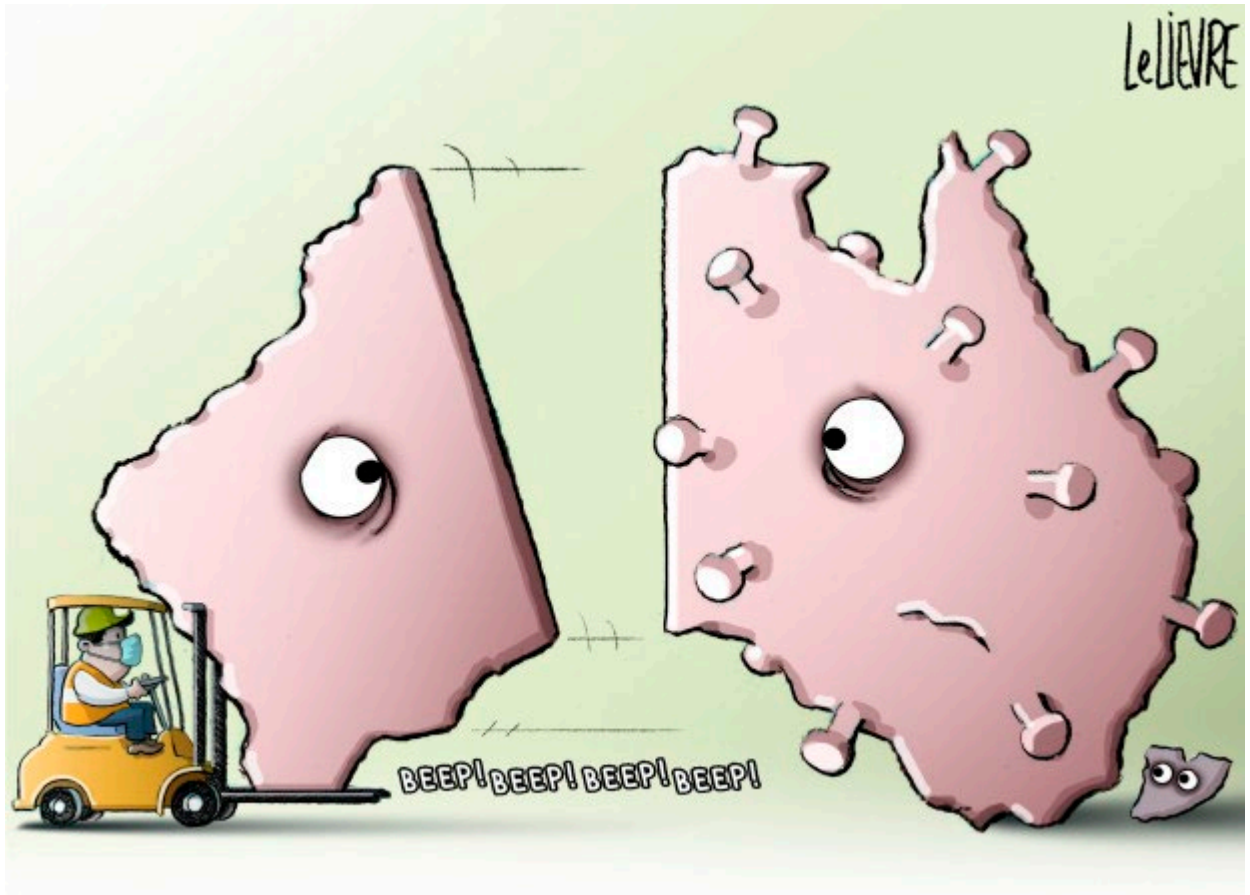
CRE infections associated with much higher rates of adverse harm and treatment failure

Carbapenems – meropenem and ertapenem

Carbapenem usage increased nationally by 16.2% between 2015 and 2019 (Table 1); usage increased by 4.5% between 2018 and 2019, driven by a 31.9% increase in Tasmania. Figure 14 shows the usage of meropenem and ertapenem between 2015 and 2019. Imipenem–cilastatin and doripenem are rarely used, and have not been included in the figure below.

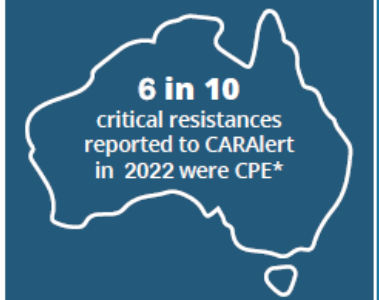
Figure 14: **Carbapenem usage rates (DDD/1,000 OBD) in NAUSP contributor hospitals, by state and territory, 2015–2019 (3-month moving average)**

DDD = defined daily dose; NAUSP = National Antimicrobial Utilisation Surveillance Program; OBD = occupied bed day


LeLIEVRE
BEEP! BEEP! BEEP! BEEP!


JUST LOOK AT THEM, JOSH...
LOCKED DOWN IN THEIR CAVE!
GOSINO

Key facts for healthcare workers about carbapenemase-producing *Enterobacterales* (CPE)



6 in 10
critical resistances reported to CARAlert in 2022 were CPE*

CPE are resistant to 'last resort' antimicrobials available for treating serious infections

CPE can cause up to

40%
mortality

Risk factors for CPE infection

Recent gastroenterology procedure

Recent intensive care admission

Recent prolonged hospitalisation

Overseas medical treatment

Inapropriate use of antimicrobials

Weakened immunity

Indwelling medical device

Prevent the spread of CPE in your hospital

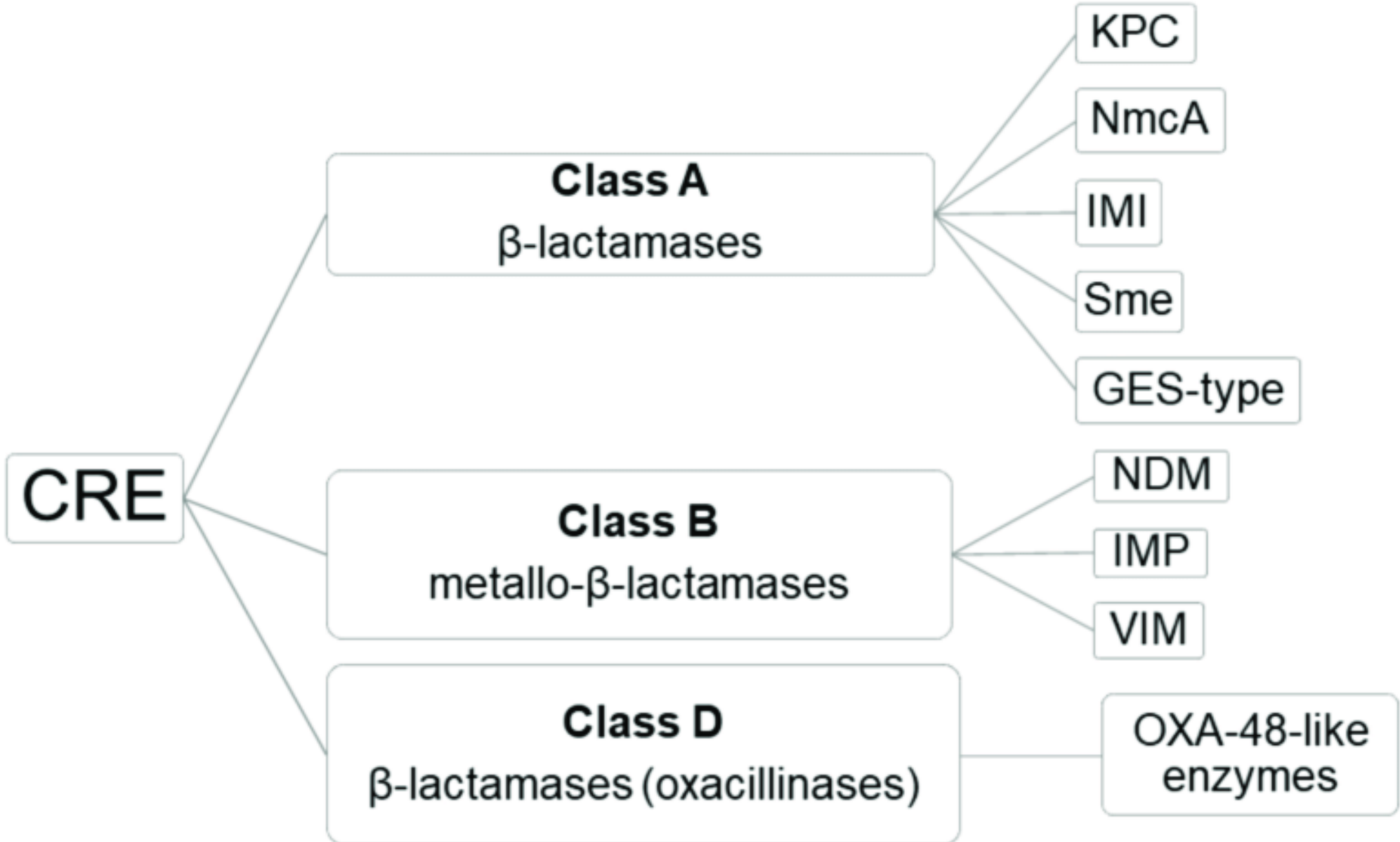
Regularly screen high-risk patients for CPE

Use standard and contact precautions when caring for a patient with CPE

AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

* For more information about CPE, refer to the National Alert System for Critical Antimicrobial Resistance (CARAlert) and the Recommendations for the control of CPE - A guide for acute care health facilities or contact HAI@safetyandquality.gov.au.

For information on CPE and Antimicrobial resistance, refer to safetyandquality.gov.au/AURA2023.


CRE
Class A
β-lactamases
KPC
NmcA
IMI
Sme
GES-type
Class B
metallo-β-lactamases
NDM
IMP
VIM
Class D
β-lactamases (oxacillinases)
OXA-48-like enzymes

Drugs that Don’t Work

- Tazocin
- Ceftriaxone
- Augmentin
- Cefepime
- Meropenem
- Ceftriaxone
- Amoxycillin
- Commonly Ciprofloxacin, occasionally Aminoglycosides and others

Optimized treatment for CRE

Empiric treatment

Risk factors

- Known colonisation or prior infection (or roomate infected) by Enterobacteriaceae strain producing KPC or OXA-48≠

OR

- Local epidemiology (or recent hospitalization in settings) with more than 20-25% prevalence of carbapenem-producing and ESBL-producing Enterobacteriaceae

PLUS any of the following:

- Prior use of carbapenems and/or colistin
- ICU admission or long admission in hospital wards
- Severe hospital-acquired infection (bacteremia, septic shock)
- Immunossuppression, multiple comorbidities

Definitive treatment

Microbiology results

- Identification,
- Susceptibility testing
- Detection of resistance mechanisms

[KPC, OXA, MBL (NDM, VIM, etc), double mechanisms]

- Determination of MICs for: carbapenems, colistin, fosfomycin, aminoglycosides and all new antibiotics (CAZ/AVI, MER/VAB, plazomicin, etc)

Combination* regimen (double or triple) to increase probability of adequate initial		**Monotherapy or combination treatment based on patient's, pathogen's and antibiotic's parameters** (Figure 1)		
CAZ/AVI or MER/VAB based combination*	**Colistin based combination* (double or triple)**	**Monotherapy** (prerequisites in Figure 1)	**CAZ/AVI ^ or MER/VAB^ based combination***	**Colistin based combination* (double or triple) For MBL, and KPC or OXA resistant to CAZ/AVI, MER/VAB**
Gentamicin or other aminoglycoside Fosfomycin Colistin Tigecycline	Carbapenem (if epidemiological data witness MICs ≤16 mg/L) Gentamicin or other aminoglycoside Fosfomycin Tigecycline	CAZ/AVI MER/VAB Colistin Aminoglycoside	Gentamicin or other aminoglycoside Fosfomycin Colistin Tigecycline	Carbapenem (subject to MIC ≤16 mg/L)^Δ^ Gentamicin or other aminoglycoside Fosfomycin Tigecycline Double carbapenem

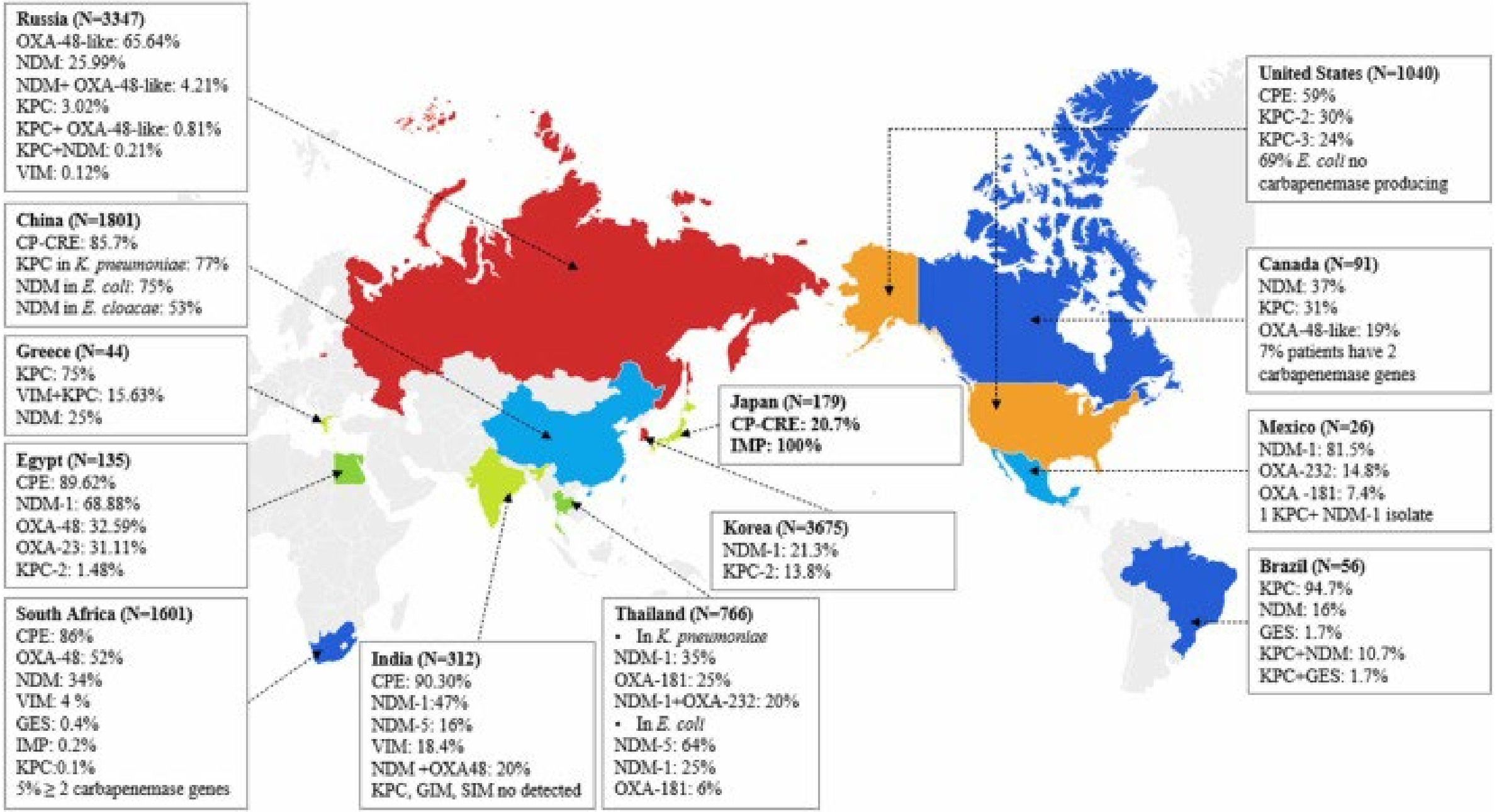
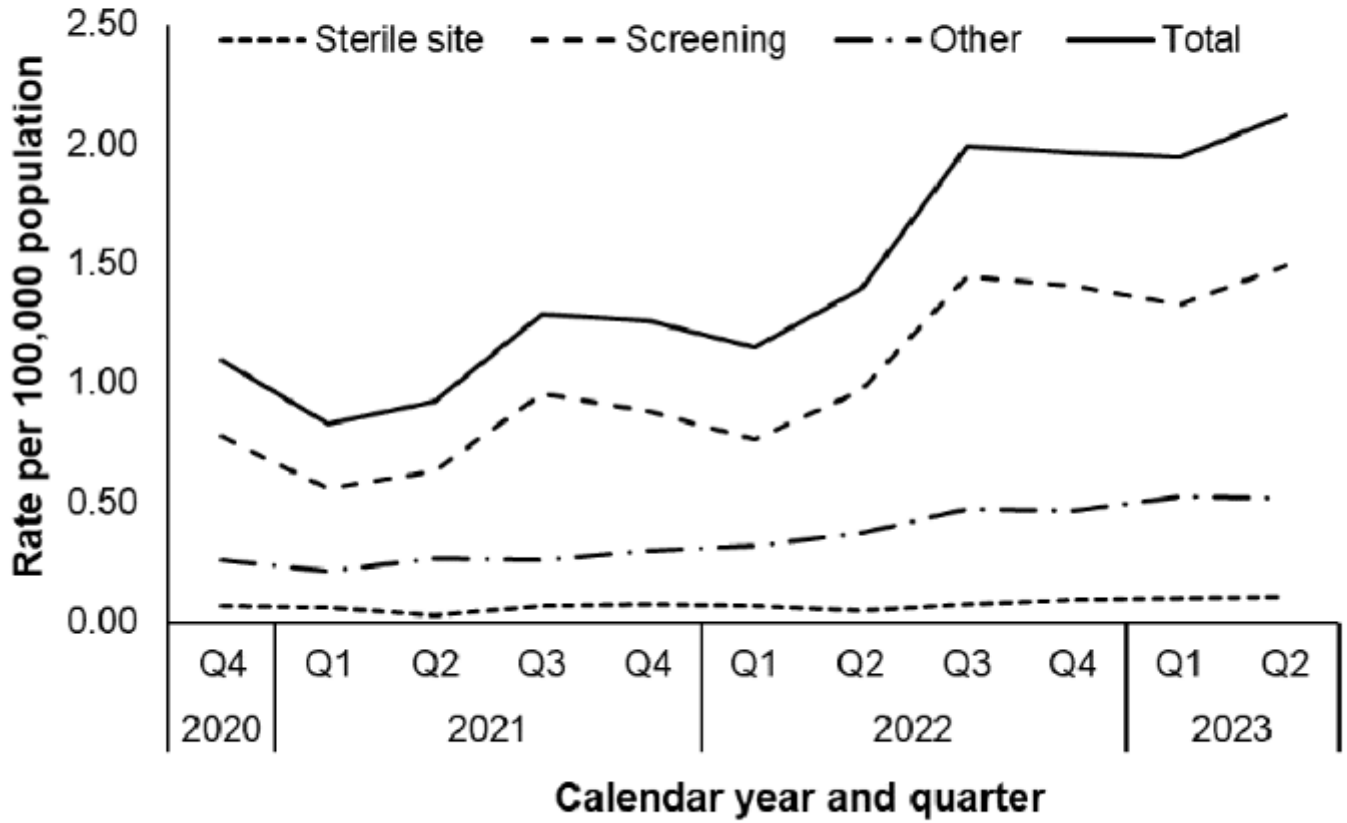
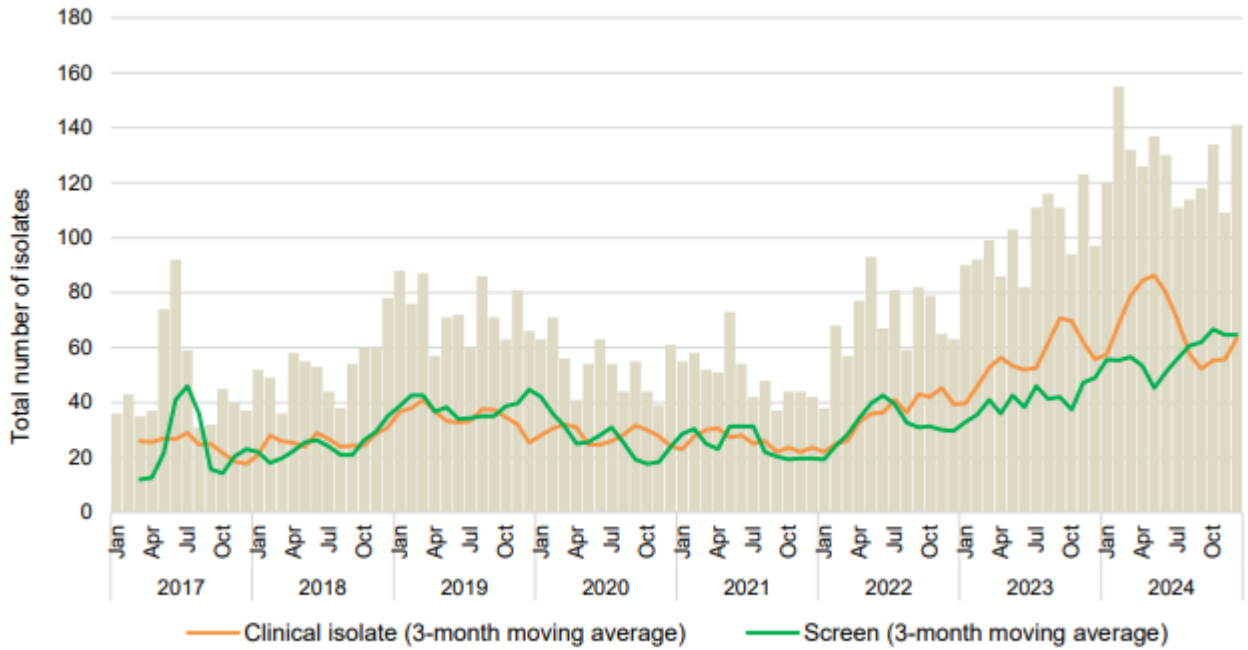

Russia (N=3347)
OXA-48-like: 65.64%
NDM: 25.99%
NDM+ OXA-48-like: 4.21%
KPC: 3.02%
KPC+ OXA-48-like: 0.81%
KPC+NDM: 0.21%
VIM: 0.12%
China (N=1801)
CP-CRE: 85.7%
KPC in *K. pneumoniae*: 77%
NDM in *E. coli*: 75%
NDM in *E. cloacae*: 53%
Greece (N=44)
KPC: 75%
VIM+KPC: 15.63%
NDM: 25%
Egypt (N=135)
CPE: 89.62%
NDM-1: 68.88%
OXA-48: 32.59%
OXA-23: 31.11%
KPC-2: 1.48%
South Africa (N=1601)
CPE: 86%
OXA-48: 52%
NDM: 34%
VIM: 4 %
GES: 0.4%
IMP: 0.2%
KPC:0.1%
5% ≥ 2 carbapenemase genes
India (N=312)
CPE: 90.30%
NDM-1:47%
NDM-5: 16%
VIM: 18.4%
NDM +OXA48: 20%
KPC, GIM, SIM no detected
Thailand (N=766)
• In *K. pneumoniae*
NDM-1: 35%
OXA-181: 25%
NDM-1+OXA-232: 20%
• In *E. coli*
NDM-5: 64%
NDM-1: 25%
OXA-181: 6%
Korea (N=3675)
NDM-1: 21.3%
KPC-2: 13.8%
Japan (N=179)
CP-CRE: 20.7%
IMP: 100%
United States (N=1040)
CPE: 59%
KPC-2: 30%
KPC-3: 24%
69% *E. coli* no carbapenemase producing
Canada (N=91)
NDM: 37%
KPC: 31%
OXA-48-like: 19%
7% patients have 2 carbapenemase genes
Mexico (N=26)
NDM-1: 81.5%
OXA-232: 14.8%
OXA -181: 7.4%
1 KPC+ NDM-1 isolate
Brazil (N=56)
KPC: 94.7%
NDM: 16%
GES: 1.7%
KPC+NDM: 10.7%
KPC+GES: 1.7%

Figure 1. Rate of acquired carbapenemase-producing Gram-negative bacteria episodes by specimen type and quarter (England): October 2020 to September 2023



National data

Figure 7: Carbapenemase-producing *Enterobacterales*, number reported to CARAlert by month and specimen type, national, 2017–2024



Note: Carbapenemase-producing *Enterobacterales*, includes those co-producing ribosomal methyltransferase and/or transmissible colistin resistance.

Conclusion

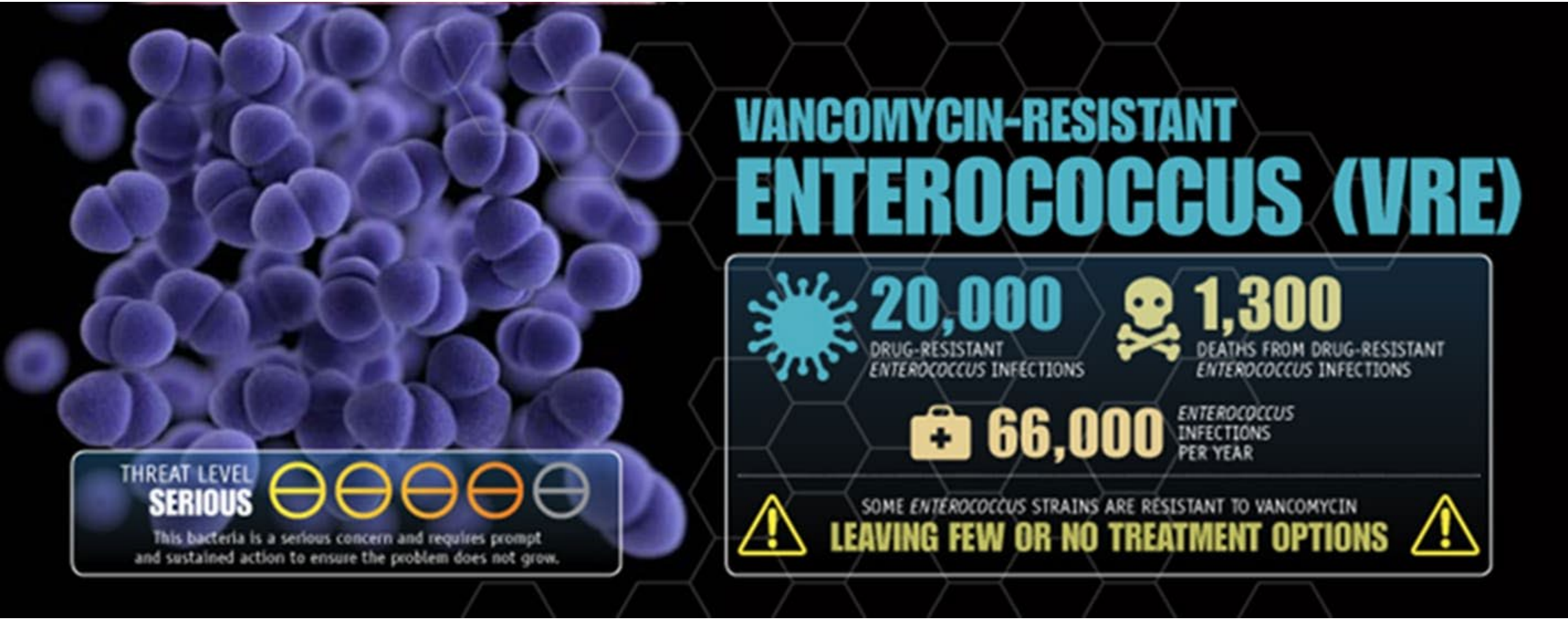
- Increased costs
- Increased length of stay
- Increased mortality
- Increased use of new or novel antimicrobial therapies
- Increased requirement for surgical interventions
- Increased phone calls
- Increased screening

ESBLs

- Extended spectrum beta-lactamase producers (coliforms)
- Defined by resistance to 3rd Generation Cephalosporins – but R's hunt in packs
- Frequently no affordable appropriate oral antibiotic options for common infections like UTIs
- Much higher frequency in patients from South East Asia or recent travellers is about 70%
- About 20-30% of all Coliforms clinical isolates tested in laboratory

ESBLs

- Increased admission to hospital
- Increased length of stay
- Increased mortality
- Increased phone calls


VANCOMYCIN-RESISTANT
ENTEROCOCCUS (VRE)
20,000
DRUG-RESISTANT
ENTEROCOCCUS INFECTIONS
1,300
DEATHS FROM DRUG-RESISTANT
ENTEROCOCCUS INFECTIONS
66,000
ENTEROCOCCUS
INFECTIONS
PER YEAR
SOME ENTEROCOCCUS STRAINS ARE RESISTANT TO VANCOMYCIN
LEAVING FEW OR NO TREATMENT OPTIONS
THREAT LEVEL
SERIOUS
This bacteria is a serious concern and requires prompt
and sustained action to ensure the problem does not grow.

- Generally, hospital acquired
- Most often associated with multi-bedded rooms, shared bathrooms and prolonged admission post surgery or critical care
- Associated with broad spectrum antibiotics

Am. J. Trop. Med. Hyg., 104(3), 2021, pp. 1131–1136
doi:10.4269/ajtmh.20-0842

Correlation between Nosocomial Carriage of Vancomycin-Resistant Enterococci and Antimicrobial Use in Taiwan

Mei-Chun Lee,[1,2] Chien-Hung Lu,[1] Wei-Ying Lee,[1] and Chun-Ming Lee[2,3,4,5]*

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Abstract. A rapid increase of nosocomial vancomycin-resistant enterococci (VRE) from 23.3% in 2009 to 44.5% in 2018 among all the medical centers in Taiwan was found. The aim of the study was to explore the relationship between antimicrobial usage and prevalence of VRE. We conducted the study between January 2010 and December 2019 in a tertiary teaching hospital in Taiwan. Antibiotic consumption was expressed as defined daily doses (DDDs) per 1,000 patient-days (PDs). The trend in antibiotic consumption and VRE prevalence were analyzed by regression analysis with yearly data. Pearson's correlation analysis was used to determine the relationship between antibiotic consumption and the prevalence of VRE. The total consumption of antibiotics increased significantly from 450.6 DDDs/1,000 PDs in 2010 to 520.1 DDDs/1,000 PDs in 2019 ($P = 0.013$). Positive correlations were found between the prevalence of vancomycin-resistant *Enterococcus faecium* and the consumption of amoxicillin/clavulanate, vancomycin, and carbapenems, which included meropenem ($P < 0.05$). The increase in total VRE prevalence was significantly correlated with increased consumption of vancomycin and carbapenems, which included meropenem ($P < 0.05$). This 10-year study in a hospital demonstrated changes in antimicrobial use, which may have affected VRE prevalence in the hospital. We found a rise in nosocomial VRE prevalence was associated with the use of specific antimicrobial agents.

MacKenzie *et al. BMC Infectious Diseases* (2023) 23:274
https://doi.org/10.1186/s12879-023-08238-4

BMC Infectious Diseases

RESEARCH **Open Access**

Previous antibiotic therapy as independent risk factor for the presence of vancomycin-resistant enterococci in surgical inpatients. Results from a matched case-control study

Philip MacKenzie[1], Jacqueline Färber[1], Marius Post[1], Torben Esser[1], Lukas Bechmann[1], Siegfried Kropf[2], Roland Croner[3] and Gernot Geginat[1,4*]

Abstract

Background Investigation of risk factors for the presence of vancomycin-resistant enterococci (VRE) in inpatients on surgical wards and associated intensive care units of a German tertiary care hospital.

Methods A single-centre retrospective matched case-control study was performed with surgical inpatients admitted between July 2013 and December 2016. Patients with in-hospital detection of VRE later than 48 h after admission were included and comprised 116 VRE-positive cases and 116 VRE-negative matched controls. VRE isolates of cases were typed by multi-locus sequence typing.

Results ST117 was identified as the dominant VRE sequence type. Next to length of stay in hospital or on an intensive care unit and previous dialysis the case-control study revealed previous antibiotic therapy as a risk factor for the in-hospital detection of VRE. The antibiotics piperacillin/tazobactam, meropenem, and vancomycin were associated with the highest risks. After taking into account length of stay in hospital as possible confounder other potential contact-related risk factors such as previous sonography, radiology, central venous catheter, and endoscopy were not significant.

Conclusions Previous dialysis and previous antibiotic therapy were identified as independent risk factors for the presence of VRE in surgical inpatients.

Keywords Vancomycin-resistant enterococci, Risk-factors, Case control study, Surgical patients

- Increased costs
- Increased length of stay
- Increased mortality
- Increased use of new or novel antimicrobial therapies
- Increased requirement for surgical interventions
- Increased phone calls
- Increased screening

Vaccine Hesitancy in Australia: Current Status and Impacts

Image: ChatGPT

Current Status of Vaccine Hesitancy in Australia

- **Childhood vaccination rates falling** – Coverage has dropped for the third year, with rates below 94% at key milestones. (NCIRS, 2024)
- **Parental age linked to hesitancy** – Parents aged 40–60 show more vaccine hesitancy than younger groups. (Harrison et al., 2024, Vaccine)
- **COVID-19 booster uptake remains low** – Only 3.5% of 18–64-year-olds had a booster in the last 6 months. (Roskam, 2024, Spectator Australia)
- **Misinformation driving distrust** – Disinformation and declining trust in health authorities fuel hesitancy. (Sharma et al., 2024, Frontiers in Public Health)
- **Regional differences significant** – Queensland (14.2%) shows highest hesitancy; Victoria the lowest (7.3%). (Melbourne Institute, 2024)
- **Flu vaccine rates also down** – 500,000 fewer flu vaccines administered in 2024 vs 2023. (DISA Australia, 2024)

Likely Impact of Declining Vaccination Rates

- **Preventable disease outbreaks likely** – Risk of measles, pertussis and pneumococcal resurgence. (Creighton, 2024, The Australian)
- **Child health at risk** – Unvaccinated children face preventable illness and complications. (SA Health, 2024, Adelaide Now)
- **Strain on hospitals** – Outbreaks may increase admissions and stress healthcare systems. (Jones, 2024, Daily Telegraph)
- **Herd immunity threatened** – Lower coverage weakens protection for immunocompromised. (Davey, 2024, The Guardian)
- **Economic impact expected** – More outbreaks increase health costs and disrupt productivity. (AIHW & PHAA reports, 2020–2024)
- **Loss of public health gains** – Falling rates risk reversing decades of progress. (Duckett & Stobart, 2024, Grattan Institute)


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GREAT AGAIN
Make AMERICA
GREAT Again

POLITICS | AFRICA

How hard are USAID cuts hitting Africa's healthcare?

Silja Fröhlich
05/11/2025

HIV patients are losing access to medication, while healthcare programs have come to a halt. What impact are the Trump administration's USAID cuts having on healthcare in Africa?

This mother in Uganda has just had her baby vaccinated against malaria, which is one of many programs suffering from cuts in US funding

Image: Hajarah Nalwadda/Getty Images

WHO director details health disruptions from US funding cuts, urges a more humane approach

Lisa Schnirring, March 19, 2025

Topics: HIV/AIDS , Malaria , Tuberculosis , Measles

SHARE

The United States has been extremely generous for many years with its support for global health projects and is well within its rights to set its own priorities and funding levels, but the country has a responsibility to withdraw direct funding in an orderly and humane way that allows countries and groups to find alternative support, the head of the World Health Organization (WHO) said **yesterday at a briefing**.

Foreign, Commonwealth & Development Office / Flickr cc

Comments from WHO Director-General Tedros Adhanom Ghebreyesus, PhD, his most direct to date on the US cuts, come as regional health groups take stock of the impact of the cuts and seek to bolster other alliances and ways to boost domestic spending to address urgent health threats.

Malaria, HIV, TB programs already disrupted

Tedros also said the WHO is already seeing an impact from the Trump administration's freeze on foreign aid and its plans to shutter the US Agency for International Development (USAID), an independent US government agency established in 1961 and tasked with administering foreign aid and developmental assistance.

The CDC at a Crossroads: Budget Cuts, Public Health, and the Growing Threat of Infectious Diseases

March 12, 2025

By Infection Control Today® Editorial Staff

News *Article*

Budget cuts to the CDC threaten disease surveillance, outbreak response, and public health programs, increasing risks from measles, avian flu, and future pandemics while straining health care infrastructure nationwide.

The CDC has historically been the backbone of US public health, delivering essential resources, guidance, and disease surveillance to state and local health departments. However, as the agency faces workforce reductions and funding cuts, public health experts warn about the unsettling future of infectious disease preparedness, response efforts, and access to vital health care programs. The consequences of these changes could be catastrophic, jeopardizing our safeguards against outbreaks and public health crises.

CDC

- ***Healthcare Infection Control Practices Advisory Committee (HICPAC):*** The CDC's key infection control advisory body was abruptly terminated. (ICEG/AHPPC/ACSQHC equivalent)
- ***Budget Cuts:*** A proposed $3.6 billion (USD) reduction to the Centers for Disease Control and Prevention (CDC) budget affected infectious disease programs and emergency preparedness.
- ***Staff Layoffs:*** Approximately 1,300 CDC employees were laid off, including officers from the Epidemic Intelligence Service (EIS), a frontline public health rapid-response program.
- ***Communication Halt:*** Publication of the Morbidity and Mortality Weekly Report (MMWR), a major CDC epidemiological bulletin, was suspended.
- ***Data Censorship:*** Public datasets related to HIV, sexually transmitted infections (STIs), and infection control were removed; CDC researchers were restricted from using terms like "LGBT," "transgender," and "gender" in publications.

Impact of USAID Cuts on Global Infection Control (2025):

- **HIV/AIDS Programs**: PEPFAR cuts halted treatment for millions, risking resurgence in sub-Saharan Africa.
- **Tuberculosis**: TB control efforts in high-burden countries, including Western Pacific nations, severely reduced.
- **Malaria**: Termination of the President's Malaria Initiative disrupted control in PNG and Solomon Islands near Australia.
- **Vaccines**: Withdrawal from Gavi hindered immunisation efforts, increasing outbreak risk in travel-linked countries.
- **Health Infrastructure**: Clinics closed, staff furloughed in 50+ countries, reducing disease surveillance capacity.

Risks to Australia:

- **Increased importation** of TB, HIV, malaria from neighbouring regions.
- **Weakened regional systems** may strain Australia's health and border control.
- **Reduced global disease surveillance** undermines early warning and response.

Candida auris – Key Points

- **Hardy & Persistent**: Survives on surfaces for weeks; ***forms biofilms***.
- **Disinfection Resistance**:
  - **Ineffective**: Chlorhexidine, QACs
  - **Effective**: Bleach (≥1000 ppm), hydrogen peroxide, peracetic acid, UV-C
- **Drug Resistance**:
  - Fluconazole (~90%), amphotericin B (~30–40%), some echinocandin resistance
- **Mortality**: Attributable mortality **30–60%**, higher in critically ill.
- **Transmission**: Spreads easily in healthcare settings.
- **Control**: Requires strict contact precautions and targeted cleaning

Candida auris Decolonisation – Evidence Summary

- Chlorhexidine washes reduce skin burden but do not eradicate colonisation → Jeffery-Smith et al., 2018; Clin Microbiol Rev
- Topical antifungals (e.g. clotrimazole, nystatin) have limited, anecdotal use → Mainly for mucosal or localized colonisation
- Systemic antifungals are not effective for decolonisation → Reserved for treatment of active infections
- Environmental cleaning with hydrogen peroxide (ineffective against biofilms) or bleach-based agents is essential → Kean et al., 2018; mSphere
- Persistent colonisation is common; patients may remain colonised for months → Schelenz et al., 2016; ARIC

No validated decolonisation protocol; infection prevention bundles remain standard

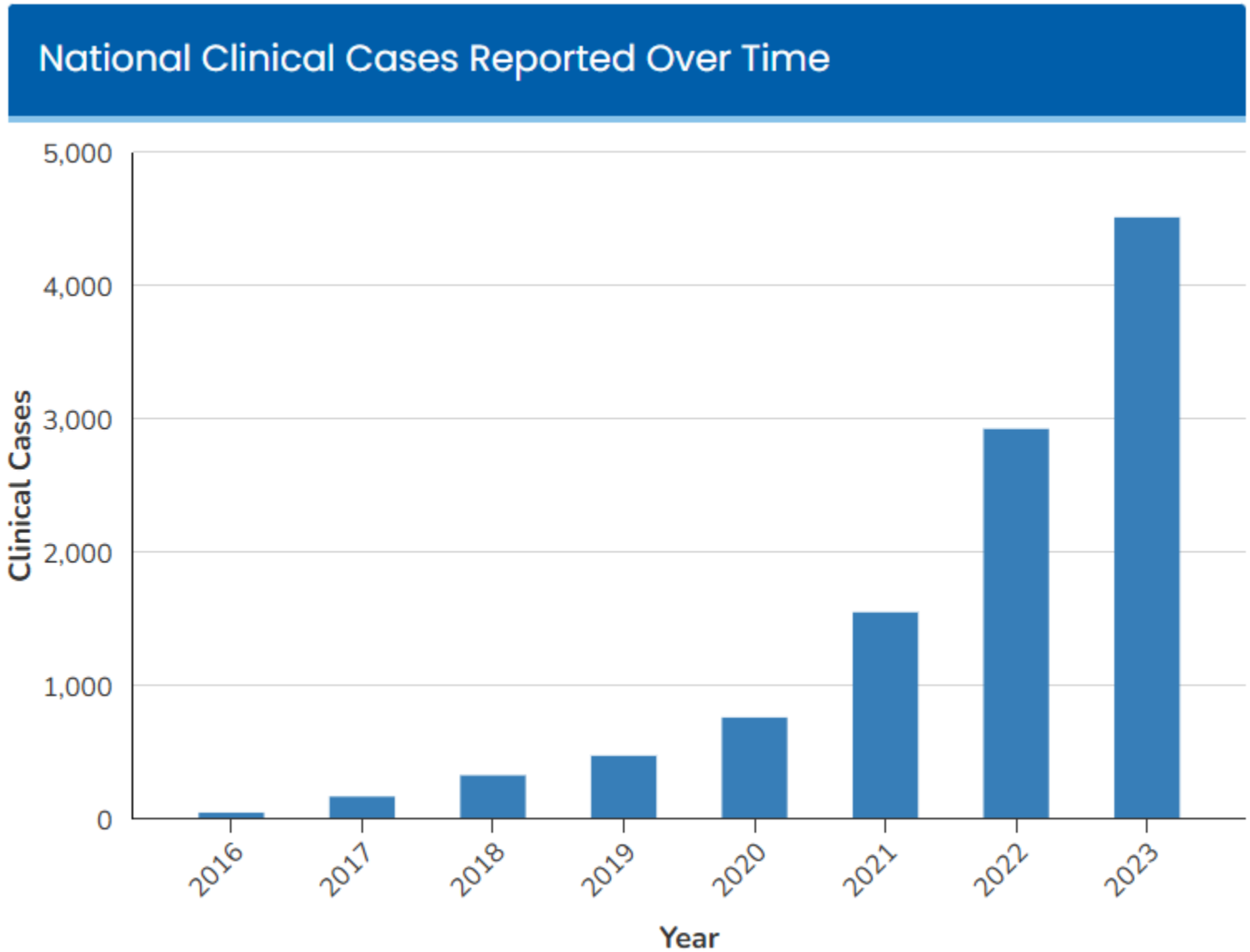
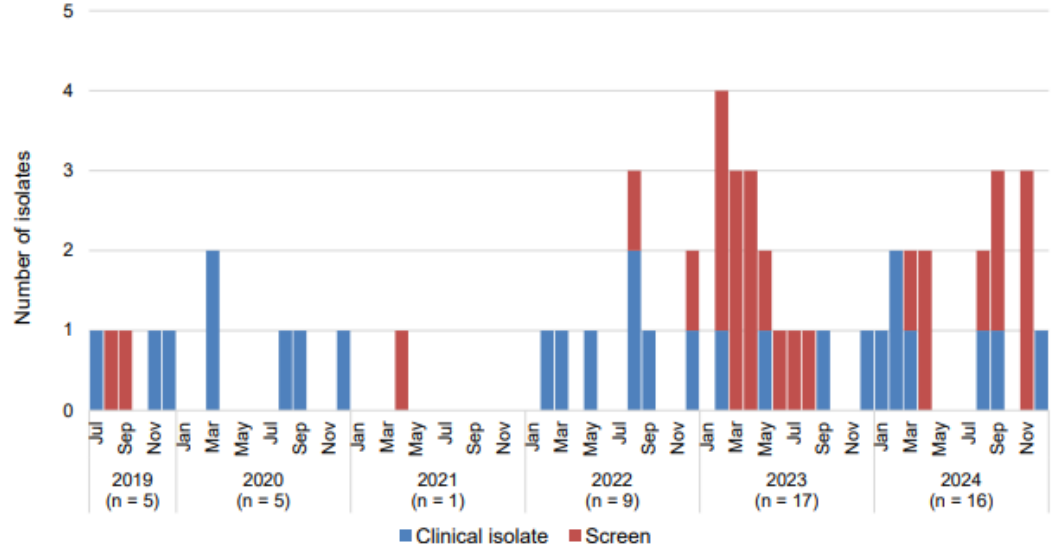
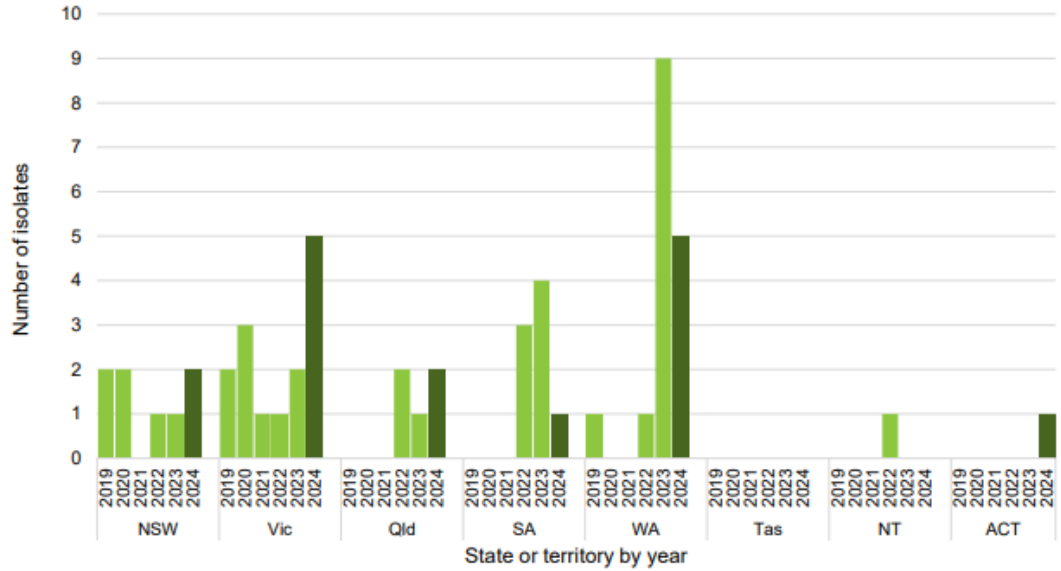

National Clinical Cases Reported Over Time
5,000
4,000
3,000
2,000
1,000
0
Clinical Cases
2016
2017
2018
2019
2020
2021
2022
2023
Year

Figure 5: *Candida auris,* number reported to CARAlert by month, national, 2019–2024



Note: Reported from July 2019.

Figure 6: *Candida auris*, number reported to CARAlert by state and territory, 2019–2024

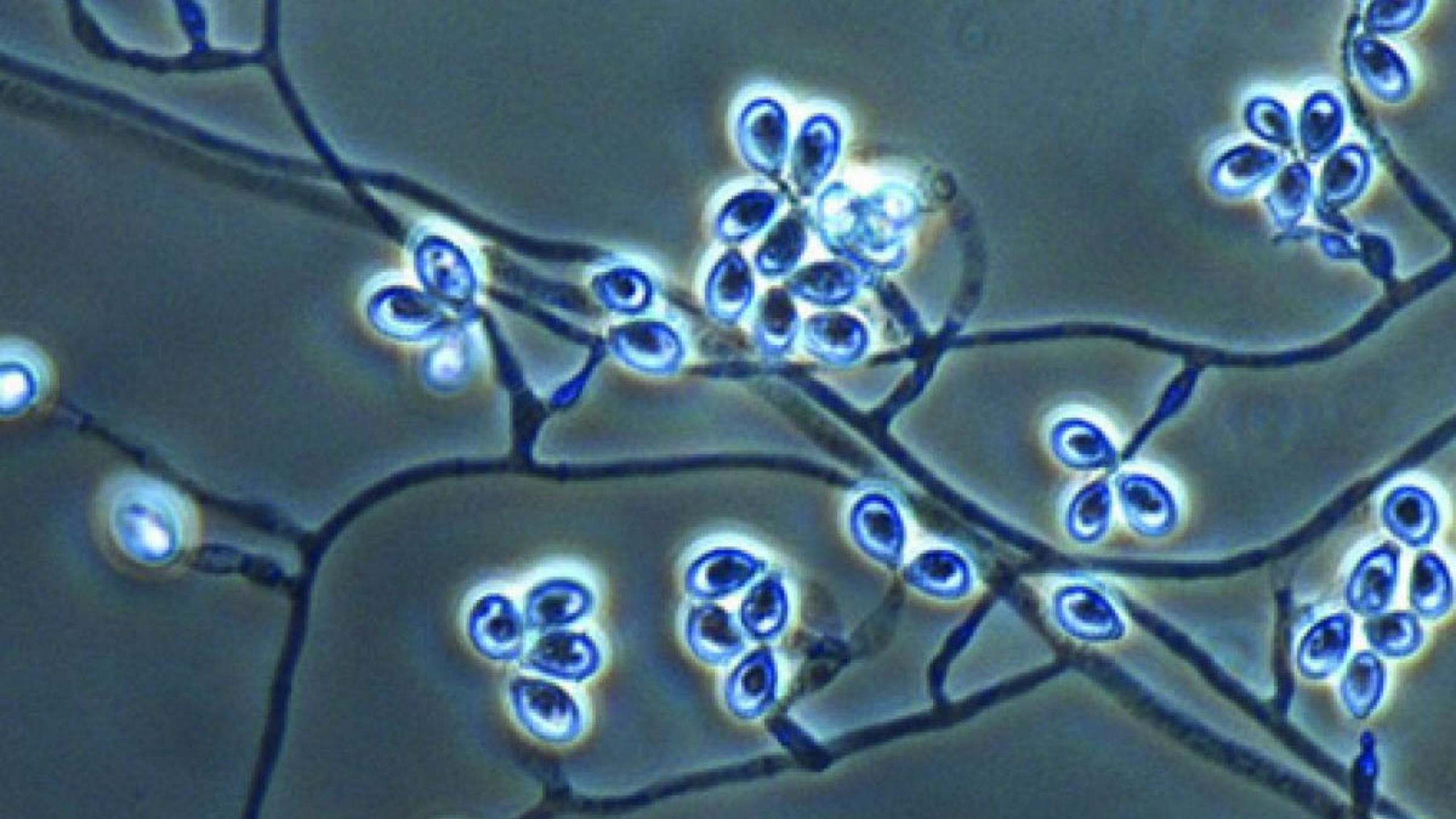


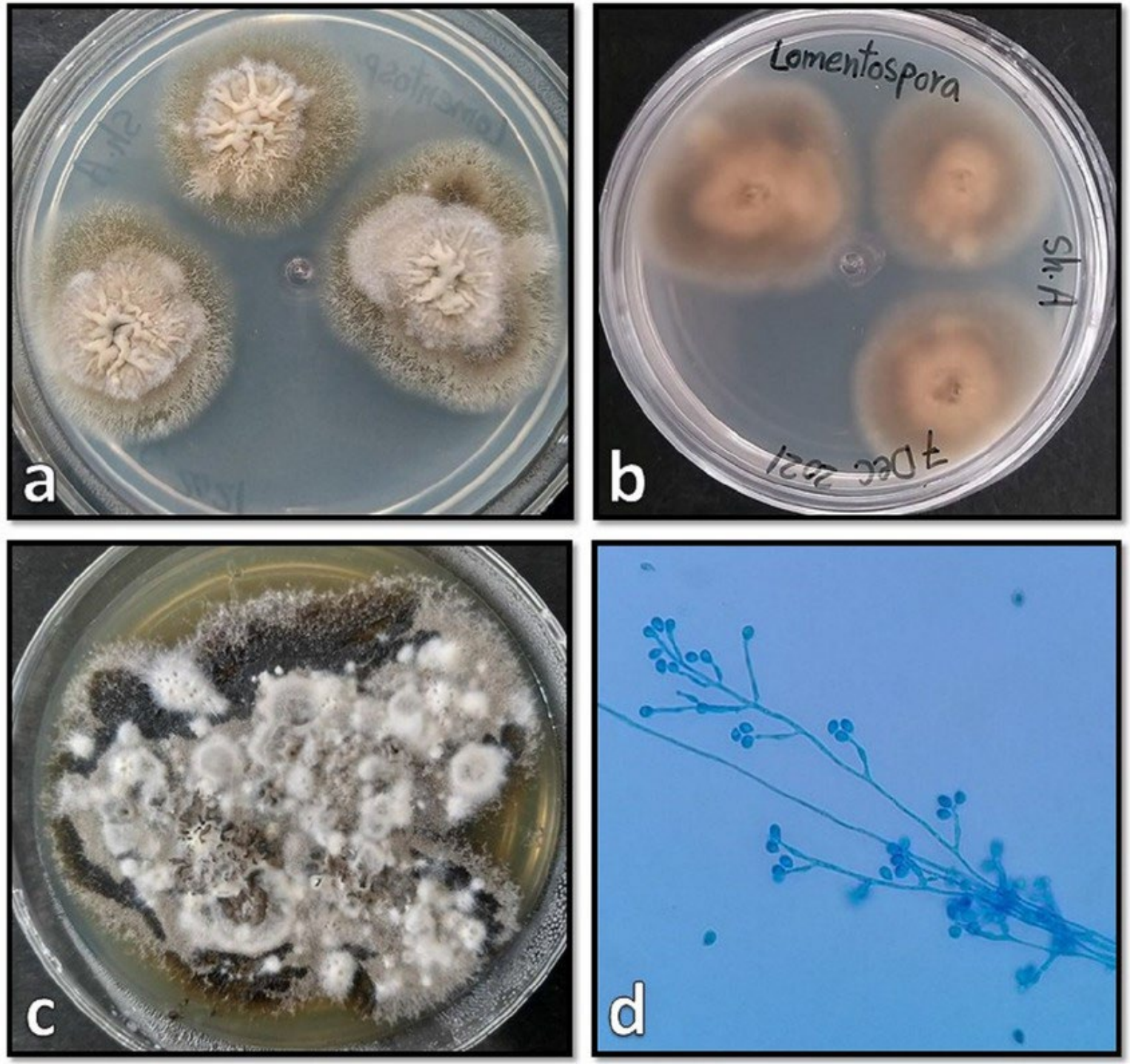
Notes:
1. Reported from July 2019.
2. Dark bars indicate values for 2024.

Agricultural Antimicrobials

Olorofim: Agriculture

- **New Antifungal Class**: First-in-class *orotomide* antifungal that inhibits fungal **dihydroorotate dehydrogenase (DHODH)**, a unique target not shared with existing antifungals.
- **Potent Against Resistant Moulds**: Active against **Lomentospora prolificans**, **Scedosporium spp.**, and **azole-resistant Aspergillus** — fungi with limited or no effective treatments.
- **High Clinical Need**: Shows promising results in **refractory or invasive mould infections**, with response rates around **50–60%** in early clinical trials for *Lomentospora*, where historical mortality exceeds 90%.





- Mycology Online

Call for concern over the use of the new agricultural fungicide, ipflufenoquin, in Australia.

3 JUNE, 2024

The Australia and New Zealand Mycoses Interest Group (ANZMIG), of the Australasian Society for Infectious Diseases (ASID), is advocating for a One Health approach to address significant concerns regarding the use of the new agricultural fungicide compound – ipflufenoquin - in Australia.

To this end, it seeks dialogue with the Australian Pesticides and Veterinary Medicines Authority (APVMA).

1. Use of ipflufenoquin in Australia

• ANZMIG notes the APVMA's approval and recent, restricted, registration of the fungicide, ipflufenoquin, to protect strawberry crops against fungal diseases.

• In particular, ipflufenoquin is designed to target *Botrytis cinerea*, a plant fungal pathogen that causes plant rot in crops including grapes, strawberries, and tomatoes. *B. cinerea* is notable for its propensity to develop resistance by multiple mechanisms upon exposure to fungicides.

> "Ipflufenoquin has a similar structure and mode of action to the novel antifungal drug, olorofim, a new medication specifically developed for human use. Olorofim is a critical addition to the antifungal armamentarium because in 2024, there are no other effective antifungal treatments for a number of highly resistant fungal infections. In this context, the demonstration of ipflufenoquin-induced cross-resistance to olorofim in fungal pathogens is very concerning."

Examples of Cross Resistance

Class	**Agent Used in Animals/Plants**	**Human Equivalent**	**Cross-Resistance Mechanism**	**Outcome**
Antibiotic	Enrofloxacin (poultry)	Ciprofloxacin	gyrA/parC mutations	Resistant *Campylobacter*
Antibiotic	Colistin (livestock)	Colistin	**mcr-1** plasmid	Resistance in *E. coli*, *Klebsiella*
Antifungal	Tebuconazole (crops)	Voriconazole	**CYP51A** mutations	Resistant *Aspergillus fumigatus*
Antibiotic	Tetracycline (feed)	Doxycycline	**tet** genes	MDR *E. coli*, *Salmonella*
Biocide	Triclosan	—	Efflux pump upregulation	Multidrug resistance in gram-negatives

Conclusion

- Thanks to Gama
- Thanks to Ramsay/JHC, PathWest and WDP
- Acknowledgment mycology online, CDC, public health England, CARAlert