Multi-Drug Resistant Organisms

Common Organisms in Nursing Facilities

Updated April 2024

CARILION CLINIC

This presentation is produced and presented by Carilion Clinic through the Virginia Long-Term Care Infrastructure Pilot Project (VLIPP)

Carilion VLIPP (2022-2024) is funded by the Virginia Department of Health to support long-term care facilities in Southwest Virginia with their infection prevention and control programs.

Disclaimer

- For educational purposes only
- No endorsement of products, software, or tools

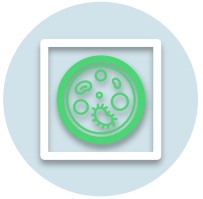
Audience

Infection Preventionist

Clinical Staff

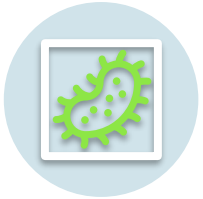
Objectives

Identify ways to prevent & manage the spread of drug resistant organisms



Explain the differences of ESBL and CRE drug resistant organisms

Describe the mode of transmission of common multidrug resistant organisms in long-term care facilities



Describe the characteristics of common multidrug resistant organisms

Identify diseases caused by multidrug resistant organisms in long-term care

Apply infection control principals to the management of multidrug resistant organisms

Introduction

- Multi-drug resistant organism (MDRO)
  - An organism (bacteria or fungus) that develops the ability to defeat the drugs (antibiotic or antifungal) designed to kill them

- CDC Estimates (2019)
  - More than 2.8 million drug-resistant infections annually
  - More than 35,000 deaths due to MDRO infections

- Studies by McKinnell et al., (2020), and Gontjes et al., (2022)
  - Estimated 50-60% of residents in nursing homes are colonized with an MDRO
  - Estimated half to three-quarter of rooms are contaminated with an MDRO
    - Associated with overprescription of antimicrobials

CDC (2022, October 5) Antimicrobial Resistance: About Antimicrobial Resistance. Retrieved from: https://www.cdc.gov/drugresistance/about.html

Gontjes, K. J., et al. (2022, February 1) Association of Exposure to High-risk Antibiotics in Acute Care Hospitals With Multidrug-Resistant Organism Burden in Nursing Homes. Retrieved from: https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2788560?resultClick=1

McKinnell, J. A., et al. (2020, June 16) High Prevalence of Multidrug-Resistant Organism Colonization in 28 Nursing Homes: An "Iceberg Effect". Retrieved from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7708431/

Methicillin-resistant Staphylococcus aureus

CARILION CLINIC

Methicillin-resistant Staphylococcus aureus

What is it?

- Gram positive bacteria

Where is it found?

- May be found on the skin
  - Doesn't cause harm until it enters the body
    - Soft tissue infections are the most common type of MRSA infection
- Found in the nose of approximately 30% of the population
- Found in the community and hospitals

CDC (2011, January 17) Healthcare Associated Infections (HAIs): Staphylococcus aureus in Healthcare Settings. Retrieved from: https://www.cdc.gov/hai/organisms/staph.html

Taylor, T. A., Unakal, C. G., (2023, July 17) Staphylococcus aureus Infection. Retrieved from: https://www.ncbi.nlm.nih.gov/books/NBK441868/

Methicillin-resistant Staphylococcus aureus

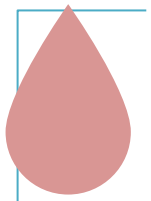
Transmission

- Contact
  - Direct touch of an infected wound
  - Contaminated hands of healthcare workers

CDC (2019, February 28) Methicillin-resistant Staphylococcus aureus (MRSA): Healthcare Settings. Retrieved from: https://www.cdc.gov/mrsa/healthcare/index.html

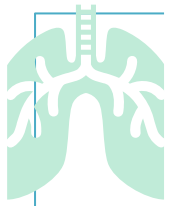
Methicillin-resistant Staphylococcus aureus

What does it cause?



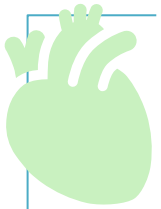
Bacteremia or sepsis

- When in the blood
  - Direct contact (touching wound or inserted device)



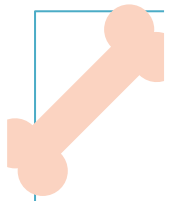
Pneumonia

- Often affecting ventilated residents



Endocarditis

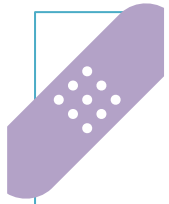
- Infection of the heart valves
  - Leads to heart failure or stroke
- Common among IV drug users



Osteomyelitis

- Bone infection caused by
  - Bacteria in the blood
  - Trauma (puncture, IV drug use)

Surgical Site Infections



Skin & Soft Tissue Infection

- Cellulitis
- Necrotizing fasciitis
- Diabetic foot ulcers

CDC (2011, January 17) Healthcare Associated Infections (HAIs): Staphylococcus aureus in Healthcare Settings. Retrieved from: https://www.cdc.gov/hai/organisms/staph.html

CDC (2019, June 26) Methicillin-resistant Staphylococcus aureus (MRSA). Retrieved from: https://www.cdc.gov/mrsa/community/index.html

Siddiqui, A. H., Koirala, J. (2023, April 2) Methicillin-Resistant Staphylococcus aureus. Retrieved from: https://www.ncbi.nlm.nih.gov/books/NBK482221/

Taylor, T. A., Unakal, C. G., (2023, July 17) Staphylococcus aureus Infection. Retrieved from: https://www.ncbi.nlm.nih.gov/books/NBK441868/

CARILION CLINIC

MRSA – Risk Factors

Communities

- Sharing items (Towels, razors)
- IV drug use

Medical Conditions

- Diabetes
- Cancer
- Cardiovascular disease

Hospitalizations

- Prolonged admissions
- Surgeries
- Medical devices in body
- Exposure to patients with organism

Nursing Facilities

- Medical devices in body
- Uncovered or draining wounds
- Exposure to residents with organism

CDC (2011, January 17) Healthcare Associated Infections (HAIs): Staphylococcus aureus in Healthcare Settings. Retrieved from: https://www.cdc.gov/hai/organisms/staph.html

MRSA Prevention & Management

- Enhanced Barrier Precautions
- Contact Precautions (When Appropriate)
  - Hand Hygiene
  - Wear Appropriate PPE
  - Appropriate handling & disposal of PPE & linen
  - Dedicated equipment
- Appropriate Dressing Changes
  - Contain and cover draining wounds

MRSA Prevention & Management

- Clean and Disinfect Equipment Between Uses/Residents
- Routine Environmental Cleaning & Disinfection
- Monitoring & Surveillance
  - Line List
  - Audits
  - Appropriate reporting to state & federal agencies
- Resident Care Plan Review

Review Questions

Mr. Bond is colonized with MRSA.

Mrs. White has MRSA in a draining wound.

- What is the appropriate precaution for Mr. Bond?
  - Enhanced Barrier Precaution

- What is the appropriate precaution for Mrs. White?
  - Contact Precaution Isolation

Vancomycin-resistant Enterococci

CARILION CLINIC

Vancomycin-resistant Enterococci

Enterococci

- Bacteria commonly found in the intestines and female genital tract
- These bacteria are also found in the environment
  - Soil
  - Water

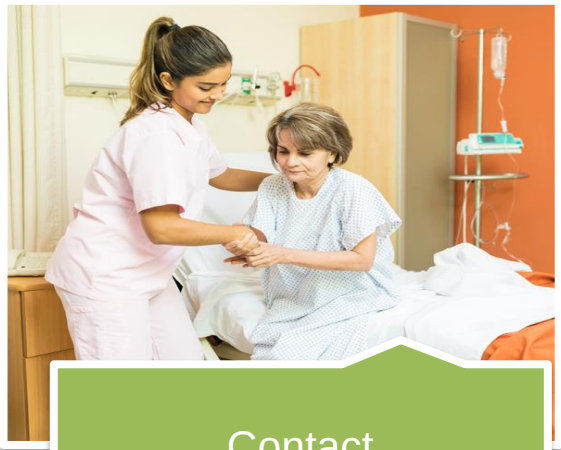
Resistance

- Vancomycin no longer kills the organism

CDC (2019, November 13) Healthcare Associated Infections (HAIs): Vancomycin-resistant Enterococci (VRE) in Healthcare Settings. Retrieved from: https://www.cdc.gov/hai/organisms/vre/vre.html

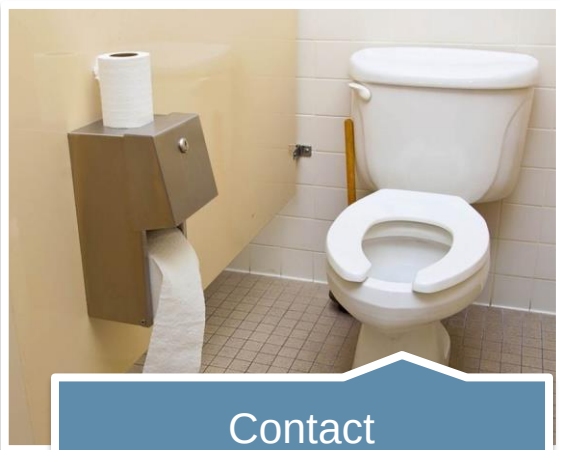
Vancomycin-resistant Enterococci

Transmission



Contact
Person to Person

Contact
Contaminated Equipment



Contact
Contaminated Surfaces/Environment

Contact
Bodily Fluids

CDC (2019, November 13) Healthcare Associated Infections (HAIs): Vancomycin-resistant Enterococci (VRE) in Healthcare Settings. Retrieved from: https://www.cdc.gov/hai/organisms/vre/vre.html

VDH (2018, September) Vancomycin-Resistant Enterococci (VRE) Infection. Retrieved from: https://www.vdh.virginia.gov/epidemiology/epidemiology-fact-sheets/vancomycin-resistant-enterococci-vre-infection/

Vancomycin-resistant Enterococci

Who is at risk?

Anyone with history of, or on current treatment with antibiotics for long periods

Previously hospitalized

Anyone who underwent a surgical procedure

Anyone with inserted devices

Urinary catheter

IV, midlines, central lines

Immunosuppressed / Immunocompromised

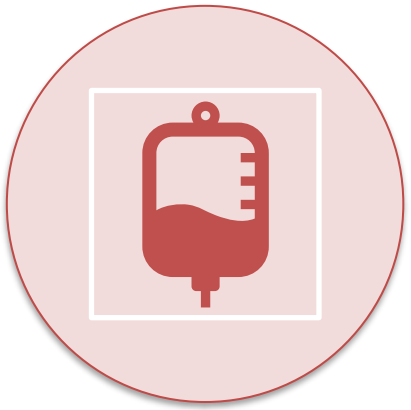
CDC (2019, November 13) Healthcare Associated Infections (HAIs): Vancomycin-resistant Enterococci (VRE) in Healthcare Settings. Retrieved from: https://www.cdc.gov/hai/organisms/vre/vre.html

VDH (2018, September) Vancomycin-Resistant Enterococci (VRE) Infection. Retrieved from: https://www.vdh.virginia.gov/epidemiology/epidemiology-fact-sheets/vancomycin-resistant-enterococci-vre-infection/

CARILION CLINIC

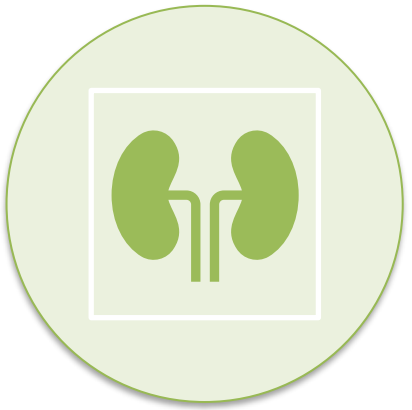
Vancomycin-resistant Enterococci

Common Infections



Bloodstream Infections

Surgical Site Infections



Urinary Tract Infections

CDC (2019) Vancomycin-Resistant Enterococci (VRE). Retrieved from: https://www.cdc.gov/drugresistance/pdf/threats-report/vre-508.pdf

VRE Prevention & Management

- Enhanced Barrier Precautions
- Contact Precautions (When Appropriate)
  - Hand Hygiene
  - Wear Appropriate PPE
  - Appropriate handling & disposal of PPE & linen
  - Dedicated equipment
- Appropriate device care using appropriate infection control techniques
  - Foley Catheter
  - Intravenous Access Management

VRE Prevention & Management

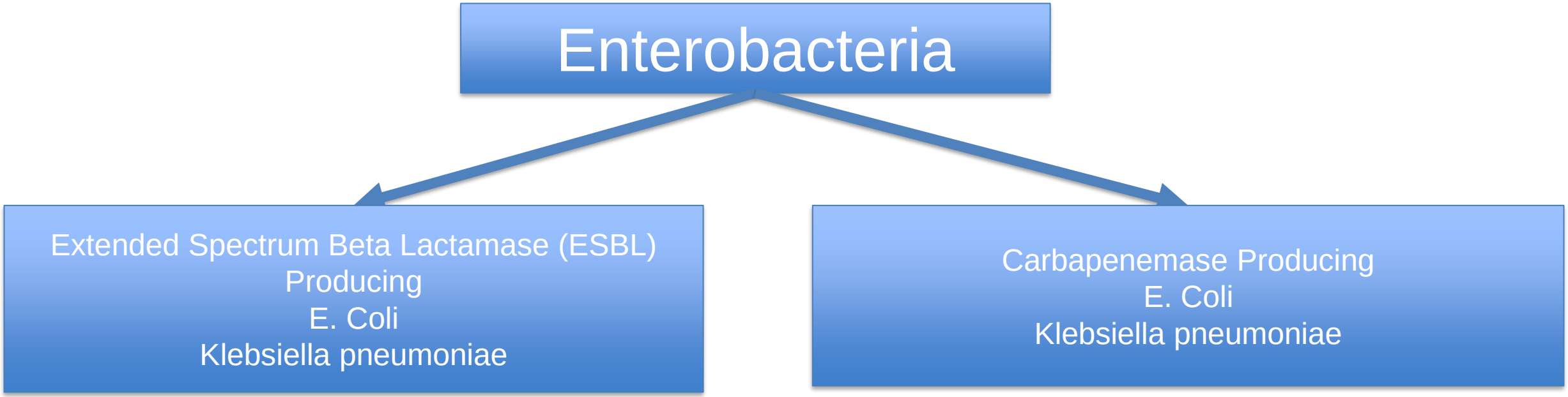
- Clean and Disinfect Equipment Between Residents
- Routine Environmental Cleaning & Disinfection
- Monitoring & Surveillance
  - Line List
  - Audits
  - Appropriate reporting to state & federal agencies
- Resident Care Plan Review
- Place in private room, cohort residents with VRE, or with person with low risk of acquiring VRE

Review Question

You have a new admission with a VRE infection. The only private room is being utilized by a COVID positive resident. Which would be the most appropriate action for the nurse?

A. Cohort with Resident #1, a 96 y/o with history of COPD
B. Cohort with Resident #2: 40 y/o with mental health disorder
C. Cohort with Resident #3: 70 y/o with MRSA & draining wound
D. Cohort with Resident #4: 67 y/o undergoing chemotherapy

Enterobacterales Family



CDC (2019, November 13) Healthcare-Associated Infections (HAIs): Clinicians: Information about CRE. Retrieved from: https://www.cdc.gov/hai/organisms/cre/cre-clinicians.html

CDC (2019, November 22) Healthcare-Associated Infections (HAIs): ESBL-Producing Enterobacterales in Healthcare Settings. Retrieved from: https://www.cdc.gov/hai/organisms/ESBL.html

Extended-spectrum Beta-lactamases

ESBL Producing Organisms

CARILION CLINIC

Extended-spectrum Beta-lactamase Organisms

- Gram negative bacteria
  - Outer membrane protects the cell
  - Can share drug-resistant genes

- Produces enzymes that break down beta-lactam antibiotics
  - Enzymes make the antibiotic ineffective
    - Carbapenem antibiotics last resort for serious infections

CDC (2022, October 5) Antimicrobial Resistance: How Antimicrobial Resistance Happens. Retrieved from: https://www.cdc.gov/drugresistance/about/how-resistance-happens.html

MedicalNewsToday (2017, September 26) What are extended-spectrum beta-lactamases (ESBL)? Retrieved from: https://www.medicalnewstoday.com/articles/319535#transmission

ESBL Organisms

- Location of most ESBL Organisms
  - Gastrointestinal tract

- Transmission
  - Contact with contaminated hands and surfaces

MedicalNewsToday (2017, September 26) What are extended-spectrum beta-lactamases (ESBL)? Retrieved from: https://www.medicalnewstoday.com/articles/319535#transmission

ESBL Organisms

- Escherichia coli (E. coli)
- Klebsiella pneumoniae
- Pseudomonas aeruginosa
- Neisseria gonorrhea
- Haemophilus influenzae
- Klebsiella oxytoca
- Proteus mirabilis
- Salmonella enterica
- Kluyvera species
- Klebsiella aerogenes
- Enterobacter cloacae

MedicalNewsToday (2017, September 26) What are extended-spectrum beta-lactamases (ESBL)? Retrieved from: https://www.medicalnewstoday.com/articles/319535#transmission

ESBL Organisms

- ESBL Organism Infections
  - Urinary Tract Infections
  - Pneumonia
  - Bloodstream
  - Wounds

- Populations at Risk
  - Hospitalized
  - Nursing Home Residents
  - Ventilated
  - Travelers to/from Foreign Countries with high prevalence

CDC (2010, November 24) Healthcare-Associated Infections (HAIs): Klebsiella pneumoniae in Healthcare settings. Retrieved from: https://www.cdc.gov/hai/organisms/klebsiella/klebsiella.html

CDC (2019, November 22) Healthcare-Associated Infections (HAIs): ESBL-Producing Enterobacterales in Healthcare Settings. Retrieved from: https://www.cdc.gov/hai/organisms/ESBL.html

ESBL Prevention & Management

- Enhanced Barrier Precautions
- Contact Precautions (When Appropriate)
  - Hand Hygiene
  - Wear Appropriate PPE
  - Appropriate handling & disposal of PPE & linen
  - Cohort residents with same organism
  - Dedicated equipment
- Appropriate device care using appropriate infection control techniques
  - Foley Catheter
  - Intravenous Access Management

ESBL Prevention & Management

- Appropriate Dressing Changes
  - Contain and cover draining wounds
- Clean and Disinfect Equipment Between Uses/Residents
- Routine Environmental Cleaning & Disinfection
- Monitoring & Surveillance
  - Line List
  - Audits
  - Appropriate reporting to state & federal agencies
- Resident Care Plan Review

Review Question

A resident has a UTI and is positive for ESBL E. coli. Which statement by the staff requires further education?

Statement

A: “I would perform hand hygiene before attending to the resident”

B: “The resident should not be isolated in their room”

C: “I would allow the resident to participate in group activities”

D: “The resident would not have to be placed on enhanced barrier precaution”

Carbapenem-resistant Enterobacterales

CARILION CLINIC

Carbapenem-Resistant Enterobacteriaceae (CRE)

- Carbapenem-Resistant
  - CRE
  - The bacteria is resistant to at least one carbapenem antibiotic

- Carbapenem-Producing
  - CP-CRE
  - Bacteria produces an enzyme, carbapenemase, that deactivates carbapenem as well as beta-lactam antibiotics
  - Enterobacterales can transmit genetic information to other bacteria, spreading resistance

CDC (2019, November 13) Healthcare-Associated Infections (HAIs): Clinicians: Information about CRE. Retrieved from: https://www.cdc.gov/hai/organisms/cre/cre-clinicians.html

Carbapenem-Resistant Enterobacteriaceae (CRE)

- Enterobacterales
  - Bacteria in the intestines
- Gram-Negative Bacteria
- Carbapenems
  - Last resort antibiotics
  - Resistant organisms difficult to impossible to treat
- Common HAI Enterobacterals
  - Klebsiella pneumoniae
  - Escherichia coli (E. coli)

CDC (n.d.) CRE Information for Facilities. Retrieved from: https://www.cdc.gov/hai/pdfs/cre/CRE-handout-V7-508.pdf

Carbapenem-Resistant Enterobacteriaceae (CRE)

Who is at risk?

- Nursing Home Residents
- Hospitalized patients
- Immunocompromised
- Exposure to antibiotics

- Inserted Devices
  - Tracheostomy/Ventilated
  - Urinary Catheters
  - Intravenous Catheters

- Age
  - Young/Children
  - Old

CDC (2019, November 13) Healthcare-Associated Infections (HAIs): Clinicians: Information about CRE. Retrieved from: https://www.cdc.gov/hai/organisms/cre/cre-clinicians.html

Carbapenem-Resistant Enterobacteriaceae (CRE)

Transmission

- Contact – Person to Person
- Contact – Contaminated Equipment
- Contact – Contaminated Environment

Common Infections

- Urinary tract infection
- Pneumonia
- Abscess
- Sepsis

CDC (2019, November 22) Healthcare-Associated Infections (HAIs): CRE Technical Information. Retrieved from: https://www.cdc.gov/hai/organisms/cre/technical-info.html

CRE Prevention & Management

- Enhanced Barrier Precautions
- Contact Precautions (When Appropriate)
  - Hand Hygiene
  - Wear Appropriate PPE
  - Change gloves between device care on same resident
  - Appropriate handling & disposal of PPE & linen
  - Cohort residents with same organism
  - Dedicate equipment
- Appropriate device care using appropriate infection control techniques
  - Foley Catheter
  - Intravenous Access Management
  - Tracheostomy

CRE Prevention & Management

- Appropriate Dressing Changes
  - Contain and cover draining wounds
- Discontinue inserted devices when no longer necessary
- Clean and Disinfect Equipment Between Uses/Residents
- Routine Environmental Cleaning & Disinfection
- Monitoring & Surveillance
  - Line List
  - Audits
  - Appropriate reporting to state & federal agencies
- Resident Care Plan Review

Review Questions

Ms. Kennedy has a UTI with CRE. She has a tracheostomy and a urinary catheter.

- What is the appropriate precaution for Ms. Kennedy?
  - Enhanced Barrier Precaution

- What can we do to prevent the spread of VRE to other sites?
  - Change gloves after each procedure
  - Perform hand hygiene before donning & after doffing gloves

Candida auris

CARILION CLINIC

Candida auris: What is it?

Fungus

- Yeast

Identified

- 2009 – Japan
- Isolated from a patient's ear
  - Auris = Ear

Referred to as

- C. auris

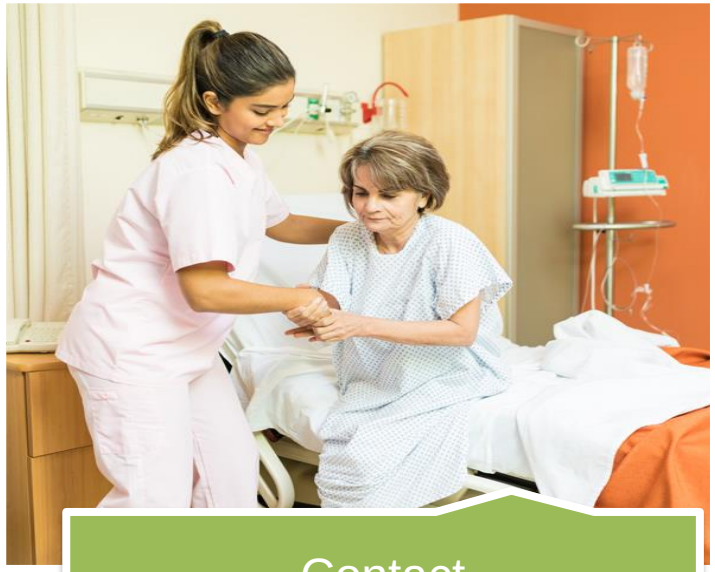
CDC (2018, November 21) Candida auris: Drug-resistant Germ That Spreads in Healthcare Facilities. Retrieved from: https://www.cdc.gov/fungal/candida-auris/c-auris-drug-resistant.html

Candida auris: Why is it a BIG Deal?

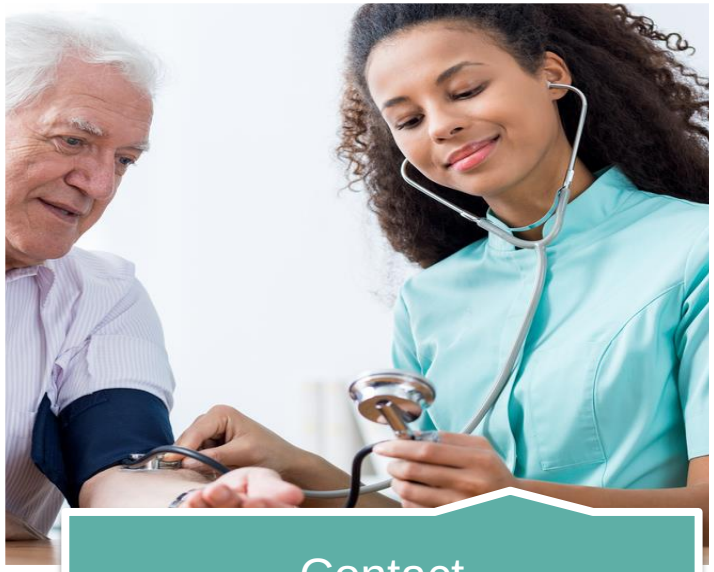
- C. auris is resistant to many antifungals used to treat Candida infections
- It is becoming more common in the United States
- It can colonize (live on) the skin without producing signs or symptoms of infection
- Affects hospital and nursing home populations - likely to be immunocompromised / immunosuppressed
- It can spread into the blood and cause infections in the kidneys, heart, and brain
- 1 in 3 people with an infection die
- Difficult to identify and leads to improper treatment

CDC (2018, November 21) Candida auris: Drug-resistant Germ That Spreads in Healthcare Facilities. Retrieved from: https://www.cdc.gov/fungal/candida-auris/c-auris-drug-resistant.html

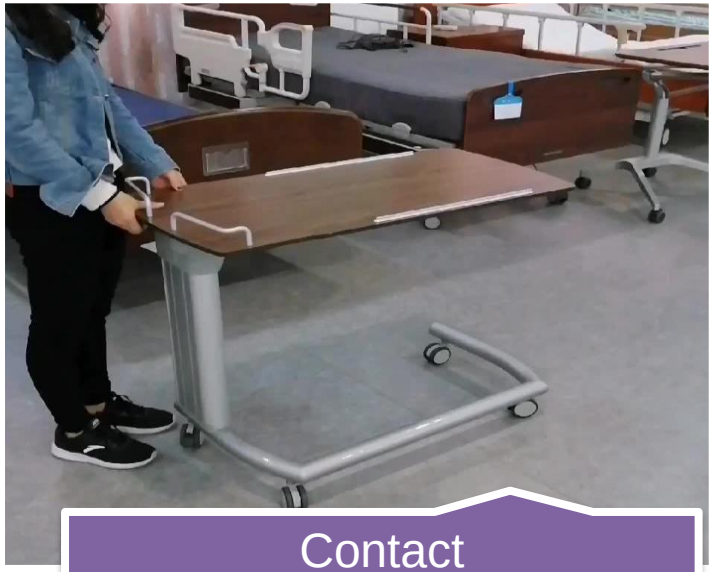
Candida auris: How Does it Spread?



Contact
Person to Person



Contact
Contaminated Equipment



Contact
Contaminated Surfaces/Environment

CDC (2018, November 21) Candida auris: Drug-resistant Germ That Spreads in Healthcare Facilities. Retrieved from: https://www.cdc.gov/fungal/candida-auris/c-auris-drug-resistant.html

Candida auris: Who is at Risk?

- Residents with:
  - Invasive Medical Devices
    - Tracheostomy
    - Urinary Catheters
    - Intravenous Catheters

- Residents:
  - In Long-Term Acute Care Hospitals (LTACHs)
  - In Nursing Facilities
  - Hospitalized

VDH (2021, May 7) Candida auris Cases are on the Rise in Virginia. Retrieved from: https://www.vdh.virginia.gov/clinicians/candida-auris-cases-are-on-the-rise-in-virginia/

VDH (2023, May) Candida auris May 2023 Report. Retrieved from: https://www.vdh.virginia.gov/content/uploads/sites/174/2023/05/C-auris-report-May.pdf

Candida auris: Difficult to Identify

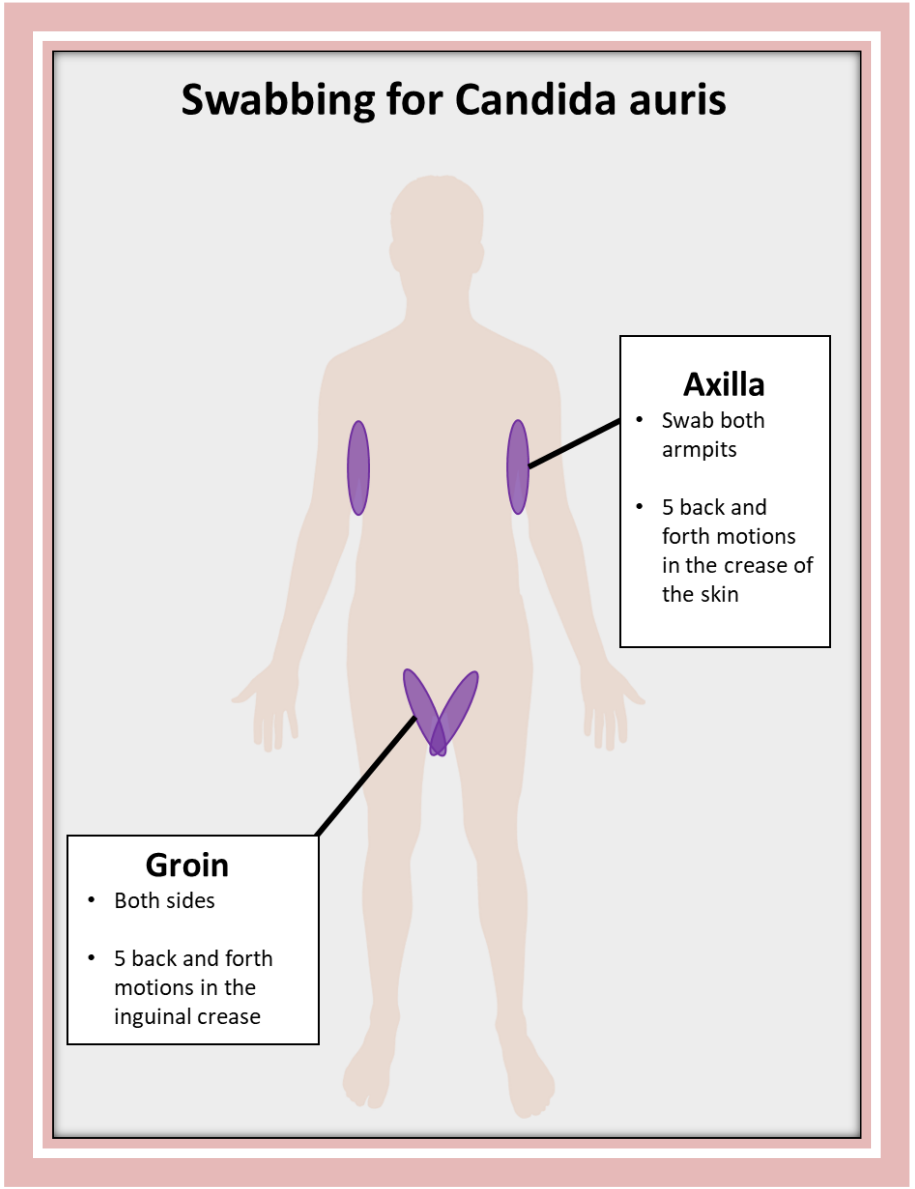
- Infections can take up to days, weeks, or months to develop
- May resemble other infections
  - Fever
  - Chills
- Consider C. auris
  - If fever and chills do not improve after antibiotics
- Can co-infect
  - It is possible to have C. auris infection on top of a viral, bacterial, or other fungal infection
- Remember
  - Hospitals and nursing homes are full of immune-suppressed and immunocompromised people

CDC (2018, November 21) Candida auris: Drug-resistant Germ That Spreads in Healthcare Facilities. Retrieved from: https://www.cdc.gov/fungal/candida-auris/c-auris-drug-resistant.html

Sikora, A., Hashmi, M., Zahra, F. (2023, April 27) Candida auris. Retrieved from: https://www.ncbi.nlm.nih.gov/books/NBK563297/

Candida auris: When to Test?

- CDC Recommendation
  - ➢ Confirmed or suspected exposure
  - ➢ Previous hospitalization in foreign country



CDC (2020, May 29) Candida auris: Screening for Candida auris Colonization. Retrieved from: https://www.cdc.gov/fungal/candida-auris/c-auris-screening.html

CDC (2020, May 29) Candida auris Testing. Retrieved from: https://www.cdc.gov/fungal/candida-auris/fact-sheets/c-auris-testing.html

C. auris Prevention & Management

- Enhanced Barrier Precautions
- Contact Precautions (When Appropriate)
  - Hand Hygiene
  - Wear Appropriate PPE
  - Change gloves between device care on same resident
  - Appropriate handling & disposal of PPE & linen
  - Cohort residents with same organism
  - Dedicated equipment
- Appropriate device care using appropriate infection control techniques
  - Foley Catheter
  - Intravenous Access Management
  - Tracheostomy

C. auris Prevention & Management

- Appropriate Dressing Changes
  - Contain and cover draining wounds
- Clean and Disinfect Equipment Between Uses/Residents
- Routine Environmental Cleaning & Disinfection
- Monitoring & Surveillance
  - Line List
  - Audits
  - Appropriate reporting to state & federal agencies
- Resident Care Plan Review

Review Question

A new admission was transferred from another facility. The new admission is placed in Rm. A . They have no sign or symptoms indicating infection. They do not get along with roommate 1 and is moved to Rm. B with roommate 2. A day passes and the health department notifies you the new admission had been exposed to a resident with Candida auris at the previous facility.

- What residents would you have to test for Candida auris?
- What precaution (if any) do you place?

Managing MDROs

The Nurses' Role

CARILION CLINIC

Nurses' Role in Managing MDROs

Hand Hygiene

Antimicrobial Stewardship

- Do Not Abuse/Overuse
- Take as Prescribed

Use Proper Isolation Signage

- Adopt enhanced barrier precautions

Use Proper PPE

Reduce Invasive Procedures

- Remove indwelling devices when no longer indicated

Aseptic Non-Touch Technique (ANTT)

Routine cleaning and disinfection of high touch surfaces

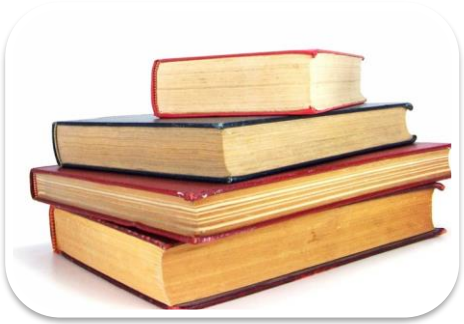
Disinfecting resident care equipment between uses

Notify facilities of infection or colonization when transferring residents

CDC (2016, September 15) Lesson 6: Investigating an Outbreak. https://www.cdc.gov/csels/dsepd/ss1978/lesson6/section2.html#step4

CDC (2023, January 12) Candida auris: Infection Prevention and Control for Candida auris. Retrieved from: https://www.cdc.gov/fungal/candida-auris/c-auris-infection-control.html

Nurses' Role in Managing MDROs

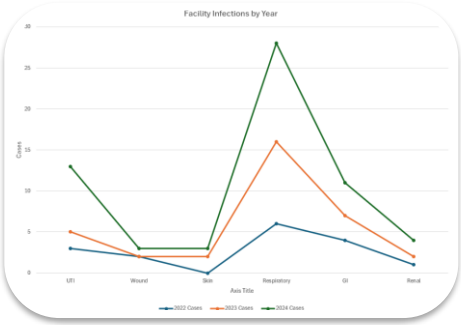


Education

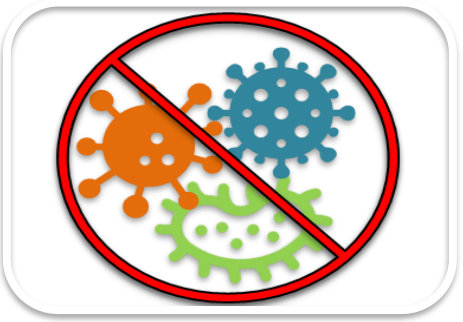
- Staff
- Family
- Residents

Surveillance & Monitoring

Care & Treatment



QA/PI



Outbreak Management

Nurses' Role in Managing MDROs

Investigating New Infections, Clusters, & Outbreaks

- Location/Unit/Wing With MDRO Residents

} Place

- Identify Residents With MDRO
  - New Admit?
  - From Nursing Home or Hospital?
  - Chronic Indwelling Device?
  - Wound/Infection Prior to Admission?

} Person

- Identify Date of Initial Report

} Time

- Confirm Lab Result(s)
- Review In-Dwelling Device Care Policies (if applicable)

CDC (2018, December 13) Describing Epidemiologic Data. Retrieved from: https://www.cdc.gov/eis/field-epi-manual/chapters/Describing-Epi-Data.html

Conclusion

Thank you for your time and attention!

CARILION CLINIC

References

CDC (2010, November 24) Healthcare-Associated Infections (HAIs): Klebsiella pneumoniae in Healthcare settings. Retrieved from: https://www.cdc.gov/hai/organisms/klebsiella/klebsiella.html

CDC (2011, January 17) Healthcare Associated Infections (HAIs): Staphylococcus aureus in Healthcare Settings. Retrieved from: https://www.cdc.gov/hai/organisms/staph.html

CDC (2018, December 13) Describing Epidemiologic Data. Retrieved from: https://www.cdc.gov/eis/field-epi-manual/chapters/Describing-Epi-Data.html

CDC (2018, November 21) Candida auris: Drug-resistant Germ That Spreads in Healthcare Facilities. Retrieved from: https://www.cdc.gov/fungal/candida-auris/c-auris-drug-resistant.html

CDC (2019, February 28) Methicillin-resistant Staphylococcus aureus (MRSA): Healthcare Settings. Retrieved from: https://www.cdc.gov/mrsa/healthcare/index.html

CDC (2019, June 26) Methicillin-resistant Staphylococcus aureus (MRSA). Retrieved from: https://www.cdc.gov/mrsa/community/index.html

CDC (2019, November 13) Healthcare-Associated Infections (HAIs): Clinicians: Information about CRE. Retrieved from: https://www.cdc.gov/hai/organisms/cre/cre-clinicians.html

CDC (2019, November 22) Healthcare-Associated Infections (HAIs): CRE Technical Information. Retrieved from: https://www.cdc.gov/hai/organisms/cre/technical-info.html

CDC (2019, November 22) Healthcare-Associated Infections (HAIs): ESBL-Producing Enterobacterales in Healthcare Settings. Retrieved from: https://www.cdc.gov/hai/organisms/ESBL.html

CDC (2019, November 13) Healthcare Associated Infections (HAIs): Vancomycin-resistant Enterococci (VRE) in Healthcare Settings. Retrieved from: https://www.cdc.gov/hai/organisms/vre/vre.html

CDC (2019) Vancomycin-Resistant Enterococci (VRE). Retrieved from: https://www.cdc.gov/drugresistance/pdf/threats-report/vre-508.pdf

CDC (2020, May 29) Candida auris: Screening for Candida auris Colonization. Retrieved from: https://www.cdc.gov/fungal/candida-auris/c-auris-screening.html

CDC (2020, May 29) Candida auris Testing. Retrieved from: https://www.cdc.gov/fungal/candida-auris/fact-sheets/c-auris-testing.html

References

CDC (2022, October 5) Antimicrobial Resistance: About Antimicrobial Resistance. Retrieved from: https://www.cdc.gov/drugresistance/about.html

CDC (2022, October 5) Antimicrobial Resistance: How Antimicrobial Resistance Happens. Retrieved from: https://www.cdc.gov/drugresistance/about/how-resistance-happens.html

CDC (2023, January 12) Candida auris: Infection Prevention and Control for Candida auris. Retrieved from: https://www.cdc.gov/fungal/candida-auris/c-auris-infection-control.html

CDC (n.d.) CRE Information for Facilities. Retrieved from: https://www.cdc.gov/hai/pdfs/cre/CRE-handout-V7-508.pdf

Gontjes, K. J., et al. (2022, February 1) Association of Exposure to High-risk Antibiotics in Acute Care Hospitals With Multidrug-Resistant Organism Burden in Nursing Homes. Retrieved from: https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2788560?resultClick=1

McKinnell, J. A., et al. (2020, June 16) High Prevalence of Multidrug-Resistant Organism Colonization in 28 Nursing Homes: An “Iceberg Effect”. Retrieved from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7708431/

MedicalNewsToday (2017, September 26) What are extended-spectrum beta-lactamases (ESBL)? Retrieved from: https://www.medicalnewstoday.com/articles/319535#transmission

Sikora, A., Hashmi, M., Zahra, F. (2023, April 27) Candida auris. Retrieved from: https://www.ncbi.nlm.nih.gov/books/NBK563297/

Siddiqui, A. H., Koirala, J. (2023, April 2) Methicillin-Resistant Staphylococcus aureus. Retrieved from: https://www.ncbi.nlm.nih.gov/books/NBK482221/

Taylor, T. A., Unakal, C. G., (2023, July 17) Staphylococcus aureus Infection. Retrieved from: https://www.ncbi.nlm.nih.gov/books/NBK441868/

VDH (2018, September) Vancomycin-Resistant Enterococci (VRE) Infection. Retrieved from: https://www.vdh.virginia.gov/epidemiology/epidemiology-fact-sheets/vancomycin-resistant-enterococci-vre-infection/

VDH (2021, May 7) Candida auris Cases are on the Rise in Virginia. Retrieved from: https://www.vdh.virginia.gov/clinicians/candida-auris-cases-are-on-the-rise-in-virginia/

VDH (2023, May) Candida auris May 2023 Report. Retrieved from: https://www.vdh.virginia.gov/content/uploads/sites/174/2023/05/C-auris-report-May.pdf