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NC SHARPPS Program

MULTIDRUG-RESISTANT ORGANISMS (MDROS) TOOLKIT

FOR LONG-TERM CARE FACILITIES

2024



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Multidrug-Resistant Organism (MDRO) Toolkit

For Long-Term Care Facilities

Introduction

Antimicrobial resistance is a major threat to public health. The Centers for Disease Control and Prevention (CDC) estimates that 2.8 million people in the United States every year get infections that are resistant to antimicrobials (drugs that treat infections caused by bacteria or fungi), and at least 35,000 people die as a result.¹ Organisms that are resistant to multiple classes of antimicrobial drugs are referred to as multidrug-resistant organisms (MDROs). Infections with MDROs can be difficult to treat and can be much more dangerous than infections with non-resistant strains of the same organism. Patients with prolonged health care stays, exposure to antimicrobial drugs, and other risk factors such as wounds or indwelling medical devices are at the highest risk for MDRO colonization and infection.

MDROs can be found in virtually any health care setting, and because every health care facility is unique, there is no one-size-fits-all solution to MDRO prevention and control. Regardless of differences in how MDRO prevention is implemented, the goal is the same: to prevent transmission of these pathogens to others within and between health care settings. In this toolkit, we describe approaches to MDRO prevention and control that are recommended for long-term care facilities. Long-term care facility residents (individuals who live in nursing homes/skilled nursing facilities, assisted living facilities/adult care homes, and other long-term care settings) may be at increased risk for acquiring an MDRO due to factors such as increased age, frequent health care exposures, other medical problems, presence of indwelling or invasive devices, and living in close proximity to other people. This makes control and prevention of MDROs in long-term care settings especially important. The approaches described in this toolkit may not be applicable or feasible for all long-term care facilities but are presented as best practices to consider for MDRO prevention. Through this toolkit, facilities will learn how to assess the risk of MDRO transmission based on their residents and the services they provide, determine which strategies are appropriate for their setting, implement prevention strategies, evaluate their effectiveness, and adjust as needed.

This toolkit was written to help those in charge of infection prevention programs at long-term care facilities implement recommended MDRO prevention and control strategies. The material provided is appropriate for those with training in infection prevention but may also be informative for other long-term care facility staff, including administrators and other facility leadership as well as frontline staff such as nurses, nursing assistants, ancillary services staff (e.g., physical therapists), and environmental services staff. The content of this toolkit may be used for many purposes, including but not limited to: creating or updating infection prevention and control protocols, conducting staff in-services pertaining to prevention and control of MDROs, or as part of facility staff orientation procedures.

What are MDROs?

When a drug that can normally be used to treat an infection does not kill the organism causing the infection, the organism is called “resistant” to that drug. Multidrug-resistant organisms (MDROs) are organisms or microbes that have become resistant to multiple types of drugs that are normally used to treat them. MDROs can include fungi, viruses, and parasites, but many are bacteria. Antimicrobial resistance is the ability of these microbes to resist the effects of drugs – that is, the germs are not killed, and their growth is not stopped. One type of antimicrobial resistance is antibiotic resistance, when bacteria are resistant to the antibiotics used to treat them. We will discuss antimicrobial resistance in more detail later in this toolkit.

There are many kinds of MDROs, ranging from very common to extremely rare. This toolkit will discuss the most concerning MDROs that need urgent control measures to prevent transmission. MDROs of high concern include:

- *Candida auris*
- Carbapenem-resistant Enterobacterales (CRE)
 - ▶ Carbapenemase-producing carbapenem-resistant Enterobacterales (CP-CRE)
- Vancomycin-intermediate *Staphylococcus aureus* (VISA)
- Vancomycin-resistant *Staphylococcus aureus* (VRSA)

What types of infections do MDROs cause?

MDROs can cause infection in any part of the body, and the type of infection depends on the organism and how the patient was exposed to it. Common locations for infections may include bloodstream, lungs, skin, surgical sites, urinary tract, and wounds.

Colonization vs. infection

Many MDROs can colonize patients, in addition to infecting them. A person is colonized with an organism when it can be found on or in the person’s body but is not making them sick. People who are colonized with an MDRO can spread the organism to others who may get an infection from it. Those colonized with an MDRO are also at a higher risk of developing an infection from organisms that they are colonized with. It’s important to identify colonized individuals and use appropriate precautions to prevent the spread of MDROs in health care facilities.

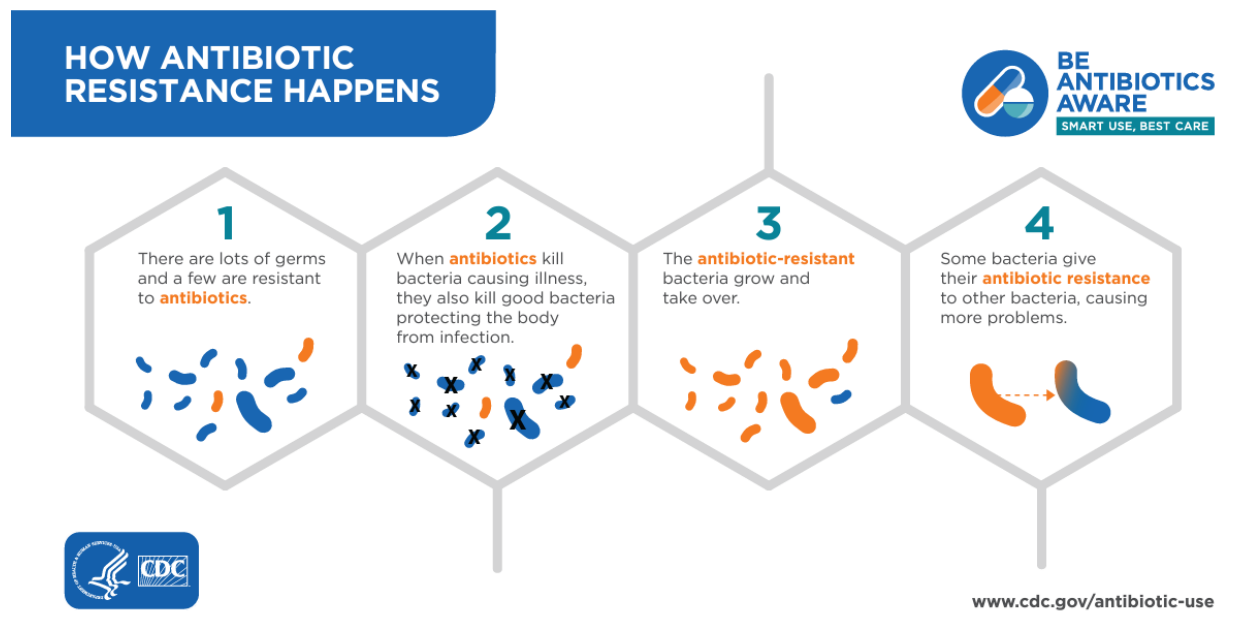
Many MDROs can cause prolonged colonization in which patients may remain colonized for years, even if the patient sometimes has negative cultures in between positive ones. Patients who are placed on precautions for an MDRO should generally remain on precautions for the duration of their health care stay, and precautions should not be discontinued without public health consultation/approval.

How does antimicrobial resistance happen?

Antimicrobial resistance occurs when bacteria or fungi learn to avoid the effects of the antimicrobial drugs used to treat the infections they cause (Figure 1). When someone takes an antibiotic, the drug kills all bacteria that are susceptible to that antibiotic. If a few of the bacteria causing the infection had evolved or acquired resistance to that antibiotic, they can now grow and take over, causing an antibiotic-resistant infection. The resistant bacteria may even be able to share the resistance gene with other bacteria, spreading the resistance problem.²

FIGURE 1

How Antibiotic Resistance Happens

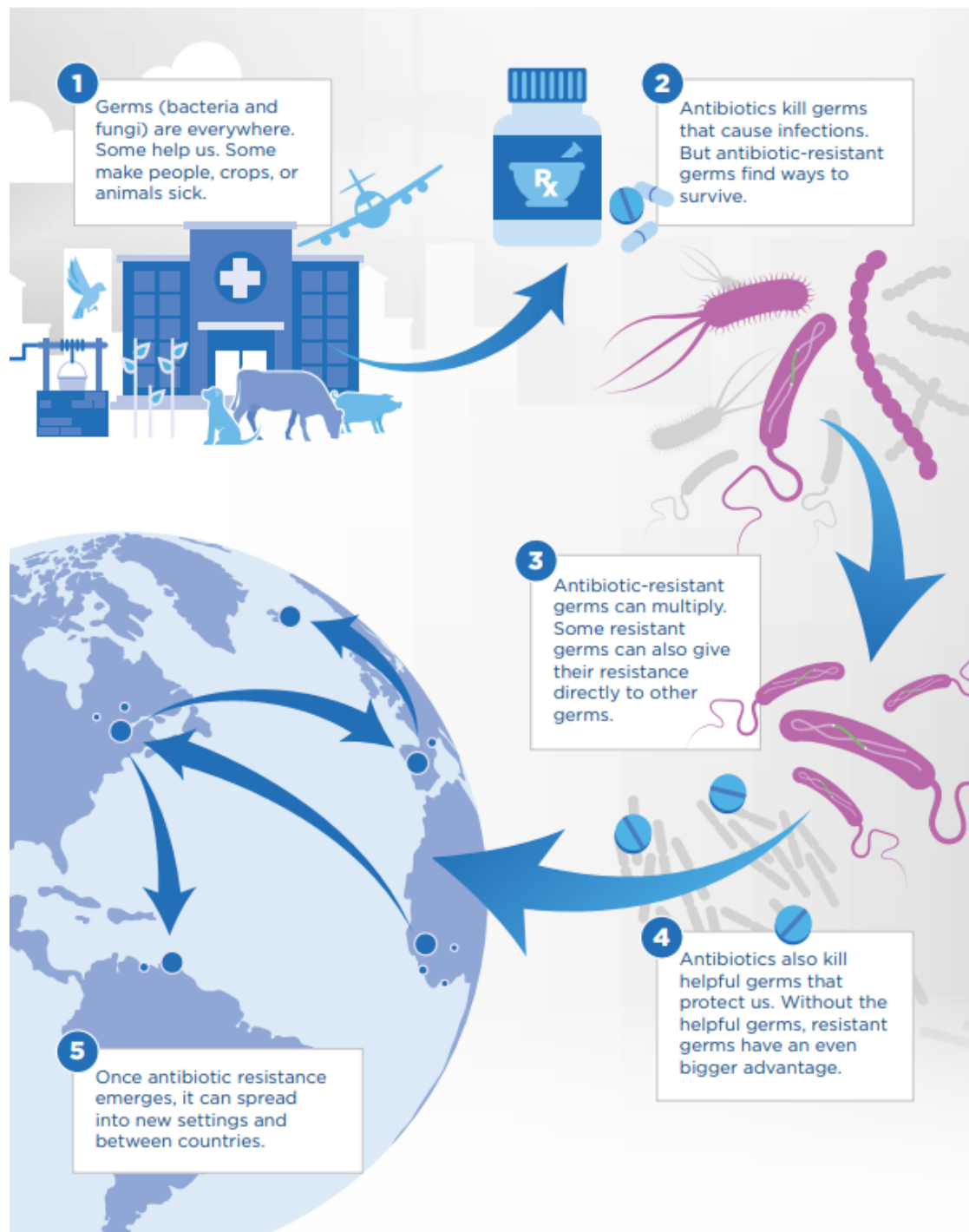


Note. From How Antibiotic Resistance Happens. CDC. Available from <https://www.cdc.gov/antibiotic-use/antibiotic-resistance.html>.

Antimicrobial drugs are incredibly important tools that save lives, which is why it is so critical to be good stewards of our antimicrobial resources and only use them when they are needed. Every time antimicrobial drugs are used, there is a chance to contribute to antimicrobial resistance (Figure 2). Antimicrobial drugs should only be used when needed, prescribed for the shortest effective duration, and should always be taken as directed. On the other hand, antimicrobial drugs are an important lifesaving measure, and should always be prescribed when they are needed to treat infections or prevent sepsis.¹

FIGURE 2

How Antibiotic Resistance Spreads



Note. From *How Antibiotic Resistance Spreads*. CDC. Available from [Antibiotic Resistance Threats in the United States, 2019 \(cdc.gov\)](https://www.cdc.gov/antibiotic-resistance/threats-in-the-united-states-2019/).

Infection Prevention and Control Practices

ADMINISTRATIVE MEASURES

Effective MDRO prevention and control requires buy-in from facility leadership and dedication of time and resources to achieve the goal. Administrative measures recommended for the prevention of MDROs in all health care settings include:

- Make MDRO prevention and control an organizational priority.
- Provide administrative support and resources (both financial resources and dedicated staff time) to prevent and control MDRO transmission.
- Identify experts who can provide consultation in analyzing epidemiologic data, recognizing MDRO problems, or devising effective control strategies.
- Implement systems to communicate information about reportable MDROs to administrative personnel and, as required, to state and local health authorities.
- Implement a multidisciplinary process to monitor and improve health care personnel adherence to recommended practices for Standard and Transmission-Based Precautions.
- Implement systems to designate residents known to be colonized or infected with a targeted MDRO and to notify receiving health care facilities and personnel prior to transfer of such residents within or between facilities.
- Implement processes to collect information about MDRO diagnoses when receiving residents from other health care facilities to ensure Transmission-Based Precautions can be continued if needed.
- Support participation of the facility in local, regional, and national coalitions to combat emerging or growing MDRO problems.
- Provide updated feedback at least annually to health care providers and administrators on facility- and unit-wide trends in antimicrobial prescribing and MDRO infections. Include information on changes in prevalence or incidence of infection, results of assessments of system failures, and action plans to improve adherence to and effectiveness of recommended infection control practices to prevent MDRO transmission.

EDUCATION AND TRAINING OF HEALTH CARE PERSONNEL

Health care facilities should provide education and training on risks and prevention of MDRO transmission during orientation and periodic educational updates for health care personnel. Education should include background information on MDROs, Standard and Transmission-Based Precautions, organizational experience with MDROs, and prevention strategies.

SURVEILLANCE

Health care facilities should establish systems to ensure that clinical microbiology laboratories promptly notify appropriate facility staff (e.g., infection control staff, medical director, or designee) when an MDRO is detected. Long-term care facilities should also develop and monitor unit-specific antimicrobial susceptibility reports and establish a frequency (at least annually) for preparing summary reports based on the volume of clinical isolates. Reference laboratories may be able to provide susceptibility data on the facility, local, or regional level to identify prevalent MDROs and trends upon request. Trends in the incidence of target MDROs in the facility over time should be monitored to determine whether MDRO rates are changing, if existing interventions are effective, and whether additional interventions are needed.

Precautions to Prevent Transmission of Infectious Agents

STANDARD PRECAUTIONS

Standard Precautions are a set of basic infection prevention practices that should be used in the care of all residents, regardless of infection status. Standard Precautions are used because a patient could have an undiagnosed infection, so providers use common sense practices such as washing hands and wearing PPE when they may be exposed to body fluids to protect themselves from infection and prevent the spread of infection between patients. Standard Precautions include:

- **Hand hygiene**
 - ▶ One of the most effective ways to prevent transmission of disease, including MDROs.
- **Personal Protective Equipment (PPE)**
 - ▶ Use PPE when possible exposure to blood, body fluid, or other infectious material is expected.
- **Respiratory hygiene/cough etiquette**
 - ▶ Avoid transmission of respiratory pathogens by using methods such as covering your mouth and nose when you sneeze or cough.
- **Clean and disinfect**
 - ▶ Clean and disinfect patient care equipment and the environment.
- **Safe injection practices**
 - ▶ Handle needles/sharps appropriately.

Transmission-Based Precautions, including Enhanced Barrier Precautions and Contact Precautions, are discussed in more detail in the “Transmission-Based Precautions” section.

HAND HYGIENE

Proper hand hygiene is the best way to prevent the spread of MDROs. In most circumstances, alcohol-based hand rub is preferred over soap and water because it is quicker, more effective, and less drying. When hands are not visibly soiled, health care personnel should use an alcohol-based hand rub (ABHR) with a 60%-95% alcohol content. Health care personnel should apply the amount of product recommended by the manufacturer and rub hands together, covering all surfaces of hands and fingers, until hands are dry (about 20 seconds) (Figure 3).

When hands are visibly soiled, or when caring for individuals infected with suspected or known spore-forming bacteria (e.g., *Clostridioides difficile*, or “*C. diff*,” outbreaks), health care personnel should wash their hands with soap and water for at least 20 seconds, covering all surfaces of hands and fingers (Figure 4). During outbreaks of *C. diff* or norovirus, handwashing with soap and water is recommended as an additional precaution, and access to ABHR should not be restricted.^{3,4} Appropriate glove use is critical in addition to hand hygiene to reduce hand and environmental contamination.⁴

Perform hand hygiene:

- Immediately before touching a patient
- Before performing an aseptic task (e.g., placing an indwelling device) or handling invasive medical devices
- Before moving from work on a soiled body site to a clean body site on the same patient
- After contact with blood, body fluids, or contaminated surfaces
- Immediately after glove removal
- After touching a patient or the patient’s immediate environment

[Healthcare Providers | Hand Hygiene | CDC](#)

FIGURE 3

How to Handrub

How to Handrub?

RUB HANDS FOR HAND HYGIENE! WASH HANDS WHEN VISIBLY SOILED

⌚ Duration of the entire procedure: 20-30 seconds

1a  **1b** 

Apply a palmful of the product in a cupped hand, covering all surfaces;

2 

Rub hands palm to palm;

3  **4** 

Right palm over left dorsum with interlaced fingers and vice versa;

Palm to palm with fingers interlaced;

5 

Backs of fingers to opposing palms with fingers interlocked;

6  **7** 

Rotational rubbing of left thumb clasped in right palm and vice versa;

Rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa;

8 

Once dry, your hands are safe.

 **World Health Organization**

Patient Safety
A World Alliance for Safer Health Care

SAVE LIVES
Clean Your Hands

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May 2009


Note. From How to Handrub. World Health Organization. Available from [WHO IPC Training tools](#)

FIGURE 4

How to Handwash

How to Handwash?

WASH HANDS WHEN VISIBLY SOILED! OTHERWISE, USE HANDRUB

 **Duration of the entire procedure: 40-60 seconds**



Wet hands with water;



Apply enough soap to cover all hand surfaces;



Rub hands palm to palm;



Right palm over left dorsum with interlaced fingers and vice versa;



Palm to palm with fingers interlaced;



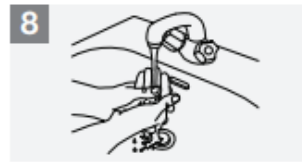
Backs of fingers to opposing palms with fingers interlocked;



Rotational rubbing of left thumb clasped in right palm and vice versa;



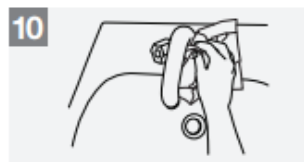
Rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa;



Rinse hands with water;



Dry hands thoroughly with a single use towel;



Use towel to turn off faucet;



Your hands are now safe.



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May 2009

Note. From How to Handwash. World Health Organization. Available from [WHO IPC Training tools](#)

Standard Precautions Recommendations

SUMMARY OF STANDARD PRECAUTIONS

Component	Recommendations
Hand hygiene	Perform hand hygiene before touching a patient, before performing an aseptic task, before moving from a soiled site to a clean site, after touching patient or their environment, after contact with body fluids or contaminated surfaces, and immediately after glove removal.
PPE - Gloves	Wear gloves for touching blood, body fluids, secretions, excretions, mucous membranes, nonintact skin, and contaminated items.
PPE - Gown	Wear a gown during procedures and patient care activities when contact of clothing/exposed skin with blood/body fluids, secretions, and excretions is anticipated.
PPE - Mask, eye protection (goggles or face shield)	Wear a face mask and eye protection (i.e., goggles or face shield) during procedures and patient care activities likely to generate splashes or sprays of blood, body fluids, or secretions, especially suctioning and endotracheal intubation.
PPE – N95 respirator	Wear N95 or higher level respirator during aerosol-generating procedures on patients with suspected or proven infections transmitted by respiratory aerosols (in addition to gown, gloves, and face/eye protection).
Soiled patient care equipment	Handle soiled equipment in a manner that prevents transfer of microorganisms to others and to the environment. Wear gloves if visibly contaminated. Perform hand hygiene after handling.
Environmental cleaning	Develop procedures for routine care, cleaning, and disinfection of environmental surfaces, especially frequently-touched surfaces in patient care areas.
Textiles and laundry	Handle soiled linens in a manner that prevents transfer of microorganisms to others and to the environment. Wear gloves and perform hand hygiene after handling.
Needles and other sharps	Do not recap, bend, break, or hand-manipulate used needles. If recapping is required, use a one-handed scoop technique only. Use safety features when available. Place used sharps in puncture-resistant container.
Patient resuscitation	Use mouthpiece, resuscitation bag, or other ventilation devices to prevent contact with mouth and oral secretions.
Patient placement	Prioritize single-patient rooms for patients who are at increased risk of transmission, are likely to contaminate the environment, do not maintain appropriate hygiene, or are at increased risk of infection or adverse outcomes.
Respiratory hygiene/cough etiquette	Instruct symptomatic people to cover mouth/nose when sneezing/coughing, use tissues and dispose in no-touch receptacle, perform hand hygiene if hands are soiled, and wear surgical mask if tolerated or maintain spatial separation (>3 feet if possible).

Adapted from: <https://www.cdc.gov/infectioncontrol/guidelines/isolation/appendix/standard-precautions.html>

TRANSMISSION-BASED PRECAUTIONS

Transmission-Based Precautions are used **in addition to Standard Precautions** for patients who are infected or colonized with certain pathogens for which additional precautions are needed to prevent transmission. There are four categories of Transmission-Based Precautions: Contact Precautions, Droplet Precautions, Airborne Precautions, and Enhanced Barrier Precautions. In general, Contact Precautions and Enhanced Barrier Precautions, in addition to Standard Precautions, should be considered for preventing MDROs in long-term care facilities.

CONTACT PRECAUTIONS

Contact Precautions are used to prevent transmission of infectious agents which are spread by direct or indirect contact with the patient or their environment. Residents with infections such as *Clostridioides difficile* infection (*C. diff*), norovirus infection, and scabies should be placed on Contact Precautions for the duration of the infection in accordance with the [CDC Guideline for Isolation Precautions](#). Contact Precautions should also be utilized for residents with acute diarrhea, draining wounds, or other sites of secretions or excretions that are unable to be covered or contained. Contact Precautions are intended to be used for a limited period of time and should be discontinued when the indication has been resolved.

Contact Precautions require a gown and gloves to be donned prior to room entry, regardless of the type of activities to be performed. PPE should be removed and discarded prior to exiting the room. Face protection may also be needed if performing an activity with the risk of splash or spray. Residents should be placed in a single-occupancy room or cohorted with other residents who have the same diagnosis if single rooms are not available and restricted to their room except for medically necessary care. Residents on Contact Precautions should have dedicated or disposable patient care equipment (e.g., blood pressure cuffs).

ENHANCED BARRIER PRECAUTIONS

Since MDROs can cause prolonged colonization lasting for months or years, patients who are infected or colonized with MDROs need to be placed on Transmission-Based Precautions for the duration of their stay in a health care facility. Using Contact Precautions indefinitely is feasible in acute care settings where patients only stay in the facility for a short period of time but has a huge impact on quality of life for residents in long-term care facilities where the facility is their home. To address this problem, CDC created a new category of Transmission-Based Precautions called Enhanced Barrier Precautions (EBP). EBP are a modified version of Contact Precautions where full PPE is only required for high-contact resident care activities and the resident is not restricted to their room, allowing residents to easily have visitors and participate in activities while preventing transmission during the highest-risk encounters.

In July 2022, CDC updated guidance on the use of EBP to recommend broader use in skilled nursing facilities/nursing homes for patients who have wounds or indwelling medical devices,

regardless of their MDRO status. Studies have found that over 50% of residents of long-term care facilities are colonized with MDROs,⁵ so placing residents who are at the highest risk of MDRO colonization/infection on EBP protects them and other residents at the facility. Other types of long-term care facilities, such as assisted living facilities/adult care homes, do not need to place residents with wounds or indwelling devices on EBP as they have a lower-acuity population, but should still use EBP for residents with MDROs.

EBP are intended to apply to wounds that place residents at risk for MDROs over an extended period of time, and residents with shorter-lasting wounds such as skin tears do not need EBP. Examples of wounds that would necessitate EBP in skilled nursing facilities include pressure ulcers, unhealed surgical wounds, diabetic foot ulcers, chronic venous stasis ulcers.

Indwelling medical devices place residents at risk because they offer a direct pathway for a pathogen to enter the body. Examples of indwelling medical devices include central lines (e.g. central venous catheters, hemodialysis catheters), indwelling urinary catheters, feeding tubes, and tracheostomy tubes. Ostomy sites (e.g., colostomy, ileostomy) are not considered indwelling devices for the purposes of Enhanced Barrier Precautions.

Enhanced Barrier Precautions recommend gown and glove use during high-contact resident care activities (when Contact Precautions do not otherwise apply) for 1. residents known to be colonized or infected with a MDRO, and 2. nursing home residents with wounds or indwelling medical devices regardless of MDRO status. Patients on EBP are not restricted to their rooms. For residents colonized or infected with a MDRO, EBP apply for the duration of the resident's stay in a facility environment. If a resident is placed on EBP solely due to a wound or device, they may come off EBP if the wound heals, or the device is removed. Standard Precautions always apply to the care of all residents.

Examples of high-contact resident care activities include:

- Dressing
- Bathing/showering
- Transferring
- Providing hygiene
- Changing linens
- Changing briefs or assisting with toileting
- Device care or use: central line, urinary catheter, feeding tube, tracheostomy/ventilator
- Wound care: any skin opening requiring a dressing.

If performed alone and not bundled with other activities, some of these activities may not be considered high contact (e.g., isolated combing of a resident's hair, transfers of short duration such as transferring a resident from wheelchair to chair in dining room).

Please see CDC’s [FAQ about Enhanced Barrier Precautions in Nursing Homes](#) and [Consideration for Use of Enhanced Barrier Precautions in Skilled Nursing Facilities](#) for more information.

EBP IN ASSISTED LIVING OR ADULT CARE HOMES

Enhanced Barrier Precautions were developed specifically for nursing home residents, but the recommendations apply to MDRO prevention in all long-term care settings. EBP are applied in assisted living and adult care homes when a resident is infected or colonized with an MDRO but are not broadly recommended for all residents with wounds or medical devices.

ENHANCED BARRIER PRECAUTIONS BY FACILITY TYPE

Facility Recommendations	Infected or colonized with MDRO	Wound or indwelling medical device, regardless of MDRO status
Nursing Home	Yes	Yes
Assisted Living, Adult Care Home	Yes	No

IMPLEMENTING TRANSMISSION-BASED PRECAUTIONS

Policies and procedures that explain how Standard and Transmission-Based Precautions are applied, including systems used to communicate information about residents with transmissible infectious agents, are essential to ensure success of these measures. [Appropriate signage](#) should be displayed on the outside of the door to identify residents on Transmission-Based Precautions. When residents are transferred between facilities, systems should be in place to communicate appropriate precautions and MDRO status.

PATIENT PLACEMENT

Patients on Transmission-Based Precautions should be placed in a private room, if possible. When single-patient rooms are limited, prioritize private rooms for patients who are at the highest risk of transmission. For example, in the setting of limited private rooms, they should be prioritized for patients with norovirus (more transmissible) over patients with MDROs (less transmissible).

When sufficient single-patient rooms are not available, patients may be cohorted with patients who have the same diagnosis. Cohorting is the practice of grouping together patients who are colonized or infected with the same organism to confine their care to one area and prevent contact with other patients. Cohorts are created based on clinical diagnosis, microbiologic confirmation when available, epidemiology, and mode of transmission of the infectious agent. It

is generally preferred not to place severely immunosuppressed patients in rooms with other patients. Cohorting has been used extensively for managing outbreaks of MDROs including methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococci* (VRE), and *Pseudomonas aeruginosa*. Modeling studies provide additional support for cohorting patients to control outbreaks. However, cohorting often is implemented only after routine infection control measures have failed to control an outbreak. Assigning or cohorting health care personnel to care only for patients infected or colonized with a single target pathogen limits further transmission but is difficult to achieve in the face of current staffing shortages in hospitals and residential health care sites. However, when continued transmission is occurring after implementing routine infection control measures and creating patient cohorts, cohorting of health care personnel may be beneficial.⁶

CONTACT PRECAUTIONS VS. ENHANCED BARRIER PRECAUTIONS IN NURSING HOMES

Precautions	Enhanced Barrier Precautions	Contact Precautions
Applies to	<p>All residents with any of the following:</p> <ul style="list-style-type: none"> • Infection or colonization with an MDRO when Contact Precautions do not otherwise apply • Wounds and/or indwelling medical devices (e.g., central line, urinary catheter, feeding tube, tracheostomy/ventilator) regardless of MDRO colonization status, in nursing homes only 	<p>All residents infected or colonized with a MDRO in any of the following situations:</p> <ul style="list-style-type: none"> • Presence of acute diarrhea, draining wounds, or other sites of secretions or excretions that are unable to be covered or contained • For a limited time period, as determined in consultation with public health authorities, on units or in facilities during the investigation of a suspected or confirmed MDRO outbreak • When otherwise directed by public health authorities <p>All residents who have another infection (e.g., <i>C. diff</i>, norovirus, scabies) or condition for which Contact Precautions is recommended</p>
Situations where PPE used	<p>During high-contact resident care activities:</p> <ul style="list-style-type: none"> • Personal care including dressing, bathing/showering, providing hygiene, changing briefs or assisting with hygiene, changing linens, transferring • Device care or use: central line, urinary catheter, feeding tube, tracheostomy/ventilator • Wound care: any skin opening requiring a dressing 	Any room entry
Required PPE	<p>Gloves and gown prior to the high contact care activity</p>	<p>Don gloves and gown before room entry, doff gloves and gown before room exit</p>
	<p>Always change PPE before caring for another resident. Face protection may also be needed if performing an activity with risk of splash or spray.</p>	
Room restriction	None	Yes, except for medically necessary care

Adapted from: [Implementation of Personal Protective Equipment \(PPE\) Use in Nursing Homes to Prevent Spread of Multidrug-resistant Organisms \(MDROs\) \(cdc.gov\)](https://www.cdc.gov/infectioncontrol/basics/ppe-use-nursing-homes-prevent-spread-multidrug-resistant-organisms)

ENVIRONMENTAL MEASURES

Facilities should clean rooms of patients who are on Transmission-Based Precautions after rooms of patients who are not on Transmission-Based Precautions to reduce opportunities for transmission. High-touch surfaces such as bed rails, bedside commodes, doorknobs, light switches, etc., and equipment in the immediate vicinity of the patient should be the focus of cleaning and disinfection. These surfaces and equipment should be frequently cleaned and disinfected by environmental services staff (e.g., at least daily) using an EPA-approved disinfectant that is active against the pathogen in question.

Facilities should dedicate noncritical medical items (i.e., items that come in contact with intact skin but not mucous membranes, such as blood pressure cuffs) to use on individual residents known to be infected or colonized with MDROs. Disposable medical items may also be considered. All non-disposable items that must be shared must be cleaned and disinfected according to manufacturer's recommendations prior to the equipment being used on another resident.

Antimicrobial Stewardship

Developing an antimicrobial stewardship program within the facility is another way to prevent the spread of MDROs. Antimicrobial stewardship is a set of commitments and actions designed to optimize the treatment of infections while reducing the adverse events associated with antimicrobial use, such as *Clostridioides difficile* (*C. diff*) infection and development of drug resistance. This includes improving antimicrobial prescribing practices and reducing inappropriate use. To develop an antimicrobial stewardship program, long-term care facilities can use resources from [The Core Elements of Antibiotic Stewardship for Nursing Homes \(cdc.gov\)](https://www.cdc.gov/antimicrobial-stewardship/core-elements/).

Starting on page 19, there is a checklist to aid in the development of an antimicrobial stewardship program ("Checklist for Core Elements of Antibiotic Stewardship on Nursing Homes.") As of November 2017, long-term care facilities regulated by the Centers for Medicare and Medicaid Services (CMS) are required to have an antibiotic stewardship program in place that includes antibiotic use protocols and a system to monitor antibiotic use (42 CFR §483.80(a)(3)).⁷

Disease Background

CARBAPENEM-RESISTANT ENTEROBACTERIALES (CRE)

Enterobacterales are a large order of different types of germs (bacteria) that commonly cause infections in health care settings. Examples of germs in the Enterobacterales order include *Escherichia coli* (*E. coli*), *Enterobacter cloacae*, and *Klebsiella pneumoniae*. When Enterobacterales develop resistance to the group of antibiotics called carbapenems, they are called carbapenem-resistant Enterobacterales (CRE).

Carbapenems (i.e., imipenem, meropenem, ertapenem, and doripenem) are important antibiotics for treating drug-resistant infections with gram-negative bacteria. Bacteria that are resistant to carbapenems frequently have few treatment options remaining, and may require toxic, costly antibiotics that result in prolonged hospital stays. Infections with CRE can have up to a 50% mortality rate due to the challenges of treating these infections.⁹

CRE can infect many different sites on the body, and the symptoms of a CRE infection depend on what site is infected. The most common type of CRE infection is a urinary tract infection (UTI), but it can also cause bloodstream infections, wound infections, and pneumonia, among other types of infections.

Some CRE make a carbapenemase, which is an enzyme that breaks down carbapenem antibiotics. CRE that make a carbapenemase are known as carbapenemase-producing CRE (CP-CRE). CP-CRE can share their carbapenemase genes with other bacteria, causing further spread of antibiotic resistance. About one in three CRE are CP-CRE.

There are several types of carbapenemases. The most common carbapenemase is KPC, which is endemic in North Carolina. Other carbapenemases include NDM, VIM, OXA, and IMP. When a CP-CRE case is identified, facilities frequently need to screen other residents who overlapped with the case to see if any transmission has occurred.

TRANSMISSION AND EPIDEMIOLOGY

In health care settings, CRE are transmitted from person-to-person, often via the hands of health care personnel or through contaminated medical equipment. Hand hygiene, equipment disinfection, and environmental cleaning are key to preventing the spread of CRE. Patients with high health care needs, such as those with indwelling devices or requiring assistance with activities of daily living, and patients who have recently taken antibiotics are at the highest risk for developing a CRE infection.

CP-CRE producing non-KPC carbapenemases are much more common outside of the United States. **Anyone who has had an overnight stay in a health care facility outside the US in the past 6 months should be screened for CP-CRE.** This screening is conducted through public health laboratories at no cost to the facility or patient; please contact nchai@dhhs.nc.gov to arrange.

REPORTING

In North Carolina, CRE are reportable if:

1. It is a reportable organism (*Klebsiella* spp., *Enterobacter* spp., and *E. coli*); AND
2. It has tested positive for carbapenemase production on a phenotypic or molecular test;
OR
3. It has not been tested for carbapenemase production.

For more information, refer to the [CRE Case Definition](#). CRE that are not reportable still need the same control measures to prevent transmission, and public health officials should be notified of any CP-CRE cases, even if they do not meet the reporting definition (i.e., are not one of the listed species).

LABORATORY TESTING

There are three components of laboratory testing for CRE: identifying the organism, determining if it produces a carbapenemase, and identifying the carbapenemase.

Identifying the organism is usually done by culturing the specimen. After the specimen has been cultured, the species can be identified, and antimicrobial susceptibility can be performed. The results of the culture and susceptibility testing determine if an organism is CRE or not—that is, a bacterium in the Enterobacterales family that is resistant to one or more carbapenem antibiotics.

Phenotypic tests, such as the modified carbapenem inactivation method (mCIM) or Carba NP, can identify whether an organism produces a carbapenemase, but cannot tell you which carbapenemase it produces. These tests are an important component of CRE surveillance because many PCR tests just look for the most common carbapenemase genes and may miss rare carbapenemases. A positive phenotypic test with a negative PCR needs further testing; please send any such isolates to the NC State Laboratory of Public Health (NC SLPH).

Molecular (PCR) tests, such as the Xpert Carba R, can identify if organism produces one of the carbapenemases in their panel.

For more information about laboratory testing methods and interpreting CRE results, please refer to the [CRE lab guide](#).

CONTROL MEASURES

Control measures need to be quickly implemented if CRE is identified to prevent transmission. Patients/residents should be placed on appropriate precautions (EBP in a long-term care setting and Contact Precautions in other settings), placed in a private room if possible, and their chart should be flagged so they will be placed on appropriate precautions again if readmitted in the future. The precautions should remain in place throughout the duration of the stay in the health care facility, as CRE can cause prolonged colonization. Negative tests are not sufficient to discontinue precautions, and the decision to do so should be made in consultation with public health officials.

For CP-CRE, screening may be needed to ensure that transmission has not occurred. For KPC-producing organisms, the case's roommate needs to be screened. For other carbapenemases, residents who overlapped on the same hall/unit as the case for at least 24 hours should be screened. Screening is available at no cost to facilities or patients through the Antimicrobial Resistance Laboratory Network (ARLN); please contact nchai@dhhs.nc.gov if you need to arrange a screening.

References:

- [CRE case definition](#)
- [Lab guide](#)
- [CRE in healthcare facilities](#)

Other Carbapenemase-Producing Organisms (CPOs)

Organisms that are not in the order Enterobacterales may also produce carbapenemases. Although these are not CRE, these organisms do pose a public health threat because the infections are hard to treat and carbapenem resistance can spread to other bacteria. The most common non-CRE carbapenemase-producing organisms (CPOs) are carbapenem-resistant *Pseudomonas aeruginosa* (CRPA) and carbapenem-resistant *Acinetobacter baumannii* (CRAB).

Both *Pseudomonas aeruginosa* and *Acinetobacter baumannii* are bacteria that are commonly found in the environment (e.g., soil, water), but are also an important cause of health care-associated infections. These organisms can infect many different sites on the body and can cause different symptoms depending on where the infection is located. People who have burns or wounds, are on a ventilator, or have medical devices such as catheters are at the highest risk of infection with these organisms. People can also become colonized with these organisms and spread these organisms to others.

Both organisms can live for a long time in the environment and can infect people if they touch a contaminated surface. They can also be spread from person-to-person via contaminated hands or equipment. Strict adherence to hand hygiene and routine, thorough environmental cleaning are essential to preventing the spread of these CPOs.

Reporting

CPOs other than CRE are not currently reportable in North Carolina but do still need public health action to ensure that transmission does not occur. If a carbapenemase is identified in a non-Enterobacterales organism, please inform your local health department to alert them of the case and get recommendations for control measures. Response to a CPO case is generally similar to the response to a CP-CRE case, including the need for appropriate precautions and screening.

References:

- [Acinetobacter in Healthcare Settings](#)
- [Pseudomonas aeruginosa in Healthcare Settings](#)

Candida auris

Candida auris is a multidrug-resistant fungus that causes serious, hard-to-treat infections and can spread easily in a health care setting. Some strains of *C. auris* are even pan-resistant, meaning that infections cannot be treated with any drugs we have. *C. auris* is uncommon in North Carolina, but the rate is increasing quickly. Preventing the spread of *C. auris* in North Carolina is a critical public health priority.

C. auris can cause infections in many different parts of the body including bloodstream infections, urinary tract infections, and ear infections. It also frequently colonizes the skin, particularly in areas such as the axilla (armpit) and groin. Most *C. auris* infections occur in people who have other medical problems, especially those who are immunocompromised.

Once a patient is colonized or infected with *C. auris*, they are considered to be colonized indefinitely and need to be in a private room on appropriate precautions for all future health care stays. Consult with the North Carolina Department of Health and Human Services, Division of Public Health before discontinuing precautions for *C. auris*.

TRANSMISSION AND EPIDEMIOLOGY

C. auris is thought to spread from person-to-person and via contaminated environmental surfaces, and spreads easily in health care settings. Since it often colonizes the skin, it widely contaminates the environment through skin shedding. *C. auris* can survive for weeks on environmental surfaces, so thorough environmental cleaning and frequent hand hygiene are essential to controlling its spread.

Patients who have been hospitalized in a health care facility for a long time, have indwelling devices, or have previously received antibiotics or antifungal medications are at the highest risk of acquiring a *C. auris* infection.

C. auris is much more common outside of the United States. **Any patient who has had an overnight stay in a health care facility outside the US in the last year should be screened for *C. auris*.** This screening is available at no cost to facilities or patients; please contact nchai@dhhs.nc.gov to arrange.

LABORATORY TESTING

One of the reasons *C. auris* is so concerning is that it can be difficult to identify in the lab. Many common types of lab equipment misidentify *C. auris* as another *Candida* species. Laboratories that speciate *Candida* isolates should be aware of [potential misidentifications](#) with the equipment they use. Speciation for suspect *C. auris* cases can be completed through public health laboratories at no cost to the submitter; please contact nchai@dhhs.nc.gov to arrange.

CONTROL MEASURES

Transmission-Based Precautions

Individuals who are colonized or infected with *C. auris* need to be placed on Transmission-Based Precautions for the duration of their stay in a health care facility, as *C. auris* is known to cause prolonged colonization that can persist even after multiple negative tests. Anyone who is colonized or infected with *C. auris* should be placed on Enhanced Barrier Precautions indefinitely, including for any future health care encounters. Given the highly transmissible nature of this organism, long-term care facilities may consider using Contact Precautions for individuals with *C. auris* until an infection control assessment has been completed in collaboration with public health to ensure all appropriate preventive measures are in place. Contact nchai@dhhs.nc.gov to arrange an infection control assessment if desired.

SCREENING

C. auris is uncommon in North Carolina, and public health authorities should be promptly notified of any suspected or confirmed *C. auris* cases. Contacts of the index case may need to be screened, which is conducted through the Antimicrobial Resistance Laboratory Network (ARLN) at no cost to facilities or patients.

ENVIRONMENTAL CLEANING AND HAND HYGIENE

Strict adherence to hand hygiene and environmental cleaning are key components of *C. auris* prevention and control. *C. auris* has been shown to widely contaminate the environment, including low-touch surfaces farther away from the patient such as windowsills, and can persist in the environment for several weeks. Thorough environmental disinfection is critical to preventing the spread of *C. auris*.

Environmental disinfection practices for *C. auris*:

- Cleaning and disinfection of the patient's room and all other areas where they received care should occur routinely (at least daily).
- Reusable medical equipment must be cleaned and disinfected after each use and should be dedicated to the patient if possible.
- **A sporicidal disinfectant must be used.**
 - ▶ Other cleaning products may not inactivate *C. auris*, even ones that are effective against other *Candida* species.
 - ▶ Disinfectants that have been proven to be effective against *C. auris* are found on the EPA's List P.
 - ▶ Quaternary ammonium compounds (QACs or "quats") are not effective against *C. auris*.

References:

- [Infection prevention and control for *C. auris*](#)
- [C. auris FAQ](#)
- [C. auris screening](#)

Vancomycin-intermediate and -resistant *Staphylococcus aureus* (VISA/VRSA)

Staphylococcus aureus is an organism that colonizes the skin or nose of about 30% of people.⁸ It usually doesn't cause problems but may result in superficial skin infections and can occasionally cause severe infections including bloodstream infections, pneumonia, endocarditis, and osteomyelitis. Many strains of *S. aureus* are resistant to the antibiotic methicillin, which is known as methicillin-resistant *S. aureus* (MRSA). Rarely, *S. aureus* can also become resistant to the antibiotic vancomycin. These bacteria are known as vancomycin-intermediate and vancomycin-resistant *S. aureus* (VISA/VRSA), depending on the level of resistance, and are a serious threat to public health.

TRANSMISSION AND EPIDEMIOLOGY

Like MRSA, VISA/VRSA are transmitted from person-to-person. In a health care setting, this often occurs via the hands of health care personnel or contact with contaminated equipment. Transmission can also occur through close skin-to-skin contact or contact with shared items or surfaces, such as towels or razors. Strategies to prevent MRSA transmission will also prevent transmission of VISA/VRSA; please see the references in the "Other MDROs" section of this chapter for additional details.

People who have serious underlying medical conditions, indwelling medical devices, or a recent history of MRSA or vancomycin use are at the highest risk of a VISA/VRSA infection.

LABORATORY TESTING

To test for VISA/VRSA, the organism is cultured, and antimicrobial susceptibility testing is performed. Minimum inhibitory concentration (MIC) is defined as the lowest concentration of an antibiotic that inhibits growth of the organism. If an organism requires an extremely high concentration of antibiotic to inhibit growth, that organism is considered resistant to that antibiotic. *S. aureus* isolates with a vancomycin MIC between 4-8 µg/ml are vancomycin-intermediate (VISA) and isolates with a vancomycin MIC ≥ 16 µg/ml are vancomycin-resistant (VRSA).

CONTROL MEASURES

Patients with VISA/VRSA colonization or infection should be immediately placed in a private room and on Enhanced Barrier Precautions (VISA) or Contact Precautions (VRSA). VISA and VRSA are very rare in North Carolina, and public health authorities should be immediately notified of any cases. Decisions about screening and discontinuing precautions will be made on a case-by-case basis in consultation with NC DPH and CDC.

References:

- [VISA/VRSA in healthcare settings](#)
- [Investigation and control of vancomycin-resistant *Staphylococcus aureus*](#)

Other MDROs (MRSA, VRE, ESBLs, etc.)

In addition to the above infections, there are many other MDROs of concern that may require Transmission-Based Precautions or other interventions to prevent transmission.

Recommendations for these MDROs vary by setting. For more information about other clinically significant MDROs, please visit the following links:

Methicillin-resistant *Staphylococcus aureus* (MRSA):

- [MRSA in healthcare settings](#)
- [Strategies to prevent MRSA transmission and infection in acute care hospitals](#)
- [Elimination of MRSA in long-term care facilities](#)

Vancomycin-resistant *Enterococci* (VRE):

- [VRE in healthcare settings](#)
- [Control of the Spread of Vancomycin-Resistant Enterococci in Hospitals](#)

Extended-spectrum beta-lactamase producing Enterobacterales (ESBLs):

- [ESBL-producing Enterobacterales | HAI | CDC](#)
- [Extended-spectrum \$\beta\$ -lactamases in Gram Negative Bacteria](#)

RECOMMENDATIONS FOR LONG-TERM CARE FACILITY (LTCF) RESIDENTS INFECTED OR COLONIZED WITH HIGH-CONCERN MDROS

Facility Recommendations	Carbapenemase-Producing CRE (CP-CRE)	Non-CP-CRE	C. auris	VISA	VRSA
Transmission-Based Precautions	Enhanced Barrier Precautions	Enhanced Barrier Precautions	Enhanced Barrier Precautions*	Enhanced Barrier Precautions	Contact Precautions
<i>Establish endpoint of transmission-based precautions with DPH</i>					
Room restrictions	No room restriction. As much as possible upon leaving their rooms, all residents should be clean with body fluids contained, compliant with infection prevention instructions, and should perform hand hygiene.				Room restriction**
Private room	When feasible	When feasible	Yes	Yes	Yes
Flag the chart to indicate precautions for future admissions	Yes	Yes	Yes	Yes	Yes
Notify transferring and receiving facilities	Yes	Yes	Yes	Yes	Yes
Consult with NC DPH regarding investigation	Yes	No	Yes	Yes	Yes
Dedicated or disposable equipment	Yes	Yes	Yes	Yes	Yes
If more than 1 case, can consider cohorting residents	Yes	Yes	Yes	Yes	Yes
Enhanced environmental cleaning	Yes	Yes	Yes	Yes	Yes
Visitor recommendations	<i>Visitors are encouraged to perform hand hygiene often, particularly after leaving the resident's room. Facilities may ask visitors to wear PPE like gowns and gloves when participating in high contact resident care. This is at the discretion of the facility. Visitors may also be asked to wear PPE when the facility is in an outbreak, discussed in consultation with NC DPH.</i>				

Adapted from: [Implementation of Personal Protective Equipment \(PPE\) Use in Nursing Homes to Prevent Spread of Multidrug-resistant Organisms \(MDROs\) \(cdc.gov\)](#)

* Facilities may consider placing people with *C. auris* on Contact Precautions until an infection control assessment has been completed

** Except for medically necessary care

Outbreak Response

An outbreak is defined as more cases than are expected during a certain time frame. Many of the MDROs discussed in this toolkit (e.g., *Candida auris*, VRSA, non-KPC CP-CRE) are rare enough that one case detected in a facility is an outbreak, while KPC CP-CRE is common enough that an outbreak is defined as three or more cases within a six-month period at a single facility.

During an outbreak, NC DHHS HAI team will work with the local health department (LHD) in order to investigate the outbreak and gather additional details to determine the next steps. This information may include, but is not limited to:

- All hospitalizations/health care exposures in the past 30-90 days, including the name of the facility, the dates of the encounter, and the unit(s) the patient was on
- What date the patient was placed on Transmission-Based Precautions, if applicable
- If the patient has had any recent roommates
- Any hospitalizations outside the US in the last 12 months

Depending on the organism, clinical circumstances, and facility layout, screening may be needed to determine if the organism has spread in the unit or facility. Screening is when specimens are collected via the rectum or axilla/groin with a swab and sent to an Antimicrobial Resistance Laboratory Network (ARLN) Lab for analysis.

If screening is indicated, the supplies and shipping are available to facilities at no cost. The NCDHHS HAI team will work with the LHD in order to determine how many collection kits are needed and have them delivered directly to the facility. Facilities simply need to collect specimens and package them for transport. Instructions for specimen collection and shipping guidance will be provided and should be precisely followed for successful testing.

If the LHD reaches out to a facility due to a suspected outbreak, there are steps the facility should take in order to streamline the process, such as:

1. Immediately place the index case on the proper Transmission-Based Precautions. Relocate them to a single room, if possible.
2. Document the index case's roommates within the last 3 months, if applicable.
3. Provide a layout of the facility.
4. Determine whether the index case has received care at any other health care facilities within the last 3 months.

5. Determine who will be the point of contact for the outbreak and provide contact information including **(Full name, email address, phone number, facility name and physical address for shipment)**

In general, variables such as facility layout, exposure, and level of risk for the population will determine the size of the screening. The LHD will communicate recommendations on which patient/residents should be screened. In many situations, it is recommended that facilities screen broadly and conduct a point prevalence survey, or PPS. PPS consists of screening all patients currently admitted to a unit where the index patient was admitted, including all units in the 30 days prior to specimen collection. If screening is needed, consult with NCDHHS Division of Public Health to coordinate.

The results of the screening will be shared with the facility via an email sent specifically to the facility point of contact. If all results are negative, additional screening is generally not required. the index case will need to remain on Transmission-Based Precautions while in a health care facility. If there is a positive result from screening, the newly identified case will need to be placed on Transmission-Based Precautions and placed in a single room, or cohorted with a case who has the same MDRO. Depending on the suspected route of transmission for the newly identified patient, expanded screening may be necessary.

ONGOING TRANSMISSION

If cases are detected after the initial screening, it is generally recommended that the facility expand screening criteria and **re-screen every two weeks until there are two consecutive rounds of negative results**. If there is ongoing transmission, the NCDHHS HAI team may determine that an assessment such as the Infection Control Assessment and Response (ICAR) is necessary in order to determine if there is a lapse in infection prevention. If there is a high population of patients receiving wound care, on-site wound care observation may be recommended. Once new infection prevention methods are implemented, it is important to continue screening until transmission is controlled, and no additional cases are identified.

Resources

- Implementation of Personal Protective Equipment (PPE) Use in Nursing Homes to Prevent Spread of Multidrug-resistant Organisms (MDROs). Available from <https://www.cdc.gov/hai/pdfs/containment/PPE-Nursing-Homes-H.pdf>
- Multidrug-resistant organisms (MDRO) Management, 2015. CDC. Available from [MDRO Management | Guidelines Library | Infection Control | CDC](#)
- Multidrug Resistance Organisms and Understanding Enhanced Barrier Precautions, 2021. North Carolina Statewide Program for Infection Control and Epidemiology (NC SPICE). Available from <https://spice.unc.edu/wp-content/uploads/2021/02/MDRO-RPST-webinar-PDF.pdf>.
- [Transmission-Based Precautions | Basics | Infection Control | CDC](#)
- [Prevention | Isolation Precautions | Guidelines Library | Infection Control | CDC](#)
- [WHO IPC Training tools](#)

REFERENCES

1. Antibiotic Resistance Threats in the United States, 2019. CDC. Available from <https://www.cdc.gov/drugresistance/pdf/threats-report/2019-ar-threats-report-508.pdf>
2. Antimicrobial Resistance Questions and Answers, 2022. CDC. Available from [Antimicrobial Resistance Questions and Answers | Antibiotic Use | CDC](#)
3. Hand Hygiene in Healthcare Settings: Show Me the Science, 2023. CDC. Available from <https://www.cdc.gov/handhygiene/science/index.html>
4. Glowicz J, Landon E, Sickbert-Bennett E, et al. SHEA/IDSA/APIC Practice Recommendation: Strategies to prevent healthcare-associated infections through hand hygiene: 2022 Update. *Infect Control Hosp Epidemiol* 2023;44(3), 355-376. doi:10.1017/ice.2022.304
5. Consideration for Use of Enhanced Barrier Precautions in Skilled Nursing Facilities, 2021. CDC. Available from <https://www.cdc.gov/hicpac/pdf/EnhancedBarrierPrecautions-H.pdf>
6. Fundamental Elements Needed to Prevent Transmission of Infectious Agents in Healthcare Settings, 2019. CDC. Available from [Prevention | Isolation Precautions | Guidelines Library | Infection Control | CDC](#)
7. Title 42, 2023. National Archives. Available from <https://www.ecfr.gov/current/title-42/chapter-IV/subchapter-G/part-483/subpart-B/section-483.80>
8. Clinicians: Information about CRE, 2019. CDC. Available from <https://www.cdc.gov/hai/organisms/cre/cre-clinicians.html>
9. Laux C, Peschel A, Krismer B. *Staphylococcus aureus* Colonization of the Human Nose and Interaction with Other Microbiome Members. *Microbiol Spectr*. 2019 Mar;7(2). doi: 10.1128/microbiolspec.GPP3-0029-2018. PMID: 31004422.