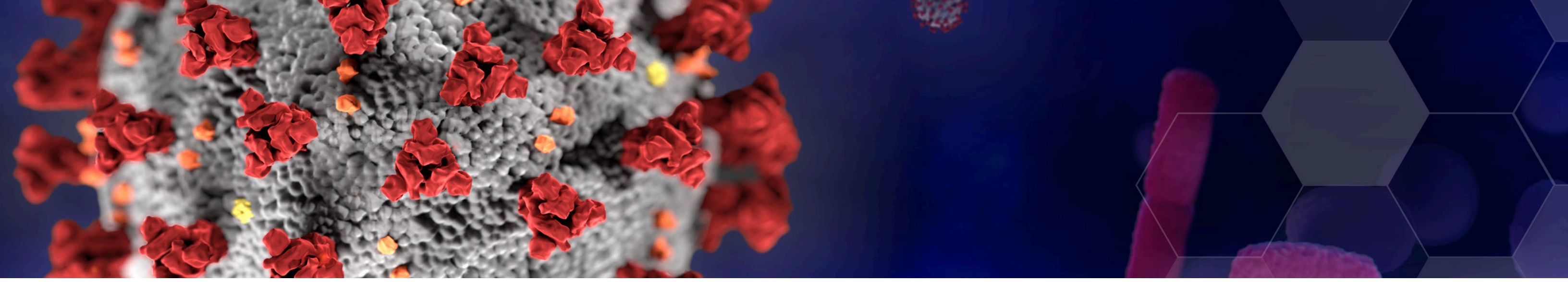


Foreword

As an infectious disease physician, I have a frontline understanding of antimicrobial resistance—when germs like bacteria and fungi defeat the drugs designed to kill them. **Antimicrobial resistance was one of our greatest public health concerns prior to the COVID-19 pandemic, and it remains so.**

Since 2013, CDC has been sounding the alarm about this potential pandemic threat in the United States across health care, the food supply, the environment, and the community. CDC showed as recently as 2019 that more than 3 million Americans acquire an antimicrobial-resistant infection or *Clostridioides difficile* infection (often associated with taking antimicrobials) each year. Nearly 50,000 people die from these threats. And a January 2022 report shows antimicrobial resistance is a leading cause of death globally, with the highest burden in low-resource countries.

After more than two years of responding to COVID-19, the threat of antimicrobial resistance is not only still present but has become an even more prominent threat. Germs continue to spread and develop new types of resistance. More investments are needed to continue addressing antimicrobial resistance while simultaneously responding to COVID-19 and other health threats.

In CDC's 2019 Antibiotic Resistance Threats Report, CDC showed that prevention is the most foundational and successful tool we have to protect people from antimicrobial-resistant infections and their spread. Between 2012 and 2017, deaths from antimicrobial resistance decreased by 18% overall and nearly 30% in hospitals. This is largely due to significant investments in U.S. prevention efforts, like improving infection prevention and control as well as antimicrobial use.

Rochelle P. Walensky, MD, MPH
Director, Centers for Disease Control and Prevention

However, as the pandemic pushed healthcare facilities, health departments, and communities near their breaking points in 2020, we saw a significant increase in antimicrobial use, difficulty in following infection prevention and control guidance, and a resulting increase in healthcare-associated, antimicrobial-resistant infections in U.S. hospitals.

In fact, CDC identified significant increases in infections across many healthcare-associated pathogens, such as carbapenem-resistant *Acinetobacter*, extended-spectrum beta-lactamase-producing Enterobacterales, vancomycin-resistant Enterococcus, and drug-resistant *Candida*. In fact, resistant hospital-onset infections and deaths both increased at least 15% during the first year of the pandemic.

Additionally, because many clinics and healthcare facilities limited services, served fewer patients, or closed their doors entirely in the face of challenges from COVID-19, there is a lack of data in 2020 for many pathogens that spread in the community, like sexually transmitted drug-resistant gonorrhea. Some laboratories experienced supply shortages, such as testing kits for sexually transmitted infections.

> These setbacks *can* and *must* be temporary. The COVID-19 pandemic has made it clear—prevention is preparedness.

In some instances, public health resources were forced to shift from tracking antimicrobial resistance to tracking COVID-19 cases.

The pandemic also greatly impacted antibiotic prescribing. Historic gains made on antibiotic stewardship were reversed as antibiotics were often the first option given to treat those who presented with a febrile pulmonary process even though this presentation often represented the viral illness of COVID-19, where antibiotics are not effective. Antibiotic and antifungal stewardship—one of our best prevention tools—remains critically important. These drugs are a shared resource, meaning that using antibiotics for one purpose or patient can impact how they work for another. We must be responsible stewards of these drugs, no matter where they are used, to prolong and preserve their efficacy and protect patients of today and tomorrow.

These setbacks *can* and *must* be temporary. The COVID-19 pandemic has made it clear—prevention is preparedness. **We must prepare our public health systems to fight multiple threats, simultaneously. Because antimicrobial resistance will not stop, we must meet the challenge.**

We must invest in the prevention-focused public health actions that we know work, such as accurate laboratory detection, rapid response and containment, effective infection prevention and control, and expansion of innovative strategies to combat antimicrobial resistance. These include alternatives to antibiotics and antifungals, new vaccines to combat infections that can develop antimicrobial resistance, and novel decolonizing agents to stop the spread of antimicrobial-resistant germs by people who may not know they are carriers.

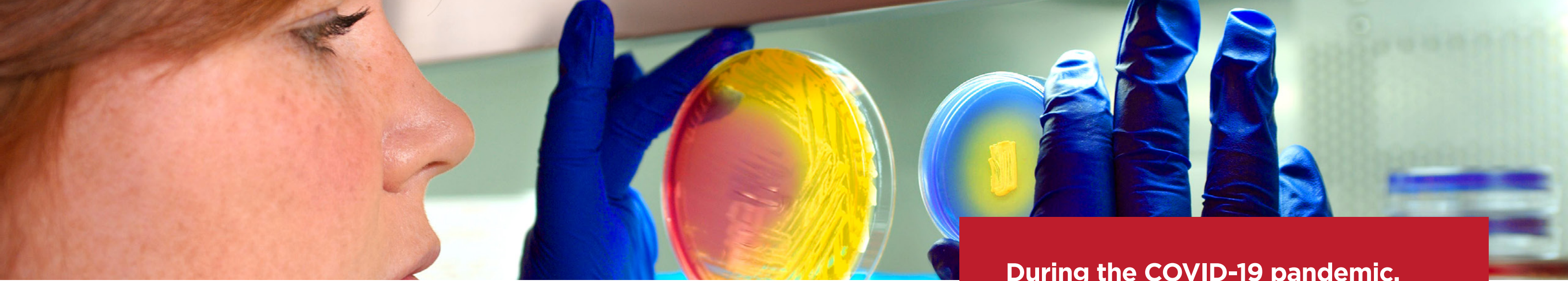
Although we have faced many obstacles in the United States over these past few years, we must stay focused on preparing for the next public health threat, whenever and wherever it emerges. The COVID-19 pandemic has showcased that the investments CDC has made in the antimicrobial resistance infrastructure are supporting flexibility and resiliency in public health systems. If properly resourced, we can continue to build a resilient public health system to keep our nation safe. The foundational capacity we need to address antimicrobial resistance will not only slow the spread of these infections but will also serve as an investment in the critical core capacity for public health threats.

The COVID-19 pandemic has taught us all hard lessons and has reminded us that the best way to prevent a looming antimicrobial-resistance pandemic is to invest in preparedness.

Now is the time for us to address our current antimicrobial-resistant threats, while simultaneously preparing for unknown emerging threats in the future.

During the COVID-19 pandemic, hospitals treated sicker patients who required more frequent and longer use of catheters and ventilators. Hospitals also experienced supply challenges, reduced staff, and longer visits during the pandemic.

Unprecedented challenges could have contributed to reduced comprehensive prevention practices, which are key to stopping antimicrobial-resistant infections and their spread.



During the COVID-19 pandemic, the detection and reporting of antimicrobial resistance data slowed tremendously because of changes in patient care, lab supply challenges, testing, treatment, and the bandwidth of healthcare facilities and health departments.

COVID-19 Impacts on

Antimicrobial Resistance Tracking and Data:

Enhance data systems and sharing to prevent infections and stay ahead of antimicrobial resistance

CDC uses several data sources and systems to track antimicrobial resistance in the United States and abroad. Knowing where and how changes in resistance are occurring helps us find solutions to prevent spread and slow resistance, especially in outbreak responses.[1]

Recently, the United States has been building a solid foundation for public health preparedness to address antimicrobial resistance.

- Some of thee CDC programs focused on antimicrobial resistance were repurposed during the pandemic to offer COVID-19 testing support or surge capacity to overwhelmed labs.
- Since 2016, CDC has used its Antimicrobial Resistance Laboratory Network (AR Lab Network) to detect known and emerging antimicrobial resistance in every state.
- It continued to collect isolates throughout 2020 using established processes, but some isolates remain untested due to testing backlogs.

> CDC's AR Lab Network received and tested 23% fewer specimens or isolates in 2020 than in 2019.[2]

The number of bacterial whole genome sequence (WGS) submissions to the AR Lab Network via PulseNet in 2020 was about 21% less than the average number of isolates analyzed 2015-2019 by WGS or legacy methods. This also reduced the number of sequences the National Antimicrobial Resistance Monitoring System for Enteric Bacteria (NARMS) used to predict antimicrobial resistance related to intestinal illnesses.

More resources are needed to continue establishing a resilient public health system that can maintain capacity to respond to antimicrobial resistance while also responding to other threats. Without an infrastructure and supply chains grounded in preparedness, critical antimicrobial resistance data will be delayed again when the next threat emerges. We must address gaps identified before the COVID-19 pandemic, including expanding the public health workforce, increasing local access to the best detection tools and technology, and expanding global lab capacities.

Infections in the Community

- During the COVID-19 pandemic, many bacterial and fungal infections went potentially undiagnosed and untreated. The COVID-19 pandemic changed healthcare-seeking behavior and access to health care when outpatient clinics closed or limited appointments, resulting in fewer in-person visits. For example, people with mild intestinal infections that cause diarrhea may have let the illness run its course at home instead of seeking care. This may have also been the case for respiratory infections, such as those caused by *Streptococcus pneumoniae*.
- Rapid treatment can keep patients from getting sicker, prevent the pathogen from spreading, and slow the development of resistance. For example, if left undetected and untreated, gonorrhea can cause serious health complications and continue circulating in a community, increasing the chances of it developing resistance to available treatments.
- Another example is tuberculosis (TB), which is spread through the air. TB is treatable and curable, but people with TB can die if they do not get proper treatment. In 2020, reported TB cases substantially decreased in the United States, probably due to factors related to the COVID-19 pandemic, including undiagnosed cases (a result of decreased medical visits) and misdiagnosed cases. Decreases in immigration and increased use of respiratory control practices may also have contributed to the decline in cases.

Because of pandemic impacts, 2020 data are delayed or unavailable for 9 of the 18 antimicrobial resistance threats.

- *Clostridioides difficile (C. diff)*
- Drug-resistant *Neisseria gonorrhoeae*
- Drug-resistant *Campylobacter*
- Drug-resistant nontyphoidal *Salmonella*
- Drug-resistant *Salmonella* serotype Typhi
- Drug-resistant *Shigella*
- Drug-resistant *Streptococcus pneumoniae*
- Erythromycin-resistant group A *Streptococcus*
- Clindamycin-resistant group B *Streptococcus*

Available data show an alarming increase in resistant infections starting during hospitalization, growing at least 15% from 2019 to 2020.

- Carbapenem-resistant *Acinetobacter* (↑78%)
- Antifungal-resistant *Candida auris* (↑60%)*
- Carbapenem-resistant Enterobacterales (↑35%)
- Antifungal-resistant *Candida* (↑26%)
- ESBL-producing Enterobacterales (↑32%)
- Vancomycin-resistant Enterococcus (↑14%)
- Multidrug-resistant *P. aeruginosa* (↑32%)
- Methicillin-resistant *Staphylococcus aureus* (↑13%)

**Candida auris* was not included in the hospital-onset rate calculation of 15%. See Data Table and Methods for more information on this pathogen.

Invest in Adaptable Programs

Established networks, like the AR Lab Network, can be tapped into during an emergency, offering foundational strength and flexibility when challenges arise.

The seven regional labs in CDC's AR Lab Network supported each other during the pandemic to maintain critical national testing for antimicrobial resistance. Some labs offered tests outside of their typical regions when others were challenged by supply shortages or staff and equipment were diverted to COVID-19 testing.

The National Tuberculosis Molecular Surveillance Center used its AR Lab Network sequencing capacity to study SARS-CoV-2, the virus that causes COVID-19. The lab sequenced more than 4,700 SARS-CoV-2 genomes in 2020 to support contact tracing and help stop the virus from spreading. These collaborations display the flexibility of the AR Lab Network and how CDC's antimicrobial resistance investments can be adapted during a crisis.

> The AR Lab Network sequenced more than 4,700 SARS-CoV-2 genomes in 2020 to support COVID-19 contact tracing and help stop the virus from spreading.

ARLABnetwork

What's Next: CDC is exploring investments in the U.S. infrastructure to better respond to the challenges of antimicrobial resistance and emerging threats simultaneously.

- Supporting uninterrupted laboratory supplies and equipment for patient care, infection control, and data tracking during emergencies and surge outbreaks.
- Merging strategies to respond to COVID-19 and antimicrobial resistance, such as using telehealth for contact tracing, supporting specimen self-collection, or offering express clinics that allow walk-in testing for sexually transmitted infections.
- Expanding the use of automated data to the National Healthcare Safety Network (NHSN) to reduce manual data collection and submission, which would allow healthcare facilities to send information on antibiotic use and antimicrobial resistance.

Pandemic-related challenges hindered many infection prevention and control practices like hand hygiene, cleaning equipment, separating patients, and using personal protective equipment (PPE)—undoing some progress on combating antimicrobial resistance.

COVID-19 Impacts on
Preventing Infections:
Prevent infections and reduce the spread of germs

Antimicrobial-resistant infections are amplified in health care. Germs spread among patients and across facilities. The inpatient population in 2020 was very different from the pre-pandemic population—hospitals saw higher numbers of sicker patients (hospitalization could not be avoided) who needed an extended length of stay. This increased their risk for resistant infections.

When done consistently and correctly, preventing infections is one of our greatest tools for combating antimicrobial resistance and saving lives.[3] We must continue building the national capacity for infection prevention and control to ensure these practices are put into action consistently.

As of 2017, dedicated infection prevention and control efforts in the United States contributed to reduced deaths from antimicrobial-resistant infections by 18% overall and by nearly 30% in hospitals.[4] However, the pandemic has undone much of this progress.

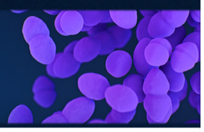
- Resistant hospital-onset infections and deaths both increased at least 15% during the first year of the pandemic. In a 2021 analysis, CDC also reported that, after years of steady reductions in healthcare-associated infections (HAIs), U.S. hospitals saw significantly higher rates for four out of six types of HAIs in 2020.[5] Many of these HAIs are resistant to antibiotics or antifungals.
- There were more and sicker patients during the pandemic who required more frequent and longer use of catheters and ventilators. This may have increased risk of HAIs and spread of pathogens, especially when combined with personal protective equipment and lab supply challenges, reduced staff, and longer lengths of stay.
- Acute care hospitals also saw more *Candida auris* cases, including in COVID-19 units.[6] *C. auris* has previously been a threat in post-acute care facilities (e.g., long-term care). The increased spread in hospitals could be a result of staffing and supply shortages and changes in infection prevention and control practices.

The United States has been building a solid foundation for public health preparedness and health systems resilience to address antimicrobial resistance. Before 2020, CDC highlighted the need for a strong foundation for health departments and healthcare facilities to rapidly identify and contain threats before they can spread. Prior to the pandemic, the *U.S. National Strategy for Combating Antibiotic-Resistant Bacteria* (CARB National Action Plan) set a goal that CDC double its investments in health departments to increase infection control and other prevention efforts.[7] In 2021, the U.S. government provided temporary funding to health departments through the COVID-19 pandemic that addresses some of these gaps. However, health departments will need sustainable resources to ensure these capacities can continue.

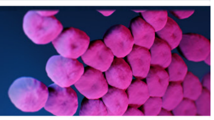
Preventing infections is one of the greatest tools for combating antimicrobial resistance—saving lives and reducing healthcare costs.

6 of the **18** most alarming **antimicrobial resistance** threats cost the U.S. more than **$4.6 billion annually**[8]

Vancomycin-resistant ***Enterococcus (VRE)***



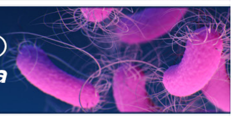
Carbapenem-resistant ***Acinetobacter species***



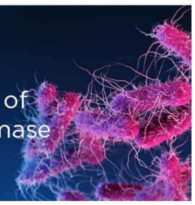
Methicillin-resistant ***Staphylococcus aureus (MRSA)***

Carbapenem-resistant **Enterobacterales (CRE)**

Multidrug-resistant (MDR) ***Pseudomonas aeruginosa***



Extended-spectrum cephalosporin resistance in Enterobacterales suggestive of extended- spectrum β-lactamase **(ESBL)** production



Investing in Healthcare Training & Education

It is essential to train anyone working in a healthcare setting on infection prevention and control and to maintain these practices to protect themselves, their coworkers, and their patients. CDC's Project Firstline was developed at the start of the pandemic to meet the infection control educational needs of the diverse U.S. healthcare workforce. Investing in healthcare workers, health departments, and programs like Project Firstline:

- Strengthens capacity to prevent, detect, and contain outbreaks of COVID-19 and antimicrobial-resistant infections.
- Expands infection prevention and control training and education to all types of healthcare staff.
- Allows local jurisdictions to provide surge capacity to facilities for clinical services.

In its first year, Project Firstline and partners:[9]

- Developed more than 130 educational products on proper infection prevention and control practices for COVID-19.
- Trained 33,300 U.S. healthcare workers via 300 educational infection prevention and control events.
- Registered more than 6,500 healthcare workers in continuing education courses through CDC's online learning platform.
- Launched an initiative with the American Hospital Association and the League for Innovation in the Community College to integrate enhanced infection prevention and control content into healthcare training at community colleges, including addressing disparities in healthcare training and access to resources for first generation or non-English speaking students.

Assessments During the Pandemic Identified Infection Control Gaps

From January through July 2020, CDC's investments to build capacity in state and local health departments allowed them to perform 14,259 consultations in response to potential COVID-19 outbreaks at healthcare facilities.[10]

14,259
Consultations

Outbreak consultations frequently included infection control assessments, which were conducted onsite or remotely using CDC's Infection Control Assessment and Response tools or similar tools adapted at the state or local level.

2,105
Onsite assessments

4,151
Remote assessments

Most of these assessments occurred in nursing homes or assisted living facilities.

Long-term care facilities

Infection control assessments and consultations were a critical component of the response to COVID-19 outbreaks, allowing facilities to rapidly address gaps in infection control practices and reduce the spread of COVID-19.

Closing infection control gaps

What's Next: CDC is exploring investments in the U.S. infrastructure to better respond to the challenges of antimicrobial resistance and emerging threats simultaneously.

- Continuing to extend high-quality infection prevention and control training to all healthcare professionals.
- Increasing infection prevention and control implementation in facilities beyond hospitals, such as nursing homes and other long-term care facilities.
- Communicating clearly to the public and fostering conversations on topics like how germs spread and the importance of keeping hands clean.
- Identifying barriers to implementing and developing plans to maintain quality infection prevention and control practices while supporting efforts to respond to new threats.
- Increasing investments in state and local health departments, as part of the CARB National Action Plan.

While antibiotic use throughout the pandemic varied across healthcare settings, antibiotics were commonly prescribed to patients for COVID-19—even though antibiotics are not effective against viruses.

COVID-19 Impacts on
Antibiotic Use:

Improve the use of antibiotics wherever they are used and improve access

When a patient (human or animal) receives an antibiotic they do not need, not only does the patient get no benefit, but they are also put at risk for side effects (e.g., allergic reactions, toxicity that affects organ function, *C. diff*). Evidence suggests that 1 in 5 hospitalized patients who receive an antibiotic has an adverse drug event.[22]

When COVID-19 cases increased in hospitals, so did antibiotic use. Antibiotics were frequently started upon admission, but several studies have shown that patients who had COVID-19 were rarely also infected with bacteria when admitted.[11,12]

Antibiotics and antifungals can save lives, but any time they are used—for people, animals, or plants—they can contribute to resistance.

Antibiotic Use Varied During the COVID-19 Pandemic

Hospitals

- From March 2020 to October 2020, almost 80% of patients hospitalized with COVID-19 received an antibiotic.[13]
- Antibiotic use was lower overall as of August 2021 compared to 2019 but increased for some antibiotics like azithromycin and ceftriaxone. Approximately half of hospitalized patients received ceftriaxone, which was commonly prescribed with azithromycin.
- This likely reflects difficulties in distinguishing COVID-19 from community-acquired pneumonia when patients first arrive at a hospital for assessment.

Outpatient Settings

- Antibiotic use significantly dropped in 2020 compared to 2019 due to less use of outpatient health care and less spread of other respiratory illnesses that often lead to antibiotic prescribing.
- However, in 2021 outpatient antibiotic use rebounded. While antibiotic use was lower overall in 2021 compared with 2019, in August 2021, antibiotic use exceeded prescribing in 2019 by 3%.
- From 2020 through December 2021, most antibiotic prescriptions for adults were for azithromycin and increases in azithromycin prescribing corresponded to peaks in cases of COVID-19. After an initial peak in azithromycin prescribing in March 2020, azithromycin use decreased during the pandemic.
- By August 2021, there was still more azithromycin prescribing than in August 2019.

Nursing Homes

- Antibiotic use in nursing homes spiked alongside surges of COVID-19 cases but remains lower overall.
- However, azithromycin use was 150% higher in April 2020 and 82% higher in December 2020 than the same months in 2019. Azithromycin prescribing remained elevated through October 2020.
- In 2021, antibiotic use overall was, on average, 5% lower than 2019. This decrease might be due to fewer nursing home residents during this time.

Public health must continue educating consumers, healthcare providers, and industry on the value, risks, and best practices of antibiotics and antifungals.

- These drugs are often a treatment option for emerging infectious diseases, particularly when no other treatment options are available or known.
- While some of this prescribing can be appropriate when risks for related bacterial or fungal infections are unknown, this antibiotic prescribing can also put patients at risk for side effects and further the pressure for resistance to develop and spread.
- Healthcare workers can protect patients by ensuring antibiotics and antifungals are only used when they are effective and needed, such as to treat life-threatening conditions caused by fungi or bacteria, like sepsis.

The United States has been building a solid foundation for public health preparedness to address antimicrobial resistance.

- Prior to the pandemic, CDC's Core Elements of Antibiotic Stewardship (Core Elements) helped many hospitals improve their antibiotic use. In 2020, more than 90% of U.S. hospitals had an antibiotic stewardship program aligned with CDC's Core Elements.[14]
- As part of the CARB National Action Plan, CDC aims to continue this progress in outpatient settings.
- CDC also aims to support and encourage antimicrobial resistance preventives, such as decolonization therapies, and vaccines coming to market. This will help reduce antibiotic and antifungal use by preventing infections from occurring or offering alternative treatments to these important drugs.

NHSN
NATIONAL HEALTHCARE SAFETY NETWORK

Tracking Antibiotic Use to Optimize Prescribing Practices

CDC's NHSN allows healthcare facilities to automate monitoring antibiotic use. These data inform interventions to optimize prescribing, which improves treatment effectiveness, protects patients from harms caused by unnecessary antibiotic use, and slows antimicrobial resistance. In CDC's 2019 AR Threats Report, CDC noted that tracking antibiotic use in settings like nursing homes and long-term care facilities is often non-existent or difficult to implement.

While more work needs to be done to improve tracking antibiotic use and stewardship efforts, the number of hospitals reporting antibiotic use data from 2018 through 2021 more than doubled. This helps CDC and facilities better monitor prescribing and use.

What's Next: **CDC is exploring investments in the U.S. public health infrastructure to better respond to the challenges of antimicrobial resistance and emerging threats simultaneously.**

- Optimizing antibiotic and antifungal use across all healthcare settings and wherever they are used.
- Continuing to improve antibiotic and antifungalprescribing and use across healthcare settings, including encouraging use of CDC's NHSN antibiotic use module for reporting and implementing CDC's Core Elements across settings.
- Tracking antibiotic and antifungal prescribing and evaluation for improvements toward optimal use.
- Enhancing communication of the latest antibiotic and antifungal use recommendations and guidance to healthcare workers.
- Supporting the development of new vaccines to address antimicrobial-resistant pathogens and other conditions for which antibiotics and antifungals are commonly prescribed.
- Working with partners to promote optimal antibiotic and antifungal use and appropriate tracking for companion animals and plant agriculture.
- Supporting basic and applied research and development for new antibiotics and antifungals, therapeutics, and vaccines.

COVID-19 Impacts on

Environment (e.g., water, soil) and Sanitation:

Addressing antimicrobials and antimicrobial-resistant threats in the environment

Antimicrobial resistance is a One Health issue, impacting the health of humans, animals, plants, and the environment. Efforts to identify antimicrobial-resistant germs, track the spread of resistance, and measure the effect of antibiotic or antifungal use require a One Health approach to surveillance.

While more research is needed to better understand how resistance develops and spreads in the environment, we do know that people can contaminate it through fecal waste. In 2018, CDC funded the University of South Carolina (U of SC) to measure resistance genes in wastewater and in treatment plant workers at municipal wastewater treatment plants.[15]

When the pandemic started, CDC recognized that the research platform to look for resistance in wastewater could also look for SARS-CoV-2 RNA (which carries genetic information) as a marker of COVID-19 in communities. Through supplementary funding to support the COVID-19 response, CDC and U of SC built upon the initial surveillance project. This work confirmed appropriateness of existing safety precautions and informed guidance drafted by partners.

CDC is looking at ways to expand surveillance through existing systems to monitor antimicrobial resistance from multiple sources across One Health. CDC is also helping to strengthen the national infrastructure for antimicrobial resistance surveillance data by improving capacity, utility, timeliness, and the use of harmonized terminology.

Exploring New Public Health Tools to Slow Resistance

Community level wastewater surveillance can help public health detect antimicrobial resistance, including new threats, before they are detected in clinical samples.[16] Wastewater from healthcare facilities could also be a key source of resistant germs, resistant genes, and antibiotic or antifungal residues. Hospital patients can have some of the most resistant infections and are commonly prescribed antibiotics or antifungals.

Monitoring healthcare facility wastewater could provide a non-invasive approach to identifying resistance in a facility and aid in decision making, like performing screening to identify cases early and implement appropriate interventions to prevent spread. Researchers could look for genes that confer resistance, especially to last-line drugs like carbapenems and colistin, to identify resistance that might be present but not yet detected in the healthcare setting.

In 2020, researchers leveraged an existing project funded by CDC's AR Solutions Initiative focused on antimicrobial resistance to better understand the burden of COVID-19 in communities—using wastewater, also called sewage.

5 Benefits of Wastewater Surveillance for Antimicrobial Resistance[17]

1. **Captures silently spreading germs.** People infected with antimicrobial-resistant germs will shed these germs in their stool or wash water, whether they have symptoms or not.
2. **Operates independent of healthcare and clinical capacity.** Antimicrobial-resistant pathogens that are causing illness are still detected even if a person does not go to a healthcare professional or have access to testing.
3. **Is efficient.** One sample of wastewater can represent millions of people in a large wastewater system.
4. **Moves fast—from toilet to data in a week or less.** This allows more time to prepare a public health response compared to clinical data.
5. **Provides an early warning system.** Potentially less costly and more effective as an early warning alert system for emerging threats compared to clinical surveillance. This makes it a suitable option to provide a broad snapshot, especially for places with limited existing surveillance and resources.

AR Pathogens Cause Infections Across the One Health Spectrum

In September 2020, CDC established the National Wastewater Surveillance System (NWSS) to provide community-level data on COVID-19 infection trends by looking for markers in wastewater that tell scientists when SARS-CoV-2 is present.[18] CDC currently funds 43 public health jurisdictions to support wastewater activities across 37 states, 4 cities, and 2 territories. By May 2022, NWSS had received data from more than 59,000 wastewater samples from more than 900 sites nationwide.

The United States has been building a solid foundation for public health preparedness to address antimicrobial resistance. The CARB National Action Plan includes a One Health approach, with an expanded effort to understand antimicrobial resistance in the environment. A main challenge to implementing a One Health approach includes the need to better understand the scale and risk to human health associated with antimicrobial resistance in the environment. In addition to efforts related to wastewater surveillance, CDC is also supporting other environmental projects to better understand how antibiotics, antifungals, and antimicrobial-resistant pathogens can spread in water and soil.

Antimicrobial resistance is a One Health issue, impacting humans, animals, plants, and the environment.

What's Next: **CDC is exploring investments in the U.S. public health infrastructure to better respond to the challenges of antimicrobial resistance and emerging threats simultaneously.**

- Expanding the capacity of NWSS to collect antimicrobial resistance data from wastewater treatment plants and healthcare facilities to continue infectious disease surveillance.
- Studying antimicrobial resistance in community and healthcare wastewater, domestically and globally.
- Expanding global capacities to fight antimicrobial resistance in the environment, as part of the CARB National Action Plan.
- Mapping existing antimicrobial resistance ecology across One Health and monitoring shifts over time, as part of the CARB National Action Plan.

COVID-19 Impacts on

Vaccines, Diagnostics, and Therapeutics:

Invest in development and improved access to vaccines, therapeutics, and diagnostics for better prevention efforts, treatment, and detection

The COVID-19 pandemic highlighted the need to stop the spread of germs before they can cause an infection. Developing therapeutic and preventive products requires dedicated resources and policies to support research, turn discoveries into products, collect data for drug approval, facilitate clinical trials, and conduct post market evaluations on impact.

Vaccines can significantly reduce infection rates, which decreases antibiotic use and the number of resistant germs. For example, drug-resistant *S. pneumoniae* is one of the only germs listed in this report with effective vaccines to prevent infections, including pneumococcal conjugate vaccines (PCVs). The PCV13 vaccine, which the U.S. Food and Drug Administration (FDA) licensed in 2010, protects people from 13 types of pneumococcus, including resistant forms. This vaccine prevented more than 30,000 cases of invasive pneumococcal disease and 3,000 deaths from 2010 to 2013 alone.[19]

> Importantly, the PCV13 vaccine also prolonged the efficacy of the oldest antimicrobial—penicillin—by preventing more resistant forms of pneumococcus.

In 2021, two new pneumococcal conjugate vaccines were licensed for adults—PCV15 and PCV20. With additional serotypes included in these vaccines, even more cases of pneumococcal disease should be prevented.

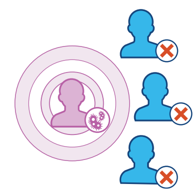
Research on novel products, like decolonizing agents, can also help reduce the impact of antimicrobial resistance. Some people carry antimicrobial-resistant pathogens in the nose, skin, lungs, or digestive tract without becoming sick or showing symptoms, known as colonization. These germs can eventually cause an infection or people can spread these germs to others.

The CARB National Action Plan supports innovative approaches to developing and deploying diagnostic tests and treatment strategies. Limited return on investment for new diagnostics is also a significant challenge, and the development pathways for some non-antibiotic/antifungal therapeutics remain uncharted.

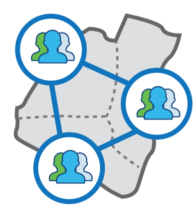
The COVID-19 pandemic highlighted the importance of prevention. Treatment after an infection occurs is not the only solution and should not be the only option. We need more prevention products, not just new drugs, to stop infections before they happen.

Decolonization is a Great ROI

People can carry resistant germs without symptoms of infection. CDC has invested in decolonization research and testing through CDC's AR Lab Network to stop the silent spread of these dangerous pathogens.



During the pandemic, CDC and the University of California, Irvine leveraged an existing regional public health collaborative with 40 healthcare facilities, including hospitals, long term-acute care hospitals, and nursing homes to conduct COVID-19 outreach to 70 Orange County nursing homes.



Facilities stopped the spread of COVID-19 by using enhanced infection prevention trainings paired with decolonization methods.[20] Staff continue to receive training and are monitoring for additional spread.

New decolonization agents are needed to make colonized patients less infectious and slow the spread and development of antimicrobial resistance.

INVESTING IN INNOVATION, 2016-2020

The United States has been building a solid foundation for public health preparedness to address antimicrobial resistance. Since 2016, CDC has funded more than 300 projects and collaborated with more than 100 public and private institutions.[21] Data from these projects help CDC better protect people by uncovering places resistant germs live and spread, improving outbreak response, and strengthening infection prevention and control practices. The United States must continue exploring and using innovative solutions to address the gaps identified in combating antimicrobial resistance, which will also prepare the country for new emerging threats.

Since 2016, CDC has invested more than $160 million in research to address knowledge gaps with scalable, innovative solutions such as vaccines, therapeutics, diagnostics and other prevention tools.

What's Next: CDC is exploring investments in the U.S. public health infrastructure to better respond to the challenges of antimicrobial resistance and emerging threats simultaneously.

- Supporting more innovation and research on therapeutics, vaccines, and diagnostics.
- Enhancing interagency collaborations to accelerate research for developing new antibiotics, antifungals, therapeutics, and vaccines, including working with FDA to identify ways to support decolonization products.
- Working to undo negative impacts the COVID-19 pandemic may have had on essential vaccine conversations.
- Supporting the widespread use of vaccines to prevent infections, slow the spread of resistance, and reduce antibiotic use.
- Building a vaccine data platform to inform and accelerate the development of new vaccines, stopping infections before they start, as part of the CARB National Action Plan.

COVID-19 Impacts on

18 Antimicrobial-Resistant Bacteria and Fungi

Threat Estimates

The following table summarizes the latest national death and infection estimates for 18 antimicrobial-resistant bacteria and fungi. The pathogens are listed in three categories—urgent, serious, and concerning—based on level of concern to human health identified in 2019.

Category	Resistant Pathogen	2017 Threat Estimate	2018 Threat Estimate	2019 Threat Estimate	2017-2019 Change	2020 Threat Estimate and 2019-2020 Change
URGENT	Carbapenem-resistant *Acinetobacter*	8,500 cases 700 deaths	6,300 cases 500 deaths	6,000 cases 500 deaths	Stable*	7,500 cases 700 deaths **Overall: 35% increase*** **Hospital-onset: 78% increase***
URGENT	Antifungal-resistant *Candida auris*	171 clinical cases†	329 clinical cases	466 clinical cases	Increase	754 cases **Overall: 60% increase**
URGENT	*Clostridioides difficile*	223,900 infections 12,800 deaths	221,200 infections 12,600 deaths	202,600 infections 11,500 deaths	Decrease	Data delayed due to COVID-19 pandemic
URGENT	Carbapenem-resistant Enterobacterales	13,100 cases 1,100 deaths	10,300 cases 900 deaths	11,900 cases 1,000 deaths	Decrease*	12,700 cases 1,100 deaths Overall: Stable* **Hospital-onset: 35% increase***
URGENT	Drug-resistant *Neisseria gonorrhoeae*	550,000 infections	804,000 infections	942,000 infections	Increase	Data unavailable due to COVID-19 pandemic
SERIOUS	Drug-resistant *Campylobacter*	448,400 infections 70 deaths	630,810 infections	725,210 infections	Increase	Data delayed due to COVID-19 pandemic‡ 26% of infections were resistant, a 10% decrease
SERIOUS	Antifungal-resistant *Candida*	34,800 cases 1,700 deaths	27,000 cases 1,300 deaths	26,600 cases 1,300 deaths	Decrease*	28,100 cases 1,400 deaths **Overall: 12% increase*** **Hospital-onset: 26% increase***
SERIOUS	ESBL-producing Enterobacterales	197,400 cases 9,100 deaths	174,100 cases 8,100 deaths	194,400 cases 9,000 deaths	Increase*	197,500 cases 9,300 deaths **Overall: 10% increase*** **Hospital-onset: 32% increase***
SERIOUS	Vancomycin-resistant Enterococcus	54,500 cases 5,400 deaths	46,800 cases 4,700 deaths	47,000 cases 4,700 deaths	Stable*	50,300 cases 5,000 deaths **Overall: 16% increase*** **Hospital-onset: 14% increase***

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	Resistant Pathogen	2017 Threat Estimate	2018 Threat Estimate	2019 Threat Estimate	2017-2019 Change	2020 Threat Estimate and 2019-2020 Change
SERIOUS	Multidrug-resistant *Pseudomonas aeruginosa*	32,600 cases 2,700 deaths	29,500 cases 2,500 deaths	28,200 cases 2,400 deaths	Decrease*	28,800 cases 2,500 deaths Overall: Stable* **Hospital-onset: 32% increase***
SERIOUS	Drug-resistant nontyphoidal *Salmonella*	212,500 infections 70 deaths	228,290 infections	254,810 infections	Increase	Data delayed due to COVID-19 pandemic‡ 14% of infections were resistant, a 3% decrease
SERIOUS	Drug-resistant *Salmonella* serotype Typhi	4,100 infections <5 deaths	4,640 infections	6,130 infections	Increase	Data delayed due to COVID-19 pandemic‡ 85% of infections were resistant, a 10% increase
SERIOUS	Drug-resistant *Shigella*	77,000 infections <5 deaths	215,850 infections	242,020 infections	Increase	Data delayed due to COVID-19 pandemic‡ 46% of infections were resistant, a 2% increase
SERIOUS	Methicillin-resistant *Staphylococcus aureus*	323,700 cases 10,600 deaths	298,700 cases 10,000 deaths	306,600 cases 10,200 deaths	Stable*	279,300 cases 9,800 deaths Overall: Stable* **Hospital-onset: 13% increase***
SERIOUS	Drug-resistant *Streptococcus pneumoniae*	12,100 invasive infections 1,500 deaths†	See pathogen page if comparing data over time	12,000 invasive infections 1,200 deaths	Stable	Data delayed due to COVID-19 pandemic
SERIOUS	Drug-resistant Tuberculosis (TB)	888 cases 73 deaths†	962 cases 102 deaths	919 cases	Stable	661 cases Decrease‡
CONCERNING	Erythromycin-resistant group A *Streptococcus*	5,400 infections 450 deaths†	See pathogen page if comparing data over time	6,200 infections 560 deaths	Increase	Data delayed due to COVID-19 pandemic
CONCERNING	Clindamycin-resistant group B *Streptococcus*	13,000 infections 720 deaths†	See pathogen page if comparing data over time	15,300 cases 940 deaths	Increase	Data delayed due to COVID-19 pandemic

See the Data Methods section for definitions of each pathogen.

†CDC's database allows for continuous updates for TB, *C. auris*, and *Streptococcus*. Variations in historical TB data are attributable to updated information submitted in the interim by reporting areas; this report includes data reported through June 14, 2021. For *Streptococcus*, table reflects infection increase for 2017 data as of October 2021. For *C. auris*, this report reflects clinical case increase for 2018 data.

*Changes are in rates, not comparisons of counts. Data for healthcare pathogens show a significant increase in hospital-onset rates of resistant infections in 2020, likely due to smaller number of overall hospitalizations during the pandemic.

‡For TB, 2019 and 2020 death reports are not available due to a 2-year lag. For enteric pathogens, 2018-2020 death estimates and 2020 estimates of total number of resistant infections are not available at this time.

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Carbapenem-resistant *Acinetobacter*

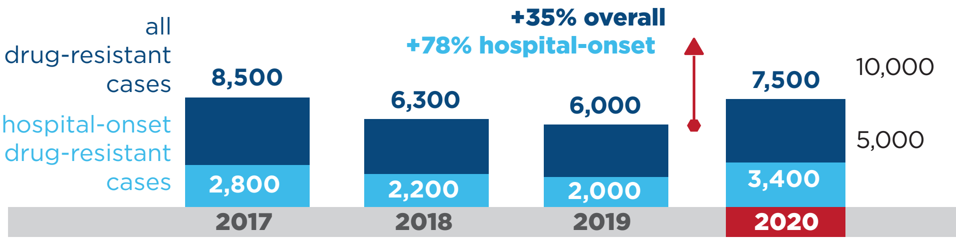
A threat to sick, hospitalized patients, often resistant to nearly all antibiotics

The rate of carbapenem-resistant *Acinetobacter* cases increased overall by 35% in 2020 compared with 2019, driven by hospital-onset cases.

U.S. healthcare facilities reported outbreaks of carbapenem-resistant *Acinetobacter* in 2020. Possible contributing factors included increased number of sicker patients, shortages in personal protective equipment, and staffing shortages.

Many carbapenem-resistant *Acinetobacter* infections tend to occur in patients in intensive care units. Due to the pandemic, hospitals saw more patients who needed an extended length of stay. This increased their risk for resistant infections.

The rates of hospital-onset carbapenem-resistant *Acinetobacter* cases decreased 2012-2017, began to plateau, then increased 78% in 2020.



Data from 2018–2020 are preliminary.

What's Next

- CDC's AR Lab Network identifies carbapenem-resistant *Acinetobacter* infections in every state and is expanding colonization screening for asymptomatic carriage of carbapenem-resistant organisms.
- CDC supports healthcare training programs like Project Firstline to help stop the spread of pathogens.
- CDC increased surveillance and infection prevention and control capacity through the American Rescue Plan Act of 2021 to strengthen efforts to reduce the spread of resistant pathogens in U.S. communities.

Antifungal-resistant *Candida auris*

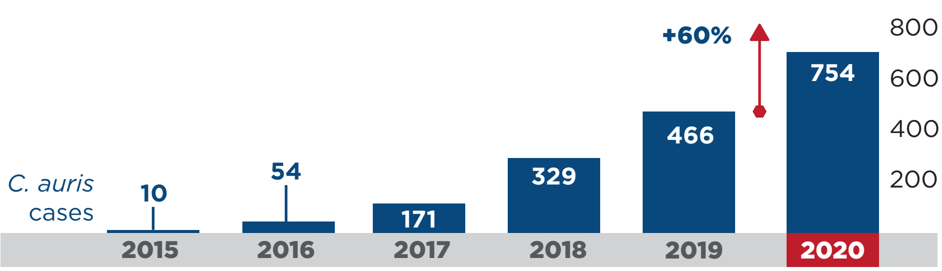
Can cause severe infections and can be resistant to all three major antifungal drug classes

***C. auris* clinical cases increased about 60% in 2020 compared to 2019. The COVID-19 pandemic likely intensified spread of *C. auris* and hindered detection of additional cases.**

Post-acute care facilities (e.g., long-term care), where most cases were identified pre-pandemic, were heavily impacted by *C. auris* during the pandemic. Acute care hospitals saw more outbreaks of *C. auris* in 2020 than previous years, especially in COVID-19 units.

C. auris surveillance activities, particularly colonization screening, were negatively impacted when resources were diverted to the COVID-19 response. This likely resulted in undetected spread of *C. auris* and undercounting of 2020 cases.

C. auris clinical cases have steadily increased since 2015 and significantly increased in 2020. The increase in 2020 could be a result of staffing and supply shortages, an increased number of sicker patients, and changes in infection prevention and control practices (e.g., re-use or extended use of gowns and gloves).



What's Next

- The rapid rise in cases is concerning and emphasizes the need for continued surveillance, expanded lab capacity, quicker diagnostic tests, and robust infection prevention and control.
- CDC is expanding support to its AR Lab Network so that more states will have the capability to rapidly detect *C. auris* infections and colonization at the local level to target interventions and slow spread.
- CDC supports innovative studies to decrease *C. auris* contamination of surfaces (e.g., testing products and methods).