Preserve Antibiotics Protect the Future

The NYS STop Antibiotic Resistance Roadmap (STARR)

NEW YORK STATE | Department of Health

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EXECUTIVE SUMMARY

Under the leadership of Governor Andrew M. Cuomo and the direction of Commissioner of Health Dr. Howard Zucker, the New York State Department of Health (NYSDOH) launched the NYS Antimicrobial Resistance Prevention and Control Task Force to lead the state effort, establish a statewide roadmap, and enhance regional collaboration to combat the threat of antibiotic resistance. New York State is a national leader in efforts to protect patients from drug-resistant infections and aims to enhance its national contribution and leadership through the efforts of the NYS Antimicrobial Resistance Prevention and Control Task Force. This report presents a summary of the problem, a series of task force recommendations, and a roadmap for partners and stakeholders in the collaborative effort to prevent and control antibiotic resistance in NYS. For the purposes of this document antimicrobial and antibiotic resistance are both abbreviated as AR.

The **New York State STop Antibiotic Resistance Roadmap (STARR)** includes recommendations from the NYS AR Task Force to prevent the development of resistance and minimize spread of resistant infections in NYS. Task Force recommendations include both immediately practical and sometimes highly aspirational goals and key recommendations to address these important problems. The STARR is intended to provide guidance for statewide stakeholders and partners to collaboratively improve upon prevention and control of AR in NYS and to remain useful and relevant for at least a five-year period from its development. Its recommendations are flexible enough to evolve with new technology and changes in the policy environment.

The New York State STop Antibiotic Resistance Roadmap (STARR) will focus on five complementary strategies:

- **Increase Awareness and Prevention of AR:** *Through educational campaigns targeted at patients, consumers, and providers, there will be statewide improvement in knowledge on the dangers of inappropriate antibiotic prescribing and AR.*
- **Enhance Optimal Antibiotic Use:** *Through efforts aimed across the spectrum of the healthcare system, optimal antibiotic use will prevent the emergence of AR.*
- **Faster Detection of AR:** *Through enhanced surveillance, data sharing, and advanced laboratory capabilities, there will be prompt detection of AR.*
- **Improve Control of AR:** *Through implementation of evidence-based practices in infection control, improved communication, and outbreak response, our statewide response to emerging AR infections and outbreaks will be strengthened.*
- **Strengthen Collaboration Throughout All AR Prevention and Control Efforts:** *Through enhanced collaboration across regions and disciplines, the effectiveness and reach of individual efforts will be maximized.*

INTRODUCTION

What is antibiotic resistance?

Antibiotic resistance (AR) occurs when antibiotics no longer work against the bacteria that cause infections. Antibiotics can be lifesaving, but bacteria are becoming more resistant. Antibiotic resistance is part of a broader threat called **antimicrobial resistance**, which includes resistance to medicines used to treat all types of infections, including those caused by bacteria, parasites, and fungi. For the purposes of this document antimicrobial and antibiotic resistance are both abbreviated as AR. If we are not careful about how we prescribe and use the antimicrobials we have relied on for years, AR will continue to increase, and these critical medicines might not work for us in the future.

How does antibiotic resistance develop and spread?

Many achievements in medicine rely on effective antibiotic therapy. It is for this reason that we need to preserve antibiotics to protect future generations. While appropriate antibiotic use can lead to the development of resistance, when needed, antibiotic therapy must continue to be used to improve health and save lives. However, the overuse or inappropriate use of antibiotics across the spectrum of healthcare and in the community, is a leading cause of preventable AR development and must be reined in.

Inappropriate antibiotic use can take several forms. Antibiotics may be unnecessarily prescribed (for viral infections where antibiotics are not effective), inappropriately used (antibiotic use without a healthcare provider's guidance), or can be used inappropriately in animals or agriculture.

Because antibiotics don't work against infections caused by viruses, using antibiotics for these infections, such as the common cold, the flu, bronchitis, most coughs, and most sore throats, is both unnecessary and can increase the risk of AR. Additionally, antibiotics kill the beneficial bacteria in the gut, allowing more harmful bacteria, such as *Clostridium difficile (C. difficile)*, to grow in their place. Taking unnecessary antibiotics increases your risk of getting a resistant infection later and the resistant bacteria can spread and become more common in the community.

Source: CDC 2013

Why should we be concerned?

Antibiotics are a shared resource.

How antibiotics are used today directly impacts how effective they will be tomorrow. Antibiotic resistance is not just a problem for the person with the infection. Resistant bacteria have the potential to spread to others, leading to more antibiotic-resistant infections.

AR reduces quality of life.

The loss of effective antibiotics will undermine our ability to fight infectious diseases, ranging from the common to the complex. Also, AR impacts our ability to prevent and manage infectious complications related to surgeries and complex care such as chemotherapy, dialysis, and organ transplants. Many procedures, such as hip replacements, allow people to remain active and in the workforce longer. If antibiotics do not work, these surgeries become far more dangerous.

AR is an economic burden.

Annual U.S. medical expenditure on AR is estimated to be up to $20 billion in excess direct healthcare costs and with additional costs of up to $35 billion due to lost productivity.[1]

How big is the problem?

Global Antimicrobial Resistance

Burden of Disease

Antimicrobial resistance has been found in all regions of the world with emergence of newly discovered strains and spread of resistant organisms globally. In India, over 58,000 babies died in one year because of infection with resistant bacteria.[2] In Thailand AR causes more than 38,000 deaths per year and 3.2 million hospital days.[3]

United Nations General Assembly

On September 21st, 2016, the United Nations General Assembly convened a high-level meeting on the issue of AR. For the first time, Heads of State committed to taking a broad, coordinated approach to address the causes of AR across multiple sectors. Members reaffirmed a commitment to a multifocal approach to AR with a One Health framework. A One Health approach encourages collaborative efforts of many experts such as veterinarians, physicians, and epidemiologists to build partnerships with human, animal, and environmental health organizations recognizing that human health, animal health, and the environment are inextricably connected.[4, 5]

Global Spread of Emerging Resistant Organisms

Factors such as increased globalization, unnecessary antibiotic use in agriculture, poor infection control in hospitals and clinics, and overprescribing of antibiotics are increasing the global threat of AR. For example, in China in November 2015, bacteria with the plasmid-mediated colistin resistance *(mcr-1)* gene were discovered. These drug resistant bacteria with the *mcr-1* gene are concerning because they are resistant to the antibiotic colistin, an antibiotic of last resort. Additionally, the *mcr-1* gene is plasmid-mediated, which means that it can be transferred to other types of bacteria and thus could spread resistance more rapidly. After initial identification in China, these resistant organisms have since been identified in humans, food, livestock and other animals, and environmental samples from over 20 countries across the globe, including the U.S.

Antimicrobial resistance in the United States

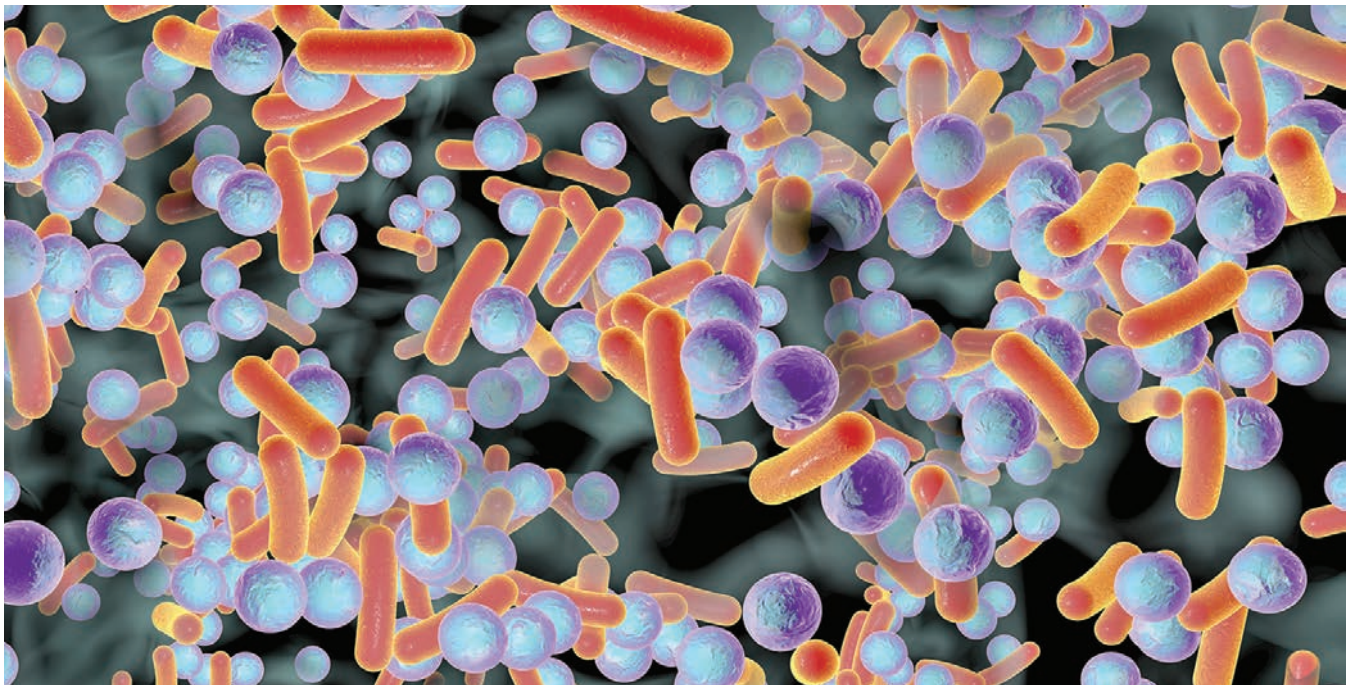
Burden of Disease

The Centers for Disease Control and Prevention (CDC) estimate that each year in the U.S. at least two million people become infected with AR bacteria and at least 23,000 people die as a direct result of these infections.[6] Pathogens designated as urgent threats by The National Action Plan for Combating Antibiotic-Resistant Bacteria include *C. difficile*, carbapenem-resistant Enterobacteriaceae (CRE), and *Neisseria gonorrhoeae (N. gonorrhoeae):*

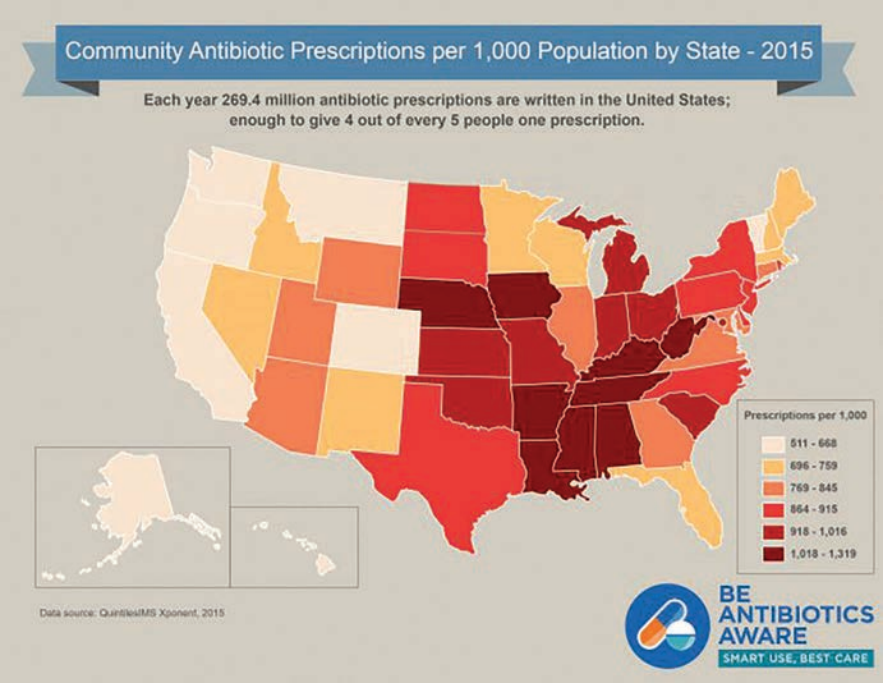
- *C. difficile* infection is often associated with antibiotic use and leads to an estimated 14,000 deaths per year.
- CRE are bacteria resistant to nearly all antibiotics, including carbapenems, an antibiotic class of last resort. CDC estimates that 9,000 cases of CRE, with an estimated 600 deaths, occur annually in the U.S.
- *N. gonorrhoeae* has developed resistance to nearly all the antibiotics used for gonorrhea treatment. Of the 820,000 cases of gonorrhea which occur annually in the U.S., 30% have resistance (246,000 cases).[6] In 2016, *N. gonorrhoeae* with resistance to the last effective class of antibiotics was identified in Hawaii.

Pathogens designated as serious threats include methicillin-resistant *Staphylococcus aureus* (MRSA), multidrug-resistant *tuberculosis* (MDR-TB), and fluconazole-resistant *Candida*, among others:

- CDC estimates that over 80,000 invasive infections and over 11,285 related deaths occur annually due to MRSA.
- From 2011-2015, 10% of TB cases were isoniazid resistant. Of these, 1.4% were MDR-TB, and 15 were identified as extensively drug-resistant (XDR-TB).[7]
- Since a June 2016 CDC alert regarding the global emergence of the multi-drug resistant yeast *Candida auris (C. auris),* the pathogen has emerged in the US with 261 clinical cases reported and an additional 407 patients found to be colonized with *C. auris* by targeted screening (as of February 28, 2018).



- **Inappropriate Antibiotic Use** One of the most important preventive approaches to combat AR is to decrease inappropriate antibiotic prescribing. A 2014 study found that only 55% of surveyed Americans correctly answered the question: "Do antibiotics kill viruses as well as bacteria?"[8] Additionally, a study of U.S. ambulatory care visits in 2010-2011 found 50% of prescriptions for acute respiratory conditions may have been unnecessary and 30% of outpatient, oral antibiotics may have been inappropriately prescribed, which represents up to 34 million unnecessary prescriptions.[9]

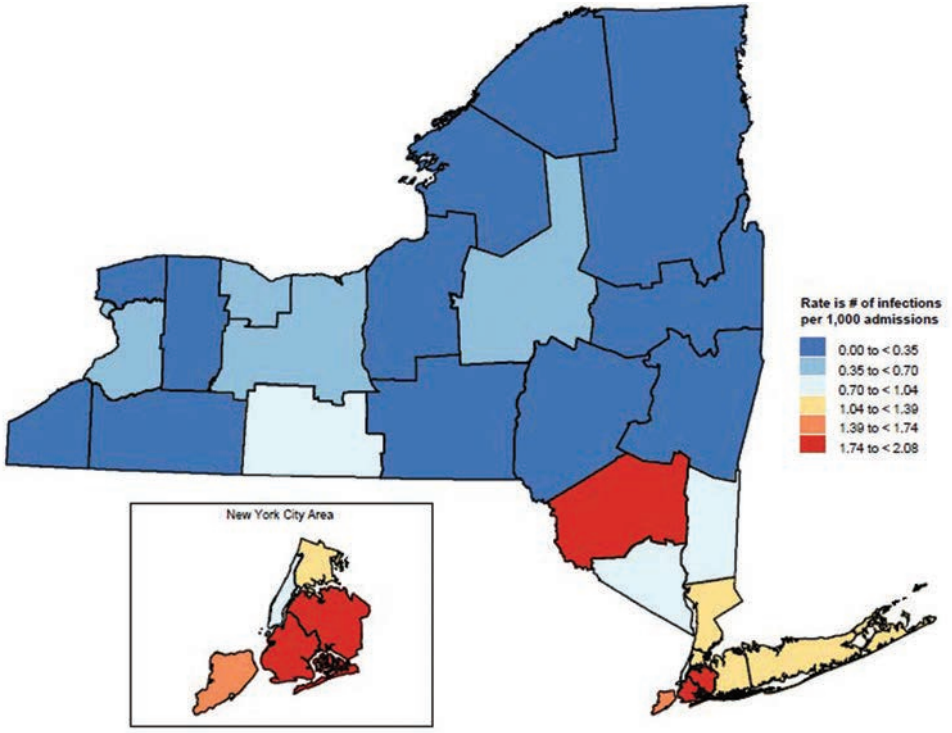


ANTIMICROBIAL RESISTANCE AND ANTIBIOTIC STEWARDSHIP IN NEW YORK STATE

Healthcare-Associated Resistant Infections in New York State

- *C. difficile* infections are a common adverse effect of antibiotic use. Over 20,000 cases of *C. difficile* were identified by NYS hospitals in 2015 with 40% of cases associated with medical care during that hospital stay, while others were identified in an emergency department or soon after a hospital admission. These infections may have caused an estimated 1,120 deaths.
- NYS hospitals reported approximately 2,200 MRSA bloodstream infections, resulting in an estimated 450 deaths.
- A small group (15%) of hospitals voluntarily reported vancomycin-resistant *Enterococci* (VRE) infections. Extrapolating to the entire state, these infections may have caused an estimated 140 deaths in 2015.
- A small group (17%) of hospitals voluntarily reported multidrug-resistant *Acinetobacter* infections. Extrapolating to the entire state, these infections may have caused an estimated 50 deaths in 2015.
- Approximately 3,600 CRE cases were reported by NYS hospitals in 2015. Eleven percent of the cases were bloodstream infections, resulting in an estimated 130 deaths. The overall prevalence rate was highest in the New York City area.[10]

Carbapenem-resistant Enterobacteriaceae (CRE) Infections
Overall Inpatient Prevalence Rate, 2017



Emerging Multidrug-Resistant Organisms Recently Identified in NYS

- *Multidrug-Resistant Tuberculosis*
  From 2013-2015, there were 27 cases of MDR-TB (1% of 2,425 TB cases) and one XDR-TB case in NYS. Resistance to all TB drugs is monitored and the percentage of TB cases exhibiting resistance to any TB drug is on the rise.

- *Plasmid-Mediated Colistin Resistance (mcr) Gene*
  In June 2016, NYSDOH issued a health advisory regarding the first *mcr-1* gene in Escherichia coli (E. coli) bacteria found in a human in the U.S., retrospectively identified in NYS after a May 2016 CDC health advisory alerted facilities to *mcr-1*.[11]

- *Candida auris*
  C. auris is an emerging multidrug-resistant yeast which has caused severe illness in hospitalized patients. Additionally, *C. auris* can persist on surfaces and spread between patients in healthcare facilities and requires specialized techniques to identify in the laboratory. Following the CDC national advisory on *C. auris*, this organism was retrospectively identified in NYS from a laboratory sample saved from May 2013.[12] In November 2016, an investigation of the first seven reported *C. auris* cases in the U.S. was published, including three cases from NYS.[13] As of March 13, 2018, there have been 137 clinical cases of *C. auris* identified in NYS (individuals who were ill and had *C. auris* detected during their clinical care) and 178 screening cases (individuals who were not ill from *C. auris* and were tested specifically for *C. auris* as part of a public health investigation). Additional aggressive case finding, investigation, prevention, and control efforts are underway at the time of this report.

Emerging Multidrug Resistant Organisms in Animals Identified in NYS

- *Multi-Drug Resistant* Salmonella *Dublin* *Salmonella* Dublin (S. Dublin) is "host adapted" in cattle, meaning animals can become long-term carriers, and can infect people through contact such as drinking raw milk or by consuming other contaminated food products. In humans, *Salmonella* Dublin causes systemic infection, similar to typhoid fever, and has higher hospitalization and fatality rates than other *Salmonella* types. Additionally, animal isolates of S. Dublin in NYS are increasingly resistant to third-generation cephalosporins (e.g. ceftriaxone), posing a serious human health concern as this drug is integral to treating human invasive salmonellosis. The NY Animal Health Diagnostic Center and the NYS Veterinary Diagnostic Laboratory, both at Cornell University, isolate approximately 100 S. Dublin isolates per year (24% of total *Salmonella* isolates and 27% of bovine isolates) and the numbers are increasing each year. These numbers are likely an underestimate due to testing practices and difficulty detecting the bacterium in feces due to intermittent shedding.
- Other serious zoonotic multi-drug resistant bacteria emerging in NYS include *Staphylococcus pseudintermedius, Klebsiella pneumoniae, Pseudomonas aeruginosa,* and *Enterococcus* spp.

NYS Healthcare Facility Antimicrobial Stewardship Programs

Despite the importance of antimicrobial stewardship programs (ASPs) in optimizing antibiotic prescribing, only 58% of the 175 hospitals that participate in the NYS Healthcare Associated Infection Reporting Program indicated on survey response in 2015 that they have an ASP that meets the seven core elements of hospital ASPs set forth by the CDC.

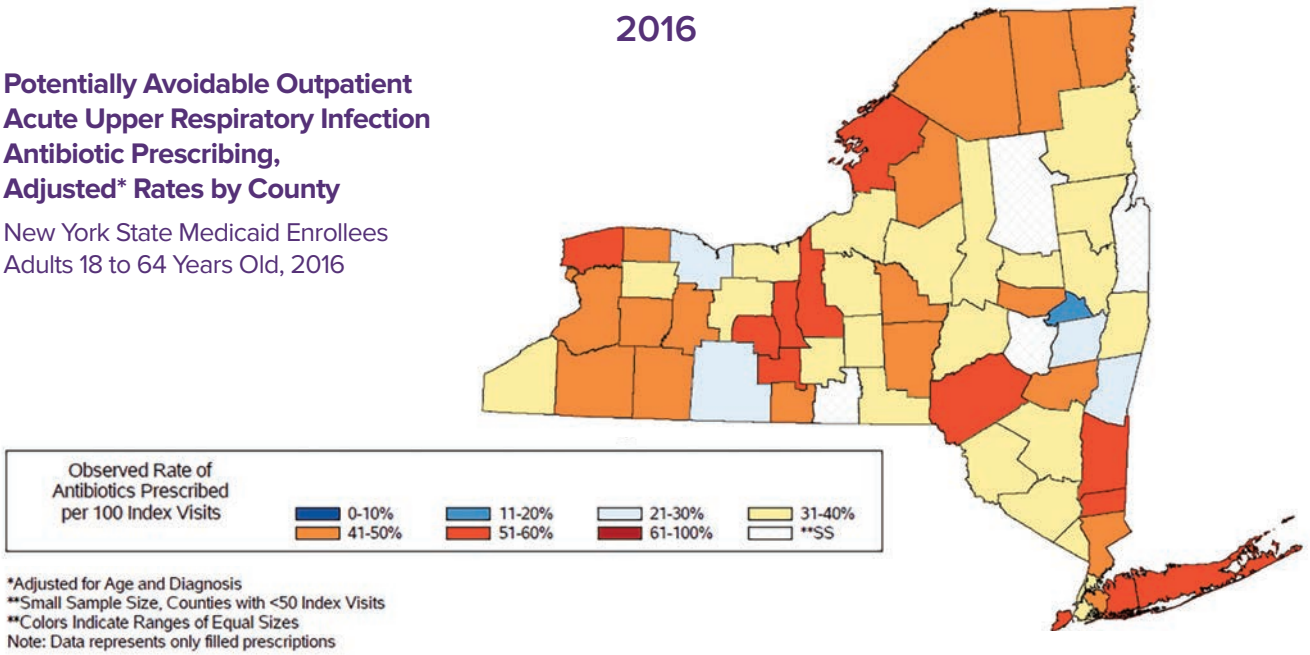
Analysis of NYS Medicaid Antibiotic Prescribing Data

The NYS Be Antibiotics Aware Program performed an analysis of 2010-2016 NYS Medicaid prescribing data which revealed significant avoidable prescribing and wide variation in use of potentially avoidable outpatient antibiotics for acute upper respiratory conditions.

2016

Potentially Avoidable Outpatient Acute Upper Respiratory Infection Antibiotic Prescribing, Adjusted* Rates by County

New York State Medicaid Enrollees
Adults 18 to 64 Years Old, 2016

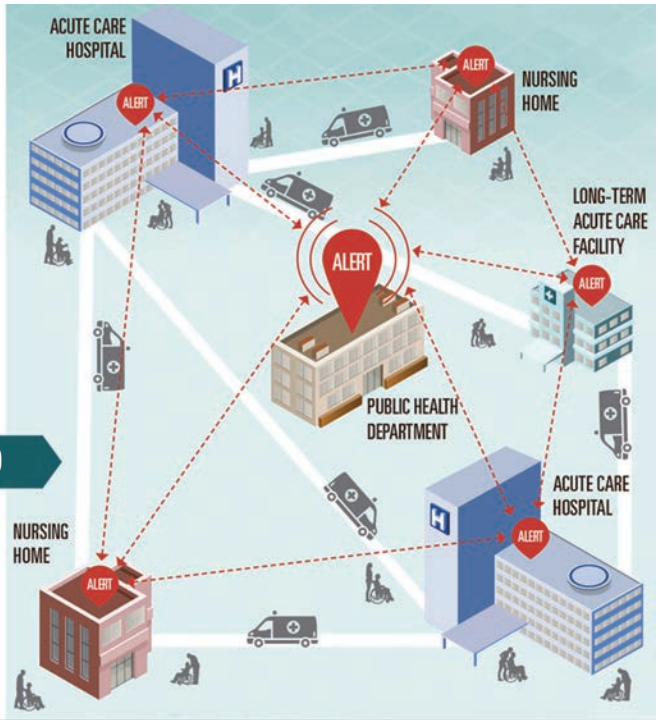


*Adjusted for Age and Diagnosis
**Small Sample Size, Counties with <50 Index Visits
**Colors Indicate Ranges of Equal Sizes
Note: Data represents only filled prescriptions

THE IMPORTANCE OF A COLLABORATIVE STATEWIDE APPROACH TO AR

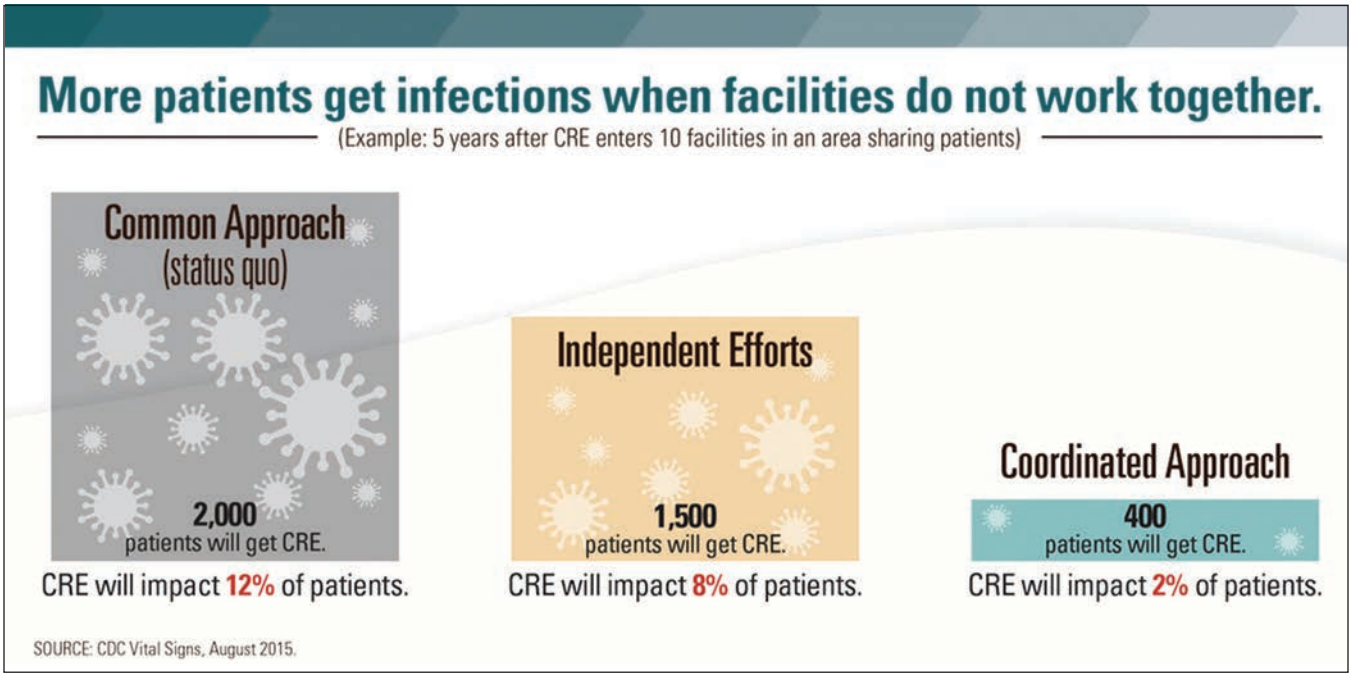
Historically, interventions to control AR pathogens and *C. difficile* are independently initiated and implemented by isolated healthcare facilities. These efforts have proven ineffective to control inter-facility spread of pathogens. A coordinated approach involving acute care hospitals, long-term care facilities, and public health departments is needed (see figure below). In this model, public health plays a central role in the coordination of a collaborative regional approach to AR.

A CDC study used mathematical models to measure the impact of a coordinated approach to AR compared to independent facility efforts. One model estimated different rates of spread of CRE over five years within a simulated network of ten healthcare facilities (acute care hospitals, long-term acute care hospital, and nursing homes) with patient sharing. Results showed that use of a coordinated approach leads to an 81% reduction in CRE acquisition compared to the baseline period when no augmented intervention was used, and a 74% reduction compared to independent efforts (augmented efforts implemented independently at individual facilities).[14]



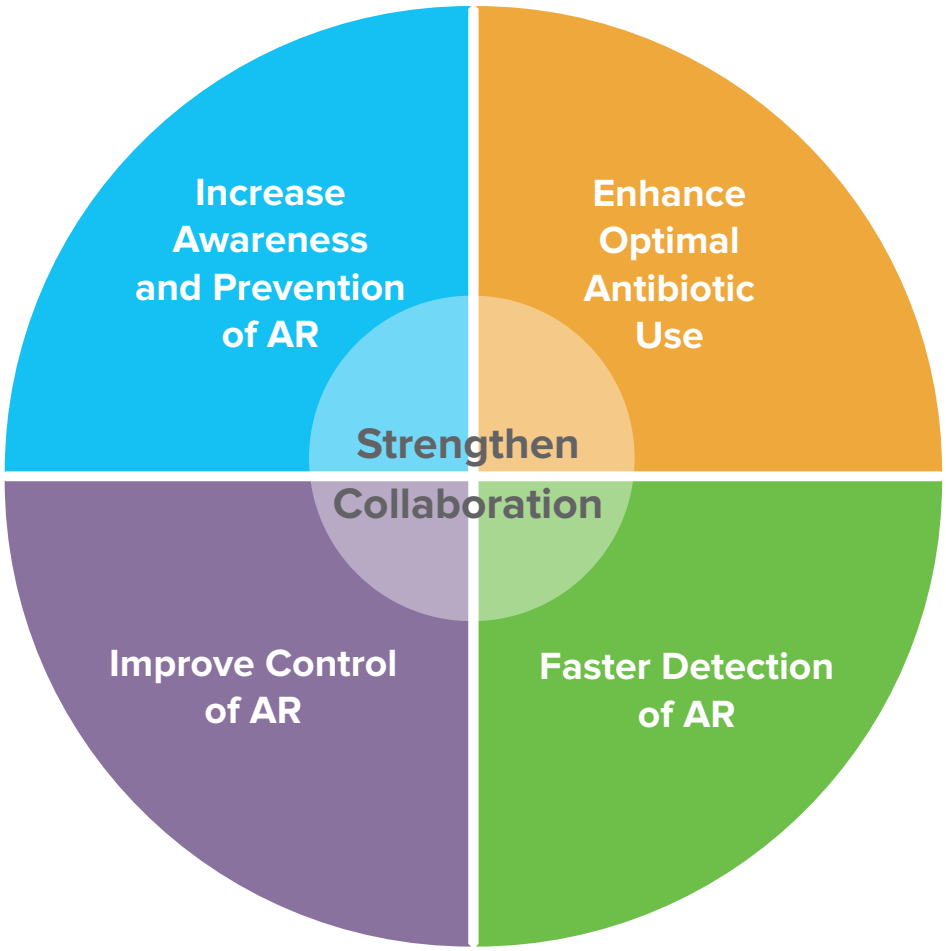
Coordinated Approach (Needed)

- Public health departments track and **alert** health care facilities to antibiotic-resistant or *C. difficile* germs coming from other facilities and outbreaks in the area.
- Facilities and public health authorities share information and implement shared infections control actions to stopspread of germs from facility to facility.



NEW YORK STATE STOP ANTIBIOTIC RESISTANCE ROADMAP (STARR)

The New York State STop Antibiotic Resistance Roadmap (STARR) includes recommendations from the NYS Antimicrobial Resistance Task Force to prevent development of resistance and minimize spread of resistant infections in NYS. Task Force recommendations include both immediately practical and sometimes highly aspirational goals and key recommendations to address these important problems. The Roadmap is intended to provide guidance for statewide stakeholders and partners to collaboratively improve upon prevention and control of AR in NYS and to remain useful and relevant for at least a five-year period from its development. Its recommendations are flexible enough to evolve with new technologies and changes in the policy environment.



"There is not a minute to waste in conserving these precious resources, antibiotics, or they might not be here for future generations. It is imperative that we meet the challenge head-on by turning the innovative ideas of this Antibiotic Resistance Task Force into real action that could diminish resistance and ultimately save lives."

- Howard Zucker, MD, JD,
Commissioner, New York State Department of Health

1. Increase Awareness and Prevention of AR: *Through educational campaigns targeted at patients, providers, and consumers, there will be statewide improvement in knowledge on the dangers of inappropriate antibiotic prescribing and AR.*

1.1. Enhance Public Understanding on the Threat of AR

Problem:
Studies reveal patients/consumers misunderstand the appropriate use of antibiotics and the risks of antibiotic overuse.

Proposed solution:
Engage the public on the threat of AR with a statewide multi-media (i.e, broadcast TV, radio, print, online, billboards) and social media (Facebook, Twitter) campaign.

Specific recommendations:

- Educate the public with a "high impact" media campaign regarding AR. Public health agencies, healthcare providers, pharmaceutical companies, healthcare systems, insurers, veterinarians, healthcare provider/veterinary professional organizations, and agriculture extension services are among the many healthcare system members who must educate the public on AR.
- Include information on: 1). the risk of unnecessary antibiotics, 2). the message that *'antibiotics aren't always the answer'*, 3). how AR affects individuals and families, including stories of everyday people whose lives have been affected by AR (loss of a family member, loss of personal health/ mobility due to AR), and 4). concrete actions the public can take to reduce AR.
- Allocate resources from both community organizations and stakeholders with investment in the health of New Yorkers.
- Evaluate messaging with focus groups to establish the most effective approach to outreach.
- Include considerations of the diverse population in NYS and consider targeted messaging according to these characteristics.
- Improve usability of the NYSDOH AR webpage and complete an evaluation of webpage traffic.

Resources

The Centers for Disease Control and Prevention's (CDC) Public Service Announcements - CDC's "Use the Right Tool" can be obtained and shared at no cost by media outlets, healthcare providers and healthcare facilities on TV screens in patient waiting areas, on social media, and integrated as links in patient portals.

1.2. Aim Education at Healthcare Providers on Optimal Antibiotic Use and Infection Prevention and Control

Problem:
Healthcare provuders' (defined through this document as individual practitioners who provide direct patient care) understanding and implementation of guideline-based antibiotic use is suboptimal. Additionally, patient reported allergy to penicillin is common, and often prevents a provider from prescribing the first-line, narrowest, guideline-recommended antibiotic. Meanwhile, studies show that the vast majority of reported penicillin allergies are not true allergies upon further evaluation. Finally, to prevent the spread of antibiotic resistant organisms, evidence-based infection prevention strategies must be learned and implemented in all settings of the healthcare system, however, formal infection control and prevention training is currently lacking for many healthcare providers.

Solution:
Implement an AR education campaign aimed at healthcare providers that should focus on risks of AR, optimal antibiotic prescribing, healthcare-associated infections, and infection prevention and control measures.

Specific Recommendations:

- Expand and enhance healthcare professional and veterinarian education on AR, optimal antibiotic use, and infection prevention via educational materials, grand rounds presentations, webinars, seminars, conferences, dissemination of video trainings, and continuing education modules. Public health agencies, healthcare provider and veterinary professional organizations, academic institutions, healthcare systems, and insurance providers must all engage in enhanced education efforts.

- Initiate AR "public health detailing" in NYS outpatient healthcare practices (educational outreach by trained personnel to health care practices to deliver tailored messages, similar to traditional pharmaceutical company outreach) and develop a public health detailing AR toolkit for use by statewide stakeholders. Public health agencies, health insurance plans, Medicaid, and healthcare systems should collaborate to engage in this type of public health/academic detailing with outpatient providers regarding AR, appropriate antibiotic use, and infection prevention and control in the outpatient setting.

- Explore the integration of AR and optimal antibiotic use training into the NYS mandated Infection Control/Barrier Precautions course required for licensing of certain healthcare professionals (e.g., nurses, doctors, physician assistants, dentists) every four years, as this is not currently in the curriculum. The NYSDOH, NYS Education Department, and Council on Graduate Medical Education could collaborate to modify the existing syllabus. Explore expanding the requirement to other allied health professionals (e.g., respiratory and physical therapists).

- Initiate an AR social media campaign aimed at prescribers (via platforms such as Sermo, Doximity, Daily Rounds, Facebook, LinkedIn, Twitter, Veterinary Information Network (VIN), etc.) with reference to developed prescriber support tools and education about AR.

- Educate healthcare providers on communication techniques to address patient expectations and the "human factors" behind inappropriate prescribing that occurs, such as more inappropriate prescribing late in the day, when the patient is *perceived* as demanding antibiotics, and due to fear of making the wrong diagnosis—viral vs. bacterial infection.

- Address healthcare provider concerns regarding the link of compensation to patient satisfaction scores and appropriate antibiotic use.

- Educate healthcare providers about and develop streamlined outpatient approaches to allergy status assessments (e.g., penicillin allergy), to allow for increased use of first-line, narrower, guideline-recommended antibiotics. Primary care, infectious disease, and allergy providers, and their respective professional organizations, healthcare systems, and practices should collaborate to increase the number of patients with reported penicillin allergy who have had an allergy assessment.

- Explore requiring a continuing education component for veterinary licensure related to AR, with the provision of several options to fulfill this requirement for small or large animal practitioners. To fulfill this requirement, develop specific veterinary modules, webinars, and learning sessions for education on AR, infection control, and existing policies and guidelines on judicious use of antibiotics.

1.3. Expand AR Education to All Members of the Healthcare Team

Problem:
Key members involved in the healthcare process are often overlooked in AR outreach and education. Lack of involvement of facility administration impairs AR prevention and control efforts. Frontline healthcare facility staff such as environmental service workers, patient care technicians, and aides lack sufficient AR and infection prevention training. There are significant challenges in effectively reaching these large numbers of staff such as high employee turnover and potential limited English language proficiency. Finally, family members are an essential component of the healthcare team, but receive very little education on appropriate antibiotic use and infection prevention and control.

Proposed Solution:
Engage essential, yet commonly overlooked, members of the healthcare and veterinary team to improve the prevention and control of AR. Administration involvement in proposed solutions to prevent and control AR is essential for any successful health system strategy. Meanwhile, staff, such as environmental service workers and patient care technicians, are truly on the frontline and deserve to have the training that they need to properly perform their jobs, care for their patients, and protect themselves.

Model

October 2017, the New York State Department of Health, the Greater New York Hospital Association, and the 1199SEIU Union, hosted a symposium to improve education and training for environmental service workers on infection prevention and control measures for the multidrug-resistant yeast *Candida auris*.

Specific Recommendations:

- Educate administrative stakeholders on both the cost-saving and patient-centered benefits of implementing strategies to reduce and prevent AR, including but not limited to, avoiding unnecessary costs due to overprescribing of antibiotics, reducing possible adverse events, and improving patient outcomes.
- Engage frontline staff through unions and employers with direct trainings, short videos, and informational posters, in multiple languages, on infection prevention and control, and other topics related to AR.
- Require dedicated paid time for frontline staff training on AR and infection prevention and control.
- Educate healthcare facility management about the importance of training frontline staff on the appropriate use of disinfectants and sanitizers to protect employees, patients, and the public from resistant organisms.
- Require appropriate staff to demonstrate competency in the appropriate use of sanitizers and disinfectants as part of the orientation process and regularly thereafter.
- Develop educational materials, such as FAQs, for family members of patients or residents regarding antibiotic usage, as families often play a key role in whether antibiotics are prescribed.
- Ensure family members are educated on infection prevention and control measures to prevent the spread of resistant infections.

1.4. Develop Student Based Learning Initiatives to Increase Understanding of the Threat of AR

Problem:
Studies reveal patients misunderstand the risks of antibiotic resistance and the use of antibiotics. Formal education in the K-12 or university school systems addressing this public health threat are currently lacking. Additionally, at the graduate level, specific, formal education on AR, appropriate antibiotic use, and infection prevention and control are insufficient.

Proposed Solution:
Educate primary, undergraduate, and graduate university students to reach future generations as well as current households and communities. Additionally, healthcare provider and veterinary trainee education will both educate future prescribers as well as generate new knowledge in the community of practices where they currently train.

Specific Recommendations:

- Implement collaborative educational initiatives with partners including the State Education Department, school and university nurses and health educators, and their professional organizations.
- Develop educational tools on the causes of common illnesses, the differences between viruses and bacteria, and the risks of AR and inappropriate use of antibiotics, for the K-12 and university systems.
- Integrate AR, appropriate antibiotic use, infection prevention and control education into curricula of medical, physician assistant, nursing, dental, patient care technician, veterinary, veterinary technology, pharmacy, and public health schools, residency training programs, and associated professional organizations in NYS.
- Encourage development of evidence-based modules on AR that could be shared across NYS health professional schools and interprofessional education.

Model

The Pennsylvania Department of Health Get Smart Program developed an AR artistic representation competition for K-12 students - Pennsylvania Department of Health Get Smart Competition.

1.5. Improve Adult Vaccination Rates in NYS

Problem:
While NYS childhood and adolescent immunization coverage rates are relatively high, NYS adult immunization coverage rates lag well below Healthy People 2020 targets. According to the 2016 and 2017 Behavioral Risk Factor Surveillance System data, less than half of all NYS adults receive the influenza vaccine each year. Additionally, the percentage of NYS adults aged 65 years and older who had ever received the pneumococcal vaccine in 2016 was 69%. NYS adult influenza and pneumococcal vaccination rates have not statistically significantly increased from 2012 to 2016.

Through improved vaccination rates, there will be a reduction in disease (bacterial and viral), thereby decreasing both appropriate and inappropriate antibiotic use to treat disease. A reduced burden of vaccine preventable diseases could also decrease interactions with the healthcare system and subsequent opportunities to develop a resistant healthcare-associated infection.

Proposed Solution:
Ensure all New Yorkers receive recommended vaccines to reduce the risk of resistant vaccine preventable diseases, such as drug-resistant *Streptococcus pneumoniae*.

Specific Recommendations:

- Promote adult vaccination campaigns through public service advertisements.
- Enhance education and outreach to healthcare providers regarding prevention of AR through vaccination.
- Consider mandating documentation of adult vaccinations in the NYS Immunization Information System (NYSIIS).
- Expand participation of all appropriate healthcare providers in offering vaccines to adults.
- Promote the adoption of standards for adult vaccination, including assessment of vaccination status at every clinical encounter via review of the immunization record at every visit, use of electronic health records prompts, and implementation of evidence-based strategies such as standing orders for vaccination.
- Seek statutory change to allow pharmacists to offer all routine adult immunizations.
- Educate adults on NY State of Health enrollment to improve preventive care and adult vaccination.
- Enhance the Vaccines for Adults program to more closely approach the model of the NYS Vaccines for Children (VFC) program, to maximize vaccine coverage for adults, especially the under-insured and uninsured. This can only be achieved if significant resources were made available.

1.6. Enhance Awareness on Smart and Sustainable Agriculture

Problem:
It is important for New Yorkers to understand where their food comes from and how it is produced. The potential consequences of antibiotic-resistant bacteria in our food supply and the risk to farm personnel of exposures to resistant organisms may not be fully understood. Likewise, knowledge on mitigating measures by the average consumer and farmers is suboptimal.

Proposed Solution:
Heighten consumer and farm personnel knowledge on the risks of AR from the food supply and from contact with livestock as an occupational hazard. Education must be provided on mitigating measures to reduce these risks, including on currently recommended measures (e.g., biosecurity, vaccination, animal care and housing), and new recommendations and guidance.

Specific Recommendations:

- Assess NYS consumer understanding of food safety and the role of AR foodborne illness. This assessment will serve as a baseline of knowledge to assist in the development of consumer educational initiatives.
- Educate consumers on the meaning of various food labels in use and AR risks from food.
- Educate on food safety measures and the prevention of AR foodborne illness.
- Educate producers and consumers on foodborne illness, illness resulting from animal contact, and on current Food and Drug Administration (FDA) restrictions on the use of medically important antibiotics in food-producing animals.
- Promote training for farm personnel concerning proper stewardship and prudent use of antibiotics. This could be in the form of written materials or web-based applications.

1.7. Perform an Assessment and Educate Consumers on the Environmental and Health Impact of Antibiotic Residuals in the Environment

Problem:
Currently, the extent of antibiotic residuals in the environment and their environmental and health impact are poorly understood. Antibiotic residuals may enter the environment from animal or human waste. Until recently, consumers have been told to flush unwanted drugs. With technological advances and research, low levels of drugs are being found in our surface waters. Long-term exposure to low levels of antibiotics might result in the evolution of, or selection for, drug-resistant microbes and bacteria.

Proposed Solution:
Perform an environmental assessment of antibiotic residuals in different environmental settings to guide public health action, serve as a baseline for future interventions, and potentially serve as an early warning system for emergence of new types of AR resistance. Additionally, promote appropriate disposal of all unused medications, including antimicrobials, to minimize the impact on the environment and associated potential health risks. These measures will also minimize the health risks associated with the inappropriate use of unused medications in the home.

Specific Recommendations:

- Promote consumer education regarding safe disposal of pharmaceuticals through the comprehensive measures of the 'Drug Take Back Act' signed by Governor Andrew Cuomo July 2018, effective 180 days thereafter. The new law greatly expands drug collection awareness, education, and collection efforts across NYS and provides for cost reimbursement by the drug manufacturers. Additionally, promote dissemination of existing educational materials such as the NYS Department of Environmental Conservation "Don't Flush" poster.
- Offer pharmaceutical collection events through municipalities or add medication drop boxes in pharmacies and facilities, in partnership with local law enforcement, and publicize locally.
- Promote regular review in facilities of safe medication disposal methods.
- Perform a pilot environmental assessment, ideally including metagenomic monitoring for AR genes in sewage at an appropriate number of sentinel sites.
- Expand research concerning excretion and breakdown of medications (antimicrobials) and their metabolites in animal waste and waste management systems.
- Conduct surveillance for AR microorganisms in wildlife.

Resources

The New York State Department of Environmental Conservation's Pilot Pharmaceutical Take-Back Program places medication drop boxes in community pharmacies, hospitals, and long-term care facilities for easy and safe disposal of unused, unwanted, or expired medications for consumers.

2. Enhance Optimal Antibiotic Use: *Through efforts aimed across the spectrum of the healthcare system and the community, optimal antibiotic use will prevent the emergence of AR.*

2.1. Advocate for a Comprehensive Global Approach to AR Prevention and Control

Problem:
In international settings, antibiotics can often be legally obtained over-the-counter without the use of a prescription. Additionally, the availability of counterfeit antibiotics can make the medication quality and potency unreliable. This overuse of antibiotics or use of antibiotics below therapeutic levels may increase rates of drug resistant organisms which can then travel with their human hosts to the U.S. and be introduced into the NYS healthcare facility setting and community. NYS has a remarkably global population including New Yorkers who travel internationally, immigrants, and visitors. Furthermore, illegal sale of prescription antibiotics over-the-counter occurs in settings in NYS, particularly among storefronts catering to immigrant populations.

Proposed Solution:
Advocate for a global policy to limit over-the-counter sale of antibiotics and control of counterfeit supplies globally and enforce existing prescribing laws in NYS.

Specific Recommendations:

- Advocate for international standards on non-prescription sales of antibiotics and control of counterfeit drugs globally, to be accepted and enforced by international governments.
- Educate residents of New York about illegal non-prescription antibiotics.
- Enforce existing laws prohibiting the sale of antimicrobials without a prescription in NYS, through the Board of Pharmacy and other appropriate mechanisms.
- Advocate that global use of medically important antibiotics in animals should always be under the direction of a licensed veterinarian and the use of influenza anti-viral drugs should be eliminated from use in food producing animals (e.g., poultry).
- Ensure all imported foodstuffs for human or animal consumption should meet the same U.S. standards for freedom from antibiotic residue.

2.2. Reduce Admissions and Length of Stay in Healthcare Facilities and Promote Options for Care within the Community

Problem:
While healthcare facilities provide essential care to ill patients, healthcare facility stays also run the risk of serious complications, including hospital-acquired, antimicrobial-resistant infections.

Proposed Solution:
Provide alternative medical service delivery options to reduce avoidable emergency department (ED) visits, hospitalization, and promote options for community based care.

Specific Recommendations:

- Maximize healthcare insurance coverage and healthcare access through health insurance reform efforts to shift care to the medical home in the outpatient setting, to avoid preventable ED and inpatient hospitalization or readmission.
- Maximize primary care access through Patient Centered Medical Homes, expanded primary care hours and urgent care utilization instead of emergency rooms for non-life-threatening urgencies.
- Promote participation of hospitals, nursing homes, home care agencies, health care providers, behavioral health providers, and other stakeholders in Performing Provider Systems (PPS) as established by the NYSDOH Delivery System Reform Incentive Payment (DSRIP) Program. DSRIP's goal is to improve population health and includes the reduction of avoidable ED visits and hospitalizations within the Medicaid population by 25% by 2020, as a primary objective.

- Promote the available options for providing primary care services in the home via a "hospital at home" model that is not traditional home care, home visiting program, remote patient monitoring, and telemedicine, expanded in the recently enacted budget to allow individuals to receive health care services via telemedicine in their place of residence, effective July 1, 2018.
- Support the development of options for additional supports to allow individuals to remain in their home and community.

2.3. Develop Useful Clinician Tools to Make Optimal Antibiotic Prescribing Easier

Problem:
Studies reveal that even when healthcare providers understand the importance of following evidence-based antibiotic prescribing guidelines, practice can lag behind best practice. One factor healthcare providers have suggested is that the current guidelines are too lengthy and dense and thus are underutilized. Additionally, concerns regarding patient expectations combined with provider lack of time can add to prescribing challenges.

Proposed Solution:
Develop tools to support providers in optimal antibiotic prescribing through public health, provider and healthcare facility associations, healthcare systems, and academic institution efforts, among others.

Specific Recommendations:
- Reimburse healthcare providers specifically for time spent counseling on appropriate antibiotic use.
- Distribute and implement tools such as the NYS AR Task Force-initiated and NYSDOH-developed AR resources through public health detailing (see resources sidebar).
- Develop additional end-user friendly, healthcare provider-focused tools for optimal antibiotic prescribing.
- Develop and implement electronic health record prescribing prompts and clinical decision support tools and "delayed prescribing/watchful waiting" e-prescribing options.
- Develop tips for healthcare providers via brief electronic mail messages, text messages, or post cards on optimal antibiotic prescribing.
- Explore smart phone applications to enhance optimal antibiotic prescribing.

Resources

NYSDOH tools for providers on optimal antibiotic prescribing:

- **The NYSDOH Adult/Pediatric Antibiotic Prescribing Guidelines and Pocket Card.**
- **The NYSDOH and CDC "Viral Prescription Pads" (also available in Spanish, and 10 other languages spoken in NYS).**
- **The NYSDOH "Smart Use Guarantee" Commitment Poster can educate patients in the waiting room that their providers are committed to optimal antibiotic prescribing.**
- **The NYSDOH Video "Educating Patients About Antibiotic Usage" provides communication tips to prescribers on how to address patient antibiotic use expectations. A video for patients on antibiotic use is also available which can be used in a waiting room or other setting.**

2.4. Pursue Policies to Promote the Highest Standards of Animal Care and Limit the Inappropriate Use of Antibiotics in Livestock

Problem:
Livestock agriculture accounts for a significant share of antibiotics used in the United States. Historically, medically relevant antibiotics had been used without a prescription for animal production purposes rather than therapeutic use. This usage was significantly curtailed with the implementation in January 2017 of the FDA's Veterinary Feed Directive (VFD).

Proposed Solution:
Monitor, educate, and enforce the VFD which requires that medically relevant antibiotics no longer be purchased for veterinary feed without a prescription.

Specific Recommendations:

- Support the implementation, monitoring, and enforcement of the FDA VFD requiring that medically important antibiotics use in animals is only under the direction of a licensed veterinarian.
- Collect baseline data on the use of antibiotics in NYS food animals in 2018 to assess trends in antibiotic use practices.
- Educate and train producers, distributors, and veterinarians on implementation of the VFD and state assets to support it.
- Ban over-the-counter sales of medically important antibiotics marketed for use in fish, as aquaculture is not currently included in the FDA VFD.

2.5. Ensure All Healthcare Facilities Have an Effective Antimicrobial Stewardship Program (ASP)

Problem:
Inappropriate and incorrectly prescribed antimicrobials lack therapeutic benefit and expose patients to potential complications including adverse drug events and the development of drug resistance. Studies reveal that 20-50% of all antibiotics prescribed in U.S. acute care hospitals are either unnecessary or inappropriate. ASPs in healthcare facilities can optimize antibiotic use, decrease adverse events, decrease risk of antibiotic resistance, and improve patient outcomes. In 2015, approximately 58% of NYS hospitals indicated having an ASP that met all seven core elements recommended by the CDC. Once ASPs are established, challenges in effective implementation of evidence-based practices abound. While a CDC defined measure of antibiotic use (Days of Therapy) and module is available through the National Healthcare Safety Network (NHSN), it requires healthcare facilities to collect data from multiple electronic databases which can be expensive and cumbersome to implement.

Likewise, in long-term care facilities (LTCFs), antibiotics are among the most frequently prescribed medications and, as in hospitals, studies have shown that 40-70% of antibiotics prescribed in nursing homes (NHs) are inappropriate or unnecessary. LTCFs lag significantly behind in both implementation and efficacy of ASPs. The movement of patients across the healthcare continuum highlights the need for including LTCFs in efforts to improve antibiotic use.

Models

In 2015 the Hospital Association of New York State (HANYS) developed the HANYS Antibiotic Stewardship Collaborative to help healthcare facilities in NYS advance their stewardship efforts and develop facility-specific antibiotic utilization reports with statewide benchmarking.

Additionally, multidisciplinary team-based training on the development and implementation of healthcare facility ASPs has been provided by the Greater New York Hospital Association (GNYHA) and United Hospital Fund (UHF) Antibiotic Stewardship Certificate Program.

Recent regulatory changes aimed at increasing ASPs have been put in place. January 1, 2017, the Joint Commission began to require accredited hospitals, critical access hospitals, and nursing homes to have ASPs that meet the CDC Core Elements. The Centers for Medicare and Medicaid Services (CMS) have also revised requirements for participation to include ASPs in LTCFs effective in 2017. However, effective implementation of these requirements can be challenging.

While the focus in ASPs has traditionally centered around appropriate antibiotic use, inappropriate antifungal use can contribute to the emergence of multi-drug resistant yeasts like *Candida auris (C. auris). C. auris* causes invasive infections that are hard to treat and spreads between patients in healthcare settings, especially LTCFs.

Proposed Solution:
Develop and implement effective healthcare facility ASPs to optimize the treatment of infections and and reduce adverse events associated with antibiotic use.

Specific Recommendations:

- Ensure all healthcare facilities, both acute care and long-term care, have established, functioning, and effective ASPs that meet CDC's Core Elements for Antibiotic Stewardship for Hospitals or Nursing Homes.
- Encourage leadership to provide adequate resources to effectively implement quality ASPs (i.e., human, financial, and information technology resources) that are tied to facility-based quality improvement and patient safety programs. ASP initiatives could be a cost saving measure.
- Establish ASP policies, procedures, and antibiotic-use protocols in healthcare facilities using current, available guidance documents (e.g., the CDC, Infectious Diseases Society of America (IDSA), Society for Healthcare Epidemiology of America (SHEA), the Society for Post-Acute and Long-Term Care Medicine).

Model

The University of Rochester Healthcare Associated Infections (HAI) Collaboratives developed and implemented quality measurements and best practices to reduce HAIs including resistant infections and Clostridium difficile. Additionally, the University of Rochester has hosted educational programs focused on antimicrobial stewardship program training for pharmacists.

Resources

The NYSDOH - Collaboration for Long Term Care Antibiotic Stewardship Program (CLASP) provides a collaborative platform and support to share best practices, information, ideas, and success stories.

- Require ASPs within healthcare facilities to measure antibiotic use and respond to issues of high utilization, when identified.
- Collaborate to find a solution to the reporting challenges currently faced in using the NHSN to report antibiotic use and multidrug-resistant organisms. Federal and state entities, healthcare facilities and associations, and electronic health record and health informational technology system vendors must collaborate to find a solution. Financial investment is required to accomplish this task.
- Alternatively, create a standard measurement and reporting mechanism of antibiotic use across all NYS hospitals and LTCFs to enable identification of prescribing patterns.
- Continue to develop opportunities in NYS for training on and implementation of ASPs in healthcare facilities, antibiotic stewardship

certificate training programs, and quality improvement training on measurement of antibiotic use in healthcare facilities.

- Make available LTCF ASP identified personnel with training in antibiotic stewardship processes and sufficient dedicated time to devote to facility ASP efforts.
- Include antifungal therapy in antimicrobial stewardship efforts, including in LTCFs. Antifungal stewardship principles are the same as those used for antibiotic stewardship.
- Expand healthcare system ASP to the outpatient realm, as large healthcare systems have expanded into the outpatient setting.
- Advance policies, protocols, funding, and information technology support for the use of telehealth communication platforms to address antimicrobial stewardship needs in rural or underserved areas.

2.6. Use Data to Inform Antibiotic Prescribing

Problem:
Healthcare providers are often unaware of their antibiotic prescribing data or potential contribution to suboptimal prescribing. Additionally, studies reveal that there are significant regional and geographic variations in prescribing patterns. Recent studies reveal that electronic peer comparison reports within a practice or facility which include individualized messages to the prescriber, indicating "you are a top performer" or "you are not a top performer" compared to others on staff, are a key evidence-based method to reduce inappropriate antibiotic prescribing. Additionally, "accountable justification" where prescribers are prompted to write justifications for prescribing antibiotics has shown to also be effective.

Proposed Solution:
Show providers data on their current prescribing, with comparison to peers, or goal, and offer prescribing guidelines and tools to assist in

Model

The NYSDOH evaluated Medicaid claims data for potentially avoidable antibiotic prescribing for upper respiratory infections over time and across regions to determine trends and focus areas to guide public health interventions. These data are available at: https://healthdata.ny.gov.

Model

The Blue-Cross/Blue Shield has evaluated prescribing patterns and produced a report on antibiotic use over time and across geographic areas: BlueCross/BlueShield The Health of America Report: Antibiotic Prescription Fill Rates Declining in the U.S. (August 24, 2017). They identified wide regional variation and higher antibiotic prescribing rates in rural compared to urban areas.

Model

In a Medicare-funded effort which began in 2016, IPRO has led an antibiotic tracking and reporting antibiotic stewardship initiative. Participating sites were provided with baseline antibiotic prescribing data as well as provider group-based education and academic detailing. Post-initiative peer-to-peer comparisons of antibiotic prescribing rates were provided quarterly at the overall group level, practice level, and prescriber level for acute bronchitis, acute sinusitis, cellulitis, and cystitis. For more information on IPRO AR efforts see this link: https://ipro.org/qualitywatch/ipro-to-lead-antibiotic-campaign.

improved prescribing. Additionally, use data at the public health and health systems levels as these data are key to guide interventions.

Specific Recommendations

- Use NYS Medicaid data, and explore other data sources, to assess trends to target public health interventions with a goal of reduction of inappropriate antibiotic prescriptions for upper respiratory infections in NYS by 25% by 2020, compared to a 2015 baseline.
- Use data to inform prescribing in different settings such as healthcare facilities and practices, healthcare plans, state and local public health agencies. Prescriber data can be compared to peers, goals, or recommended guidelines, by county, practice setting, insurance provider, or other. It is imperative to include practitioners with antimicrobial expertise who have dedicated time to develop the appropriate antibiotic use data feedback system for each setting.
- Provide non-punitive feedback to prescribers accompanied by education and tools to support and assist in improvements and with the support and input of provider professional organizations.
- Enhance appropriate antibiotic prescribing through value based payment models to improve quality of healthcare delivery.

3. Faster Detection of AR: *Through enhanced surveillance, data sharing, and advanced laboratory capabilities, there will be prompt detection of AR.*

3.1. Develop a Statewide Repository of Relevant Multidrug-Resistant Organisms for Laboratory Testing and Analysis

Problem:
Most clinical microbiology laboratories do not typically save multidrug-resistant organism (MDRO) culture growth (isolates) after routine identification and susceptibility testing, losing the opportunity for possible future molecular and resistance-mechanism testing for outbreak management and research. Additionally, as advances in laboratory methods have led to the increased use of molecular testing, laboratories may rely less on traditional culture and susceptibility testing methods, leading to less availability of susceptibility data and isolates. Additionally, the burden of MDROs (e.g., carbapenem-resistant Enterobacteriaceae (CRE), *Salmonella* Dublin, *Staphylococcus pseudointermedius*) in animal populations in NYS is unknown, as testing for these organisms is not performed.

Model

In 2016 The United Hospital Fund (UHF) Outpatient Antibiotic Stewardship Initiative engaged health systems in the greater New York area to participate in a learning collaborative to facilitate development of antibiotic stewardship in the outpatient setting with a focus on adult acute respiratory infections (ARIs). Over 30 outpatient practices participated with interventions aimed at both patients and practitioners, including the use of patient handouts and waiting room videos for patients and provider feedback reports and education on patient-provider communication for prescribers. Overall, antibiotic prescribing for these patients dropped 5 percentage points to 26 percent, which is below the national average. Approaches, tools, and lessons learned from the initiative will be shared in an 'UHF Antibiotic Stewardship for ARIs Ambulatory Care Practices Toolkit' to help outpatient clinics understand their own prescribing patterns, identify priorities, and target areas for intervention (see this link for more information: https://uhfnyc.org/news/881334).

Proposed Solution:
Create a network of clinical human and veterinary microbiology laboratories in NYS that culture, save, and send targeted MDRO isolates to a predetermined site for storage to be used for tracking of organisms during outbreaks and possible future molecular and resistance-mechanism testing and research.

Specific Recommendations:

- Establish a repository of MDRO isolates to allow for additional molecular testing by NYS public health and academic laboratories, as indicated.
  - Use these data to identify clusters and outbreaks for additional case finding, prevention, and control.
  - Expand molecular and resistance mechanism testing in novel organisms.
  - Improve metagenomic laboratory evaluation of resistant organisms to better understand the level of connectedness.
- Broaden our understanding of the true burden of MDRO's in companion animals and livestock in NYS, including what AR testing is currently being conducted at commercial veterinary laboratories.
- Work with veterinary and livestock communities to develop an approach to share isolates between commercial veterinary laboratories and the New York State Animal Health Diagnostic Center. Advocate for resources to test these isolates for resistance.
- Compare and sequence both animal and human isolates (e.g., *Salmonella* Dublin, methicillin-resistant *Staphylococcus aureus* (MRSA)) to identify potential organism transmission between animal species and humans and study risk factors and potential causes of these transmission events.

3.2. Electronic Reporting of Resistant Organisms of Public Health Importance to Inform Public Health Action

Problem:
The true burden of MDROs (e.g., CRE, *C. auris*, etc.) in NYS is unknown, as these organisms are not specifically mandated as reportable diseases to public health. While NYS was one of the first to mandate reporting of CRE within the hospital setting, there is likely a significant burden in the community and long-term care facility settings. These data are essential to establish burden, trends, outbreak identification and control, and implement and evaluate targeted public health interventions.

Proposed Solution:
Require electronic laboratory reporting of important MDROs to inform public health action.

Specific recommendations:

- Make CRE, *C. auris*, and other important MDROs reportable in NYS through existing electronic laboratory reporting processes.
- Evaluate reported MDRO data to find clusters or outbreaks and more rapidly institute public health infection prevention and control measures.
- Enhance data sharing with partners to increase statewide capacity for prompt, targeted public health intervention.

A Collaborative Building Block

The NYSDOH Wadsworth Center (WC) Laboratory was recently awarded $1.8 million as one of seven regional laboratories in the CDC's AR Lab Network (ARLN). As part of the ARLN, the WC will boost local capacity and technology to detect, support response to, and prevent AR threats and create new innovative laboratory methods to combat AR.

3.3. Improve Efficiencies and Modernize the NYS Public Health Laboratory and Epidemiologic Surveillance Platforms to Meet the Escalating Needs of the State

Problem:
Both laboratory and surveillance capacity at the state public health level require modernization to address the growing threat of AR and complexity of the current healthcare system. For example, genomic testing of resistant organisms can assist in understanding relatedness and the spread of organisms within healthcare facilities. Integration of genomic data with traditional epidemiologic data and other data sources may reveal transmission pathways in regional outbreaks. These advanced and coordinated analyses lead to improved understanding of the mechanism of spread and provide a target for public health intervention. It is essential to both modernize and integrate laboratory and surveillance data.

Proposed Solution:
Provide new efficient laboratory facilities and surveillance systems that allow for cross training and streamlining of processes so the laboratory can be nimble and responsive to emerging issues and situations around AR.

Specific Recommendations:

- Increase the state public health laboratory capacity through new efficient laboratory facilities to meet the escalating needs of the state. These efforts will build on the expertise of the NYS AR Regional Laboratory.
- As part of the Governor's Life Sciences Initiative, the New York State 2018-2019 Budget provided $750M for the design and construction of a new laboratory facility in the Capital Region.
- Advance the use of molecular testing methods used to look for similarities between resistant strains and identify potential spread within and between facilities to inform public health and infection control action.
- Update to new technology software platforms that combine laboratory and epidemiologic surveillance systems, including the data from whole genome sequencing (WGS), to inform public health action and enhance response to multi-institutional outbreaks.
- Modernize the public health workforce to meet 21st century demands to combat AR by ensuring state and local public health staff have training and experience in antibiotic stewardship, antibiotic resistance, infection prevention and control, performance and interpretation of advanced molecular diagnostics, and data analytics.
- Modernize and improve timeliness in the electronic delivery of state public health laboratory results to healthcare providers during an AR outbreak response.
- Utilize new technology surveillance platforms to examine trends in AR, including evaluation of possible health disparities in AR, in line with NYS Prevention Agenda priorities.
- Ensure capacity to compare sequenced animal, food, environment, and human isolates to evaluate for critical antibiotic resistance gene concerns.

3.4. Improve Tuberculosis Rapid Diagnostics and Resistance Testing Through Advanced Laboratory Technology in NYS

Problem:
Globally, one third of the world's population is infected with tuberculosis (TB) and TB remains the top infectious killer, as well as a main cause of death related to antimicrobial resistance. New York is one of four states that account for over half of the TB cases in the United States. In the U.S. in 2016, 9% of TB cases had resistance to isoniazid (a key first-line antibiotic for TB), 1.4% (96) had multidrug-resistant TB (MDR TB), and one case had extensively drug-resistant TB (XDR TB), which was located in NYS.

Resistance testing is essential to guide TB therapy to effectively treat patients, prevent development of further resistance, and prevent spread, however, traditional laboratory culture-based methods can take as long as eight weeks. The NYSDOH WC Laboratory has made enormous strides in the development of cutting-edge technology that improves the rapidity of testing, hence improving the treatment and control of TB (see 'A Collaborative Building Block' sidebar). While considerable progress has been made through these advances, funding for both the laboratory testing and clinical implementation have been cut, threatening advances made in NYS to control TB.

Proposed Solution:
Continue and advance the use of state-of-the-art laboratory techniques for prompt diagnosis, appropriate treatment, and prevention of drug resistance in TB. These efforts remain crucial to successfully reducing—and ultimately eliminating—drug resistant TB. These goals can only be reached with both cutting-edge technology coupled with traditional public health services and outreach. Resources are needed to continue these efforts.

Specific Recommendations:

- Optimize new technology to improve identification and treatment of drug-resistant TB cases in NYS, including further development and implementation of WGS for resistance testing on primary specimens (thereby eliminating the need to wait for culture growth).
- Continue to build a library of drug-resistant strains.
- Educate healthcare providers and local health departments on WGS TB resistance testing results and appropriate public health and clinical actions.
- Enhance collaborative efforts to support directly observed therapy to prevent the development and spread of drug resistant TB, including the use of new technologies such as video-based directly observed therapy.
- Update TB testing algorithm to reduce phenotypic analysis for those TB strains with no genomic predictors of drug resistance.

A Collaborative Building Block

The NYSDOH and the Wadsworth Center (WC) Laboratory have implemented new and dramatically faster approaches to TB diagnostics and resistance testing. The WC performs rapid molecular testing on primary specimens to improve the speed of TB diagnosis and early detection of drug resistance, providing key resistance information in the first two weeks of treatment. Additionally, in 2016 WC began to provide early identification of resistance through the implementation of whole genome sequencing (WGS). WGS provides a comprehensive resistance profile for every case of culture positive TB in NYS. Currently, NYS is the only state providing WGS for all culture positive TB cases for purposes of detecting drug resistance. Additionally, WGS improves the ability to determine strain relatedness.

3.5. Decrease Resistant *Neisseria gonorrhoeae* Through Rapid Detection of Resistant Infections and Effective, Timely Treatment

Problem:
Neisseria gonorrhoeae causes significant morbidity, with an estimated 820,000 infections nationally each year. Historically, the organism has developed resistance to the major antibiotics recommended for its use. An estimated 246,000 infections annually are resistant to at least one antibiotic. Currently, only one class of antibiotics, the cephalosporins, remains for its treatment. Delaying and preventing the emergence of cephalosporin-resistance requires increased healthcare provider awareness of and adherence to current treatment recommendations. Reducing the spread of resistant infections within sexual networks is another key prevention strategy and relies on collaboration between healthcare providers and public health investigators to quickly identify, notify, and treat all partners. Laboratory capacity to detect resistant infections relies on traditional culture-based technology, however, the majority of gonococcal infections are diagnosed with molecular, culture-independent, diagnostic tests which cannot currently detect resistance. This testing improves the rapidity of test results and hence control in sexual networks, however, significantly reduces the opportunities to detect resistant gonococcal infections.

Proposed Solution:
Develop point-of-care antibiotic susceptibility testing for gonorrhea and promote use of test results to direct appropriate patient management. Establishing rapid resistance testing will also enable earlier detection of resistant infections which in turn will allow for more timely effective treatment and investigation of both patients and their sexual partners thereby reducing the potential spread of resistant infections.

A Collaborative Building Block

The Gonococcal Isolate Surveillance Project (GISP) is a sentinel surveillance project which monitors trends in antimicrobial susceptibility of Neisseria gonorrhoeae *N. gonorrhoeae* strains at 27 sites throughout the U.S. NYSDOH and the New York City Department of Health and Mental Hygiene (NYC DOHMH) each have a participating sexually transmitted infection clinic. GISP data have been critical for detecting and monitoring gonococcal resistance as well as informing national treatment recommendations.

Specific Recommendations:

- Promote the development of rapid diagnostic tests to identify antibiotic-resistant gonorrhea infections and encourage implementation in clinical and commercial laboratories and healthcare settings.
- Develop tools and educational materials to assist healthcare providers in: 1). adhering to treatment guidelines, including electronic health record prompts supporting the currently recommended two-drug regimen, 2). routinely retesting patients three months following treatment, and 3). using antibiotic susceptibility test results to choose antibiotics for patient treatment.
- Develop educational materials for patients on the risks of antibiotic-resistant gonorrhea, signs of treatment failure, and importance of referring sexual partners for testing and treatment.
- Establish a repository of resistant gonococcal isolates to allow for additional molecular testing by NYS and NYC public health laboratories, as indicated, and for the exploration of WGS of gonococcal isolates.

4. Improve Control of AR:

Through implementation of evidence-based practices in infection control, improved communication, and outbreak response, our statewide response to emerging AR infections and outbreaks will be strengthened.

4.1. Improve Infection Prevention and Control Capacity in Healthcare Settings Across NYS

Problem:
Effective infection prevention and control in healthcare facilities can be extremely challenging due to increased volume of MDROs identified among patients, increased complexity of healthcare facility based care, and expansion of complex care across setting types.

In LTCFs challenges abound where infection prevention activities are often carried out by a staff member with many other roles and limited formal training in infection prevention and control. Additionally, in LTCFs there is an overarching aim to optimize a home-like environment challenging infection control efforts. Finally, many residents with MDROs are often undiagnosed, furthering silent transmission within these facilities.

Hospitals and, increasingly, LTCFs are investing in efforts to maintain proper infection control precautions, especially in an era of resistant emerging infections such as *C. auris*. The sustainability of these efforts, however, is being challenged due to multiple competing priorities, a lack of reimbursement for these activities, and costs of maintaining infection control precautions such as private rooms, gloves, gowns, time and expertise of infection preventionists and nurses, extra time required of environmental services staff for appropriate cleaning and disinfection, and training of all staff.

Proposed Solution:
Enhance infection prevention and control training and capacity in all NYS healthcare settings, with a focus on improved infection prevention in LTCFs. Stakeholders such as nursing home associations, local and state public health, LTCFs, and healthcare systems need to ensure that these basic evidence-based infection prevention and control measures are in place in modern 21st century healthcare settings with complex medical care.

Model

The New York State Department of Health and the Greater New York Hospital Association held a training event for nursing home leadership in May 2018 focused on protecting patients from exposure to carbapenem-resistant Enterobacteriaceae (CRE) and *Candida auris*. The day-long training included "hands on" instruction on assessing the thoroughness of cleaning and emphasized the importance of ongoing monitoring of the effectiveness of cleaning and disinfection in a facility's comprehensive infection control program. Participating facilities were equipped with fluorescent marking equipment and were trained to monitor the effectiveness of environmental cleaning practices at their facilities. Each facility will conduct observations, join coaching calls, and share best practices to sustain improvements.

Specific Recommendation:

- Enforce new CMS rules requiring LTCFs to designate one or more individuals as an infection preventionist, who has completed specialized training in infection prevention and control by 2019.
- Offer specialized training in infection prevention and control for LTCF infection prevention staff to meet this requirement (see 'Model' sidebar). Trainings may be provided through in-person or digital platforms by stakeholders such as nursing home associations, professional organizations such as Association for Professionals in Infection Control (APIC),

healthcare systems, local and public health agencies, and learning collaboratives, among others.

- Enforce the availability of readily accessible hand hygiene equipment and products for both resident and staff use and accessible personal protective equipment for Standard and Transmission-Based Precautions in LTCFs.
- Standardize and ensure the use of proper signage for optimal infection control and prevention in LTCFs, ambulatory surgery centers, and office-based surgery settings, to alert staff of the need for Transmission-Based Precautions for patients or residents colonized or infected with MDROs. This signage must include information regarding actions to be taken when residents are infected with or carrying an MDRO (e.g., wear gloves and gown prior to entering the room, special cleaning measures). Explore additional signage or tools for extremely drug resistant infections that require special attention, such as cohorting, special cleaning, or other special measures (e.g., the need for hand washing with soap and water or the need for particular cleaning products to prevent transmission).
- Appoint dedicated infection prevention and control staff to address infection prevention issues in outpatient settings and other non-acute care settings.
- Provide supportive educational visits and infection control site assessments by public health agency experts on a regular basis, with increased frequency as needed.
- Provide infection prevention and control training for the state survey agency to effectively incorporate infection prevention and control assessments during regulatory visits, as appropriate, with follow-up of significant discrepancies.
- Explore incentives and mechanisms for reimbursement of screening tests and Transmission-Based Precautions for MDROs (e.g., specific reimbursement to encourage proper implementation of Transmission-Based Precautions, use of private rooms whenever indicated, admission screening, point prevalence surveys, targeted screening, and contact screening) to enhance detection and limit spread of MDROs for acute care and long-term care settings.
- Encourage LTCFs to join a learning collaborative to address infection control and prevention by 2019.

4.2. Improve Interfacility Communication

Problem:
There is enormous variability in interfacility communication provided by transferring and admitting facilities regarding a patient's or resident's history of infection or colonization with resistant organisms. This leads to delayed or inadequate initiation of infection control precautions upon the individual's arrival into the new healthcare setting. History of past infection or colonization with a resistant organism is often lacking, as discharge instructions usually reflect current or active patient/resident infections only. However, past infection or colonization with resistant organisms may warrant implementation of infection control precautions. Furthermore, in NYS there is considerable interfacility exchange, particularly in the New York City metropolitan area. Health information exchanges in NYS have been developed and could serve as a foundation for improved interfacility communication.

Proposed Solution:
Develop a user-friendly universally adopted electronic system to reliably improve interfacility communication statewide.

Specific Recommendations:

- Adopt a system for notification of receiving facilities regarding patient MDRO infection or colonization history with a minimum data set such as contained in the standardized CDC interfacility infection control transfer form, until a secure electronic platform is developed and implemented. This allows MDRO colonization history as well as active infections to be documented clearly in the medical record and upon every transfer to a healthcare facility.

- Develop a secure user-friendly electronic platform for transfer of infection control and MDRO information between facilities, with use of health information exchanges or a novel software platform. The system would flag a patient or resident with an MDRO or infection control need and send an alert on interfacility transfer. Novel software platforms that link to and input drug resistance testing data from the health information exchanges would enhance user acceptability.

- Pilot a program for electronic transfer of MDRO and infection control information, to serve as a model for other facilities.

4.3. Boost Aggressive Statewide Response to Emerging Drug-Resistant Organisms

Problem:
As a major hub for international travelers, NYS, and specifically the NYC metropolitan area, is vulnerable to emerging global threats, including extremely or multidrug-resistant organisms. Indeed, at the outset of the 21st century, CRE (a group of bacteria resistant to a 'last resort' antibiotic) took a foothold in the NYC metropolitan area and this highly resistant pathogen continues to maintain high rates in the area when compared to the rest of the state and country.

Most recently, with the emergence of the latest drug-resistant organism to gain prominence - *C. auris*, a multidrug-resistant yeast, NYS again finds itself at the forefront of a response to an emerging drug-resistant infection. The NYSDOH, working with the CDC, is leading the response to *C. auris* and is taking aggressive action to contain the spread of the resistant organism in hospitals and LTCFs. NYSDOH has provided guidance and assistance to healthcare facilities to strengthen readiness, enhance surveillance, and implement effective infection prevention and control measures. Additionally, the NYSDOH public health laboratory, the Wadsworth Center, was designated one of seven regional labs within CDC's Antimicrobial Resistance Laboratory Network (ARLN), and along with the Division of Epidemiology, will be leaders in mounting NYS's response in the identification and prevention of CRE, *C. auris*, plasmid-mediated colistin resistance *(mcr)* gene-carrying resistant organisms, and other drug-resistant organisms. While significant advances have been made, an enhanced and sustained statewide response is required.

Proposed Solution:
Boost and sustain an aggressive and coordinated multifaceted statewide response to emerging highly resistant organisms.

Specific Recommendations:

- Increase MDRO colonization screening using new methods of rapid resistance testing, using recent work by NYSDOH as a model and expanding upon these efforts. This will help determine MDRO colonization status of patients and residents in real-time so effective infection control measures can be instituted promptly. While the NYSDOH ARLN Wadsworth Center has developed testing methods and significantly increased capacity to support these efforts, additional laboratories must develop capacity to perform similar molecular testing in order to provide availability of screening tests statewide.

- Increase onsite reviews of hospitals and LTCFs, as initiated for CRE and *C auris* responses, to support, educate, and assess compliance with infection prevention and control requirements.

- Create a NYS Multidrug-Resistant Organism (MDRO) Toolkit that addresses the differences between drug-resistant organism (e.g., CRE, *C. auris, mcr* resistant organisms) burden seen throughout the state and provide step-by-step instructions for facilities on important interventions for prevention and control with escalation of efforts for increased burden of resistant organisms.

- Require clinical staff in all hospitals and nursing homes to participate in enhanced infection prevention and control education.

4.4. Ensure the Safety of our Food

Problem:
Food safety measures protect consumers from infection acquired from contaminated food products. Antibiotic-resistant organisms, if present, can be transmitted as a foodborne illness through unsafe food practices, such as consumption of raw milk and improper supply methods, handling, storage, or preparation of food products.

Proposed Solution:
Ensure optimal food safety measures are codified and effectively enforced throughout NYS. Ensure education of consumers regarding food safety in food storage, handling, and preparation at home. Educate consumers that proper food handling and preparation, mitigates the risk of foodborne illness, including infection with AR pathogens.

Specific Recommendations:

- Promote ongoing research and education on best management practices and disease control for food producing animals.

- Expand farm level enrollment in New York State Cattle Health Assurance Program (NYSCHAP) and other similar species-specific health management programs.

- Increase educational outreach on the benefits of pasteurization, in light of increased trends for consumers to choose unpasteurized, raw dairy products.

- If sales of raw milk will continue to be permitted in NYS, implement safety measures including:

  – Monitor raw milk for the presence of antibiotic-resistant pathogens to guide future policy decisions related to raw milk sales.

  – Require that the mandatory educational material posted at the site of raw milk sales includes information regarding the potential for the presence of antibiotic-resistant pathogens.

4.5. Improved Biosecurity and Veterinary Infection Control

Problem:
Heightened infection control in all settings including veterinary facilities and among livestock producers is an essential component in efforts to prevent the spread of infection, including resistant infection, between animals, between farms, and to humans. For example, better biosecurity and hygiene can prevent the spread of highly resistant organisms from animals (such as cattle) to humans. Additionally, the number of small ("hobby") farms and backyard poultry flocks is increasing in NYS and these animal caretakers may have little or no training or experience in agriculture, animal husbandry, disease prevention, or biosecurity. Finally, veterinary facilities (e.g., animal hospitals or animal shelters) often face challenges in infection control and prevention of zoonotic disease transmission.

Proposed Solution:
Promote preventive strategies among farmers and veterinarians, such as appropriate husbandry and hygiene, routine health monitoring, immunization, and management practices that promote and protect animal and human health and reduce the incidence of disease. Educate food animal producers and others who have animal contact on how to prevent human exposure to zoonotic pathogens.

Specific Recommendations:

- Assess farmer knowledge and evaluate existing biosecurity on NYS farms to better understand where educational efforts should be targeted.
- Promote the principles within the National Association of State Public Health Veterinarians (NASPHV) Compendium of Measures to Prevent Disease Associated with Animals in Public Settings.
- Increase knowledge among small scale farmers and those with backyard poultry flocks about animal husbandry and infection control measures.
- Provide resources through the Cornell Cooperative Extension, and other outreach mechanisms, to educate owners of small farms and backyard poultry flocks.
- Improve outreach by NYS agencies and organizations to commercial and niche industries (backyard, organic, etc.) to promote optimal animal health, biosecurity, and good agricultural practices.
- Improve education about and adherence to infection control practices in veterinary hospitals, clinics, and animal shelters, e.g., following the recommendations of the National Association of State Public Health Veterinarians Veterinary Infection Control Committee.

Model

In May 2017, Cornell University brought together healthcare providers, veterinarians, researchers, food safety experts, epidemiologists, and other public health workers from across the One Health spectrum. This meeting opened discussion and provided a networking opportunity and platform for future research, public health action, and clinical collaboration focused on the AR One Health spectrum.

5. Strengthen Collaboration Throughout All AR Prevention and Control Efforts: *Through enhanced collaboration across regions and disciplines, the effectiveness and reach of individual efforts will be maximized.*

5.1. Supply Platforms for Diverse Stakeholders to Share Information and Collaborate on AR Research and Initiatives

Problem:
Mechanisms and resources for collaboration and sharing AR prevention and control best practices remain scarce. Collaboration is essential to maximize the effectiveness of proposed interventions.

Proposed Solution:
Create opportunities for the diverse population of AR stakeholders in NYS to meet, share information and promising practices, and to network. In November 2016, the NYS AR Prevention and Control Task Force was convened and the first summit was held. The task force is a multidisciplinary, NYSDOH-led partnership of stakeholders and subject matter experts from across New York, which includes federal, state and local agencies, academia, and representatives from agriculture/veterinary, fields of medicine, infection prevention, and multiple healthcare settings.

Specific Recommendations:

- Convene the NYS AR Prevention and Control Task Force Summit annually, or as needs demand. To ensure sustainability, funding will be needed.
- Increase AR enhanced surveillance, research, and study of public health interventions through programs such as the NYS Emerging Infections Program (EIP), a CDC-funded NYSDOH program with academic partner University of Rochester.
- Create multidisciplinary collaborations at the regional or local level (such as the NYC Antibiotic Resistance Prevention Advisory Group) to collaborate on the detection, prevention, and control AR.

- Create forums where administrators from both acute and long-term care facilities can establish and cultivate meaningful partnerships within their "smaller healthcare community circles" to facilitate ongoing interventions to combat transmission and spread of MDROs.
- Increase academic and NYS agency partnership to communicate, share ideas, and train a collaborative workforce.

5.3. Synchronize AR and Infection Control Strategies Across the Continuum of Healthcare

Problem:
Efforts to reduce resistance in a silo (i.e., in an acute care facility alone) will be ineffective without mirrored efforts in other settings where patients reside (i.e., nursing homes, the community healthcare setting). Isolating the implementation of AR prevention strategies within each level of healthcare services (i.e., acute care versus nursing home versus outpatient settings) complicates the ability to sustain gains.

Proposed Solution:
Synchronize implementation of AR prevention strategies across the continuum of care, so that gains made by one group (i.e. acute care facilities) can be maintained and sustained throughout the spectrum of healthcare.

Specific Recommendations:

- Facilitate collaboration among healthcare facility associations, professional organizations, healthcare facilities, and public health to synchronize infection prevention and control recommendations across the healthcare spectrum.

5.4. Create and Maintain Clinically Useful Regional Antibiotic Resistance Charts (Antibiograms)

Problem:
Antimicrobial resistance can be evaluated on a facility, community, or regional level. Development and use of antibiograms (a report on the amount of antimicrobial resistance by organism) are currently largely restricted to the hospital setting. These antibiograms can be used to develop empiric treatment for many infections when there is no resistance testing readily available. In many community or healthcare settings, antibiograms may not be available at all.

Proposed Solution:
Create regional antibiograms to be shared among facilities and providers.

Specific Recommendations:

- Encourage all hospitals to create antibiograms.
- Increase sharing of antibiograms both regionally and statewide.
- Encourage LTCFs to use antibiograms and educate on proper use and importance of appropriate antibiotic prescribing.
- Support collaboration between public health and healthcare organizations to develop regional antibiograms.
- Provide antibiogram data to support use in antibiotic guidelines and algorithms (e.g., use regional susceptibility data to guide prescribing in the outpatient setting, see 'Model' sidebar).
- Investigate novel software platforms to exchange information from facilities, analyze data, and provide regional antibiograms.
- Develop a network to provide statewide information.

Model

In 2017, the NYC DOHMH collaborated with experts at local healthcare systems to create a regional antibiogram for urinary tract infections occuring in the outpatient setting. The antibiogram included borough level antimicrobial susceptibilities and was generated to assist primary care clinicians with treatment decision making and to promote judicious prescribing in the outpatient setting. It is available at: www.nyc.gov/health/antibiogram.

5.5. Enhance Communication Between Public Health and Healthcare Facilities in NYS

Problem:
There are considerable time lags in current systems that alert public health agencies about emerging AR threats and, alternatively, that provide public health alerts to facilities regarding emerging outbreaks.

Proposed Solution: Expedite communication between public health and healthcare facilities regarding AR and outbreak response.

Specific Recommendations:

- Develop and operationalize a method to expedite the provision of information on emerging AR infections.
- Increase direct contact between infection preventionists, hospital epidemiologists and local and state public health.
- Explore implementation of a regular, collaborative forum for LTCFs, hospitals, and public health.
- Foster collaborative relationships among LTCFs, hospitals, and public health.

5.6 One Health Data Integration

Problem:
Antimicrobial resistance data is not integrated and should be shared across veterinary medicine, food production, human medicine, environmental, and public health. AR information is currently housed in different systems.

Proposed Solution: Improve sharing AR information across the one health spectrum, from animal health and the environment to human and public health.

Specific Recommendations:

- Develop a method to share clinical veterinary and human AR data into a single system.
- Acknowledging the challenges, work with veterinary and livestock communities to, when feasible, increase surveillance of AR in animals, food products, and the environment.
- Develop an integrated AR monitoring network that includes whole genome sequencing-based monitoring of AR pathogens and AR genes in humans, animals, foods, and environmental and wildlife samples, using a One Health framework, through collaborations with NYSDOH, NYS Department of Agriculture and Markets, the NY Animal Health Diagnostic Center, and the NYS Veterinary Diagnostic Laboratory.

Collaborative Building Block

The New York Integrated Food Safety Center of Excellence led by the NYSDOH and Cornell University, is one of six regional centers of excellence nationally, and serves as a collaborative platform for improvement in regional food safety measures, including foodborne illnesses associated with resistant organisms. Among many initiatives, in May 2018, a meeting was held to bring together diverse stakeholders in AR to discuss strategies for One Health AR data sharing between animal and public health. This effort will broaden our understanding of AR in New York State, establish baselines, set priorities, and determine next steps in the plan to integrate animal AR data with human public health to improve rapidity of response to AR threats.

Model

The National Antibiotic Resistance Monitoring System (NARMS) is a collaboration among public health departments, the CDC, the U.S. Food and Drug Administration (FDA), and the U.S. Department of Agriculture (USDA) which tracks changes in the antimicrobial susceptibility of certain enteric (intestinal) bacteria found in ill people, retail meats, and food animals. The program provides information about emerging bacterial resistance and the ways in which resistance is spread. An interactive online tool, NARMS Now: Human Data, presents state specific data regarding AR trends over the past 20 years.

5.7. Inclusion of AR Plans within Emergency Health Preparedness Processes

Problem:
AR is a rising public health threat and New York must channel its resources to prepare the state to prevent, respond, and recover from a large-scale AR outbreak.

Proposed Solution:
Strengthen and expand support to NY communities and build upon existing emergency health preparedness partnerships with state agencies, local health authorities and coalitions, health systems, and private sector stakeholders.

Specific Recommendations:

- Coordinate alliances to work together to increase public awareness and develop plans to withstand the adversity posed by this threat by strengthening health and response systems and enhancing public security.
- Promote inclusion of AR research as a priority within public health emergency preparedness, with advanced preparation of institutional review board protocols, electronic consenting systems for more rapid initiation of emergency public health research within established secure platforms, effective pre-planned partnerships with health systems, public health, and academia, and involvement of a research team within public health emergency response.

5.8. Engage the Community in the Effort to Combat AR

Problem:
As antibiotic resistance is a wide-ranging problem across many facets of our communities, it will take a comprehensive approach, including most importantly community members themselves, to reach our goals to prevent, control, and mitigate the effects of AR.

Proposed Solution:
Engage at the community level with involvement of local leaders, local health departments, schools, academia, local agencies and organizations, pharmacies, and local healthcare providers.

Specific Recommendations:

- Engage opinion leaders in the community (e.g. Commissioners/Directors of local health departments, healthcare system CEOs, county medical societies, etc.) to make a public commitment to raising awareness about fighting AR in their communities. Their leadership in speaking out publicly about the threat of AR will call attention to what has been, for many, a "hidden" concern among healthcare leaders, and transition knowledge from these leaders to individuals.
- Host events such as town halls and community forums about AR where the problem and solutions from community leaders can be discussed.
- Develop certificates for patients who engage in appropriate antibiotic use and nominate "patient champions" who educate their peers and networks on appropriate AU.
- Engage public employee unions for action concerning the threat of AR and how it will affect the health and well-being of their membership and members' families now and in the future. Likewise, large employers such as large healthcare systems should educate their staff on what the average consumer can do to fight AR and messages can be disseminated with newsletters, rallies, health awareness days.

Acknowledgements: *We would like to thank the NYS AR Prevention and Control Task Force members for their time, expertise, and enthusiasm.*

Observation

"This is not just a public health problem, this is not just a healthcare system problem, this is a community problem."

– NYS AR Task Force member, Don Weiss, MD, MPH, New York City Department of Health and Mental Hygiene.

LIST OF ABBREVIATIONS

AR:
Antibiotic/antimicrobial resistance

ARLN:
Antimicrobial Resistance Laboratory Network

ASP: Antibiotic stewardship program

C. auris:
Candida auris

C. difficile:
Clostridium difficile

CARB:
Combating antibiotic-resistant bacteria *(of The National Action Plan for Combating Antibiotic-Resistant Bacteria)*

CDC:
Centers for Disease Control and Prevention

CRE:
Carbapenem-resistant Enterobacteriaceae

DSRIP:
Delivery System Reform Incentive Payment

E. coli:
Escherichia coli

EHR:
Electronic health record

EIP:
Emerging Infections Program

FDA:
U.S. Food and Drug Administration

GISP:
The Gonococcal Isolate Surveillance Project

HAI:
Healthcare associated infection

LTCF:
Long-term care facility

MCR-1:
Plasmid-mediated colistin resistance gene

MDRO:
Multidrug-resistant organism

MDR-TB:
Multidrug-resistant *tuberculosis*

MRSA:
Methicillin-resistant *Staphylococcus aureus*

N. gonorrhoeae:
Neisseria gonorrhoeae

NARMS:
The National Antimicrobial Resistance Monitoring System for Enteric Bacteria

NHSN:
The National Healthcare Safety Network

NYSDOH:
New York State Department of Health

NYSIIS:
NYS Immunization Information System

PPS:
Performing Provider Systems

***S.* Dublin:**
Salmonella Dublin

STARR:
The New York State STop Antibiotic Resistance Roadmap

TB:
tuberculosis

USDA:
The U.S. Department of Agriculture

VFC:
Vaccines for Children

VFD:
Veterinary Feed Directive

VIN:
Veterinary Information Network

VRE:
Vancomycin-resistant *Enterococci*

WC:
The Wadsworth Center *(The NYDSOH Public Health Laboratory)*

WGS:
Whole genome sequencing

XDR-TB:
Extensively drug-resistant *tuberculosis*

APPENDIX A. Promising Evidence-based Strategies and Solutions

National Action Plan for Combating Antibiotic-Resistant Bacteria (CARB)

The National Action Plan for CARB *(March 2015)* outlines a national strategy to guide actions against drug-resistant bacteria. Although focused on federal action, several goals and objectives from the National Action Plan can inform our work in NYS.[15] For example, the Antimicrobial Stewardship Program (ASP) goals were among actions recommended and the National Action Plan for CARB set a national goal of 100% of hospitals with ASPs by 2020.

Antibiotic Stewardship Programs

The CDC Core Elements of Hospital Antibiotic Stewardship Programs guidance (2014) highlights seven core elements identified as contributing to successful ASPs **www.cdc.gov/antibiotic-use/healthcare/implementation.html**

- Ensure commitment of hospital leadership
- Enhance accountability for program outcomes
- Appoint team members with drug expertise
- Initiate specific actions to address antibiotic use in the facility
- Track antibiotic use
- Provide data to healthcare providers
- Educate staff

The document was adapted in 2015 for nursing homes as a means to provide practical ways to initiate or expand antibiotic stewardship activities in the long-term care setting (**www.cdc.gov/longtermcare/pdfs/core-elements-antibiotic-stewardship.pdf**).

Reduction of Carbapenem-resistant Enterobacteriaceae (CRE) on a National Level in Israel

Israel experienced a national outbreak of CRE starting in early 2006. To control the spread, in 2007, the Israel Ministry of Health implemented a three-part intervention against all CRE in acute-care hospitals.[16]

- Mandatory reporting of every patient with a CRE specimen
- Mandatory isolation of hospitalized CRE carriers in self-contained nursing units
- Establishment of a Task Force on AR and Infection Control. The Task Force collected data on hospital activity, including a daily census of CRE carriers, evaluated isolation guideline compliance, conducted hospital site visits, and provided feedback reports.

At the peak, there were 56 CRE cases per 100,000 patient days. Following implementation, CRE incidence declined to 12 cases per 100,000 patient-days.

Evidence-based Outpatient Stewardship Interventions

The *CDC's Be Antibiotics Aware formerly Get Smart Program* contains a webpage on "Interventions That Work" which highlights evidence-based strategies to improve antibiotic prescribing in outpatient settings: **www.cdc.gov/antibiotic-use/community/improving-prescribing/evidence/index.html**

Studies reviewed include systematic reviews of outpatient stewardship, evaluations of audit and feedback, academic detailing, clinical decision support, delayed prescribing practices, and poster-based interventions. Multifaceted interventions with active provider education appear to have the greatest benefit. Some examples include:

- A 2014 randomized clinical trial evaluated inappropriate antibiotic prescriptions for acute respiratory infections (ARIs) with the use of a poster-based intervention. Clinicians who displayed a signed poster-sized letter in their examination room committing to appropriate antibiotic use (AU)

had a significant reduction in inappropriate prescribing rates for ARIs (34% inappropriate prescribing rates with the poster intervention compared to 53% in the control group).[17]

- A 2016 multisite randomized trial evaluated three electronic health record (EHR) interventions in primary care practices to reduce inappropriate antibiotic prescribing for ARI. These interventions were developed based on insights from the behavioral sciences.
  - An *accountable justification* intervention prompted clinicians to enter a free text "antibiotic justification note" in the EHR when antibiotics were prescribed for ARI. This led to a decrease in prescribing rates from 23% to 5%.
  - A *peer comparison* intervention ranked clinicians within regions based on prescription rates for ARI diagnoses which did not warrant antibiotic treatment. Clinicians with the lowest inappropriate prescribing rates received a monthly email that they were top performers, while all other clinicians received an email that they were not a top performer and were given their prescription numbers compared to top performers. This intervention led to a decrease in prescribing rates from 20% to 4%.[18]

A One Health Approach to Antimicrobial Resistance Prevention and Control

A One Health approach encourages collaborative efforts of many experts such as veterinarians, physicians, and epidemiologists to build partnerships with human, animal, and environmental health organizations recognizing that the health of people is connected to the health of animals and our shared environment.

The United States Department of Agriculture (USDA) Antimicrobial Resistance Action Plan

The USDA AR Action Plan *(June 2014)* outlines USDA's current activities and proposes a voluntary comprehensive, integrated approach for future surveillance; research and development; and education, extension, and outreach activities that span three objectives:

- Determine and model patterns, purposes, and impacts of antibiotic use in food-producing animals.
- Monitor antibiotic drug susceptibilities of selected bacterial organisms in food-producing animals, production environments, and meat and poultry.
- Identify feasible management practices, alternatives to antibiotic use, and other mitigations to reduce AR associated with food-producing animals and their production environments.

The USDA AR Action Plan can be found at: **www.usda.gov/sites/default/files/documents/usda-antimicrobial-resistance-action-plan.pdf**

The United States Food and Drug Administration Veterinary Feed Directive Final Rule

Over the past several years, the Food and Drug Administration (FDA) has taken important steps toward fundamental change in how medically important antibiotics can be legally used in feed or water for food-producing animals. Now, the agency is moving to eliminate the use of such drugs for production purposes (i.e., growth promotion and feed efficiency) and bring their remaining therapeutic uses in feed and water under the supervision of licensed veterinarians – changes that are critical to ensure these drugs are used judiciously and only when appropriate for specific animal health purposes. The Veterinary Feed Directive (VFD) final rule *(October 2015)* outlines the process for authorizing use of VFD specified drugs (animal drugs intended for use in or on animal feed that require the supervision of a licensed veterinarian) and provides veterinarians in all states with a framework for authorizing the use of medically important antimicrobials in feed when needed for specific animal health purposes. Information about the VFD can be found at: **www.fda.gov/AnimalVeterinary/DevelopmentApprovalProcess/ucm071807.htm**

APPENDIX B. Current NYS Initiatives to Combat Antibiotic Resistance

The New York State Department of Health (NYSDOH)

The NYSDOH has been on the forefront of advances in the surveillance, prevention, and control of AR. NYSDOH AR prevention and control includes, but is not limited to, routine surveillance and response through the Healthcare Associated Infections (HAI) reporting program, response to healthcare facility and community infectious disease outbreaks, and prevention and control of TB, sexually transmitted infections, and vaccine preventable diseases. Key programs with on-going activities in AR prevention and control are detailed below. For further information, the NYSDOH AR website is available at: **www.health.ny.gov/antibioticresistance**

Healthcare facility antimicrobial resistance prevention and control

Long-Term Care Facility Prevention Projects

Since 2010, the Bureau of HAI has worked with long-term care facilities (LTCFs) to create statewide prevention collaboratives. The goals have been to decrease *C. difficile* infection and reduce transmission of resistant organisms in LTCFs through improved communication during patient care transfers, development of ASPs in LTCFs, and implementation of best practices in infection control and prevention. The collaborative has had multiple projects over the years with activities ranging from providing educational webinars to assisting with surveillance. To date, over 115 facilities voluntarily participated.

Collaboration to Launch Antibiotic Stewardship Programs (CLASP) in NYS LTCFs

This project is a continuation and expansion of the work done in previous LTCF collaborative projects and aids NYS LTCFs in the implementation of ASPs and improved use of antibiotics through evidence-based practices. In addition, participating facilities provided data about antibiotic use in their facility, specifically related to treatment for urinary tract infections to inform stewardship efforts. The project was initiated in 2017 and analysis and ongoing evaluations are currently in progress.

Carbapenem-resistant Enterobacteriaceae (CRE) Surveillance and Prevention Project

Funded through the Epidemiology and Laboratory Capacity (ELC) for Infectious Diseases Cooperative Agreement with the CDC and led by the NYSDOH Bureau of HAI, this project combats the spread of CRE in healthcare facilities, with dedicated staff assigned to coordinate surveillance and prevention activities throughout the state, and with a focus on the New York City metropolitan area. Activities include:

- On-site visits by the state CRE coordinator to hospitals and LTCFs with CRE rates that are higher than the state average. These visits include discussions on facility-wide CRE surveillance and prevention practices, antibiotic stewardship activities, and inter-facility transfer of information, among other strategies intended to reduce facility incidence rates.
- A CRE/AR workgroup was established to develop strategies to improve identification of CRE-colonized patients and implementation of prevention measures to control its spread.
- A statewide comprehensive survey of infection control practices surrounding CRE and other multidrug-resistant organisms (MDROs) was distributed in early 2017.
- Input from both the workgroup and survey will be used to develop a statewide coordinated plan for CRE/MDRO control.

NYSDOH-Funded HAI C. difficile *and AR Prevention Projects, 2013-2018*

Three collaborative prevention projects funded by the NYSDOH:

- A collaborative of four hospitals and seven LTCF facilities was formed in the western region of NYS. Led by the University of Rochester, this project is aimed at reducing LTCF *C. difficile* through use of antibiotic stewardship programs.
- A collaborative with six participating healthcare facilities, led by Westchester Medical Center, has been conducting a project aimed at reducing *C. difficile* through enhanced environmental disinfection guided by clinical and molecular epidemiology.
- A collaborative led by Weill Cornell Medical College with five acute care hospitals in NYC has been conducting a project aimed at reducing *C. difficile* and MDRO infections by improving environmental cleaning, antimicrobial stewardship, and education.

Ebola Virus Disease Infection Control Assessment and Response Program

NYSDOH was granted supplemental funding to the CDC ELC cooperative agreement to improve and sustain public health infection control assessment and response for Ebola and other emerging and highly transmissible pathogens. Program activities include healthcare facility site visits for infection control and prevention evaluation and assistance. While these activities were developed to improve and sustain readiness for Ebola in NYS, these efforts will additionally enhance infection control and prevention generally and improve readiness for other HAI threats, such as highly resistant organisms.

Community based antimicrobial resistance prevention and control

The Gonococcal Isolate Surveillance Project

The Gonococcal Isolate Surveillance Project (GISP) is a sentinel surveillance project which monitors trends in antimicrobial susceptibility of *Neisseria gonorrhoeae* strains at 27 sites throughout the U.S. NYSDOH and the NYC Department of Health and Mental Hygiene each have a participating STI clinic. GISP data have been critical for detecting and monitoring gonococcal resistance as well as informing national treatment recommendations.

The NYS Emerging Infections Program (EIP)

The EIP network, a collaboration between CDC, ten state health departments and academic institutions, is a national resource for surveillance, research, prevention, and control of emerging infectious diseases. NYSDOH and the Wadsworth Center (WC), with academic collaboration with the University of Rochester, have served as an EIP site since 1997. EIP has been credited with serving a critical role in the study of emerging infections, the result of which has informed public health action.[19] Activities include an active population-based enhanced surveillance system for invasive bacterial pathogens of public health importance, including the evaluation of AR in the studied pathogens. FoodNet, part of EIP, is an active population-based laboratory surveillance system to monitor the incidence of foodborne diseases. Activities include conducting surveillance and tracking AR.

The NYS Be Antibiotics Aware Program

This public health outreach campaign, funded through the CDC ELC cooperative agreement, is aimed at both healthcare providers (HCPs) and patients. *The NYS Be Antibiotics Aware (*formerly *Get Smart) Program* works to ensure that antibiotics are prescribed at the right time, with the right dose, with a focus on common illnesses that account for most of the antibiotic prescriptions written in outpatient settings. Key activities include:

- Analysis of NYS Medicaid data to identify high prescribing areas in the state with provision of targeted education to HCPs in these areas.

- Development of evidence-based tools to support HCPs, such as the NYSDOH "Smart Use Guarantee" Poster and the Adult and Pediatric Antibiotic Prescribing Guidelines
- Development of educational videos for HCPs and health professional trainees which model effective communication techniques to address patient expectations surrounding antibiotic use and a brief video for patients regarding appropriate antibiotic use.
- Resources are available at the NYSDOH AR Webpage at: **www.health.ny.gov/antibioticresistance.**

The NYSDOH Bureau of Immunization

Through aggressive efforts to ensure all New Yorkers receive recommended vaccines, the risk of resistant vaccine preventable diseases is reduced. Additionally, there is a reduction in bacterial and viral diseases thereby decreasing both appropriate and inappropriate antibiotic use to treat disease. The reduced burden of vaccine preventable diseases also decreases the number of interactions with the healthcare system and subsequent opportunities for developing a healthcare-associated infection.

Antimicrobial resistance in One Health

The National Antimicrobial Resistance Monitoring System for Enteric Bacteria (NARMS)

The NARMS is a collaboration among state and local public health departments, the CDC, the U.S. Food and Drug Administration (FDA), and the U.S. Department of Agriculture (USDA) which tracks changes in the antimicrobial susceptibility of certain enteric (intestinal) bacteria across the One Health spectrum of ill people, retail meats, and food animals. As part of NARMS, the NYSDOH and the WC participate in surveillance for AR in enteric bacteria from foodborne illness. The program provides information about emerging bacterial resistance, the ways in which resistance is spread, and how resistant infections differ from susceptible infections in terms of severity of the illnesses. An interactive tool, NARMS Now: Human Data, is available online which presents state specific data regarding AR trends over the past 20 years: **www.cdc.gov/narmsnow/**.

Antimicrobial resistance in laboratory research and diagnostics

The NYSDOH Wadsworth Center Antibiotic Resistance Regional Laboratory

The WC Bacteriology Laboratory was awarded $1.8 million as one of seven regional laboratories in the CDC's AR Lab Network (ARLN).[20, 21] As part of the ARLN, the WC will boost local capacity and technology to detect, support response to, and prevent AR threats and create new innovative laboratory methods to combat AR.

The Wadsworth Center-Pilot Site for "Mycobacterium tuberculosis complex" Whole Genome Sequencing[22]

NYSDOH and the WC have implemented new technologies to improve the speed of TB diagnosis and early identification of resistance. This is important because susceptibility results are essential to guide TB therapy; however, traditional culture-based methods for testing for resistance can take as long as eight weeks. Rapid molecular testing is provided that can identify TB and resistance directly from sputum samples without having to wait for culture growth. Additionally, in 2016, the WC began performing whole genome sequencing (WGS) which provides a more comprehensive resistance profile. Funded by CDC and administered by the Association for Public Health Laboratories, this program generates a drug resistance profile for every case of culture positive TB in NYS. Currently, NYS is the only state providing WGS for all culture positive TB cases. Additionally, the program improves the ability to determine strain relatedness between cases of TB through WGS analysis, which can help control spread of TB.

The NYS College of Agriculture and Life Sciences at Cornell

The NYS College of Agriculture and Life Sciences at Cornell has a number of research and outreach efforts to combat AR across the food chain. Examples of relevant projects include:

- The PRO-DAIRY program at the College of Agriculture and Life Sciences and the Quality Milk Production Services (QMPS) group in the College of Veterinary Medicine collaborate on research focused on selective dry cow antibiotic therapy, which is designed to decrease and focus antimicrobial use. Cornell University's QMPS supports New York in producing high quality milk through the control of dairy cow mastitis and the avoidance of antibiotic residues in milk and meat via field and laboratory diagnostic evaluations and recommendations. This program helps reduce antibiotic use in dairy cattle by optimizing mastitis therapy through rapid testing and dissemination of information to dairy producers.

- The Cornell Food Safety Laboratory is conducting active research on surveillance of AR genes in human and animal isolates of foodborne pathogens and WGS-based detection of AR genes focusing on *Salmonella* (**https://foodsafety.foodscience.cornell.edu/**).

- The Dairy Environmental Systems program in the College of Agriculture and Life Sciences have a collaborative project (with the State University of New York at Buffalo, University of Maryland, University of Michigan, and several participating NY dairy farms) looking at how manure treatment affects AR organisms and spread of AR: **www.manuremanagement.cornell.edu/Pages/AMR.html.**

- The Doerr lab in the Cornell University College of Agriculture and Life Sciences studies antibiotic tolerance and resistance in Gram-negative pathogens such as *Vibrio cholerae, Pseudomonas aeruginosa, Acinetobacter baumannii and Enterobacter spp.*
- The Cornell Animal Health Diagnostic Center and the NYS Veterinary Diagnostic Lab (AHDC/NYSVDL) is a WGS reference lab for a Food and Drug Administration (FDA) AR initiative and an isolate contributing lab for an USDA initiative. The AHDC/NYSVDL performs more than 5,000 automated antibiotic susceptibility tests every year on bacterial isolates originated from a variety of animal species from across the state. AHDC, with advanced bacterial identification systems and WGS, plays an essential role in animal surveillance for AR.
- The Cornell University Hospital for Animals has partnered with the AHDC/NYSVDL on *Salmonella* surveillance to pioneer a routine environmental surveillance program for monitoring clinical facilities using novel technology developed and recently published by Cornell faculty (**https://ahdc.vet.cornell.edu/programs/salmonella/**).
- The Department of Population Medicine and Diagnostic Sciences, funded through an National Institute of Health/USDA grant, is studying non-antibiotic means to prevent salmonellosis.
- The fruit pathology program at Geneva performs research on the impact of disease and horticultural management programs on the development of AR in apple-associated bacteria. This group is currently finishing a two-year investigation on the use of early season growth regulators and biologicals as a means of circumventing the need for antibiotics to manage fire blight in apples and pears.

APPENDIX C. The New York State Antimicrobial Resistance Prevention and Control Task Force

Mission statement

To create partnerships, develop new initiatives, and enhance collaboration to prevent and control antimicrobial resistance (AR) in order to reduce the burden of disease due to AR in NYS.

Vision statement

To create a NYS free of preventable disease due to AR.

Organization

The NYS AR Prevention and Control Task Force is a NYSDOH-led statewide, interprofessional, multidisciplinary initiative. By aligning efforts of stakeholders, the aim of the AR Task Force is to establish priorities and lead efforts to improve our ability to combat AR threats statewide.

The AR task force and each of the committees currently consist of NYSDOH representatives across programs including epidemiology, healthcare associated infections, communicable disease control, immunization, statistics, public health laboratory, public health practice, primary care and health systems management, quality and patient safety, environmental health, foodborne investigations, sexually transmitted infections, tuberculosis, public affairs, legal, health insurance programs, and executive leadership, among others.

External partners have been invited and include hospital and nursing home associations, provider professional organizations, academic partners, subject matter experts, federal representation, other NYS agencies, and local health department representation, among others.

See **Appendix D** for the NYS AR Prevention and Control Task Force member list and **Appendix E** for the NYS AR Prevention and Control Task Force organizational chart.

Task Force Activities To-Date

Over the past years, the NYSDOH has been working on a broad NYS response to the problem of AR. The NYS AR Task Force has been meeting regularly since 2016 and four committees were established:

1). Healthcare Facility AR Prevention and Control

2). Community-Based AR Prevention and Control

3). AR and One Health

4). AR Laboratory Research and Diagnostics

The committees have met regularly and have discussed priority goals and activities, determined key stakeholders and partners for the statewide task force, and have initiated multiple AR prevention and control activities. NYSDOH compiled an inventory of existing AR prevention and control activities within NYS. Many of these key programs are described in this document in the section titled "**Current NYS Initiatives to Combat Antibiotic Resistance**".

Roundtable Discussion on Antimicrobial Resistance in Healthcare Facilities

(July 21, 2016)

The NYSDOH, the Greater New York Hospital Association (GNYHA), and the Hospital Association of New York (HANYS) co-hosted a roundtable discussion on AR in healthcare facilities with hospital representation present. This meeting included initial discussions on approaches to organisms containing the *mcr-1* resistance gene, the multi-drug resistant yeast *Candida auris*, and the next steps to enhance surveillance for these and other MDROs.[23]

NYS Antimicrobial Resistance Task Force Summits

NYSDOH convened the first multidisciplinary NYS AR Prevention and Control Task Force Summit on November 1st, 2016 which brought together the task force members including federal, state, and local partners and experts from various disciplines including healthcare, agriculture, veterinary care, and academia to work collaboratively and comprehensively to combat AR in NYS. The summit included expert speakers on AR topics and over 100 participants provided input to inform the development of the NYS Stop Antibiotic Resistance Roadmap (STARR). The second NYS AR Task Force Summit was held on November 30th, 2017 when the task force reconvened for further expert speakers, discussion to inform the completion of the NYS STARR, and to bring 'Collaboration into Action', the theme of the event.

APPENDIX D.
NYS Antimicrobial Resistance Prevention and Control Task Force Member List

Healthcare Facility Prevention and Control		
First Name	**Last Name**	**Organization**
Eleanor	Adams	New York State Dept. of Health (NYS DOH)
Donna	Armellino	Northwell Health
Coralie	Bucher	NYS DOH
Joseph	Carreno	Albany College of Pharmacy & Health Sciences
Ghinwa	Dumyati	University of Rochester Medical Center
Janet	Eagan	Memorial Sloan Kettering Cancer Center
Sarah	Elmendorf	Albany Medical Center
Bruce	Farber	Northwell Health
Kelly	Flynn	NY Chapter of Amer. Soc. Of Cons. Pharmacists
Conn	Foley	Parker Jewish Institute for Health Care and Rehabilitation
Mathew	Foley	NYS American College of Emergency Physicians
Mary	Foote	New York City Dept. of Health and Mental Hygiene (NYC DOHMH)
Yoko	Furuya	New York Presbyterian Hospital
Rosalie	Giardina	NYS DOH
Shelly	Glock	NYS DOH
Roderick	Go	Stony Brook School of Medicine
Valerie	Haley	NYS DOH
Brad	Hutton	NYS DOH
Geraldine	Johnson	NYS DOH
Mini	Kamboj	Memorial Sloan Kettering cancer center
Jillian	Karr	NYS DOH
Linda	Kirschenbaum	Northwell Health
Sarah	Kogut	NYS DOH
Brian	Koll	Mount Sinai Health System
Molly	Kratz	NYC DOHMH
Ilya	Krichavets	Lenox Hill Hospital
David	Landman	SUNY Downstate Medical Center
Nancy	Leveille	NYSHFA
Gale	Liddell	NYS DOH
Emily	Lutterloh	NYS DOH
Prashant	Malhotra	Northwell health
Patricia	Many	NYS DOH

Healthcare Facility Prevention and Control of AR (continued)		
First Name	**Last Name**	**Organization**
Barun	Mathema	Columbia University
Lisa	McMurdo	NYS DOH
Monica	Mehta	NYS Council on Health-System Pharmacists
Brenda	Naizby	NYS DOH
Belinda	Ostrowsky	CDC/NYSDOH
Gopi	Patel	Mount Sinai Health System
Marianne	Pavia	Long Island Jewish Valley Stream
Shaun	Peterson	NYS Department of Environmental Conservation (DEC)
Vinh	Pham	NYUHC
Karen	Puglisi	LeadingAge NY
Monica	Quinn	NYS DOH
Monika	Shah	Memorial Sloan Kettering Cancer Center/Council on Graduate Medical Education
Karen	Southwick	NYS DOH
Zeynep	Sumer King	Greater New York Hospital Association
Michael	Tapper	Lenox Hill Hospital
Monica	Toohey	NYS DOH
Brandi	Van Valkenburg	American Society of Consultant Pharmacists
Gregory	Weston	Montefiore Medical Center
Loretta	Willis	Healthcare Association of NYS
Mark	Zender	New York State Society of Physician Assistants
Howard	Zucker	NYS DOH

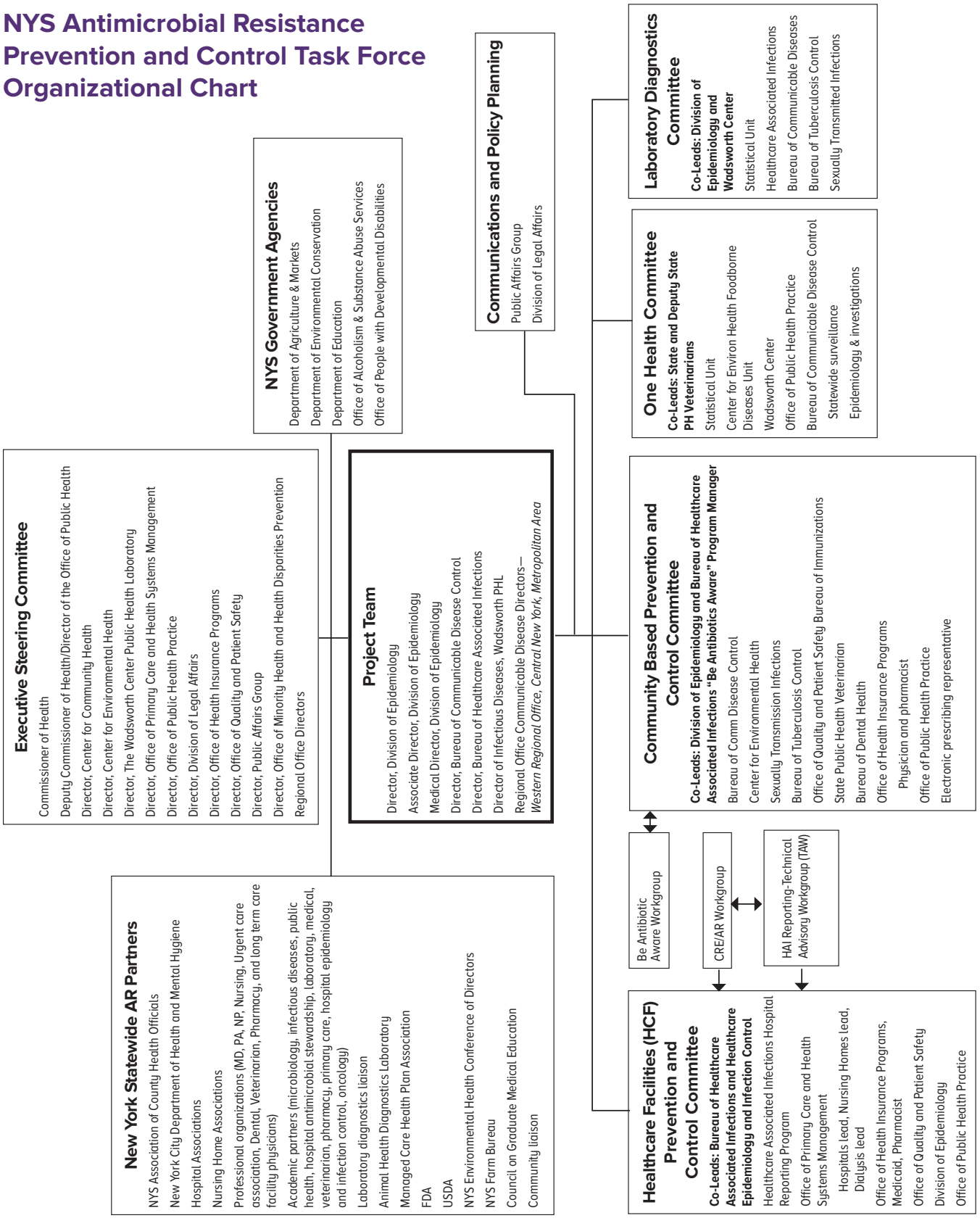
Community Based Prevention and Control of AR		
First Name	**Last Name**	**Organization**
Wilma	Alvarado-Little	NYS DOH
Sherlita	Amler	Westchester Co Health Department
Tara	Babu	University of Rochester
Tracy	Berger	NYS DOH
Guthrie	Birkhead	School of Public Health, University at Albany
Barbara	Bright-Motelson	NYS DOH
David	Brittain	NYS DOH
Gale	Burstein	Erie County Department of Health
Inderpal	Chhabra	Lefferts Medical Associates PC
Christa Rita	Christakis	The American College of Obstetricians and Gynecologists
Jan	Chytilo	NYS DOH
Patricia	Clancy	Medical Society of the State of New York
Christine	Compton	NYS DOH
Elizabeth	Dufort	NYS DOH
Stephen	Ferrara	The Nurse Practitioner Association NYS
Doug	Fish	NYS DOH
David	Flashover	NYS DOH
Mathew	Foley	NYS ACEP
Marcus	Friedrich	NYS DOH
Louanne	Giangreco	North East Regional Urgent Care Association
Arlene	Gonzalez-Sanchez	NYS Office of Alcoholism and Substance Abuse Services (OASAS)
Joan	Guzik	United Hospital Fund
Deborah	Halper	United Hospital Fund
Andrew	Handel	Stony Brook Children's Hospital
Julie	Joseph	NY American College of Physicians
Sarah	Kogut	NYS DOH
Daniel	Kuhles	NYS DOH
Teresa	Lubowski	IPRO
Emily	Lutterloh	NYS DOH
Paul	Macielak	Health Plan Association

Community Based Prevention and Control of AR (continued)		
First Name	**Last Name**	**Organization**
Adrienne	Mazeau	NYS DOH
Michael	Mendoza	Monroe County Department of Human Services
James	Mumford	New York Academy of Family Physicians
Kenya	Murray	NYC DOHMH
Alison	Muse	NYS DOH
Travis	O'Donnell	NYS DOH
Lula	Phillips	Weill Cornell Medicine
Susan	Prendergast	NYS Office for People with Developmental Disabilities
Sarah	Ravenhall	NYS Association of County Health Officials
Dionne	Richardson	NYS DOH
Barbara	Rogler	State University of New York at Buffalo
Avraham	Schreiber	Circle Urgent Care
Steve	Shost	NYS DOH
Lou	Smith	NYS DOH
Suzanne	Sullivan	New York State Education Department
Marguerite	Urban	University of Rochester
Elie	Ward	American Academy of Pediatrics, District II, NYS
Don	Weiss	NYC DOHMH
Mary Beth	Wenger	NYS DOH
Nora	Yates	NYS DOH
Gregory	Young	NYS DOH

AR in One Health		
First Name	**Last Name**	**Organization**
Craig	Altier	Cornell University
Debra	Blog	NYS DOH
Jeanine	Broughel	Department of Environmental Conservation
Kevin	Cummings	Cornell University
Russ	Davis	FDA
Melanie	Hemenway	NYS Dept. of Agriculture & Markets
Saul	Hymes	Stony Brook Children's Hospital
Karyn	Langguth McCloskey	NYS DOH
Elizabeth	Lewis	Albany County DOH
Angie	Maxted	NYS DOH
Andie	Newman	NYS DOH
David	Nicholas	NYS DOH
David	Smith	NYS Dept. of Agriculture & Markets
Dean	Snyder	NYS Veterinary Medical Society
Belinda	Thompson	Cornell University
Jennifer	Trodden	NYS Dept. of Agriculture & Markets
Neil	Vora	NYC DOHMH
Martin	Wiedmann	Cornell University
Jeff	Williams	New York Farm Bureau
Caroline	Yancey	Cornell University

AR Laboratory and Diagnostics		
First Name	**Last Name**	**Organization**
Craig	Altier	Cornell University
Deena	Altman	Mt Sinai Health System
Hoefer	Dina	NYS DOH
Sudha	Chaturvedi	NYS DOH
Cara	Clementi	Kaleida Health
Colleen	Courtney	NYC DOHMH
James	Crawford	Northwell Health
David	Dicesare	NYS DOH
Vincent	Escuyer	NYS DOH
Mary	George	Albany Medical Center
Laura	Goodman	Cornell University
Daniel	Green	Columbia University Medical Center
Camille	Hamula	Mount Sinai Health System
Maria	Ishida	NYS Dept. of Agriculture & Markets
Cheryl	Kearns	NYS DOH
Vincent	Labombardi	New York Hospital Queens
Michael	Levi	Montefiore Medical Center
Ron	Limberger	NYS DOH
Kimberlee	Musser	NYS DOH
Stephanie	Ostrowski	NYS DOH
Margaret	Oxtoby	NYS DOH
Matthew	Pettengill	University of Rochester Medical Center
Jennifer	Rakeman	NYC DOHMH
Arash	Ronaghy	Northwell Health
Jill	Taylor	NYS DOH
Hank	Wang	Westchester Medical Center

APPENDIX E.
NYS Antimicrobial Resistance Prevention and Control Task Force Organizational Chart



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