Hello, my name is Nimalie Stone, and I’m an infectious disease physician and epidemiologist working at the Centers for Disease Control and Prevention. My division at the CDC focuses on healthcare safety, and my team works specifically on preventing infections and reducing antibiotic resistance in nursing homes and other long-term care settings.

The series of recorded videos that I’ll be doing in this module were adapted from a presentation called “Taking Action to Prevent and Manage Multidrug-resistant Organisms and C. difficile in Nursing Homes” which I gave for the American Association of Nurse Assessment Coordination in January of 2014. A link to that original presentation can be found in the optional tools and resource section of this module.

So in this Part 1 video, we’re going to review the principles of antibiotic resistance and some common multidrug-resistant organisms or MDROs, as well as C. difficile. Much of this material should be review if you have worked on other modules in this Train the Trainer session.

Let’s start by reviewing some principles you may have previously learned, including some basics about bacteria. When we send a specimen to the microbiology laboratory for culture, they identify the presence of bacteria using a series of steps. One of the steps is called the Gram stain, which is a process which uses different dyes to differentiate the shape and structure of a bacteria when you look at it under a microscope.

Gram stain positive bacteria, as shown on the left of the slide, look purple because their cell walls pick up a violet dye during the process. Gram negative bacteria, as shown on the right, look reddish or pink because their cell wall can’t absorb the violet dye and instead they take up a counter stain. The size, shape and growth patterns seen in a laboratory not only help us identify which bacteria are present but also help us develop new antibiotics which can target and kill those bacteria.

I know you previously reviewed in the Antibiotics module these examples of common Gram positive and Gram negative bacteria which occur in healthcare, but here they are again as a refresher, organized by Gram stain and shape.

Many of the Gram positive bacteria we see colonizing or causing illness in residents are the Gram positive cocci or round, circular-shaped bacteria like group A Streptococci and Staphylococci, including Staphylococcus aureus. Staph and strep can harmlessly colonize the surfaces of our skin, on wounds, or even in parts of the upper airway, like the nose and throat, but if they invade into spaces they shouldn’t be, these Gram positive bacteria can cause serious skin and wound infections and can even get into the bloodstream. Enterococci, on the other hand, colonize parts of the intestinal tract, and sometimes they can be found in urine cultures.

Now as you recall from previous modules, Clostridium difficile, or C. diff, is a Gram positive rod, or box-shaped bacteria. It also happens to be an anaerobic bacteria, meaning it prefers environments with low to no oxygen, such as what you might find in the colon. Many of the common Gram negative bacteria identified in healthcare are also rod shaped or what we call “bacillus.” E. coli, Klebsiella and Enterobacter are all members of a family of Gram negative rods called Enterobacteriaceae, which is a very fancy-sounding term for bacteria that live in the intestinal tract. “Entero-” means “intestine,” and “bacteriaceae” means bacteria. So the term for that family is pretty descriptive.
Pseudomonas is in a different family of Gram negative bacteria, but it’s also commonly found on people receiving healthcare. Similar to Enterococcus, because many of these organisms colonize the intestines, they frequently can be found in urinary tract cultures, especially in residents with catheters.

Antibiotics, as you reviewed earlier, are a group of drugs which were developed to halt the growth and kill harmful bacteria which cause infection. We have to remember, though, that our bodies are naturally colonized with lots of helpful bacteria, which are known as normal bacterial flora, or the microbiota, and these bacteria work with us to aid in things like digestion and metabolism as well as protect us from invading bacteria.

Unfortunately, these bacteria can also be disrupted and killed when we take antibiotics. Killing that normal bacterial flora in our system makes us vulnerable to more resistant or aggressive pathogenic bacteria. An example of this is when C. difficile gets into our GI tract because antibiotics have wiped out the normal bacterial flora in our guts.

You’re probably familiar with several classes of antibiotics like the penicillins, cephalosporins and fluoroquinolones. Some of these drugs have a very narrow spectrum of activity, meaning they target only a few bacteria. An example of a narrow-spectrum antibiotic is metronidazole, which is often used to treat mild C. difficile infections. Metronidazole targets anaerobic bacteria, those bacteria which aren’t able to survive around oxygen.

Now other antibiotics have very broad spectrum of killing. An example of that would be the carbapenem antibiotics, and they are very active against Gram positive, Gram negative and even some of the resistant organisms. So we look at these agents as very powerful, and often we think of them as one of our last lines of defense against many serious infections. But unfortunately, we’re starting to see resistance emerging even to those powerful drugs.

And of course, “resistance” is the term that we use when we see antibiotics start to lose their killing effect on bacteria. Infections from resistant bacteria can be more severe, and because of their resistance can be harder to treat and more costly. And that is why our infection prevention programs should be monitoring resistant bacteria in our facilities, so we can take steps to prevent them from spreading.

So given that background, multidrug-resistant organisms are bacteria which have developed clinically important resistance to one or more classes of antibiotics. Sometimes one key resistance pattern will define an MDRO. Examples of this include methicillin resistance in Staphylococcus aureus and vancomycin resistance in Enterococci. Other times bacteria acquire resistance to many different antibiotic classes. For example, carbapenem resistance that I mentioned earlier doesn’t just take out that one powerful group of drugs, but it often travels with other resistance elements which make those bacteria resistant to several other classes of agents, like the fluoroquinolones or the cephalosporins. We often see multidrug resistance in Gram negative bacteria, and this can be quite concerning when we are trying to find ways to treat our patients.

This table quickly summarizes some of the common types of antibiotic-resistant bacteria that we track and try to prevent in healthcare settings along with the abbreviations we often use to describe those resistance patterns.

We have a lot of data from nursing homes showing that antibiotic resistance is a real problem impacting our residents. Studies have shown as high as 1 in every 2 residents is colonized with resistant bacteria at
a given time. This frequency of colonization varies by the type of bacteria. We see high rates of resistance occurring among Gram negative bacteria, and here in the study I have cited the prevalence of antibiotic-resistant Gram negatives colonizing residents was around 20 percent, and we also see very high rates of methicillin-resistant Staphylococcus aureus or MRSA colonizing nursing home residents. Now VRE, or vancomycin-resistant Enterococci carriage rates seem to be a little lower, but it’s possible all of these numbers will rise as we continue admitting more residents directly from hospital settings with many of the risk factors for developing colonization and infection from MDROs.

Now let’s switch gears to talk about C. difficile. I mentioned earlier that C. diff is a Gram positive rod when grown in a lab and it’s also an anaerobic bacteria, meaning it doesn’t like to grow in environments where oxygen is present. It helps explain why C. diff and other anaerobic bacteria live in our intestinal tracts, but then you may be wondering: How can C. diff spread and survive in healthcare settings once it gets out of our bodies? Well, C. diff has the special ability to convert itself into a spore. The spore form of the bacteria is protected by a hard outer coat which allows the bug to exist in unfavorable places and environments. The bacteria lies sleeping in the spore form until it gets back into a good environment where it can grow, like someone’s GI tract. Then it wakes up and begins multiplying again.

C. diff is mainly known for causing acute diarrheal infections, and these infections can be quite severe in older adults. Infected patients shed high numbers of the spore form of C. diff in their diarrhea, which can get on their skin and all over their environment. Even people who have resolved their diarrhea can still shed levels of C. diff into their environment, especially in the first few days to weeks immediately after their infection. Once the spores get into the environment, it’s very easy for them to contaminate the hands of caregivers or the equipment we use to take care of other residents. C. diff, like MDROs, is a significant and growing challenge for nursing homes. More than half of healthcare-associated C. diff infections are occurring in long-term care settings, and a large number of people entering nursing homes are colonized with C. diff, even if they aren’t actively sick. Another large number will acquire C. diff while receiving care in nursing homes. Antibiotic use, as you’ve heard previously, is a major risk factor for C. diff infection, and fluoroquinolones, like the drug levofloxacin, have been associated with more severe C. diff infections.

Here are some data from 2012 which were used to estimate that in the US, over 100,000 cases of C. difficile infections may be occurring in nursing homes every year. Most of the people with C. difficile infections had recent exposure to antibiotics, and almost 80 percent of them developed C. diff in the nursing home within the first month of being discharged from an acute care hospital. Almost 1 in 5 residents with C. difficile infection were transferred back to the hospital because of their infection, and close to 10 percent died within a month of their infection.

So to summarize the main points of this first presentation, antibiotic-resistant bacteria and C. difficile are significant and growing problems in all healthcare settings and particularly have major impact on the frail and older nursing home population. The large reservoir of multidrug-resistant organisms and C. difficile found within nursing homes can become a source of transmission, and the population coming into nursing homes for care are bringing with them many of the risk factors which cause them to be vulnerable to colonization and infection with these dangerous organisms. So as you move to other parts of this presentation you will hear how these bacteria emerge and spread in healthcare settings and learn some strategies we can take to prevent them.

Thank you.