Forty Years of *Salmonella enterica* Dublin in People

[Announcer] This program is presented by the Centers for Disease Control and Prevention.

[Sarah Gregory] Today, I'm talking with Dr. Reid Harvey about *Salmonella enterica,* serotype Dublin, found in people. Welcome Dr. Harvey.

[Reid Harvey] Thank you. Glad to be here.

[Sarah Gregory] Would you tell us a little bit about yourself and your job when you wrote this article?

[Reid Harvey] Sure, I'm Reid Harvey and I'm currently an epidemiologist with the Respiratory Health Division of CDC's National Institute for Occupational Safety and Health in Morgantown, West Virginia. I completed this study on *Salmonella* Dublin as an Epidemic Intelligence Service Officer with CDC's Division of Foodborne, Waterborne and Environmental Diseases from 2013 to 2015.

[Sarah Gregory] Why were you interested in doing this study?

[Reid Harvey] As a public health veterinarian, I have a longstanding interest in the intersection between animal and human health. Multidrug resistant bacterial infections are an important public health problem, and we know that use of antibiotics in both humans and food-producing animals drives antimicrobial resistance. Surveillance data from the National Antimicrobial Resistance Monitoring System showed that Dublin had a higher proportion of antimicrobial resistant isolates than any other *Salmonella* serotype, so I set out to learn more about multidrug resistant Dublin infections in humans.

[Sarah Gregory] Tell us what *Salmonella* Dublin is and what makes it unique?

[Reid Harvey] Dublin is a particular serotype of *Salmonella* bacteria. Most *Salmonella* have the ability to affect a wide variety of host species, but Dublin's unique in that it is cattle-adapted, meaning that this serotype has evolved over time with cattle. Although rare, it can affect other species, including people. And because it is relatively rare, there's a lot we don't know about human Dublin infections. But we do know that when people are infected, they seem to have much more severe infections than those caused by most other *Salmonella.* Typical *Salmonella* infections in people often cause no symptoms at all, or cause diarrhea, fever, and cramps that generally improve in a few days without specific treatment. Dublin, on the other hand, seems to cause severe infections, such as bloodstream infections, much more often than nearly all other *Salmonella* serotypes. These severe infections can be life threatening and often require specific antibiotics to fight the infection.

[Sarah Gregory] So this is a zoonotic infection. Talk to us a little about zoonoses and its impact on emerging diseases.

[Reid Harvey] Zoonotic diseases are those that can be transmitted from animals to people or, more specifically, a disease that normally exists in animals but can infect people. Similar to other typically foodborne infections, direct contact with an infected animal isn't necessary to acquire a

Dublin infection. It's actually more commonly acquired by consuming contaminated food or other animal products, such as raw milk, rather than direct contact with an infected animal. Many zoonotic diseases, including most *Salmonella,* do not actually harm or cause symptoms for the animal host. Dublin however can cause disease and death in cattle, particularly in calves. Therefore, Dublin affects animal health as well as human health. This emphasizes the interconnectedness of human, animal, and environmental health, a concept we call One Health. One Health issues, such as Dublin, require collaboration among physicians, veterinarians, ecologists, and many others to monitor and control public health concerns and to learn about how diseases spread among people, animals, and the environment.

[Sarah Gregory] So, tell us about your study and how you conducted it.

[Reid Harvey] We wanted to better understand the epidemiology of Dublin in the United States and describe any trends occurring over time that could warrant intervention efforts, so we used five different CDC surveillance systems that have been in place for roughly 20 to 50 years. We described Dublin infections in people in more detail than ever before in terms of incidence, demographics, severity of disease, outbreaks and foods responsible for illnesses, and antimicrobial resistance patterns over time.

[Sarah Gregory] And what did you find?

[Reid Harvey] We found that Dublin infections have remained relatively rare during the past 50 years, and yet the number of infections has increased more than other *Salmonella* infections during that time. Regarding disease severity, more than 60 percent of Dublin infections were bloodstream infections, compared with only five percent of other *Salmonella* infections. Dublin was also more likely to result in hospitalization, longer hospital stays, and death than other *Salmonella* infections. More than half of Dublin isolates tested were multidrug resistant, meaning they were resistant to three or more antimicrobial classes, compared with only 12 percent of other *Salmonella* isolates. The antimicrobial resistance we see is concerning because physicians often choose to treat patients infected with Dublin with one or more of these antibiotics. In addition, we found that both clinical severity, in terms of hospitalization and death rates, along with antimicrobial resistance, increased together during the last 20 years of our study window.

[Sarah Gregory] What do you think are the main reasons for these infections?

[Reid Harvey] Cattle continue to be the source of human Dublin infections. This could be through direct contact, but is more likely through consumption of contaminated animal products, such as undercooked beef and raw milk. The increasing incidence of human Dublin infections during the past 50 years likely follows the spread of Dublin in the U.S. cattle industry. Dublin often contains what is called a virulence plasmid, which is a set of genes that can jump from one bacterium to another that contributes to disease severity in people infected with Dublin, for example, resulting more often in bloodstream infection rather than the typical gastrointestinal illness caused by most other *Salmonella* infections. However, we suspect the recent increase in antimicrobial resistant Dublin infections in people may be driven by antimicrobial use in cattle, and the similar increase in clinical severity may stem from antimicrobial treatment failures resulting in increased hospitalizations and deaths.

[Sarah Gregory] Is there an area of the country where the most people are infected with Dublin?

[Reid Harvey] Historically, most human Dublin infections occurred in California; more than half of the total infections were reported from California. The largest recorded outbreak of Dublin was caused by contaminated raw, or unpasteurized, milk from a California dairy in the early and mid-1980s, and in part led to the U.S. Food and Drug Administration, or FDA's, interstate ban on selling raw milk. Dublin was only discovered east of the Rocky Mountains in cattle in 1968. And although most cases of human Dublin infections continue to be reported from California, possibly because of their large population of both humans and cattle, Dublin has spread throughout the United States by way of the transport of animals and their products. In 2013, the Animal Health Diagnostic Center at Cornell University issued an animal health advisory warning cattle owners about an increase in multidrug resistant Dublin infected cattle in the northeastern United States.

[Sarah Gregory] Is there a way to eliminate this infection?

[Reid Harvey] Efforts aimed to decrease the burden of Dublin are underway in the United States. Vaccines have been developed for use in calves, but so far, none have been effective in reducing the incidence of disease, although research in that area continues. Most importantly, antimicrobial stewardship and judicious use of antimicrobial agents in agriculture, specifically cattle in the case of Dublin, could help curb the multidrug antimicrobial resistance, which has been on the rise in both humans and cattle with Dublin infections. The FDA prohibited certain extra-label uses of cephalosporins, which is a commonly used antimicrobial agent in humans and animals, in cattle and other species in 2012, which could help slow the spread of cephalosporin resistance among food animals, and protect these drugs for human use. In 2016, the FDA finalized regulations under the Veterinary Feed Directive to eliminate antimicrobial drugs that are important in humans, for use in animals for growth promotion or feed efficiency, representing another important step toward reducing the burden of antimicrobial resistance in agriculture that can ultimately affect human health. Husbandry and management practices on the farm are also important to decrease the spread of Dublin in cattle. For example, access to shelters and housing that are dry, well ventilated, and that can easily and effectively be cleaned.

[Sarah Gregory] Are there things individuals can do to help prevent getting *Salmonella* Dublin infections in themselves?

[Reid Harvey] Drinking raw milk is risky and should be avoided, as evidenced by the large outbreak of Dublin in the 1980s in California from unpasteurized milk. And more generally, by following safe food handling and preparation measures, people can avoid getting sick with bacteria like *Salmonella.* Cooking foods to the correct temperature reduces the risk of infection. Thorough handwashing is also important, before and after food preparation, and after contact with cattle or their environment. Foodsafety.gov is an excellent resource for more information and additional food safety tips.

[Sarah Gregory] Thank you, Dr. Harvey. I've been talking with Dr. Reid Harvey about his September 2017 article, Epidemiology of *Salmonella enterica* Serotype Dublin Infections among Humans, United States, 1968–2013, online at cdc.gov/eid.

I'm Sarah Gregory for *Emerging Infectious Diseases.*

[Announcer] For the most accurate health information, visit cdc.gov or call 1-800-CDC-INFO.