Outcomes of Reduced Antimicrobial Use in Chickens, Canada, 2013–2019

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

[Sarah Gregory] Hello, I'm Sarah Gregory, and today I'm talking with Dr. Laura Huber. She's an assistant professor in the Department of Pathobiology at Auburn University in Alabama. We'll be discussing antimicrobial use and bacteria resistance in broiler chickens during 2013–2019.

Welcome, Dr. Huber.

[Laura Huber] Hi, thank you.

[Sarah Gregory] We on this podcast have talked a lot about antimicrobial resistance (or AMR), but remind us why it's such an important topic.

[Laura Huber] So antimicrobial resistance is when microorganisms, such as bacteria, viruses, parasites, or fungi change in any way they can (either by mutation or by acquiring resistance genes) in a way that they would no longer be affected by available medicine. So the treatment of an animal or human that is sick with resistant microorganism becomes difficult, increasing the risk of severe disease and death. And antimicrobial resistance is nowadays a global concern, and while it's possible for us to develop new antimicrobials, if we don't change the way that we use them, then these new developed drugs will have the same fate as the current ones and become ineffective. So relying just on drug discovery to tackle the resistance problem is not sustainable and that's why we need to reduce consumption, which is the subject of the work that we are talking about today.

[Sarah Gregory] When you have a drug-resistant pathogen, is that pathogen resistant to all drugs or just a certain kind?

[Laura Huber] So by definition, multidrug-resistant organisms are resistant to three or more classes of antimicrobial agents.

[Sarah Gregory] What does AMR have to do with the poultry industry?

[Laura Huber] So as we know well, the world population increases very rapidly. During the 20th century, the population in the world has grown from 1.6 billion to 6 billion people and in the '70s, we were roughly half as many people as we are today. And because of this rapid growth in human population, also the demand for animal protein to feed the world has also increased, leading to the intensification of animal production. And when animal production systems are intensified, then we also have a greater need to prevent disease because of the high densities of animals in these farms. And then consequently, to treat and prevent diseases in these chickens or decrease animal death and loss of production, we also have increased antimicrobial use which largely contributes to the development of antimicrobial resistance.

So now, why chicken? Why should we study antimicrobial resistance in poultry? Poultry is one of the most important source of animal protein and its production has increased drastically throughout the world. Poultry meat production increased from nine to 132 million tons between 1961 through 2019. And in 2019, 39% of global meat production was poultry. So given also the rapid growth in poultry production, poultry needs to be one of the most important production

animals to have attention from us (the scientists) to try to understand the development of resistance and ways to control it.

[Sarah Gregory] So how do you give an antimicrobial drug to chickens? Pills seem unlikely.

[Laura Huber] So antimicrobials can be administered to chicken in many ways, including, for example we can administer in ovo (so directly inside the egg), also subcutaneously, intramuscularly. But most commonly we administer them via food or water. There are very well-defined guidelines for administration of antimicrobials in poultry. So for example in the U.S., these guidelines are developed by the American Veterinary Medical Association, and antimicrobial administration in chickens needs to be supervised by a vet.

[Sarah Gregory] And how does AMR affect people?

[Laura Huber] This is a key question and scientists (including myself) are still investigating this. There are many possible paths that lead to contamination of humans with resistant organisms from chickens, which include, for example: the contamination of environment, water sources, and produce with poultry waste; also by the consumption of resistant organisms present in the meat and poultry products; or even by direct contact with animals. The food supply in the U.S. and Canada are among the safest in the world, although people are still getting infected with foodborne agents. And, as we mentioned before, illness caused by resistant organisms can be very difficult to treat. So first of all, we need to work on reducing the presence of antimicrobial-resistant pathogens in the environment and the food we eat. And second, we need to make sure we follow the guidelines for food safety in our daily routines at home. So for example, be careful about cleaning our hands and food properly, separating raw meat and eggs from ready-to-eat foods, cooking food well, and keeping food refrigerated.

[Sarah Gregory] In 2014, Canada began a program called the Antimicrobial Use Reduction Strategy. Who created this program and why?

[Laura Huber] So the Chicken Farmers of Canada, which represents the poultry industry in Canada, was the one creating this program. And they wanted to find ways to control, monitor, and reduce the antimicrobial use on poultry farms of Canada to mitigate antimicrobial resistance.

[Sarah Gregory] What does the program entail?

[Laura Huber] So the program was designed to progressively (so in three steps) eliminate the use of antimicrobials in poultry specifically to prevent diseases, starting from antimicrobials that are of higher importance to human medicine to lower importance. So the first step, (which was accomplished in 2014) focused on eliminating the use of category I antimicrobials, which include third-generation cephalosporins and fluoroquinolones, which are critically important antimicrobials to human medicine. And then the second step was accomplished in 2018 and eliminated the preventive use of category II antimicrobials, which are still included as critically important antimicrobials to human medicine. And then step three is still pending.

So, our work aimed on evaluating how antimicrobial resistance levels were affected by the steps taken by the industry to reduce antimicrobial use thus far.

[Sarah Gregory] What exactly is a broiler chicken? You mentioned broiler chickens in your study. Are they different than other chickens people eat? And their exposure to antibiotics—is it different?

[Laura Huber] So broiler chickens are raised specifically for meat production, whereas layers are females used for production of eggs. And broilers are fast-grown mixed-sex populations, which attain market size between six and seven weeks of age. And in general, broiler production systems use more antimicrobials than layers.

[Sarah Gregory] There were geographical and pathogen differences in how well this program worked. Tell us about that.

[Laura Huber] So the main difference we found was when looking at antimicrobial resistance over time in *Salmonella* when compared with the other pathogens that we included in the study that were *E. coli* and *Campylobacter*. And we believe that one of the reasons for this difference is a shift in *Salmonella* serotypes over time. So we do know that the different serotypes of *Salmonella* have different antimicrobial resistance genes. And we think that by shifting the populations' proportions, we also had a shift in antimicrobial resistance rates over time.

And geographically, the most important finding was that Quebec had the lowest levels of resistance comparing with other provinces in Canada. And we believe that this difference was because Quebec started to reduce the use of antimicrobials in chickens earlier than other provinces in Canada. So for example, they eliminated the use of ceftiofur in their hatcheries in 2005. And then a study that was performed a year later—which was also published in *Emerging Infectious Diseases* (so you should check that out)—they found that this measure led to the reduction in prevalence of ceftiofur-resistant *Salmonella* in retail chickens (so the chicken that we eat) and in humans.

[Sarah Gregory] Overall, did farms reduce their use of antimicrobial drugs?

[Laura Huber] Yes, they did for the most part. One exception is that the use of aminoglycosides through water increased over time. And historically, we know that the use of aminoglycosides through water is for treatment of diseases in young chicks. So this finding indicates that after reducing the use of preventive antimicrobials in the ovo in the hatcheries, there may have increases in diseases, and consequently the need to use antimicrobials in the water to treat these diseases. And this is one aspect that needs to be further investigated. So we do need to find ways to improve further the production systems to prevent animals of getting sick now that we reduced the use of antimicrobials.

[Sarah Gregory] What happened to AMR rates?

[Laura Huber] AMR rates had an overall decrease in all pathogens investigated, including *E. coli*, *Campylobacter*, and *Salmonella*. But we did have a few exceptions.

[Sarah Gregory] Some types of AMR actually increased. Why is that?

[Laura Huber] So other than the already mentioned before about the shift in serotypes and consequently the AMR rates in *Salmonella*, we also saw increase of resistance to aminoglycosides in *Salmonella* and *E. coli*. And we believe that this increase is due to the increase in use of these antimicrobials via water to treat diseases, as we actually also mentioned before.

[Sarah Gregory] I see, okay.

What role did disinfection practices play in these results?

[Laura Huber] So it was interesting for us that we found that using the ideal method for cleaning and disinfection did not appear to help too much decreasing the overall AMR rates. And just to explain a little bit better, the ideal method here refers to the one that is recommended by the World Organisation for Animal Health and consists on first dry cleaning the chicken house and then washing with warm water, and then an application of disinfection. And our finding that we didn't see much effect of using this ideal method to decrease AMR demonstrates the importance of avoiding the emergence of AMR, since trying to eliminate AMR pathogens after their emergence was not very efficient. But we did find the ideal disinfection did decrease the prevalence of *Salmonella* serotypes of higher public health importance, which indicates that implementation of sanitation best practices and reducing antimicrobial use programs are beneficial.

[Sarah Gregory] Did the way the drugs were administered have any effect on resistance? And if so, why?

[Laura Huber] So the most important finding regarding the way antimicrobials are administered is that the use of antimicrobials in ovo, even before the chick is born and transported to the farm, contributed significantly to the presence of antimicrobial resistance in broilers. Which is interesting, and this finding shows the importance of knowing the origin of the chicks in the first place.

[Sarah Gregory] Just curious, how do they administer the drugs to the egg? Is it injected or is it wiped all over it? How's this done? And that must be incredibly time-consuming.

[Laura Huber] Yeah, so what they do in the hatcheries is that they actually administer the antibiotics injecting inside the egg, so then the chick has access to the antibiotics even before it is born. And that was interesting to us to see that the chick actually carries those resistant pathogens with them when they grow up to be broilers.

[Sarah Gregory] Your study didn't identify any difference in AMR rates at antimicrobial-free and conventional farms. I find this surprising. Why is this?

[Laura Huber] Previous studies also have shown mixed results in this aspect. Some find differences in AMR rates between antimicrobial-free and conventional farms and others don't. Some factors can contribute to the presence of AMR even in antimicrobial-free farms; for example, the history of previous use of antimicrobials in the farm, cross-contamination between farms, if you have the origin of chicks that are from hatcheries that use antimicrobials. All these factors can contribute to the presence of resistance in farms that don't use antimicrobials in theory.

So in our study, we did have very different numbers of farms for each of the classifications, which is a limitation in our study which may have affected the ability to detect significant differences in AMR levels. So we still need to research more about the advantages, disadvantages, and the strategies to transition from conventional to antimicrobial-free farms. And I do have plans to conduct further studies in this aspect as well.

[Sarah Gregory] Okay. So tell us how you conducted this study.

[Laura Huber] So for this study, the data was collected by the Canadian Integrated Program for Antimicrobial Resistance Surveillance (so the CIPARS program), which is very similar to the National Antimicrobial Resistance Monitoring System (NARMS) in the U.S. So the data on antimicrobial use practice and antimicrobial resistance in three foodborne pathogens were

collected from broiler farms between the years of 2013 and 2019. And then with this data, we performed a series of statistical analysis to understand how antimicrobial use and other factors affected the level of resistance in broilers in four provinces in Canada over time. And we also produced a few graphs to help us illustrate the trends in antimicrobial resistance and use over time. So this is how we were able to see what are the factors that were influencing the presence of antimicrobial-resistant bacteria in broilers.

[Sarah Gregory] Were there any surprises?

[Laura Huber] Yes. To me in particular, my biggest surprise was how easy and interactive was our collaboration with the Public Health Agency of Canada and how rich the data from the CIPARS program is. It was such a pleasure to work with them and with their extremely informative data. And this...such a level of openness to access of very detailed data is very uncommon when collaborating with public health agencies. So I would like to thank them again for this great team effort and for the trust with their data.

[Sarah Gregory] Glad to hear it. It's always good to hear about good cooperation, we need that globally.

What were the challenges?

[Laura Huber] So there are always challenges with science. It takes a while for you to understand the data fully and find ways to explain it in a way that will be informative to the industry and to consumers. But we did work hard on this data and now we have this paper that will hopefully contribute to better our ways to raise animals and aim on health and animal welfare.

[Sarah Gregory] In your opinion, what's the most important takeaway from this study?

[Laura Huber] So to me, the most important takeaway is that it is possible for us to decrease the use of antimicrobials in food animals without compromising animal health, welfare, and production if we keep improving food animal facilities and systems. And by decreasing antimicrobial use in food animals, we make raising animals more sustainable in the long term, and we potentially protect human health and efficacy of critically important antimicrobials.

[Sarah Gregory] This study took place in Canada, as we've discussed. Do you think it could be and should be done elsewhere?

[Laura Huber] Absolutely. For example, as I mentioned before, we do have a similar surveillance program in the U.S. that can provide rich data to help us understand the trends in antimicrobial resistance in poultry production in the U.S., and also surveillance for antimicrobial resistance in animals is done very regularly in Europe as well. So we do have rich data. And such studies are critical for us to understand what works well in terms of what are the policies that are contributing for us to have more sustainable animal production systems.

[Sarah Gregory] You work at Auburn University in Alabama in the United States. Tell us about your job and how you became involved in a Canadian study.

[Laura Huber] So just to give a little bit of a background, I am a veterinarian and I graduated in a university in the south of Brazil, which is called the Federal University of Santa Maria, and currently I work as a professor of epidemiology in the College of Vet Med at Auburn University. And my lab, nowadays, studies the spread of antimicrobial resistance in the animal, human, and environment interface (so very similar work as we are discussing here). But this paper in particular initiated when I was a postdoc researcher at ETH Zurich under the mentorship of

Professor Thomas Van Boeckel, who is a principal investigator in the Health Geography and Policy Group at ETH. And during my postdoc (which was last year), we were approached by Dr. Agnes Agunos and her collaborators at the Public Health Agency of Canada to collaborate and analyze the data from CIPARS. So that is how we started this great team and we do have plans to keep collaborating in the future.

[Sarah Gregory] With the pandemic still going on and getting worse in some places, what are you doing to destress almost two years into it?

[Laura Huber] It has been hard for me and for everyone. For me in particular, it has been very challenging not to be able to go home and visit my family in Brazil for over two years now. So I'm very thankful for technology and for the internet. I am able to talk with my family every day via video call, so it's not as bad as it could be. And other than that, my dogs and my friends and my work keep me busy, happy, and safe. But I also find that by keeping my focus on major issues threatening animal and human health other than COVID (such as antimicrobial resistance) has given me a sense of purpose and keeps me looking ahead to better days.

[Sarah Gregory] Well thank you for taking the time to talk with me today, Dr. Huber.

[Laura Huber] Thank you. This was a pleasure.

[Sarah Gregory] And thanks for joining me out there. You can read the September 2021 article, Reduction in Antimicrobial Use and Resistance to *Salmonella*, *Campylobacter*, and *E. coli* in Broiler Chickens, Canada, 2013–2019, online at cdc.gov/eid.

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