White Paper

National Institute for Animal Agriculture

9TH ANNUAL ANTIBIOTIC SYMPOSIUM

Communicating the Science of Responsible Antibiotic Use in Animal Agriculture

In Partnership with
National Institute of Antimicrobial Resistance Research & Education

This Symposim was held
October 15-17, 2019
Iowa State University
Ames, IA

NIAMRRE

Information synthesized from the National Institute for Animal Agriculture's Symposium, "Communicating the Science of Responsible Antibiotic Use in Animals" conducted October 15-17, 2019, in Ames, Iowa, in partnership with the National Institute of Antimicrobial Resistance Research and Education. Full presentations are available online at www.animalagriculture.org.

DISCLAIMER: The information provided in this White Paper is strictly the perspectives and opinions of individual speakers and discussions at the 2019 Antibiotic Stewardship Symposium

Table of Contents

Background 3
Purpose and Design of the Symposium 4
Symposium Topics and Speakers 5
Executive Summary 7
Presentation Highlights 13
Opening Remarks: Why Communication Matters to AMR 13
Panel Discussion – What's New? US Government Panel on Science and Policy, 2019-2020 13
Antibiotic Resistance Year in Review: Progress Across One Health 13
Supporting Antimicrobial Stewardship - FDA Update 14
Antimicrobial Resistance Research at the USDA Agricultural Research Service 16
The Future is Now, Part 1: Where Have We Come in One Health and AMR in the Last Five Years? 17
Panel Discussion – Managing AMR Risk in Humans with Applied Veterinary Medicine and Science 22
Antibiotic Use in Chickens 23
Does Antibiotic Use in Cattle Affect Human Health? 25
Antimicrobial Resistance and the Environment (Swine) 25
Case Study in Communication 30
Panel Discussion – Can You Hear Me Now? Overcoming Communication Challenges 31
Values First - Reframing the Conversation about Antibiotic Use in Animal Agriculture 32
Overcoming Communication Challenges 33
Communication and Transparency 34
The Future is Now, Part 2: The Promise of Precision Agriculture 36
Why Precision Livestock Farming? 36
Can Technology Offer Solutions to Animal Health Challenges? 36
Field Experience with Whisper® … Extension of Stockmanship - Antibiotic Stewardship 37
Science Communication Strategies: Summary of Breakout Sessions 38
Information Avoidance: Does Ignorance Keep Us Uninformed About Antimicrobial Resistance? 42
2020 Vision: Getting Our Message Across and Making a Difference 48
Wrap Up 49
Appendices 50
Appendix 1: Six Americas' 50
Appendix 2. Research Survey Questions Regarding Objective Knowledge of Antibiotic Use and AMR. 51
Footnotes 52

Background

The symposium, "Communicating the Science of Responsible Antibiotic Use in Animal Agriculture", conducted in partnership with the National Institute of Antimicrobial Resistance Research & Education (NIAMRRE) on October 15-17, 2019 in Ames, Iowa, was the ninth annual antibiotic symposium hosted by the National Institute of Animal Agriculture (NIAA). The symposium included participants from the United States, Canada, and Nigeria, and brought together a range of stakeholders including producers, producer organizations and other industry leaders; veterinarians; public health professionals; representatives of pharmaceutical and technology companies and diagnostic laboratories; researchers representing several universities; and United States regulatory officials from the Food and Drug Administration (FDA), Centers for Disease Control (CDC), and United States Department of Agriculture (USDA). This diverse group advocates collaboration by stepping beyond our silos to advance the discussion of antibiotic use from a One Health perspective, taking into account animals, people and the environment and the synergistic interactions between them.

For the past eight years, a national dialogue focused on the use of antibiotics in food animals and the science surrounding antimicrobial resistance has been hosted by NIAA. Antibiotic stewardship and responsible use of antibiotics continue to be a top priority for the animal agriculture industry and its allies. However, the message that is received by the public regarding responsible use of antibiotics is muddied by inaccurate reporting, opinioned agendas, and misrepresented science. This ninth annual symposium addressed that message, providing a forum to discuss communication strategies and methods for delivering accurate information to a variety of audiences regarding the role of antimicrobial use and mitigation of antimicrobial resistance in the livestock industry. Participants identified the audiences that present communication challenges, evaluated a variety of strategic communication approaches that work constructively to deliver accurate information to those audiences, and reached consensus that communications should constructively support all segments of animal agriculture by broadening accurate understanding of the challenges, solutions, and industry commitment to combating antimicrobial resistance.

The NIAA is a non-profit, membership-driven organization that unites and advances animal agriculture for the challenges facing animal agriculture industries (aquatic, beef, dairy, equine, goat, poultry, sheep and swine). NIAA is dedicated to furthering programs for the eradication of diseases that pose risk to the health of animals, wildlife and humans; promoting the efficient production of a safe and wholesome food supply for our nation and abroad; and promoting best practices in environmental stewardship and animal health and well-being.

The 2019 Ninth Annual Antibiotic Symposium was funded in part by Advanced Animal Diagnostics, the Beef Checkoff, Boehringer Ingelheim, Iowa Cattlemen's Association, Iowa Pork Producers Association, Kentucky Beef Council, Merck Animal Health, National Institute of Antimicrobial Resistance Research and Education (NIAMRRE), Phibro Animal Health Corporation, USDA, and United Soybean Board.

Purpose and Design of the Symposium

As the public is bombarded with inaccurate statistics, misreported study results and opinions which align more with agendas than science, the agriculture industry has struggled with communicating accurate information regarding antimicrobial use, resistance, and mitigation in a positive manner. The purpose of the symposium was to bring leaders from all parts of the animal agriculture industry to join with allied veterinarians, researchers and experts in human and public health, and regulatory officials to discuss how to convey our knowledge of antimicrobial use and resistance in animal agriculture to the pubic in an effective and positive manner. The objective of this discussion was to identify communication challenges and present new communication strategies to encourage a shift in consumer attitudes away from opinioned agendas and fear and toward thoughtful understanding. Tomorrow's responsible antibiotic use will be shaped by consistent, effective communication of scientific collaboration and the commitment of the agriculture industry and its allies to progress in best practices and transparency, in ways that build public trust.

2019 Symposium Planning Committee

Co-chairs:

Eric Moore, DVM – Director of Technical Services, North America, *Norbrook Inc.*

Steven Solomon, MD – Principal, *Global Public Health Consulting, LLC*

Committee Members:

Michael Dahlstrom, PhD – Interim Director, Greenlee School of Journalism and Communication, *Iowa State University*

William T. Flynn, DVM, MS – Deputy Director, Science Policy, *FDA Center for Veterinary Medicine*

Kerry Keffaber, DVM – Principal Advisor, *GLUE, LLC*

Kristen Obbink, DVM, MPH – Associate Director, *National Institute of Antimicrobial Resistance Research and Education (NIAMRRE)*

Paul Plummer, DVM, PhD – Executive Director, *National Institute of Antimicrobial Resistance Research and Education (NIAMRRE)*

Rick Sibbel, DVM – President and Owner, *Executive Veterinary and Health Solutions LLC*

Dawn Sievert, PhD, MS – Senior Science Advisor for Antimicrobial Resistance Coordination & Strategy, *CDC*

Symposium Topics and Speakers

(in order given at the symposium)

Opening Remarks: Why Communication Matters to AMR
Leah C. Dorman, DVM, Director, Food Integrity & Consumer Engagement, *Phibro Animal Health Corp.*

Panel Discussion – What's New? US Government Panel on Science and Policy, 2019-2020
Moderator: Kerry Keffaber, DVM, MSC, Principal Advisor, *GLUE, LLC*

> ***Antibiotic Resistance Year in Review: Progress Across One Health***
> Dawn Sievert, PhD, MS, Senior Science Advisor for Antimicrobial Resistance Coordination and Strategy, *CDC*
>
> ***Supporting Antimicrobial Stewardship - FDA Update***
> William T Flynn, DVM, MS, Deputy Director, Science Policy, *FDA Center for Veterinary Medicine*
>
> ***Antimicrobial Resistance Research at the USDA Agricultural Research Service***
> Kim Cook, PhD, National Program Leader, Nutrition, Food Safety and Quality Staff, *USDA-ARS*

The Future is Now, Part 1: Where Have We Come in One Health and AMR in the Last Five Years?
Christine Petersen, DVM, PhD, Director, Center for Emerging Infectious Diseases (CEID), *University of Iowa, College of Public Health*

Panel Discussion – Managing AMR Risk in Humans with Applied Veterinary Medicine and Science
Moderator: Steve Solomon, MD, FACP, FIDSA, Principal, *Global Public Health Consulting, LLC*

> ***Antibiotic Use in Chickens***
> G. Donald Ritter, DVM, ACPV, Director of Technical Marketing, *Mountaire Farms*
>
> ***Does Antibiotic Use in Cattle Affect Human Health?***
> Paul S. Morley, DVM, PhD, Diplomate ACVIM - Professor and Director of Research, Veterinary Education, and Outreach Programs, *Texas A&M University* and *West Texas A&M University*
>
> ***Antimicrobial Resistance and the Environment (Swine)***
> Shivaramu Keelara, DVM, MPH, PhD - Research Assistant Professor, Department of Population Health and Pathobiology, *North Carolina State University College of Veterinary Medicine*

Breakout Session: The Challenges of Communicating About AMR
Breakout Groups (Governments, Industry, Producers, Veterinarians)

Moderators from Greenlee School of Journalism and Communication, Iowa State University:
Denise Coberley, Graduate Student
Michael Dahlstrom, PhD, Interim Director
Andy King, PhD, Assistant Professor
Dara Wald, PhD, Assistant Professor

Case Study in Communication
Dawn Sievert, PhD, MS, Senior Science Advisor for Antimicrobial Resistance Coordination & Strategy, *CDC*
Leah C. Dorman, DVM, Director, Food Integrity & Consumer Engagement, *Phibro Animal Health Corp.*

Panel Discussion – Can You Hear Me Now? Overcoming Communication Challenges
Moderator: Dawn Sievert, PhD, MS, Senior Science Advisor for Antimicrobial Resistance Coordination & Strategy, *CDC*

> ***Values First - Reframing the Conversation about Antibiotic Use in Animal Agriculture***
> Leah C. Dorman, DVM, Director, Food Integrity & Consumer Engagement, *Phibro Animal Health Corporation*
>
> ***Overcoming Communication Challenges***
> G. Donald Ritter, DVM, ACPV, Director of Technical Marketing, *Mountaire Farms*
>
> ***Communication and Transparency***
> Mr. Andy Bishop, Chair, *Kentucky State Beef Council*

Panel Discussion - The Future is Now, Part 2: The Promise of Precision Agriculture
Moderator: Lucas Pantaleon, DVM, MS, DACVIM, MBA, Animal Health Industry Advisor, *Pantaleon PLLC*

> **Can Technology Offer Solutions to Animal Health Challenges?**
> Justin Sexten, PhD, Vice President of Strategy, *Performance Livestock Analytics*
>
> **Field Experience with Whisper… Extension of Stockmanship - Antibiotic Stewardship**
> Tom Noffsinger, DVM, Animal Handling & Staff Development, *Production Animal Consultation*

Science Communication Strategies: Summary of Breakout Sessions
Michael Dahlstrom, PhD, Interim Director, Greenlee School of Journalism and Communication, *Iowa State University*

Information Avoidance: Does Ignorance Keep Us Uninformed About Antimicrobial Resistance?
Kate Brooks, PhD, Assistant Professor, Agricultural Economics, *University of Nebraska-Lincoln*

2020 Vision: Getting Our Message Across and Making a Difference
Paul J. Plummer, DVM, PhD, Executive Director, *National Institute of Antimicrobial Resistance Research and Education (NIAMRRE)*

Wrap Up
Paul J. Plummer, DVM, PhD, Executive Director, *National Institute of Antimicrobial Resistance Research and Education (NIAMRRE)*
Eric Moore, DVM, Director of Technical Services, North America, *Norbrook Inc.*

Executive Summary

The agriculture industry has struggled with communicating accurate information regarding antimicrobial use, resistance, and mitigation in a positive manner. Communicating with different audiences is a challenge. Our words are powerful, and we must strive to ensure they carry the meaning we intend. Conversations with consumers need to be 'real'. 98% of people in the United States have no direct connection to agriculture – we must to ensure that our communications make that connection.

Overview of Government Efforts to Combat Antimicrobial Resistance

Across the United States government, agencies are planning, challenging, and acting to make a difference in antimicrobial resistance. Antimicrobial resistance (AMR) is a One Health issue: any time antimicrobials are used in any person or animal, or make their way into the environment, they can lead to resistance. In the United States, the CDC estimates that 2 million AMR infections with 40,000 deaths occur annually.

In 2013, the CDC released its first Antimicrobial Resistance Threats Report, highlighting that resistant pathogens have significant effects on human health. That report was followed by the CDC's creation of a National Strategy on Combating Antibiotic Resistant Bacteria (CARB) in 2014, and soon after, multiple federal agencies began to develop and implement action plans to combat antibiotic resistance. New antibiotics are needed, but that's only a part of the solution. The AMR Challenge is a yearlong initiative recently developed by the CDC with the goal of gathering commitments to reduce the spread of AMR in agriculture. More than 350 organizations made commitments in 2019, including governments, private industry, and civil society from around the world. The National Strategy to Combat Antibiotic Resistant Bacteria (CARB) is an ongoing National Action Plan, initiated by CDC in 2013, designed to slow the emergence of resistance bacteria, strengthen One Health surveillance efforts, advance diagnostic test development, accelerate research into drug development, and improve national collaboration. Associated with this National Action Plan is $170 million in funding for CDC distribution to state and local health departments, individual researchers, the Antibiotic Resistance Laboratory Network, and the Antimicrobial Resistance Isolate Bank. Preliminary data shows that these efforts are working, but more work is needed. The CDC is committed to continuing to support efforts to combat AMR across the One Health spectrum.

In 2012 and 2013, the FDA released Guidance for Industry (GFI) #209 and #213, setting official policy with respect to use of medically important antimicrobial drugs in food-producing animals. The goals of these guidances were two-fold: to eliminate growth promotion uses of medically important antimicrobials and to bring their use under veterinary oversight. Once implemented, antimicrobials used in feed require a Veterinary Feed Directive (VFD), and those used in water require a prescription. These guidances were fully implemented in January 2017. The FDA'S Five-year AMR Plan builds on GFI's #209 and #213, and serves as a guide for moving forward. The Five-year Plan continues to focus on medically important antimicrobials, but expands the scope to include companion animals, and enhances stewardship and AMR monitoring including the collection of animal antimicrobial use data. Key projects include transitioning over-the-counter (OTC) products to prescription (Rx); better defining durations of use; updating the list of medically important antimicrobials; collecting use data in real-world animal agriculture situations; and issuing an Assessment Report that integrates and analyzes veterinary antimicrobial use data to provide a

more comprehensive assessment of progress than sales data. The FDA has made significant progress in the fight against antimicrobial resistance, and continues striving to build on past achievements.

A third government agency tackling antimicrobial resistance in the agricultural sector is the USDA's Agricultural Research Service (ARS). The ARS addresses AMR through a diverse range of research areas, including crop production and protection; animal production; foodborne pathogens; and the development of alternatives to antimicrobials. ARS research encompasses diverse livestock species and environments. Major locations investigating antimicrobial resistance include the US National Poultry Research Center (USNPRC), US Meat Animal Research Center (USMARC), National Animal Disease Center (NADC), Southern Plains Agricultural Research Center, Beltsville Agricultural Research Center (BARC), Soil/Agriculture/Water studies, and the National Center for Agricultural Utilization Research (NCAUR). The studies at these institutions focus on everything from characterizing antimicrobial resistance in a large-scale animal feedlot, to non-antibiotic strategies to enhance growth promotion, to alternatives to antimicrobials such as vaccines, immune-derived products, and phytochemicals.

The efforts of these government agencies, combined with those of private industry and the global community, are making great strides towards antimicrobial stewardship and towards understanding and combating antimicrobial resistance. As we continue to move forward, continuation of these efforts is vitally important, but equally important is communicating the findings of these efforts.

One Health and AMR

The main approach to detecting AMR-based disease in people is multi-focal. Efforts by hospitals address overall surveillance both externally through the Emerging Infections Program (EIP), and internally through hospital network surveillance. Local, county, and state public health infrastructure disease reporting allows for rapid detection and characterization of outbreaks. Finally, the CDC and FDA provide targeted Epi and Lab Capacity grants to increase surveillance and detection of specific pathogens.

Antimicrobial resistance is complicated. Human medicine often blames animal agriculture, but reacting by blaming human medicine will not solve the problem, either. Life is messy. We are not going to eliminate antimicrobial resistance pathogens. Hospitals have begun to address the issue by developing institutional controls, such as engineering controls that systematically guide practitioners to the correct antibiotic choice and offer checks and balances. Other aspects of human medicine, and veterinary medicine as well, can address AMR by similar engineering controls, as well as work practice controls and the use of personal protective equipment (PPE). The best approach may be a collaborative One Health approach, which can only work with increased communication: between providers, hospitals, and public health; between veterinary public health labs; and between human and veterinary medicine; taking lessons learned and applying them across the antimicrobial use spectrum.

Antibiotic Use in Animals and Managing AMR Risk in Humans

Antibiotics are shared resources with shared risk, and antimicrobial resistance is a global societal problem that affects everyone. There is significant concern that an acquired foodborne illness in humans will not respond to antibiotics because animals were treated with the antibiotic of choice. Risk analysis demonstrates that the odds of this happening are low.

Responsible animal care means raising healthy animals and minimizing risk of AMR for both humans and animals. The poultry industry has made marked progress in this regard. Overall use of antibiotics in poultry is greatly reduced over the past few years. The rise in NAE (No Antibiotics Ever) poultry has contributed to this reduction in use, but unfortunately, NAE has unintended consequences. At every life stage, NAE flocks have increased mortality compared to conventional flocks. Maintaining an NAE label sometimes has priority over animal health and welfare. From a poultry welfare standpoint, NAE is not the answer to AMR. A more viable solution is to integrate responsible antibiotic use into all animal care programs. Reduce the need for antibiotics, but when they are necessary, use them following best antibiotic stewardship practices. Track antibiotic use and measure treatment outcomes with the goal of using the data to review and update veterinary flock health plans.

All antimicrobial users must practice consistent vigilance to ensure continued antimicrobial effectiveness. Is problematic human AMR linked to food animals? Metagenomic studies of multiple animal species, studies of antibiotic use and resistance in hospitalized human and bovine patients, studies of conventional versus Raised Without Antibiotics (RWA) cattle, studies of specific antibiotic exposure in feedlot cattle, and human risk analysis studies all indicate no clear answer. As we approach antimicrobial use decisions in the future, it is clear that more research is needed, and that sacrificing animal welfare is not the solution. We need to work through the complications in order to accurately characterize AMR throughout One Health spectrum, in animals, but also in people and the environment. Bacteria have been around much longer than humans, giving them time to develop survival mechanisms such as AMR. AMR has been present since the discovery of the very first antibiotic, and resistance has emerged to every antimicrobial ever developed. When studying AMR we often neglect the environment, as we tend to focus more on the vectors than where they live. Every day, people and animals are exposed to a diverse range of environmental factors, and all are interlinked as facets of a complex ecosystem with equally complex exposures and challenges. Studying AMR in a system this complex is daunting, but can be simplified by studying the environmental reset that occurs with major environmental events such as hurricanes, flood, drought, floods, and volcanic eruptions. Analysis of results in studies of these reset events should be able to help start to fill in the environmental gaps in our understanding of AMR.

Reframing the Conversation about Antibiotic Use in Animal Agriculture

Often an audience sees a small fraction of what's happening and rushes to judgement. When confronted with this reaction in animal agriculture, we tend to act in one of two ways: defensively, or by 'data dumping'- spewing facts and science. Neither of these reactions helps us to effectively communicate with consumers. The 'data dump' overwhelms. Facts and science are important, but they don't connect with the consumer. Shared values are more important in building trust than facts, science, skills, or abilities. Consumers today buy products from companies whose values align with theirs. Animal agriculture must

communicate our values to these consumers. They aren't asking if we can use antibiotics in animal agriculture, but rather, if we should. It's an ethical question, and requires a different approach. We need to shift the focus of the antimicrobial use conversation to the topics that interest the consumer. We need to talk about the things they care about – food safety, animal care, environmental impact, , and other values that we ourselves share. As we reframe the conversation, the focus should be on the societal benefits of using antibiotics in animals.

Engage to build trust. Avoid getting defensive. Listen to consumers. Lead with your values - not the science. Food is personal - let's talk about it that way. Let the consumer know that animal agriculture has taken action, and our responsible use of antimicrobials makes food safer and more affordable.

Overcoming Communication Challenges

Many consumers get all of their information on the meat they buy from the package, at the point of sale. This package represents a huge opportunity to provide information to consumers, but can present a confusing landscape. Marketers in many cases know they are selling to an uninformed public, thus produce labeling claims that respond to misinformation and fear.

Animal production programs are a pendulum of consumer choice. Conventional programs are less accepted in the marketplace than they have been in the past. Extreme animal production programs, such as the 'No Antibiotics Ever' program, represent the opposite end of the spectrum. These programs are a package-based approach to animal production, and create two tiers of animals: those raised with the package label requirements, and those that can't meet the requirements. In the middle are balanced programs, such as the 'Certified Responsible Antibiotic Use' program. These are systems-based use programs, in which all animals are raised under the same rules. Balanced programs tend to be under-advertised, and represent a consumer communication opportunity.

An alternative to single attribute animal production programs is an umbrella multi-protein standard based on the principles of One Health that strives for optimal health outcomes for animals, people and the planet. One such program currently in development is *One Health Certified*. Responsible antibiotic use practices are included as part of this holistic approach to responsible animal care. *One Health Certified* features an on-package retail label with co-labeling restrictions for most other voluntary animal production label claims to reduce consumer confusion. It is a systems-based certification program which allows for all animals raised using the same requirements to bear the label. The *One Health Certified* label will be launched in January 2020.

Communication and Transparency

Pressures on farmers are ever-increasing. American consumers are concerned about animal welfare, antibiotics, GMOs, organic foods, hormones, and similar issues, but in most cases, they have the luxury of not worrying about getting enough to eat. In the food insecure parts of the world, the concern is the increasing world population, and how to feed that population. By 2050, production will need to have

increased by 60% to meet global food demand. In addition to the need for production increase, consumer demands, global disease pressures and other forces, farmers face increasing regulation and control on their operations. How do they feed the population when the pressure from consumers continues to increase, and more actions of farmers are controlled? Much of the answer to this question comes from communication – to galvanize the support of the consumer. Today's consumer largely gets their news and information on-line. They control what they see and read. Stories get their attention. Farm kids get their attention. And farm family values convey a positive message that the consumer can understand. We need to communicate our farm values in order to garner the support of the public. That support makes all of the pressures of farming bearable, and farming to continue as a rewarding and fulfilling profession.

The Promise of Precision Agriculture

As we work to engage consumers, we still have to figure out how to increase production to feed the world. Part of that answer lies with precision agriculture. As applied to livestock farming, precision agriculture is a system of technologies that monitor the health, welfare and environmental impact of an animal production system in real time. The animal management challenge to the modern producer comprises three major needs: to aggregate data from multiple sources, to provide individual animal management within the pen, and to understand the range of normal. Growing mobile connectivity, coupled with continually improving data storage capacity, inform precision agriculture techniques and devices that will allow us to address those management challenges with increasing efficacy.

Individual-level animal management is one of the keys to enhanced animal care and efficient production. One precision management tool enhancing animal care is Whisper® – a diagnostic audio tool that allows the stockman or the veterinarian to accurately diagnose Bovine Respiratory Disease (BRD) much earlier in the disease that ever before, providing the critical information necessary to treat and heal that animal before it passes the point of no return. And it provides the data to review the efficacy of treatment protocols and treat as needed.

Technological innovations of precision agriculture such as Whisper® allow us to work with the animals at a higher level. Whisper® is one of many connected tools providing specific insights to help us interpret what the animal are really trying to say, enhancing animal care and health allowing for more efficient production as we strive to feed the world.

Science Communication Strategies

Science communication can be broken down into four components: focus, content, format and values. Focus is a pre-communication stage. Communication is a tool, not a goal in itself, so it's important to focus on a single, specific goal that you might achieve through your communication. And once this goal is identified, it's important to determine which particular audience you want to reach – there is no 'general public'. Once goal and audience are identified, the next step is to determine content. In today's world, everyone takes in a lot of information every day. To effectively communicate, we need to try to figure out how to get the audience to slow down, pay attention, and really think about the message. The content needs to reach the audience. Thus content goes hand-in-hand with format. There are different formats

for communication, but stories are often the most effective. Stories build a bridge between storyteller and audience. The personal experience they offer gives the audience a specific example from which to generalize. Stories humanize the communication around your goal. Finally, stories that resonate the best with your audience – those that are most easily understood, recalled, and retained – incorporate values shared between audience and storyteller. What we know is always interpreted through the filter of our underlying value system. Values can be a valuable communication strategy. Expressing values shared by your audience builds trust, and opens the gate for more effective communication of your message.

You want to be a successful communicator? Focus to identify a specific and goal and audience. When developing content, think beyond sharing the science to how to reach your specific audience. Humanize the message through stories, and build trust through shared values.

Information Avoidance: Does Ignorance Keep Us Uninformed About Antimicrobial Resistance?

Antimicrobial resistance is one of the most serious threats to animal and human healthcare and the global economy, yet little is known about the knowledge and attitudes of the majority of the public towards antimicrobial resistance in livestock production. A recent agricultural economics research study examined that question. Study findings indicate that in general, a majority of the population supports the use of antimicrobials to treat and control infections, but also find it unacceptable to use antibiotics for prevention or growth promotion. Increased knowledge of antimicrobial use tends to escalate these trends. So it appears that to promote support for the judicious use of antimicrobials in animals, we should provide for the increased knowledge of antimicrobial use in animals. However, a second part of the study investigated the phenomenon known as information avoidance. When offered an educational video regarding antimicrobial use in animals, 40% of research survey participants chose not to watch. The educational video was avoided for a number of reasons, but in general, the more general knowledge a survey respondent had about antimicrobials, the more likely they were to watch the video. Knowledge appears to beget the desire for more knowledge. Among those who did watch the video, views on antimicrobial use were significantly changed – and those with the least knowledge before the video were the most likely to change their views. What's the answer? How do we help the public get to the point where they have the knowledge base to seek out more knowledge? This research generates a whole new set of questions about how to communicate accurate information to consumers regarding the use of antimicrobials in animal agriculture. The point this study really highlights is that the issue of what we communicate, and how we communicate it, is extremely complex.

Conclusions of the Symposium

As we communicate in the One Health spectrum, each of us brings different values and perspectives to the table. In some cases we're trying to push others to action, in some promote knowledge, and in some push others away from action. How do we really understand underlying values – both those of ourselves and those of our audience – and address that in our communication? This symposium has started the discussion. It's up to all of us to take it home and continue. Listen to your audience. Know your biases. Focus the message. Communicate your values. And keep cultivating the conversation.

Presentation Highlights

Opening Remarks: Why Communication Matters to AMR

Leah C. Dorman, DVM, Director, Food Integrity & Consumer Engagement, *Phibro Animal Health Corporation*

Communicating complex information like antimicrobial resistance to different audiences is a challenge. Our words are powerful, and we must strive to ensure they carry the meaning we intend, but also remember that how we convey the message is at least as important as the message itself. Conversations with consumers need to be 'real'. We need to craft our words and create our conversation to capture the spirit of what we do and the essence of why we do it. 98% of people in the United States have no direct connection to agriculture – it is our responsibility to ensure that our communications connect the dots from farm to table, through the lens of our shared values. Reframe the conversation - and make that connection.

Panel Discussion – What's New? US Government Panel on Science and Policy, 2019-2020

Kerry Keffaber, DVM, MSC, moderator

Panel:

Dawn Sievert, PhD, MS, Senior Science Advisor for Antimicrobial Resistance Coordination and Strategy, *CDC*

William T Flynn, DVM, MS, Deputy Director, Science Policy, *FDA Center for Veterinary Medicine*

Kim Cook, PhD, National Program Leader, Nutrition, Food Safety and Quality Staff, *USDA-ARS*

Antibiotic Resistance Year in Review: Progress Across One Health

Dawn Sievert, PhD, MS, Senior Science Advisor for Antimicrobial Resistance Coordination and Strategy, *CDC*

The CDC definition of One Health is a collaborative trans-disciplinary approach working across all levels with the goal of achieving optimal health outcomes, while recognizing the interconnection between people, animals, plants and the shared environment. Antimicrobial Resistance (AMR) is a One Health issue, as any time antibiotics are used or released into any setting, they can lead to antimicrobial resistance.

National momentum to address antimicrobial resistance has built for years, and the CDC stepped up their role beginning in 2013 with its first *Antibiotic Resistance (AR) Threats Report (TR)*[1], highlighting the fact that resistant pathogens have significant effects on human health. That report was followed by the CDC's creation of a National Strategy on Combating Antibiotic Resistant Bacteria (CARB)[2] in 2014, and soon after,

many federal agencies began to develop and implement action plans to combat antibiotic resistance. The UN General Assembly put AMR on their agenda in 2016. Work continues in this space today. (Figure 1)

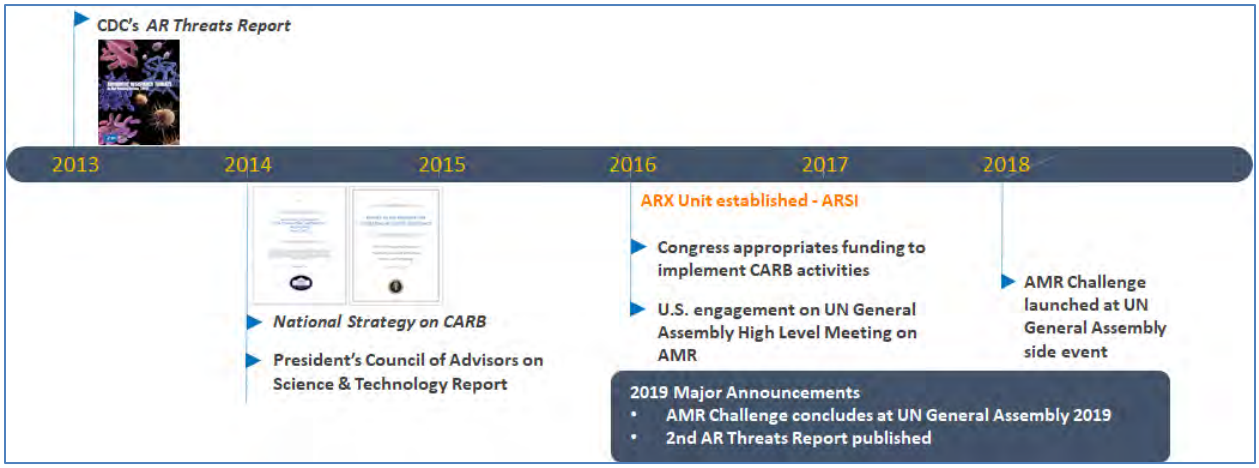


Figure 1. Timeline of national momentum to combat AMR[3]

New drugs aren't enough to protect Americans. We do need new antibiotics, but that's only a part of the solution. The AMR Challenge[4] is a yearlong initiative recently developed by the CDC with the goal of gathering commitments to reduce the spread of AMR across the One Health space. Challenge focus areas include tracking and data; infection prevention and control; antibiotic use; environment and sanitation; vaccines, diagnostics, and therapeutics; and collaborations to address AMR. More than 350 organizations have made commitments, including governments, private industry, and civil society from around the world. The National Strategy on Combating Antibiotic Resistant Bacteria (CARB)[5] is an ongoing National Action Plan, initiated across all US federal agencies in 2013, designed to slow the emergence of resistant bacteria, strengthen One Health surveillance efforts, advance diagnostic test development, accelerate research into drug development, and improve international collaboration. Associated with this National Action Plan is $170 million in annual funding for CDC distribution to state and local health departments, individual researchers, the Antibiotic Resistance Laboratory Network, and the Antimicrobial Resistance Isolate Bank, in the service of combating antimicrobial resistance. Preliminary data shows that these efforts are working, but more work is needed.
The *2019 AR Threats Report* is due to be released in November 2019, and has a significant focus on the interconnection between humans, animals and the environment. Following the release of the *2019 Threats Report*, the CDC Antibiotic Resistance[6] website will be updated to reflect that report. The CDC is committed to continuing to support and foster efforts to combat antimicrobial resistance throughout the One Health spectrum.

Supporting Antimicrobial Stewardship - FDA Update

William T Flynn, DVM, Deputy Director, Science Policy, *FDA Center for Veterinary Medicine*

In 2012 and 2013, the FDA released GFI's #209 and 213[7], limiting the use of medically important antimicrobials in food-producing animals. The goals of these guidances were two-fold: to eliminate growth promotion uses of medically important antimicrobials, and to bring their use under veterinary oversight.

Antimicrobials used in feed require a VFD authorization, and those administered in drinking water require a prescription. The guidances were fully implemented as of January 2017. The 2017 annual summary report on antimicrobials sold or distributed indicates that GFI's #209 and #213 have been successful in reducing the sale of these limited antimicrobials for use in food-producing animals. (Figure 2).

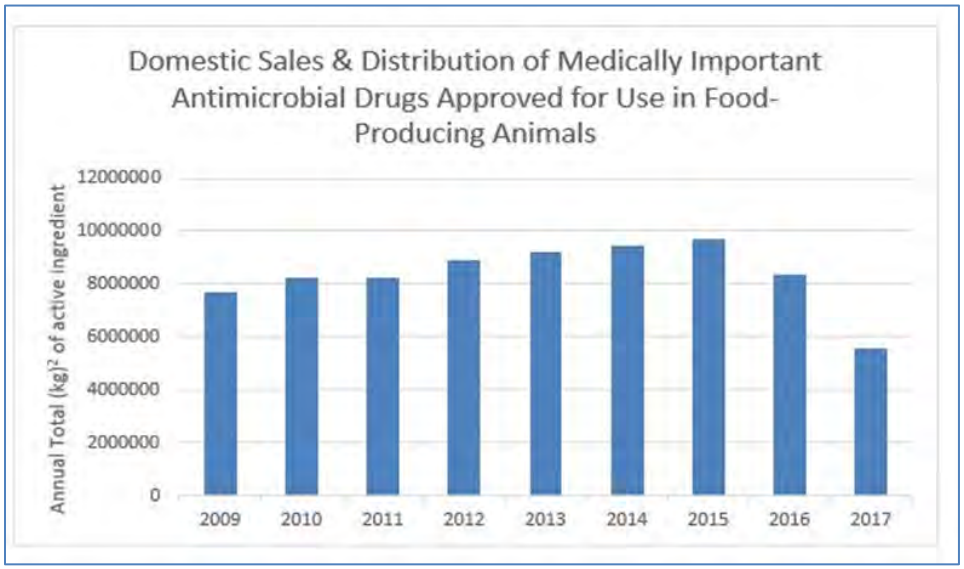


Figure 2. Sales and distribution of medically important antimicrobials from 2009 to 2017.[8]

The FDA Center for Veterinary Medicine's (CVM) Five-Year Plan for Supporting Antimicrobial Stewardship in Veterinary Settings[9], published in September 2018, builds on GFI's #209 and 213, and serves as a guide for moving forward. The 5-year Plan continues to focus on medically important antimicrobials, but expands to include companion animals, and enhances stewardship, AMR monitoring, and the collection of antimicrobial use data in animals. Some of the key projects include transitioning over the counter (OTC) products to prescription (Rx); defining durations of use for medically important antimicrobials used in the feed of food-producing animals; updating the list of medically important antimicrobials[10]; collecting use data in real-world animal agriculture situations; and the issuance of an Assessment Report that provides a more comprehensive assessment of progress than sales data. Progress on CVM's 5-year plan is available on FDA-Track[11], a tool that promotes transparency and monitors certain FDA programs through performance measures and key projects.

The FDA has made significant progress in the fight against antimicrobial resistance, and continues striving to build on past achievements. Future efforts are expanding to include all veterinary sectors, guided by the FDA-CVM Five Year Plan, good science and good data.

Discussion

Dr. Flynn was asked about the terminology 'medically important', and if the updated list of medically important antimicrobials will include a section for drugs designated for use in food animals?

The term 'medically important' was coined to identify those antimicrobials of primary concern with respect to implementing GFI's #209 and #213, but it has been adopted by a variety of sectors both national and international, and has taken on broader significance. The updated list of medically important antimicrobials will continue to focus on those drugs that are important therapies for humans. However, all 'medically important' antimicrobials are not the same. The FDA has tried to rank medically important antimicrobials to take into account those that are considered critically important, but we have lost some of the granularity of this list and need to shift the narrative to highlight that some medically important antibiotics are more critical than others.

Antimicrobials that are 'medically important' to humans are where the effort has been focused because of heightened risk. However, the framework moving forward should allow for certain drugs, like ionophores, to be designated as not medically important.

Antimicrobial Resistance Research at the USDA Agricultural Research Service

Kim Cook, PhD, National Program Leader, Nutrition, Food Safety and Quality Staff, *USDA-ARS*

The Agricultural Research Service (ARS) is the non-regulatory research arm of the USDA, conducting research to address agricultural issues of high national priority. ARS comprises of 90 locations, 16 national programs, 25 ongoing antimicrobial resistance projects and a $1.3 billion budget.[12] ARS works within USDA and with other federal agencies to coordinate research efforts around AMR. The ARS addresses AMR through a diverse range of research areas, including crop production and protection; animal production; foodborne pathogens; and the development of alternatives to antimicrobials. ARS research also encompasses diverse livestock species and environments, from beef to dairy to poultry to swine to the laboratory. Major locations investigating antimicrobial resistance include the US National Poultry Research Center (USNPRC), US Meat Animal Research Center (USMARC), National Animal Disease Center (NADC), Southern Plains Agricultural Research Center, Beltsville Agricultural Research Center (BARC), Soil/Agriculture/Water studies, and the National Center for Agricultural Utilization Research (NCAUR).

Some of the research at USNPRC includes studies with underdeveloped countries, development of alternative to antimicrobials for treating poultry, and investigating the role of poultry litter in transferring antimicrobial resistance (AMR). The feedlot at USMARC allows for studies to be conducted as they would occur in a large scale production operation. USMARC has consistently found that AMR in RWA (Raised Without Antibiotics) cattle is about the same level as that for conventional animals. NADC is identifying non-antibiotic strategies for growth promotion and developing a vaccine for salmonella in swine and turkeys. Like USNPRC, the Southern Plains Agricultural Research Center is developing alternatives to antimicrobials, but is also looking to breed chickens with enhanced innate immunity and conducting research on the chicken gut microbiome. BARC is evaluating AMR in dairy cattle and investigating the use of nanoparticles to improve the coccidiosis vaccine. Soil, Ag and Water studies have evaluated AMR in dust, aerosols, and watersheds. And NCUAR is investigating novel antibiotics like tunicamycin and liamicin.

In all research areas, ARS emphasizes antimicrobial alternatives, seeking solutions that will not further drive resistance development. These include early diagnosis, preventing specific diseases through

vaccines and immunotherapies, supportive treatment such as cytokines and nutraceuticals like l-glutamine for use when animals are under stress, and alternative treatments for disease that will not drive resistance. (Figure 3)

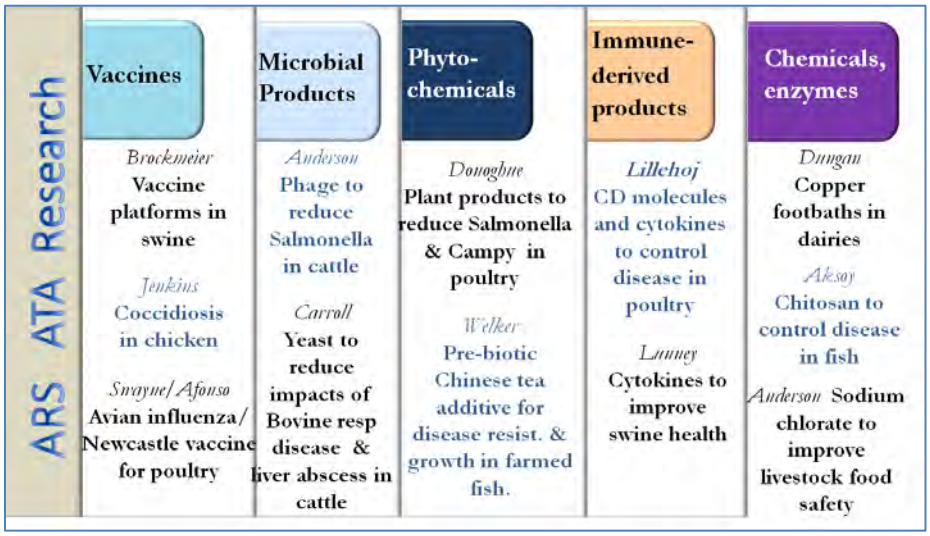


Figure 3. ARS Alternatives to Antimicrobials Research.[13]

The many studies at these ARS locations focus on everything from characterizing antimicrobial resistance in diverse populations and environments, to non-antibiotic strategies for growth promotion, to alternatives to antimicrobials such as vaccines, immune-derived products, and phytochemicals. The agency will be publishing the *USDA ARS Antimicrobial Resistance (AMR) and Alternatives to Antibiotics (ATA) Accomplishment Report (2016-2018)* in late 2019, highlighting these studies, findings and accomplishments.

Discussion

Dr. Cook was asked how ARS sets priorities for funding use?

Funding for ARS research priorities is congressionally appropriated. Congress obligates funds to ARS with the mandate of finding solutions to problems of importance to U.S. agriculture. AMR is a priority topic for U.S. agriculture and public health, for ARS and for the USDA. ARS program leadership meets with stakeholders to determine where knowledge gaps are, and those gaps help define research priorities.

The Future is Now, Part 1: Where Have We Come in One Health and AMR in the Last Five Years?

Christine Petersen, DVM, PhD, Director, Center of Emerging Infectious Diseases, *University of Iowa, Public Health*

One Health is an approach in which people working across different fields collaborate to achieve the best possible health outcomes for humans, animals and the environment. In the animal realm, many antibiotic

stewardship efforts have been focused in production animal medicine and food surveillance, through efforts such as Quality Assurance programs, residue prevention programs and withholding times, veterinary training through accreditation modules, and others. We tend to spend the most time thinking about what happened in the incubation period – where the infection was contracted. Human medicine tends toward this emphasis as well. But we need to focus more time and energy thinking about what happens after the human or animal is infected – on how that infection then spreads.

An outbreak of *Salmonella Newport* in late 2018 highlights this need for a broader focus. In late 2018 and early 2019, the rate of cases of human *Salmonella Newport* resistant to azithromycin increased dramatically, with 255 cases identified in 32 states. Epidemiologic investigation and core genome multilocus sequence typing (cgMLST) linked cases to Mexican queso fresco and US beef. The increase can be attributed to a number of factors, such as a novel outbreak *salmonella* strain not identified before 2016, cases and exposures scattered around the US thus difficult to link epidemiologically, and a lack of a single point source to be removed. The fact that the strain was present in cattle from both the US and Mexico and suggested a possible tie to macrolide use in cattle.[14] However, macrolides account for just 4% of all antibiotics used in cattle. This explanation doesn't adequately describe how the resistant bacteria became so widespread. An alternative conclusion is that the increase in case identification was due to surveillance artifact – laboratories had recently switched from using PFGE to using cgMLST, a more sensitive test.

With no identified point source, a broad idea of pathogen source, and no clear idea of how the pathogen might have spread, CDC communicated risk and how to mitigate by infographic.[15]

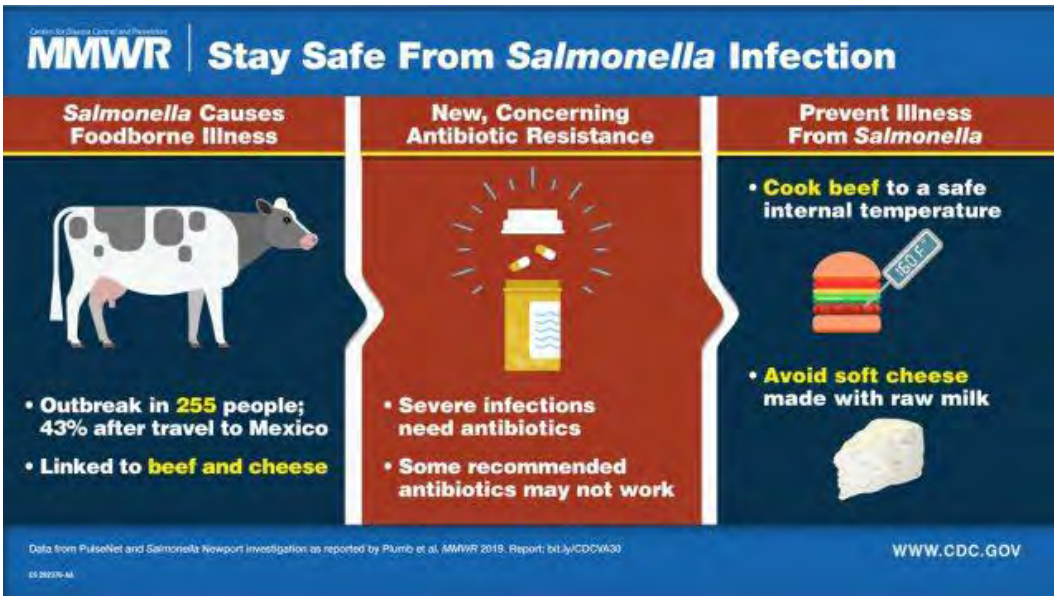


Figure 4. CDC infographic to educate consumers after a 2018/2019 *Salmonella Newport* outbreak linked to US beef and Mexican soft cheese.[16]

The main approach to detecting AMR-based disease in people is multi-focal. Efforts by hospitals address overall surveillance both externally through the Emerging Infections Program (EIP), and internally through hospital network surveillance both in private and Veterans Administration (VA) networks. Local, county, and state public health infrastructure disease reporting allows for rapid detection and characterization of outbreaks. Finally, the CDC and FDA provide targeted Epi and Lab Capacity grants to increase surveillance and detection of specific pathogens.

The EIP is primarily focused on large hospitals and populations in urban centers, and uses active surveillance to generate baseline AMR data. An example of how this helps actually combat AMR is highlighted by EIP MRSA data. In 2005, EIP began collecting baseline information on MRSA using molecular techniques. From generation of that baseline in 2005 to eight years later in 2013, the incidence of methicillin-resistant Staphylococcus aureus (MRSA) bloodstream infections dropped significantly (Figure 5). Knowing the extent of the problem through baseline data, allows us to begin to work towards solutions.

EIP MRSA Surveillance Data: hospital onset bloodstream infections

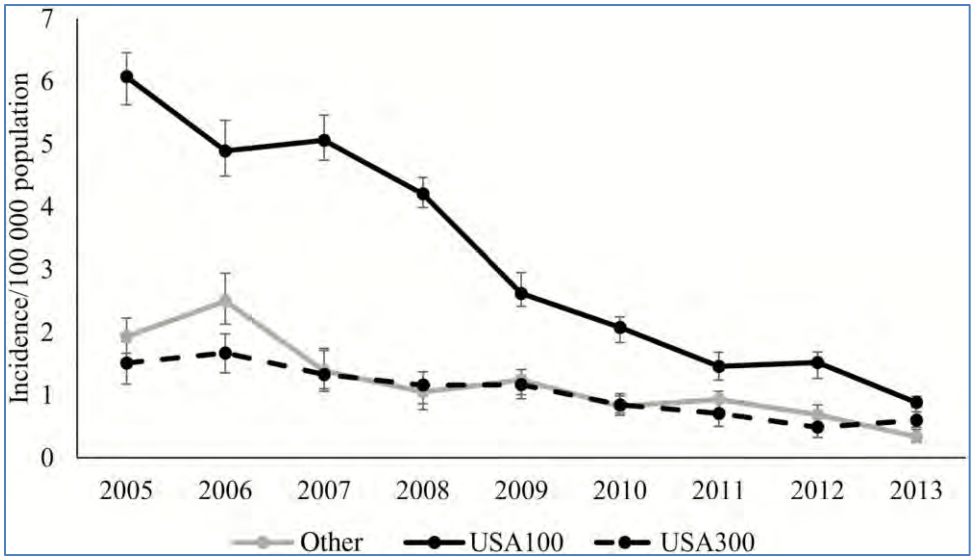


Figure 5. Estimated incidence of hospital-onset methicillin-resistant Staphylococcus aureus (MRSA) bloodstream infections, by strain type, in 5 Emerging Infections Program sites, 2005–2013. Incidence is stratified by strain type (USA 300, USA 100, and other)[17]

CDC/FDA Epi and Lab Capacity Grants provide for the increased surveillance and detection of pathogens tracked by FoodNet (the Foodborne Diseases Active Surveillance Network[18]) and NARMS (National Antimicrobial Resistance Monitoring System for Enteric Pathogens[19]). An outbreak of *Salmonella Typhimurium* associated with chicken salad demonstrates how the state public health infrastructure and the FoodNet and NARMS systems funded by federal grants worked together to stop a major disease outbreak. The Iowa State Hygiene Laboratory noticed an unusual increase in number of *Salmonella* samples it received over a short period of time. The lab notified the Iowa State Public Health Department, which activated its Foodborne Investigation Team, mobilizing epidemiologists and others to investigate and collect samples. Chicken salad was identified as a food of concern, and subsequent testing identified

a very specific allele in both patient and chicken salad samples. The grocery store supplying the chicken salad pulled the product from the shelves and the public was notified by press release. The rapid identification of disease and removal of contaminated product was able to stop the outbreak. (Timeline in Figure 6)

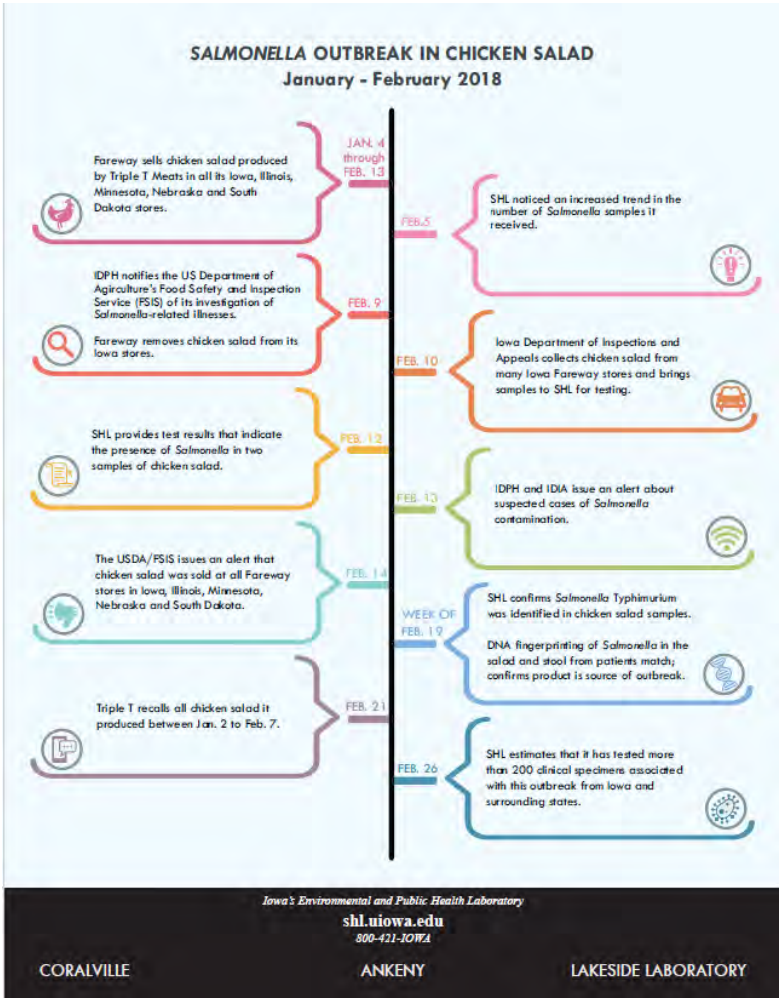


Figure 6. Timeline of *Salmonella Typhimurium* chicken salad outbreak and response.[20]

Hospital network surveillance is another way human medicine detects AMR-based disease. One recent hospital study expanded this approach to look at AMR in the hospital environment. Using MALDI TOF mass spectrometry, the study showed that hospital privacy curtains, which are changed only when visibly soiled, grow a large number of pathogens on their surface over a short period of time. While bleaching was effective in reducing pathogen burden on the curtain surfaces, the effect of bleaching on these pathogens lasted at most just 2 days.[21] The take-home messages from this study are that places where sick people live are not sterile environments, that those environments are very hard to keep clean. To put it simply – the world is messy. This study is an example of a hospital based study done to try to intervene in the messy world we live in.

As we ramp up surveillance across the One Health spectrum for AMR, an often missing piece is environmental studies such as the hospital curtain study above. A recent study in Kenya tackled the question of AMR in the broader environment, investigating the role of private households versus public milk food systems in foodborne enteric pathogen transmission to infants.[22] The study looked at multiple points along the pathway from market to consumption and analyzed samples to see where bacterial contamination was occurring. The study examined many different aspects of milk safety and pathogen control, but one of the main conclusions was that the milk was being contaminated after opening in the private home.

These environmental studies highlight the idea that one of the most important controls for the transfer of pathogens is better public education about the sanitary handling of food. We need a different perception about the interaction between food, bacteria, and our bodies. Bacteria is everywhere. We can't make everything sterile. Every handling step before consumption increases the chance for contamination. Precooked and prepackaged foods are handled at many steps prior to consumption, so are some of the most likely to be contaminated.

Antimicrobial resistance is complicated. Human medicine often blames animal agriculture, but reacting by blaming human medicine will not solve the problem, either. Life is messy. We are not going to eliminate antimicrobial resistant pathogens. Hospitals have begun to address the issue by institutional controls, such as engineering controls that systematically guide practitioners to the correct antibiotic choice and offer checks and balances. Both human and veterinary medicine can address AMR by similar engineering controls, as well as work practice controls and the use of PPE. The best approach may be a collaborative One Health approach, which can only work with increased communication: between providers, hospitals, and public health; between veterinary public health labs; and between human and veterinary medicine, taking lessons learned and applying them across the antimicrobial use spectrum.

Discussion

We need more veterinary data, but in our effort to simplify the message to protect human health, producers become concerned that they will be unfairly blamed. How to we provide that data, and reach as many people as possible with a simplified message, while allaying producer concerns?

Dr. Petersen answered that in order to get closer to figuring out what's happening in an outbreak in real time, and thus stop disease sooner, we must work toward identifying point sources instead of patients – and those are sometimes producers. It's a risk that will need to be managed, but not collecting the data is more of a risk. Dr. Sievert from CDC commented that *the Salmonella Newport* outbreak described is a good example of how outbreaks often progress, with no point source ever identified. There is a problem, it causes illness, but there is no point source to go to. It's often too vague for people to really grasp. It's not easy to do this communication.

During an outbreak such as that related to the chicken salad - do you go all the way back to investigating the people handling the food?

Yes. Dr. Sievert noted that all agencies work together during an outbreak, to ensure that as much detailed information as possible is collected. Ultimately, it's not about who is at fault but how it happened, so that corrections can be made as quickly as possible to stop people from getting sick.

How is a multistate outbreak identified and investigated?

Dr. Nichols from CDC answered that when CDC starts to see people in multiple states infected with the same strain of bacteria, then they start to look for a common exposure. The epidemiologists ask questions of every person involved in the exact same way to make sure they are comparable, and the data is compared against background levels of illness. Dr. Petersen noted that new sequencing data is redefining how we characterize outbreaks as well, and has generated the need for a redefined baseline.

Info from case patient is often uploaded on a six month delay. Is that timeline going to be rethought to get data out as rapidly as possible?

Dr. Petersen responded that the hope is that with more streamlined reporting that data will get out much sooner. Case definitions that don't match lead to data that can't be compared, and that delay means more people will get sick. Dr. Nichols commented Megin Nichols that isolates from CDC are publicly available almost in real time. Looking at these to compare before an outbreak happens is significantly shortens the timeline.

Will bacteria eventually overcome handwashing?

Dr. Petersen noted that handwashing decreases pathogen burden, but you can still have high pathogen burden on your hands despite handwashing.

Panel Discussion – Managing AMR Risk in Humans with Applied Veterinary Medicine and Science

Steve Solomon, MD, FACP, FIDSA, moderator

Panel:

G. Donald Ritter, DVM, ACPV, Director of Technical Marketing, *Mountaire Farms*

Paul S. Morley, DVM, PhD, Diplomate ACVIM, Professor and Director of Research, Veterinary Education, and Outreach Programs, *Texas A&M University and West Texas A&M University*

Shivaramu Keelara, PhD, Research Assistant Professor, Department of Population Health and Pathobiology, *North Carolina State University College of Veterinary Medicine*

Antibiotic Use in Chickens

G. Donald Ritter, DVM, ACPV, Director of Technical Marketing, *Mountaire Farms*

Antibiotics are shared resources with shared risks. The epidemiology of antimicrobial resistance is complicated (Figure 7), and managing the risk requires a broad approach.

AMR is a global societal problem that affects everyone, and all antibiotic use contributes. For the veterinary sector, the first step is to admit that veterinary medicine is part of the problem. The second step is that every veterinarian commits to developing a holistic animal care program and strategy using best antibiotic stewardship practices.

As we discuss AMR in the production animal space, a major concern that surfaces is the fear that an acquired foodborne illness in humans will not respond to antibiotics because animals were treated with that antibiotic. Risk analysis indicates the odds of this happening are low. However, 2 million AMR infections and 40,000 deaths occur annually, and poultry related foodborne pathogens are responsible for 400,000 of these annual AMR infections and 120 deaths.

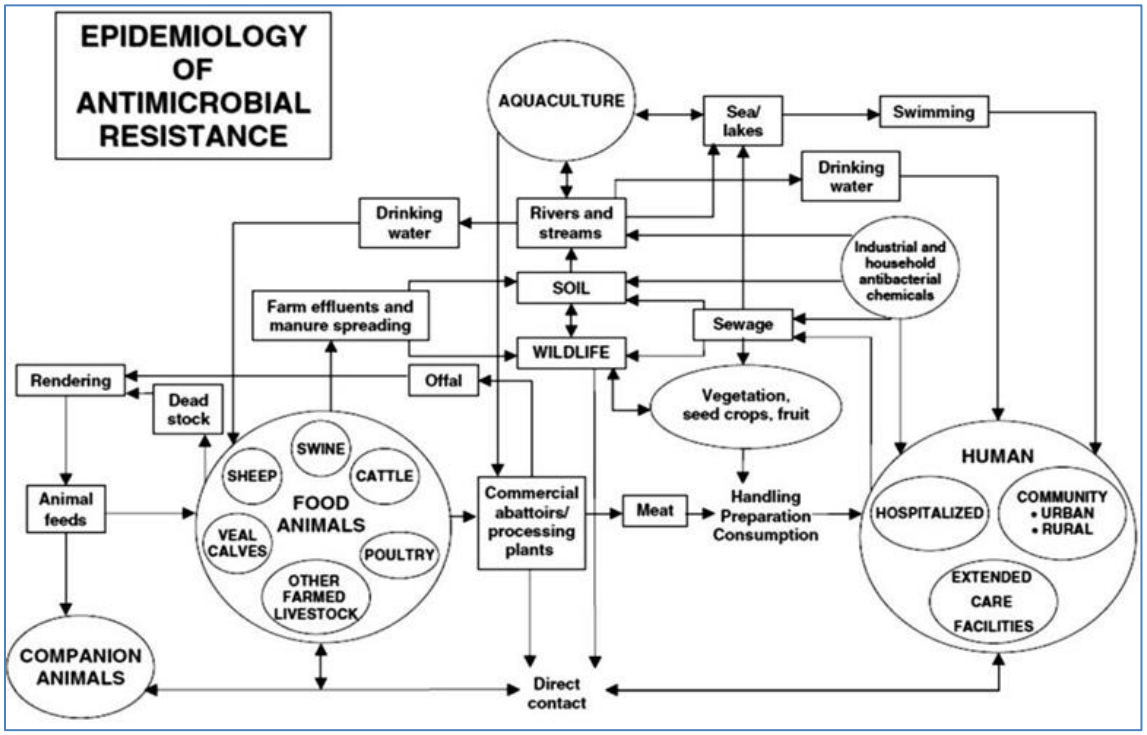


Figure 7. Epidemiology of Antimicrobial Resistance[23]

Responsible animal care means raising healthy animals and minimizing risk of AMR for both humans and animals. The poultry industry has made marked progress in this regard. Overall use of antibiotics in poultry is greatly reduced over the past few years. (Figure 8)

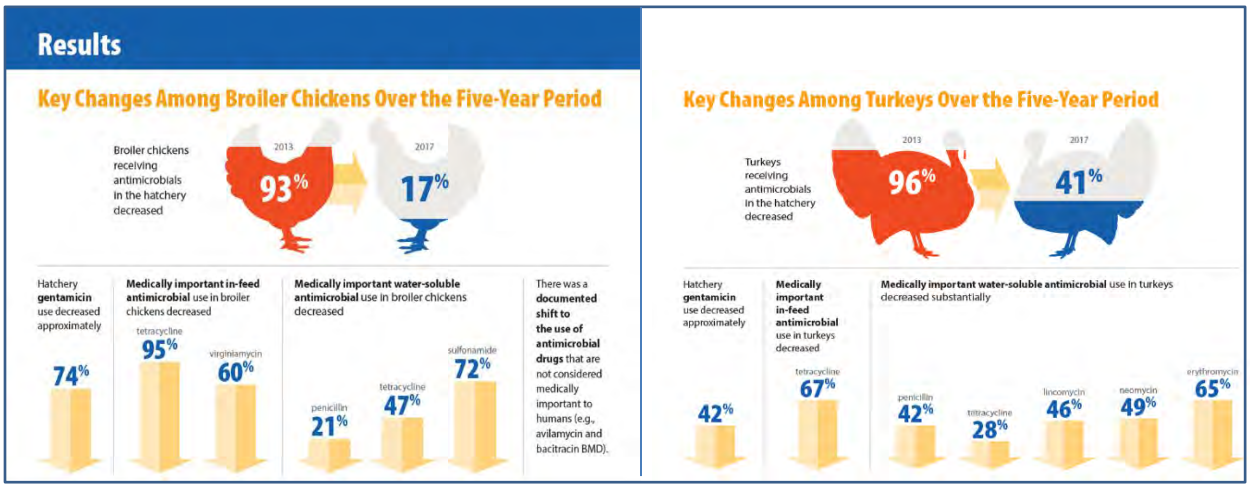


Figure 8. Key changes in antimicrobial use among broiler chickens and turkeys[24]

The rise in NAE (No Antibiotics Ever) poultry has contributed to this reduction in use. NAE is the most common meat animal product claim, driven by the misperception of over half of consumers who think if antibiotics are used during animal production the harmful antibiotic residues will still be present in the meat. Unfortunately, NAE has unintended consequences. NAE is a package-based certification that results in a two-tiered system, where all poultry starts out as NAE but if they become ill, then they are bumped to a less lucrative conventional class of animals. This leads to competing priorities, and more than half of veterinarians working with NAE programs note that maintaining an NAE label sometimes has priority over animal health and welfare. NAE flocks have increased mortality (10-20% higher) compared to conventional flocks. (Figure 9)

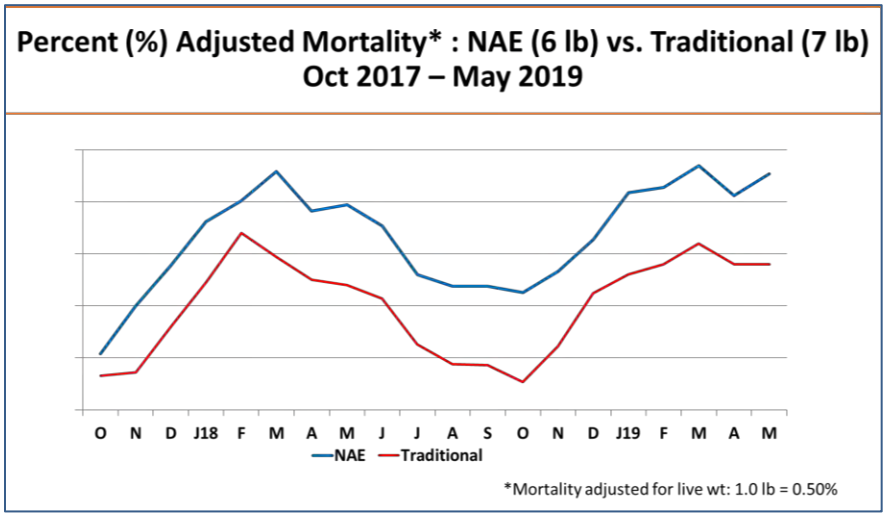


Figure 9. Mortality of NAE vs Traditional Broilers[25]

While NAE does contribute to reduced overall use of antibiotics, from a poultry welfare standpoint it is not the answer. A more viable solution is to integrate responsible antibiotic use into all animal care programs. Reduce the need for antibiotics by optimizing animal husbandry, biosecurity, and health planning. When antibiotics are necessary to treat and control disease, use them following best antibiotic

stewardship practices and treat the fewest number of animals possible. Track antibiotic use and measure treatment outcomes with the goal of using the data to review and update veterinary flock health plans. All users must practice consistent vigilance to ensure continued antimicrobial effectiveness.

Does Antibiotic Use in Cattle Affect Human Health?

Paul S. Morley, DVM, PhD, Diplomate ACVIM - Professor and Director of Research, Veterinary Education, and Outreach Programs, *Texas A&M University and West Texas A&M University*

Is problematic human AMR linked to food animals? Many people believe that antimicrobial drug (AMD) use in animals poses an unacceptable human risk. This belief is a strong motivator for the Raised Without Antibiotics (RWA) label desired by consumers. Does AMD use in cattle affect human health? AMD does provide for the health and welfare of cattle, and care for the welfare of our animals supports societal well-being. AMD use also promotes efficient, abundant production of a safe food supply. However, AMD use could lead to residues or cover for poor management – and we in animal agriculture need to do a better job of telling the public about the many systems that are in place to protect against both of these negatives.

To have problematic AMR in people, the four following are required: antimicrobial drug use in animals, evidence of AMR bacteria in animals, infection of humans, and adverse health events in humans Metagenomic studies of multiple animal species support the idea that overall AMD use is associated with resistomes, but that ADU is not the cause of those resistomes. Studies of antibiotic use and resistance in hospitalized humans in the ICU, hospitalized horses and dogs, and ill cattle in small hospital pens indicate that acute exposures to antibiotics in these hospital settings are associated with an increase in resistance for all species studied. Studies of conventional versus RWA cattle demonstrate no difference in prevalence of resistance across antibiotics between the two groups. Studies of AMR in feedlot cattle treated with specific antibiotics indicate treated cattle are associated with increased finding of resistant isolates, but subsequent studies indicate that the greatest changes occur over time, not by treatment group. Finally, risk analysis studies in humans show no correlation between resistant beef salmonella isolates and human cases associated with consumption of beef meals. All of these lead to the basic conclusion that the answer isn't clear. The truth about AMR is that it is extremely complicated.

As we approach antimicrobial use decisions in the future, it is clear that to maintain animal welfare we need to continue to treat the sick, but we need more research in animal populations to better characterize the mechanisms and implications of AMR. We need to work through the complications in order to accurately characterize how AMR plays out throughout the entire One Health spectrum, in animals, but also in people and the environment.

Antimicrobial Resistance and the Environment (Swine)

Shivaramu Keelara, DVM, MPH, PhD - Research Assistant Professor, Department of Population Health and Pathobiology, *North Carolina State University College of Veterinary Medicine*

As we discuss antimicrobial resistance (AMR) and shape those discussions into public communications, we need to remember that bacteria have been around much longer than humans. They have had plenty

of time to develop survival mechanisms such as AMR. Antimicrobial resistance has been present since the discovery of the very first antibiotic, and resistance has emerged to every antimicrobial ever developed.

An often-missed piece of the AMR puzzle is the environment. We tend to focus more on the vectors than the environment they live in. Every day, people and animals are exposed to a diverse range of environments and factors, all of which are interlinked as facets of a complex ecosystem with equally complex exposures and challenges. (Figure 10)

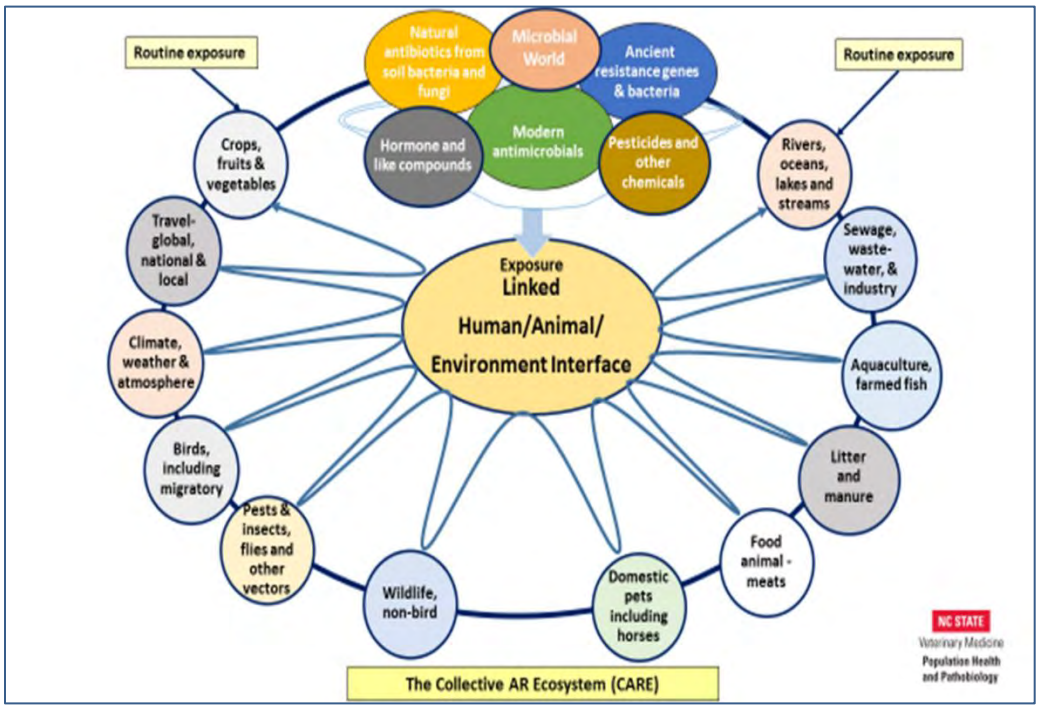


Figure 10. Complex ecosystem in which humans, animals, and the environment are linked.[26]

Investigating environmental AMR in a system this complex is daunting. However, investigation can be simplified by examining the environmental reset that occurs with major events such as hurricanes, floods, drought, and volcanic eruptions. A study of one of these environmental resets, the aftermath of Hurricane Florence in North Carolina, offers a unique perspective following the reset. After Hurricane Florence, the overflow of both human and animal sewage resulted in soil and water contamination. Researchers sampled soil and water at human, poultry, and swine sites monthly for eleven months. *Enterococcus* was found everywhere, generic and extended spectrum beta lactamase (ESBL) resistant *E. coli* was highest near a recreational park, and *Salmonella* was highest near swine locations. *Salmonella* contamination of both soil and water showed a decreasing trend from November (a month after the hurricane) through June, then began a slow increase through the following September. (Figure 12 – yellow line)

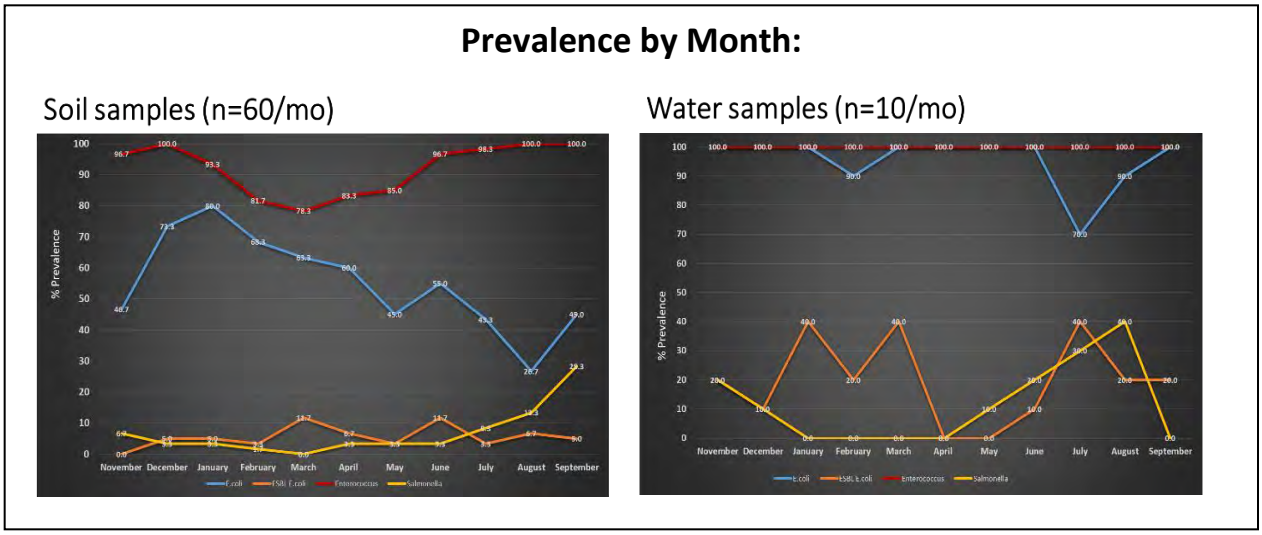


Figure 11. Pathogens measured in soil and water samples in North Carolina for 11 months following Hurricane Florence. (blue = *E. coli*; orange = ESBL *E. coli*; red = *Enterococcus*; yellow = *Salmonella*)[27]

ESBL isolates were profiled for resistance. Significant resistance was found only in ESBL *E.coli* compare to generic *E.coli*, and majority of the *Salmonella* isolates were pansusceptible. All of the resistant *Salmonella* isolates were found in soil, and they were only resistant to one antibiotic: streptomycin.

The environment has been neglected in the AMR discussion. However, if we are to better understand AMR, the complex ecosystems in which we live mean we must add a focus on the environment. Analysis of results in studies like this one should be able to help start to fill in the environmental gaps in our understanding of AMR.

Dr Dawn Sievert from the CDC remarked that CDC is mandated to distribute majority of the AMR funding they receive out to external partners. CDC has a number of projects funded with external partners that address resistant pathogens in water and soil, including some that investigate use of antifungals on crops and effluent or run-off from nearby hospitals and farms, respectively. They are always interested in ideas for partnering.

Discussion

Some of the strongest evidence for AMR transferred from animals to humans comes with human outbreaks that can be traced back to the farm level. However, often industry really pushes back against this. Why has industry been so resistant, and how can we change that?

Dr. Morley responded. We can find resistant foodborne pathogens that are transmitted from animals to people - this is why we have extremely effective regulatory controls and why producers work so hard to reduce pathogen resistance. However, we don't know how those resistant foodborne pathogens came to be in the animals in the first place. Antimicrobial treatment gets blamed for that resistance, but AMR can be found in animals never treated with antimicrobials. We are confusing the question of 'how did that

pathogen get into the animal?' with 'did the resistant pathogen in the animal cause human illness?' We blame the producer for causing the animal to have resistant bacteria, when in fact, we don't know where the resistant bacteria in the animals came from.

Dr. Heather Fowler of the National Pork Board also commented on this question. The theme of this meeting is communication of responsible antibiotic use, and we as an industry need to make sure we're communicating that use clearly. We need to communicate that we as an industry are providing a wholesome product, regardless of the method (conventional, RWA, etc.) by which the animals are raised.

Dr. Amanda Beaudoin from University of Minnesota added a comment about producer data. Without actual data pertaining to antibiotic use on the farm, it's difficult to share any information. A lot of people haven't thought about animal health and welfare impacts of reduced antibiotic use. Equine barns are similar to nursing homes in terms of exposure to antibiotic and AMR-associated healthcare impact. We don't hear much about the veterinary medicine resistome that may have clinical implications for animal health and welfare.

What can other sectors in animal health learn from the poultry industry about better antimicrobial stewardship?

Dr. Ritter responded. Reductions in use are not necessarily better. Responsible use is better. We need to save medically important antibiotics for when animals are actually sick. Dose and duration affect resistance – so we need to ask if we need to administer continuously, or if can we pulse use? And as Dr. Morley mentioned, just because you find a resistant bug in a food animal does not mean that resistance is a result of antibiotic use on the farm. Chickens have been found to have bacteria resistant to drugs that have never been used in chickens.

There seems to be confusion between definitions of prevention and control. Can these be clarified?

Dr. Ritter noted that the definitions for these have been rewritten numerous times, both nationally and internationally. His definition of 'control' includes infected but not yet symptomatic animals. In the case of vertically transmitted diseases that infect embryos, you can wait for the chicks or poults to start dying after placement and start antibiotic treatment then - or you can inject an appropriate antibiotic in the embryos in the hatchery to stop that death loss before it occurs. It becomes very nuanced, even though people want it to be black and white. Dr. Morley noted that AVMA provides definitions for prevention and control[28], and they hit the mark on these nuanced definitions. There have been multiple studies that distinctly show that the high risk of mortality in cattle in feedyards from Bovine Respiratory Disease can be effectively mitigated by dosing those cattle with tulathromycin upon arrival.[29,30] This single dose prevents death and the need for additional and increased volume treatment with antimicrobials in the future. Producers are using evidence-based practices to manage cattle health.

Two of the panelists commented that AMR is ancient, and also pointed out that resistance is sometimes found in animals not treated with antibiotics. This adds to the incredible complexity of the issue. Can quantitative methods (molecular biology) can help unravel some of that complexity and answer some of the questions that keep coming up?

Dr. Morley responded that we are counting on molecular tools being able to help us understand AMR. We need to go to the gene level because of the potential for sharing resistance genes. Bioinformatic analysis looks at SNP difference across genes, and human studies are beginning to look at these SNP differences. Dr. Keelara commented that NC State is part of GenomeTrakr program, which implements these molecular tools. The cost for genetic work has significantly decreased, thus it's more available, but it's relatively new that it's reachable to do these molecular techniques to characterize bacteria. Dr. Morley noted that molecular tools are changing thinking to a different scale, and a specific example is provided by *mannheimia haemolytica*. We know it's a respiratory organism that leads to the majority of death in feedlot cattle. Interesting evidence suggests that exposure of these organisms to antibiotics may not only increase clonal populations, but also upregulate certain resistance elements at the molecular level.

With different populations of cattle, aren't there different management practices across feedlots?

Dr. Morley agreed that there are differences by location. Through the microbiome lens, location is definitely important. We want to make generalities about drugs and resistance, but microclimates that have a huge effect.

Dr. Akinlabi Ogunleye from University of Ibadan in Nigeria noted that a common occurrence in Nigeria is to see isolates from poultry and companion animals that are resistant to virtually all available antibiotics. This is not surprising because there is little control over the way antibiotics are used in Nigeria. How should this situation be addressed?

Dr. Ritter replied that although we rarely see treatment failures in US poultry, we do see resistance trends. We use that trend data in a decision tree to determine which antibiotic to use, but also include other factors such as withdrawal time and when the animal is going to slaughter. In countries where antibiotics are less regulated, the main recommendation would be stewardship education for animal owners. Dr. Keelara noted that he's a facilitator for a WHO global Tricycle project including Africa and other low and middle income countries (Ghana, Senegal, Indonesia, etc.). A huge percentage (70-80%) of market chickens in those countries are positive for ESBL *E.coli*. With the lack of antibiotic prescription regulations in Asia and Africa, he agrees that education is the best way to reduce use of these drugs.

Ernie Birchmeier of the Michigan Farm Bureau commented that farmers are working in one of the most economically challenging times they've ever faced - weather disasters, trade agreements/restrictions - but we're talking about major changes they may have to implement on their farms. Based on what we've learned and moving forward, have we gone too far too fast, and what has been the impact on animal welfare and farms?

Dr. Ritter agreed that we are moving too far, too fast, and in poultry production animals are suffering from the production practices that have been implemented. We need to bring it back to an ethical program. Dr. Morley commented that it's really important that we make sure we include producers in the discussion with regulators, agriculture industry leadership, and the public. Agriculture is a for-profit industry, and we should not apologize for that, even though sometimes the idea that there's a profit associated with producing food is a negative. The organic movement, with regard to longer generation animals, potentially leads to welfare concerns as older animals have increasing potential for need of antibiotic treatment.

Those animals that are treated end up being 'second class' animals. We should speak out about that. Dr. Ritter noted that in Europe, use of antibiotics is a pre-competitive issue, so they aren't marketing against each other. In contrast, in the US we use antibiotic use against each other, even though antibiotic use is often beyond the control of the producer. There are ways to fix the system, but we are going to have to get food buyers to change their thought process for this to happen.

Case Study in Communication

Dawn Sievert, PhD, MS, Senior Science Advisor for Antimicrobial Resistance Coordination and Strategy, *CDC*

Leah C. Dorman, DVM, Director, Food Integrity & Consumer Engagement, *Phibro Animal Health Corporation*

On September 23, 2019, the United States celebrated a year of progress and nearly 350 commitments from 33 countries to implement actions to combat antibiotic resistance. This event, an unofficial side event to the 74th United Nations General Assembly, was the culmination of the CDC's AMR Challenge Year.[31] Titled 'A Night Celebrating Global Antimicrobial Resistance Fighters',[32] the event was widely advertised and attended by a wide range of participants from around the globe. The event was livestreamed[33] and is posted on the CDC website.

When considering speakers for this event, the CDC and other organizers wanted to 'make it real' by including a patient story. The idea was to have someone speak who had experienced a range of health care in different countries and settings, and had experienced antibiotic resistance. David Ricci, a young man who first survived a terrible accident where he was hit by a train in India, then survived a leg amputation and subsequent hospital-acquired antibiotic resistant infection (HAI) - and had told his story at other known events – was identified as a speaker who could provide that patient story. He was vetted then invited by the CDC through their usual process, and accepted the invitation.

When speaking at the AMR Celebration event, Mr. Ricci went off script, straying from the information he had indicated he would discuss. Mr. Ricci was ultimately treated with colistin, a last line drug that finally resolved the infection. Colistin also happens to be an antibiotic used in agriculture in other countries. [34] Somewhere in his journey back to health, Mr. Ricci had decided that agriculture and the way animals are raised in the United States are the causative factors of antibiotic resistance. He described the 'wretched conditions' of animal agriculture, the 'disgusting way we eat meat', and noted that cattle live four times as long in other cultures than in the United States. He described much of the false rhetoric about agriculture and animal agriculture that can be found. During the vetting process, he revealed none of this anti-agriculture sentiment, and his presentation stunned event organizers and opened up a situation of immediate damage control.

Lessons learned during this situation were many. We have to stop talking only about reductions in use of antibiotics, but instead put their use in context with animal health, animal welfare, food safety, and public health outcomes. We have to continue working together and stop blaming each other, and we are making

significant progress towards this goal, but more is needed. Relationships are enormously important, but, as demonstrated by David's Ricci's presentation, we also need to be careful who we partner with.

Trust is incredibly important. Dr. Dorman and Dr. Sievert had only met face-to-face for the first time the evening of this AMR challenge celebration event, although, they had been in contact before that evening. After Mr. Ricci's presentation, the even happened to have a scheduled break. Dr. Sievert found Dr. Dorman, and her first words out were, "I am so sorry. That is not what CDC believes about animal agriculture." Dr. Dorman's follow-up was, "How can we help?" They proceeded to find the animal agriculture people in the room to make immediate connections, and start that process of rebuilding trust in the first few critical minutes after the speech.

Relationship-building is also extremely important. Dr. Sievert noted that CDC spends considerable effort developing and distributing communications that are understandable to a variety of audiences, but obviously, the work is not finished. If Dr. Sievert had not had the relationships in place with Dr. Dorman and other animal agriculture stakeholders, she would not have been able to apologize and have people believe her, and the damage done would have been significant and possibly irreversible.

Finally, communication is critically important. When speakers come to a venue such as this one, they have a huge microphone. When we offer that microphone, deep vetting needs to occur to determine if speakers are accurately informed, and to ensure they do not have a hidden agenda that could surface unexpectedly.

One conference attendee asked if there had been any follow up with Mr. Ricci. The CDC spoke with Mr. Ricci following the Event, to provide him with accurate information on all of the successful AR work that is being conducted within the food animal industry, and how important the CDC- animal industry partnerships are to the fight against antibiotic resistance. He now is empowered with accurate information and knows where to find updates and new data on trusted websites.

Panel Discussion – Can You Hear Me Now? Overcoming Communication Challenges

Dawn Sievert, PhD, MS, moderator

Panel:

Leah C. Dorman, DVM, Director, Food Integrity & Consumer Engagement, *Phibro Animal Health Corporation*

G. Donald Ritter, DVM, ACPV, Director of Technical Marketing, *Mountaire Farms*

Mr. Andy Bishop, Chair, *Kentucky State Beef Council*

Values First - Reframing the Conversation about Antibiotic Use in Animal Agriculture

Leah C. Dorman, DVM, Director, Food Integrity & Consumer Engagement, *Phibro Animal Health Corporation*

Most of the American public is far removed from the farm and animal agriculture. This audience often sees just a small fraction of what's happening, and the aspects that it does see are influenced by the views of friends and family, social media, educators, and the sometimes biased message that other people want them to see. That small glimpse is the basis for how the public develops their view of animal agriculture, which is often a flawed rush to judgement. And the single biggest reason people rush to judgement about animal agriculture is that we're not telling them in a way that resonates with them.

When confronted with audience judgement, we in animal agriculture tend to act in one of two ways: defensively, or with a 'data dump'. Neither of these reactions helps us to really communicate with the consumers. Shared values are more important that facts, skills, or abilities. The 'data dump' doesn't work. Facts and science are important, but they don't connect with the consumer. Shared values make that connection. We shouldn't throw out the science, but only once we make that values connection do we gain the permission to talk about the science and be heard.

Activists who decry animal agriculture have created a critical dialogue, but activists represent only a small part of the consuming public. The target audience for animal agriculture is not these activists, but rather the 'movable middle' - those consumers that don't have the information to make informed decisions but are interested in finding out. We need to create a counter-narrative to that of the activists, and we do that from the lens of shared values. Only in that manner can we build consumer trust. This consumer audience isn't asking if we can use antibiotics in animal agriculture, but rather, if we should. It's an ethical question, and requires a different approach. We need to shift the focus of the antimicrobial use conversation from us, the animal agriculture community, to them, the consumer. We need to talk about the things they care about – food safety, animal care, environmental impact, and other values that we ourselves share.

As we reframe the conversation, the focus should be on the societal benefits of using antibiotics in animals. Antibiotics support animal welfare by treating and preventing diseases that cause pain and suffering. And we need to emphasize that antibiotics are an ethical choice, to alleviate disease, but they are just one tool in the box, along with vaccines, good animal husbandry and farm practices, a clean environment, and others. We need to explicitly make the connection: healthy animals produce healthy food. Veterinarians, government, producers and the entire animal health community are working together to use antibiotics responsibly and to reduce the need for antibiotics.[35]

Studies have shown that the environment in which we do business has forever changed. Purchasing is driven by purpose. Consumers today purchase products from companies whose values align with theirs. This can take shape as 'ethical eating', which places focus on a variety of different values including animal welfare, waste reduction, worker welfare, reduced impact and support of local economies. It is more important than ever that we communicate our values to our consumers.

Engage to build trust. Avoid getting defensive. Listen to consumers. Lead with your values - not the science. Food is personal - let's talk about it that way. Let the consumer know that animal agriculture has taken action, and our responsible use of antimicrobials makes food safer and more affordable.

Overcoming Communication Challenges

G. Donald Ritter, DVM, ACPV, Director of Technical Marketing, *Mountaire Farms*

Many consumers get all of their information on the meat they buy from the package, at the point of sale. This package represents a huge opportunity to provide information to consumers, but can present a confusing landscape. Marketers in many cases know they are selling to an uninformed public, thus produce labeling claims that respond to misinformation and fear.

Animal production programs are a pendulum of consumer choice. Conventional programs have become dated, and are less accepted in the marketplace than they have been in the past. Extreme animal production programs, such as the 'No Antibiotics Ever' program, represent the opposite end of the pendulum. These programs are expensive, with many restrictions, and are thus difficult to scale. They are a package-based approach to animal production, and create two tiers of animals: those raised with the package label requirements, and those that can't meet the requirement, and this leads to an unpredictable supply chain. In the middle are balanced programs, such as the 'Certified Responsible Antibiotic Use' program. These are systems-based use programs, in which all animals are raised under the same rules, with no diversion and thus more predictable supply. Balanced programs tend to be under-advertised, and represent a consumer communication opportunity.

An alternative, and perhaps better, alternative to single attribute animal production programs is an umbrella multi-protein standard based on the principles of One Health that strives for optimal health outcomes for animals, people and the planet. The program currently being developed is named One Health Certified . The multi-stakeholder volunteer coalition developing this program comprises technical experts across animal agriculture, NGOs and universities with input from government agencies and food purveyors. The plan is to start with chicken, turkey, and pork, and the goal is to have 10% of all animals produced involved in the standard. It's a comprehensive systems-based certification program of transparent responsible animal care practices that includes an on-package retail label, and is open to all producers, governed by multiple stakeholders and managed by a major public land grant university. The program is based on five measurable, auditable core principles: disease prevention, veterinary care, responsible antibiotic use, promotion of animal welfare, and minimizing environmental impact. Compliance with this evolving continuous improvement program and its regularly scheduled updates will be verified by annual government audits conducted through the processed verified program of the USDA-Agricultural Marketing Service. In an effort to remove misinformation from packaging, co-labeling with most other programs will not be allowed. Consumer focus groups have reacted positively to the program with the One Health concept very well-received. Surveyed consumers indicated that the One Health label reduces their concerns about buying meat more than the NAE label and said that they would be willing to pay more for the One Health label vs NAE. Of the five core principles, surveyed consumers valued

veterinary care and responsible antibiotic use the most. The One Health label is still in the final stages of development and will be launched in January 2020

Communication and Transparency

Mr. Andy Bishop, Chair, *Kentucky State Beef Council*

Pressures on farmers are ever-increasing. Consumers think about animal welfare, antibiotics, GMOs, organic foods, hormones, and similar issues. For the most part, American consumers have the luxury of a large number of food choices, and don't about getting enough to eat, but American consumers also waste a third or more of the food they purchase each week. In the food insecure parts of the world, the worry is the increasing world population, and the increase in production that will be needed to feed that population. By 2050, production will need to have increased by 60% to meet global food demand. In addition to this need for production increase, as well as reaction to consumer demands, global disease pressures and other forces, farmers face increasing regulation and control on their operations. How do they feed the population when the pressure from consumers continues to increase, and more actions of farmers are controlled?

Much of the answer to this question, and to alleviating the pressure, comes from communication – to galvanize the support of the consumer. Today's consumer largely gets their news and information on-line. Many platforms vie for consumer attention, and have just seconds to capture that attention. On-line information often uses scare tactics and fear to achieve that goal. If you google 'antibiotics in animals' one of the first hits is an infographic that says animals in the USA consume more than twice as many medically important antibiotics than humans. (Figure 12)

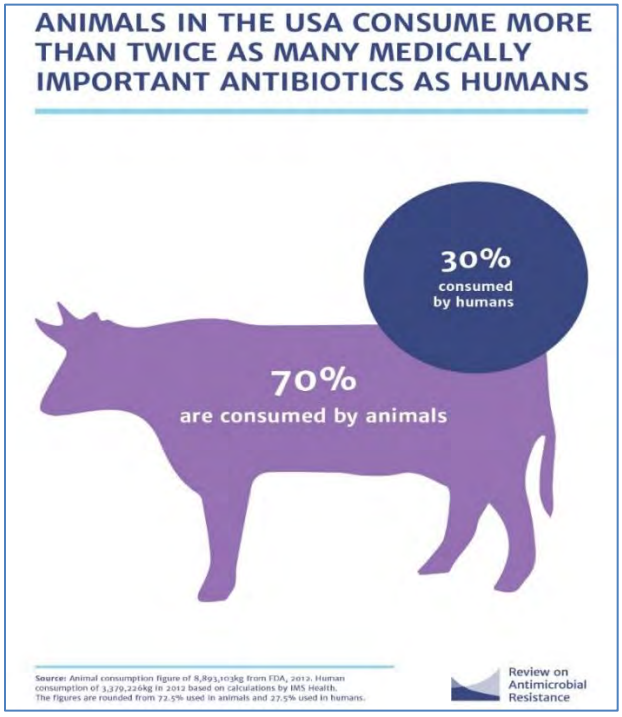


Figure 12. Infographic that is one of the first hits on a google search for "antibiotics in animals".[36]

This infographic oversimplifies the animal antibiotic use picture to the point of intentional misinformation. Humans, in fact, use approximately the same amount of antibiotics per pound as livestock – they just weight less

As mentioned by an earlier speaker, most Americans are far removed from the farm. They have no frame of reference from which to judge the information they consume. But they control what they see and read. So, how does the 1% of the population involved in agriculture confront misinformation such as this, and how do we accurately educate the consuming public? Stories get their attention. But they need to be the right stories. Mr. Bishops's organic laying operation has had to be depopulated twice because of introduction of disease – but consumers won't stop and read about that. What they do want to read about is farm kids and their story. That family lens – that picture of agriculture – gets their attention. (Figure 13)

Figure 13. Farm kids and their story - through photos.[37]

Farm family values convey a positive message that resonates with the consumer as something we share. We need to communicate our farm values in order to build the trust and support of the public. That support makes all of the pressures of farming bearable, and allows farming to continue as a rewarding and fulfilling profession.

The Future is Now, Part 2: The Promise of Precision Agriculture

Lucas Pantaleon, DVM, MS, MBA, moderator

Panelists:

Justin Sexten, PhD, Vice President of Strategy, *Performance Livestock Analytics*

Tom Noffsinger, DVM, Animal Handling & Staff Development, *Production Animal Consultation*

Why Precision Livestock Farming?

Lucas Pantaleon, DVM, MS, MBA, moderator, Board Certified Large Animal Internal Medicine Specialist, Veterinary Advisor, *Pantaleon PLLC*

With the growth of the population, we will need to produce more food. It is projected that there will be 60% more need for food by 2050. We aren't going to have more land for farming - so intensification is a must. There is a very complicated supply chain, with many stakeholders with different motivations, goals, and needs. Fewer farmers are attending more animals, with less qualified labor available. Environmental impacts must be monitored and adjusted. And animal health and welfare must be supported.

How do we make this complicated system more efficient and work together to move forward, creating and communicating positive environmental effects, supporting animal health and welfare, and producing safe food in a sustainable manner? Precision livestock farming is an important set of technologies that help the producer and veterinarian monitor animal health and welfare, as well as the environmental impact of the animal production system in real time. If done properly, these technologies produce a significant value-add for the producer and the veterinarian.

Can Technology Offer Solutions to Animal Health Challenges?

Justin Sexten, PhD, Vice President of Strategy, *Performance Livestock Analytics*

A survey of the mobile technology landscape reveals that there approximately 1.75 mobile connections per person on the planet. This mobile connectivity is expected to remain fairly stable, but the Internet of Things (IoT), which includes agriculture applications such as UHF tags in cattle, is expected to grow at least 2.5 times in the next six years. This mobile connectivity provides the opportunity to passively gather information, enabling the possibility of precision agriculture. Labor is a significant daily challenge in agriculture – but the connectivity of precision agriculture techniques allows for optimization of available labor, freeing up the stockman to take care of the stock.

The animal management challenge to the modern producer comprises three major needs: to aggregate data from multiple sources, to provide individual animal management within the pen, and to understand the range of normal. The difficulty of data aggregation is the coordination of thousands of bits of data into a comprehensive data picture that gives us the information and knowledge we need to make management decisions. With machine learning and artificial intelligence, computers can compile information and make decision without the operator personally needing to know the details, but we have to be willing to allow that to happen. The challenge is getting good data into the computer in a seamless way.

In the realm of management of the individual animal within the pen, technologies are available that allow for medical advances with minimal handling, such as time-released growth promotants and long activation duration dewormers. But to allow for individual animal management, we must shift thinking to an endpoint perspective. Sensors coupled with ultra-high frequency identification show promise of managing the individual within a pen to optimum performance endpoints and health outcomes. Efficiency gained by managing the individual within a pen offers cost effective opportunities as the technology advances and becomes more affordable.

Finally, how do we define 'normal' and 'healthy'? Today we can monitor vital statistics, but how do we manage the deviations? What deviations are normal? Understanding how individuals differ from their normal allows us to detect disease earlier, use less antibiotics to treat it, for a shorter duration. Precision agriculture can help us understand the normal animal in a way that optimizes operator labor using the growing IoT and rapidly advancing sensor technology.

To put it succinctly, precision agriculture allows you to manage animals to enhance their care. Growing mobile connectivity, coupled with sensor technologies and improving data storage capacity will inform the precision agriculture techniques and models that will allow us to address management challenges with increasing efficacy.

Discussion

There are lots of sensors out there, but what about the problem of connectivity and standardization?

The question of how to bridge the technology gap is one Performance Livestock Analytics wrangles regularly. The solution, as they see it, is a platform model that all of the sensors can plug into, ideally one the producer already uses on a daily basis. A singular, platform interface allows for data integration across sources rather than creating larger data silos with multiple sensor specific interfaces.

Incorporating precision technology into a confined operation seems relatively straightforward, but what about extensive systems?

It is more of a challenge to monitor, address, and treat cattle in an extensive system. In general, with extensive operations, you need to evaluate natural behavior and determine where within that behavior monitoring could be placed. For example, UHF tag could be used with a UHF reader positioned over a waterer, or even around a creek. It is also not uncommon to have drone technology used to monitor cattle. Dr. Sexten's advice is to start simple, with a measurement such as the number of times to the waterer, and gradually expand your monitoring from there.

Field Experience with Whisper®… Extension of Stockmanship - Antibiotic Stewardship

Tom Noffsinger, DVM, Animal Handling & Staff Development, *Production Animal Consultation*

Individual-level animal management is an important key to enhanced animal care and efficient production. What we're really talking about is an extension of stockmanship, justifying more human interaction with our animals, not less. We need to understand the animals we work with at a higher level addressing their needs, such as low stress handling, and remembering that these are prey animals,

programmed to conceal weakness from those they don't trust. We need to encourage the stockman to be a shepherd and caregiver, not a cowboy. This approach reduces animal stress, increases animal trust, and encourages animals to be honest about their health status.

Sick cattle management goals are timely detection of disease and calm acceptance by cattle of the medical interventions necessary to heal them. We have discussed generally the opportunities provided by the technologies of precision agriculture, but no specific tools. One precision management tool enhancing animal care is Whisper® – a diagnostic audio technology tool that is basically an electronic stethoscope. Bovine Respiratory Disease (BRD) is the number one cause of morbidity and mortality in the feedlot industry. Non-clinical BRD is common, and in general, animals affected by BRD are difficult to identify. Currently, we have to practice and objective diagnostic tools for this devastating disease, and we often rely on the imprecise 'undifferentiated fever' to identify possible cases. Whisper® allows the stockman or the veterinarian to do a more completed, accurate physical exam, with the device assigning a lung score indicating severity, duration and progression of lung disease after 'hearing' and evaluating auscultated lung sounds. There is a 74% correlation between Whisper®'s evaluation and actual BVD. This is compared to a 6% correlation between BVD and 'undifferentiated fever'. Whisper® provides the ability to diagnose Bovine Respiratory Disease much earlier in the disease that ever before, providing the critical information necessary to treat and heal that animal before it passes the point of no return. And it provides the data to review the efficacy of treatment protocols and treat as needed.

Technological innovations of precision agriculture such as Whisper® allow us to work with the animals at a higher level. These tools help us interpret what the animal are really trying to say, enhancing animal care and health allowing for more efficient production as we strive to feed the world.

Discussion

Have you put together any metrics to monitor antibiotic use?

There is no metric to specifically monitor antibiotic use, but the combination of good stockmanship, stabilizing nutrition, and the creation of a case definition picture through Whisper® data allows for significantly reduced antimicrobial use that is just a fraction of the amounts used without these tools.

Science Communication Strategies: Summary of Breakout Sessions

Michael Dahlstrom, PhD, Interim Director, Greenlee School of Journalism and Communication, *Iowa State University*

Stakeholders throughout animal agriculture face complex antimicrobial resistance (AMR) communication challenges. Science communication is extremely difficult, and few animal agriculture stakeholders have formal training in scientific communication. Many communication messages are well-intentioned, but still fail the communicator as well as the audience. Dr. Dahlstrom's research group investigates how science communication is communicated to various audiences, how audiences interpret that scientific

communication, and the effect of communication practice upon scientific understanding, acceptance, and support.

During the workshop session of the conference, participants were divided into four breakout groups, each led by a moderator from the Greenlee School of Journalism and Communication. Breakout groups were based on professions: producers, ranchers, and farmers; industry; government; and veterinarians. Each group participated in a guided discussion designed to determine what kind of scientific communication their particular sector needs to accomplish, identify target audiences, and the communication difficulties they have experienced.

Moderators
Denise Coberley, Graduate Student, Greenlee School of Journalism and Communication, *Iowa State University*
Michael Dahlstrom, PhD, Interim Director, Greenlee School of Journalism and Communication, *Iowa State University*
Andy King, PhD, Assistant Professor, Greenlee School of Journalism and Communication, *Iowa State University*
Dara Wald, PhD, Assistant Professor, Greenlee School of Journalism and Communication, *Iowa State University*

After the breakout sessions, collected information was collated, summarized, and synthesized into an overall representation of scientific communication of AMR within animal agriculture. Today's session presented strategies to overcome communication difficulties. A more in-depth analysis will be conducted at the conclusion of the symposium, and results will be provided to conference attendees.

The challenge we're facing as an industry is not one big communication problem, but rather lots of little communication problems. Producers, industry, veterinarians, and government each identified a different target communication audience with a different set communication goals and tactics. Producers, ranchers, and farmers named consumers and the media, and industry indicated consumers and retail. But veterinarians and government both noted that producers were one of their most important audiences. Veterinarians also identified veterinary students, and government pointed to legislators.

The practical suggestions offered for improved science communication comprised four components: focus, content, format and values. Focus is a pre-communication stage. Communication is a tool, not a goal in itself, so it's important to focus on a single, specific goal that you might achieve through your communication. Do you want to educate? Counter misinformation? Convince consumers to buy a product? Gain greater compliance with regulation? Gain greater respect for agriculture? Your goal needs to be achievable and measurable – something that will allow you to choose specific communication tactics. To help with focus, it is useful to identify what you want to appeal to: awareness, emotions, attitudes, knowledge, behavior? The most commonly identified appeals among breakout session attendees were knowledge and behavior. Finally, once this goal is identified, it's important to determine which particular audience you want to reach. There is no 'general public' - there are instead multiple and varied publics that respond differently, ranging from alarmed to dismissive. (See Appendix 1 for a

description of the six Americas). Once you know these different audiences are out there, you can determine which group of people you want to reach.

The second component of effective communication is content. What do you want to actually include in your message? When is focusing on the science the solution – and when should you begin by looking elsewhere? The Elaboration Likelihood Model of communication postulates that there are two routes through which people process information: the central and the peripheral. The central route is activated when a person pays close attention to a message, thinks about it in detail, and follow up with a long-lasting decision. The peripheral route is activated when a person isn't paying close attention to the message and uses peripheral cues having little to do with the content of the message to arrive at a decision, such as the credibility of the person delivering the message or even the color of shirt they are wearing. In today's world, everyone takes in a lot of information every day, and much of that information is processed through the peripheral route in order to maximize efficient use of cognitive resources.

To encourage a message to be processed through the central route, a communicator can focus on increasing ability, motivation, self-efficacy, social norms, and identity. For ability, the message needs to be reduced in complexity so that the audience has the ability to understand. This ability is an absolute necessity, but the audience must also be motivated to pay attention to the message, have a belief that they can act on the message, feel like the people that they care about want them care about the message, and the message must fit with the audience's identity of themselves. It is also possible to use peripheral cues to strategically increase acceptance of your message.

Content goes hand-in-hand with format. There are different formats for communication, including descriptive reports and advocacy arguments, but stories are often the most effective. Stories support central processing – they motivate the audience to pay attention, remove barriers, and connect with values and identities. Stories build a bridge between the storyteller and the audience. They offer a personal experience, giving the audience a specific example from which to generalize. They are easier to understand, process, and recall. Stories humanize the communication around your goal.

Finally, messages and stories that resonate the best with your audience – those that are most easily understood, recalled, and retained – incorporate values shared between audience and storyteller. What we know is always interpreted through the filter of our underlying value system. Science describes and explains the world, but can never tell society what should be done. Application of knowledge in the service of values drives attitudes. These values are powerful, but often remain unspoken and assumed. When thinking about your message and the stories that will deliver it, you need to consider the values that drive controversy, recognize that your own attitudes and behaviors are built on your underlying value system, and find the intersection of those two that supports the message you are conveying. Values are effective communication strategies. Expressing values shared by your audience builds trust, and opens the gate for more effective communication of your message.

Do you want to be a successful communicator? Focus to identify a specific and goal and audience. When developing content, think beyond sharing the science to how to reach your specific audience. Humanize the message through stories, and build trust through shared values.

Discussion

Can you comment on proving harm versus proving no harm?

It's easier to prove harm than no harm, *e.g.* 'look at this vaccine that caused this horrible outcome' versus 'look at all these people where nothing particularly interesting happened.' Instead of showing nothing happened, think instead of a story that demonstrates something happening in a good direction, *e.g.* 'Here's a parent who was struggling with whether or not to vaccinate, and when they decided to, they had more peace of mind.'

When do you not respond?

This comes down to the goal. There are times when not responding is a pretty big liability. Usually you want to be the source in order to frame the message. If you don't, then someone else will take that power away from you. But in some cases, such as when the controversy hasn't yet started, it may be better to not respond.

In agriculture we talk amongst ourselves a lot, but we don't know how to reach out to other audiences. How do we break out of that?

The answer is the traditional media. They know how to communicate beyond the agriculture audience. If you know the types of stories the media want to tell, sometimes called 'media logic', then you can position your stories to fit and get the media to pick them up. Communication science describes six categories, and any topic can really be adjusted to fit any of these hooks:

1. Oddity – Is it new, novel, or unexpected?
2. Conflict – Is there a fight?
3. Prominence – Someone well-known is involved
4. Proximity – Is it close to the audience (either geographic or social)?
5. Impact – The information will actually change something in the reader's life.
6. Timeliness – This is happening right now, and if you don't read this, you'll miss out.

Comment from Dr. Leah Dorman: Don't start with the media. Start with conversations with consumers. If you see someone at the grocery store buying a steak, tell them, "Thanks for buying that. I'm a beef producer, and we raise cattle on my ranch." Just start the conversation. Many people have never met a real farmer before and have lots of questions.

Comment from Ernie Birchmeier: When you're dealing with the media, invite them out to your turf. Bring them out to your farm, your business, your industry. They get a different and much better understanding of what you do. Dr. Dahlstrom noted that he absolutely agrees with Mr. Birchmeier.

How do we understand who is our audience? How many resources do you put into that?

If that understanding is really important, for example, during market research, then you should take the time and money to gain that insight. In other situations, take a guess, express your values, and see what works and what doesn't.

What about peer pressure?

Peer pressure is everywhere. The 'spiral of silence' is the idea that if you think your opinion is in the majority, you are more likely to speak out. But if you think you're in the minority, you're less likely to speak out. Why does this matter? The opinion you think is in the majority gets more voice, even if you're wrong about which opinion is the majority. You get more one-sidedness.

Information Avoidance: Does Ignorance Keep Us Uninformed About Antimicrobial Resistance?

Kate Brooks, PhD, Assistant Professor, Agricultural Economics, *University of Nebraska-Lincoln*

Antimicrobial resistance (AMR) is one of the most serious threats to animal and human healthcare and the global economy, causing approximately 700,000 deaths globally every year, and with an estimated total cost to United States healthcare as high as $55 billion per year.[38] Educating the public about AMR in both humans and animals is a priority both nationally and internationally, yet little is known about the knowledge and attitudes of the public towards AMR, particularly in livestock production. Dr. Brooks recent agricultural economics research study examined that question. The study comprised two research objectives:

(1) To examine public knowledge, attitudes, and acceptance of antimicrobials in livestock production, as well as their understanding of and attitudes towards AMR
(2) To assess subjective and objective knowledge of AMR and use of antimicrobials in livestock and the relationship to information avoidance behavior

The study survey was conducted in May and June 2018, administered by the research firm IRi. A representative random sample of 1030 United States residents participated in the survey, which was divided into two sections to address the two study objectives. In the first sections, survey participants were asked to rank acceptance of antibiotic use in livestock to treat, control, and prevent infections, or to promote growth. A majority of survey participants found use of antibiotics to treat or control infection acceptable, but were less accepting of use for prevention, and the majority found use for growth promotion completely unacceptable.[39] (Figure 14)

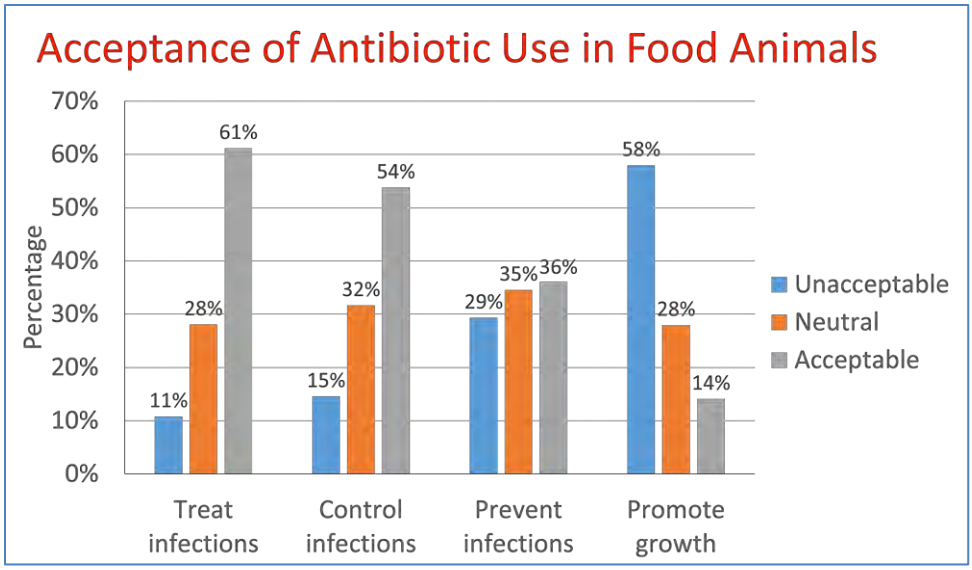


Figure 14. Consumer acceptance of antibiotic use in food animals.[40]

Product attributes and production practices influence consumer preferences and choices, but what is driving those preferences? Subjective and objective knowledge of AMR, along with demographics, attitudes towards AMR and animal welfare, personal use history are the independent variables that inform those acceptance attitudes. Subjective knowledge was assessed on a scale of no knowledge to a great deal of knowledge, regarding antibiotic use in livestock; antibiotic resistance in humans, animals, and bacteria; drug resistance; and superbugs. On average, two thirds of survey participants self-identified with little to no knowledge of AMR and antibiotic use in livestock production.[41] (Figure 15)

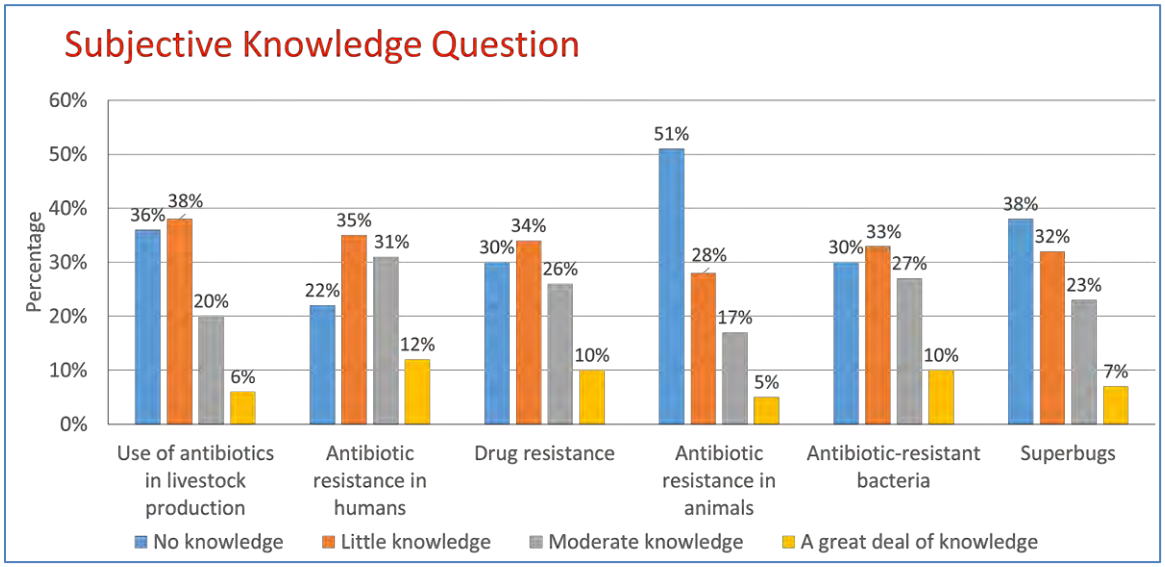


Figure 15. Subjective knowledge of antibiotic use among survey participants.[42]

Objective knowledge was measured using a percentage index based on correct answers to ten true/false questions about antibiotics use in livestock production and AMR. (For list of questions, see Appendix 2.) On average, survey participants scored 40% correct overall. The best scores were for the questions:

(1) Antibiotics are common drugs useful in treating infections in humans (75%)
(2) Overuse and misuse of antibiotics accelerates resistance (70%)

While the worst score was for the question:

(3) Antibiotic resistance existed before human development of antibiotics (19%)

Survey participants demonstrated a positive relationship between subjective, self-assessed knowledge and objective, measured knowledge: those that felt they had more knowledge tended to actually have more knowledge. Thus survey participants were largely truthful in their subjective assessments.

Additionally, participants were also asked to assess their level of concern, from not at all concerned to extremely concerned, regarding questions about the use of antibiotics in food animals. Most survey participants ranked most questions in the range of moderately concerned.[43] (Figure 16)

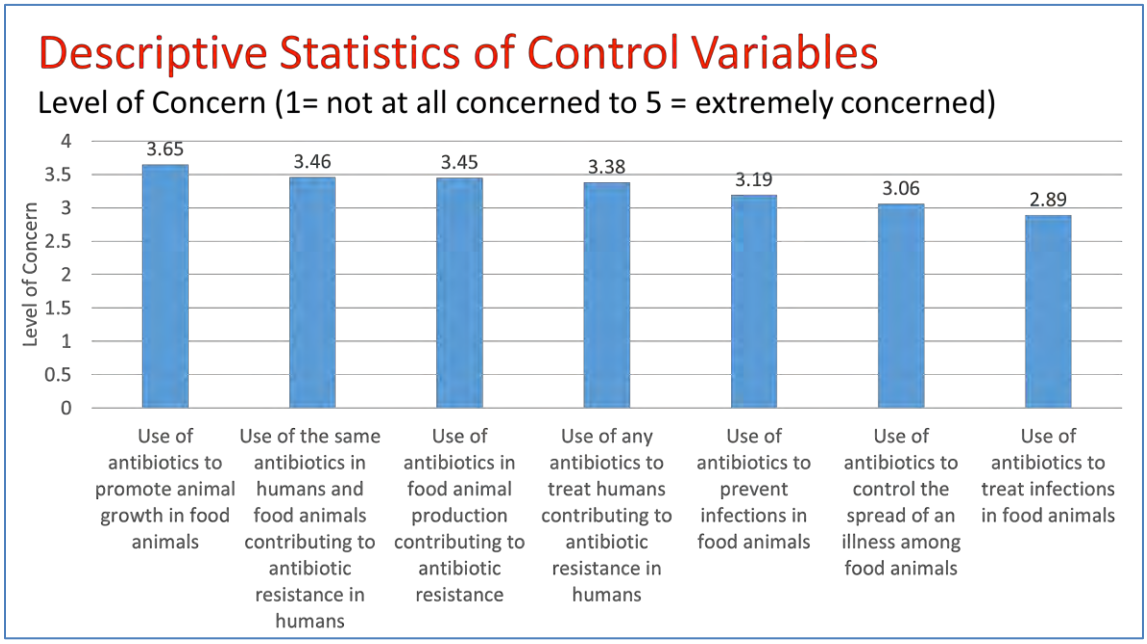


Figure 16. Survey findings related to level of concern for antibiotic use in food animals.[44]

In a second section of the survey, researchers sought to determine the role of knowledge on information avoidance behavior. Survey participants were given a choice of video to watch: antimicrobial resistance and the role of food and agriculture[45], or nature white noise. 40% of survey participants chose the white noise video. The top three reasons given for not watching the AMR video were: watching video won't change my existing view; there is nothing I can do about it; and I am were scared of knowing more about AMR. (Figure 17)

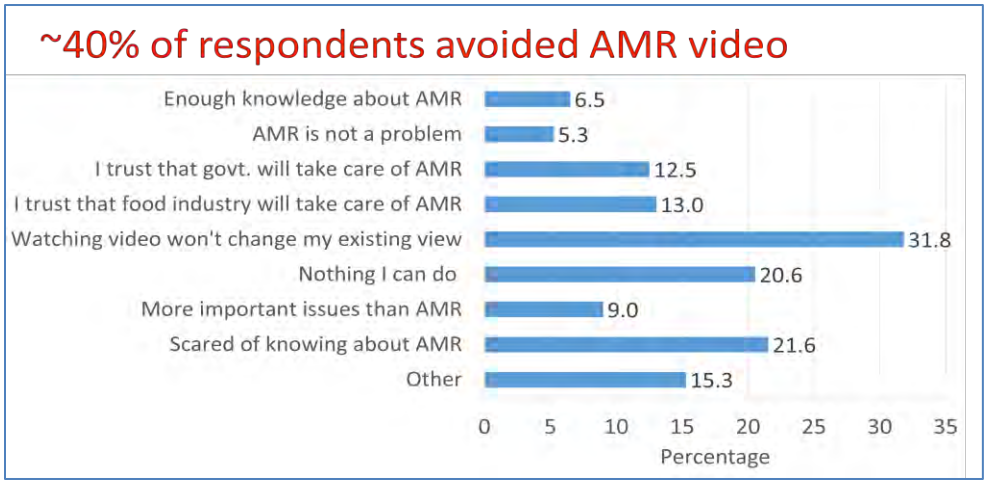


Figure 17. Reasons given for choosing to watch a white noise video instead of a video about AMR.[46]

There is a growing body of literature discussing behavior in which people avoid information even with it is free and could enhance their ability to make decisions.[47] Previous literature on information avoidance shows that responses to potentially uncomfortable information, like information on AMR, is highly variable. This study showed that survey participants with little or no subjective or objective knowledge about AMR were more likely to avoid the information in the AMR video, while those with more objective knowledge were more likely to watch the video.

All survey participants answered four subjective questions both before and after their chosen video, regardless of which video they chose. Of those that had chosen to watch the AMR video, there were significant changes in acceptance in all four categories (Figure 18). For all but one subjective category, the information provided in the video increased acceptance of the subjective statements.[48] Those self-assessed with little or no knowledge before the video increased in their acceptance the most. For everyone who watched the video, the 'perceived importance' of AMR increased significantly after watching the video.

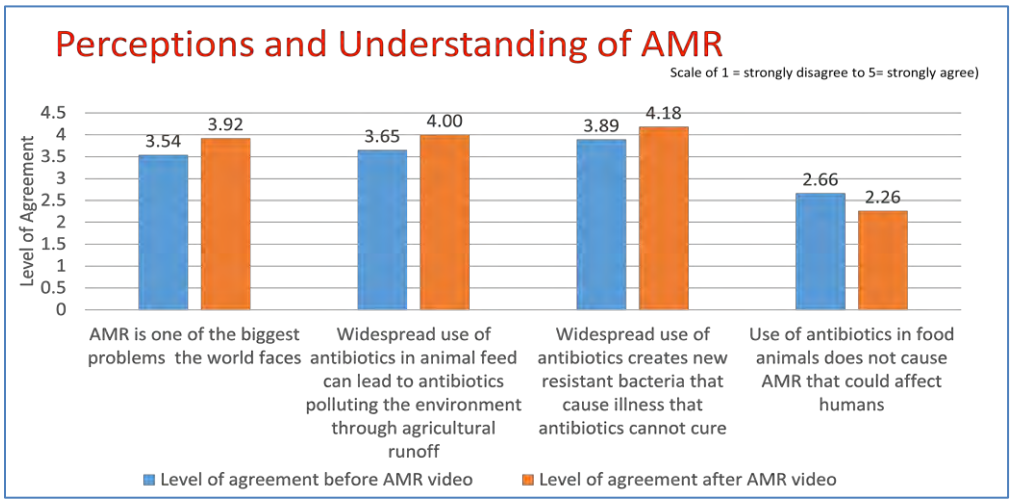


Figure 18. Changes in agreement with four subjective statements after watching a video about AMR.[49]

Upon reflection on the entire study four key results emerged. The greater the objective knowledge of antibiotic use and AMR, the more like the survey participant was to accept antibiotic use to treat and control, but the less likely to accept antibiotic use to prevent and promote growth. Those with high levels of concern about AMR in livestock production were less likely to accept antibiotic use, but those with high levels of concern for animal welfare were more likely to accept antibiotic use. However, those concerned for AMR were also were less likely to accept any use at all. Those with little or no knowledge of AMR were more likely to avoid AMR information compared to more knowledgeable respondents. However, of participants who chose to watch the AMR video, those with little or no knowledge changed their views the most.

This research generates a new set of questions about how to communicate accurate information to consumers regarding the use of antimicrobials and antimicrobial resistance in animal agriculture. One point this study particularly highlights is that the issue of what we communicate, and how we communicate it, is extremely complex.

Future research will focus on how to encourage willfully uninformed individuals to access information about AMR, and will consider the effect of the different forms of AMR communication and information sources, as well as consumer willingness to pay for animal products associated with AMR risk-reducing practices and labels. Additionally, future research will need to take into account the fact that consumer purchasing decisions are often based on economics, regardless of how the consumer says they'd like animals to be treated or antibiotics to be used.

Discussion

Do you have this written up in a research paper?

Yes. The Proceedings paper is published,[50] and the final journal submission is in publication.

Does including the cost of AMR have more impact with consumer in getting message across?

This question wasn't explored in this survey. However, survey results indicate that information does push consumers one way or another, so Dr. Brooks assumes that if they included economic numbers it would have the same general information effect.

Do these models and approaches you mention work during political campaigns?

Consumer behavior changes on a daily basis. When Dr. Brooks goes grocery shopping alone, she has time to read labels and compare prices. When she goes shopping with her three young children, she's lucky if she manages to get everything on her list. The best way to get good information is to do multiple surveys over time. The bottom line with political campaigns is yes, these models and approaches should work.

It's great to give folks information, but if you give them information they can't act upon, it seems like it may create more avoidance behavior?

This speculation is also a testable hypothesis. Consumer reaction changes, and communication changes, as new information enters the arena.

Is there any thought about redoing this study with a bent toward human medicine? What is the belief, opinion, and thought of consumers if we share similar information from the human side as it relates to antibiotic resistance?

Dr. Brooks would be happy to look at this information again from another angle, as funding allows. Originally, her research was going to look at the survey questions from both the consumer and the producer side, but due to funding constraints was only able to examine consumer responses.

We are going through a revolution right now with feed and water based antibiotics. It would be good to have research into consumer acceptance to learn how consumer acceptance is affected by learning that antibiotics are given only under the oversight of the veterinarian.

Dr. Brooks agrees that this is a good question, but notes that research such as this must be careful with lengths of survey. Like any trial, researchers can only look at one thing at a time.

There are papers that have been written on how consumers view human patients and prescribers. Along the lines of the last comment - what about positive (veterinarians and producers are working together to address AMR) versus negative (AMR in livestock production is a problem) delivery?

Dr. Brooks is unaware of any studies addressing positive versus negative messaging related to AMR. However, there is research that says consumers tend to retain negative messaging better than positive messaging.

Comment from Dr. Paul Plummer: What Dr. Brooks presented really brings us to an understanding of what we've heard throughout this conference.

One of the things that struck him about the video was that the 'bugs' looked nothing like the bacteria they were supposed to represent. They looked like bugs or spiders (Figure 19), and that's a subtle peripheral cue, as people tend to react negatively to bugs.

Figure 19. Screenshot of microbe graphic from the video *Antimicrobials and Resistance: The Role of Food in Agriculture*[51]

The whole issue of communication, how we communicate, and what we communicate, is extremely complex, in addition to the subject of AMR itself being very complex. We have a lot to build on coming out of this meeting.

2020 Vision: Getting Our Message Across and Making a Difference

Paul J. Plummer, DVM, PhD, Executive Director, *National Institute of Antimicrobial Resistance Research and Education (NIAMRRE)*

As we reflect on the last three days, there is a lot we can learn and think about. Although the video Dr. Brooks shared generated some controversy, we can agree that it contained good communication efforts that put AMR information into a format people can understand, like the depiction of the bacteria and the video game. The challenge discussed throughout this conference is the complexity of AMR communication. Each item that is developed for communication is dependent on a different goal. For example, CDC's goal is to influence change toward public health. Animal agriculture must work with CDC to get our message out to the public, but we must also realize that we can't change their message. Every video produced has a goal and a communication audience, but if we don't share the audience, we are going to disagree about how it's done.

One significant challenge as we communicate in the One Health spectrum is that each of us on that spectrum have different values and different perspectives we bring to the table. In some cases we're trying to push toward action, in others promote knowledge, and in others is to push people away from doing things. How do we really understand those underlying values and address that in our communication - and how do we address those that don't share our values?

This conference has started the discussion, and we need to make sure it is not also the end of the discussion. Dr. Dawn Sievert commented that every year that she attends this symposium she learns more and gathers more tools to help move forward, communicate, and collaborate. It's still about information-

sharing, and she is leaving with more new tools. After this symposium she has more ideas about how to update CDC infographics and videos to make them more One Health connected across the spectrum, as well as better ideas to help expand knowledge with links that provide important additional information.

Listen to the people you're talking to better. Acknowledge that they have an opinion. Ask why they feel that way. This approach leads to a conversation, instead of a lecture. If nothing else, perhaps we can leave here with the understanding that we need to be better listeners, instead of just jumping to talking. Hopefully everyone learned something they can take home from this conference.

Wrap Up

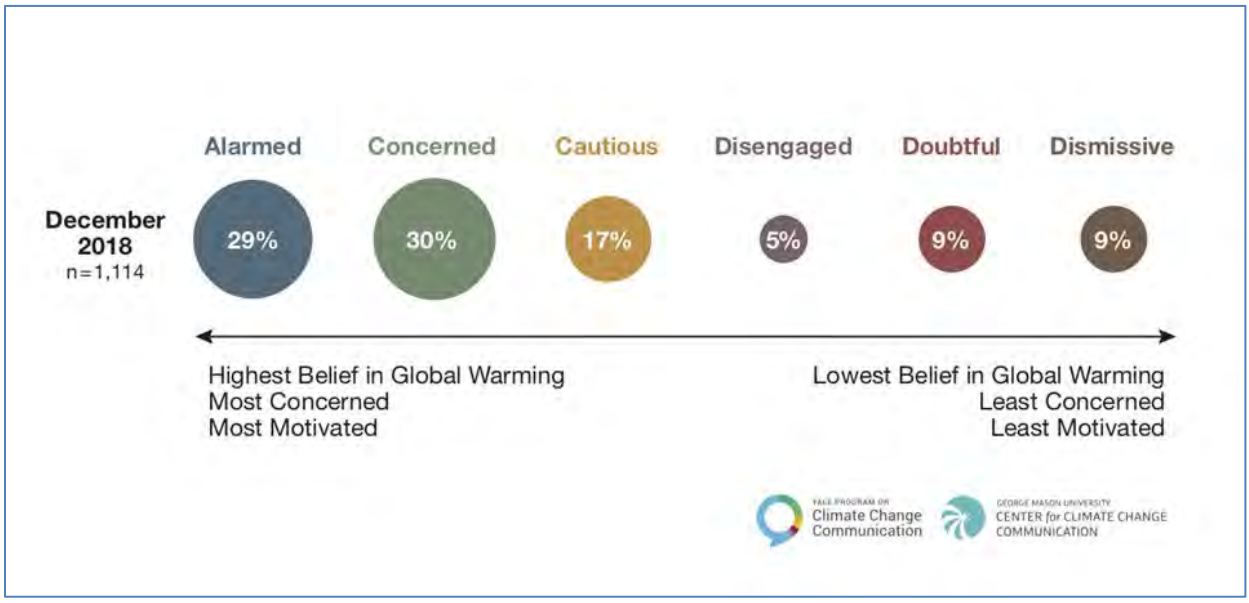
Paul J. Plummer, DVM, PhD, Executive Director, *National Institute of Antimicrobial Resistance Research and Education (NIAMRRE)*
Eric Moore, DVM, Director of Technical Services, North America, *Norbrook Inc.*

The world belongs to those that show up. How do we take what we've learned here outside these walls and share it with our partners, clients, and the public?

Human nature says we have to tie a link to everything. If you leave with just one closing thought, have it be this: think in terms of pathways instead of links. Pathways go both directions. Communication is your tool to use on that pathway.

Appendices

Appendix 1: Six Americas[52,53]



Six Americas - alarmed, concerned, cautious, disengaged, doubtful, and dismissive – and the percentage of each when addressing climate change.[54] The six Americas can be applied to, and measured, for many controversial topics, such as antibiotic use in animals.

Appendix 2. Research Survey Questions Regarding Objective Knowledge of Antibiotic Use and AMR[55]

Table 2. Objective knowledge of AMR and antibiotic use in livestock production

Objective Knowledge	Correct Answer	% of participants answering correctly
Antibiotic use in livestock production:		
Antibiotics are common drugs useful in treating bacterial infections in humans	True	75%
Antibiotics are common drugs useful in treating viral infections in humans.	False	41%
Antibiotics are common drugs useful in treating any kind of pain or inflammation.	False	53%
Antibiotics are common drugs useful in treating bacterial infections in food animals.	True	49%
Antibiotics are common drugs useful in treating viral infections in food animals.	False	31%
AMR:		
Antibiotic resistance occurs when bacteria become resistant to antibiotics and antibiotics no longer work as well.	True	69%
Overuse and misuse of antibiotics accelerate antibiotic resistance.	True	70%
The overuse and misuse of antibiotics in animals do not cause antibiotic resistance in humans because the antibiotics that are used to treat animals are different than those used to treat humans.	False	29%
Antibiotic resistance existed before human development of antibiotics.	True	19%
Antibiotic resistance has been found in every environment studied, including many not impacted by food animal or human antibiotic use.	True	31%

Footnotes

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