

**Meeting Summary**

**Second Public Meeting of the  
Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria  
(PACCARB)  
March 30–31, 2016**

**Department of Health and Human Services  
Great Hall, Hubert H. Humphrey Building  
200 Independence Avenue, SW  
Washington, DC 20201**

## Table of Contents

<b>Welcome and Overview</b> .....	<b>1</b>
<b>Martin J. Blaser, M.D., Chair, and Lonnie J. King, D.V.M., M.S., M.P.A., ACVPM, Vice Chair</b> .....	<b>1</b>
<b>Roll Call and Rules of Engagement</b> .....	<b>1</b>
<b>Bruce G. Gellin, M.D., M.P.H., Deputy Assistant Secretary for Health, Office of the Assistant Secretary for Health, Department of Health and Human Services (HHS)</b> .....	<b>1</b>
<b>Opening Remarks</b> .....	<b>1</b>
<b>Karen B. DeSalvo, M.D., Acting Assistant Secretary for Health, HHS</b> .....	<b>1</b>
<b>Presentation</b> .....	<b>2</b>
<b>U.S. Government Budgets Dedicated to Combating Antibiotic-Resistant Bacteria Activities</b> .....	<b>2</b>
Miriam Cabezas, Office of the Assistant Secretary for Financial Resources, HHS.....	2
<b>Council Member Questions and Answers (Q&amp;A)</b> .....	<b>2</b>
<b>Presentation</b> .....	<b>3</b>
<b>National Action Plan for Combating Multidrug-Resistant Tuberculosis (MDR-TB)</b> .....	<b>3</b>
Cheri Vincent and Amy Bloom, USAID .....	3
<b>Council Member Q&amp;A</b> .....	<b>3</b>
<b>PACCARB Working Group Reports</b> .....	<b>5</b>
<b>Introduction</b>	
Martin J. Blaser, M.D., Chair, and Lonnie J. King, D.V.M., M.S., M.P.A., ACVPM, Vice Chair.....	5
<b>Working Group #1, Antibiotic Stewardship</b> .....	<b>5</b>
Sara E. Cosgrove, M.D., M.S., Chair, and Michael D. Apley, D.V.M., Ph.D., DACVCP, Vice Chair.....	5
<b>Discussion</b> .....	<b>5</b>
<b>Working Group #2, One Health Surveillance</b> .....	<b>6</b>
Elizabeth Jungman, J.D., M.P.H., Chair, and Peter Robert Davies, B.V.Sc., Ph.D., Vice Chair.....	6
<b>Discussion</b> .....	<b>6</b>
<b>Working Group #3, Diagnostic Innovations</b> .....	<b>7</b>
Angela Caliendo, M.D., Ph.D., FIDSA, Chair, and John H. Rex, M.D., Vice Chair.....	7
<b>Discussion</b> .....	<b>7</b>
<b>Working Group #4, Treatment, Prevention, and Control R&amp;D</b> .....	<b>7</b>
Helen W. Boucher, M.D., FIDSA, FACP, Chair, and Kent E. Kester, M.D., FACP, FIDSA, FASTMH, Vice Chair .....	7
<b>Discussion</b> .....	<b>8</b>
<b>Working Group #5, International Collaboration on Combating Antibiotic-Resistant Bacteria</b> .....	<b>8</b>
Ramanan Laxminarayan, Ph.D., M.P.H., Chair, and Thomas R. Shryock, Ph.D., Vice Chair.....	8
<b>Discussion</b> .....	<b>9</b>
<b>Summary of Recommendations</b> .....	<b>9</b>
Martin J. Blaser, M.D., Chair.....	9
<b>Public Comment</b> .....	<b>10</b>
<b>Council Discussion</b> .....	<b>13</b>
<b>Closing Remarks</b> .....	<b>15</b>
<b>Martin J. Blaser, M.D., Chair, and Lonnie J. King, D.V.M., M.S., M.P.A., ACVPM, Vice Chair</b> .....	<b>15</b>
<b>Welcome and Overview</b> .....	<b>16</b>
<b>Martin J. Blaser, M.D., Chair, and Lonnie J. King, D.V.M., M.S., M.P.A., ACVPM, Vice Chair</b> .....	<b>16</b>
<b>Vote: Draft Report 1: Initial Assessments of the NAP CARB</b> .....	<b>16</b>
<b>Council Comments</b> .....	<b>16</b>

<b>Presentations .....</b>	<b>17</b>
<b>One Health and Antibiotic Resistance .....</b>	<b>17</b>
Introduction .....	17
Animal Agriculture and One Health .....	18
Michael D. Apley, D.V.M., Ph.D., DACVCP, Kansas State University College of Veterinary Medicine .....	18
Peter Robert Davies, B.V.Sc., Ph.D., University of Minnesota .....	18
Randall Singer, D.V.M., M.P.V.M., Ph.D., University of Minnesota .....	19
Council Member Q&A .....	19
Public Health and One Health .....	19
James M. Hughes, M.D., Emory University School of Medicine .....	19
Environmental Health and One Health .....	20
Randall Singer, D.V.M., M.P.V.M., Ph.D., University of Minnesota .....	20
Global Health and One Health .....	20
John Clifford, D.V.M., Chief Trade Advisor, APHIS, USDA (by phone) .....	20
USG and One Health .....	21
Bernadette Dunham, D.V.M., Ph.D., Director, Center for Veterinary Medicine, FDA .....	21
Beth P. Bell, M.D., M.P.H., Director, National Center for Emerging and Zoonotic Infectious Diseases, CDC .....	21
Jane Rooney, D.V.M., Director, One Health Coordination Office, APHIS, USDA (by phone) .....	22
Council Member Q&A .....	22
Summary .....	24
Lonnie J. King, D.V.M., M.S., M.P.A., ACVPM, Vice Chair .....	24
<b>Public Comment .....</b>	<b>24</b>
<b>Closing Remarks and Adjournment .....</b>	<b>26</b>
<b>Martin J. Blaser, M.D., Chair .....</b>	<b>26</b>
<b>Appendix A: Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria (PACCARB) Members .....</b>	<b>27</b>
<b>Glossary of Abbreviations .....</b>	<b>29</b>

## Meeting Proceedings — Day 1

### Welcome and Overview

**Martin J. Blaser, M.D., Chair, and Lonnie J. King, D.V.M., M.S., M.P.A., ACVPM, Vice Chair**

Dr. Blaser welcomed the participants to the second meeting of the Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria (PACCARB). He described some personnel changes among the liaison and ex officio members of the Council.

### Roll Call and Rules of Engagement

**Bruce G. Gellin, M.D., M.P.H., Deputy Assistant Secretary for Health (Vaccines and Immunizations), Office of the Assistant Secretary for Health, Department of Health and Human Services (HHS)**

Dr. Gellin reviewed the PACCARB charter and the rules that govern federal advisory committees. He then called the roll (see Appendix A).

### Opening Remarks

**Karen B. DeSalvo, M.D., Acting Assistant Secretary for Health, HHS**

Dr. DeSalvo stated that combating antibiotic-resistant bacteria is a top priority for this Administration. She praised PACCARB for their intensive efforts of the past six months in reviewing and making recommendations on the National Action Plan (NAP) to Combat Antibiotic-Resistant Bacteria (CARB), saying PACCARB may already be among the most productive federal advisory committees ever.

Recognizing that antimicrobial resistance (AMR) involves multiple departments and administrations, federal agencies are collaborating to address it. For example, the Centers for Disease Control and Prevention (CDC) released guidance on antibiotic stewardship programs in nursing homes, and the Centers for Medicare and Medicaid Services (CMS) has proposed new long-term care and infection control requirements. The Department of Defense (DoD) established a new multidisciplinary group under the Assistant Secretary of Defense for Health Affairs. The Department of Agriculture (USDA) and the Food and Drug Administration (FDA) have initiated educational outreach on antibiotics and animals as well as created a new task force on education and research.

Dr. DeSalvo relayed two questions from the Secretary for PACCARB to consider:

1. How can we incentivize the development of therapeutics, rapid diagnostics, and vaccines while maximizing the return on investment for the public?
2. How should government prioritize investments for maximum impact in reducing antibiotic resistance in the context of the One Health approach?

The current administration is seeking suggestions on how it can carry forward the work that PACCARB and others are doing into the next administration, so recommendations on prioritizing efforts within HHS and across agencies will have a lasting effect, Dr. DeSalvo noted. She emphasized that PACCARB's work has an impact, and the Administration appreciates its clear, discrete recommendations.

## **Presentation**

### **U.S. Government Budgets Dedicated to Combating Antibiotic-Resistant Bacteria Activities**

*Miriam Cabezas, Office of the Assistant Secretary for Financial Resources, HHS*

In fiscal year (FY) 2015, HHS, USDA, the Department of Veterans Affairs (VA), and DoD invested \$604 million in support of longstanding activities and collaborative programs. The FY 2016 budget called for a historic investment in combating antibiotic-resistant bacteria of over \$1.2 billion; the FY 2016 appropriations provided \$1 billion. Ms. Cabezas described some activities made possible by the funding, such as innovative research at the National Institutes of Health (NIH) on treating skin infections, a USDA-CDC collaboration to collect data on a judicious-use strategy, investments by the Biomedical Advanced Research and Development Authority (BARDA) to support public-private partnerships for new advanced development, and the biopharmaceutical accelerator program cosponsored by BARDA and NIH's National Institute of Allergy and Infectious Diseases (NIAID).

The FY 2017 budget requests \$1.1 billion. Ms. Cabezas outlined proposed budget increases. For example, USDA would receive an additional \$35 million to increase monitoring and address AMR pathogens in humans and livestock. Also, CDC would receive \$40 million more to expand prevention, surveillance, and stewardship efforts and increase capacity of state health laboratories, among other efforts. The Agency for Healthcare Research and Quality (AHRQ) would receive \$2 million more to expand antibiotic stewardship programs. If approved, HHS would receive \$1 million for a new effort in its Office of Global Affairs to promote international collaboration and communication.

Ms. Cabezas believed that the Administration succeeded in getting most of the requested FY 2016 budget in part because of its strong justification of the need. The FY 2016 request clearly explained why resources could not be diverted from other important programs and how the federal government, through comprehensive and coordinated efforts, could have a significant impact on public health.

### **Council Member Questions and Answers (Q&A)**

Council members requested additional budget details, including the following, and Ms. Cabezas agreed to work with the PACCARB staff to gather the information for the Council's review:

- Specific projects for which funding was requested but denied in FY 2016 (and whether they are proposed again in the FY 2017 request);
- Status of the funding request for the USDA Center for Veterinarian Medicine's collection of data on antimicrobial use in animals in the FY 2016 and FY 2017 proposals;
- Funding for international activities to combat antibiotic-resistant bacteria by the U.S. Agency for International Development (USAID) or other agencies and as part of other funded programs of HHS, DoD, VA, and USDA; and
- Funding activities to combat antibiotic-resistant bacteria under the Environmental Protection Agency (EPA).

Alicia Cole said the budget heavily favors antibiotic stewardship and research and development (R&D); she asked about funding for patient safety, prevention, and education (including professional development). Ms. Cabezas responded that AHRQ and CDC support such efforts. Beth P. Bell, M.D., M.P.H., added that prevention and patient safety around antibiotics are integral to CDC's programs.

Elizabeth Jungman, J.D., M.P.H., pointed out that surveillance systems take time to build and failure to fund such systems results in delays in getting needed information. John H. Rex, M.D., asked how

NIH's new clinical trials network for rapid testing of new drugs for multidrug-resistant organisms (MDROs) intersects with BARDA's support for new drug development. Dennis M. Dixon, Ph.D., explained that BARDA will address the potential costs and logistics associated with registration-type trials, while NIH will leverage its existing infrastructure to test new drugs. Ms. Cabezas said that demonstrating interagency collaboration helps build support and garner funding, but collaboration is not the only factor that dictates funding.

Thomas R. Shryock, Ph.D., asked how the federal government might take a One Health approach to combating antibiotic-resistant bacteria given budgetary constraints and the many areas involved. Ms. Cabezas agreed to provide more information to PACCARB from budget proposal planning that better describes, for example, what agencies are doing, what projects are evolving or delayed, and what changes are expected. With multiyear strategies in particular, agencies try to estimate how long implementation might take.

Several members raised the topic of environmental health, and Ms. Cole suggested PACCARB add an EPA representative. Dr. Gellin pointed out that representatives from EPA and other agencies sit on the interagency task force for combating antibiotic-resistant bacteria, and that group can weigh in as needed. Ramanan Laxminarayan, Ph.D., M.P.H., hoped the Council could review information from the Office of Management and Budget or some other entity that tracks the cost-effectiveness of spending in this area.

#### **Action Item**

Staff will work with Ms. Cabezas to gather more detailed budget information to inform PACCARB's deliberations on how the U.S. Government (USG) should prioritize its investments around combating antibiotic-resistant bacteria for maximum impact.

### **Presentation**

#### **National Action Plan for Combating Multidrug-Resistant Tuberculosis (MDR-TB)**

*Cheri Vincent and Amy Bloom, USAID*

Ms. Bloom explained that many of the players involved in the NAP for CARB are also involved in the National Action Plan for Combating MDR-TB. Its main goals are to 1) strengthen domestic capacity (led by CDC), 2) improve international capacity and collaboration (led by USAID), and 3) accelerate basic and applied R&D (led by NIH). The plan focuses on areas for improvement in the next three to five years—specifically prevention, diagnosis, and treatment, as well as enhancing capacity for research in countries where tuberculosis (TB) is endemic.

Ms. Bloom described how the plan will build on international efforts by the World Health Organization (WHO), the U.S. President's Emergency Plan for AIDS Relief (PEPFAR), and the Global Health Security Agenda. Specific targets are set for 2016, 2018, and 2020; they include decreasing the incidence of MDR-TB in the United States by 15 percent and achieving a 90-percent treatment success rate in countries facing a high burden of MDR-TB. The plan relies on partnerships across public and private sectors to ensure continued support. The first progress report will be completed in September 2016, and the first annual report will be presented in March 2017.

#### **Council Member Q&A**

Ms. Bloom pointed out that prevention of TB infection is embedded in current efforts around the world. The bacille Calmette-Guerin (BCG) vaccine is not effective in children over three or in adults, so there is ongoing work to develop a new vaccine. With no vaccine candidates, infection control is key. In the

developing world, infection control focuses on those at highest risk of infection. Dr. Blaser added that treatment of the disease is inherently a form of prevention, because humans are the reservoir for TB.

Ms. Vincent described several successes, saying that in 2007, no high-quality, second-line drug was available to treat the disease. Now, at least two manufacturers are making them, and prices are coming down. Ms. Vincent said USAID has several large projects addressing supply chain concerns for HIV, malaria, and other diseases. For TB, the goal is getting the drugs down to the provider level and encouraging private-sector providers to follow standard treatment practices. In addition, USAID has worked on regulations to prevent over-the-counter sales of antimicrobial drugs.

Dr. Blaser asked how to reduce the likelihood of resistance emerging when patients run out of money for private health care. Ms. Bloom responded that USAID works independently with different providers on this matter. In some areas, for example, pharmacies are the first contact for sick people. The agency also works with communities so that individuals know what to expect and what they should demand as appropriate care. Ms. Vincent added that financial incentives help. The success of such programs varies across countries and is dependent on the status of the health care system.

Ms. Bloom said USAID has worked with regulatory bodies in other countries to prevent over-the-counter sales of isoniazid (INH) and other antibiotics. Dr. Blaser pointed out that pharmacies have strong financial incentives to sell such drugs and that over-the-counter sales are a problem domestically as well. Ms. Vincent said some efforts also address counterfeit drugs, but the problem is not as widespread for TB as it is for malaria. Ms. Bloom added that the Global Drug Facility of the Stop TB Partnership provides drugs at low prices that have been subject to quality assurance procedures.

Ms. Vincent said the overlap among agencies dealing with MDR-TB and combating antibiotic-resistant bacteria allows for exchange of information across the two areas, but formal communications channels has yet to be established.

Ms. Vincent said USAID established the goals of the NAP for Combating MDR-TB on the basis of TB surveillance. It has good measurement programs in place and has supported WHO on surveillance for the past 20 years. For drug-resistant TB and MDR-TB, USAID more often relies on models and estimates as countries dramatically improve their diagnostic and treatment capacity.

Ms. Bloom explained that treatment failures are caused by many factors, including the spread of new cases, the number of patients lost to follow-up, and the side effects of the treatment. The limited options for treatment and length of the drug regimen are among the biggest problems; however, new drugs and new regimens are promising. Ms. Bloom said China has achieved high success rates by providing lots of treatment support. Ms. Vincent said the plan aims to shorten drug regimens and scale up demonstration projects.

**Action Item**

Staff will invite USAID representatives to give a progress report to the PACCARB in a year on the NAP for Combating MDR-TB.

# PACCARB Working Group Reports

## Introduction

**Martin J. Blaser, M.D., Chair, and Lonnie J. King, D.V.M., M.S., M.P.A., ACVPM, Vice Chair**

Dr. Blaser explained that PACCARB established five working groups, each aligned with one of the goals of the NAP for CARB, that have been working intensively on initial assessments of the USG's progress toward the goals of the NAP. This process was informed by review of the First 180-Days Report (Progress Report) on the NAP and in-depth discussions with subject matter experts from federal departments and agencies, including experts in the field. Each PACCARB member served on two working groups. Dr. Blaser commended the members for their efforts and commitment.

The findings and recommendations of the working groups are described in detail in the PACCARB draft report, *Initial Assessments of the National Action Plan for Combating Antibiotic-Resistant Bacteria*, which will be finalized pending PACCARB deliberation and approval at this public meeting. The Chairs of each working group were asked to give brief summaries of their findings and recommendations.

## Working Group #1, Antibiotic Stewardship

**Sara E. Cosgrove, M.D., M.S., Chair, and Michael D. Apley, D.V.M., Ph.D., DACVCP, Vice Chair**

The goal of antibiotic stewardship is to ensure optimal use of antibiotics and only when needed, Dr. Cosgrove stated. To achieve this goal, the group recommended sustained, enhanced funding for antibiotic stewardship and surveillance. Significant changes among prescribers are needed to move the needle, said Dr. Cosgrove, and that cannot happen in isolation. Multiyear funding is critical to ensure the needed research and implementation of the milestones occurs. More coordination is needed across all federal agencies. For example, departmental and interdepartmental leads for human and veterinary medicine should be established and should coordinate to avoid duplication of effort. From a One Health perspective, consistent education with similar messages about antibiotic stewardship for trainees and practitioners in human and veterinary medicine is vital.

Among many notable activities underway, CDC is enhancing its ability to collect information about antibiotic use. Much work is needed to put the reporting infrastructure in place and to encourage hospitals to report. Various areas of need were identified, such as the following:

- Adequate training of physicians and pharmacists on antibiotic stewardship;
- Increased attention to outpatient use of antibiotics and more robust methods for assessing such use;
- Sustained funding and coordination of surveillance to gather consistent data; and
- Expanded outreach and education about antibiotic use in food animals and companion animals.

## Discussion

Aileen M. Marty, M.D., FACP, pointed out that surveillance is key to action. She suggested surveying patients to learn whether they understand why they are getting antibiotics and how to use them.

Much discussion centered around the need for more professional education. Dr. Cosgrove said antibiotic stewardship is part of training for infectious disease (ID) specialists but is not the general medical curriculum of human or veterinary medicine. Dr. Apley agreed that antibiotic stewardship should be part of all medical education, beginning with physiology. Ideally, the message would be

standardized across curricula and have broad support. Ms. Cole noted that California will survey teaching programs to assess education about antibiotic stewardship and appropriate prescribing. California plans to require that all continuing medical education in the state incorporate curricula on antibiotic stewardship and resistance.

Helen W. Boucher, M.D., FIDSA, FACP, pointed out that the ID workforce is dwindling, probably because of low pay in the field. Dr. Cosgrove agreed that more ID specialist physicians and pharmacists are needed to help address antibiotic stewardship.

Dr. Bell said CDC is addressing outpatient antibiotic use on several fronts. For example, interventions around the appropriate use of antibiotics for bronchitis are making progress. For some conditions, effective approaches are known, so collaborations across partners can succeed. In other cases, more granular information is needed to better understand what drives prescribing practices, said Dr. Bell.

### **Working Group #2, One Health Surveillance**

*Elizabeth Jungman, J.D., M.P.H., Chair, and Peter Robert Davies, B.V.Sc., Ph.D., Vice Chair*

Ms. Jungman said the recommendations in this section speak to the significant asymmetry between human and animal surveillance methods. While progress is being made in human surveillance, animal surveillance is hampered by asymmetric funding, among other challenges. Inadequate funding for surveillance poses a challenge across all agencies for all the objectives outlined in the NAP but is especially problematic for animal surveillance. Pursuing a One Health approach will require significant support, said Ms. Jungman, but the barriers to One Health should not stifle action. Environmental surveillance strategies are particularly important and are a good place to start with the One Health approach. USG agencies also need to enhance partnerships with state and local health agencies and with other stakeholders.

Ms. Jungman outlined several efforts underway in human surveillance, including the DoD's expansion of its Multidrug-Resistant Organism Repository and Surveillance Network (MRSN) repository and the CDC-FDA collaboration to create a database of reference strains. On the animal side, discussions are in progress on what to test and what capacity to identify infection exists in the field. More efforts are needed to define the targets of animal surveillance and how to integrate and build on current approaches.

### **Discussion**

Dr. Davies explained that other countries have models for collecting antibiotic use data on farms that may be informative, but the first step is clearly defining the purpose (e.g., to gather representative data to monitor trends in antimicrobial usage in food animals over time). Notably, the USDA is working with industry groups to assess the availability of existing data and how those data contribute to meaningful estimates of current and ongoing trends; much of those discussions center around transparency of the process and confidentiality of the data.

Dr. King raised concerns about the capacity of agencies to handle meta-data. Dr. Davies added that with new technology comes a need to address the scope of sampling and the utility of the data gathered. Dr. Blaser pointed out that the enactment of the Veterinary Feed Directive (VFD) will result in significant changes and presents an opportunity to ramp up surveillance.

Dr. Bell clarified that the CDC-FDA repository brings together 80,000 specimens for which CDC has a lot of epidemiologic information from population-based studies. It was created in response to

longstanding requests from industry for curated panels to help with diagnostics and drug development. Paige Waterman, M.D., FACP, FIDSA, said DoD's repository seeks to collect clinical information on resistant isolates from within its health system to improve stewardship.

### **Working Group #3, Diagnostic Innovations**

*Angela Caliendo, M.D., Ph.D., FIDSA, Chair, and John H. Rex, M.D., Vice Chair*

Dr. Caliendo stressed the importance of developing economic incentives for diagnostics use. New payment models are needed to encourage use of diagnostics to guide therapy instead of empirical treatment with antibiotics. More collaboration is needed between clinical microbiology programs and antibiotic stewardship initiatives. The costs of clinical studies and the complexity of the current regulatory process are barriers to development of diagnostics. Interpreting the results of diagnostics to guide decision-making will have to be incorporated into education and training—and linked to antibiotic stewardship. In the realm of animal health, veterinarians need diagnostics to distinguish viral from bacterial infections; as with human health, incentives are needed to drive development and use of diagnostics in animals, and more research is needed to assess whether human diagnostics can be used in animals.

NIH has supported several important projects to develop and validate diagnostic tests. BARDA and NIH partnered to offer a prize around diagnostic innovation. FDA and CMS have developed a parallel review process to look at new devices and national coverage determinations.

### **Discussion**

Dr. Caliendo said there was discussion about harmonizing clinical breakpoints around antimicrobial susceptibility testing (AST) to smooth the way for diagnostic development, and relevant legislation is pending in Congress. She noted that the lack of alignment around breakpoints has held back progress on updating AST.

Dr. Blaser asked whether there should be repositories of specimens for companies to use for creating diagnostics. Dr. Caliendo said such repositories are difficult and very expensive to put together. Dr. Dixon said NIH created a repository but companies decided against using it. Currently, the NIAID's Antibacterial Resistance Leadership Group (ARLG) collects specimens as needed, so the approach is more targeted, streamlined, and economical.

### **Working Group #4, Treatment, Prevention, and Control R&D**

*Helen W. Boucher, M.D., FIDSA, FACP, Chair, and Kent E. Kester, M.D., FACP, FIDSA, FASTMH, Vice Chair*

Dr. Boucher offered a reminder that while the focus is often on antibiotics, vaccines, non-pharmaceutical treatment, and prevention (including hand hygiene) are also important approaches to addressing antibiotic resistance. However, to ensure a novel, robust, and sustainable pipeline of treatment options, more incentives are needed, from traditional approaches like tax credits and innovation prizes to new paths such as "delinkage." Regulatory barriers to R&D should also be addressed. Opportunities for collaboration across the USG, such as the BARDA-NIH accelerator project, should be supported along with more private-public partnerships. Globally, harmonization of rules and regulations regarding R&D is important to speed up the results. USG agencies can work together to advance R&D by looking for links in basic science research in humans and animals.

One glimmer of hope in regulation is the legislation pending in Congress to support a limited-population antibacterial drug (LPAD) approval pathway, said Dr. Boucher. The BARDA-NIH

incubator project and clinical trials networks are essential to R&D and demonstrate how public and private entities can work together.

## **Discussion**

Ms. Cole called for more focus on prevention, pointing out that effective preventive practices stopped the spread of Ebola virus before new drugs or diagnostics were available. Dr. Boucher agreed that science shows prevention works and behavioral changes make a difference. Dr. Bell said CDC and AHRQ would be happy to take up the issue of prevention.

### **Action Item**

PACCARB will consider devoting a portion of a future public meeting to discussion of prevention mechanisms.

Dr. Marty pointed out the challenges of vaccine uptake even when effective vaccines are available. Dr. Gellin noted that the National Vaccine Advisory Council (another federal advisory group that reports to the HHS Secretary) is considering the role of vaccines in combating antibiotic-resistant bacteria.

Dr. Laxminarayan wondered how to link incentives for product development with appropriate use. Dr. Boucher said that, clearly, the same incentives do not work for both efforts. Delinkage, a concept that is gaining traction, aims to incentivize development without reimbursing for high levels of use. Another approach is to value and charge for antibiotics according to their worth.

Dr. Caliendo and Dr. Boucher both supported the notion of encouraging companies to develop new antibiotics and diagnostics in tandem, but Dr. Boucher said the drug and device regulatory pathways are different and need to be addressed. Along the same lines, economic incentives and regulatory pathways for the development of narrow-spectrum antibiotics should be considered.

Dr. Apley emphasized the importance of maintaining the effectiveness of current first-line antibiotics by evaluating current dosages to assess whether shorter durations may be sufficient. Dr. Boucher and Dr. Dixon said the ARLG is well-positioned to address such questions. Dr. Blaser said looking more closely at drug regimens for every common infection could have a significant impact on resistance.

## **Working Group #5, International Collaboration on Combating Antibiotic-Resistant Bacteria**

*Ramanan Laxminarayan, Ph.D., M.P.H., Chair, and Thomas R. Shryock, Ph.D., Vice Chair*

Dr. Laxminarayan said many of their findings and recommendations overlap with those of other working groups. Broadly speaking, the working group recommended measuring the effectiveness of strategies in reaching the NAP goals by choosing a few indicators that target outcomes of interest; with limited resources, it is important to ensure that efforts are making an impact, and the resources invested by the USG should be commensurate with the priority of the goals. Some low- and middle-income countries with rapidly growing livestock and poultry populations are seeing huge increases in wealth and should be further engaged in international collaborations around antibiotic resistance. More efforts should be made to leverage the resources and expertise of nongovernmental assets and to expand engagement with other governments' pharmaceutical and diagnostic industries and academia around R&D.

From a One Health perspective, the environmental component of antibiotic resistance should weigh more heavily; terminology should be clarified and more effort is needed to identify common areas of interest among animal and human health. International partnering and information sharing should be

encouraged. Like the public health infrastructure for humans, the animal health infrastructure needs to increase capacity to improve health and reduce the use of antibiotics.

Several global surveillance platforms exist, with a lot of emphasis on AST. Expanding them to include more molecular typing and transmission tracing would better show how infections are spreading across the world and serve as an early warning system. The Transatlantic Task Force on Antimicrobial Resistance (TATFAR) has been the hub for international engagement and could expand to include other countries through the Global Health Security Agenda. A first step toward improving communication and dissemination of information is to harmonize definitions. As in the United States, efforts in animal health are lagging far behind human health internationally.

## **Discussion**

Dr. Laxminarayan said the most challenging gaps in knowledge revolve around emerging resistance, and there is both interest and opportunity to act quickly to address them. A few efforts are underway, but more ambitious, larger-scale approaches are needed. Dr. Bell said CDC is working closely with India and other countries on AMR. She offered to provide PACCARB more detailed information about the mechanisms, platforms, and locations where their global initiatives are ongoing. Dr. Bell said PACCARB is well positioned to address goal 5 objectives to enhance global communication and improve platforms for information sharing.

Ms. Cole asked whether international partnerships have addressed patient education as part of antibiotic stewardship. Dr. Laxminarayan responded that the problem of antibiotic resistance lacks visibility and momentum. Pressure from patient advocacy groups is needed to spur action.

Dr. Shryock noted that getting international data to track progress is challenging because the host country determines the level of partnership, which is often bilateral or regional. He said some agencies have laid the groundwork for broader surveillance, and he is optimistic they will generate useful data.

Dr. Laxminarayan said lessons learned from the European Union and TATFAR on addressing AMR should be shared with other growing countries that do not have access to best practices.

Richard Carnevale, V.M.D., asked whether harmonization efforts will look beyond One Health definitions to how data are collected and used. Dr. Shryock said practices are very different across countries, but he believes the discussion will eventually focus on harmonizing data.

## **Summary**

*Martin J. Blaser, M.D., Chair, and Lonnie J. King, D.V.M., M.S., M.P.A., ACVPM, Vice Chair*

Dr. Blaser summarized the six overarching themes that arose from the working groups that should be addressed to ensure the NAP has a strong impact on combating antibiotic-resistant bacteria, as described in the executive summary of the report:

- Fully embrace a One Health approach
- Identify a lead federal champion for combating antibiotic-resistant bacteria
- Better coordinate the federal response
- Ensure sufficient resource allocation
- Develop critical partnerships
- Create economic incentives for developing and deploying new diagnostic, preventive, and therapeutic tools

Dr. James Cleeman of AHRQ said the executive summary does not mention research to develop improved methods for combating antibiotic-resistance and promoting antibiotic stewardship, which is crucial for effective interventions. To avoid the impression that the PACCARB does not value that kind of research, Dr. Cleeman suggested adding a sentence indicating that agencies such as AHRQ, CDC, and NIH have increased their investments in this area. He also said that reallocating full-time employees to other agencies was identified as a potential solution for resource allocation in the PACCARB's report, however, reallocation was a political "hot potato" during clashes over the budget last fall, so he strongly suggested removing it from the recommendations. Dr. Cleeman noted that while Objective 1.1 (page 11) mentions research to prevent the spread of antibiotic-resistant bacteria, it does not address research on primary prevention of healthcare-associated infections (HAIs). He suggested adding to the report the need to promote such research.

## **Public Comment**

**Carole Moss of Nile's Project MRSA** said she has been deeply engaged in healthcare advocacy since losing her son to a hospital-acquired infection after he received care at a children's hospital in Orange County. She has been a voting member of California's Healthcare Associated Infection Advisory Committee for eight years. Ms. Moss said a key area to focus on is environmental cleaning. She noted that California passed two new laws for infection prevention.

Ms. Moss added that surveillance is key, and prevention tied to surveillance is what the Council should focus on first, because preventing infections will eliminate the need to use and make antibiotics that have very harmful side effects. Preventing infections is something we do really well, said Ms. Moss, pointing to the Ebola virus response. PACCARB's first meeting featured an incredible presentation from the VA that described its success rate in preventing methicillin-resistant *Staphylococcus aureus* (MRSA) and carbapenem-resistant Enterobacteriaceae (CRE). The VA would be an incredible place to start with surveillance efforts. California's Healthcare Associated Infection Advisory Committee begins each meeting with a patient's story to set the tone of what their work is all about.

**Kevin Kavanagh of Health Watch USA** said one of the major approaches institutions use to control MDROs is universal daily bathing with chlorhexidine, but there are concerns about the development of bacterial resistance. Researchers have recently reported that chlorhexidine bathing may affect the incidence of genetic resistance. The genes encode for reflex pumps which can cause resistance to multiple types of antibiotics. These pumps may be giving a selective advantage to CRE and may well become a driver of the antibiotic resistance epidemic. A number of institutions are using minimum inhibitory concentration (MIC) testing to detect antibiotic resistance, but there are concerns about the use of this test and its validity with antiseptics.

There are also concerns about chlorhexidine's effectiveness. Much of the research has integrity problems. However, some characteristics of chlorhexidine are cause for concern. One, chlorhexidine is not effective against bacterial spores such as those formed by *Clostridium difficile*. Chlorhexidine should not be used in the major location of MRSA colonization in the anterior nares and thus requires a second agent. Multiple studies have found chlorhexidine bathing is not effective in preventing catheter-associated urinary tract infections (CAUTIs). Finally, daily chlorhexidine bathing would not be expected to add much to prevention when a catheter is placed with an alcohol chlorhexidine preparation and then sealed under a plastic barrier.

Dr. Kavanagh encouraged the Council to reexamine the surveillance protocols as exemplified by the VA at the last PACCARB meeting, which reported a dramatic decrease in MRSA infections in high-

risk populations. He planned to submit a peer-reviewed paper on infectious disease research integrity for the PACCARB to review. Dr. Kavanagh called for PACCARB members to publically disclose all conflicts of interest.

**Lisa McGiffert of Consumer Reports' Safe Patient Project** said she was very disturbed to hear about the hedging of the timeline to include antibiotic stewardship programs in the CMS Conditions of Participation (COP). There should not be incentives, she said. Mandates are needed to track antibiotic use within the hospitals as a first step to solving the problem. Consumer Reports also supports tracking outbreaks in real time. Patients are not advised (nor are public health authorities) about outbreaks, and providing that information is a clear step in preventing the spread of antibiotic resistance.

Ms. McGiffert said more accountability is needed for prescribers. Medicare and pharmacy data that are currently available should be used to respond to the trends. She called for a serious approach. Instead of thinking about voluntary processes, there should be real accountability.

Regarding the incentives for new therapies, Ms. McGiffert spoke against methods that would bypass the current system that requires clinical testing for safety and effectiveness. Antibiotics are dangerous, powerful drugs. Consumer Reports is not excited about expediting antibiotics for narrow use because once they get on the market, they will be used everywhere for everything, and there is no way to get that genie back in the bottle once it is out.

Finally, Consumer Reports calls for beefing up postmarket surveillance systems for new and existing antibiotics that engage consumers and patients, allowing them to provide input in an easy way to the FDA. The system needs patients to report on antibiotic-resistant infections that they get from devices. The unfolding of the duodenoscope issue in this country is shameful; the way manufacturers have behaved, FDA's failure to respond, and providers' continued use of these devices—when patients are not told and are not aware that devices have been recalled—is shameful and must stop, said Ms. McGiffert. Better input is needed from the patients who are affected.

**John Boyce**, a private infection prevention consultant, hoped that in considering the different types of infrastructure needed to capture AST data from clinical laboratories, consideration be given to a platform such as the WHONET, which is used widely to capture data from clinical laboratories in hospitals.

**Amanda Jezek of the Infectious Diseases Society of America (IDSA)** said her organization strongly supports federal efforts to require health care facilities to establish stewardship programs and strongly recommends that these programs be run by ID physicians. Such physicians possess unique expertise regarding antibiotic use. Their leadership is needed to ensure that stewardship programs produce optimal results for patients in public health. IDSA was pleased to hear several Council members express commitment to the workforce needs for stewardship programs to work.

Regarding NAP goals 3 and 4, IDSA remains concerned that antibiotic and diagnostic R&D face significant economic and regulatory hurdles. It advocates strongly for bipartisan legislation to provide tax credits to support clinical trial expenses for new antibiotics and rapid diagnostics. IDSA encourages the Council to support additional economic incentives, as well as to urge the Administration to release its report regarding antibiotic incentives.

Existing regulatory pathways pose significant challenges to the development of new antibiotics to treat some of the most deadly and highly resistant pathogens. Currently many of these superbugs are

infecting a relatively small number of very ill patients, making it extremely difficult to conduct large trials. To address this problem, IDSA continues to advocate for a new LPAD approval pathway. This pathway will not only help facilitate R&D but also promote appropriate use of these limited-population drugs. Ms. Jezek hoped the Council and the Administration would endorse this approach, which was also recommended by the President's Council of Advisors of Science and Technology. Finally, IDSA strongly supports increased federal funding for all of the important work to be done in this space.

**Steven Roach of the Food Animal Concerns Trust** described several coalitions advocating for food safety, humane treatment of farm animals, antimicrobial use in animal agriculture, and AMR. He noted that the 2016 World Consumer Rights Day focused on antibiotic resistance. Advocates are trying to engage with the WHO on a global action plan.

Mr. Roach prefaced his comments by acknowledging that animal agriculture is just one source of AMR. The first goal of the NAP is to slow the emergence of resistant bacteria and prevent the spread of resistant infections, and Mr. Roach hoped these concepts would be kept in mind, rather than just talking about the vague idea of stewardship. On the animal agriculture side, the primary action to stop resistance is to reduce or eliminate the use of antibiotics for growth promotion. However, such efforts have probably already been done, largely before the current process even started. It is hard to see how focusing on antibiotics for growth promotion will reduce the spread of AMR. Efforts should be looking to determine the next step—specifically, reducing antimicrobial misuse, which is linked to surveillance.

Setting targets for reduction in antibiotic use should be a primary goal. To reduce misuse, we need to go beyond growth promoters and look at other uses that are inappropriate. For example, Dr. Apley mentioned the duration of antibiotic use. Are there other things that are causing problems? Mr. Roach asked.

Finally, better data collection systems are needed to answer questions. Surveying a farmer's group or a sector of agriculture once every five years to determine what they used in the last six months is not adequate. There has been no consideration of what types of data are adequate.

**Patrick Johnson of the American Academy of Pediatrics (AAP)** said pediatricians are on the front line of treating children and that it is critically important that any national plan for AMR and stewardship include adequate strategies for children and their doctors. The AAP believes it would be helpful for the PACCARB report to delineate those areas in which pediatric populations are included to ensure that the appropriate work is being done.

For goal one, AAP notes that in ambulatory settings, antibiotics are the most commonly prescribed drug for children. Therefore, pediatrics is crucial to the discussion of achieving this goal. AAP encourages the Council to acknowledge the unique situation of pediatrics in the outpatient setting.

For goal number two, in terms of the One Health approach, AAP believes that more attention is needed on exposure during pregnancy and birth. The PACCARB report could be strengthened with more emphasis in these areas.

For goal number three, AAP feels that this strategy might place too much emphasis on better testing and technology. As much time should be spent understanding cultural, social, and political barriers to improving the use of antibiotics as on testing and technology.

For goal number four, AAP notes that, as the primary administrators of vaccines, pediatricians are

uniquely positioned to speak to the importance of vaccines and their potential to prevent infections and, therefore, reduce the transmission of antibiotic-resistant strains.

In summary, AAP believes that obstetric, neonatal, and pediatric experiences are part of the healthcare spectrum, that they should be included in the formation of any additional strategies, and that any collaboration going forward should include representatives from these specialties.

**Jonathan Daniels of Advancing Tuberculosis Vaccines for the World (Aeras)** said that as a nonprofit organization dedicated to TB vaccine research, his organization is pleased to see that the National Action Plan for Combating MDR-TB included the goal to advance R&D of novel vaccines. The action plan's recommendation that the USG expand its collaborations with not-for-profit product development partnerships emphasizes the role that organizations like Aeras play. The world desperately needs new tools to bring an end to the TB epidemic, including better drugs, diagnostics, and vaccines.

Mr. Daniels described recent data on the burden of disease of TB and the spread of MDR-TB. Treatment alone will not end the TB epidemic. The current TB vaccine is only moderately effective in preventing TB in certain populations, and treatment regimens are long, expensive, and difficult to implement, with serious side effects. A new and effective TB vaccine would help end the epidemic.

Aeras asks PACCARB to emphasize the important role that vaccines can play in combating any microbial resistance. For diseases of poverty, such as TB, industry alone is unlikely to meet the funding challenges of vaccine R&D. The USG, via agencies such as NIH, USAID, BARDA, and others, plays a key role in fostering collaboration with nonprofit product development partnerships that are working to create the next generation of tools in the fight against TB. Aeras urges the Administration to prioritize funding for new tools and R&D that is commensurate with the urgency of the TB epidemic.

**Carolyn La Jeunesse of LaJeune Consulting** said she is a veterinarian who has worked in private practice and internationally in global health, global health emergency, and crisis response. She referred to Senator Al Franken's bill, the One Health Act of 2016, and proposals for greater interagency cooperation. A broad group of stakeholders have acknowledged and endorsed the coordinated One Health approach for combating AMR and noted the discrepancy in funding between human and animal health. Ms. La Jeunesse asked PACCARB to look at the bill and how it might be employed to potentially close the funding discrepancy.

**Sharon Morgan of the American Nurses Association** said she was very pleased with the unified focus, particularly the focus on the One Health approach. She asked that PACCARB consider the role of nursing in its efforts. There are 3.4 million registered nurses: they serve as preventionists, health advocates, and educators. They work in hospitals, communities, and homes. As strategies to combat antibiotic-resistant bacteria move forward, Ms. Morgan asked that PACCARB consider including nurses at the table.

## **Council Discussion**

In response to suggestions to revise the draft report, Dr. Blaser proposed adding the following to the executive summary:

Lastly, the Agency for Healthcare Research and Quality, the National Institutes of Health, and the Centers for Disease Control and Prevention have all significantly increased their investment

in research to develop better methods of combating antibiotic resistance and promoting antibiotic stewardship. This research is critically important to strengthen the knowledge base for insuring the effectiveness of the interventions used today and for developing more effective interventions for tomorrow.

Dr. Cosgrove agreed it is reasonable to include the proposed language in the executive summary, as the matter is discussed in the main report.

Dr. Rex said he would like to draft language for review by the Council that better distinguishes the NIH and BARDA clinical trial networks. Dr. Boucher supported the proposal and said it is important to emphasize the potential benefit of the more pragmatic clinical trials network that use standing protocols, so that centers could become adept at conducting registrational clinical trials, which would advance R&D of therapeutics. Dr. Dixon agreed to work with Dr. Rex on proposed language to add to the report.

Dr. Cosgrove pointed out that there is a recommendation in the report to streamline regulatory processes for updating and approving or clearing AST devices. She asked whether PACCARB should make a stronger recommendation about the need for legislative action. Dr. Caliendo suggested recommending that FDA and the Clinical & Laboratory Standards Institute harmonize the breakpoints, because that lack of harmonization is delaying the update of AST systems.

Edward Cox, M.D., M.P.H., of FDA clarified for the audience that AST refers to the categorization of bacteria as either susceptible, intermediate, or resistant to a particular drug. Current practice reflects the labeling on the testing device and the drug. Dr. Cox described barriers to providing more details on drug labels. He noted that standards development organizations evaluate AST and provide information beyond the initial approval data. A better mechanism for incorporating data from the standards development organizations would make processes more efficient and timely, as long as FDA retained the authority to approve or reject the data. Other barriers are the volume of new drug applications for antibacterials submitted to FDA and the need to update information on older drugs. Dr. Cox said one solution may be to remove the interpretive criteria for susceptibility from drug labels and instead post them on FDA's website so they could be updated frequently to reflect the work of the standards development organizations. Dr. Blaser asked that Dr. Caliendo and others work on language they would like to add to the report to address the issue of harmonization of breakpoints.

Dr. Blaser agreed with Dr. Laxminarayan that PACCARB needs a more thorough understanding of the budget for combating antibiotic-resistant bacteria to assess whether the resources requested match the goals, objectives, and milestones described in the NAP.

Dr. Shryock noted that the USDA recently hosted a meeting to discuss alternatives to antibiotics, and the proceedings are online. He suggested considering the information.

Dr. Boucher recommended PACCARB review the White House report on economic incentives for antibiotic development referenced by a public commenter. Dr. Rex felt it should be considered, but he and Dr. Blaser said the report presented today can move forward as is.

## **Closing Remarks**

**Martin J. Blaser, M.D., Chair, and Lonnie J. King, D.V.M., M.S., M.P.A., ACVPM, Vice Chair**

Dr. Blaser said the suggested changes to the draft report will be reviewed and discussed by the Council on day two, and the Council members will vote to approve or reject the report as a whole. The Council adjourned for the day at 4:38 p.m.

## Meeting Proceedings — Day 2

### Welcome and Overview

**Martin J. Blaser, M.D., Chair, and Lonnie J. King, D.V.M., M.S., M.P.A., ACVPM, Vice Chair**

Dr. Blaser welcomed the participants. He announced that the new PACCARB liaison from the Association of State and Territorial Health Officials, Jay Butler, M.D., a pediatrician and internist, would join the meeting by phone. Dr. Gellin called the roll (see Appendix A).

### Vote - Draft Report 1: Initial Assessments of the NAP CARB

The Council voted unanimously to approve the report with the following changes:

Executive Summary (end of fourth paragraph):

Lastly, the Agency for Healthcare Research and Quality, the National Institutes of Health, and the Centers for Disease Control and Prevention have all significantly increased their investment in research to develop better methods of combating antibiotic resistance and promoting antibiotic stewardship; this research is critically important to strengthen the knowledge base for ensuring the effectiveness of the interventions used today and for developing more effective interventions for tomorrow.

Goal 1, Objective 1.1, Regulatory Processes:

- Legislative attention and action is needed to establish new approaches for updating antibacterial susceptibility interpretive categories that leverages the work of standards development organizations, takes advantage of electronic resources to achieve timely and efficient updating of these interpretive categories and that addresses the diversity of bacteria that cause infections in the real world. These new approaches are needed to support appropriate therapeutic decisions and infection control practices.
- The FDA is to consider an expedited process to for the concurrent approval of the antibiotic and its corresponding AST.

Goal 4, Broad Recommendations:

- Allocation of funding to establish a registration trial-focused clinical network. PACCARB lauds (a) the work done by NIAID and BARDA to create an Antimicrobial Accelerator, (b) the work done by NIAID via ARLG to implement clinical trial network(s) focused on highly resistant pathogens, and (c) the work done by BARDA to explore the creation of master protocol-based clinical trials network(s) focused on efficiently conducting registration trials in core indications. The first two of these are now launched and PACCARB strongly encourages allocation of funding to establish the registration trial-focused clinical network.

### Council Comments

Dr. Blaser asked Council members to describe what issues resonated with them in the report. Several cited the need for resources, the importance of more and better coordination and collaboration, and the attention to the One Health approach. It was noted that work is well underway in some areas. The following areas of particular concern or interest were identified, among others:

- Addressing regulatory processes so products can reach the marketplace;

- Developing economic incentives;
- Collecting real-time data on AMR in animals;
- Promoting handwashing as a simple, effective preventive intervention;
- Translating data into action;
- Ending inappropriate use of antibiotics;
- Building the animal health infrastructure;
- Prioritizing resource allocation needs;
- Enhancing prevention through education, training, and use of best practices;
- Anticipating the impact of rapid population growth on antibiotic use and abuse;
- Bolstering the workforce pipeline;
- Increasing attention to the role of the environment in the spread of AMR;
- Sounding the alarm to further convey the urgency of combating antibiotic-resistant bacteria;
- Recognizing the role of human behavior in combating antibiotic-resistant bacteria; and,
- Considering how efforts to combat antibiotic-resistant bacteria can inform other human and animal health issues.

Dr. Blaser said the NAP and the Council’s report are only initial steps in the process, but they are steps in the right direction. He added that national, bipartisan agreement is needed to move forward initiatives to combat antibiotic-resistant bacteria, and that international cooperation is vital. The report will be finalized and delivered to the HHS Secretary, and the President.

## **Presentations**

### **One Health and Antibiotic Resistance**

#### *Introduction*

*Lonnie J. King, D.V.M., M.S., M.P.A., ACVPM, PACCARB Vice Chair*

Dr. King described the convergence of genetic, biological, social, political, economic, environmental, and physical forces in recent history to contribute to new disease in humans, animals, and plants. Infectious diseases have been on the rise since at least the 1980s; a significant portion of infectious diseases are characterized as new because they are resistant to existing treatment. Dr. King called AMR a “wicked” problem—one that is complex, unprecedented, and difficult to define and for which there is no clear solution.

Some of the factors that complicate efforts to combat antibiotic resistance are as follows:

- Pollution and the mixing of antibiotics and other compounds in the environment in new, unrecognized ways
- Population growth in the developing world and the attendant growth in animal food production
- Unchecked antibiotic use in developing countries
- Poverty in urban areas, which creates a perfect storm of human, animal, and environmental interactions that spread disease

Wicked problems call for innovative solutions. One Health is a new mindset that encourages thinking about the interaction of all three domains—animal, human, and environmental—at all points to prevent or mitigate AMR. In an integrated, interconnected world, continuing to operate in silos will not be effective. The One Health approach posits that animal and environmental health are integral to public health. Focusing on one area alone only solves one third of the problem. The United Kingdom crafted a five-year plan that aligns with the global One Health approach and may serve as a model.

Dr. King introduced the presenters for this session. Each was asked to consider these questions:

- Why is the One Health concept necessary for the future of combating antibiotic-resistant bacteria and the NAP?
- What will it take to better adopt the One Health strategy across organizations and governments?
- What are the barriers to adopting One Health as part of the NAP?
- How can PACCARB focus on the barriers?

#### *Animal Agriculture and One Health*

*Michael D. Apley, D.V.M., Ph.D., DACVCP, Kansas State University College of Veterinary Medicine*

Dr. Apley described the scope of the beef and dairy industries in U.S. agriculture and summarized some industry commitments that tie into One Health. The Beef Quality Assurance Program, the Beef Industry Food Safety Council, and the National Cattle and Beef Association all address animal health issues related to AMR. The Dairy Beef Quality Assurance Program of the National Dairy Farm Program recently released a manual on antimicrobial stewardship. The American Association of Bovine Practitioners is wrestling with similar issues. All of these private-sector organizations provide platforms that can be supported as part of a One Health initiative.

The Wisconsin Veterinary Medical Association's Food Armor program is a shining example of the One Health approach. It incorporates the hazard analysis critical control point principles and includes identifying drugs of concern, putting protocols in place to ensure appropriate use with veterinary oversight, auditing for compliance by external entities, and certifying compliant programs. The first step in the program asks users to consider a nonantibiotic alternative that would treat or control disease, which speaks to prevention. If there is no alternative, the user should ask whether there is a safe, effective antibiotic specifically for this situation. Each step of the process requires users to assess for possible alternatives and to carefully consider appropriate use of antibiotics. The program addresses antibiotic stewardship, animal health, and consumer health issues.

*Peter Robert Davies, B.V.Sc., Ph.D., University of Minnesota*

Dr. Davies described the scope of pork production in the United States. He pointed out that the number of pigs is about the same as in the 1920s, but the amount of meat produced is about four times higher, so efficiency and productivity are especially important to pork producers.

The industry has implemented numerous structural and operational changes in the past 30 years, most of which revolve around improving animal health and productivity. It has made strides in identifying major pork-borne pathogens that affect public health. Some diseases have been eliminated in developed countries or significantly reduced—except where pigs have outdoor access, which illustrates one of the tradeoffs that must be considered when system changes are recommended. In the past 20 years, carcass contamination has decreased markedly, as measured by human zoonotic foodborne diseases. Recent data show that antibiotic residues in pork, which were high in the 1970s, are now at very low levels, largely because of quality assurance, education, industry maturity, and export market discipline. Dr. Davies said these examples show that not all change has been negative.

The industry will still need antibiotics for animal health. The challenge is to identify and eliminate misuse of antibiotics so they are used only in ways that benefit animal health and food safety.

*Randall Singer, D.V.M., M.P.V.M., Ph.D., University of Minnesota*

Dr. Singer pointed out that the poultry industry encompasses various types of production, including broiler chickens, turkey, and eggs—each of which has its own health concerns and its own professional veterinary groups. Avian influenza is a good example of a disease that concerns poultry production and poses animal and human health threats. Judicious use of antibiotics is a key component of poultry production and is addressed by guidelines from the American Association of Avian Pathologists.

An example of a significant One Health initiative within the poultry sector is the development of a public-private partnership with USDA'S Animal and Plant Health Inspection Service (APHIS) to collect quantitative antibiotic usage data on farms that include the type of drug, indication, route, dose, and duration. One segment has already started data collection and others are almost ready to start. Data will be collected every six months. The data can help assess how antibiotic use practices are shifting with revised regulations and changing consumer interests.

#### *Council Member Q&A*

Elizabeth Allen Wagstrom, D.V.M., M.S., said the importance of the quality assurance programs cannot be underestimated. Certification now requires producers not just to sit through a brief educational course but to pass tests and on-farm audits that look at objective indicators of quality.

#### *Public Health and One Health*

*James M. Hughes, M.D., Emory University School of Medicine*

Dr. Hughes explained that the Institute of Medicine first called attention to new, reemerging, and drug-resistant infections 25 years ago and then reiterated its concerns in a 2003 publication. The latter identified multidisciplinary, cross-sector collaboration as key to addressing AMR. A siloed approach to human and animal health contributes to resistance, while interdisciplinary collaboration offers many opportunities to combat it. At present, the environmental component of the One Health approach—and in particular, the role of wildlife—seems to be underrepresented in the discussion, said Dr. Hughes.

Looking at topics of major concern in both human and animal medicine, it is clear that many relate to AMR, so the One Health approach makes sense, Dr. Hughes noted. As an example, he described a drug-resistant gene that is showing up in tap water in India. Within the NAP, the goals of fostering antibiotic stewardship and strengthening One Health surveillance capacity and approaches in the United States and abroad are especially important to success.

Dr. Hughes listed several ways to address barriers to One Health that echo the Council's recommendations for the NAP:

- Stop looking for blame and increase trust and transparency
- Leverage the current federal pushes for combating antibiotic-resistant bacteria
- Build on shared commitments to antibiotic stewardship and to develop better data on use and resistance
- Develop and implement a collaborative research agenda
- Promote shared commitment to communication and collaboration across private and public sectors

The collaborative research agenda could address the following:

- Assessment of stewardship approaches in human and animal settings

- Better quantification of the relationship between agricultural use and resistance in humans
- Assessment of the possible role of food in community transmission of resistant microbes
- Environmental risk assessments of resistance and antibiotic residues (e.g., in soil, water, human and animal waste, marine environments)
- Role of companion animals

### *Environmental Health and One Health*

*Randall Singer, D.V.M., M.P.V.M., Ph.D., University of Minnesota*

Dr. Singer said the environmental contribution to One Health is dramatically understated in the NAP. Many sources of antibiotic-resistant bacteria, antibiotic resistance genes, and antibiotic residue metabolize in natural habitats related to animal agriculture, waste water treatment, aquaculture, crop and orchard production, and companion animals. At the same time, antibiotic resistance genes often occur naturally in the environment and through mutation, and can potentially become pathogens. The One Health framework takes into account the wide range of environmental sources that affect and are affected by AMR and their relationship to humans and animals.

A significant barrier to adopting the One Health approach is that antibiotic-resistant bacteria are pervasive and their role in health is uncertain, so there is little will to act until the health impacts are better understood. Therefore, research should assess how environmental observation translates into health outcomes.

Addressing other barriers requires systematic review of data, which forces investigators to consider potential biases in research, such as confounding factors. Without a better understanding of the complexity and diversity of sources that impact the environment, resources could potentially be allocated inappropriately, and conclusions about how particular compounds have an impact could result in inaccuracies, said Dr. Singer. Other knowledge gaps include lack of understanding of the amount of antibiotics that get into the environment, how long they persist, and how they affect other bacteria in the environment.

To adopt a One Health strategy, Dr. Singer called for better definitions of objectives and interdisciplinary teams to guide the design of monitoring systems, so that data are meaningful and useful. In addition to microbiologists and epidemiologists, chemists (such as soil scientists) should be involved. Funding such research requires a serious investment.

### *Global Health and One Health*

*John Clifford, D.V.M., Chief Trade Advisor, APHIS, USDA (by phone)*

Dr. Clifford explained that the World Organization for Animal Health (OIE), WHO, and the Food and Agriculture Organization (FAO), have forged an alliance to address AMR. They plan to raise awareness, strengthen national infrastructure, encourage appropriate policy and legislation, support surveillance, promote R&D, and promote improved infection prevention and control. Through its standards for animal and veterinary health care, the Terrestrial Animal Health Code, OIE will promote standards for prudent and responsible use of antimicrobial agents in veterinary medicine, as well as raise awareness about risk analysis methods for AMR. The Terrestrial Animal Health Code includes a chapter on developing and harmonizing international AMR, surveillance, and monitoring programs. It also addresses monitoring of quantities and usage patterns of antimicrobial agents used in food-producing animals, which encourages member countries to collect quantitative information by animal species, antibiotic class, type of use, and route of administration; the OIE has already collected some data that will serve as a baseline. Additional data will improve quality control and effectiveness of the

products in use.

The OIE's Performance in Veterinary Services tool will help identify gaps to address, such as the need for legislation on antibiotic distribution and use. Most of the member countries assessed by the OIE do not have meaningful legislation to ensure appropriate measures for manufacturing, importing, and distributing antimicrobial agents. Such agents are widely available with minimal restrictions in these countries.

Among the significant challenges, Dr. Clifford said the greatest is the lack of legislation in many OIE member countries, where political will and infrastructure to stem AMR are nonexistent. Commitment to pass meaningful legislation and sustainable funding are needed at the local, regional, and global levels. The United States must recognize that progress involves constantly educating those in charge of appropriations about the barriers to combating resistance. More collaboration across funding bodies on both the animal and human health sides is also needed because each has its own priorities and concerns.

### *USG and One Health*

*Bernadette Dunham, D.V.M., Ph.D., Director, Center for Veterinary Medicine, FDA*

Dr. Dunham reiterated the need for an integrated model to address AMR and said that funding remains the central barrier to adopting a One Health approach. Funding is siloed and insufficient to the task. Confusion about the benefits, metrics, and stakeholders for One Health persists, so the approach should be better defined. Sharing data is hampered by obsolete data systems, outdated policies, and unfounded fears about consequences.

The Open Data Initiative is one attempt to foster openness and transparency. The FDA has been a leader in sharing data on foodborne bacteria via the National Antimicrobial Resistance Monitoring System (NARMS), which will soon include whole genome sequence data that will be shared in near real-time. The Global Microbial Identifier project is attempting to do the same for all pathogens on a global scale.

To adopt the One Health strategy and better coordinate activities across government agencies, Dr. Dunham said agency leads must work together to enable open collaboration and effective multidisciplinary partnership across federal agencies and with states, local agencies, tribal nations, private-sector organizations, commodity groups, philanthropic organizations, and international bodies. Congress should embrace One Health, as has been proposed by Sen. Franken. Stable, high-level (e.g., White House or Cabinet level) leadership and representation is also needed to ensure One Health is adopted.

Curricula for medical, veterinary, public health, and environmental education should be evaluated, so that future researchers and practitioners can learn and demonstrate the benefits of the One Health approach. For example, pairing students across disciplines and sharing lecturers across departments can facilitate awareness. Communication across professional fields through journals and conferences will also be helpful, as will joint efforts on assessment, treatment, and prevention of AMR in humans and animals, including companion animals. Cooperation in developing new medicines, diagnostics, and vaccines for prevention and control of resistance across species is needed. Multidisciplinary efforts to educate policymakers are also important.

*Beth P. Bell, M.D., M.P.H., Director, National Center for Emerging and Zoonotic Infectious Diseases, CDC*

Dr. Bell said CDC applies the One Health approach daily as it seeks to track the sources of new health threats or outbreaks and to understand how antibiotic resistance spreads. For example, with the inclusion of whole genome sequencing in NARMS, CDC will be able to scale up research and detection of salmonella to better understand pathways and relationships that affect transmission.

Among the barriers to One Health is the difficulty of answering some of the basic research questions, such as the impact of contamination on both environmental and human health. The ability to measure and track antibiotic use in agriculture will be pivotal to demonstrate the impact of One Health interventions on resistance in both agriculture and human health.

Dr. Bell said CDC has numerous veterinarians on staff, and efforts are underway to translate lessons learned from human health—for example, antibiotic stewardship practices—to animal health practices. Corporate responsibility is another area in which success on the human health side may be a model for animal health.

CDC has directed some funding toward research on AMR in companion animals, an area with a lot of overlap between animal and human health. Dr. Bell concluded that there is still much to do to improve human health, and those efforts should not be stalled by concerns about the current lack of coordination.

*Jane Rooney, D.V.M., Director, One Health Coordination Office, APHIS, USDA (by phone)*

Dr. Rooney echoed others regarding the need for a One Health approach. Collaborating across sectors requires working across siloes and optimizing resources, while still respecting the autonomy of the various sectors. For USDA, the primary barrier to adopting the One Health approach is funding, particularly dedicated, long-term funding. The agency needs funding to continue current efforts and additional resources to implement proposed activities described in the NAP.

Demonstrating the value of One Health to diverse stakeholders will help drive acceptance. Dr. Rooney said the federal government has already begun to adopt a One Health, multisector strategy around AMR. One example is the strong partnership by FDA, CDC, and USDA around NARMS, which has been ongoing for 20 years.

#### *Council Member Q&A*

Dr. Laxminarayan said that all the representatives of animal food production described making great strides in optimizing their quality assurance systems, so he wondered if commensurate decreases in antibiotic use can be expected. Dr. Davies said the lack of good measurement tools limits observation, but monumental changes are coming as a result of new regulations. Removing over-the-counter antimicrobial products and putting them under the responsibility of veterinarians is another significant change. Dr. Davies stressed that each industry faces different issues, so it is not always useful to make comparisons across industries. European models have demonstrated that reduction in antibiotic use following regulation is not necessarily immediate or large scale. Dr. Davies added that Holland reduced antibiotic use, but health challenges remain.

Dr. Apley stressed that veterinarians are taking on new roles under these new regulations. Their goal is to optimize use—which should translate to reduction in antibiotic use—and to do so without a catastrophic effect on animal welfare or resources. Dr. Singer emphasized the different challenges each industry faces, even within the poultry industry. For example, chickens have a very short lifespan, so eliminating antibiotic use can be a viable option for those flocks, while it may not be feasible for

longer-lived turkeys. Some dramatic changes in management are already underway, he said.

Dr. Blaser asked whether NARMS is sufficient to understand the flow of antibiotic resistance genes into humans. Dr. Bell said recent improvements to NARMS will provide a better sense of the molecular epidemiology and overall prevalence of various types of resistance in foodborne infections in people, retail meat, and on the farm, which will increase knowledge about outbreaks and infections. However, more research is needed, such as understanding how antibiotic resistance in foodborne pathogens drives non-foodborne infections in humans. Dr. Dunham added that NARMS is a good surveillance model that other countries can implement, which will improve global surveillance and data sharing. She also said NARMS has potential to grow to serve more epidemiological purposes.

Ms. Cole asked about the role of the public as consumers in preventing antibiotic resistance. Dr. Bell said consumer expectations have driven improvements, for example, in healthcare-associated infections. Similar engagement could be translated to animal health concerns.

Dr. Rex asked whether the United States has used its purchasing power to encourage good food production practices and whether it has the right tools to do so. Dr. Dunham responded that the issue comes back to education, awareness, and stewardship. Regulatory agencies set standards on drugs and food, but practitioners and producers are responsible for judicious use. Dr. Dunham hoped to get more input on how to spread public health messages about safe food handling practices, for example. In developing countries, there is an opportunity to assist with surveillance, identify needs, and fill gaps, she noted.

Dr. Dixon said an interagency task force on AMR generated numerous action items, many of which centered on communicating across agencies and coordinating activities. However, funding remains critical. The ability to collaborate across agencies depends on what each agency can do individually within its budget.

Dr. Wagstrom pointed out that a consumer-driven, simplistic approach of banning antibiotics in food production can have serious side effects for animal health, animal welfare, and potentially food safety. Economic incentives should focus on appropriate antibiotic use.

Dr. Wagstrom asked what is being done to collect better data on antibiotic use in humans and how those data can be tied to antibiotic resistance. Dr. Bell responded that a broad coalition of public and private partners is working toward this with high priority. The National Healthcare Safety Network (NHSN) was a successful mechanism for identifying and decreasing healthcare-associated infections in hospitals. The new NHSN Antibiotic Use and Resistance module can be a very powerful tool in this effort. It can be used at the state level to identify outliers and at the federal level for benchmarking. The VA has adopted the module, and CDC is working with vendors of electronic health records to incorporate the module into hospital systems. Dr. Bell emphasized the importance of measurement in prevention.

Ms. Jungman said One Health is a worthy goal, but she cautioned that the complexity of the endeavor could result in inaction. Some could see the scope of the effort and the breadth of stakeholders involved as an excuse to avoid making progress. She urged the Council to think about One Health in ways that facilitate progress rather than hinder it.

Dr. Blaser asked for examples of education that incorporate the One Health approach. Dr. Dunham said she believes veterinary and medical colleges are stepping up to the plate, and she gave a specific

example. Internationally, there is an effort to designate November 3<sup>rd</sup> as World One Health Day. Dr. King said the Ohio State University has seven health science colleges and a program that encourages inter-professional education and collaboration around research questions. Focusing on inter-professional education from the outset can influence a student's entire educational experience, he said.

### *Summary*

*Lonnie J. King, D.V.M., M.S., M.P.A., ACVPM, Vice Chair*

Dr. King pointed out that significant changes in animal agriculture are occurring right now with new regulations on the use of antibiotics for growth production purposes. However, problems are likely to continue in developing countries where populations are growing and food production is rapidly increasing. Dr. King particularly appreciated the concept of an integrated research strategy to understand and address such problems.

Dr. King expressed optimism based on past success in human and animal health, in part because of repeated calls for trust, transparency, and partnership. The Council needs to pay more attention to environmental aspects of One Health, he said. He also hoped that the calls for a broad, integrated approach would spur more action, not inaction. Finally, Dr. King stressed that One Health is a means to an end. The goal is reducing AMR and its spread.

### **Public Comment**

**Bill Wenzel of the U.S. Public Interest Research Group (US PIRG)** said his organization has leveraged the power of the consumer to drive change by encouraging restaurants to think about their role in supply chains, and how agriculture practices need to accommodate the interests of not only the consumer, but also restaurants. Such campaigns have resulted in some dramatic changes. US PIRG hopes that the federal government will look at its own purchasing power and the potential impact it could have not only on international purchasing but also at home. Mr. Wenzel pointed out that in Washington, D.C., every federal building has its own restaurant, which purchases a large amount of meat and poultry and livestock each year. The federal government could go a long way in impacting agricultural practices by addressing the issue of antibiotics in food animals.

Regarding the issue raised by Dr. Wagstrom about animal health and welfare, Mr. Wenzel said US PIRG strongly encourages the treatment of sick animals and birds and supports the use of antibiotics to that end.

Finally, there is agreement that animal agriculture is way behind in terms of data and reporting and needs to catch up. Mr. Wenzel pointed out that even as the VFD is being implemented, there are no benchmarks. He suggested looking to feed mills for information. Some of the data needed are available, said Mr. Wenzel; species-specific data can be aggregated to address such concerns.

**Kevin Kavanagh** wanted to highlight comments by Ms. Cole that a major goal of this Council should be to prevent person-to-person transmission. Not doing so would be similar to confronting the recent Ebola epidemic in Africa by solely developing vaccines for the animal host without adequately addressing human transmission.

Another major idea of the Council is to rely on China and India to bring their antibiotic overutilization under control. Based on his experience with carbon emissions, this may be difficult to do. Unfortunately, these two countries are also major manufacturers of antibiotics. They may even account for the majority of manufacturing of antibiotics and drugs used in the United States. As a result, FDA

oversight of those antibiotics and other drugs is inhibited. Based on current antibiotic overutilization, we may expect rapid development of resistance to any new agents, especially if they are developed overseas. Dr. Kavanagh said these observations underscore the importance of being able to identify carriers and prevent patient-to-patient transmission. Thus, he advocated for a “plan B.”

**Carole Moss** emphasized that there are things that can be done right now that will help save lives and reduce the amount of antibiotics being used. When the Ebola outbreak took place, nurses marched in the streets for fear of their lives because they saw what happened in their hospitals. They are not using the surveillance that the VA hospitals are using to prevent the spread of antibiotic-resistant disease. Nurses see that patients are cohabitating with other patients that are infected with antibiotic-resistant infections. Ms. Moss urged the use of the VA surveillance programs throughout the United States. It makes no sense that we are not protecting health care workers and their patients when there are tools that can do that, she said.

Second, CMS is doing great things in requiring pay for performance, which takes away the incentives to do more procedures. Ms. Moss asked the Council to urge CMS to require pay-for-performance approaches in children’s hospitals. Right now, pay-for-performance initiatives do not include children’s hospitals, and that is a huge error, she noted. Pay-for-performance resulted in \$389 million in funds that were not paid to hospitals because they were unable to address preventable infections.

Finally, several people mentioned the need for viral and bacterial rapid diagnostic tests. Canadians can go online and order a rapid diagnostic test that involves taking blood from a fingertip and provides results in fifteen minutes. The results show whether an infection is viral or bacterial. Such products should also be in the hands of American consumers. Ms. Moss suggested working with the Department of Homeland Security, which is well aware of this test and the developers, to adopt this test in order to solve many problems that the Council is talking about today.

**Lisa McGiffert of Consumer Reports** said her organization sees antibiotic resistance from a One Health perspective. She noted that the international plan on antibiotic-resistant TB was impressive because it set specific targets. The President’s action plan set very specific targets on the human side for reducing inappropriate antibiotic use in inpatients and outpatients by 2020. But so far, there have been no numeric targets set for reducing antibiotic overuse in agriculture, where 70 percent of all medically important antibiotics are sold.

As efforts move forward, Ms. McGiffert called for setting a hard target for reducing use of medically important antibiotics in livestock production. Ultimately, Consumer Reports would like to see a ban on the use of these antibiotics for both growth promotion and disease prevention, but for now, some hard targets are needed.

**Andrew Geltman** pointed out that the EPA does have an enforcement program for pharmaceuticals in the environment and antibiotics are part of that program. He also pointed out that most antibiotics get into the environment through the excrement of people and animals, and the best way to reduce that source is stewardship, which is an approach that has bipartisan support.

Mr. Geltman raised concern about the Council grouping AMR with global warming, because it will cause polarization around the issue and lead to problems in addressing AMR in Congress. He hoped the Council would not overly focus on the global warming aspect of AMR, so that work can get done on the Hill.

**Carolyn La Jeunesse** said she recently joined the Council of Advisors for the One Health Commission, which is very focused on education, and she would be happy to discuss that with anybody who might be interested. She said another point that came up in the previous day's meeting was concern about protection of health care workers both in the animal and human health professions, and she hoped the Council would consider that topic. Veterinarians may be treating pets with resistant infections in the hospital or in companion animal health care practices and then going home and taking care of elderly patients with MRSA. The situation can be a wicked problem, said Ms. La Jeunesse, and she urged the Council to keep in mind the importance of protecting health workers.

Regarding the veterinary workforce, Ms. La Jeunesse noted that with the transition away from having antimicrobials available over the counter, it may be necessary to look to veterinarian medical educators for ways to incentivize students to go into the swine, poultry, and beef sectors.

## **Closing Remarks and Adjournment**

### **Martin J. Blaser, M.D., Chair**

Dr. Blaser thanked the Council members for their hard work and federal colleagues for their contributions. He said the Council plans to publish some questions for consideration in the *Federal Register* within a few weeks as a way to gather public and stakeholder input. The next PACCARB meeting will take place in June, and the group will consider the questions posed by the HHS Secretary. Dr. Blaser adjourned the meeting at 11:48 a.m.

I hereby certify that, to the best of my knowledge, the foregoing minutes of the proceedings are accurate and complete.

Martin J. Blaser, M.D., Chair, Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria

## **Appendix A: Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria (PACCARB) Members**

**March 30–31, 2016**

### **PACCARB Voting Members Present**

Martin J. Blaser, M.D., Chair  
Lonnie J. King, D.V.M., M.S., M.P.A., ACVPM, Vice Chair  
Michael D. Apley, D.V.M., Ph.D., DACVCP  
Helen W. Boucher, M.D., FIDSA, FACP  
Angela Caliendo, M.D., Ph.D., FIDSA  
Alicia R. Cole  
Sara E. Cosgrove, M.D., M.S.  
Peter Robert Davies, B.V.Sc., Ph.D.  
Kent E. Kester, M.D., FACP, FIDSA, FASTMH  
Ramanan Laxminarayan, Ph.D., M.P.H.  
Aileen M. Marty, M.D., FACP  
John H. Rex, M.D.  
Thomas R. Shryock, Ph.D.  
Randall Singer, D.V.M., M.P.V.M., Ph.D.  
Robert A. Weinstein, M.D.

### **Organizational Liaisons Present**

*Animal Health Institute*  
Richard Carnevale, V.M.D.  
*Association of State and Territorial Health Officials*  
Jay C. Butler, M.D. (Day 2 only - by phone)  
*National Association of Directors of Nursing Administration in Long Term Care*  
Sherrie Dornberger, R.N., CDONA, GDCN, CDP, CADDCT, FACDONA  
*National Pork Producers Council*  
Elizabeth Allen Wagstrom, D.V.M., M.S.  
*The Pew Charitable Trusts*  
Elizabeth Jungman, J.D., M.P.H.

### **Ex Officios Present**

*U.S. Department of Health and Human Services*  
Beth P. Bell, M.D., M.P.H., Director, National Center for Emerging and Zoonotic Infectious Diseases, Centers for Disease Control and Prevention  
Dennis M. Dixon, Ph.D., Chief, Bacteriology and Mycology Branch, Division of Microbiology and Infectious Diseases, National Institute of Allergy and Infectious Diseases, National Institutes of Health  
Joe Larson, Ph.D., Acting Deputy Director, Biomedical Advanced Research and Development Authority, Assistant Secretary for Preparedness and Response  
Marjory Cannon, M.D., Medical Officer, Centers for Medicare and Medicaid Services  
William Flynn, M.D., M.P.H., for Peter Lurie, M.D., Associate Commissioner for Public Health Strategy and Analysis, Food and Drug Administration

*U. S. Department of Defense*

David Smith, M.D., Deputy Assistant Secretary of Defense for Health Readiness Policy and Oversight  
Paige Waterman, M.D., FACP, FIDSA, Antimicrobial Resistance Lead, Armed Forces Health  
Surveillance Center-Global Emerging Infectious Disease Surveillance

*U. S. Department of Agriculture*

David Goldman, M.D., Chief Medical Officer and Assistant Administrator, Office of Public Health  
Science, Food Safety and Inspection Service (Day 2: Neena Anandaraman, D.V.M., M.P.H., for  
David Goldman, M.D.)

Steve Kappes, Ph.D., Deputy Administrator, National Program Staff, Animal Production and  
Protection, Agricultural Research Service

Brian McCluskey, D.V.M., Ph.D., for Jack Shere, D.V.M., Ph.D., Chief Veterinary Officer and Deputy  
Administrator for Veterinary Services, Animal and Plant Health Inspection Service

**Designated Federal Official**

Bruce G. Gellin, M.D., M.P.H., Deputy Assistant Secretary for Health, Office of the Assistant  
Secretary for Health, Department of Health and Human Services

**Advisory Council Staff**

Tiffany Allen Archuleta, M.P.H., M.Ed., Senior Research Coordinator, PACCARB, New York  
University Langone Medical Center

Marcus Manning, Advisory Council Administrative Assistant, Office of the Assistant Secretary for  
Health, Department of Health and Human Services

Jomana F. Musmar, M.S., Ph.D.c, Advisory Council Committee Manager, Office of the Assistant  
Secretary for Health, Department of Health and Human Services

MacKenzie Roberston, Committee Management Officer, Office of the Assistant Secretary for Health,  
Department of Health and Human Services

Ayah Wali, M.P.H., Committee Management Officer, Office of the Assistant Secretary for Health,  
Department of Health and Human Services

## Glossary of Abbreviations

AAP	American Academy of Pediatrics
AHRQ	Agency for Healthcare Research and Quality
AMR	antimicrobial resistance
APHIS	Animal and Plant Health Inspection Service
ARLG	Antibacterial Resistance Leadership Group
AST	antimicrobial susceptibility testing
BARDA	Biomedical Advanced Research and Development Authority
BCG	bacille Calmette-Guerin (vaccine)
CDC	Centers for Disease Control and Prevention
CMS	Centers for Medicare and Medicaid Services
CRE	carbapenem-resistant Enterobacteriaceae
DoD	U. S. Department of Defense
EPA	U.S. Environmental Protection Agency
FAO	Food and Agriculture Organization of the United Nations
FDA	Food and Drug Administration
FY	fiscal year
HHS	Department of Health and Human Services
ID	infectious disease
IDSA	Infectious Diseases Society of America
INH	isoniazid
LPAD	limited-population antibacterial drug
MDRO	multidrug-resistant organism
MDR-TB	multidrug-resistant tuberculosis
MIC	minimum inhibitory concentration
MRSA	methicillin-resistant <i>Staphylococcus aureus</i>
MRSN	Multidrug-Resistant Organism Repository and Surveillance Network
NAP CARB	National Action Plan for Combating Antibiotic-Resistant Bacteria
NARMS	National Antimicrobial Resistance Monitoring System
NHSN	National Healthcare Safety Network
NIAID	National Institute of Allergy and Infectious Diseases
NIH	National Institutes of Health
OIE	World Organization for Animal Health
PACCARB	Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria
PEPFAR	U.S. President's Emergency Plan for AIDS Relief
Q&A	questions and answers
R&D	research and development
TATFAR	Transatlantic Task Force on Antimicrobial Resistance
TB	tuberculosis
USAID	U.S. Agency for International Development
USDA	U.S. Department of Agriculture
USG	U.S. government
US PIRG	U.S. Public Interest Research Group
VA	U.S. Department of Veterans Affairs
VFD	Veterinary Feed Directive
WHO	World Health Organization

