

ADVANCING INTERPROFESSIONAL
EDUCATION AND PRACTICE TO
COMBAT ANTIMICROBIAL
RESISTANCE

A REPORT WITH RECOMMENDATIONS

June 2021

PACCARB

Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria

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EXECUTIVE SUMMARY

Education has been recognized in the National Action Plan for Combating Antibiotic-Resistant Bacteria (NAP), 2020-2025,¹ as playing a key role in preventing antimicrobial resistance (AMR); however, because AMR is a complex, interconnected problem, single-disciplinary educational methods have proven ineffective. Instead, a holistic and multidisciplinary approach that promotes collaborative education and continued practice, such as the existing paradigms of Interprofessional Education and Practice (IPE/P) or One Health education, has the potential to further advance progress on this global issue. The recommendations in this report aim to address how collaborative, multidisciplinary education and practice can be leveraged to ultimately sustain and improve antimicrobial stewardship practices and infection prevention and control.

In October 2020, the Assistant Secretary for Health, Admiral Brett P. Giroir, M.D., on behalf of the Secretary of Health and Human Services, Alex M. Azar, II, tasked the Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria (PACCARB) to provide input on how interprofessional education (IPE) that includes human, veterinary and agricultural disciplines can address AMR. To accomplish this task, the PACCARB established a working group (WG) composed of council members and federal official subject matter experts (SMEs) in the human, animal, and environmental domains. The WG collected and discussed information from experts in interprofessional and One Health education to identify ways to leverage these concepts toward combating AMR.

The findings presented in this report ultimately aim to establish a stronger public health infrastructure, which aligns with many of the priorities set out by the current administration as they relate to both COVID-19 and future public health threats. As described in the Executive Order written on January 21, 2021, and the letter to Dr. Eric S. Lander, the President's Science Advisor and nominee as the Director of the Office of Science and Technology Policy, the current administration has prioritized creating a stronger public health infrastructure to help prevent, detect, and effectively respond to future biological threats, including AMR.^{2,3} This includes a focus on One Health and interagency coordination, as noted in the National Security Memorandum from January 21, 2021 and the National COVID-19 Strategy Plan.^{4,5} Since its creation in 2015, the PACCARB, too, has emphasized a foundation in One Health to

¹ Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria. (2019). *Priorities for the National Action Plan on Combating Antibiotic-Resistant Bacteria: 2020-2025 A report with recommendations*. Retrieved from <https://www.hhs.gov/ash/advisory-committees/paccarb/reports-and-recommendations/index.html>.

² President J R Biden. (2021, January 21). Executive Order on Ensuring a Data-Driven Response to COVID-19 and Future High-Consequence Public Health Threats. Retrieved from <https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/21/executive-order-ensuring-a-data-driven-response-to-covid-19-and-future-high-consequence-public-health-threats/>.

³ President J.R. Biden. (2021, January 20). A Letter to Dr. Eric S. Lander, the President's Science Advisor and nominee as Director of the Office of Science and Technology Policy. Retrieved from <https://www.whitehouse.gov/briefing-room/statements-releases/2021/01/20/a-letter-to-dr-eric-s-lander-the-presidents-science-advisor-and-nominee-as-director-of-the-office-of-science-and-technology-policy/>.

⁴ President J. R. Biden. (2021, January 21). National Security Memorandum on United States Global Leadership to Strengthen the International COVID-19 Response and to Advance Global Health Security and Biological Preparedness. Retrieved from <https://www.whitehouse.gov/briefing-room/statements-releases/2021/01/21/national-security-directive-united-states-global-leadership-to-strengthen-the-international-covid-19-response-and-to-advance-global-health-security-and-biological-preparedness/>.

⁵ President JR Biden. (2021, January 21). National Strategy for the COVID- 19 Response and Pandemic Preparedness. Retrieved from <https://www.whitehouse.gov/wp-content/uploads/2021/01/National-Strategy-for-the-COVID-19-Response-and-Pandemic-Preparedness.pdf>.

combat AMR throughout their public meetings and reports, with recommendations made to the Secretary of Health and Human Services.⁶

Recommendations

The efforts of the IPE WG identified gaps and barriers to a truly holistic One Health approach to interdisciplinary AMR pedagogy in current U.S.-based interprofessional education and practice paradigms. The WG has provided recommendations on areas in collaborative education to effectively apply interdisciplinary efforts to prevent AMR and promote antimicrobial stewardship and infection prevention and control (IPC). From these, the PACCARB identified three high-level recommendation themes: sharing a vision of collaborative education and practice, implementing collaborative education and practice, and defining and monitoring outcomes. These high-level themes were further broken down into ten recommendations which are presented in Figure 1. A detailed explanation of each recommendation is presented in the body of this report.

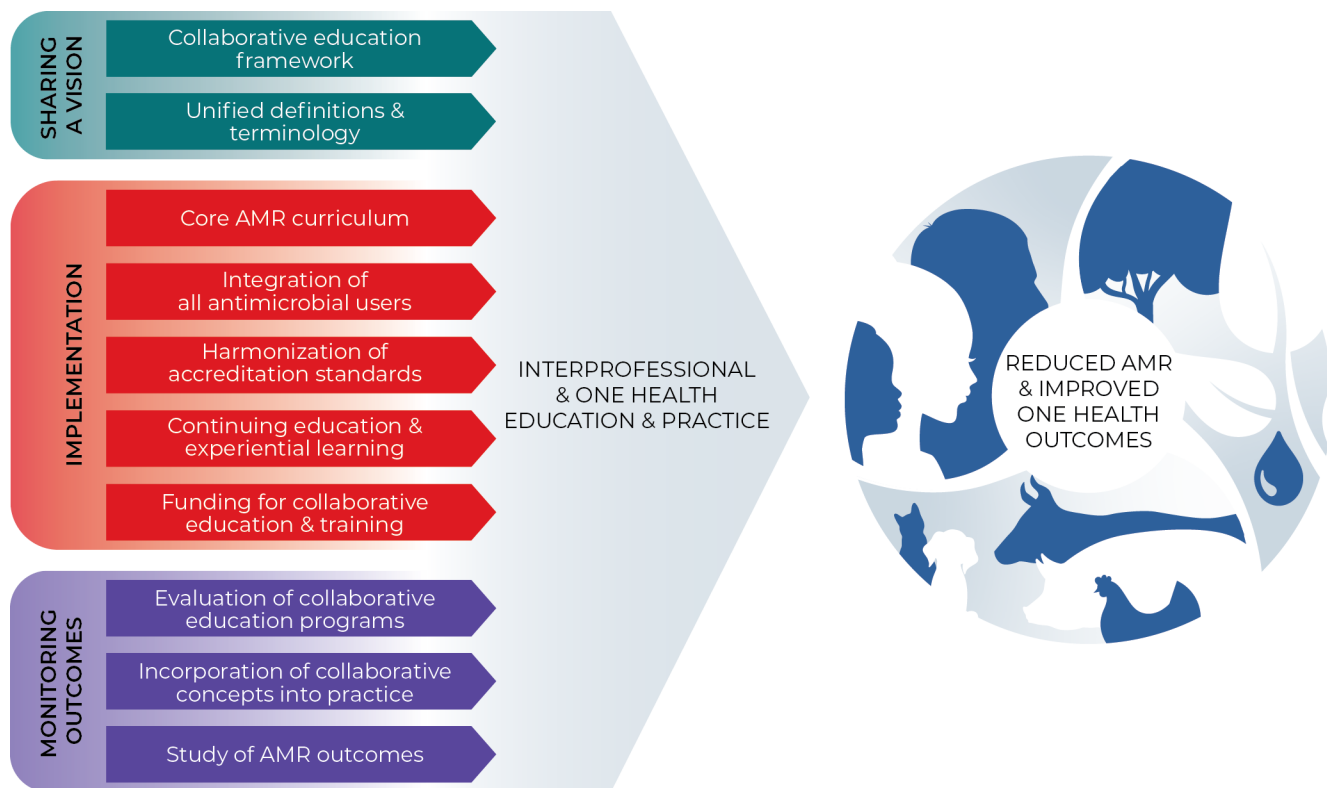


Figure 1: Summary recommendations from the PACCARB for advancing interprofessional education and practice to combat antimicrobial resistance. Please see the report for the full recommendations.

Sharing a vision of collaborative education and practice: Both IPE and One Health are collaborative education and practice pedagogies that espouse a multidisciplinary approach to health issues and are driven by similar goals, outcomes, and competencies. Effective collaborative education and practice

⁶ Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria. (2019). Reports & Recommendations. Retrieved from <https://www.hhs.gov/ash/advisory-committees/paccarb/reports-and-recommendations/index.html>.

should come from a shared vision of these ideas. This shared vision would be served by a framework that bridges the differences between IPE and One Health and supported through the adoption of unified definitions and a common understanding of collaborative education and practice terminology. The goal is to have both IPE/P and One Health paradigms learn from each other, and this can be achieved by expanding the traditionally included roles beyond only medical or veterinary professionals.⁷

Implementing collaborative education and practice: Few IPE/P and One Health programs address AMR in their curriculum. To further the impact of collaborative education and practice on reducing AMR, a core AMR curriculum founded on collaborative principles should be developed. This common curriculum can be used across all health science disciplines to develop or expand their educational programs, with an eye on including perspectives from all involved in the use of antimicrobials. To facilitate and incentivize incorporation of AMR and collaborative concepts into health science education and training, funding should be provided for development of new curricula and accreditation standards should be harmonized across health science professional schools. Additionally, collaboration, preventing AMR, antimicrobial stewardship, and IPC, which are often only taught during an individual's professional education (e.g., MD, DVM), should be taught along the entire learning continuum of the health professional, including continuing education.

Defining and monitoring outcomes: Once implemented, the PACCARB recommends monitoring both the short- and long-term measurable outcomes of the collaborative education and practice frameworks. This includes evaluating the education programs to ensure that the competencies identified in the shared vision of collaboration are taught within all health science fields, and that these skills are carried into practice-- with an emphasis on stewardship and infection prevention and control. Further study is necessary to measure the effects of collaborative education and practice on AMR by defining and monitoring measurable outcomes for positive impacts to help reinforce these skills.

⁷ The PACCARB Antibiotic Access and Use Working Group has identified medical “virtualists” and other non-physician providers as key personnel in promoting stewardship. See Recommendation 7 of their report *Bridging the Gap: Improving Antimicrobial Access and Use Across One Health* for more information.

INTRODUCTION

In October 2020, the Assistant Secretary for Health, Admiral Brett P. Giroir, M.D., on behalf of the Secretary of Health and Human Services, Alex M. Azar, II, tasked the Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria (PACCARB) to provide input on two important issues related to antimicrobial resistance (AMR)—the first addressing AMR through inter-professional education (IPE), and the second on exploring variations in antimicrobial access and use in human, animal, and environmental health.⁸ This report reflects the PACCARB recommendations for the first task: decreasing AMR through IPE and One Health education.

Process

To accomplish its assigned task, the PACCARB established a working group (WG) composed of council members and federal official subject matter experts (SMEs) in human, animal, and environmental domains. This report presents the IPE WG's findings on how IPE and One Health education can be used to address the topic of AMR and antimicrobial stewardship and how this education can be translated into interprofessional practice to improve antimicrobial prescribing practices. Each section of the report describes the issues and gaps identified regarding best practices, implementation, and the recommendations developed to address them.

To gain extensive feedback from involved stakeholders, the IPE WG held a series of virtual meetings hosting federal and non-federal SMEs to explore the issues related to the WG's mission statement and goals. As part of their investigation, they also received input at the PACCARB's 16th public meeting, held on February 10-11, 2021. This meeting included two days of panel presentations with a range of participants from the One Health domains, with the second day focused on interprofessional education and practice. A draft of this report with recommendations was presented to the full PACCARB at the June 29-30, 2021 public meeting for further evaluation and discussion. At that meeting the final version was approved unanimously for transmittal to the Secretary of Health and Human Services.

⁸ Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria. (2021). *Bridging the Gap: Improving Antimicrobial Access and Use Across One Health*. Retrieved from <https://www.hhs.gov/ash/advisory-committees/paccarb/reports-and-recommendations/index.html>.

BACKGROUND

The National Action Plan for Combating Antibiotic-Resistant Bacteria (NAP), 2020-2025,⁹ has recognized the role that education can play in promoting antimicrobial stewardship with its objective to “engage the public and other stakeholders to develop, expand, and increase national and State education, training, and communication campaigns focused on using antibiotics responsibly, stopping the spread of antibiotic resistance, and preventing infections and life-threatening conditions like sepsis.”¹⁰ Because AMR is often due to complex, interrelated, and difficult problems for which single-disciplinary methods have proven ineffective, a holistic and multidisciplinary approach including Interprofessional Education and Practice (IPE/P), is warranted.

Current WHO definition of IPE and the One Health Commission definition of One Health

WHO IPE/P Definition: “When students from two or more professions learn about, from and with each other to enable effective collaboration and improve health outcomes,” and “When multiple health workers from different professional backgrounds work together with patients, families, caregivers, and communities to deliver the highest quality of care.”

One Health Commission definition of One Health: “Collaborative, multisectoral, and trans-disciplinary approach - working at local, regional, national, and global levels - to achieve optimal health and well-being outcomes recognizing the interconnections between people, animals, plants and their shared environment.”

Since its establishment in 2015, PACCARB has espoused a One Health perspective on all tasks and encouraged coordination across disciplines in human, animal, plant, and environmental health. Although both are interdisciplinary with congruent goals and competencies, One Health and IPE are not used interchangeably across all fields (see Figure 2). IPE has historically been used as a modality for collaborative education and practice in human health and is typically focused on individual patient care. The collaborations formed are usually across human health professions, and as of yet have infrequently integrated the fields of animal, environmental, plant (in particular crop), or population health. One Health is intersectional, focuses on health issues that affect human, animal, plant, and environmental domains, and is frequently applied on the population level to topics in global and public health (such as zoonoses), with less focus on individual patient care. For simplicity in this report, the PACCARB outlines improvements to both IPE/P and One Health, using the term *collaborative education and practice* to refer to practices that can be ascribed to either paradigm or to both. The goal of *collaborative education* is to execute a successful pedagogy to ensure the effective education of, and life-long implementation by, all health science professionals. This includes a wide range of professions from human, animal, crop, and environmental health disciplines that make up One Health, such as physicians, nurses, laboratory medicine professionals, veterinarians, veterinary technicians, nutritionists, environmental scientists, public health officials, and others. The goal of *collaborative practice* is to translate learning into practice to allow for efficient healthcare delivery through innovations and shared

⁹ Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria. (2019). *Priorities for the National Action Plan on Combating Antibiotic-Resistant Bacteria: 2020-2025 A report with recommendations*. <https://www.hhs.gov/ash/advisory-committees/paccarb/reports-and-recommendations/index.html>

¹⁰ Federal Task Force on Combating Antibiotic-Resistant Bacteria. (2020, October). *National Action Plan for Combating Antibiotic-Resistant Bacteria, 2020-2025*. Retrieved from <https://aspe.hhs.gov/pdf-report/carb-plan-2020-2025>.

leadership. For the purposes of this report, the phrases “health professionals,” “health sciences,” and “healthcare,” include the entire range of One Health professions.

To accomplish the goal of translating collaborative education into practice, a successful collaborative education program requires introducing interprofessional learning early in the learning continuum and reinforcing it throughout a student’s education with an eye toward life-long practice. In pursuance of this goal, collaborative education should be competency-based with a focus on teamwork.¹¹ To combat the threat of AMR, collaborative education curricula should specifically address antimicrobial use, infection prevention and control (IPC), and antimicrobial stewardship.

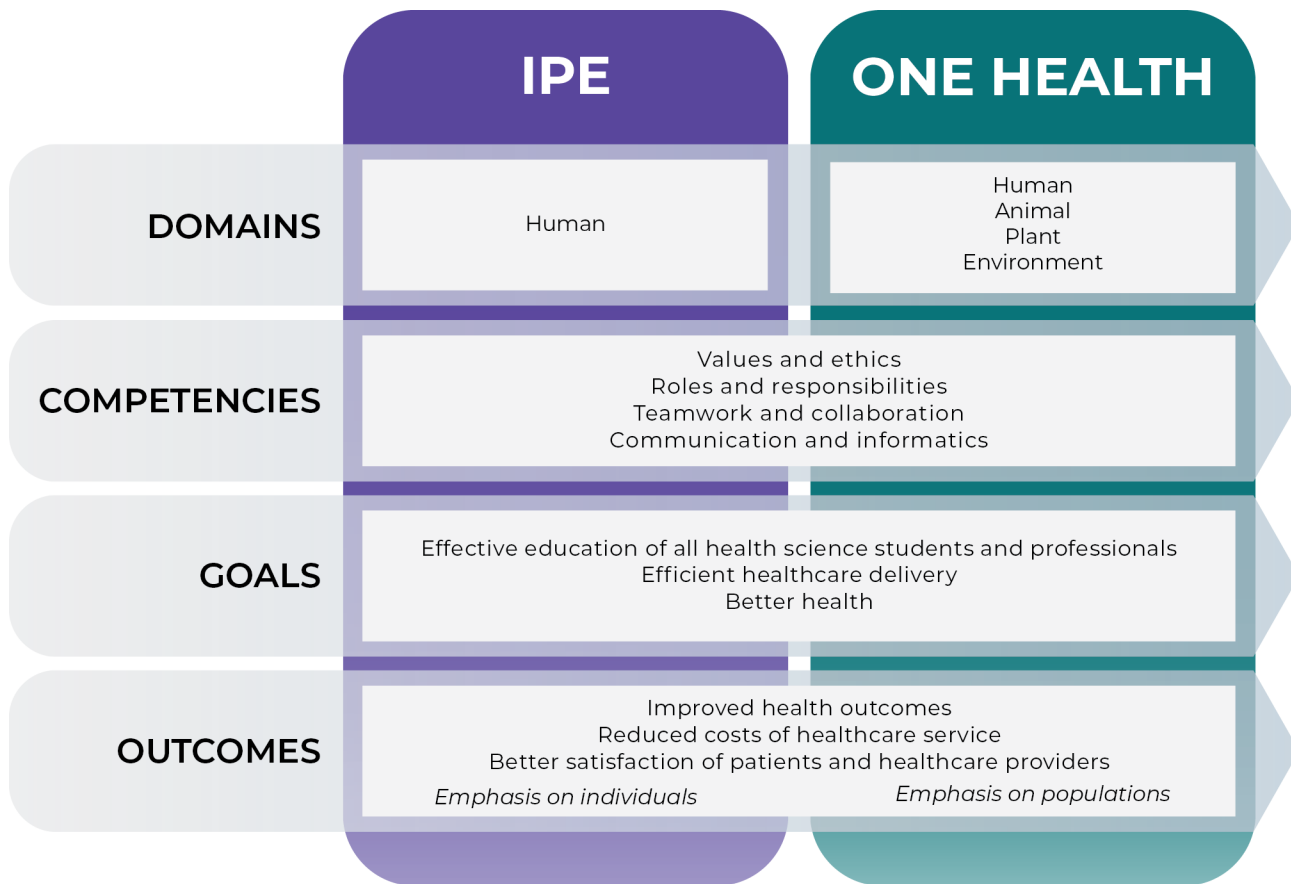


Figure 2: Parallels and divergences of the interprofessional education and One Health paradigms. Please see the report for full explanation.

Interprofessional Education Success and Applications for Combating AMR

Throughout the development of IPE, a number of core competencies, values, and outcomes for successful collaboration have been identified. One widely accepted framework for IPE has been proposed by the Interprofessional Education Collaborative (IPEC) and is described below. The core competencies, values, and outcomes of the IPEC framework were used by the PACCARB as the

¹¹ Institute of Medicine. (2015). Measuring the Impact of Interprofessional Education on Collaborative Practice and Patient Outcomes. Washington, DC: The National Academies Press. Retrieved from <http://nap.edu/21726>.

foundation for the development of the following recommendations to promote collaborative education and practice across the learning continuum for the health sciences.

The IPEC was established in 2009 as a collaboration between six national education associations of health professional schools to “promote and encourage constituent efforts that would advance substantive interprofessional learning experiences to help prepare future health professionals for enhanced team-based care of patients and improved health outcomes.”¹² To this end, the IPEC has described a successful IPE program as having three important outcomes:

- 1) Improve the patient experience of care.
- 2) Improve the health of populations.
- 3) Reduce the per capita cost of health care.¹³

Although the IPEC focuses specifically on health professionals, these outcomes are critical to collaborative education across all health sciences within the One Health framework.

The IPEC has also identified four overarching competencies for interprofessional collaborative practice.¹⁴ The PACCARB believes these competencies can provide a design framework that will generate successful collaborative education and practice programs and positive outcomes when applied to the crisis of AMR.

Values/Ethics: Successful collaborative practices require that professionals maintain a climate of mutual respect and shared values. Values and ethics represent the cornerstone of thinking and decision making; therefore, to combat AMR, practitioners across the health sciences must value the role of antimicrobial stewardship and IPC in the health of patients and populations.

Roles/Responsibilities: Each profession should understand their role and the roles of other professions in addressing the needs of patients and promoting and advancing the health of populations. To promote antimicrobial stewardship, each practitioner should understand their role in preventing antimicrobial misuse, including utilizing appropriate prescribing practices and patient messaging as well as effective IPC.

Communication: A multidisciplinary approach’s success relies on communication between practitioners across the health sciences, as well as patients, families, and communities. With regards to antimicrobial stewardship, practitioners should clearly communicate to patients/clients and other professionals the reasons underpinning their decision to prescribe a particular antimicrobial, or why antimicrobials are not being prescribed. Additionally, the collaborative team should communicate a unified message about prescription and IPC compliance.

Teams and Teamwork: Collaborative practice requires teamwork to plan, deliver, and evaluate patient/population centered care. To further the mission of antimicrobial stewardship and IPC, practitioners should particularly focus on the IPEC’s Team and Teamwork sub-competency to,

¹² Interprofessional Education Collaborative. (2020). About Us. Retrieved from <https://www.ipecollaborative.org/about-us>.

¹³ Interprofessional Education Collaborative. (2016). Core Competencies for Interprofessional Collaborative Practice: 2016 Update. Retrieved from <https://www.ipecollaborative.org/core-competencies>.

¹⁴ Ibid.

“Engage health and other professionals in shared patient-centered and population-focused problem solving.”

To leverage collaborative education and practice toward reducing AMR and promoting antimicrobial stewardship and IPC, PACCARB has identified three high-level recommendation themes: sharing a vision of collaborative education and practice, implementing collaborative education and practice, and defining and monitoring outcomes. These high-level themes capture recommendations for collaborative education from conception, through implementation, and into monitoring the effectiveness of the efforts. Within the three themes are ten recommendations to help promote and advance collaborative education and practice.

SHARING A VISION OF A COLLABORATIVE EDUCATION AND PRACTICE FRAMEWORK

Collaborative education can establish a framework that can be used to improve the training of medical, veterinary, agricultural, and environmental professionals with respect to antimicrobial stewardship, IPC, and reduction of AMR. Currently, AMR topics are not sufficiently represented in most IPE and One Health curricula.¹⁵ Furthermore, the animal, plant, and environmental domains of One Health have seldom been incorporated into existing IPE activities and programs. However, before existing programs can be successfully expanded to include antimicrobial stewardship and IPC, a number of barriers to effective enactment of interdisciplinary training must be acknowledged and addressed.

The current systems of education among the health science disciplines are still largely siloed. Professions are trained separately, and even if there is a recognition of the importance of interprofessional experience and cross-disciplinary training, there is no shared vision among disciplines of a cohesive collaborative education framework. As a result, students have limited exposure to other disciplines during training. This lack of interaction between disciplines allows each to have its own culture, which can lead to clashes when disciplines do come together. Inconsistencies in terminology and lexicons also contribute to the disconnect between disciplines. Even within human healthcare disciplines, vocabulary is variable and can result in misunderstandings and miscommunication. To break down the disciplinary silos, cultural differences, and inconsistent terminology, **a shared vision is needed that includes teamwork and interdisciplinary practice as key goals of collaborative practice.**

Collaboration is learned more effectively with experiential rather than solely didactic and lecture-based education, but incorporating new learning paradigms system-wide is more difficult than creating an additional lecture. Development of meaningful learning experiences requires more resources, pedagogical expertise, and planning. Furthermore, coordinating shared educational programs across different professions presents major hurdles because they are on different schedules, progress at different rates, and consist of different educational pedagogies. When looking to bring One Health disciplines together, the logistical challenges are multiplied and compounded by the widely varying number of institutions for each discipline. For example, in the U.S. there are approximately 172 medical schools, over 2,000 nursing schools, 136 pharmacy schools, and 33 veterinary schools.^{16,17,18,19,20}

¹⁵ Togami, Eri & Gardy, Jennifer & Hansen, Gail & Poste, George & Rizzo, David & Wilson, Mary & Mazet, Jonna. (2018). Core Competencies in One Health Education: What Are We Missing?

¹⁶ Association of American Medical Colleges. (2021). AAMC Medical School Members. Retrieved from <https://members.aamc.org/eweb/DynamicPage.aspx?site=AAMC&webcode=AAMCOrgSearchResult&orgtype=Medical%20School>.

¹⁷ American Association of Colleges of Nursing. (2021). Baccalaureate Education. Retrieved from <https://www.aacnnursing.org/Nursing-Education-Programs/Baccalaureate-Education>.

¹⁸ Nursing Explorer. (2021). Associate Degree in Nursing (ADN). Retrieved from <https://www.nursingexplorer.com/adn>.

¹⁹ American /veterinary Medical Association. (2021). Accredited Veterinary Colleges. Retrieved from <https://www.avma.org/education/accredited-veterinary-colleges>.

²⁰ Accreditation Council for Pharmacy Education. (2021). Programs by Status. Retrieved from <https://www.acpe-accredit.org/accredited-programs-by-status/>.

Promote Interprofessional Collaboration and One Health in Health Sciences Pedagogy to Reduce AMR and Improve Health Outcomes

Recommendation 1: Advance the adoption of a framework of effective collaborative education across all health science professions that are impacted by AMR.

Goal 1, Objective 2 of the NAP directs federal agencies to develop and expand stakeholder outreach and education, including training guidelines that can increase responsible use of antimicrobials and help stop the spread of AMR. A common collaborative education training framework that can be used across all One Health professions will allow educational institutions to develop programs that emphasize collaboration. An effective framework would accomplish the following:

- **Establish core competencies.** The framework should define core competencies that all educational programs should achieve. A competency-based, rather than activity-based, framework focuses on educational outcomes and is less prescriptive, allowing individual institutions flexibility in how to achieve the defined goals of a successful collaborative education program.²¹ Defining core competencies such as the four promoted by IPEC (referred to in the background section of this report) will help to harmonize professional education goals across the health science professions.
- **Define teamwork.** The framework should define what behaviors constitute effective teamwork for successful collaboration. As an example, the framework might define observable team skills (based on IPEC competencies) such as collaborative decision making, conflict management, mutual support, and accountability.²²
- **Describe roles.** The framework should focus on generating flexible roles of leadership, co-leadership, and followership so that individuals can define their role based on the needs of any scenario. Roles should also be rotated so that individuals may experience the entire breadth of responsibilities.
- **Emphasize One Health.** The framework should expand the traditional scope of IPE, which is largely confined to human medicine, to include all One Health domains: human, animal, plant, and environment. To facilitate adoption of this new paradigm, the framework should help identify the types of interdisciplinary collaborations that can be especially effective in helping to improve antimicrobial prescribing and use as well as IPC, recognizing that not all clinical situations will require the entirety of One Health professionals to participate.
- **Encourage practice-based education.** The framework should direct programs to develop collaborative team skills through practice-based experiences, with reflection and review for each experience. Experiential learning is more effective than didactic learning, and the

²¹ Interprofessional Education Collaborative. (2016). Core Competencies for Interprofessional Collaborative Practice: 2016 Update. Retrieved from <https://www.ipecollaborative.org/core-competencies>.

²² Case Western Reserve University. (2021). The Interprofessional Learning, Experience and Practice program at Case Western Reserve University. Retrieved from <https://case.edu/ipe/>.

teamwork and cooperation that is the focus of collaborative education is best learned and reinforced through team-based experiences.

Recommendation 2: Adopt unified definitions for collaborative education and practice terminology.

One barrier to effective interprofessional coordination and collaboration is the inconsistent terminology used across and within One Health disciplines. Terms such as interdisciplinary, interprofessional, transdisciplinary, and others are used interchangeably by some and have distinct meanings to others. Further, consensus on the scope of interprofessional education and practice and bridging the gaps between human, animal, plant, and environmental health have not been achieved. Discussion and harmonization of terminology and definitions are important early steps that will facilitate coordination in developing and implementing collaborative education and practice programs. In reviewing terminology, the following should be considered:

- Clearly define a common *understanding* of collaborative education and practice across collaborating groups. All fields and professions do not need to use the same vocabulary and changing a longstanding lexicon would be very difficult. However, it is necessary to establish understanding among groups as to each other's intention when specific terms are used and the concepts that they represent. Furthermore, participants in collaborative education and practice need to understand and be respectful of each other's definitions, which may have a long and deliberate history.
- Adopt a definition of collaborative education and practice that includes and unifies IPE/P and One Health. Doing so will create a collaborative approach in which students and/or professionals from human, animal, plant, and environmental health disciplines learn about, from, and with each other, as well as work together to achieve greater One Health outcomes.
- Ensure that AMR is included in collaborative education and practice. Among existing programs, antimicrobial stewardship, IPC, and other AMR-related topics are poorly represented, despite being ideal examples of tangible collaborative education and practice applications. To effectively incorporate the two, identify and articulate how collaborative concepts relate to and are applied to antimicrobial use and stewardship and IPC.

IMPLEMENTING COLLABORATIVE EDUCATION AND PRACTICE

Successful collaborative frameworks must be integrated throughout an individual's education and career.²³ If the collaborative education and practice framework is to be utilized to improve the understanding of AMR across the health sciences, system-wide adoption of these concepts is necessary. Implementation of collaborative education programs targeted towards AMR, IPC, and antimicrobial stewardship concepts across the learning continuum (professional—e.g., MD, DO, RN, DVM, PharmD, PhD, MPH; graduate—e.g., residencies and fellowships; and post-graduate/continuing education) will ensure the internalization of collaborative concepts. However, there are barriers that must be acknowledged and addressed before improvement and long-term sustainability of collaborative education and practice can be effectively adopted.

There are currently few incentives for institutions to integrate collaborative concepts into the education or practice of health science disciplines. Educational systems are already overburdened with content mandates and practice standards from the educational institution itself and from external sources such as accrediting bodies and professional associations. The pressures of meeting these competing interests can make voluntary adoption of additional non-mandated content, such as collaborative education, difficult. Some health science professional or graduate programs have implemented collaborative education concepts, but they have not been widely or equally adopted across all such programs and have not been applied to the entire learning continuum of One Health professionals.

The lack of collaborative education and training exists not only in professional education but throughout a practitioner's education and career. There are limited efforts to integrate collaborative education formally or informally within the foundational education phase (e.g., undergraduate), and engagement in graduate and post-graduate education is ad hoc and generally at the discretion of the learner. Even later in careers, mechanisms for sustained learning, such as continuing education, rarely focus on or even include collaborative practice concepts. Because of these deficiencies, many health science professionals are only exposed to collaborative education and practice during their professional education, if at all. This results in an incomplete or fragmented application of collaborative concepts that can be quickly lost in a workplace that does not adopt collaborative practice, which threatens the sustainability of collaborative education and practice. Furthermore, the focus on collaboration only during professional education limits the pool of participants for collaboration, neglecting the education of many of the roles that touch the antimicrobial use-chain, such as patients or veterinary technicians.

Along the learning continuum, regulation of educational content for students and professionals is decentralized and varied. Accrediting bodies of education systems ensure that broad standards are adopted and taught, but curricula are ultimately determined by the faculties of the educational institutions themselves. Continuing education mandates and board requirements are generally determined at the state level, while professional certification is nationally organized by professional societies, and none have embraced issues of AMR or collaborative practice in a standardized, effective way. Across these institutions, the Federal Government has little to no oversight, making widespread implementation even more difficult. **Collaborative education and practice concepts should be**

²³ Institute of Medicine. (2015). *Measuring the Impact of Interprofessional Education on Collaborative Practice and Patient Outcomes*. Washington, DC: The National Academies Press. Retrieved from <http://nap.edu/21726>.

applied throughout the learning continuum, but this will require cooperation and harmonization across a wide swath of institutions and organizations that all function independently from each other.

Promote Integration of AMR Topics and Collaborative Education into Curricula and Extracurricular Learning

Recommendation 3: Define and create a core AMR curriculum founded on team and collaborative learning concepts that can be used for all health science students.

Educational institutions are overburdened and have little incentive to invest resources into creating collaborative education content. A standardized, core collaborative curriculum that focuses on antimicrobial stewardship, IPC, and other AMR issues can be used to lessen burdens on education systems. Furthermore, generating a harmonized curriculum will ensure that all students in every health science discipline receive an effective and complete education regarding collaborative concepts and AMR. When developing a core AMR collaborative curriculum, the following should be considered:

- The content of the curriculum should be:
 - i. Designed for team and collaborative learning with a primary learning goal of creating a professional capable of collaboration;
 - ii. Based on competencies that have measurable outcomes to assess the effectiveness of collaborative learning;
 - iii. Founded on relevant examples to engage learners in the content, leading to effective learning; and
 - iv. Inclusive of collaborative models of antimicrobial stewardship and IPC as practical methods to combat AMR.
- Develop a curriculum that can be readily integrated into existing health science courses, either in modules or in whole, rather than adopted as a separate IPE course. Doing so will create a more effective learning environment by incorporating concepts across multiple classes and environments. Furthermore, it will reduce the resource burden on institutions implementing the curriculum.
- Ensure that the curriculum is flexible to allow health science professions to add customized AMR-relevant materials to make the instructions more pertinent to their mission. A truly collaborative education curriculum will include concepts that can be adapted to various health science disciplines and provide suggestions on how and when to do so.
- Promote adoption of the curriculum through extracurricular learning (e.g., One Health clubs) to provide an alternative route for adoption of collaborative education in overtaxed educational systems. Incorporation of the curriculum's educational concepts in multiple settings will also help learners absorb the material and develop a culture of collaboration and AMR awareness.

- Ensure that the curriculum can be distributed using online learning to minimize the logistical and/or geographical limitations of collaborating across health science disciplines. While it may not be feasible to design a single curriculum that can be used both in-person and virtually, the curriculum should be flexible enough to allow for either or both modalities.

Recommendation 4: Integrate all antimicrobial users (e.g., prescribers, practitioners, clients, and patients) into collaborative education and practice.

Examples of collaborative education implementation exist at the professional education level, but collaborative efforts can be made more effective when learners are introduced to other disciplines earlier in their careers. A need for collaborative education in the pre-graduate phase provides an opportunity to instill collaborative concepts earlier so that they can be ingrained. Additionally, the disciplines and professions that have historically been engaged for collaborative or AMR education are few and expanding efforts to broader communities will help create a more cohesive One Health system. Gaps in knowledge regarding AMR and effective stewardship among some antimicrobial users can be filled by integrating more disciplines into collaborative education.²⁴ Effective collaborative AMR engagement should include the following:

- Ensure that individuals across all professions that utilize or interface with antimicrobials participate in the collaborative education process, both as students and educators. This includes professions traditionally included in IPE (e.g., physicians, nurses, pharmacists, etc.) as well as those that can create a broader One Health perspective, but which have historically been excluded, such as veterinarians, veterinary technicians, and nutritionists. When possible, students from different disciplines should learn together, and concepts should be taught by multidisciplinary teams.
- Introduce collaborative learning as early into the learning continuum as possible. From early in their academic careers, students learn (intentionally or unintentionally) to think of healthcare in terms of roles and disciplines that are siloed. The sooner students can think outside of these silos, the sooner an appreciation for other disciplines can be developed and the need for collaboration recognized.
- Integrate non-traditional educators into collaborative education, curriculum development, and practice to include diverse viewpoints and create a greater connection across all antimicrobial users. For example, the nation’s Land-Grant Cooperative Extension System provides non-formal higher education and learning activities and can be leveraged to reach a variety of stakeholders, including agricultural producers, communities, youth, and families throughout the country. Likewise, patient educators can be included in the collaborative education system to provide the patient perspective during medical and graduate education, and patients can be integrated into their own collaborative care.

²⁴ The PACCARB Antibiotic Access and Use Working Group strongly recommends the inclusion and integration of crop and environmental health experts in all AMR related collaborative activities to fully embody a One Health perspective. See Recommendation 2 of their report *Bridging the Gap: Improving Antimicrobial Access and Use Across One Health* for more information.

Incentivize AMR Collaborative Education and Practice through Accreditation and Funding

Recommendation 5: Harmonize accreditation standards across health science professional schools to include antimicrobial stewardship, AMR prevention, IPC, and collaborative skills.

Regulation of educational content across the health sciences is decentralized and varied. There are different accrediting bodies for each of the One Health disciplines and for different professional tracks within human health (i.e., there are different accrediting bodies for veterinarians, physicians, nurses, pharmacists, etc.). To ensure that all institutions are educating their students and future practitioners to the same standard in regard to AMR prevention and collaborative practice, the accrediting organizations of the health science professions, such as the Liaison Committee on Medical Education for Association of American Medical Colleges, the Council on Education for American Veterinary Medical Association, the Accreditation Council for Pharmacy Education for Pharmacy, and the Commission on Collegiate Nursing Education for Nursing, should harmonize their accreditation standards.

- When creating new standards or harmonizing existing ones, the accrediting organizations should ensure that accreditation standards are tied to a competency-based core curriculum with measurable learning outcomes that uphold the goals of collaborative education and AMR prevention.

Recommendation 6: Promote collaborative practice through continuing education and experiential learning opportunities.

Concepts taught during education can be lost in the transition to practice. It is important to perpetuate the lessons of collaborative education throughout a practitioner's career. One barrier to transitioning collaborative education into practice is that there is no requirement to continue using collaborative skills. Continuing education is mandated for some professions but regulations and requirements for the content of that education are variable and are determined at the state level. There is an abundance of continuing education opportunities, some of which address collaborative skills and/or AMR reduction, but there is little incentive for a practitioner to select these courses as part of their continuing education. The following actions can enhance the current continuing education system to better promote collaborative practice while strengthening antimicrobial stewardship and IPC:

- Ensure that the standards for continuing education across disciplines incorporate AMR and collaborative competencies. To fully foster collaborative practice and its use to combat AMR, all health science disciplines must encourage continuing education on these topics and facilitate opportunities for collaboration across disciplines.
- Utilize Joint Accreditation for Interprofessional Continuing Education to mandate inclusion of interprofessional continuing education, antimicrobial stewardship, and IPC for health professionals across all states and certifications.
- Generate regional collaboratives between health professional schools and health professions to generate a nurturing learning system. To facilitate this process, identify leaders in

collaborative education and practice that can spearhead and support the regional collaboratives.

- Employ alternative modalities for experiential learning, such as simulation, to overcome logistical challenges of on-site, in-person experiences (e.g., in extremely rural settings, when multidisciplinary programs are on different schedules, or during disasters such as the COVID-19 pandemic).
- Promote opportunities for professional exchanges, such as externships, to allow for experiential learning across One Health disciplines to maintain a climate of mutual respect, shared values, and interdisciplinary knowledge that can bolster collaborative practice which is consistent with the core competencies of IPE.

Recommendation 7: Provide or increase funding for collaborative education and training.

Development of new curricula and educational programs is a time- and resource-intensive process. Current medical, veterinary, and other health professional curricula have evolved over decades in response to advancing science and increasing requirements from accrediting bodies and other institutions. Restructuring existing health professional education systems will require significant investments from all involved. Curriculum development is not funded at the federal level; however, the Health Resources & Services Administration grant program has provided funding for health professional training programs and could provide funding specifically for collaborative education and practice. Additionally, there are non-governmental organizations (e.g., Spencer Foundation, Macy Foundation, Institute for Healthcare Improvement) that provide grants for improved educational outcomes. These organizations should be encouraged to consider prioritizing the funding of collaborative education and training opportunities.

- Additional resources will be important to overcome some of the logistical challenges of bringing together multiple disciplines to implement collaborative education and practice programs.
- Current IPE/P programs rarely cross the human, animal, plant, or environment discipline silos, and One Health programs, which do, are scarce. Funding can be leveraged to develop novel frameworks that expand disciplines traditionally included in both IPE/P and One Health programs.
- Funding can also be used to develop extracurricular opportunities to foster collaborative practice, such as mentorship opportunities, conferences, and workshops that focus on creating cross-disciplinary training programs or using collaborative practice concepts to address AMR issues.

DEFINING AND MONITORING OUTCOMES

A crucial step in developing and implementing collaborative education and practice programs is measuring and evaluating progress and effectiveness. Administrators, whether in educational or professional settings, should **define desired outcomes of collaborative education and practice and develop metrics to measure and monitor success**. Outcomes should be both short-term, such as effective teaching of collaborative concepts, and long-term, such as incorporation of collaborative concepts into practice. Furthermore, monitoring the intended health outcomes that collaborative education and practice are meant to improve should be a long-term goal that will help demonstrate the value and effectiveness of collaborative concepts. In 2015, the National Academies of Sciences, Engineering, and Medicine (NASEM) released a report on measuring the impact of IPE on collaborative practice and patient outcomes. One of the key findings in this report was that “more purposeful, well-designed, and thoughtfully reported studies are needed to answer key questions about the effectiveness of IPE in improving performance in practice and health system outcomes.”²⁵ Six years later, **studies are still needed to verify that the collaborative education and practice process is improving health outcomes, particularly as they relate to AMR.**

Assess Effectiveness of Collaborative Education and Practice Programs

Recommendation 8: Evaluate collaborative education programs.

Institutions implementing collaborative education should perform periodic evaluations of the programs to ensure their effectiveness. As with any educational tool or curriculum, evaluation is important to determine whether educational goals are met, and specifically whether the program successfully imparts the desired knowledge and behaviors on learners.

- Existing models of program evaluation can be used to determine the success of the program. Common questions to answer include: 1) Did the learners enjoy the courses and find them relevant? 2) Did the learners acquire the intended knowledge and skills? 3) Did the learners incorporate the gained knowledge and skills into their professional practice?²⁶
- Short-term outcomes can be determined through feedback mechanisms and testing to assess how effective educational courses are at imparting the desired knowledge and skills.
- Evaluating long-term outcomes such as how well learners incorporate concepts into practice and whether behavior changes result in the desired health outcomes require longer-term studies which incorporate multifactorial surveillance. Monitoring these long-term outcomes is discussed further in recommendations 9 and 10.

²⁵ Institute of Medicine (U.S.). Committee on Medical Evaluation of Veterans for Disability Compensation. (2015) Measuring the impact of interprofessional education on collaborative practice and patient outcomes. Washington, D.C.: National Academies Press.

²⁶ The Kirkpatrick Model is one commonly used framework that espouses such evaluation factors. See <https://www.kirkpatrickpartners.com/Our-Philosophy/The-Kirkpatrick-Model>.

Recommendation 9: Ensure that collaborative concepts are incorporated into practice.

Collaborative concepts and skills learned during graduate, post-graduate, and continuing professional education must be implemented and become central to the principle of practice for collaborative professionals. Only when incorporated into regular practice can collaborative concepts lead to the desired improvements in health outcomes. Both educational and professional institutions have a role in ensuring this incorporation.

- Educational institutions should monitor uptake and utilization of collaborative skills by their learners as they enter and advance through the workforce. As part of the program evaluation process, these institutions should seek input and feedback regarding the effectiveness of the educational program and how well the concepts are being applied from former students that are now practicing (e.g., physicians, veterinarians, nurses).
- In the workplace or clinic, organizations wishing to implement or improve collaborative practice must develop and implement a plan to monitor its progress. To further their collaboration goals, these organizations should explore opportunities to incentivize measuring outcomes and monitoring effectiveness of collaborative practice.

Recommendation 10: Perform or fund studies of collaborative education and practice programs to determine their impact on reducing AMR.

While interprofessional education aims to improve the health of individuals and populations, it has not been directly applied to addressing the issue of AMR. However, the concepts of collaborative education and practice could be used to improve AMR outcomes. Upon execution and integration of the aforementioned recommendations, outcome studies such as the ones promoted by the NASEM, should be conducted to understand the role of collaborative education and practice in AMR.

- Define measurable outcomes for the positive impacts of collaborative education and practice on AMR. Measurable positive outcomes are necessary to identify successful programs and the connection between collaborative education and AMR.
- Develop an evaluation plan to assess the processes and outcomes of collaborative education and practice endeavors to address AMR. Evaluations should be tied to the competencies that were integrated into the collaborative education and/or practice program.
- Institutions should report on the implementation of collaborative education to track positive outcomes. These data can then be leveraged to influence administrative choices to continue the collaborative education programs. When possible, these reports should also include descriptions of barriers to implementation to help develop lessons learned and best practices for collaborative education implementation.
- The measurable outcomes can be used to develop institutional incentives to implement collaborative education and practice strategies. Establishing a connection between collaborative education and practice, improved health outcomes, and reducing healthcare costs may be an incentive to continue the program.

CONCLUSIONS

The collaborative systems of One Health and IPE/P are complementary, with overlapping goals and competencies, and can be adopted in education and practice to effectively combat AMR. This report puts forth ten recommendations for promoting effective collaborative education and practice from conception, through implementation, and into monitoring the effectiveness of the efforts.

Despite their similarities, the two concepts of One Health and IPE/P remain mostly separate, with most health science disciplines subscribing to one or the other and little coordination between them. Furthermore, explicit application of these paradigms to reducing AMR through improving antimicrobial stewardship and IPC is infrequent. The complex, interdisciplinary nature of AMR necessitates that such collaborative approaches be used in training health professionals, therefore steps should be taken to better integrate these concepts across the One Health disciplines.

First, a shared vision of collaborative education and practice should be promoted that highlights the common goals of teamwork and interdisciplinary practice. This collaborative framework would emphasize core competencies, many of which have already been established in One Health and IPE/P programs, with a special focus on bridging connections between the One Health domains (human, animal, plant, and environment). A consensus definition of terms used should be reached to facilitate communication across disciplines and ensure a common understanding of goals.

To implement the collaborative framework and employ it in the fight against AMR, a core curriculum that includes the foundational activities of antimicrobial stewardship and IPC in an interdisciplinary, collaborative structure should be developed. Adoption of this curriculum across the One Health disciplines will help to ensure that all health science professionals are similarly and adequately trained on these concepts. Incorporation of this core curriculum and the collaborative framework should be supported across the spectrum of health sciences and through the entirety of the learning continuum through mechanisms such as accreditation standards, continuing education, and experiential learning opportunities, supported by additional funding. These actions will ensure that all health professionals are learning about antimicrobial stewardship, as well as integrating antimicrobial stewardship and collaboration beyond education and into professional identities and practice settings.

As these recommendations are implemented, progress measurement through outcome monitoring will be important. Short-term goals of collaborative education, such as the integration of collaborative competencies into education curricula, creation of opportunities for extracurricular activities, and long term-goals, including the reduction of AMR, must be measured to evaluate the effectiveness of these efforts. This outcome data is important to inform administrative and business decisions and support sustained collaborative education and practice programs.

Collaborative education and practice paradigms such as IPE/P and One Health provide powerful opportunities to harmonize efforts across the health science disciplines to combat AMR and improve antimicrobial stewardship and IPC. Ultimately, it is the PACCARB's hope that the recommendations presented here, along with the noted action steps, provide a framework for a successful path toward this goal.

ANNEX I – TASK LETTER FROM SECRETARY



October 16, 2020

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Dear Drs. Blaser and King:

On behalf of the Secretary of Health and Human Services, Alex M. Azar, II, I would like to thank you for your continued leadership of the Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria (Advisory Council). The Advisory Council continues to inform and lead discussion of the most pressing issues facing us as we battle the threat of antibiotic resistance. The COVID-19 pandemic poses new challenges in this fight, and I thank you and the Advisory Council for gathering and presenting the most current information available on the intersection of antibiotic resistance and COVID-19 at your recent public meeting in September, 2020. The presentations and discussions helped raise awareness of the issues that have emerged and may still arise as we address two concurrent public health crises. As we continue our fight against antibiotic resistance during this pandemic, your expertise is once again needed to provide input on two important issues.

Task#1 – Inter-professional Education on Antimicrobial Resistance (AMR)

Education and training of our healthcare professionals is an essential component of our fight against antibiotic resistance. We must continually evaluate the effectiveness of our professional education system and incorporate modern curricula and training regimens for human health, veterinary and agricultural settings. Inter-professional education is one such strategy that deserves our attention; it occurs when two or more professions (for example, students, residents and health workers) learn with, about and from each other to enable effective collaboration and improve health outcomes.¹ Inter-professional education has the potential to lead to better implementation of infection prevention and control strategies, as well as more appropriate use of and reduced need for antibiotics, including both antibacterial and antifungal agents, in healthcare and agricultural settings.

I would like the Advisory Council to explore the status of professional education opportunities and availability, and the extent to which they incorporate inter-professional components in human, veterinary and agricultural disciplines as they relate to antibiotic stewardship and infection prevention and control.

Deliverable Requested by Sept 2021: A report on the status of inter-professional education for antibiotic stewardship and infection prevention with an assessment of the extent to which a common curriculum across professions exists, and identification of opportunities for improvement. Your investigation should explore curricula for frontline healthcare workers, animal care providers and agricultural extension agents, as well as administrators and others who make purchasing decisions so that all aspects of healthcare, animal care and agricultural provisions are considered holistically. As part of your findings, please provide observations and recommendations as to whether and how U.S. educational institutions, federal agencies, training programs and specialty boards can strengthen national and state board certification and continuing education of medical and veterinary professionals.

Task #2 – Variations in Access, Prescribing and Use of Antibiotics

Appropriate use of antibiotics across One Health depends on several factors. For human health, the availability and quality of healthcare, level of knowledge among patients, and many socioeconomic factors play a key role. We know that health disparities exist among different populations in many aspects of healthcare, including those demonstrated in the current COVID- 19 outbreak. As our healthcare system evolves, new and alternate models for providing patient treatment are arising to facilitate access to healthcare, such as telehealth, walk-in retail clinics and urgent care centers. As these models become more ubiquitous, it is important to assess both the opportunities and challenges they may provide for improving antibiotic stewardship, and how they may affect currently observed disparities in antibiotic prescribing.

Additionally, given the broad variety of species and animal care settings in the veterinary sector, there are numerous factors that can impact how antibiotics and antifungals are used. Differences in how antibiotics are prescribed among veterinary settings and the different agricultural commodities may vary and should be further explored.

Therefore, I would like the Advisory Council to provide an overview of the existing variations in the prescribing, access, and use of antibiotics and antifungals (as appropriate) across the One Health spectrum (medical, veterinary, and agricultural settings), and identify any knowledge gaps that are observed. Please explore how these factors may be impacted by the availability of health resources, education level and access to appropriate information and training.

Deliverable Requested by Sept 2021: A two-part report addressing human and animal health, respectively. One part should address health disparities and inequities related to how antibiotics are accessed and used. This report should include an investigation into differences in perception and usage of antibiotics among minority groups and other historically disadvantaged populations. Your findings should explore and incorporate the role that new modalities of outpatient care, such as medical telehealth options and retail walk-in clinics, may play in alleviating or deepening disparities or inequities, and the opportunities and challenges they may present in advancing antibiotic stewardship efforts.

¹ World Health Organization. (2010). Framework for action on interprofessional education and collaborative practice. World Health Organization. <https://apps.who.int/iris/handle/10665/70185>

For the other part of your report, please consider the current differences among various animal care and plant agriculture settings, and the factors that may be affecting antibiotic use. It should include a discussion of how to encourage stewardship and mitigate any variances in antibiotic prescribing and use in these diverse settings and modalities.

Please form two new working groups to address these two tasks, and host two public meetings to gain stakeholder feedback to inform your reports. Thank you again for your continued dedication and I look forward to learning about your proceedings in the coming months.

Sincerely yours,

Brett P. Giroir, M.D.
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ANNEX IV – ACRONYMS AND ABBREVIATIONS

AMR	Antimicrobial resistance
APHIS	Animal and Plant Health Inspection Service
CARB	Combating antibiotic-resistant bacteria
CDC	Centers for Disease Control and Prevention
CMS	Centers for Medicare and Medicaid Services
IPC	Infection prevention and control
IPE	Interprofessional education
IPEC	Interprofessional Education Collaborative
IPE/P	Interprofessional education and practice
NAP	National Action Plan for Combating Antibiotic-Resistant Bacteria, 2020-2025
NASEM	National Academies of Sciences, Engineering, and Medicine
PACCARB	Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria
SME	Subject matter expert
WG	Working group