Translating Microbiome Science to Public Health Prevention

The Human Microbiome and its Links to Communicable and Non-Communicable Diseases, November 5, 2020

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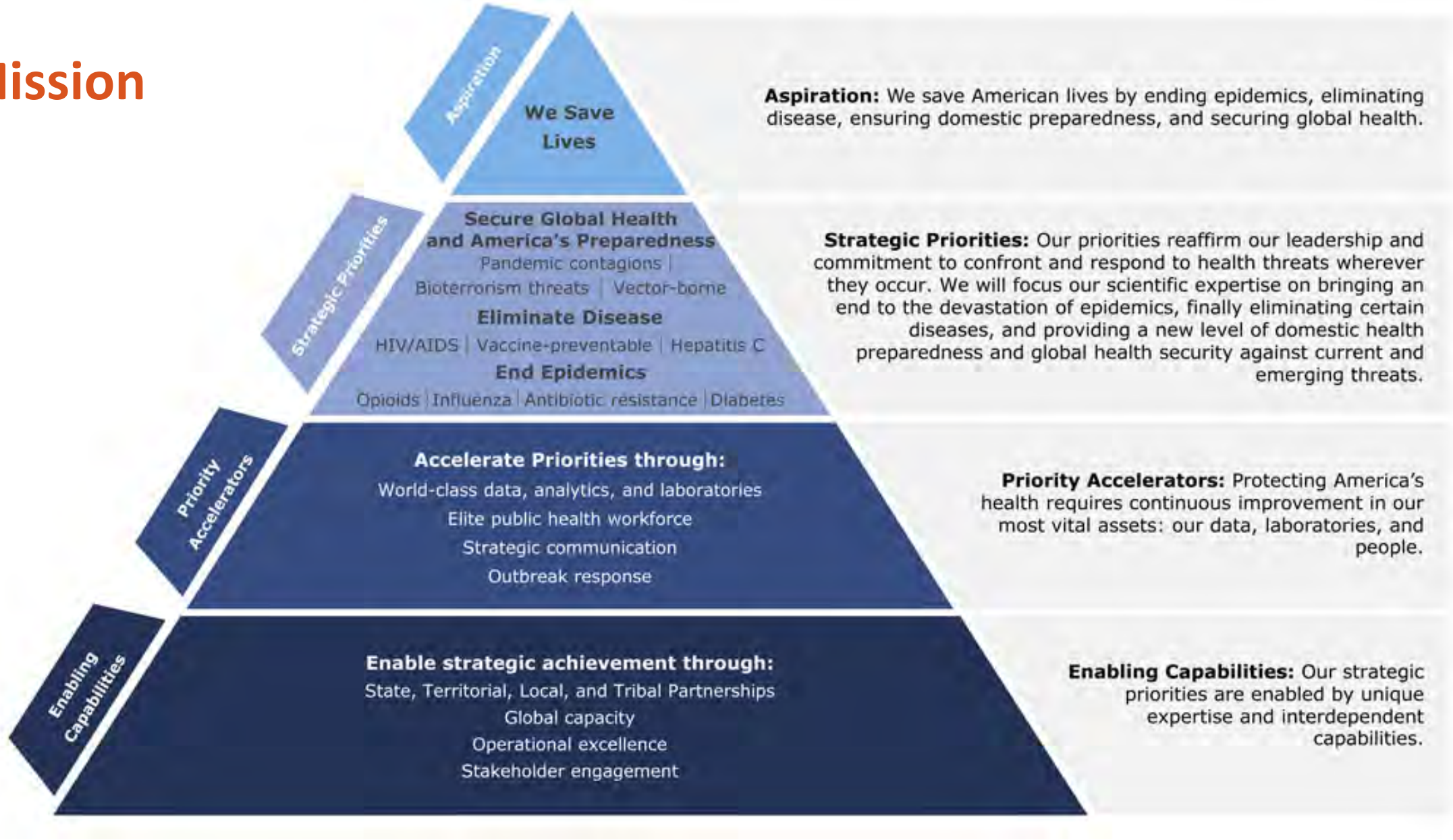
Disclosures

- *No Financial Disclosures*

- *The findings and conclusions in this presentation are solely those of the author and do not necessarily represent the official position of the Centers for Disease Control and Prevention.*

CDC's Mission



https://www.cdc.gov/about/organization/strategic-framework/index.html

Great Advances in Public Health in the Past Century

- Vaccination
- Smoking cessation
- Motor vehicle safety
- Sanitation, hygiene, control of infectious diseases
- Safer workplaces
- Fluoridation of drinking water
- Decline in deaths due to coronary heart disease and stroke

MMWR. April 02, 1999 / 48(12);241-243

Great Advances in Public Health in the Past Century cont.

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What's Next?

MMWR. April 02, 1999 / 48(12);241-243

Mission of The Division of Healthcare Quality Promotion

To protect patients; protect healthcare personnel; and promote safety, quality, and value in both national and international healthcare delivery systems.

The Threat of Antibiotic Resistance in the United States

U.S. Department of Health and Human Services
Centers for Disease Control and Prevention

New National Estimate*

Antibiotic-resistant bacteria and fungi cause at least an estimated:

2,868,700 infections

35,900 deaths

+

***Clostridiodes difficile* is related to antibiotic use and antibiotic resistance:**

223,900 cases

12,800 deaths

New Threats List

Updated urgent, serious, and concerning threats—totaling 18

5 urgent threats

2 new threats

NEW:
Watch List with 3 threats

Antibiotic resistance remains a significant One Health problem, affecting humans, animals, and the environment.

www.cdc.gov/DrugResistance/Biggest-Threats

Current Antibiotic Resistance Threats in the U.S.

Urgent Threats

- Carbapenem-resistant *Acinetobacter*
- *Candida auris*
- *C. difficile*
- Carbapenem-resistant *Enterobacteriaceae*
- Drug-resistant *Neisseria gonorrhoeae (N. gonorrhoeae)*

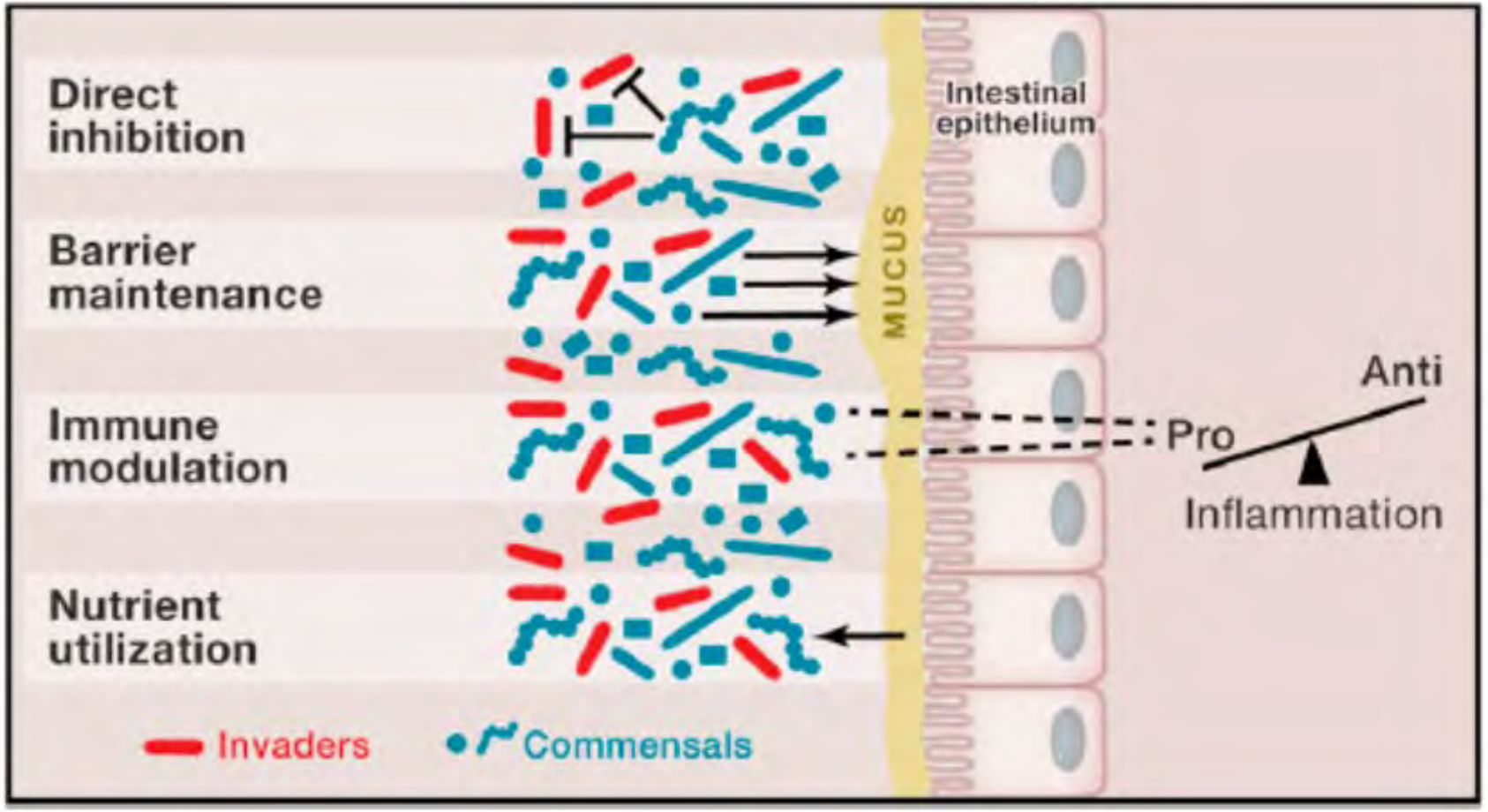
Serious Threats

- Drug-resistant *Campylobacter*
- Drug-resistant Candida
- ESBL-producing Enterobacteriaceae
- Vancomycin-resistant *Enterococci*
- Multidrug-resistant *Pseudomonas aeruginosa*
- Drug-resistant nontyphoidal *Salmonella*
- Drug-resistant *Salmonella* serotype Typhi
- Drug-resistant *Shigella*
- Methicillin-resistant *Staphylococcus aureus*
- Drug-resistant *Streptococcus pneumoniae*
- Drug-resistant Tuberculosis

Concerning Threats

- Erythromycin-resistant Group A *Streptococcus*
- Clindamycin-resistant Group B *Streptococcus*

Colonization Resistance

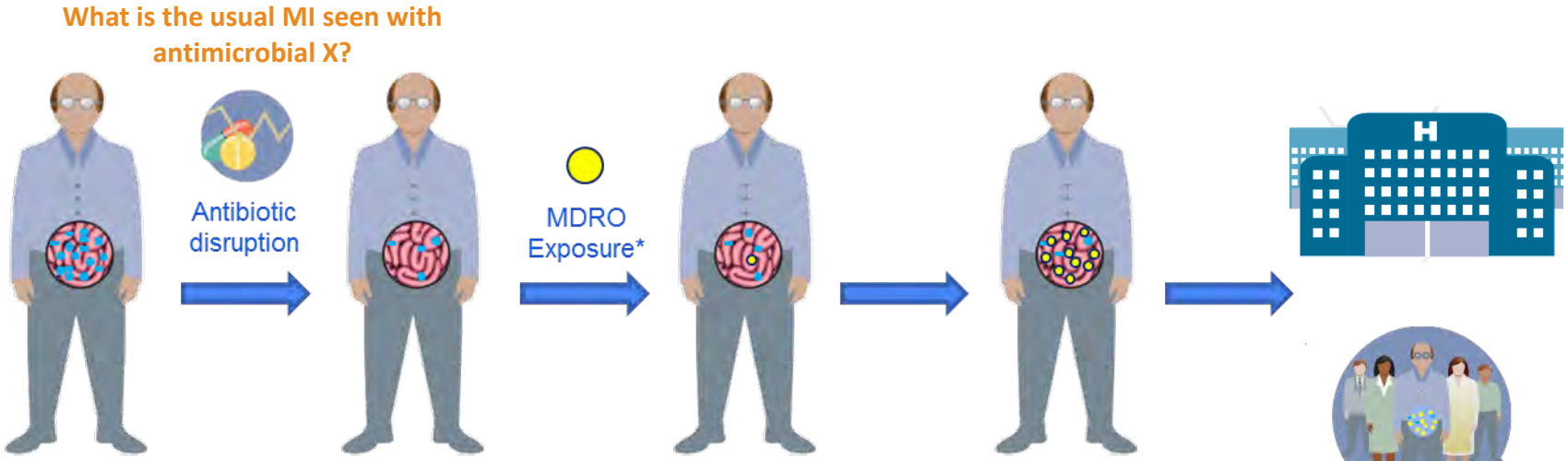


McKenney PT and Pamer EG. From Hype to Hope: The Gut Microbiota in Enteric Infectious Disease. Cell 2015 (163): 1326-32

The effects of antibiotics on your microbiome are like a fire in a forest.

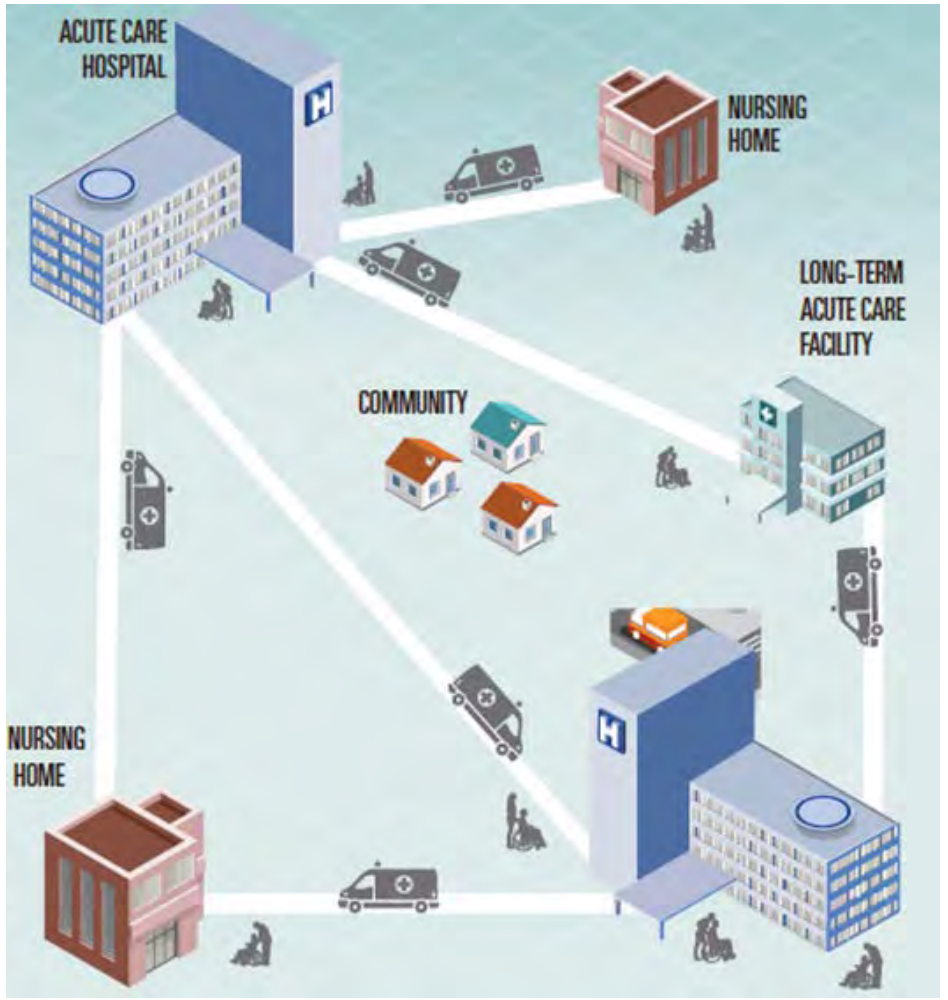
1. A healthy microbiome helps protect you from infection. Improved antibiotic use and a healthy microbiome can keep us and our communities well.
2. Antibiotics disrupt your microbiome, wiping out both good and bad bacteria.
3. Tough-to-kill bacteria—like MRSA, CRE, and *C. difficile*—can take advantage of this disruption and multiply.
4. With this overgrowth of resistant bacteria, your body is primed for infection. Once colonized, you can easily spread the resistant bacteria with others.

Antibiotic Resistance Threat Quantified by Microbiome Indices (MI)



Antibiotic Resistance Can Be Amplified in Health Care

- Disproportionally impacts the vulnerable—young, elderly, and sick—who receive medical care
- Germs spread from patient to patient and across healthcare facilities through patient transfer
- When not stopped, these germs can spill over into communities, becoming much harder to control



For CRE alone, **containment responses could prevent** 1,600 cases in 1 state over 3 years.[1]

programs reduced antibiotic-resistant deaths by nearly 30% (2012-2017).

Germs Can Spread to People in Many Ways

- Close contact
- In the air
- Contaminated water
- Contact with contaminated surfaces (e.g., medical devices, countertops)
- Animals
- Sexual contact

Microbial Ecology Impacting Patients:

Sources of Environmental Pressures and Transit of Microbes

Potable Water and Water Treatment

Patients

Healthcare Environment

Antibiotics and Other Medications

Communities

Food and Feedlots

CDC's Human Microbiome Portfolio: Protect the Microbiome, Preserve Antibiotics, Maximize Public Health Impact

- **Predict impact** of new and old antibiotics on microbiome, determine risk of disruption (i.e., disruptive potential)
- **Tailor antibiotic use** to a patient's microbiome and/or to a specific population of patients
- **Develop and test microbiome diagnostics and protocols**
  - Measure and monitor a patient's risk for colonization, transmission, and infection
  - Assist with diagnosis of infection
- **Support development of therapeutics**
  - Microbiome restoratives
  - Microbiome protectants

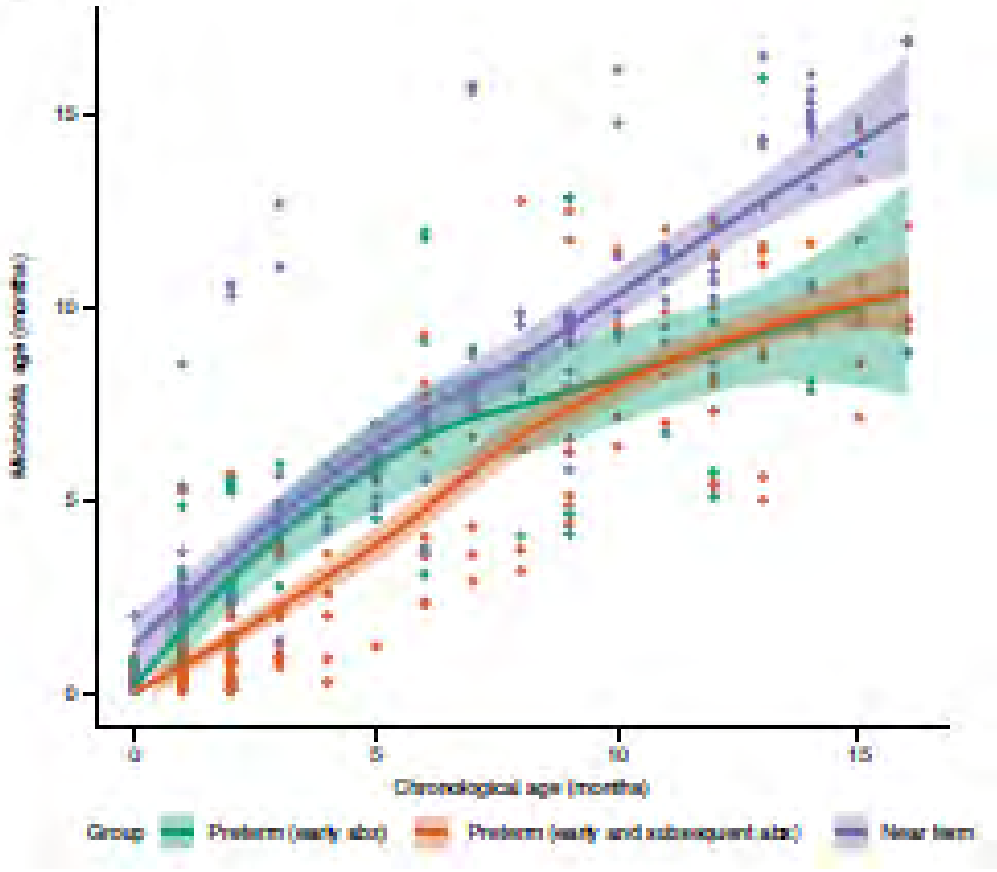
nature microbiology

ARTICLES

https://doi.org/10.1038/s41564-019-0550-2

Persistent metagenomic signatures of early-life hospitalization and antibiotic treatment in the infant gut microbiota and resistome

Andrew J. Gasparrini[1], Bin Wang[1,2], Xiaoqing Sun[1,2], Elizabeth A. Kennedy[1], Ariel Hernandez-Leyva[1], I. Malick Ndao[3], Phillip I. Tarr[3,4], Barbara B. Warner[3] and Gautam Dantas[1,2,4,5]*



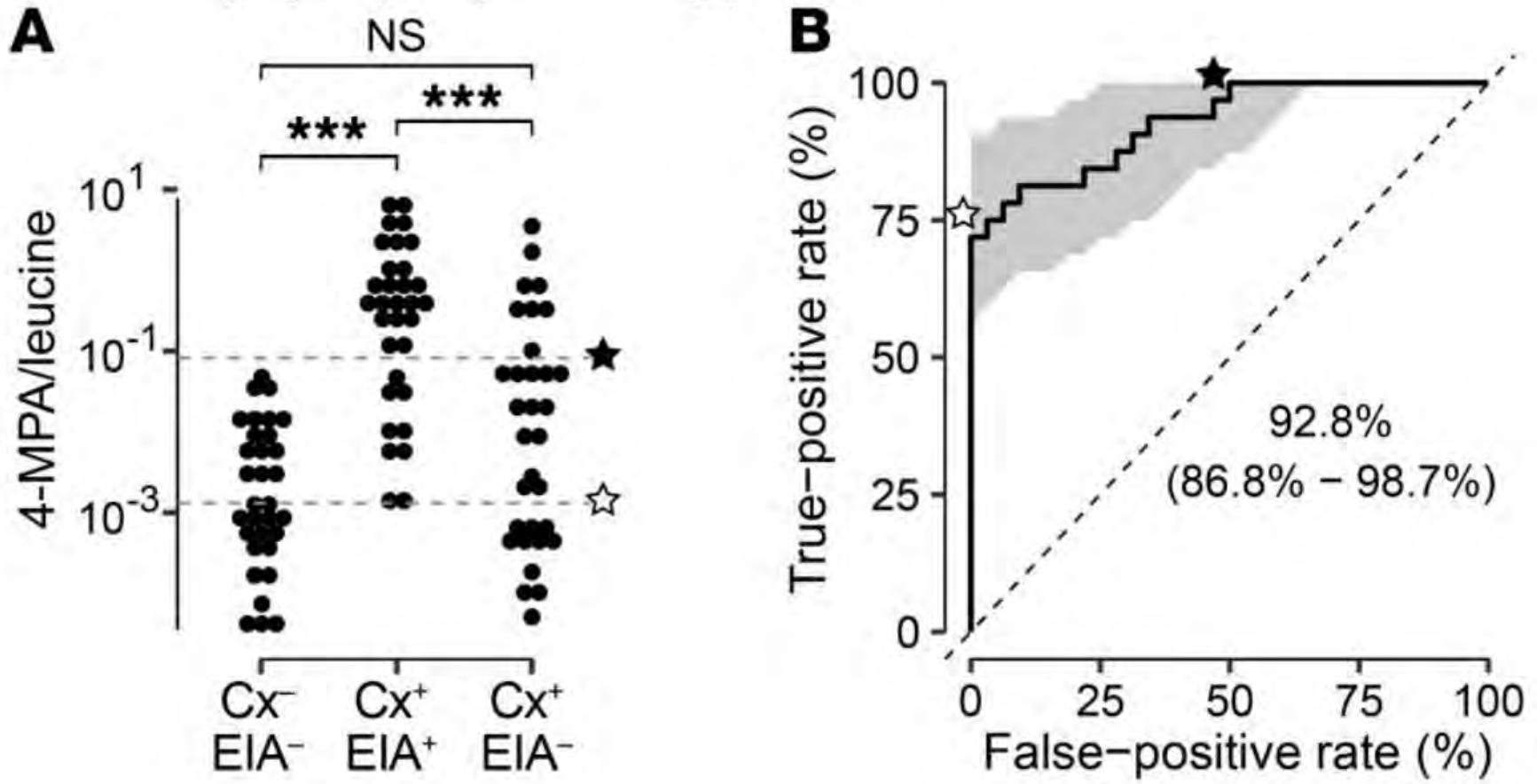
Exploring New Approaches to Diagnosing *C. difficile* infections

Metabolomic networks connect host-microbiome processes to human *Clostridioides difficile* infections

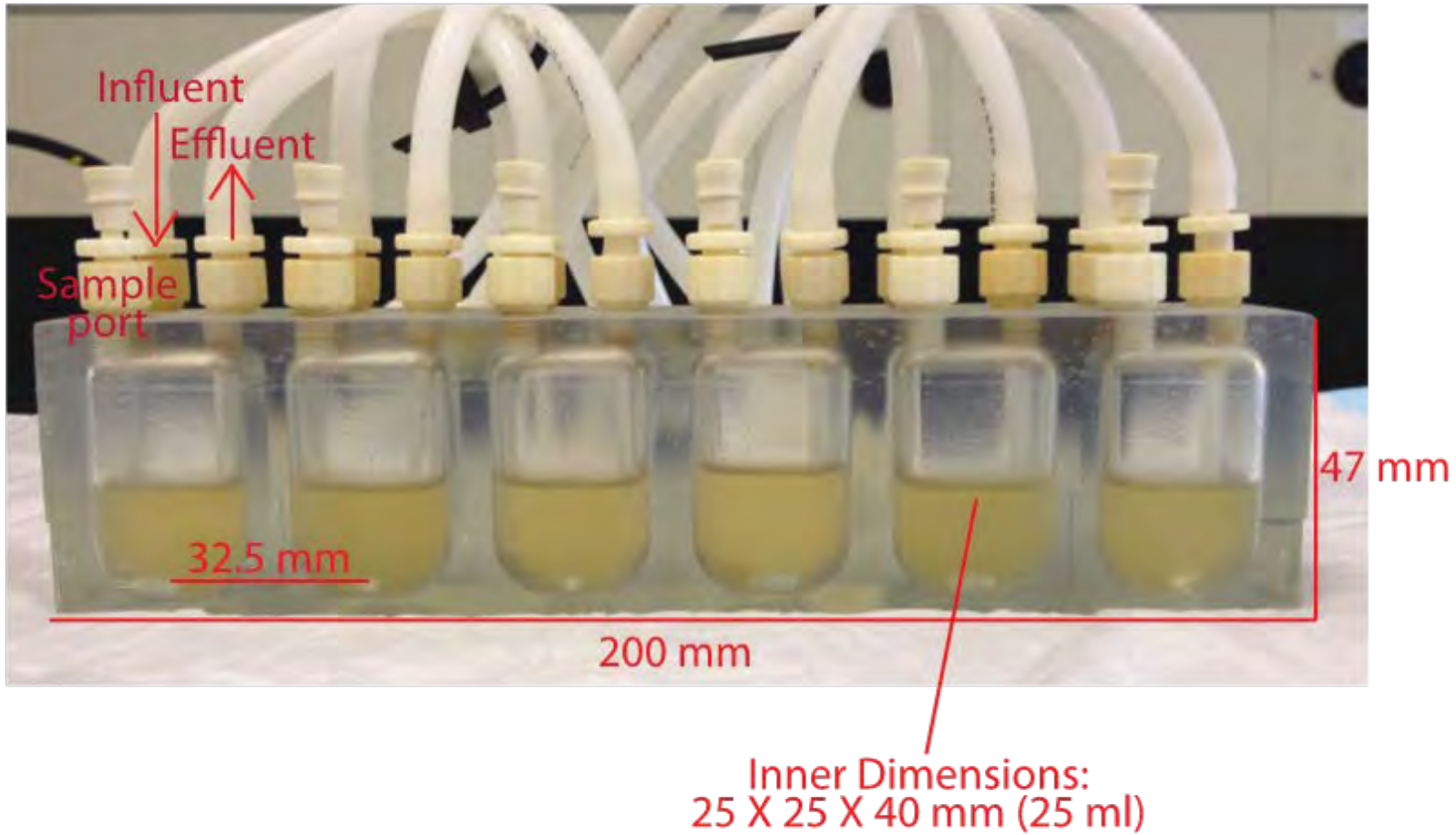
John I. Robinson,[1] William H. Weir,[2] Jan R. Crowley,[1] Tiffany Hink,[1] Kimberly A. Reske,[1] Jennie H. Kwon,[1] Carey-Ann D. Burnham,[3] Erik R. Dubberke,[1] Peter J. Mucha,[2] and Jeffrey P. Henderson[1]

JCI The Journal of Clinical Investigation

First publis



Minibioreactor arrays (MBRAs) are a platform for higher throughput in vitro cultivation of human fecal communities



Horvath TD et al. A high-throughput LC-MS/MS method for the measurement of the bile acid/salt content in microbiome-derived sample sets MethodsX. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7327831/pdf/main.pdf

Microbiome and Microbial Ecology at the Intersection of Communicable and Non-communicable Disease

- **Certain underlying medical conditions increase risk for severe illness from the virus that causes COVID-19**
  - Cancer
  - Chronic kidney disease
  - COPD (chronic obstructive pulmonary disease)
  - Heart conditions, such as heart failure, coronary artery disease, or cardiomyopathies
  - Immunocompromised state (weakened immune system) from solid organ transplant
  - Obesity (body mass index [BMI] of 30 kg/m2 or higher but < 40 kg/m2)
  - Severe Obesity (BMI ≥ 40 kg/m2)
  - Pregnancy
  - Sickle cell disease
  - Smoking
  - Type 2 diabetes mellitus

https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-conditions.html

Thank you!

For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov

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