Protecting the microbiome essential to fighting antibiotic-resistant bacteria

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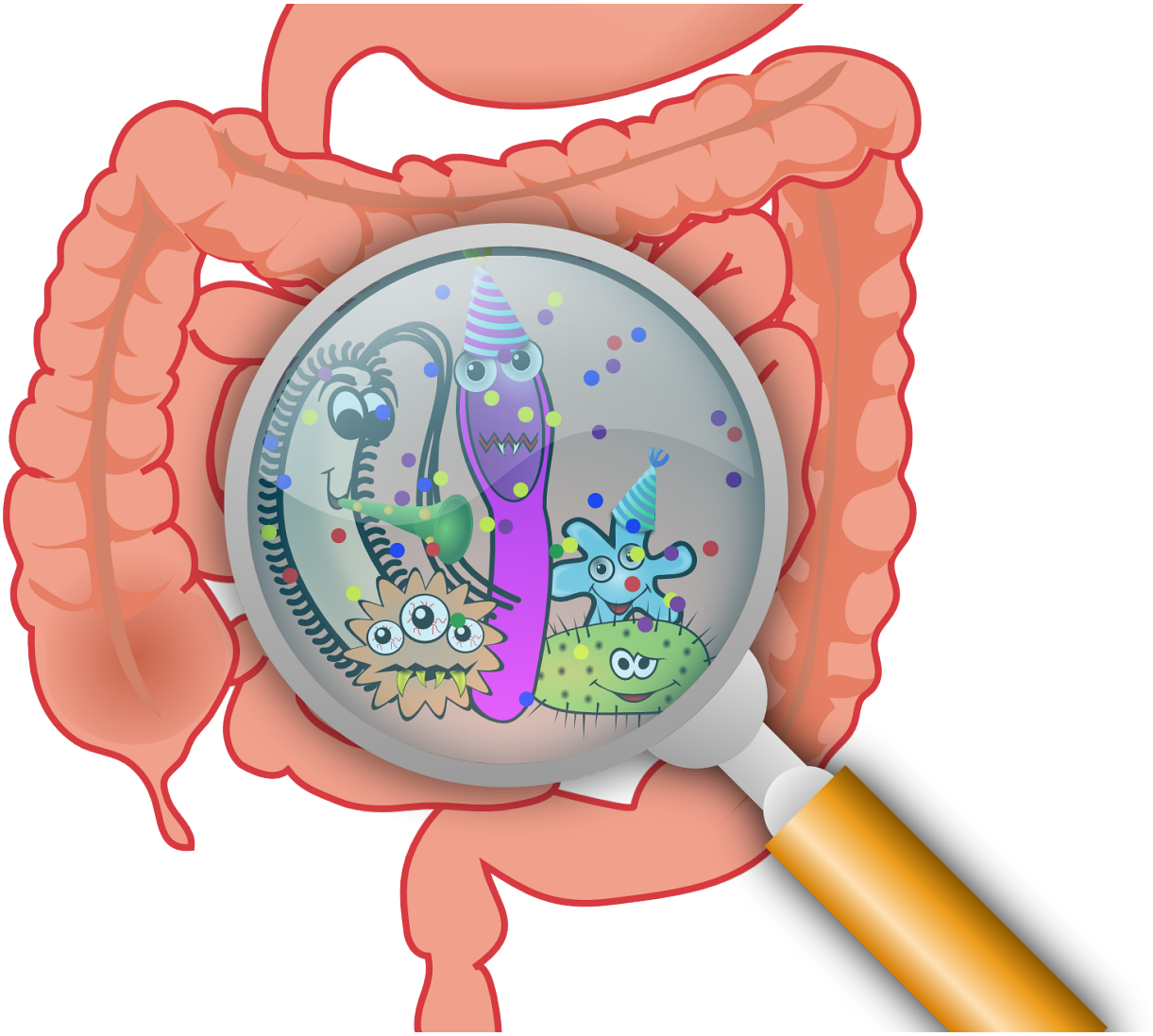

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Protecting the microbiome may be essential to curbing the spread of harmful, drug-resistant bacteria, suggests a study published today in *eLife*.

Trillions of bacteria inhabit the human body and there is growing evidence that this microbiome is essential to human health. The findings add to this evidence by showing that a healthy microbiome not only plays a crucial role in preventing or fighting off infections, but also helps reduce the spread of drug-resistant strains of harmful bacteria.

Antibiotics are a key tool in treating infections with harmful bacteria, but they may also harm the microbiome. Without a healthy microbiome, there is less competition for resources which may allow harmful bacteria to multiply.

"The use of antibiotics may also result in the emergence of strains of both helpful and harmful bacteria with genetic mutations that allow them to survive antibiotics," explains lead author David Smith, a Ph.D. student at the Institut Pasteur and the CESP laboratory (Inserm/University of Versailles Saint-Quentin-en-Yvelines (USVQ)), France. "We used mathematical modeling to see how the effects of antibiotics on the microbiome might drive the spread of antibiotic-resistant bacteria in healthcare settings."

By modeling how harmful, antibiotic-resistant bacteria interact with the microbiome and how antibiotic use changes those interactions, Smith and his colleagues show that antibiotic use plays an outsized role in increasing the abundance of drug-resistant pathogens. It does this by wiping out the helpful microbe communities that prevent harmful bacteria from becoming established.

"We demonstrate a trade-off where antibiotics can simultaneously clear harmful bacteria and make people more susceptible to infection with

those same bacteria," says co-senior author Laura Temime, Professor at the Conservatoire National des Arts et Métiers, Paris, France.

Next, the team simulated how well different prevention strategies might work to stop the spread of drug-resistant bacteria, including Clostridioides difficile, methicillin-resistant Staphylococcus aureus, and multidrug-resistant Enterobacteriaceae. Their results show that precautions to prevent infections with harmful bacteria such as Enterobacteriaceae can have limited benefits. However, interventions that protect the microbiome, such as using fewer antibiotics or helping to restore the microbiome in patients after antibiotic treatment, may help limit the spread of drug-resistant bacteria.

"Our study reveals how important it is to consider the protective effects of a healthy microbiome when designing strategies to reduce the dissemination of drug-resistant strains of bacteria," concludes co-senior author Lulla Opatowski, Professor in Mathematical Epidemiology at UVSQ, and senior researcher in the Epidemiology and Modeling of Antibiotic Evasion group at the Institut Pasteur. "Together, both antibiotic stewardship and interventions to support a healthy microbiome could be effective in mitigating the burden of these infections."

More information: David R M Smith et al, Microbiome-pathogen interactions drive epidemiological dynamics of antibiotic resistance: a modelling study applied to nosocomial pathogen control, *eLife* (2021). DOI: 10.7554/eLife.68764

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