# Listen to your gut: Research discusses using microbiota analysis for precision health care

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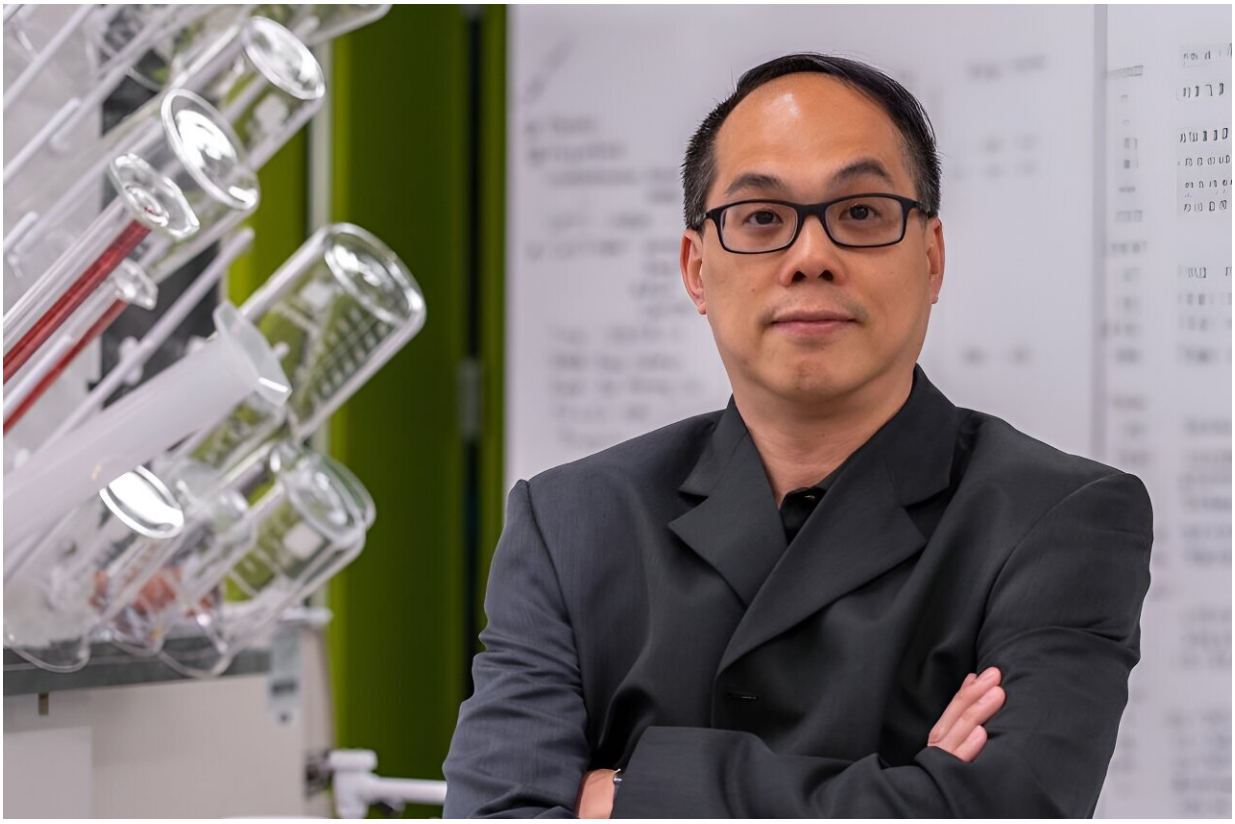

In a recently published paper, Pak Kin Wong discusses the methods discusses the methods available for incorporating microbiota analysis into clinical decision-making, the challenges of doing so and the need for new technologies to capitalize on the potential of microbiota's role in medicine. Credit: Kate Myers/Penn State

The human body harbors approximately 30 trillion microbes, known collectively as the microbiota. These microorganisms influence various bodily functions, including digestion and metabolism to immune response, according to Pak Kin Wong, Penn State professor of biomedical engineering and of mechanical engineering. Analysis of microbiota holds potential for informing disease diagnosis, prognosis predictions and treatment, Wong said, but has yet to be adopted into clinical decision-making.

Penn State News spoke to Wong about his recent paper, published in *Nature Reviews Bioengineering*, that discusses the methods available for incorporating microbiota analysis into clinical decision-making, the challenges of doing so and the need for new technologies to capitalize on the potential of microbiota's role in medicine.

## What is microbiota analysis? Why is it important? What medically useful information does it provide?

Microbiota analysis involves examining the composition, diversity, abundance, distribution, evolution and functions of microorganisms within specific environments, employing advanced genomic and bioinformatic tools. In the human body, these microbes are pivotal to health and disease management.

For instance, the gut microbiota is essential for intestinal health through the production of vital fermentation products and metabolites. This microbial community is also linked to various bodily functions and diseases, highlighting its significance beyond just the gut.

By analyzing the microbiota, we can gain invaluable insights for disease diagnosis, predict disease progression and tailor treatments to individual needs, paving the way for personalized medicine. For example,

microbiota analysis has been crucial in understanding conditions like inflammatory bowel disease and obesity, offering new avenues for intervention.

## Why isn't microbiota analysis currently incorporated into medical decision-making? What needs to be done in order to change that?

High-throughput sequencing, which allows rapid evaluation of the DNA content in a sample, has been a game-changer for studying human microbiomes, helping us dive deep into research and discovery. Yet, turning these insights into something we can use in clinics isn't straightforward. These methods can be expensive, slow, complex and labor intensive.

For microbiota analysis to fit into medical settings, it needs to be affordable, quick and user-friendly. And there's more—there are standard sequencing struggles with things like telling apart living from dead microbes, analyzing different kinds of biological molecules together and mapping out where microbes are located. In addition, since the mix of microbes varies so much from person to person, and because there's no one-size-fits-all for what a "healthy" microbiome looks like, it's tricky to adopt microbiota analysis into medical decision-making.

To really get how diseases progress, we need to keep an eye on how someone's microbiota changes over time. This tracking is key not just for understanding diseases but also for making sure treatments that affect the microbiome are working as they should. All these challenges are significant hurdles for making the most of our knowledge about the microbiome in real-world health care.

## What are some examples of medical conditions that

## could benefit from microbiota analysis? How would it work?

Analyzing the differences in microbial composition between healthy individuals and those with specific diseases offers medical professionals crucial insights into patient health, disease risk and potential treatment outcomes. The diversity and types of microbes in our intestines, for example, are linked to a range of health issues, such as C. difficile infections, inflammatory bowel diseases and neurodegenerative conditions.

Beyond diagnosis and prognosis, there are groundbreaking approaches to altering these microbial communities to fight diseases more effectively. Strategies like the use of prebiotics, probiotics and fecal microbiota transplants are being employed to tackle persistent infections and improve the efficacy of treatments. Specifically, fecal transplants have emerged as a pivotal therapy for refractory C. difficile infections and show promise in enhancing cancer treatment outcomes.

Moreover, the direct bladder administration of the BCG, a form of bacterial immunotherapy approved by FDA, has been an effective bladder cancer treatment for decades. These developments highlight the critical importance of microbiota analysis and the innovative potential of leveraging our microbiota to combat diseases.

## What next steps do you plan on taking in your research related to this topic?

We have been collaborating with experts from academia, industry and the clinical field, each bringing extensive knowledge in technology, biology and health care. Currently, we are developing innovative microbiota analysis platforms that employ single-cell analysis and

artificial intelligence.

A significant challenge we face is determining the most effective methods to unlock the medical potential of the human body's microbiota. Our primary focus is on identifying a viable application that not only underscores the intrinsic value of microbiota analysis but also accelerates its integration into clinical practice.

As the health care landscape evolves, the full utilization of microbiota analysis stands to revolutionize the field. This journey we're on is all about innovation and collaboration. We believe it's going to take us to a future where precision medicine makes better health and well-being achievable for a wider array of people.

**More information:** Jyong-Huei Lee et al, Translating microbiota analysis for clinical applications, *Nature Reviews Bioengineering* (2024). DOI: 10.1038/s44222-024-00168-3

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