COVID-19 Disrupts the Gut Microbiome

COVID can also affect the gut lining, which may allow pathogenic bacteria to enter the bloodstream and cause secondary infections.

November 22, 2022 By Brian Doctrow and National Institutes of Health

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The trillions of microbes living in the gut—bacteria, fungi, and viruses—are known collectively as the gut microbiome. Research has shown that changes in gut microbes may contribute to a variety of diseases and conditions.

COVID-19 patients often have imbalances in their gut microbes that allow antibiotic-resistant bacterial infections to take over. These patients also have a high rate of secondary bacterial infections that may be life-threatening. However, it hasn't been clear how SARS-CoV-2, the virus that causes COVID-19, affects the gut microbiome. Many critically ill COVID-19 patients receive antibiotics. These can also affect gut microbes. So, it's not clear if COVID-19 or antibiotic treatment causes the microbiome disruptions in these patients.

An NIH-funded research team, led by Drs. Ken Cadwell and Jonas Schluter at New York University School of Medicine, investigated how SARS-CoV-2 infection affects gut microbes in mice. They also explored the relationship between gut microbe imbalances and bacterial infections in COVID-19 patients. Their findings were published in Nature Communications on November 1, 2022.

The researchers first looked at mice engineered to make the human ACE2 protein, which SARS-CoV-2 uses to infect cells. Infection with SARS-CoV-2 led to a loss of species diversity in the gut microbes of these mice. Infected mice also had changes to their gut lining. The number of goblet cells, which produce mucus, increased. Meanwhile, the number of Paneth cells, which produce antimicrobial compounds, decreased. The remaining Paneth cells had abnormalities resembling those found in inflammatory bowel disease. These changes in the gut lining correlated with disruptions to the microbiome.

Next, the team examined the microbes in stool samples from 96 COVID-19 patients. In a quarter of the samples, a single bacterial genus dominated. These dominant bacteria included opportunistic and antibiotic-resistant pathogens. Patients with secondary bloodstream infections tended to have less diverse microbes.

The researchers sequenced bacterial DNA from the gut microbes of patients with secondary infections. In most cases, the species infecting the blood also turned up in the gut. This suggests that the infection may migrate from the gut to the bloodstream.

Together, these results suggest that SARS-CoV-2 infection disrupts the gut microbiome. This enables secondary bacterial infections, both by allowing pathogenic bacteria to colonize the gut, and by altering the gut lining to let these bacteria more easily spread from the gut to the bloodstream.

“Our findings suggest that coronavirus infection directly interferes with the healthy balance of microbes in the gut, further endangering patients in the process,” Schluter says.

“Now that we have uncovered the source of this bacterial imbalance, physicians can better identify those coronavirus patients most at risk of a secondary bloodstream infection,” adds Cadwell.

This research summary was originally published by the National Institutes of Health on November 22, 2022.

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