The microbiome and neurosurgery

Dear Editor,

Working in concert with and learning to manage the human microbiome has become one of the many rapidly evolving interest throughout the medical field. The human microbiome consists of a complex, individualized system of millions of microorganisms in the gut and on the surface of the skin. Most of this developing interest is the result of the corpus of work known as the Human Microbiome Project.[1] The microbiome influences various systems within the human body ranging from the development of the neurological processes to nutrient metabolism.[2] Consequently, these systems and their corresponding organs respond to any number of external and internal signals that ranges from neurological, somatic, among others. It stands to the reason that the gut microbiome is a dynamic population that is in constant flux, suggesting one's microbiome is completely different for the individual.[1]

Neurosurgery is the next field which should benefit from utilization of the human microbiome. An even more rapidly developing area within the gut microbiome space is the characterization of the gut-brain axis (GBA).[2] The GBA is a bidirectional highway of communication between the enteric nervous system exposed to the microbiome and the central nervous system that may regulate brain chemistry and neuro-endocrine systems.[2] Disruption of the microbiome can lead to gut dysbiosis, a loss of diversity of intestinal microorganisms associated with a higher incidence of acute and chronic conditions.[3,4]

A recent paper published by Willman *et al*. explores the connection between secondary spinal cord injury (SCI) and gut dysbiosis, disrupting the SCI healing process.[5] Gut dysbiosis has been shown to prolong locomotive recovery and increase inflammation, which can reduce the potential for functional recovery as well as possibly curtail the development of molecules such as brain-derived neurotrophic factor that are pivotal for neuroplasticity.[6,7]

This article along with another from Yuan *et al*. elucidates the gut microbiome as an innovative, therapeutic target for traumatic brain injury (TBI). The secondary effects of TBI after initial stabilization of the patient are disruption of the blood–brain barrier, elevated inflammation within the brain, increased production of reactive oxygen species as well as a dysregulated microbiome because of secondary neurodegeneration seen in TBI.[5,8]

These articles also investigate the potential causal role of the microbiome in stroke as well as poststroke-related secondary injury. With respect to its causal role, the severity of gut dysbiosis has been positively correlated with stroke severity scores such as the National Institute of Health Stroke Score.[9] With regard to poststroke injury, gut dysbiosis severity has been strongly positively correlated with poststroke disability scores such as the modified Rankin scale.[9] In addition, strokes lead to increased levels of systemic inflammation and perturb proper immune function which can cause secondary brain injury.

This established research opens the door to the benefits of precision medicine, which is the practice of tailoring disease treatment and prevention that accounts for differences in people's genetic, environmental, and lifestyle differences. One way of determining the composition of the microbiome is to utilize plasma technology such as microbial cell-free DNA (mcfDNA), which has recently been shown to be extracted from stool samples.[10] mcfDNA yields distinct advantages because it is a noninvasive technology that garners results completely independent of any prior clinical information or laboratory tests.[11] While this has typically been utilized for the detection of pathogens in the setting of hospital sepsis, it could be alternatively used for microbiome detection, which could provide invaluable information regarding the presence of gut dysbiosis. This could lend itself to improving patient outcomes of acute central nervous system injury by promoting targeted interventions in conjunction with standard neurological care.

It is the authorial team's highest recommendation that patients recovering from SCI, TBI, or stroke have small fecal and blood samples taken for mcfDNA analysis and potential correction of the microbiome with important bacterial cultures from probiotics to prevent secondary damage. This is a low-cost proposal that could help to prevent secondary injury and to maximize the chances of a functional recovery. Overall, the microbiome is becoming more pertinent to each specialty and is worth pursuing therapeutic solutions to the ever-increasingly clear connection between the GBA and recovery for acute central nervous system injury.

Sincerely,

The Authorial Team

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

James Kelbert[1], Thomas C. Varkey[1,2]

[1]Deparment of Neurology, College of Medicine-Phoenix, The University of Arizona, [2]Department of Business Management, Colangelo College of Business, Grand Canyon University, Phoenix, Arizona, USA

Address for correspondence:
Dr. Thomas C. Varkey,
302 W, Medlock Dr. Apt #11, Phoenix, Arizona 85013, USA.
E-mail: thmsvrk7@gmail.com

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Access this article online	
Quick Response Code:	**Website:** http://www.braincirculation.org
	DOI: 10.4103/bc.bc_59_23

How to cite this article: Kelbert J, Varkey TC. The microbiome and neurosurgery. Brain Circ 2023;9:264-5.

Submission: 17-07-2023, Revised: 28-08-2023, Accepted: 05-09-2023, Published: 30-11-2023