From back pain to cancer, how the interstitium could transform medicine

For centuries, we've ignored the interstitium, but research is now revealing that this body-wide network of fluid is instrumental to our health and points the way to new treatments

By Scott Anderson on August 24, 2026

An interconnected network called the interstitium is causing a quiet revolution in medicine.
Grace Russell

In the 17th century, physician Samuel Collins observed a mesh around each organ, which he called a "common Vest" made of "curious well-spun Threads… wonderfully interwoven with each other". The "remanent spaces", he noted, were filled with a "concreted Animal Liquor".

Over the following centuries, the purpose of these structures was thought to be purely architectural. The vest, known today as fascia, offers a kind of girding that holds our organs in place; the gaps filled with that "animal liquor" – called interstitial fluid – provide a kind of shock absorber that allows our organs to slide freely as we move, without bruising.

We now know that those pockets of fluid are far more important than this. Emerging research suggests they form an interconnected network called the interstitium that provides an important channel of communication between and inside our tissues. And that is set to cause a quiet revolution in medicine, changing how we think about everything from muscle pain and the microbiome to the spread of cancerous tumours across the body.

According to some scientists, it may even offer a modern explanation for concepts in traditional Chinese medicine, including the fundamental life force “qi”.

The discovery of body-wide channels

The interstitium’s basic anatomy certainly suggests some structural role. The extracellular matrix within it provides structural support for pockets of fluid, with threads made of collagen, which create a strong scaffold, and elastin, which act like tiny bungee cords and offer flexibility. The interstitial fluid coursing through gaps in this matrix comprises around 12 per cent of our body weight and contains hyaluronic acid, a large molecule that forms a gel in water, perfect for cushioning delicate tissue.

The mainstream view was that each organ and muscle is sealed off in its own compartment, with its own, isolated interstitium. While a few researchers, such as molecular engineer Melody Swartz at the University of Chicago, have long been interested in how the fluid flows within the different compartments, there was little evidence that they were interconnected.

That was partly due to a serious practical limitation: when you take tissue samples to study under a microscope, the interstitial fluid drains away and the collagen fibres that give the cavities their structure collapse in on themselves. This made it very hard to characterise the space.

That changed with a groundbreaking study in 2018, using a new procedure that combines a laser with an endoscope to build microscopic images of tissue in a living body. This enabled Neil Theise, professor of pathology at the New York University Grossman School of Medicine, and his colleagues to follow the movement of a fluorescent dye injected during pancreatic surgery. This revealed a series of channels and cavities where they had expected to find dense connective tissue, suggesting that the interstitium was larger and more intricate than previously recognised. Widening their search to other organs, their detailed images provided the strongest evidence yet that it comprised a network spanning the whole body.

“If this organ is present in every tissue and other organ the way the cardiovascular and lymphatic systems are, then we have an incomplete understanding of the entire body,” Theise said at the time. “I don’t think there’s anything that doesn’t get changed by this.”

Building on these results, Theise and his colleagues later examined biopsies of people with tattooed skin. They found that some of the ink had crept from the skin into the interstitial spaces around other organs, proving that the interstitial compartments are interconnected.

Tattoo ink travels through the interstitium between tissues. ZUMA Press/Alamy

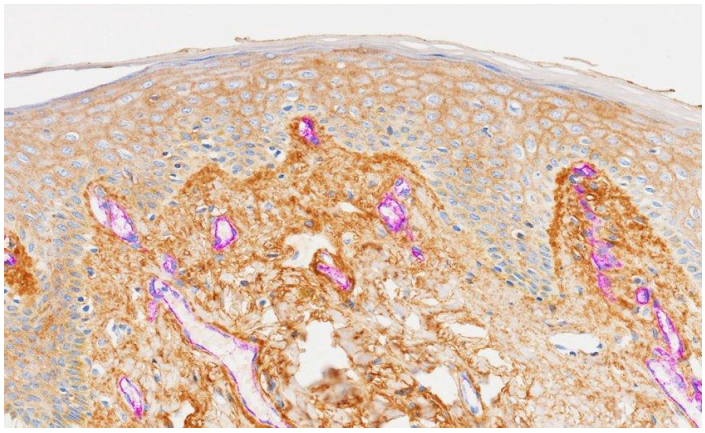
Such discoveries paint the interstitium as a tidal marsh, streaming in nutrients and washing out waste. The main drift comes from high-pressure arteries, which supply much of the interstitial fluid, to low-pressure lymphatic vessels where the trash is deposited. But the motion of the fluid is also strongly affected by body movement, with every muscle in the body contributing a squeeze. Even in repose, there is flow from the peristaltic motion of the digestive tract, overlaid with the tremolo of arterial pulsing throughout the body.

This may have immediate implications for fast-moving infections like necrotising fasciitis, which destroys the tissue beneath the skin, including fascia and muscles, and cellulitis, a deep infection that leaves the skin red and swollen. “Appreciating the interstitial location of these infections may give us important information about their spread,” says Rebecca Wells, professor of gastroenterology at the University of Pennsylvania and part of the team behind the 2018 study. “On the flip side, the patterns of spread in fasciitis and cellulitis may tell us about interstitial structure and flow.”

Rewriting biology

More profoundly, a closer study of the interstitium could offer new insights into basic biological systems.

We know, for instance, that immune cells called T-cells pursue pathogens throughout the extracellular matrix. Peter Friedl, director of the Microscopic Imaging Centre at Radboud University in the Netherlands, who has studied cellular transport through the interstitium since 2007, compares them to “little monkeys” swinging through the “jungle” of collagen. Investigations into the interstitium might therefore reveal overlooked but essential elements of the immune response.



Neil Theise's microscopic images revealed interconnected channels of interstitial fluid around the skin and capillaries. Neil Theise

Presiding over the interstitial tissues are multi-tentacled cells called telocytes, first named in 2010 by Laurentiu Popescu at the Carol Davila University of Medicine and Pharmacy in Romania and Maria-Simonetta Faussone-Pellegrini at the University of Florence in Italy. Using electron microscopy, they found that the arms of these cells have an impressive reach, which they use to create junctions with distant cells. The junctions are similar to neural synapses, except they connect with all types of body cells, including blood vessels, nerve fibres, muscle cells, glands, stem cells and other telocytes.

Like neurons, telocytes have electric properties that allow them to stimulate those neighbouring cells. In this way, the interstitium complements the nervous system as a body-wide sensory tissue, responding to stretching, tension, pressure, vibration and movement. The resulting input provides us with proprioception – the sense of where our body is – and much of what we feel as muscle pain and stiffness may originate in the interstitium.

Telocytes also play a crucial role in healing. Popescu and Faussone-Pellegrini observed them controlling the release of heart stem cells in the myocardial interstitium, for instance.

Stemming the spread of cancer

The interstitial fluid is also awash with extracellular vesicles, tiny packets filled with bits of RNA, proteins and lipids. These interstitial messengers bud off from sender cells and drift to a recipient. Extracellular vesicles include potent regulatory microRNAs that can make epigenetic changes to the receiving cell, altering its behaviour or even changing its identity.

This may have particularly important implications for the treatment of cancer. In 2015, David Lyden at Weill Cornell Medical College in New York and his colleagues discovered that tumour cells continuously launch extracellular vesicles into the interstitium, complete with a chemical "address" directing them to specific target tissues.

Because they are tiny, they can easily sail through the interstitium, leaving a trail of chemical breadcrumbs behind them. When they hit their target, they promote the growth of new blood vessels, preparing the ground for the metastatic cells to follow.

To make that journey, the cancer cell reaches out a sticky appendage and attaches to a fibre in the matrix of collagen. It isn't an easy trek; it must pull its cell body along until its chunky nucleus gets jammed in the webbing. At that point, the cell releases chemicals that break down the collagen around the nucleus, freeing the cell to continue hacking its way through the interstitial undergrowth.

In this way, rogue cancer cells create tunnels throughout the interstitium, making it easier for subsequent metastatic cells to slide through.

With time, researchers may find ways to interfere with interstitial metastasis before the tumours embed. Because the tumour extracellular vesicles are addressed to specific organs, Lyden's goal is to create personalised treatments that direct therapeutic payloads to specific tissues, avoiding damage to healthy organs.

Swartz, meanwhile, has been developing a vaccine that induces the growth of lymphatic vessels in the interstitium around melanomas. The idea is that these would attract cancer-killing T-cells. The research is still in its early stages, but her tests on mice suggest it can limit the spread of the disease.

Beyond cancer, the interstitium and its contents may shed light on endometriosis, in which tissue similar to the lining of the womb starts to grow outside the uterus, leading to pain, fatigue and fertility problems. Some experts have therefore proposed that malfunctioning telocytes may support the growth of new blood vessels that help the endometrial tissue to implant and survive.

A back door to the brain

The all-encompassing continuity of the interstitium, including organs, blood, lymph cells and nerves, is astonishing. But there is an exception: the brain, which has its own private interstitium.

This is largely to avoid friendly fire from our immune system, which could take out memories, cognitive function and motor control. The brain is therefore separated from the rest of the body by the blood-brain barrier. It keeps out most microbes most of the time, but if they do manage to sneak in, they alert the brain's more delicate immune cells, the microglia, that must avoid too much collateral damage.

In the brain, the interstitial liquid is called cerebrospinal fluid (CSF). It provides the fuel for brain tissue and picks up the waste afterwards. The flow of CSF runs through the glymphatic system, first discovered by Maiken Nedergaard, a neuroscientist at the University of Rochester Medical

Center in New York state. Arteries and veins normally run alongside lymphatic vessels, but in the brain, they run inside the glymphatic vessels. The pulsing of arteries drives the surrounding CSF into the brain interstitium, pushing its fluid towards returning veins, helping to flush out detritus.

Crucially, the glymphatic system ultimately drains into ordinary lymphatic vessels, meaning there is still a connection to the body's interstitium – and this may affect the famous gut-brain axis.

The communication between the gut and the brain is important enough to have at least three other conduits, including the bloodstream, the vagus nerve and hormonal signalling. But the interstitium may provide a new corridor.

"A continuous interstitial pathway means that gut-derived signals might find a more direct anatomical back door into the central nervous system's fluid compartments," says Theise, possibly via interstitial fluid surrounding arteries and nerve bundles.

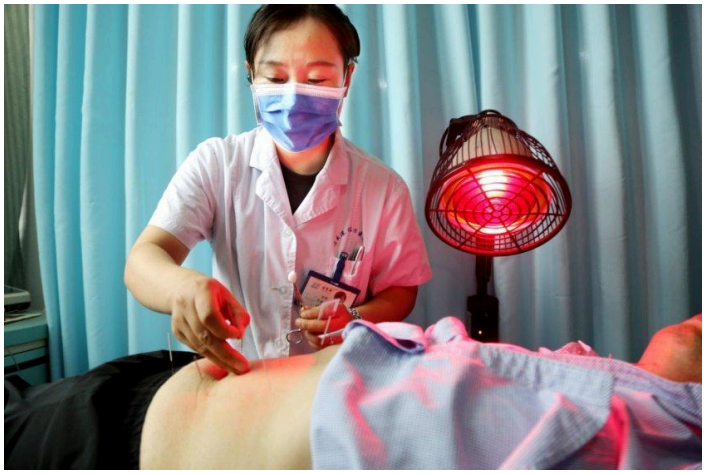
This would a good reason to avoid a leaky gut, where the lining of the gut becomes too porous to properly contain microbes and their toxins. The best advice here is to add fibre and fermented food to your diet. These encourage your gut microbes to produce substances like butyrate that both heal and maintain your gut lining.

A source of 'qi'

One of the most provocative claims about the interstitium concerns its relationship to the ancient concept in traditional Chinese medicine known as qi, the flow of energy that is supposed to underlie our physical health.

Researchers like Wei-Bo Zhang at the China Academy of Chinese Medical Sciences suggest there are anatomical analogies between six of the bodies named in traditional Chinese medicine – the Fu organs – and six tissues integrated with the interstitium: epidermis, dermis, deep fascia, joints, visceral fascia and the rest of the inter-organ interstitium. In ancient Chinese texts, the largest of these organs, the Sanjiao, is described as "the official in charge of drainage, from which waterways emerge", an apt description of the interstitium.

Traditional Chinese medicine posits that energy flows through the body in a system of pathways called meridians. This is the basis for acupuncture and acupressure, which have been shown in several studies to be better than placebo for back pain, knee pain and headaches.



Practices like acupuncture and acupressure may work through changes to the interstitium.
CFOTO/Future Publishing via Getty Images

Could these pathways represent the movement of liquid in the interstitium? Some evidence of this arrived in 2021, when Andrew Ahn at Harvard University used fluorescent dyes to track interstitial flow from the wrist to the elbow. The path, he found, followed the accepted meridian line.

Intriguingly, Nedergaard has shown that gently rotating acupuncture needles releases adenosine, which acts like an analgesic, into the interstitium – offering one potential mechanism for the pain relief achieved through traditional Chinese medicine.

Qi is sometimes interpreted as an electric phenomenon, which makes sense in the context of the interstitium. The interstitial framework of stiff collagen fibres is piezoelectric, meaning it generates a small charge of electricity when the fibres bend. The hyaluronic acid that fills the interstitium is negatively charged, so there is electric potential throughout. Bioelectric fields are known to alter epigenetics and shape cell development, as well as attracting immune cells to the site of injury. The charges created by interstitial activity could therefore influence these processes.

These ideas remain to be proven, though. Swartz suspects the interstitial flow is too sluggish and local to explain the long-distance effects of meridians. If anything, the meridian lines show lymphatic flow, she suggests, which is quicker. “You don’t walk from Minneapolis to Chicago – you take a bus and then you walk from the bus stop to your home,” she says.

For her part, Wells is sceptical of the idea that interstitial fluid moves along well-defined channels akin to the meridians. “An ocean, or a bath, may be a more useful way to think of the interstitium than something like a river delta,” she says.

Wells is also doubtful of the role of electrical energy. “Although it sounds very promising as a physical, Western explanation for qi, it’s still not clear that elastin [or] collagen piezoelectricity

could support flow of the magnitude of qi," she says, although she is planning new studies to better determine the actual voltages that can be generated in this wet environment.

There may be other mechanisms. Helene Langevin at the University of Vermont has shown that when you rotate an acupuncture needle, it grips fascial tissue. This causes fibroblast cells, whose primary job is to maintain the interstitium's collagen, to move and reorganise. "In mice, we were able to demonstrate propagation of the mechanical signal from acupuncture needle rotation several centimetres away from the needle," says Langevin, who is also the former director of the US Center for Complementary and Integrative Health. "That is a very large distance – nearly the whole mouse." Such changes to the connective tissue may have knock-on effects for the interstitial flow.

Whether or not the interstitium offers a point of contact between traditional and Western medicine, this unifying tissue promises to revolutionise our understanding of our bodies. Four hundred years since Samuel Collins made his observations, we may have just seen a glimpse of what the "animal liquor" means to our health.