Your death microbiome could catch your killer

27 August 2014 by **Anna Williams**
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The bugs are having a field day *(Image: Marten Adolfson/plainpicture)*

MILLIONS want you dead. No, it's not a Twitter conspiracy, but a battle raging beneath your skin. The cells in your body are outnumbered 10 to one by microbial cells, and like it or not, eventually the microbes will win.

Surprisingly, what happens next has largely been a mystery. Now researchers have made the first study of the thanatomicrobiome – the army of gut microbes that take over your internal organs once you are dead. The results could have applications in forensic science and medicine.

While we are alive, the 100 trillion bacteria resident in our gut work on our behalf. They ease digestion and keep the immune system functioning smoothly, in exchange for a constant supply of food. These "friendly" bacteria adhere to the lining of the gut and keep the microbial villains at bay by outcompeting them.

After we die, however, our gut flora have a party. Dying cells leak carbohydrates, amino acids and lipids, causing a frenzy of microbial feeding and reproduction. The bacteria eventually escape the gut and swarm through the circulatory and lymph systems, spreading to organs that are shielded during life by the immune system.

Understanding how microbes inside a dead body colonise it can help pathologists work out the time of death, where the body has been lying, and how its decomposition could affect the soil and ecology around it. Until now, research in this area has largely focused on the way that insects and microbes from a corpse's environment take up residence in putrefying flesh.

To study how a dead body decays in isolation, Peter Noble at Alabama State University in Montgomery sampled microbes from a selection of internal organs, as "these aren't influenced by environmental conditions", he says. He hoped to discover how long it took gut bacteria to reach each organ after death, and establish which species go where.

Microbial signature

Traditional techniques for identifying microbes rely on growing them in Petri dishes, but gut bacteria are particularly tricky to culture. Instead, the team isolated and amplified bacterial genetic material from cadaver tissues to reveal the microbes present. Their samples came from the liver, spleen, brain and heart of 11 cadavers, between 20 and 240 hours after death.

In the newest cadavers, the researchers found bacteria such as *Streptococcus*, *Lactobacillus* and *Escherichia coli*, which mop up any oxygen left in the tissues after respiration stops. These gut flora are the "usual

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suspects" you would expect to find in most people.

As the time since death increased, the bacteria present were more likely to be those that can function without oxygen, such as *Clostridium* strains. For example, some of the cadavers harboured *C. botulinum*, which can cause botulism, and *C. difficile*, one of the main culprits in hospital infections. A more unusual strain, *C. novyi*, turned up in one body (see "Gut bugs united").

Contrary to the team's expectations, there was no predictable pattern of microbe distribution. This was a surprise, says Noble, as he had expected different microbes to thrive in different organs. For example, the team had thought that bile-tolerant species would flourish in the liver, whereas those adapted to iron-rich environments would do better in the spleen.

In fact, there was more variation between individuals and according to time since death than there was between the organs within a single cadaver (*Journal of Microbiological Methods*, doi.org/t6x).

So does this individual variation mean that we can use the gut flora "signature" of a dead body to identify unknown victims of crime or a disaster, by matching it to bacteria on the unwashed clothes of missing persons?

"The only way to answer this is with a really big sample of cadavers," says Sibyl Bucheli of the Sam Houston State University in Huntsville, Texas, who is also studying the death microbiome. She points out that someone's immediate environment is bound to have a strong influence on the microbes living in and on them, and therefore on their thanatomicrobiome. This means that even though an individual's gut flora might be unique to them, they could also be broadly similar to those of people around them, making it hard to identify a person using bacterial profiling.

Even if it turns out to be impractical as a method of identification, there are other potential uses. Sequencing the DNA present could confirm a suspected bacterial infection, identify an infection when the cause of death was unknown, or even help assess the efficacy of antibiotics in treating an infection, says John Cassella, a professor of forensic science at Staffordshire University, UK.

What's more, "the predictable shift in microbial colonisation of a body means we can use microbes as a clock to estimate how long a body has been decomposing", says Bucheli.

Examining the internal organs could also be useful for bodies where the presence of microbial contamination on skin could confuse the investigation, says Cassella. He thinks it could help determine whether a body had been moved after death. For example, if someone died at home but their body was subsequently dumped elsewhere, the bacteria in their internal organs should have more in common with their home environment than where they ended up.

However it ends up being used, "cataloguing this ecosystem can help us understand how we coexist with microbial communities all around us", says Bucheli. "The microbiome of a cadaver is an unknown data set in biology," she says.

We may not have long to wait to find out whether the microbiome of death holds more surprises: Noble and his colleagues are about to start a bigger investigation, exploring the thanatomicrobiomes of 100 cadavers.

This article appeared in print under the headline "Death: the great bacterial takeover"

Gut bugs united
Lactobacillus (various species)

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Found in the gut, vagina and mouth, these bacteria are vital for healthy digestion, helping to break down lactose, the sugar found in milk. *L. acidophilus* is often present in probiotic yogurt, and there is some evidence that consuming it can help with vaginal infections.

Escherichia coli

E. coli is found in the intestines of mammals. Most strains are harmless, although some are beneficial because they synthesise vitamin K2 (see "A to zinc: What supplements are worth taking?") and protect the gut from pathogenic bacteria; others give us food poisoning or urinary tract infections.

Clostridium difficile

The culprit in many hospital-acquired infections, *C. difficile* is a normal part of our gut flora, but readily causes diarrhoea if antibiotics have wiped out its neighbours. It is also a common cause of bowel inflammation, which can be fatal in severe cases.

Clostridium botulinum

C. botulinum is infamous for making the neurotoxin botulinum, the cause of the paralysing condition botulism, and the active ingredient in botox cosmetic procedures. It thrives in the anaerobic conditions of a fresh cadaver, before the decomposing skin bursts open.

Clostridium novyi

Found in soil and faeces, *C. novyi* secretes several necrotising, or "flesh-eating", toxins, and can cause gangrene in people with open wounds, such as intravenous drug users. It thrives in anaerobic conditions.

Streptococcus (various species)

These bacteria are responsible for a range of infections, from sore throats to necrotising fasciitis or flesh-eating disease – in which connective tissue is destroyed. Other non-pathogenic strains are commonly found in and on the body.

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