

JUNE 29, 2010

Delivery Method Influences Microbial Communities in Newborns

Babies delivered via Cesarean section harbor a different ecosystem of bacteria than babies born vaginally, according to new research by Howard Hughes Medical Institute scientists and their colleagues. That difference could be why C-section babies experience higher rates of allergies, asthma, and infections with methicillin-resistant

Staphylococcus aureus

(MRSA).

"In nature, there's only one way babies are born, so it wouldn't be surprising at all if the vaginal bacterial community was important for all sorts of normal development."

- Rob Knight

The study, published June 29, 2010, in the *Proceedings of the National Academy of Sciences*, found that the microbes colonizing each baby reflected the mode of delivery. Babies born vaginally carried species of bacteria found in their mother's vaginas, while babies born via C-section carried species of bacteria typically found on skin.

"While the research is very early, these findings could help explain the increased health risks faced by babies born via C-section," says study author Rob Knight, an HHMI early career scientist and assistant professor of computer science at the University of Colorado at Boulder. María Gloria Domínguez Bello, a professor at the University of Puerto Rico, coordinated the study.

Previous research had shown that 64 to 82 percent of reported cases of MRSA skin infections, which are more difficult to treat than infections caused by other strains of *Staphylococcus*, in infants occur in babies

delivered by C-section. Previous research also suggests that C-section babies are at higher risk of allergies and asthma later in life. According to the Centers for Disease Control and Prevention, some 30 percent of babies born in the United States are delivered via C-section.

“We see two possibilities,” says Knight. “One is that being colonized by skin bacteria is bad in some respect. The other is that being colonized by the vaginal bacteria is good in some respect. That’s obviously something we are really interested in following up on.”

Unlike the C-section babies, the babies delivered vaginally in the study carried species of *Lactobacillus* and *Prevotella*, which Knight says could be protective. “It’s entirely conceivable that the bacterial species from the mother’s vagina form a coating that makes it more difficult for other bacteria like *Staphylococcus aureus* to colonize and invade the infant,” he says.

The researchers also found that during the first day of life, the study babies carried virtually the same mix of bacteria all over their bodies. That is, the mix of bacteria found in an individual baby’s nose, skin, and rectum were virtually identical. This stands in contrast to adults, who, according to earlier research from Knight and colleagues, carry vastly different microbial communities on different parts of the body. In adults, “the difference between what’s in your mouth and what’s on your hand is like the difference between the microbes in dirt and the microbes in seawater,” says Knight. But not with babies. “That was really surprising,” he says. He plans follow-up research to track the development of microbial communities in infants, to see when and how the communities on the various parts of the body begin to diverge.

For the study, Venezuelan scientists Monica Contreras and Magda Magris, from the Amazonian Center for Research in Tropical Diseases and Venezuelan Institute of Scientific Research, and María Gloria Domínguez-Bello of the University of Puerto Rico in San Juan obtained permission from nine pregnant women to sample bacterial communities from themselves and their newborns. The mothers’ forearms, mouths, and vaginas were sampled with cotton swabs about one hour before delivery. The newborns were swabbed on the arms and forehead immediately after birth, with additional swabs of the nasal passage and rectum collected soon thereafter. Four women delivered vaginally, and five delivered via C-section.

The samples were sent to Boulder and run through a high-throughput DNA sequencing procedure developed by Knight and University of Colorado colleague Noah Fierer. The procedure isolates the same gene from every bacterium in the sample, known as the *16S* ribosomal RNA gene. This gene differs from species to species and thus serves as a handy bacterial fingerprint.

The sequencing procedure quickly identified the mix of bacteria found in each sample. Knight then analyzed that data with an algorithm he developed

that determines the degree of relatedness of different microbial communities.

The algorithm showed that babies born vaginally carried a mix of bacteria very similar to the mix found in their mother's vaginas, while the C-section babies carried a mix of bacteria generally found on skin, though not necessarily their mothers' skin. Knight said that in the Venezuelan hospital where the samples were obtained, fathers typically hold their children first. As a result, the fathers' skin bacteria may have been transferred to the newborns. However, the fathers' skin was not sampled.

A spate of recent research into the human microbiome – all the microbes that live in and on the human body – suggests that humans serve as hosts for an astounding diversity of microorganisms. In fact, each of us supports as many as 10 times the number of microbes as there are cells in the human body. In 2008, Knight, Fierer, and Jeffrey I. Gordon at Washington University in St. Louis, and their colleagues reported that the composition of microbial communities varies considerably from place to place on the same person's body. Earlier this year, Knight and colleagues found that individuals leave a tell-tale trail of bacteria on keyboards that they type on, pointing to a possible future tool for forensic investigators.

Knight says much more research is needed to determine whether the absence of vaginal bacterial on the C-section babies leads to poorer health outcomes. "In nature, there's only one way babies are born, so it wouldn't be surprising at all if the vaginal bacterial community was important for all sorts of normal development," says Knight. "When we alter that by delivering babies by C-section, we're bringing those infants into the world in a way that is evolutionarily foreign. Any biological process that requires normal vaginal bacteria might not work the same way in the absence of those bacteria."