Breastfeeding protects infants from antibiotic-resistant bacteria

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A recent study completed at the University of Helsinki investigated the amount and quality of antibiotic-resistant bacteria in breast milk and gut of mother-infant pairs. The findings have been published in the journal *Nature Communications*.

The researchers report three findings. First, infants who were breastfed for at least six months had a smaller number of resistant bacteria in their gut than babies who were breastfed for a shorter period or not at all. In other words, breastfeeding seemed to protect infants from such bacteria.

Second, antibiotic treatment of mothers during delivery increased the amount of antibiotic-resistant bacteria in the infant gut. This effect was still noticeable six months after delivery and treatment.

The third finding was that breast milk also contains bacteria resistant to antibiotics and that the mother is likely to pass these bacteria on to the child through milk. Nevertheless, breastfeeding reduced the number of resistant bacteria in the infant gut, an indication of the benefits of breastfeeding for infants.

Microbiologist Katariina Pärnänen of the University of Helsinki's Faculty of Agriculture and Forestry investigated with her colleagues the breast milk and faecal matter of 16 mother-infant pairs. The researchers sequenced bacterial DNA in the milk and decoded its genetic code. However, the study did not focus on the mother's DNA found in milk. The researchers created the most extensive DNA sequence library of breast milk thus far.

The specific focus of the study was the number of antibiotic resistance genes (ARGs). Such genes make bacteria resistant to certain antibiotics, and they are often able to transfer between bacteria. Individual bacteria can have several antibiotic resistance genes, making them resistant to more than one antibiotic.

The study demonstrated for the first time that breast milk contains a significant number of genes that provide antibiotic resistance for bacteria, and that these genes, as well as their host bacteria, are most likely transmitted to infants in the milk. Mothers transmit antibiotic-

resistant bacteria residing in their own gut to their progeny in other ways, as well, for example, through direct contact. Yet only some of the resistant bacteria found in infants originated in their mothers. The rest were likely from the environment and other individuals.

The study does, however, support the notion that breastfeeding overall is beneficial for infants. Although breast milk contains bacteria resistant to antibiotics, sugars in the milk nourish beneficial infant gut bacteria, such as Bifidobacteria, which are used as probiotics. Breast milk helps such useful bacteria gain ground against resistant pathogens, which is probably why infants who were nursed for at least six months have less antibiotic-resistant bacteria in their gut compared to infants who were nursed for a shorter period.

"As a general rule, it could be said that all breastfeeding is for the better," says Pärnänen.

"The positive effect of breastfeeding was identifiable also in infants who were given formula in addition to breast milk. Partial breastfeeding seemed to reduce the quantity of bacteria resistant to antibiotics. Another finding was that nursing should be continued for at least the first six months of a child's life, or even longer. We have already known that breastfeeding is all in all healthy and good for the baby, but we now discovered that it also reduces the number of bacteria resistant to antibiotics."

Antibiotic use by mother impacts the child

Women can be prescribed an intravenous antibiotic treatment during labour for various reasons, for example, if they have tested positive for Streptococcus, a bacterium hazardous to infants. In such cases, antibiotic treatment is intended to prevent the transmission of bacteria living in the birth canal to the infant during delivery. Antibiotic treatment can also be

used if the mother's water has broken long before labour begins, or if potential infection is otherwise suspected.

However, the study indicated that the antibiotic treatment of the mother increases the number of bacteria resistant to antibiotics in the infant's gut. While the study did not demonstrate why this happens, according to one theory, the bacteria that first reach the infant gut gain a head start. Since antibiotics administered to the mother eliminate all bacteria except those resistant to the drug; in such deliveries, the mother is likely to pass mainly resistant bacteria on to her child.

"We cannot advise that mothers should not be given antibiotics during delivery," says Pärnänen. "The consequences of infection for both mother and infant are potentially serious. What we can state is our findings, and physicians can use them to consider whether practices should be changed or not."

However, antibiotic treatment administered during delivery is only one of all the antibiotic courses taken by mothers at some point in their life that may impact the gut microbiota of infants. The bacterial flora in the gut changes every time we take antibiotics. Antibiotics kill both good and bad bacteria, leaving alive only those bacteria that are resistant to the antibiotic in question. These bacteria may gain a permanent foothold in the gut, even though most of the other bacteria will return soon after the antibiotic treatment as well.

Since the mother transmits bacteria resistant to antibiotics to the infant, all of the antibiotic courses taken by the mother in her life may also affect the bacterial flora of the infant's gut and the prevalence of resistant bacteria in the gut.

One of the major global health threats

Antibiotic resistance is one of the greatest global threats to human health. According to estimates from previous research, bacteria and other micro-organisms resistant to antibiotics and other drugs will cause more deaths than cancer by 2050 since infections can no longer be effectively treated.

Bacteria resistant to antibiotics are everywhere. They are present in the human gut, regardless of antibiotic use. They are transmitted between individuals in the same way as bacteria, viruses and other micro-organisms usually are: through, for example, direct contact and in food.

Not all resistant bacteria cause diseases, and thus do not harm their carriers. In suitable conditions, however, such bacteria can either induce the onset of a disease or transfer the gene that provides antibiotic resistance to another bacterial pathogen.

Because such bacteria cannot be killed with antibiotics, and because the immune system of infants is weak, infections caused by resistant bacteria can be fatal to infants. In Finland, where Pärnänen is based, babies die of such infections only rarely. Yet prior studies show that, globally, more than 200,000 newborns die annually of infections caused by antibiotic-resistant bacteria that have advanced to the stage of sepsis.

"Babies inherit every facet of antibiotic misuse since the discovery of antibiotics," notes Pärnänen. "The amount of bacteria resistant to antibiotics in the infant gut is alarming, since infants are also otherwise vulnerable to diseases. Babies are more likely to suffer from this than adults, even if the babies have never been given antibiotics."

Health problems originating in resistant bacteria are accrued by those with weak immunity. Infants and the elderly are in particular danger. Since the immune system of infants has not reached the efficiency of adult immunity, small children often need antibiotics to recover from

diseases, which makes antibiotic inefficiency more dangerous to children.

More information: Katariina Pärnänen et al, Maternal gut and breast milk microbiota affect infant gut antibiotic resistome and mobile genetic elements, *Nature Communications* (2018). DOI: 10.1038/s41467-018-06393-w

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