Human milk and SARS-CoV-2 - A summary of knowledge to date
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As with all new pathogens, the emergence of SARS-CoV-2, the causative virus of COVID-19, has raised questions regarding the possibility of vertical transmission from mother to child through breastfeeding and the safety of human milk donated to milk banks. Almost 6 months since the WHO declared COVID-19 to be a pandemic, this is what is now known:

Vertical transmission:

- The WHO published a systematic review of all available data regarding human milk and breastfeeding on the 23rd June. The authors concluded the risk of COVID-19 infection in infants from breastfeeding is low, but there are not currently enough data to make a definitive conclusion.[1]
- Currently available epidemiological evidence suggests the harms of breastfeeding cessation disproportionately outweigh the risk of transmission.
- To date, samples of milk from 46 cases of maternal COVID-19 infection have been tested for SARS-CoV-2: 43 were negative and 3 were positive for viral fragments, but no infectious viral particles have been demonstrated.
- Of the three infants whose mothers had RT-PCR positive samples of milk, only one became symptomatic with COVID-19. The infant's symptoms coincided with the positive sampling of the mother's breast milk, which had been negative prior to the infant developing symptoms.[2] Personal communication with the author confirmed that the infant had breastfed just prior to sampling, although the skin of the nipple and breast were cleaned before pumping. This finding could therefore represent contamination of the milk through the backwash of infant saliva,[3, 4] as saliva is known to hold high levels of virus during the earliest days of COVID-19 symptoms.[5, 6]

Mothers should be supported to establish and continue breastfeeding if COVID-19-positive, and a full set of recommendations on neonatal care is available on the RCPCH website.[7]

Careful work should continue to understand whether there is any viable infectious SARS-CoV-2 virus in milk, particularly during the earliest days of lactation when the breast ductal system is relatively leaky, or in cases of concurrent breast inflammation such as mastitis.

Safety of donor milk

Milk banks nationally in the UK[8] and internationally[9] have cooperated from the start of the pandemic to share information and best practice. Critically, guidelines have been developed through a consensus formed through a global alliance of milk banks and associations, enabled by virtual communication and cooperation. Various strategies have been employed in UK milk banks to ensure the safety of donated milk through the stages of transportation, handling by milk bank teams, and quarantining milk for 2 weeks where possible. It was known from April that the virus was heat sensitive,[10] and so any risks of the virus were primarily to milk bank and transportation teams handling containers. Standard procedures in milk banks are sufficient to mitigate this risk, but a full list of the guidance adopted in UK milk banks is available.[8]

Three studies are now available as preprints showing that when SARS-CoV-2 virus is spiked into human milk and then pasteurised, Holder pasteurisation (62.5^{o}C for 30 min) is sufficient to completely inactivate the virus.[11-13]

Protective mechanisms of human milk

As a consequence of the relative immunocompromise of neonates, infants and young children, human milk contains a range of anti-viral components, including secretory immunoglobulin A (sIgA) and lactoferrin(14) through direct binding. Levels of both sIgA and lactoferrin increase over the second year of lactation.[15] Many other anti-viral mechanisms have evolved against both enveloped and non-enveloped viruses. A non-exhaustive list includes human milk oligosaccharides[16], oxysterols[17], gangliosides GM1, 2 and 3 and chondroitin sulphates[18], monolaurin, vitamin A[19], and Tenascin C[20].

Very little is yet known about the specific antiviral response of human milk or the human breast innate and active immune system to SARS-CoV-2. A preliminary study of 15 mothers post-COVID-19 showed that 80% (12/15) had detectable levels of sIgA in samples of their milk. One also had anti-SARS-CoV-2-IgG. [21]

Work is now ongoing to understand the strength and durability of the milk-derived SARS-CoV-2 antibodies as a protective factor for breastfed infants, but also as a potential therapy, as secretory antibodies would be highly resistant to proteolysis in respiratory tissue.[22] There would also be utility in being able to test donor milk batches for antibodies and preliminary work suggests that commercially available rapid detection kits would be suitable for use in milk after centrifugation.

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