

# Protection Against Hepatitis C and Other Enveloped Viruses? Another Reason Why “Breast Is Best”

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(See the major article by Pfaender et al on pages 1943–52.)

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Breastfeeding rates in the United States have been steadily increasing from rates of 30% initiation and 5%–10% continuing through 6 months in 1971, 70% and 30%, respectively, in 2003 and 77% and 47% in 2009 [1–3]. These numbers also include mothers who are not exclusively breastfeeding and still fall short of HealthyPeople 2020 national goals of 80% initiation and 60% breastfeeding at 6 months [3]. In 2012, the American Academy of Pediatrics reaffirmed its recommendation that infants be exclusively breastfed until 6 months of age with continuation through at least 1 year as solid foods are introduced [1].

The many benefits of breastfeeding have long been touted: it is the “natural” option, the nutritional content of breast milk is more easily absorbed by the infant’s digestive system compared to formulas, breastfeeding enhances the mother-infant emotional bond, breast

milk provides beneficial effects on the infant’s microbiome, including the introduction of probiotic-like organisms [1, 2, 4], and breast milk may exclude infectious agents. It has long been accepted in both the industrialized and developing world that breastfeeding protects infants against respiratory and diarrheal illnesses [1, 2]. This benefit is so powerful that it outweighs that possible risk of acquisition of human immunodeficiency virus (HIV) for infants born to infected mothers in resource-poor settings [5]. The reasons for this protection have long been attributed to maternal antibodies within the milk, as well as maternal lymphocytes that also confer protection against various infectious agents [6, 7]. Other milk contents, like lactoferrin, have also been shown to have antimicrobial properties that offer additional protection [8]. In this issue of the *Journal*, Pfaender et al identify a novel mechanism by which breast milk may protect infants against enveloped viruses such as hepatitis C virus (HCV; [9]).

It is widely known that HCV is a major cause of liver disease among adults [10]. The bloodborne and vertical transmission of HCV are well known, but less is known about other modes of transmission [10, 11]. Breastfeeding transmission of HCV was reported in several studies in the 1990’s [12–14]. In these studies, HCV was detected in breast milk at

concentrations 3–4 logs lower than serum concentrations [13]. One study declared that breast milk was a source of transmission to an infected infant, but this study used criteria for infection that likely indicated vertically acquired virus [12]. No specific evidence has ever existed for definitive transmission of HCV by breastfeeding, and neither the Centers for Disease Control and Prevention nor the American Association for the Study of Liver Diseases argue against this practice for HCV-infected women unless they have cracked or bleeding nipples [10]. The reasons for the absence of transmission have been attributed to many of those listed above: maternal antibodies, maternal HCV-specific lymphocytes, very low levels of HCV or perhaps that virus does not exist in its most infectious form (virus complexed to low-density lipoproteins). No specific studies have adequately investigated the protective mechanisms involved until the article by Pfaender et al [9].

In this article, the authors designed an *in vitro* system to study the ability of breast milk to neutralize the infectivity of the HCV cell culture virus, JFH1 [9]. They first showed that frozen aliquots of breast milk inhibited viral infectivity of JFH1 by 2–3 logs. After systematically testing breast milk and showing there was no interference with RNA replication nor with capsid protein production, the

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authors showed that breast milk disrupted the integrity of the HCV viral envelope. In further support of their hypothesis, they then went on to test the ability of breast milk to reduce the infectivity of other enveloped viruses and indeed found that breast milk also inactivated influenza and partially inactivated herpes-simplex and vaccinia. There was no protection against rotavirus and norovirus when tested in their assay. They ultimately show that this activity involves the lipases within human milk and the generation of free fatty acids that then likely damage the envelope structure within HCV and other viruses.

The significance of this work relative to the HCV field is that the results provide a plausible explanation for why breastfeeding is not a risk factor for HCV transmission. This is reassuring to us as practitioners when we counsel our HCV patients that it is safe for them to breastfeed. More broadly, the work by Pfaender et al provides a novel mechanism that humans have evolved to protect their young against enveloped viruses during the newborn period. The lipases within human milk have not before been proposed as playing a role in antiviral protection, and Pfaender et al demonstrate that this activity is not present in the breast milk of other species [9].

The limitations of this model system must be acknowledged. The authors showed that freezer storage was a key aspect of antiviral protection, and freshly isolated milk did not protect against HCV infectivity. This suggests that the freezing process somehow augments natural lipase

activity in breast milk, which is consistent with prior observations made regarding methods to reduce viral titers in human milk [15]. They used HCV concentrations in their in vitro assays that exceed by almost 4 logs what has been demonstrated to be present in breast milk, which also could serve to explain the lack of activity seen with freshly isolated breast milk. Their proposed mechanism of how lipases generate free fatty acids to damage the viral envelope is still theoretical and needs to be supported by further experimentation. However, these limitations do not negate the broad implications of the work presented.

After reading this article, when we clinicians next encounter an HCV-infected patient that just delivered a healthy infant and wants to breastfeed, we have yet another reason to say “Breast is Best”.

## Notes

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