CMV Transmission and Breastmilk

Innovating Practice Through Research & Evidence
Research Overview:
The Transmission of Cytomegalovirus to Preterm Infants via Breastmilk: Evidence and Issues

Breastmilk - with all of its bioactive, immunological, anti-inflammatory and nutritive components - is generally believed to be the most beneficial form of nourishment for human infants. However, breastmilk is also a mode of cytomegalovirus (CMV) transmission to infants. While term infants infected with CMV via breastmilk rarely exhibit any outward signs of illness, preterm infants infected with CMV can present with a variety of signs and symptoms, some quite serious. How to approach this clinical issue is both complex and controversial.

Women who have had CMV at some point in their lives are seropositive for CMV antibodies. During pregnancy and lactation, CMV may reactivate and be excreted in her milk and other mucosal surfaces. Infants receive CMV antibodies from their mothers during the third trimester of pregnancy such that at the time of birth, they have a form of passive immunity to the virus. Term infants are protected through breastmilk through what is thought to be a natural immunization process. CMV-infected term infants will shed the virus in urine and saliva, but are generally asymptomatic for the infection.

Researchers hypothesize that preterm infants miss the transmission of maternal antibodies to CMV. Thus, when preterm infants - who are by nature physically immature and vulnerable - acquire CMV postnatally via breastmilk, they are at greater risk than term infants of exhibiting symptoms of the disease.

The distinctions among asymptomatic infection, symptomatic infection and a CMV sepsis-like syndrome in preterm infants have evolved through clinical studies and case reports. Asymptomatic infection is the most common scenario in term and preterm infants: the infant sheds CMV in urine and saliva but otherwise shows no signs or symptoms of illness. In studies reporting symptomatic infections in preterm infants, infants present with a variety of laboratory and/or clinical conditions. Generally, they recover spontaneously without evidence of long-term consequences. Of greatest concern to researchers, health care providers and parents is a CMV sepsis-like syndrome evidenced by a very small percent of preterm infants. These cases can clinically be very challenging, however most resolve spontaneously.

Strategies to reduce or prevent CMV transmission to preterm infants have focused on breastmilk treatment such as pasteurization or freezing or simply withholding breastmilk until the infant is more mature. None of these options is ideal: each option prevents the preterm infant from receiving fresh mother’s milk during a time of critical growth and development. Theoretically, withholding milk may not protect against CMV exposure from other maternal secretions.

In addition, studies of human milk consistently demonstrate not all components survive heating and freezing intact. For example, live milk cells such as leukocytes and lymphocytes are significantly diminished or damaged by pasteurization and freezing. The emerging science of human milk illuminates promising new discoveries, e.g., live stem cells, antigen-specific T cells and highly-activated memory B lymphatic cells, which, as live cells, are vulnerable to temperature changes. In this context, the risks and benefits of freezing and pasteurizing breastmilk require additional scrutiny.

These articles present current research related to breastmilk-acquired CMV infection in preterm infants.
Through them, we will explore dominant themes in the literature and their implications for clinical practice. Article reprints are included for your review.


**References:**


Research Overview: The Transmission of Cytomegalovirus to Preterm Infants via Breastmilk: Evidence and Issues

Clinicians and researchers have studied CMV acquisition by preterm infants via breastmilk for more than 40 years. In this collection of materials, you will find summaries with commentary on three current research articles. These materials provide an overview of breastmilk-acquired CMV infection in preterm infants and discuss implications of common management strategies.

Key Points

• CMV is a common virus present in body tissues and sheds in body fluids: saliva, urine, genital secretions, blood, and breastmilk.

• However, if acquired early in pregnancy, initial CMV infection may result in congenital infection.

• Women who have had CMV are seropositive for CMV antibodies. During pregnancy and lactation, CMV can reactivate, causing asymptomatic infection in the mother with viral shedding in her breastmilk, cervical secretions and urine. The terms seropositive, CMV-seropositive, CMV-positive, CMV- IgG-positive are interchangeable in this context.

• Infants can acquire non-congenital CMV infection during the birth process or through breastfeeding if mothers are seropositive.

• Term infants rarely show indications of breastmilk-acquired CMV infection.

• Preterm infants who acquire CMV via breastmilk may become symptomatic of the disease. The most common signs and symptoms are neutropenia, thrombocytopenia, hepatitis, elevated liver enzymes and hepatosplenomegaly.

• A sepsis-like syndrome may occur in preterm infants with breastmilk-acquired CMV. These symptoms may include apnea, bradycardia, distended abdomens and gray pallor.

• Despite a wide range of clinical symptoms, preterm infants recover from breastmilk-acquired CMV spontaneously and without long-term sequelae.

• Pasteurization eliminates CMV in breastmilk and freezing reduces viral load. Both processes affect milk components so are not recommended for usual feeding practices.
Concluding Remarks

The survival very premature infants presents challenges in neonatal care that did not exist forty years ago. The majority of reports of acute and serious CMV illness are clinical cases of extremely low birth weight infants born before 28 weeks gestation. Kurath and colleagues point out it is often difficult to distinguish between complications related to prematurity and complications from CMV infection. The research evidence suggests the actual risk of severe, symptomatic CMV infection is very low, even in very immature, tiny infants. All three studies in this collection, along with many others, support this conclusion.

At the time postnatal CMV came of interest, techniques for milk pasteurization were well established; thus, they were logical interventions for study and practice in response to CMV in breastmilk. Since that time, human milk science has expanded exponentially. Science supports the greater potential benefits from fresh milk compared to frozen or pasteurized milk and that this competes with the previous desires to reduce CMV transmission with heat and cold treatment of milk. This new information, along with current clinical and outcome data on CMV infection in preterm infants, obligates a more comprehensive analysis of the risks and benefits of temperature treatments on human milk. As such, the intentional withholding of fresh breastmilk from preterm infants deserves further attention.

Shifting focus away from breastmilk related interventions, two of the three authors presented in these materials suggested more study of prophylactic immunoglobulin therapy. Not everyone will agree this is the right approach or even necessary. Undoubtedly, additional research is needed before clinicians and researchers come closer to a consensus on the issue of CMV transmission via breastmilk.

Notes

_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________
Research Summary

Prepared by Jean Rhodes, PhD, CNM, IBCLC

Transmission of Cytomegalovirus Via Breast Milk to the Prematurely Born Infant: A Systematic Review.

Background:
The purpose of this systematic review was to analyze data related to breastmilk-acquired CMV infection in preterm infants, including long-term sequelae of infection.

The authors analyzed 26 prospective studies published between January 1966 and December 2008 of CMV transmission in preterm and/or low birth weight infants. Studies analyzed varied in design, infant inclusion criteria, and laboratory evidence of CMV infection. In some studies, breastmilk was pasteurized or frozen prior to feedings, in others it was given fresh. Four studies were case reports and five studies focused long-term outcomes. The remaining studies were clinical research of CMV transmission in hospitalized preterm infants.

Results:
• In CMV-seropositive mothers who were expressing milk for their preterm infants:
  • A median of 87% had CMV detected in their breast milk.
  • A median of 20% of their infants acquired CMV. The range of infection was 5.7-58.6%.
  • A median of 3.7% of their infants had laboratory and/or clinical indices of infection (mean 9.3%, range 0-34.5%). The most common signs and symptoms were neutropenia, thrombocytopenia, hepatitis, elevated liver enzymes and hepatosplenomegaly.
  • Sepsis-like symptoms due to CMV infection occurred in a median of 0.7% of these preterm infants (mean 3.5, range 0-13.8%). Sepsis-like symptoms were not specifically identified.
  • The risks of neurosensory or developmental delays were generally low and not significant.

Conclusions
• The risk of CMV acquisition and clinical symptomatology is low.
• When mothers are CMV-seropositive and infants are less than 32 weeks, the authors recommended an individualized clinical approach to breastmilk feedings rather than a generalized approach such as routine pasteurization or freezing.

Addendum
Kurath and Resch published a follow-up letter to the editor in *Pediatric Infectious Disease Journal* in which they proposed a clinical algorithm in cases of CMV-seropositive mothers who wish to provide breastmilk to their preterm infants. The algorithm starts with a stable preterm infant. If parental consent is obtained, fresh breastmilk is given and the infant is tested weekly for CMV. If an infected infant exhibits signs and symptoms of CMV infection, fresh breastmilk feedings are withheld until the infant is greater than 32 weeks.

**Commentary**

In this systematic review, Kurath *et al* examined the short and long-term outcomes of preterm infants who become infected with CMV via maternal breastmilk. As with most meta-analyses or systematic reviews, studies evaluated varied in methodology, testing procedures, populations and outcomes. The purpose of this review was to combine multiple studies to get a broader perspective on the problem of breastmilk-acquired CMV in preterm infants. As is common in this type of research, statistical results are reported as ranges of occurrence but also as medians and means. When wide variations in ranges occur, median values are usually more accurate indicators of the data as they buffer the effects of outliers or extremes.

This analysis of multiple studies suggests the majority of women of childbearing age are CMV-positive and more than three-quarters of CMV-seropositive women shed the virus in their breastmilk. Of preterm infants receiving breastmilk from CMV-positive mothers, CMV infection occurs at a rate of approximately 20%. A small percent (median rate of 3.7% or mean of 9.3%) of preterm infants of breastfeeding seropositive mothers will develop symptomatic CMV infection. Symptoms vary widely in terms of severity and can include one or more of the following: hepatitis, pneumonia or pneumonitis, neutropenia, thrombocytopenia, elevated liver enzymes, hepatosplenomegaly, gray pallor, fever and hyperbilirubinemia.\(^1\)\(^4\) The most commonly reported single symptom is neutropenia alone without other indications of illness.\(^5\)\(^6\) In studies reporting symptomatic infections in preterm infants, the infants generally recover spontaneously without evidence of long-term consequences.\(^1\)\(^5\)\(^7\)\(^8\)\(^9\)

Of greatest concern to researchers, health care providers and parents is a severe CMV sepsis-like syndrome evidenced by a very small percent of preterm infants. This analysis by Kurath and colleagues suggests a median of less than 1% of preterm infants of CMV-positive mothers will demonstrate symptoms of severe infection. (Of note, Kurath *et al* do not report any deaths in infants with breastmilk-acquired CMV.) In a separate review of multiple clinical and case studies, Hamprecht *et al*\(^7\) reported very similar results and infant outcomes. Their total sample size was more than 1000 infants. Unlike Kurath *et al*, they identified two infant deaths in one study by Cheong,\(^10\) both deaths in infants with NEC and CMV.

In 1998, Vochem *et al*\(^11\) identified in five preterm infants with breastmilk-acquired CMV a pattern of more acute illness now known as sepsis-like symptoms or syndrome. These infants exhibited apnea, bradycardia, distended abdomens and gray pallor. Later studies reported similar and additional clinical findings in infected infants, many of whom were extremely low birth weight.\(^1\)\(^2\)\(^5\)\(^10\) However, despite the severity of sepsis-like infections, almost all infants recovered and were discharged home.\(^1\)\(^5\)

After publication of their systematic review, Kurath and Resch (both physicians) published a letter to the editor\(^12\) proposing an algorithm for individualized clinical management of CMV in preterm infants. Their
algorithm outlines a management protocol based on clinical and laboratory surveillance. If an infant becomes positive for CMV and is symptomatic, mother’s milk is stopped until 32 weeks. But some important questions go unanswered: what symptoms of CMV infection warrant intervention and what are infants missing when fresh breastmilk is withheld?


Research Summary

Prepared by Jean Rhodes, PhD, CNM, IBCLC

Transmission of Cytomegalovirus Via Breast Milk in Extremely Premature Infants.


Background:

The purpose of this study was to evaluate prospectively the rate of CMV infection in extremely preterm infants.

CMV testing included the use of real-time polymerase chain reaction (PCR) assays to identify CMV DNA in breastmilk, serum and urine. This molecular biology technique is the gold standard for CMV detection. Genetic testing was also used to link specific cases of CMV transmission from mother’s breastmilk to infant.

Of the 25 mothers enrolled, 21 were CMV-seropositive; 4 were CMV-seronegative.

Twenty-seven infants with birth weights <1000 grams and/or gestational ages <28 weeks were followed. The median gestational age was 26.4 weeks and the median birth weight was 802 grams.

Mothers stayed in the hospital for 5-7 days after delivery. During this time, all infants were given fresh - not frozen - colostrum and milk. After the mothers were discharged, all infants were fed frozen-thawed breast milk for at least one month. If a mother’s milk was not available, frozen donor milk was used. Each milk donor was paired with one infant in need of milk.

Breast milk from mothers and donors, infant serum and infant urine samples were collected every 2 weeks and screened for CMV infection using PCR assays.

Results:

- Twenty-two infants received CMV DNA-positive breastmilk.
- Infants of seronegative mothers received only CMV DNA-negative milk, including donor milk.
- 100% of CMV-seropositive mothers had detectable CMV DNA in their breast milk. CMV was not detected in the milk of any seronegative mothers.
- In the first week postpartum, 35% of colostrum samples contained CMV DNA.
- CMV shedding in breastmilk increased at two weeks postpartum, peaked at 4 to 6 weeks, then declined until undetectable by 10-12 weeks.
- One of the 22 CMV exposed infants (4.3%) became CMV-positive. He displayed no clinical symptoms except for a transient elevation of liver enzymes. His mother’s milk was verified as the source of CMV by genetic study using CMV UL144 gene.
Conclusions:

- Use of frozen-thawed breastmilk may decrease, but does not eliminate, the rate of breastmilk-acquired CMV infection.

Commentary

Shortly after CMV was first reported in breastmilk in 1967, researchers began publishing reports of breastmilk freezing and pasteurization. In 1982 Friis and Andersen reported freezing breastmilk significantly reduced the virus in breastmilk. The same year Dworsky et al investigated the effects of pasteurization and freezing on CMV in breastmilk. In the Dworsky study, CMV was destroyed completely by Holder pasteurization (heat treatment at 62°C for 30 minutes) but only reduced by freezing. The authors expressed concerns, just as important today as it was then, about the effects of temperature treatment on the immunological properties of human milk.

Breastmilk pasteurization and freezing studies increased in the literature in response to reports of preterm infants with breastmilk-acquired CMV infection. In an attempt to preserve the beneficial properties in human milk, Hamprecht et al compared the effects of Holder pasteurization, short-term pasteurization (5 seconds at 72°C) and freezing at -20°C on CMV-positive breastmilk. Both methods of pasteurization destroyed the CMV, but breastmilk enzymes were also significantly reduced. The authors recommended more study to find the pasteurization temperature at which CMV could be inactivated and breastmilk preserved. Study continues on pasteurization but as Hayashi points out, it is not always practical in a clinical setting.

However, freezing breastmilk is common practice in neonatal intensive care units. Breastmilk is often stored in the freezer for later use or per protocol to reduce CMV transmission. Like Hayashi et al, other researchers have found lower rates of breastmilk-acquired CMV transmission in infants fed primarily frozen breastmilk. In Taiwan - where 95% of mothers are seropositive for CMV and all breastmilk is frozen before use - Jim et al found a 15% CMV transmission rate by seropositive mothers to their preterm infants. In Japan - another country where breastmilk is routinely frozen - Yasuda reported 10% CMV transmission via breastmilk with no infant exhibiting clinical symptoms.

While freezing breastmilk seems to reduce CMV transmission, its effects are not entirely benign. The notion that “freezing breastmilk preserves the biochemical and immunologic quality of the milk…”(p. 529) is often taken out of context and repeated. However, this assertion is not consistent with current evidence regarding important breastmilk components and properties. For example, freezing breastmilk kills or significantly reduces cellular components, including macrophages and lymphocytes. Freezing also reduces antioxidants and immunoglobulins IgG, IgM and IgA. This information along with recent breastmilk discoveries such as stem cells and the specific immunologic actions of breastmilk lymphoid T and B cells should be included in discussions about freezing, pasteurizing or withholding breastmilk for preterm infants.


**Research Summary**

Prepared by Jean Rhodes, PhD, CNM, IBCLC

**Very Low Birth Weight Infants Born to Cytomegalovirus-seropositive Mothers Fed with Their Mother’s Milk: a Prospective Study.**


**Background**

The purpose of this observational, prospective study was to evaluate the risk of CMV transmission in very low birth weight (VLBW) infants fed fresh breastmilk. The sample consisted of 68 mothers and their 80 infants. All infants were ≤ 32 weeks and <1500 grams with a mean gestational age of 29.0 weeks and a mean birth weight of 1125 grams.

All infants received only fresh mother’s milk for at least the first month of life. No donor milk was used. Mothers were tested for CMV status, their breastmilk and infants’ urine were tested weekly for CMV. CMV identified in milk and urine was genotyped to confirm CMV transmission from mother to infant.

Per the neonatal unit’s policy for infants < 28 weeks, 19 infants received three doses of prophylactic IgM-enriched intravenous immunoglobulin (IVIGMA), beginning at birth. All 19 of these infants had CMV-positive mothers.

**Results:**

- Fifty-three of 68 mothers (78%) were CMV-seropositive. Of these 53 seropositive mothers, 21 (40%) had CMV detected in their milk by viral culture.

- No infants who received CMV negative milk became CMV infected.

- CMV transmission occurred in 9 of 26 infants (35%) fed CMV-positive milk. One infant had no signs or symptoms of illness. Five infants had neutropenia and/or elevated bilirubin levels but no sepsis-like symptoms. Three infants (11.5%) had mild sepsis-like illness. All CMV infected infants recovered.

- There was no difference between infected and non-infected infants in morbidity, length of stay or outcomes at discharge.

- Of the 19 infants < 28 weeks treated at birth with IVIGMA, 1 developed CMV infection.
Conclusions:

- Breastmilk-acquired CMV infection was asymptomatic, self-limited and without sequelae in stable VLBW infants who did not have chronic illness. However, CMV infection could worsen the clinical course of pre-existing illnesses such as chronic lung disease.
- Administration of IVIGMA to infants <28 weeks may have reduced risk of CMV transmission via breastmilk.
- The authors concluded, “…the potential benefits of fresh human milk seem to outweigh the risks related to CMV transmission in most VLBW infants” p.847.

Commentary

This study by Capretti et al supports the use of fresh breastmilk for preterm infants from CMV-positive mothers. Study infants acquired CMV infection from their mothers at rates comparable to those in other research reports and the disease course was generally mild: all infected infants had positive outcomes with no neurosensory deficits at two years. Miron et al in 2005 reported similar outcomes in a study of 70 preterm infants fed fresh breastmilk from sero-positive mothers. These authors reported a 5.7% infection rate with all infants recovering.

Unlike Miron et al, the study by Capretti and associates included an additional variable - immunoglobulin therapy. The neonatal unit’s treatment policy for infants less than 28 weeks included IVIGMA therapy at birth. IVIGMA contained variable titers of anti-CMV antibodies. Nineteen study infants less than 28 weeks received IVIGMA; only one developed CMV. In comparison, three of five infants less than 28 weeks who did not receive IVIGMA became infected with CMV. Capretti et al hypothesized the administration of IVIGMA may have helped the very preterm infants compensate for the lack of maternal antibodies they would have received in utero if they had delivered at term.

This is not the first mention in the literature of immunoglobulin therapy to prevent breastmilk CMV transmission: a thin thread of this idea runs through the literature from beginning to end. As early as 1983, Yeager et al recommended the administration of CMV immunoglobulin to preterm infants if the connection between the lack of maternal antibodies and CMV infection could be confirmed. In a later report, Mosca and associates used intravenous immunoglobulins in preterm infants less than 34 weeks receiving CMV-positive breastmilk. In their study, five of 20 exposed infants were CMV infected, but none had any clinical signs or consequences of infection. Lastly, in their 2010 letter presented in a previous summary, Kurath and Resch concluded, “passive immunization with either HCMV monoclonal antibodies or immune globulins might be a case of debate for high-risk low birth weight infants” (p.680). Clearly, more research is needed on this topic.

Capretti et al concluded that the benefits of giving fresh breastmilk outweigh the risks of CMV infection in most preterm infants. For the past 40 years, when interventions for breastmilk-acquired CMV were proposed, they have centered on treating or withholding breastmilk. The discussion of immunoglobulin therapy could shift the focus from treating breastmilk to treating the infant. The more we understand about breastmilk-acquired CMV and breastmilk itself, the closer we come to a comprehensive appreciation of all the relevant issues and options.


Notes

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

________
Additional Cytomegalovirus Resources


CMV Transmission and Breastmilk