# Breastfeeding and Medication Use in Kidney Disease



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**Pregnancy in CKD is a condition fraught with challenges including multiple medications, high-risk pregnancy followed by maternal and fetal compromise such as preterm delivery, and low birth weight infant. Breastfeeding is unique in its impact on the mother and the baby, their bonding, and future health implications impacting the society. Breast milk is produced specific for the infant by the biological mother. It changes in composition with lactation stage and leads to optimal growth of the baby including establishing circadian rhythms, getting protective antibodies, and establishing a healthy gut microbiome. Multiple hormones influence the composition of the milk. Lactation is maintained by removal of the milk. Blood-milk barrier allows for the specific composition of milk by transporting different sized molecules through different mechanisms. It is safe to assume that most medications will be found in some amount in human milk; however, the impact of that is usually not enough to justify stopping breastfeeding. When the mother's milk is not available, formula or donor milk can be considered. There are resources to guide the use of medications during lactation that the providers should be aware of and use, to guide medication and breastfeeding recommendations.**



**Key Words:** Lactation, Kidney diseases, Medication adherence, Breast feeding

Pregnancy in CKD is a challenging condition. Starting with difficulties in getting pregnant, through maintaining a high-risk pregnancy, to the postpartum complications, motherhood with CKD requires critical and complete attention. Adding to the challenges is the increased risk of adverse fetal outcomes such as premature birth, low birth weight, and small for gestational age infants.[1] Breastfeeding is a challenge, unique in its impact on the mother and the baby, their bonding, and future health implications impacting the society. The American Academy of Pediatrics (AAP) recommends exclusive breastfeeding for about the first 6 months to be continued alongside the introduction of complementary foods for at least 1 year. Despite these recommendations, a report compiled by the Centers for Disease Control and Prevention shows that from over 80% of infants in the United States of America that started out on breastfeeding, about 25% were exclusively breastfed at 6 months and only 35% for 1 year.[2] There are not much data available in the area of breastfeeding and CKD or kidney transplant. Extrapolating from these numbers, few women with CKD or after kidney transplant are able to breastfeed their children.[2]

It is an established recommendation to counsel a patient early on in CKD and before a kidney transplant, covering the known and anticipated complications of pregnancy. The majority of this counseling addresses the anticipated complications, but it is also recommended to include advice regarding breastfeeding. Breastfeeding is not contraindicated and should not be discouraged, either in patients with CKD or transplant.[3] The rationale behind encouraging breastfeeding is the value of human milk to the infant, which has shown many advantages. However, there are concerns over the impact of medications on lactation and the infant, and the ability of a mother to feed her baby, considering her clinical state after complicated high-risk pregnancy. This review addresses lactation and the impact of breastfeeding on the infant and the mother. It also addresses the impact of medications over this important aspect of motherhood with specific focus on CKD including end-stage kidney disease and transplant.

To understand the process, it is important to understand lactation basics that consist of mammary glands, milk composition, and the blood-milk barrier.

## LACTATION BASICS

### Mammary Glands

Mammary glands are modified sweat glands. In a nonpregnant woman, breast tissue mainly has adipose and collagenous connective tissue matrix, with a few mammary glands. The mammary glands develop through puberty under influence of estrogens. In pregnancy, enhanced growth happens under the multifactorial influence with a balance of pituitary, adrenal, ovarian, and placental hormones including adrenocorticotropin, thyrotropin, growth hormone, prolactin, adrenal corticoids, estrogen, and progesterone. At parturition, the physiology is influenced by a balance of prolactin and progesterone. Placental progesterone provides the stimulus for growth of the breast alveoli and inhibits prolactin initially. After delivery, the inhibition of progesterone fades with the delivery of the placenta and prolactin becomes the main stimulating hormone, working in concert with the pituitary gland which with oxytocin production aids milk ejection. Breast alveoli are lined with secretary lactocytes and

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contractile myoepithelial cells. Milk is secreted from the lactocytes, held within the alveoli, ejected into the ducts because of the action of the myoepithelial cells.[4]

## Composition

Human milk is a complex biological entity. Mothers' milk is tailored to the nutritional needs of her specific infant, with some variation based on her own state.[5] In primipara, the secretory activation stage may be delayed, and they can have a lower volume of initial milk production. Lower milk volume is observed in postcesarean births compared with vaginal delivery. Delayed lactogenesis has been seen in women with complicated delivery such as those with retained placental fragments, and diabetes.[6]

The milk changes in composition and amount over time and also during each feeding session. Usually, human milk contains the majority of water with about 1% protein, 5% fat, 7% carbohydrates, and 0.2% minerals, many vitamins, and over 600 types of microbes, also being slightly acidic compared with plasma at pH 7 to 7.2.[7] There is also a difference between morning samples and evening samples with cortisol being higher in the morning samples, whereas melatonin being higher in the evenings, thus providing 'chrononutrition' well-timed nutrition and other factors as needed by that specific baby. For the first 48 to 72 hours, colostrum is secreted, a fluid rich in immunoglobulins, followed by transitional milk for approximately 4 days to 1 week and eventually mature milk is produced for the baby. The amount of colostrum on the first day is under 100 mL and enough for the infant, whereas mature milk quantities vary from 1.5-2 L. Human milk varies in composition through stages of lactation and has significant diurnal variation, thus highlighting the need to match donor milk if needed, to the developmental stage of the baby. Having a complex composition, it is imperative to understand what exactly is delivered to the baby when the baby is fed with human milk. However, there are certain limitations to the data collection for this purpose. To study the composition, ideally a standardized collection process is needed. The gold standard would be a sampling all the milk expressed over 24 h, on multiple occasions from the same mother over different stages of lactation. Unfortunately, studies on human milk vary widely in the collection methods, storage conditions, pasteurization, and several freeze-thaw cycles, so the impact of collection time and storage cannot be well assessed. Most studies rely on samples from donor milk for banking, thus the above-stated limitations. Despite these limitations, some studies are available that do detail the composition.[8] Milk composition depends on secretion from the lactocytes supplemented by maternal diet and stores. Nutritional components include micronutrients (including vitamins and minerals) that are impacted by maternal lifestyle and diet and macronutrients, the composition of which is well conserved over different populations (include the ratio of protein, fat, and carbohydrate). There are bioactive compounds including macrophages, stem cells, interleukins, cytokines, chemokines, immunoglobulins, hormones, growth factors, and antimicrobials such as lactoferrin. Growth factors impact development of the gastrointestinal tract, microbiome, blood vessels, and nervous and endocrine systems. Protection against illnesses such as Rotavirus through lactadherin and Norwalk and human immunodeficiency virus through bile salt–stimulating lipase protect from pathogens. Human milk harbors a microbiome specific to the characteristics of the mother and the stage of lactation. The condition of the mother also influences the milk composition, and differences have been found in milk from mothers with allergies, pre-eclampsia, mastitis, and also being on dialysis. A detailed review of the composition of human milk is beyond the scope of this article, but reviews and composition tables are available in the cited references. Lactation is maintained by feeding the baby, which potentiates prolactin and oxytocin release from the anterior and posterior pituitary glands, respectively. After milk matures and increases in volume, lactation becomes a milk consumption–driven process. Thus, continued breastfeeding is necessary for the continuation of lactogenesis.[8]

**CLINICAL SUMMARY**

- Breastfeeding in CKD is a challenging issue for most patients, especially with concerns around the need for multiple medications and the concern of adverse impact on compromised infants.
- Breastfeeding by the biological mother is beneficial to infants specially when they are preterm or compromised as the mother's milk is specific to the needs of her infant. However, if not available, donor human milk and formulas may be considered as an alternative.
- There are resources to help guide the utilization of medications during lactation that providers should be aware of and use to help guide recommendations and use alternatives if needed.

## Blood-Milk Barrier

The blood-milk barrier consists of endothelial cells, the basal membrane, epithelial cells, and connective tissue. The epithelial cells are closely connected by structures such as adherens junctions, desmosomes, tight junctions, small gap junctions, intermediate junctions. These structures control the cell-to-cell adherence and cell signaling and preferential solute movement across the epithelial cells. There is a significant role of transcellular and paracellular transport in allowing different size structures to pass through this barrier. Medications can affect the stability of this barrier—some like steroids can stabilize the barrier, whereas some like titanium dioxide nanoparticles (present in many medications, food additives) can disrupt this barrier.[9] During the initial stage of breastfeeding, the tight junctions are not as tight and allow space between lactocytes, which is the path essential for the transmission of immunologic cells in colostrum. These large pathways have the potential to allow high molecular weight drugs to enter breast milk.[10] However, at this time, the volume of milk consumed is very low, thus the quantity of drug exposure is minimal.

## IMPACT ON THE INFANT

As emphasized earlier, human milk is tailored to the infant for whom it was produced. Exclusive breastfeeding is recommended for at least 6 months after a baby is born, regardless of the maturity (term or preterm delivery), if there are no contraindications. Advantages of exclusive breastfeeding include optimal growth of the baby, reduction in childhood infections (upper respiratory tract illness, otitis media, and gastroenteritis), allergies, autoimmune diseases (diabetes, celiac, and inflammatory bowel disease), childhood leukemia, higher cognitive functions, and improved neurocognitive outcomes.[11] Mothers milk, in addition to preventing obesity in adolescence and adulthood, is essential to growth, active and passive immunity, establishing circadian rhythms, and cognitive and psychosocial development of newborns.[12] In addition, there are known benefits on length of hospital stay, as well as significant impact on rates of necrotizing enterocolitis in the infants.[13] In a referenced study, compared to breastfed children, never-breastfed children had smaller kidney volumes and lower estimated glomerular filtration rate at school age. These results suggest that breastfeeding is associated with subclinical changes in kidney outcomes.[14]

## MEDICATIONS AND BREASTFEEDING

It is safe to assume that all medications enter milk to some degree.[15] However, most of these simply transfer across the blood-milk barrier by passive diffusion. Infants of women on medications are exposed to the medications through gestation if the medicine passes the placental barrier. This barrier is similar functionally to the blood-milk barrier. Thus, safety profiles of many medications used during pregnancy are similar to those used during lactation. Some active transport systems do exist across the blood-milk barrier for immunoglobulins, electrolytes, and iodine, but facilitated transport systems are limited. Selective transport across this barrier is limited to very few medications. Most chemicals that can concentrate in human milk must have low molecular weight, low protein binding, high lipid solubility, high maternal plasma concentration, and high pKa to facilitate trapping in milk.[15] The impact of being present in milk is further toned down by lack of oral bioavailability and the changing composition of the milk for the infant. For most calculations, clinicians use 150 mL/kg/day as the volume of the ingested milk to calculate the relative infant dose (RID). RID is calculated as the ratio of dose in the infant in mg/kg/day divided by the dose in the mother also in mg/kg/day, and an RID over 10% is deemed a matter of concern.[15] Most medications are not tested in nursing women, so it is difficult to ascertain the drugs that can affect a breastfed child. Usually, medication changes are made before pregnancy, continued through pregnancy, parturition, and postpartum period. Medications that can cross the placental barrier have the same characteristics as most that can cross the blood-milk barrier; therefore, most commonly, the same medications can be continued through pregnancy to lactation. The AAP advises patients and practitioners to consult the online LactMed® database.[16] The LactMed® database contains detailed information for breastfeeding mothers and the infants regarding drugs and other chemicals and is maintained by the National Institutes of Health. The AAP suggests that providers weigh the risks and benefits of prescribing medications by considering the following issues: need for the drug by the mother, potential effects of the drug on milk production, amount of the drug excreted into human milk, the extent of oral absorption by the breastfeeding infant, potential adverse effects on the breastfeeding infant, age of the infant, and the proportion of feedings that are breast milk.[17]

## WOMEN WITH CKD

There are not much data on women with CKD and lactation and breast milk composition. The top 2 diseases leading to CKD remain diabetes and hypertension. The concerns over medication use may be secondary to having an uncontrolled disease. For instance, uncontrolled hyperglycemia is a significant risk factor for poor fetal outcomes compared with the use of most pregnancy-safe antihyperglycemics. Breastfeeding decreases mothers' risk of obesity, metabolic syndrome, and progression from gestational to overt diabetes later in life.[18] Women with early CKD, for example, stages CKD 1-3a may breastfeed successfully.[19] With moderate to severe CKD, breastfeeding can be attempted when the baby and the mother are both stable after delivery. Breastfeeding has been suggested to reduce the incidence of type 2 diabetes mellitus, cardiovascular disease, and metabolic syndrome for the mother. There is paucity of data regarding the use of oral hypoglycemic agents for breastfeeding, so insulin remains the optimal antidiabetic treatment during lactation. There are no data on use of SGLT2 inhibitors although it is expected that very little of it can pass in the breast milk because of protein binding.[20,21]

Similarly, hypertensive mothers should breastfeed their infants.[22] Mothers who never fed their infants had a higher risk of hypertension compared with mothers who breastfed.[23]

Earlier studies implicated that diuretics may diminish milk production; however, this inference is not supported by significant data. Methyldopa, commonly used antihypertensive in pregnancy, may suppress milk production after delivery. An active infant can counteract this effect through stimulation of lactogenesis when suckling.[24] Table 1 provides a list of commonly used medications that are used during lactation. A mention needs to be made that angiotensin-converting enzyme inhibitors, which are one of the medication classes that are contraindicated in pregnancy, can be resumed postpartum. Captopril and enalapril are secreted in low amounts in breast milk and may be used if needed, with a close assessment of neonates for hypotension.

## WOMEN WITH KIDNEY TRANSPLANT

Transplant Pregnancy Registry International (earlier known as National Transplantation Pregnancy Registry) data show an increased prevalence of breastfeeding

**Table 1. Commonly Used Medications in CKD and ESKD and Their Safety in Breastfeeding**

| Medication | Class | Safety in Breastfeeding | Comments for Lactation |
|---|---|---|---|
| Antihypertensives | | | |
| Furosemide | Diuretic | Caution recommended | Large doses of diuretics can suppress lactation. Safer alternative is to consider chlorothiazide and hydrochlorothiazide. |
| Amlodipine | Calcium channel blocker | Acceptable for use | |
| Nifedipine | Calcium channel blocker | Acceptable for use | Has also been used to treat painful nipple vasospasms. |
| Labetalol | Beta blocker | Acceptable for use | Case reports of sinus bradycardia and isolated atrial premature beats in a preterm (26 weeks) infant and of worsening nipple vasospasm in 1 woman. Consider alternatives during lactation for preterm and women with a history of Raynaud's phenomenon. |
| Metoprolol | Beta blocker | Acceptable for use | |
| Methyldopa | Alpha adrenergic agonist | Other agents preferred | Usually avoided because of increased risk of maternal depression |
| Clonidine | Alpha adrenergic agonist | Other agents preferred | High concentration in infant serum |
| Captopril | Angiotensin-converting enzyme inhibitors | Acceptable for use | |
| Lisinopril | Angiotensin-converting enzyme inhibitors | No data available | Better to consider an alternative |
| Losartan | Angiotensin II receptor blocker | No data available | |
| Candesartan | Angiotensin II receptor blocker | Preliminary data–acceptable for use in term infant | Caution in preterm and newborn infants |
| Valsartan | Angiotensin II receptor blocker | No data available | |
| Hydralazine | Vasodilator | Acceptable for use | |
| Antidiabetics | | | |
| Glipizide | Short-acting sulfonylureas | Other agents preferred | Limited data, infant monitoring needed for hypoglycemia and other side effects |
| Glimepiride | Short-acting sulfonylureas | Limited data available, negligible concentration in breast milk | Limited data, infant monitoring needed for hypoglycemia and other side effects |
| Glyburide | Long-acting sulphonylurea | Not recommended in CKD | Limited data, infant monitoring needed for hypoglycemia and other side effects |
| Metformin | Biguanide | Acceptable for use | Caution in preterm and newborn. Usually not prescribed in CKD with GFR<30 |
| Insulin | Hormone | Acceptable for use | Preferred agent in advanced CKD and in patients on dialysis. |
| Anemia management | | | |
| Iron preparations | Iron | Acceptable for use | |
| Darbepoetin | Erythropoiesis-stimulating agent | No data available | Darbepoetin is biologically the same as erythropoietin, which is normally present in breast milk |
| Methoxy polyethylene glycol-epoetin beta | Erythropoiesis-stimulating agent | No data available | Similar agent, epoetin alfa, is considered acceptable |

(*Continued*)

**Table 1. Commonly Used Medications in CKD and ESKD and Their Safety in Breastfeeding (*Continued*)**

| Medication | Class | Safety in Breastfeeding | Comments for Lactation |
|---|---|---|---|
| Bone-mineral disease management | | | |
| Calcium salts | Phosphate binders | Acceptable for use | Phosphate content of breast milk in a case report was lower than controls. The infant was given supplemental phosphates |
| Sevelamer | Phosphate binder | Acceptable for use | Not orally absorbed, not present in breast milk |
| Lanthanum | Phosphate binder | No data available | |
| Ferric citrate | Phosphate binder | No data available | Iron is present in breast milk. |
| Sucroferric oxyhydroxide | Phosphate binder | No data | Not orally absorbed, not expected to be present in breast milk |
| Calcitriol | Vitamin D analogs | Acceptable for use | Low levels found in breast milk |
| Cinacalcet | Calcimimetic | No data available | |
| Kidney transplant medications | | | |
| Prednisolone/steroids | Steroids | Acceptable for use | |
| Cyclosporine | Calcineurin inhibitor | Acceptable for use weighing risk vs benefit | Present in breast milk, variable concentration |
| Tacrolimus | Calcineurin Inhibitor | Acceptable for use weighing risk vs benefit | Present in breast milk, variable concentration |
| Mycophenolate Mofetil | Immunosuppressant | Not recommended | |
| Azathioprine | Immunosuppressant | Inconclusive data, can be used at lower doses | Manufacturer does not recommend use |
| Metabolic acidosis management | | | |
| Sodium bicarbonate | Alkalizing agent | Acceptable for use, no specific lactation data | Sodium is found in breast milk |
| Sodium citrate | Alkalizing agent | Acceptable for use, no specific lactation data | Metabolizes to bicarbonate |
| Calcium salts (citrate, carbonate, acetate) | Alkalizing agents, calcium supplement, phosphate binders | Acceptable for use, no specific lactation data | Are used as supplements, the levels not altered in breast milk by intake |
| Hyperkalemia management | | | |
| Patiromer | Potassium binder, exchanges potassium for calcium | | Not orally absorbed, not expected to be present in breast milk |
| Sodium zirconium cyclosilicate | Potassium binder, exchanges potassium for sodium and hydrogen ion | | Not orally absorbed, not expected to be present in breast milk |

ESKD, end-stage kidney disease; GFR, glomerular filtration rate.

mothers on maintenance immunosuppression after kidney transplant. The limited research on breastfeeding after a kidney transplant shows that although immunosuppressed, the mother can produce immunocompetent milk. The other commonly used medications do have some data to support their use through lactation.[25]

Most commonly used medications are detailed in the following.

### Steroids

Breast milk transfer of prednisolone is 0.1% of the total maternal dose. Maintenance prednisolone <20 mg/day leads to an infant dose <10% of endogenous corticosteroid production and is regarded to be safe. In 1 study, the concentration of corticosteroids within the breast milk of women taking 10–80 mg of prednisolone per day was between 5% and 25% of maternal serum concentrations.[26]

### Tacrolimus

In an early study, 50% of maternal serum concentration was detected in colostrum within the immediate postpartum period, associated with a 36% risk of transient hyperkalemia and mild kidney impairment in the infant. However, more recent studies demonstrated that total tacrolimus ingestion was <0.5% of the total adult weight-adjusted dose, with no detectable tacrolimus level in infants' serum at 2–3 weeks postpartum. Infant exposure, when breastfed by mothers taking tacrolimus, is about 0.23%. In a small study, no differences were reported between bottle-fed and breastfed infants after serial testing. Similarly, 1 study found that infant tacrolimus concentrations were lower than maternal concentrations after delivery and became undetectable by 2 weeks postpartum, regardless of the method of feeds.[28-30]

### Cyclosporine

The rate of cyclosporine ingestion from breast milk is < 0.1 mg/kg/day in comparison to a therapeutic dose of 2–10 mg/kg/day. The estimated infant exposure to weight-adjusted maternal cyclosporine dose is 0.33%. Cyclosporine levels have also been measured as undetectable in these infants. In a study of 6 exposed infants, only 1 had detectable cyclosporine concentrations and had normal development up to 1 year.[31]

### Mycophenolate Mofetil

Mycophenolic acid treatment in the first trimester is associated with birth defects including microtia and facial abnormalities. It is avoided in women of childbearing age with strict advice to establish long-acting and preferably double contraception before starting this medication. Therefore, there are limited data on the effects on breastfed infants of mothers taking mycophenolic acid. Although a limited series has suggested no discernible adverse effect in 7 infants from breastfeeding, it is currently not advised.[32]

### Azathioprine

There have been no clinically observed adverse effects from maternal azathioprine use in breastfed infants up to 3 years of follow-up, with safety data derived from both the kidney transplant setting and women with inflammatory bowel disease. At doses up to 200 mg per day, there are almost no measurable active metabolites in breast milk or infant blood. Longer follow-up data are lacking. It is likely to be safe if given 4 hours before breastfeeding. The manufacturer does not recommend use during breastfeeding.[32] To summarize, in the kidney transplant subgroup, calcineurin inhibitors (cyclosporine and tacrolimus), prednisone, and azathioprine are generally considered safe although they require close monitoring because of lack of data and potential for adverse effects, while mycophenolate mofetil and mycophenolic acid are contraindicated. There is not enough information on sirolimus, everolimus, and belatacept.[25-32]

## WOMEN ON DIALYSIS

Similar to women with CKD, there are minimal data available on lactation and breast milk composition in women on dialysis. There is 1 study that directly looked at human milk composition in a woman on hemodialysis (HD).[33] Women on HD had significantly higher levels of creatinine, urea, and uric acid in pre-HD breast milk than in post-HD milk. Sodium and chloride were significantly increased in post-HD samples. Phosphate was significantly lower in pre-HD and post-HD breast milk than in milk from control women (low-risk mothers matched for postpartum age), whereas calcium showed no significant differences. In terms of nutrient components, glucose levels were decreased, whereas protein, triglycerides, cholesterol, and immunoglobulins were similar to the control milk and were not affected by dialysis.[33] Similarly, no significant differences were found in iron, potassium, and magnesium content. Thus, overall, there was a high similarity of breast milk samples from HD patients to samples from low-risk control mothers. The variations in breast milk composition between pre-HD and post-HD samples suggest that breastfeeding after a dialysis session is preferable to breastfeeding before dialysis. The author of this study suggested that the mother discard milk pumped immediately before dialysis.[33]

There are no data on women receiving peritoneal dialysis; however, we assume that similar changes can be expected but without major variations because of the continuous nature of peritoneal dialysis.[34] Aggressive ultrafiltration may reduce the milk supply. Avoiding heparin that contains the preservative benzyl alcohol is prudent because it is potentially toxic to at-risk infants.[34]

## BREASTFEEDING AND CONTRACEPTION

The next question for most women with complicated pregnancies has been contraception. Nonhormonal methods, such as intrauterine devices, and the barrier method remain the first choice for breastfeeding women, given the lack of potential to interfere with lactation and low failure rate, while progestin-only agents are considered next. All major international family planning organizations endorse progestin-only contraceptive methods once lactation has been established. Prospective, multicenter studies of infants of mothers on progestin-only methods found no deleterious effects of the drug on infant growth and

development.[35] As progesterone withdrawal stimulates the final lactogenesis, natural progesterone levels must decline before progestin contraceptives may be used. Other concerns have been that with too early initiation, the neonatal liver and kidney may not be able to metabolize and excrete this steroid. Thus, using progestin-only contraceptive methods should be delayed optimally until 6 weeks postpartum to establish adequate lactation.[36]

## BREAST MILK AND FORMULA FEEDS

The best outcomes for the infants are from their own mother's milk, fed on demand, exclusively through the first 6 months of life. However, it is understandable that this optimal scenario may not always be available. A mother with chronic illness has complex medical needs as also does an infant born under such challenging circumstances. In such cases, using human milk from donors is a viable option,[37] as is use of formulas for nutritional needs of the infant. Formula feeds are used more than donor milk, likely due to cost, access, and familiarity considerations.[38,39]

There are some data showing that adding formula feeds to human milk results in better weight gain, linear growth, and head growth but has a higher risk of necrotizing enterocolitis.

If donor milk is considered, obtaining from milk banks is recommended because of infection screens and proper storage with pasteurization.[39]

## RESOURCES

LactMed® database remains a leading resource for information on medications during lactation. It is advised to reconcile prescribed medications from this list for safety. In addition, the U.S. Department of Health and Human Services and the U.S. Department of Agriculture jointly publish the Dietary Guidelines for Americans (Dietary Guidelines) every 5 years. The Agricultural Act of 2014 mandated that starting with the 2020–2025 edition, it must also guide women who are pregnant and infants and toddlers from birth to age 24 months[40] To inform such guidance, pregnancy exposure registries on the U.S. Food and Drug Administration website have studies collecting health information on exposure to medical products such as drugs and vaccines. However, there are multiple challenges for research on this topic leading to paucity of data. As of updated content current on 03/03/2020, there were only 4 entries (filtered from 117 total entries) on a kidney topic in this registry.[41]

## COVID-19 AND BREASTFEEDING

No article would be complete this year without looking at the impact of the coronavirus on the topic of interest to the reader. Coronavirus disease 2019 (COVID-19) is dreaded for person-to-person spread via respiratory droplets, similar to other respiratory pathogens, requiring social distancing as the mainstay of preventing spread. Needless to explain that this strategy will not work for a mother and her infant, especially if breastfeeding. Fortunately, limited studies on women with COVID-19 and another coronavirus infection, severe acute respiratory syndrome (SARS-CoV), did not detect the virus in breast milk. A report from China states that SARS-CoV-2 nucleic acid was not detected in the breast milk of a mother with COVID-19, and antibodies against SARS-CoV-2 were detected in the mother's serum and milk, raising suggestions that her milk may even be protective for her 13-month-old child, who unfortunately was also positive at the time of her diagnosis because they shared the same exposure history.[42]

However, it is not certain at this time that the mothers with COVID-19 cannot transmit the virus via breast milk as much is unknown about COVID-19.[43] The Centers for Disease Control and Prevention recommends that decisions around breastfeeding need to be determined by the mother in coordination with her family and health care providers. A mother with COVID-19 must take all precautions to avoid infecting her infant. If expressing milk with a breast pump, the mother would need to maintain universal precautions such as washing hands before touching the pump and expected containers and follow recommendations for proper pump cleaning after each use. Expressed milk can be fed by another person to the infant.[43]

Although no treatment has any proven efficacy at the time of writing this article, current investigational approaches include some combination of tocilizumab (interleukin-6 pathway inhibitor), remdesivir (nucleotide analog), hydroxychloroquine, and convalescent plasma. Tocilizumab is recommended to be used with caution, was found in small quantities in breast milk, but no adverse effects on the breastfed infants were noted in the few case reports that are available based on data from rheumatologic diseases.[44,45] Hydroxychloroquine has a similar profile.[46] However, azithromycin being an antibiotic can cause non–dose-related microbiome changes, gastrointestinal disturbances,[47] and an increased risk of infantile hypertrophic pyloric stenosis.[48,49] There are no data regarding remdesivir in breast milk.

### Contraindications to Breastfeeding

Although breast milk remains the optimal nutrition of choice for most infants, it is also important to know the few contraindications to its use.[50]

The AAP guidelines state that the 2 absolute contraindications for breastfeeding infants are for the infants with galactosemia (galactose 1-phosphate uridyltransferase deficiency) and for infants of mothers with HIV. However, it needs to be also stated that in the developing countries, HIV infection risk needs to be weighed against the risk of malnutrition. Other relative contraindications include women positive for human T-cell lymphotropic virus and those with untreated brucellosis. These mothers are advised not to provide even expressed breast milk. Women with the following infections are advised to provide expressed breast milk but not directly feed the infant—sputum-positive untreated tuberculosis, active herpes simplex lesions on a breast, varicella infection a week before through 2 days postpartum, and acute

infection with H1N1 influenza. Breastfeeding can be resumed in these patients once the mother is considered noninfectious, that is, 2 weeks of antituberculous therapy, or being afebrile after H1N1 infection. Mothers actively using recreational drugs such as cocaine and cannabis are able to cross the blood-milk barrier and can harm the growing infant; however, mothers on methadone maintenance programs can breastfeed their infants.[50]

Alcohol use can impact the development of the infant and is a concern. The AAP recommendation is to limit alcohol intake to under 0.5 g alcohol per kg body weight and to feed after at least a gap of over 2 hours after alcohol intake.[51] Smoking can cause failure to thrive in the infant and also affect the baby through childhood because of exposure to secondary smoke and is to be discouraged.

The AAP also recommends that mothers on statins, amphetamines, chemotherapeutics agents, and ergotamines should not breastfeed because of drug concentration in human milk.[51] Breast milk and impact of radiopharmaceuticals and diagnostic radioactive compound use needing temporary withholding of feeding is provided by U.S. Nuclear Regulatory Commission.[52]

## SUMMARY

Breastfeeding is a challenge for mothers with CKD or transplant, especially as they are dealing with chronic illness requiring procedures and multiple medications. It is critical to understand the impact that medications have on breastfeeding and use available resources to help guide the mother who may want to breastfeed despite these obstacles. In addition, 1 must be aware of the changes in breast milk during dialysis. There is additional need to understand the impact of medications on lactation itself and the effect of these medications on the infant. Breastfeeding is recommended whenever possible, with or without supplemental nutritional support as needed by the baby. The advantages such as improved neurodevelopmental outcomes in preterm and very-low-birth-weight babies far outweigh the risks associated with medication use, especially as alternative medications that are safe in lactation and are available for most conditions. This information is available on LactMed® database, an invaluable resource for health care providers. Nationally, breastfeeding remains lower than optimal, impacted by multiple disparities such as race, age of the mother, socioeconomic status, and disease burden.[53] Providers should encourage and address barriers to breastfeeding where appropriate for mothers with CKD, on dialysis, or after transplantation. Providers are also encouraged to refer to the resources provided to better facilitate lactation and breastfeeding to optimally support their patient.

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