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NARRATIVE REVIEW

Congenital Zika Syndrome

Background and Nutrition Care of Affected Infants

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Zika infection of pregnant women can result in infants with microcephaly and other severe birth defects. With these conditions come a variety of challenges that impair nutritional status. While Zika infection in the United States remains relatively rare, registered dietitian nutritionists should be prepared to assess and provide support to affected children. The most common nutrition-related consequences of Zika infection have some possible nutrition interventions to minimize their impact. The goal of nutritional care for infants and children with congenital Zika syndrome is to promote optimal functional capacity and quality of life. **Key words:** *birth defects*, *congenital Zika syndrome*, *feeding*, *infants*, *infectious disease*, *microcephaly*, *nutrition*, *Zika virus*

ZIKA IS a viral illness which, when contracted by pregnant women, can result in congenital Zika syndrome (CZS). Congenital Zika syndrome is associated with significant perinatal morbidity and mortality in infants.[1] While this disease is not common in the United States, registered dietitian nutritionists (RDNs) should be prepared to address the needs of these infants when they are encountered. Optimizing nutritional status can support better quality of life. A review of the literature did not identify any specific guidelines or recommendations for the nutritional assessment or care of infants and children affected by Zika virus infection. However, published research about conditions with some similar challenges, such as cerebral palsy (CP) and epilepsy, provides some direction for RDNs encountering infants and children with CZS.

Zika virus (Zika V) is a blood-borne, single-stranded, enveloped RNA virus that has spread throughout the world in a short time.[2] As part of an ongoing project investigating yellow fever, Zika virus initially was isolated from a sentinel case rhesus monkey with fever and from the blood of *Aedes africanus* mosquitoes at the Zika forest in Uganda in 1947.[3] The first Zika infection in a human was reported in 1964 in Uganda.[4] The patient presented with fever, frontal headache, rash, and myalgia. Subsequently, serological studies indicated that the disease had spread in East and West Africa, as well as parts of Asia,[5-10] and limited to sporadic cases or clusters within populations. In 2007, Zika virus infection resurfaced with outbreaks in French Polynesia, Easter Island, and more recently in

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North and South America.[11] By 2013, Zika infection was alarmingly pandemic.[12] The ominous and threatening ability of Zika virus to infect pregnant women, leading to serious birth defects in fetuses and newborns, may be associated with neurodevelopmental conditions in children.[1]

ZIKA VIRUS PREVALENCE

The World Health Organization (WHO) has identified 85 countries, territories, and subnational areas reporting an active presence of the Zika virus as of January 2018.[13] These data show that transmission is ongoing in North and South America, the Western Pacific region, Southeast Asia, and Africa. The US Centers for Disease Control and Prevention (CDC) has identified specific countries with active maternal to infant transmission of the Zika virus.[14] A total of 5716 cases of adults with Zika virus infection have been reported in the continental United States,[15-17] with an additional 37 292 cases in US territories, chiefly Puerto Rico.[18] In addition to adults, Zika virus–affected infants have been identified in Florida[19,20] and Texas.[21]

The CDC established the US Zika Pregnancy Registry in February of 2016. Analysis of their data so far has indicated that for completed pregnancies by Zika-infected women, 6% bore infants with CZS. This figure increased to 11% for women who were infected in their first trimester of pregnancy.[22]

Details of the biology and pathogenesis of the Zika virus were largely unknown until 2014. Only a few cases of Zika virus infection had been observed in humans, were self-limited, and displayed only mild symptoms. There had been epidemics of Zika infection in the Yap Islands in Micronesia in 2013 and in French Polynesia in 2014, but no major clinical outcomes were reported from these instances.[23,24] Since then, Zika virus has garnered more clinical and public health attention due to evidence linking it to microcephaly in neonates and Gillian-Barre syndrome in adults.[25-29] By May 2017, 48 countries in North, Central, and South America reported vector-borne transmission of Zika virus disease.[30]

Incidence has been estimated at 1.23% of adult cases.[31] This was exemplified by reports of the outbreak of Zika infection in Brazil in 2015, showing the virus to be associated with a significantly increased incidence of congenital microcephaly and other birth defects in infants born to Zika-infected mothers.[32,33] A recent review by Moore et al[34] provides a detailed list of anomalies found in infants with what has come to be called congenital Zika syndrome.

Although 20% of Zika virus infections are symptomatic, and for most people, the disease is mild and resolves within a week, it remains problematic, as there is no vaccine against infection.[35] The most alarming symptoms are the increased risk of birth defects in pregnant women, particularly if the infection occurs in early pregnancy. According to the CDC statistics, 10% of infants with confirmed Zika infection and 1 in 20 or 5% of infants in the United States had Zika-associated birth defects.[35]

TRANSMISSION AND SYMPTOMS IN ADULTS

Zika virus is a blood-borne pathogen that is most commonly transmitted to adults by the bite of an infected mosquito[36] or by unprotected sexual activity with an infected partner.[17,37,38]

Eighty percent of infected individuals show no recognizable symptoms. Symptoms of Zika infection are generally mild when evident in otherwise healthy adults[39] and may include fever, joint pain, a bumpy red skin rash, and conjunctivitis, all of which can be overlooked or attributed to other causes.[40] One case report demonstrated possible optic neuropathy in an adult and a 17-day old infant, both with recent Zika viral infection.[41] Children aged 12 months to 16 years contracting Zika from mosquito bites showed a range of symptoms similar to those seen in adults.[42] The aim of this review is to summarize the complications of Zika infection during pregnancy with a

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focus on infants with Zika-related neurological and developmental symptoms, nutritional complications of the fetus and newborns, and the nutrition care management of such cases.

TRANSMISSION AND SYMPTOMS IN INFANTS

Zika virus has been shown to cross the placental barrier and infect the developing fetal brain, resulting in damage to the central nervous system.[43] A comparison of 602 infants with Zika infection with 899 infants who had been ruled out for this disease found that Zika virus–affected infants had a significantly higher ($P = .004$) likelihood of birth before 37 weeks of gestational age, lower birth weight ($P = .0001$), and higher mortality ($P = .0001$). Mortality rate was almost 4 times higher for infants with CZS.[32] Data from the US Zika Pregnancy Registry showed that 10% to 15% of women with laboratory-confirmed Zika infection gave birth to infants with birth defects consistent with CZS.[14] The most prominent feature of CZS is microcephaly, defined as a head circumference that is more than 2 standard deviations below the mean for age and gender based on normative growth charts.[44,45] It is a clinical finding, not a diagnosis in and of itself. The brains of infants with microcephaly are proportionally smaller than the brains of unaffected infants,[46] and the condition is almost always associated with some degree of disability.[47]

A prospective, population-based study found that head size at 3 months of age was a strong predictor of mental and psychomotor development at 12 and 24 months.[48] Furthermore, a prospective cohort study by Olusanya[49] reported that microcephalic infants who were not exclusively breastfed were unlikely to experience catch-up growth when seen for follow-up at 6 to 8 weeks of age. Together, these findings demonstrate that microcephaly is an important risk factor for impaired nutritional status.[49] There is some evidence that infants with Zika infection and microcephaly may represent only the most severely affected cases, with some normocephalic infants also having neurological impairment.[50] In addition to microcephaly, CZS may also include vision problems, congenital contractures, hypertonia, poor sucking, dysphagia, low birth weight, failure to thrive, hearing impairment, and seizures.[51,52] Infants with CZS are at an increased risk of infantile spasms, a severe form of epilepsy that may worsen developmental delay.[53,54] Evidence indicates that brain and eye anomalies can occur without microcephaly.[34] In addition, an increased incidence of congenital heart defects has been reported for infants with CZS.[55]

While microcephaly is a prominent feature of CZS, its absence at birth does not rule out the possibility of congenital Zika virus infection, Zika-related brain abnormalities, or other problems.[56] Children born to Zika-infected mothers may experience developmental disabilities later in life. Thus, the number of affected individuals may be underestimated at present. It is also important to monitor the children of Zika-infected mothers with periodical serological testing or a urine analysis for detecting Zika infection.

The WHO examined the risk of Zika transmission via breastfeeding. The WHO reported that no neurologic damage had been documented in infants 0 to 23 months who were infected with Zika *after* birth. The WHO has issued interim guidance on breastfeeding for women infected with Zika.[57] These guidelines state that available evidence suggests that the "benefits of breastfeeding for the infant and mother outweigh any potential risk of Zika virus transmission through breast milk."[57(p7)] The WHO therefore continues to recommend breastfeeding as the optimal feeding modality for infants in this setting.[57]

EFFECTS OF ZIKA INFECTION ON BREASTFEEDING

Breastfeeding is the recommended mode of feeding for infants by virtually all entities issuing guidelines on the subject.[58-62] Zika virus has been detected in both colostrum and breast milk of infected mothers, and this

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potential route of infection has been explored.[63] Zika is a flavivirus, along with dengue, Japanese encephalitis, tick-borne encephalitis, Powassan virus, West Nile virus, and yellow fever. Viral genetic material from these sources can be detected in human milk.[64] The CDC lists the possible modes of transmission as in utero, mosquito bite, sexual intercourse, blood transfusion, and possibly breast milk.[65] However, further studies have found that, for Zika, there is not a sufficient amount of the virus present in breast milk to transmit the disease from a mother to her uninfected infant.[66,67] Few studies exist that address breastfeeding practices for infants with congenital Zika infection. While Howard et al[21] reported that affected infants required nasogastric tube feedings due to poor nutrition status and were discharged with milk formulas, Gieseke Guevara and Agarwal-Sinha[68] indicated that the infants with CZS were breastfed. Based on the available literature, it appears that the severity of CZS varies and feeding practices need to be adjusted accordingly.

Although there is an increased rate of prenatal and neonatal mortality associated with Zika infection, most infants with CZS have a life span similar to that of infants with other neurological impairments.[69] Infants and children affected with Zika will need ongoing care; however, gaps in our present knowledge of the long-term impacts of Zika infection prohibit an understanding of the full extent of those needs over a lifetime.[70] Bailey and Ventura[71] point out the likelihood of needing lifelong care and suggest a family-centered approach through a medical home. This care will come at a significant cost. One report showed that the mean length of stay for infants with microcephaly (from any cause) was 6.6 days at an average cost of $33 590 per hospitalization.[72]

RISK IDENTIFICATION AND PREVENTION EFFORTS

In January 2016, the CDC issued guidelines for clinicians caring for pregnant women with potential Zika exposure[73] and updated these in 2017.[74] They issued an advisory warning for pregnant women about the risk of travel to countries where active transmission of Zika virus occurred.[75] Travel updates are posted periodically on CDC's travel Web site.[76] Zika was declared to be a "public health emergency of international concern" by the WHO in February of 2017.[76]

Because mosquitoes primarily transmit the Zika virus, areas with tropical climates conducive to high mosquito populations are at especially high risk. Dissemination in the United States is a possible threat, especially in southern states.[77] Control of mosquitoes as a vector for Zika is an important preventive measure and involves hygienic activities such as eliminating standing or stagnant water as a breeding place and maintaining window and door screens on homes to prevent entry, as well as the application of insecticides.[78]

Travel exposures put large urban centers at risk, as well. The New York State Department of Health and the New York City Department of Health and Mental Hygiene obtained data on the prevalence of microcephaly from all causes in New York State from 2013 to 2015 to establish baseline levels prior to the introduction of Zika.[79] They reported a prevalence of 4.2 cases per 10 000 live births. In 2016, New York had the highest number of travel-related Zika virus cases in the continental United States.[80] For this reason, hospitals in New York City have implemented Zika prevention and response protocols.[81,82] Similar guidelines for patient education on Zika prevention were included in a review article by Sampathkumar and Sanchez.[83] Vaccines against the Zika virus are under development as a preventive measure.[84,85]

PUBLIC AWARENESS

Despite statements from WHO, CDC, and other organizations, knowledge of Zika prevention by the general public has remained low. A survey of people in New York City found that there were significant gaps in knowledge about Zika, especially as a

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sexually transmitted disease.[86] A larger national survey had similar results.[87] A nationwide survey of pregnant women in the United States elicited reports of being worried about Zika virus infection. Women identified themselves as being at risk but had gaps in their factual knowledge about the disease.[88]

A ROLE FOR THE RDN

In 2017, an editorial in *The New England Journal of Medicine* pointed out that new knowledge about the Zika virus and CZS should be widely disseminated to practitioners and applied to improve patient care.[89] While it is uncommon for an infant with CZS to present in a US hospital, RDNs should be aware of this syndrome and be prepared to address the needs of these infants when they are encountered. Marchand and Motil[90] suggested that neurologically impaired children should have ongoing monitoring for nutritional comorbidities as an integral part of their care.

Care of infants and children with a congenital Zika virus infection is not curative but should consist of supportive care. Ongoing assessment and care should be carried out with the infant's individual medical and neurodevelopmental needs in mind.[49,91,92] Further investigations should seek to understand what services will be needed by these children as they grow.[93] According to the CDC, because of the variety of problems that are seen in infants with CZS, individualized care is essential and requires an interdisciplinary team, including an RDN.[94-96] Evaluating and maintaining optimal nutritional status in infants with CZS are important. Consideration of any food and nutrition problems that arise is warranted. Extracting best practices by symptoms from similar conditions may provide some guidance to those responsible for the nutritional care of these infants. An initial search of PubMed using the terms "Zika infant" and "congenital Zika syndrome" was conducted, resulting in 390 documents. These documents were evaluated for timeliness and relevance to the nutrition assessment of infants with CZS. The findings of this analysis are reported later.

NUTRITION CARE OF INFANTS WITH CZS

As noted earlier, little has been reported about the details of nutritional care received by infants with CZS. Cases of 2 infants with CZS in Texas have been described in detail.[21] Both were delivered by cesarean section at 39 weeks of gestation, and both had a low birth weight, 2.62 kg, and 2.39 kg, respectively. Both infants received care in the neonatal intensive care unit, the first for 9 days and the second for 28 days. Both infants required nutritional support via orogastric tube due to poor feeding ability. They were both transitioned to bottle-feeding before discharge, although details of the formula type, concentration, and rate of administration were not reported. Another case report from Florida described an infant born at 36 weeks of gestation, who exhibited severe microcephaly, but was able to breastfeed successfully.[68]

CZS FEATURES IMPACTING NUTRITIONAL STATUS

Low birth weight, poor suckling, dysphagia, developmental delay, movement disorders, and vision and hearing impairment manifest in congenital Zika infection. In spite of the lack of literature reporting nutritional interventions for infants and children affected by CZS, characteristics of this syndrome likely to impact nutritional status are described in this section.

Low birth weight

Analysis of 34 infants with CZS in Brazil reported that their average birth weight was 2.77 kg at an average of 37.7 weeks of gestational age. Close to 60% of these infants were delivered by cesarean section and 47.1% were exclusively breastfed.[97] Ramenghi et al[98] point out the increased probability of malnutrition due to difficulty feeding infants who are very sick and unstable.

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Inadequate feeding can result in intakes well below the recommended dietary intake and nutritional deficits. Neonatologists generally agree that one of the goals when caring for low-birth-weight infants is to achieve satisfactory growth and functional development. Inadequate nutrition can result in increased risk of infectious diseases, lung injury caused by impaired tissue repair, muscle weakness, and decreased rate of maturation of the intestines.[99]

Poor sucking/dysphagia/ gastroesophageal reflux

Zika infection in pregnant women can result in devastating neonatal complications in their infants. Many of the difficulties seen with Zika-affected infants are similar to those of other premature infants, including deficits in oral feeding ability.[100] Infants with neuromuscular diseases may be unable to consume enough breast milk or formula to meet their needs. These infants should be monitored closely for indicators of dysphagia, such as difficulty breathing with feeding, coughing or choking during feeding, or extended feeding times.[101(p1095)] Signs of dysphagia warrant an evaluation from a speech and language therapist. Enteral feeding may be required to prevent aspiration and to promote adequate intake.[102]

Zika-associated outcomes include symptoms affecting the digestive system.[103] The most common symptoms are dysphagia, reflux esophagitis, constipation, and impaired gastrointestinal motility. An analysis of 83 infants with CZS found that most could be fed normally, with 9.6% having gastroesophageal reflux with aspiration. In some cases, feeding difficulties did not become evident until several weeks or months after birth.[104] Saad et al[105] noted that around 4 months of age, sucking and swallowing reflexes disappear, exacerbating dysphagia and increasing the risk of aspiration. Gastroesophageal reflux disease (GERD) is also a common complication in these infants. In a study of older children (average age of 21 months), more than 70% had severe difficulty eating and required a modified diet (with consistency of mashed, pureed, strained, or liquid). Almost 95% of participants could not use utensils or drink from a cup.[68]

A study by Leal et al[106] examined 9 infants with CZS referred for evaluation of dysphagia and found several issues including choking, coughing, regurgitation, respiratory infections, and extended feeding time. All of the infants were evaluated by 3 methods; the Schedule for Oral Motor Assessment to examine the oral phase of swallowing; a fiberoptic endoscopic evaluation of swallowing; and a videofluoroscopic swallowing study. The evaluations indicated that liquid foods were more likely to be problematic than pureed foods. Most of the infants had abnormal movements of the tongue that contributed to their dysphagia. They also had difficulty visually judging how far to open their mouth to take a bite you need of certain foods, called "jaw grading." Interventions included nasoenteric feeding required by 2 infants and thickened liquids and purees for the other 7 infants.

Developmental delay

Wheeler et al[69,107] reported a follow-up study of 27 children (13-22 months), looking at developmental milestones and skills. Children in this sample had developmental skills comparable with infants 6 to 8 months of age. Less than half were able to drink liquids from a cup held by a caregiver. Another study of 24 children with CZS (18-24 months) found that their growth rate was less than expected, and they exhibited severe neuropsychomotor impairment. All required feeding via gastric tube and 25% were classified as malnourished.[53]

Movement disorders

Pessoa et al[108] noted that the description of abnormal neurological findings in reports about Zika-affected infants is consistent with a diagnosis of CP. Early onset of involuntary movements and epilepsy is likely related to severe brain damage. Having 1 or both of these neurologic conditions placed them at risk for malnutrition as well as swallowing and feeding difficulties.[108] Forty-eight infants

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(1-8 months of age) with CZS in Brazil were examined by de Silva et al.[109] Twenty-seven (56.3%) had involuntary movements and rigidity in the extremities that were absent during sleep; 7(14.6%) had dysphagia. Most of these infants (42, 87.5%) had been born at full term and only 9 (18.7%) had very low birth weights.[109]

A follow-up of 19 infants with CZS enrolled in the Zika Outcomes and Development in Infants and Children study at ages of 19 to 24 months revealed that 14 (79%) had severe motor impairments; 13 (68%) had hearing problems; 11 (58%) had vision problems; and 9 (47%) had difficulty with feeding/eating.[110] The number and severity of eating problems may have been underreported, in view of their other finding that 13 of the 19 (68.4%) had weights at 1 to 3 standard deviations below the mean for their age and sex.[110]

Vision/hearing impairment

A study of 29 infants with CZS and microcephaly reported that 10 (34.5%) had vision-threatening eye problems.[111] In a prospective case series of 43 infants with CZS seen at clinics in Columbia and Venezuela, all were found to have bilateral ophthalmic abnormalities.[112] Five (12%) had congenital glaucoma, and 38 (88%) had macular or optic nerve manifestations.

Another case series looking at 32 infants with CZS found visual impairments in all of them, with 14 (44%) having diagnosed retinal and/or optic nerve damage.[89] These authors evaluated the infants to assess the impact of their visual impairment on their attainment of the usual milestones of infant development. They found that these were negatively impacted. Eight of the infants (26%) could not make eye contact, and 16 (32%) had no social smile when interacting with care givers. By 6 months of age, 17 (63%) were unable to reach for an object presented to them. Using the same assessment protocol, this group conducted a subsequent study, comparing 119 infants with CZS with 85 demographically matched controls.[113,114] In this study, the results for the infants with CZS were similar to their previous report and were significantly different ($P < .001$) from the control infants. A review on Zika virus and the visual impairments noted that reports indicate that between 34% and 55% of infants with CZS have a visual impairment.[113,115-117] It is recommended that these "children should have ophthalmic evaluations every 3 months and a formal evaluation of vision function at 1 year of age."[117(p599)] Ventura et al showed that 60 children 9 to 16 months of age responded well to visual correction with eyeglasses.[118] In addition to visual impairment, hearing loss has also been reported in infants with CZS.[86,114]

NUTRITION ASSESSMENT AND INTERVENTION

Nutrition approaches that have been used in the assessment and treatment of individuals with similar challenges could be applied in children with CZS. Standard laboratory tests should be included in nutrition assessments. These children with CZS, especially those exclusively tube-fed, may be at an increased risk of micronutrient deficiencies.[119] A complete blood count should be evaluated periodically to identify iron-deficiency anemia, and serum calcium, phosphorus, and vitamin D levels be checked to assess bone mineral status.[119] Nutritional assessment of a neurologically impaired child should include a thorough medical history, a social history, a dietary intake history, growth and anthropometric measures, a nutrition-focused physical examination, observation of intake at a meal, and other diagnostic studies as needed. Specific neurological disabilities and their severity, ambulatory status, and cognitive ability are also important to evaluate in neurologically impaired children.[120]

A number of national and international organizations have published recommendations and guidelines for the nutritional care of children with neurological impairments.[90,119,121-125] The issues identified are similar to those described previously for

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infants and children with CZS. There is a strong consensus that monitoring the nutritional status of these individuals is a critical component of their care and should be done in the context of an interdisciplinary team. Most of the literature on which these are based is derived from studies of infants and children with CP and/or epilepsy. The general picture with general neurological impairment can include issues with feeding, gastroesophageal reflux, dysphagia, constipation, osteopenia, micronutrient deficiencies, growth failure, and cognitive impairment limiting the ability to communicate hunger or satiety to caregivers. The goal of any planned nutrition intervention should be to optimize quality of life while promoting adequate growth and development and optimizing nutritional status.[90]

The majority of children with neurological impairment have some degree of dysphagia.[126] Irregularities in movements by the jaw and/or tongue may interfere with chewing and swallowing.[127,128] These can result in poor intakes and a diminished rate of growth and development. Evaluation by a speech-language pathologist can determine the type and severity of dysphagia and provide guidance as to optimal consistency of foods and fluids. The RDN then operationalizes the speech-language pathologist recommendations to provide a diet that meets the individual's needs and preferences.

Energy requirements are often difficult to determine in neurologically impaired individuals. Assessment of body composition and indirect calorimetry should be employed when available.[124,125] Serial measurements of growth, weight, and anthropometrics should be monitored, and adjustments to feeding made as needed.[90] For those unable to meet their nutritional needs via an oral diet, enteral nutrition support is recommended. A 5-year retrospective study of malnourished, neurologically impaired children (aged 4 months to 18 years) found that most improved their nutritional status and attained catch-up growth after percutaneous endoscopic gastrostomy (PEG) placement and enteral feeding with a standard polymeric formula at a rate equal to their estimated energy needs.[129]

Gastroesophageal reflux disease affects up to 75% of children with neurological impairment and creates an increased risk of aspiration.[126] Feeding thickeners have been shown to be of benefit for some infants with GERD.[130] Children with GERD are given the same advice as adults, that is, to avoid foods known to potentially worsen reflux, such as acidic, spicy, or high-fat foods.[126] The North American Society for Pediatric Gastroenterology, Hepatology and Nutrition has published extensive guidelines on evaluation and treatment of GERD in pediatric patients.[129]

Herrera-Anaya et al examined nutritional status in a population of children with CP.[131] They found a high prevalence of malnutrition in the children with the lowest motor function, based on WHO criteria. Nutrition-related problems that were identified included dysphagia, gastrointestinal reflux, and aspiration, similar to that described in infants with CZS. This suggests that nutrition care recommended for infants and children with CP may also be applicable to those with CZS. A commentary by Leandro in Developmental Medicine & Child Neurology pointed out the similarity between symptoms of CP from all sources and symptoms of CZS.[132]

Attention to any potential drug effects is also an important part of the nutrition assessment with CZS. Neurologically impaired children may be taking medications for seizures, drooling, or other issues that can cause a decrease in appetite, dry mouth, constipation, or other problems that impact intake.[128]

Finally, enteral nutrition support could be used if the infant's nutritional needs cannot be met orally. Minar et al[133] showed that PEG tube placement could be safely done in 40 infants with dysphagia, who had a gestational age of 23 to 41 weeks and birth weights between 2.1 and 5.6 kg. Another study by Macchini et al[134] showed similar results. Human breast milk or infant formula is recommended for children younger than 12 months, with pediatric feeding formulas thereafter.[124]

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CONCLUSIONS

Given the consequences of CZS, the prevention of Zika infection is paramount in minimizing the number of infants affected by this disease. The CDC has provided guidance for the general public on how to avoid Zika infection.[135] However, the likelihood of additional severely affected infants and children remains a challenge, given that there is no vaccination available to prevent the disease. Registered dietitian nutritionists should be prepared to engage in the multidisciplinary care that is required. In the absence of any evidence-based directives for practice on the nutrition assessment, intervention, referral, monitoring, and evaluation of infants with CZS, lessons learned from infants and children with other neurological disorders can provide some guidance.

An assessment of an infant or a child with CZS must include an examination of any difficulty with feeding, including dysphagia, gastrointestinal reflux, and adequacy of intake, as well as weight and developmental status. Consultation with a speech-language pathologist is recommended when symptoms of dysphagia are present. Where appropriate, the occupational therapist may suggest adaptive equipment to promote independence. Diet modifications or nutrition support to address identified problems should be implemented and family caregivers educated as appropriate. Challenges due to visual and/or hearing impairment and developmental delays may also impact nutritional status with CZS. As the child gets older, these problems are likely to create ongoing issues with self-feeding. Finally, when adequate intake to maintain growth and development is not possible via an oral diet, enteral nutrition support has been shown to be a viable alternative in infants with neurological impairment.

REFERENCES

1. Valentine G, Marquez L, Pammi M. Zika virus epidemic: an update. *Expert Rev Anti Infect Ther*. 2016;14(12):1127-1138.
2. Wolford RW, Schaefer TJ. *Zika Virus*. Treasure Island, FL: StatPearls; 2018.
3. Dick GW, Kitchen SF, Haddow AJ. Zika virus. I. Isolations and serological specificity. *Trans R Soc Trop Med Hyg*. 1952;46(5):509-520.
4. Simpson DI. Zika virus infection in man. *Trans R Soc Trop Med Hyg*. 1964;58:335-338.
5. Fagbami AH. Zika virus infections in Nigeria: virological and seroepidemiological investigations in Oyo State. *J Hyg (Lond)*. 1979;83(2):213-219.
6. Jan C, Languillat G, Renaudet J, Robin Y. [A serological survey of arboviruses in Gabon]. *Bull Soc Pathol Exot Filiales*. 1978;71(2):140-146.
7. McCrae AW, Kirya BG. Yellow fever and Zika virus epizootics and enzootics in Uganda. *Trans R Soc Trop Med Hyg*. 1982;76(4):552-562.
8. Darwish MA, Hoogstraal H, Roberts TJ, Ahmed IP, Omar F. A sero-epidemiological survey for certain arboviruses (Togaviridae) in Pakistan. *Trans R Soc Trop Med Hyg*. 1983;77(4):442-445.
9. Marchette NJ, Garcia R, Rudnick A. Isolation of Zika virus from Aedes aegypti mosquitoes in Malaysia. *Am J Trop Med Hyg*. 1969;18(3):411-415.
10. Olson JG, Ksiazek T, Suhandiman T, Triwibowo R. Zika virus, a cause of fever in Central Java, Indonesia. *Trans R Soc Trop Med Hyg*. 1981;75(3):389-393.
11. Fauci AS, Morens DM. Zika Virus in the Americas—yet another arbovirus threat. *N Engl J Med*. 2016;374(7):601-604.
12. Morens DM, Fauci AS. Pandemic Zika: a formidable challenge to medicine and public health. *J Infect Dis*. 2017;216(suppl 10):S857-S859.
13. World Health Organization Regional Office for the Western Pacific Zika Incident Management. Zika virus classification tables. http://www.who.int/emergencies/zika-virus/classification-tables/en/. Published January 2018. Accessed August 2, 2018.
14. Reynolds MR, Jones AM, Petersen EE, et al. Vital signs: update on Zika virus-associated birth defects and evaluation of all U.S. infants with congenital Zika virus exposure—U.S. Zika Pregnancy Registry, 2016. *MMWR Morb Mortal Wkly Rep*. 2017;66(13):366-373.
15. Centers for Disease Control and Prevention. Cumulative Zika virus disease case counts in the United States 2015-2017. https://www.cdc.gov/zika/reporting/2017-case-counts.html. Published 2017. Accessed July 13, 2017.
16. Zacharias N, Whitty J, Noblin S, et al. First neonatal demise with travel-associated Zika virus infection in the United States of America. *AJP Rep*. 2017;7(2):e68-e73.

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17. Armstrong P, Hennessey M, Adams M, et al. Travel-associated Zika virus disease cases among U.S. residents—United States, January 2015-February 2016. *MMWR Morb Mortal Wkly Rep*. 2016;65(11): 286-289.
18. Centers for Disease Control and Prevention. Cumulative Zika virus disease case counts in the United States 2015-2018. https://www.cdc.gov/zika/reporting/case-counts.html. Published 2018. Accessed August 2, 2018.
19. Khawar W, Bromberg R, Moor M, Lyubynska N, Mahmoudi H. Seven cases of Zika virus infection in South Florida. *Cureus*. 2017;9(3):e1099.
20. Shiu C, Starker R, Kwal J, et al. Zika virus testing and outcomes during pregnancy, Florida, USA, 2016. *Emerg Infect Dis*. 2018;24(1):1-8.
21. Howard A, Visintine J, Fergie J, Deleon M. two infants with presumed congenital Zika syndrome, Brownsville, Texas, USA, 2016-2017. *Emerg Infect Dis*. 2018;24(4):625-630.
22. Honein MA, Dawson AL, Petersen EE, et al. Birth defects among fetuses and infants of US women with evidence of possible Zika virus infection during pregnancy. *JAMA*. 2017;317(1):59-68.
23. Duffy MR, Chen TH, Hancock WT, et al. Zika virus outbreak on Yap Island, Federated States of Micronesia. *N Engl J Med*. 2009;360(24):2536-2543.
24. Hayes EB. Zika virus outside Africa. *Emerg Infect Dis*. 2009;15(9):1347-1350.
25. Cao-Lormeau VM, Blake A, Mons S, et al. Guillain-Barre syndrome outbreak associated with Zika virus infection in French Polynesia: a case-control study. *Lancet*. 2016;387(10027):1531-1539.
26. Mlakar J, Korva M, Tul N, et al. Zika virus associated with microcephaly. *N Engl J Med*. 2016;374(10): 951-958.
27. Broutet N, Krauer F, Riesen M, et al. Zika virus as a cause of neurologic disorders. *N Engl J Med*. 2016;374(16):1506-1509.
28. Rasmussen SA, Jamieson DJ, Honein MA, Petersen LR. Zika virus and birth defects—reviewing the evidence for causality. *N Engl J Med*. 2016; 374(20):1981-1987.
29. Petersen LR, Jamieson DJ, Honein MA. Zika virus. *N Engl J Med*. 2016;375(3):294-295.
30. Pan American Health Organization (PAHO). Regional Zika epidemiological update (Americas) May 25, 2017. http://www.paho.org/hq/index.php?option=com_content&view=article&id=11599&Itemid=41691&lang=en. Published 2017. Accessed August 13, 2018.
31. Luksic B, Pandak N, Drazic-Maras E, et al. First case of imported chikungunya infection in Croatia, 2016. *Int Med Case Rep J*. 2017;10:117-121.
32. Franca GV, Schuler-Faccini L, Oliveira WK, et al. Congenital Zika virus syndrome in Brazil: a case series of the first 1501 live births with complete investigation. *Lancet*. 2016;388(10047):891-897.
33. Teixeira MG, Costa Mda C, de Oliveira WK, Nunes ML, Rodrigues LC. The epidemic of Zika virus-related microcephaly in Brazil: detection, control, etiology, and future scenarios. *Am J Public Health*. 2016;106(4):601-605.
34. Moore CA, Staples JE, Dobyns WB, et al. Characterizing the pattern of anomalies in congenital Zika syndrome for pediatric clinicians. *JAMA Pediatr*. 2017;171(3):288-295.
35. Centers for Disease Control and Prevention. Zika and pregnancy: data and statistics. https://www.cdc.gov/pregnancy/zika/data/index.html. Published 2018. Accessed August 15, 2018.
36. Zanluca C, Dos Santos CN. Zika virus—an overview. *Microbes Infect*. 2016;18(5):295-301.
37. D'Ortenzio E, Matheron S, Yazdanpanah Y, et al. Evidence of sexual transmission of Zika virus. *N Engl J Med*. 2016;374(22):2195-2198.
38. Moreira J, Peixoto TM, Siqueira AM, Lamas CC. Sexually acquired Zika virus: a systematic review. *Clin Microbiol Infect*. 2017;23(5):296-305.
39. Musso D, Stramer SL, Committee AT-TD, Busch MP, International Society of Blood Transfusion Working Party on Transfusion-Transmitted Infectious Diseases MP. Zika virus: a new challenge for blood transfusion. *Lancet*. 2016;387(10032):1993-1994.
40. De Carvalho NS, De Carvalho BF, Fugaca CA, Doris B, Biscaia ES. Zika virus infection during pregnancy and microcephaly occurrence: a review of literature and Brazilian data. *Braz J Infect Dis*. 2016;20(3):282-289.
41. De Moraes CG, Pettito M, Yepez JB, et al. Optic neuropathy and congenital glaucoma associated with probable Zika virus infection in Venezuelan patients. *JMM Case Rep*. 2018;5(5):e005145.
42. Karwowski MP, Nelson JM, Staples JE, et al. Zika virus disease: a CDC update for pediatric health care providers. *Pediatrics*. 2016;137(5): pii: e20160621.
43. Tang BL. Zika virus as a causative agent for primary microencephaly: the evidence so far. *Arch Microbiol*. 2016;198(7):595-601.
44. Center for Disease Control and Prevention (CDC). Growth charts. Head circumference-for-age and Weight-for-length percentiles. Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000). http://www.cdc.gov/growthcharts. Published 2000. Accessed January 19, 2018.
45. Harris SR. Measuring head circumference: update on infant microcephaly. *Can Fam Physician*. 2015;61(8):680-684.
46. Cooke RW, Lucas A, Yudkin PL, Pryse-Davies J. Head circumference as an index of brain weight in the fetus and newborn. *Early Hum Dev*. 1977;1(2): 145-149.
47. Hack M, Breslau N, Weissman B, Aram D, Klein N, Borawski E. Effect of very low birth weight and

Copyright © 2020 Wolters Kluwer Health, Inc. Unauthorized reproduction of this article is prohibited.

subnormal head size on cognitive abilities at school age. *N Engl J Med*. 1991;325(4):231-237.
48. Neubauer V, Griesmaier E, Pehbock-Walser N, Pupp-Peglow U, Kiechl-Kohlendorfer U. Poor postnatal head growth in very preterm infants is associated with impaired neurodevelopment outcome. *Acta Paediatr*. 2013;102(9):883-888.
49. Olusanya BO. Pattern of head growth and nutritional status of microcephalic infants at early postnatal assessment in a low-income country. *Niger J Clin Pract*. 2012;15(2):142-146.
50. Aragao M, Holanda AC, Brainer-Lima AM, et al. Nonmicrocephalic infants with congenital Zika syndrome suspected only after neuroimaging evaluation compared with those with microcephaly at birth and postnatally: how large is the Zika virus "Iceberg"? *AJNR Am J Neuroradiol*. 2017;38(7):1427-1434.
51. White HL. Alerts for nurse practitioners: caring for pregnant women with Zika virus. *J Natl Black Nurses Assoc*. 2016;27(2):46-49.
52. White MK, Wollebo HS, David Beckham J, Tyler KL, Khalili K. Zika virus: an emergent neuropathological agent. *Ann Neurol*. 2016;80(4):479-489.
53. Alves LV, Paredes CE, Silva GC, Mello JG, Alves JG. Neurodevelopment of 24 children born in Brazil with congenital Zika syndrome in 2015: a case series study. *BMJ Open*. 2018;8(7):e021304.
54. Alves LV, Mello MJG, Bezerra PG, Alves JGB. Congenital Zika syndrome and infantile spasms: case series study. *J Child Neurol*. 2018;33(10):664-666.
55. Cavalcanti DD, Alves LV, Furtado GJ, et al. Echocardiographic findings in infants with presumed congenital Zika syndrome: retrospective case series study. *PLoS One*. 2017;12(4):e0175065.
56. van der Linden V, Pessoa A, Dobyns W, et al. Description of 13 infants born during October 2015-January 2016 with congenital Zika virus infection without microcephaly at birth—Brazil. *MMWR Morb Mortal Wkly Rep*. 2016;65(47):1343-1348.
57. World Health Organization. *Infant Feeding in Areas of Zika Virus Transmission*. Geneva, Switzerland: World Health Organization. http://www.who.int/elena/titles/zika_breastfeeding/en/. Published 2016. Accessed August 2, 2018.
58. US Department of Health & Human Services. The surgeon general's call to action to support breast feeding. https://www.surgeongeneral.gov/library/calls/breastfeeding/calltoactiontosupportbreastfeeding.pdf. Published 2011. Accessed August 15, 2018.
59. American Academy of Pediatrics. Policy statement: breastfeeding and the use of human milk. http://pediatrics.aappublications.org/content/pediatrics/early/2012/02/22/peds.2011-3552.full.pdf. Published 2012. Accessed August 15, 2018.
60. World Health Organization UNICEF. Global nutrition targets 2025: breastfeeding policy brief. http://www.who.int/nutrition/publications/globaltargets2025_policybrief_breastfeeding/en/. Published 2014. Accessed August 17, 2018.
61. The American College of Obstetricians and Gynecologists' Committee on Obstetric P, Breastfeeding Expert Work G. Committee opinion no. 658: optimizing support for breastfeeding as part of obstetric practice. *Obstet Gynecol*. 2016;127(2):e86-e92.
62. Lessen R, Kavanagh K. Position of the academy of nutrition and dietetics: promoting and supporting breastfeeding. *J Acad Nutr Diet*. 2015;115(3):444-449.
63. Sotelo JR, Sotelo AB, Sotelo FJB, et al. Persistence of Zika virus in breast milk after infection in late stage of pregnancy. *Emerg Infect Dis*. 2017;23(5):856-857.
64. Mann TZ, Haddad LB, Williams TR, et al. Breast milk transmission of flaviviruses in the context of Zika virus: a systematic review. *Paediatr Perinat Epidemiol*. 2018;32(4):358-368.
65. Centers for Disease Control and Prevention. Zika virus. https://www.cdc.gov/breastfeeding/breastfeeding-special-circumstances/maternal-or-infant-illnesses/zika.html. Published 2018. Accessed August 16, 2018.
66. Cavalcanti MG, Cabral-Castro MJ, Goncalves JLS, Santana LS, Pimenta ES, Peralta JM. Zika virus shedding in human milk during lactation: an unlikely source of infection? *Int J Infect Dis*. 2017;57:70-72.
67. Colt S, Garcia-Casal MN, Pena-Rosas JP, et al. Transmission of Zika virus through breast milk and other breastfeeding-related bodily-fluids: a systematic review. *PLoS Negl Trop Dis*. 2017;11(4):e0005528.
68. Guevara JG, Agarwal-Sinha S. Ocular abnormalities in congenital Zika syndrome: a case report, and review of the literature. *J Med Case Rep*. 2018;12(1):161.
69. Wheeler AC. Development of infants with congenital Zika syndrome: what do we know and what can we expect? *Pediatrics*. 2018;141(suppl 2):S154-S160.
70. Broussard CS, Shapiro-Mendoza CK, Peacock G, et al. Public health approach to addressing the needs of children affected by congenital Zika syndrome. *Pediatrics*. 2018;141(suppl 2):S146-S153.
71. Bailey DB Jr, Ventura LO. The likely impact of congenital Zika syndrome on families: considerations for family supports and services. *Pediatrics*. 2018;141(suppl 2):S180-S187.
72. Moffitt KB, Case AP, Farag NH, Canfield MA. Hospitalization charges for children with birth defects in Texas, 2001 to 2010. *Birth Defects Res A Clin Mol Teratol*. 2016;106(3):155-163.
73. Oduyebo T, Igbinosa I, Petersen EE, et al. Update: interim guidance for health care providers caring for pregnant women with possible Zika virus exposure—United States, July 2016. *MMWR Morb Mortal Wkly Rep*. 2016;65(29):739-744.

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74. Oduyebo T, Polen KD, Walke HT, et al. Update: interim guidance for health care providers caring for pregnant women with possible Zika virus exposure—United States (Including U.S. Territories), July 2017. *MMWR Morb Mortal Wkly Rep*. 2017;66(29):781-793.
75. Centers for Disease Control and Prevention. CDC issues interim travel guidance related to Zika virus for 14 countries and territories in Central and South America and the Caribbean. https://www.cdc.gov/media/releases/2016/s0315-zika-virus-travel.html. Published January 17, 2016. Accessed July 13, 2017.
76. World Health Organization. Zika virus and microcephaly: why is this situation a PHEIC? *Lancet*. 2016;387(10020):719-721.
77. Messina JP, Kraemer MU, Brady OJ, et al. Mapping global environmental suitability for Zika virus. *Elife*. 2016;5:pii: e15272.
78. Singh RK, Dhama K, Khandia R, et al. Prevention and control strategies to counter Zika virus, a special focus on intervention approaches against vector mosquitoes-current updates. *Front Microbiol*. 2018;9:87.
79. Graham KA, Fox DJ, Talati A, et al. Prevalence and clinical attributes of congenital microcephaly—New York, 2013-2015. *MMWR Morb Mortal Wkly Rep*. 2017;66(5):125-129.
80. Centers for Disease Control and Prevention. *Zika Virus: Case Counts in the US*. Atlanta, GA: US Department of Health & Human Services, CDC; 2016. https://www.cdc.gov/zika/reporting/2016-case-counts.html. Accessed July 16, 2018.
81. Madad SS, Masci J, Cagliuso NV Sr, Allen M. Preparedness for Zika virus disease—New York City, 2016. *MMWR Morb Mortal Wkly Rep*. 2016;65(42):1161-1165.
82. Madad S, Tate A, Rand M, et al. Zika virus preparedness and response efforts through the collaboration between a health care delivery system and a local public health department. *Disaster Med Public Health Prep*. 2018;6:1-3.
83. Sampathkumar P, Sanchez JL. Zika virus in the Americas: a review for clinicians. *Mayo Clin Proc*. 2016;91(4):514-521.
84. Kwek SS, Watanabe S, Chan KR, et al. A systematic approach to the development of a safe live attenuated Zika vaccine. *Nat Commun*. 2018;9(1):1031.
85. McArthur MA. Zika virus: recent advances towards the development of vaccines and therapeutics. *Viruses*. 2017;9(6):pii: E143.
86. Samuel G, DiBartolo-Cordovano R, Taj I, et al. A survey of the knowledge, attitudes and practices on Zika virus in New York City. *BMC Public Health*. 2018;18(1):98.
87. Squiers L, Herrington J, Kelly B, et al. Zika virus prevention: U.S. travelers' knowledge, risk perceptions, and behavioral intentions—a national survey. *Am J Trop Med Hyg*. 2018;98(6):1837-1847.
88. Fraiz LD, de Roche A, Mauro C, et al. U.S. pregnant women's knowledge and attitudes about behavioral strategies and vaccines to prevent Zika acquisition. *Vaccine*. 2018;36(1):165-169.
89. Morain SR, Wootton SH, Eppes C. A devastating delay—Zika and the Implementation gap. *N Engl J Med*. 2017;377(16):1505-1507.
90. Marchand V, Motil KJ. Nutrition support for neurologically impaired children: a clinical report of the North American Society for Pediatric Gastroenterology, Hepatology, and Nutrition. Naspghan Committee on Nutrition. *J Pediatr Gastroenterol Nutr*. 2006;43(1):123-135.
91. Olusanya BO. Maternal antecedents of infants with abnormal head sizes in southwest Nigeria: a community-based study. *J Family Community Med*. 2012;19(2):113-118.
92. Olusanya BO. Full-term newborns with congenital microcephaly and macrocephaly in Southwest Nigeria. *Int Health*. 2012;4(2):128-134.
93. Atif M, Azeem M, Sarwar MR, Bashir A. Zika virus disease: a current review of the literature. *Infection*. 2016;44(6):695-705.
94. Centers for Disease Control and Prevention. Care for babies born with birth defects related to congenital Zika syndrome. https://www.cdc.gov/zika/parents/care-for-babies-with-congenital-zika.html. Published 2017. Accessed July 13, 2017.
95. Russell S, Ryff K, Gould C, Martin S, Johansson M. Detecting local Zika virus transmission in the continental United States: a comparison of surveillance strategies. *PLOS Curr*. 2017;9. doi: 10.1371/currents.outbreaks.cd76717676629d47704170ecbdb5f820.
96. Russell K, Oliver SE, Lewis L, et al. Update: interim guidance for the evaluation and management of infants with possible congenital Zika virus infection—United States, August 2016. *MMWR Morb Mortal Wkly Rep*. 2016;65(33):870-878.
97. Ferreira HNC, Schiariti V, Regalado ICR, et al. Functioning and disability profile of children with microcephaly associated with congenital Zika virus infection. *Int J Environ Res Public Health*. 2018;15(6):pii: E1107.
98. Ramenghi LA, Fumagalli M, Bassi L, et al. Brain maturation of preterm newborn babies: new insights. *J Pediatr Gastroenterol Nutr*. 2007;45(suppl 3):S143-S146.
99. Ricci D, Cesarini L, Groppo M, et al. Early assessment of visual function in full term newborns. *Early Hum Dev*. 2008;84(2):107-113.
100. Gianni ML, Sannino P, Bezze E, et al. Effect of comorbidities on the development of oral feeding ability in pre-term infants: a retrospective study. *Sci Rep*. 2015;5:16603.

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101. Adebanjo T, Godfred-Cato S, Viens L, et al. Update: interim guidance for the diagnosis, evaluation, and management of infants with possible congenital Zika virus infection—United States, October 2017. *MMWR Morb Mortal Wkly Rep*. 2017;66(41):1089-1099.
102. van den Engel-Hoeka L, de Groot IJM, de Swarta BJM, Erasmusb CE. Feeding and swallowing disorders in pediatric neuromuscular diseases: an overview. *J Neuromuscul Dis*. 2015;2:357-369.
103. Kapogiannis BG, Chakhtoura N, Hazra R, Spong CY. Bridging knowledge gaps to understand how Zika virus exposure and infection affect child development. *JAMA Pediatr*. 2017;171(5):478-485.
104. Del Campo M, Feitosa IM, Ribeiro EM, et al. The phenotypic spectrum of congenital Zika syndrome. *Am J Med Genet A*. 2017;173(4):841-857.
105. Saad T, PennaeCosta AA, de Goes FV, et al. Neurological manifestations of congenital Zika virus infection. *Childs Nerv Syst*. 2018;34(1):73-78.
106. Leal MC, van der Linden V, Bezerra TP, et al. Characteristics of dysphagia in infants with microcephaly caused by congenital Zika virus infection, Brazil, 2015. *Emerg Infect Dis*. 2017;23(8):1253-1259.
107. Wheeler AC, Ventura CV, Ridenour T, et al. Skills attained by infants with congenital Zika syndrome: pilot data from Brazil. *PLoS One*. 2018;13(7): e0201495.
108. Pessoa A, van der Linden V, Yeargin-Allsopp M, et al. Motor abnormalities and epilepsy in infants and children with evidence of congenital Zika virus infection. *Pediatrics*. 2018;141(suppl 2): S167-S179.
109. Moura da Silva AA, Ganz JS, Sousa PD, et al. Early growth and neurologic outcomes of infants with probable congenital Zika virus syndrome. *Emerg Infect Dis*. 2016;22(11):1953-1956.
110. Satterfield-Nash A, Kotzky K, Allen J, et al. Health and development at age 19-24 months of 19 children who were born with microcephaly and laboratory evidence of congenital Zika virus infection during the 2015 Zika virus outbreak—Brazil, 2017. *MMWR Morb Mortal Wkly Rep*. 2017;66(49): 1347-1351.
111. McCarthy M. Severe eye damage in infants with microcephaly is presumed to be due to Zika virus. *BMJ*. 2016;352:i855.
112. Yepez JB, Murati FA, Pettito M, et al. Ophthalmic manifestations of congenital Zika syndrome in Colombia and Venezuela. *JAMA Ophthalmol*. 2017;135(5):440-445.
113. Ventura CV, Ventura LO. Ophthalmologic manifestations associated with Zika virus infection. *Pediatrics*. 2018;141(suppl 2):S161-S166.
114. Ventura LO, Ventura CV, Lawrence L, et al. Visual impairment in children with congenital Zika syndrome. *J AAPOS*. 2017;21(4):295-299. e292.
115. de Oliveira Dias JR, Ventura CV, de Paula Freitas B, et al. Zika and the eye: pieces of a puzzle. *Prog Retin Eye Res*. 2018;66:85-106.
116. Marquezan MC, Ventura CV, Sheffield JS, et al. Ocular effects of Zika virus—a review. *Surv Ophthalmol*. 2018;63(2):166-173.
117. de Paula Freitas B, Ventura CV, Maia M, Belfort R Jr. Zika virus and the eye. *Curr Opin Ophthalmol*. 2017;28(6):595-599.
118. Ventura LO, Lawrence L, Ventura CV, et al. Response to correction of refractive errors and hypoaccommodation in children with congenital Zika syndrome. *J AAPOS*. 2017;21(6):480-484. e481.
119. Penagini F, Mameli C, Fabiano V, Brunetti D, Dilillo D, Zuccotti GV. Dietary intakes and nutritional issues in neurologically impaired children. *Nutrients*. 2015;7(11):9400-9415.
120. Stevenson RD, Roberts CD, Vogtle L. The effects of non-nutritional factors on growth in cerebral palsy. *Dev Med Child Neurol*. 1995;37(2):124-130.
121. Marchand V, Baker SS, Baker RD. Enteral nutrition in the pediatric population. *Gastrointest Endosc Clin N Am*. 1998;8(3):669-703.
122. Quitadamo P, Thapar N, Staiano A, Borrelli O. Gastrointestinal and nutritional problems in neurologically impaired children. *Eur J Paediatr Neurol*. 2016;20(6):810-815.
123. Akkina R, Ellerbrok H, Hall W, et al. 2016 international meeting of the global virus network. *Antiviral Res*. 2017;142:21-29.
124. Romano C, van Wynckel M, Hulst J, et al. European Society for Paediatric Gastroenterology, Hepatology and Nutrition guidelines for the evaluation and treatment of gastrointestinal and nutritional complications in children with neurological impairment. *J Pediatr Gastroenterol Nutr*. 2017;65(2):242-264.
125. Romano C, Dipasquale V, Gottrand F, Sullivan PB. Gastrointestinal and nutritional issues in children with neurological disability. *Dev Med Child Neurol*. 2018;60(9):892-896.
126. Srivastava R, Jackson WD, Barnhart DC. Dysphagia and gastroesophageal reflux disease: dilemmas in diagnosis and management in children with neurological impairment. *Pediatr Ann*. 2010;39(4):225-231.
127. Andrew MJ, Sullivan PB. Growth in cerebral palsy. *Nutr Clin Pract*. 2010;25(4):357-361.
128. Andrew MJ, Sullivan PB . Feeding difficulties in disabled children. *Paediatr Child Health*. 2010;7:321-326.
129. Dipasquale V, Catena MA, Cardile S, Romano C. Standard polymeric formula tube feeding in neurologically impaired children: a five-year retrospective study. *Nutrients*. 2018;10(6):pii: E684.
130. Kwok TC, Ojha S, Dorling J. Feed thickeners in gastro-oesophageal reflux in infants. *BMJ Paediatr Open*. 2018;2(1):e000262.
131. Herrera-Anaya E, Angarita-Fonsecca A, Herrera-Galindo VM, et al. Association between gross motor

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function and nutritional status in children with cerebral palsy: a cross-sectional study from Columbia. *Dev Med Child Neuol*. 2016;58(9):936-941.
132. Leandro CG. Nutritional and gross motor function in children with cerebral palsy, and implications for Zika virus infection. *Dev Med Child Neurol*. 2016;58(9):893-894.
133. Minar P, Garland J, Martinez A, Werlin S. Safety of percutaneous endoscopic gastrostomy in medically complicated infants. *J Pediatr Gastroenterol Nutr*. 2011;53(3):293-295.
134. Macchini F, Zanini A, Farris G, et al. Infant percutaneous endoscopic gastrostomy: risks or benefits? *Clin Endosc*. 2018;51(3):260-265.
135. Centers for Disease Control and Prevention. Zika: the basics of the virus and how to protect against it. www.cdc.gov/zika. Published 2017. Accessed May 8, 2018.

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