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Emergency and disaster response strategies to support mother-infant dyads during COVID-19

Felipe Aros-Vera, Ph.D., Assistant Professor a, *, Semyon Melnikov, Ph.D., Senior Lecturer b, Ilana R. Azulay Chertok, Ph.D., MSN, RN, IBCLC, Professor c

a Department of Industrial and Systems Engineering, Ohio University, 1 Ohio University, Athens, OH, 45701, USA
b Department of Nursing, Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel
c Associate Director of Nursing Research and Scholarship, Ohio University, 1 Ohio University, Athens, OH, 45701, USA

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ABSTRACT

The COVID-19 pandemic has produced an unprecedented global health crisis. Vulnerable populations, such as breastfeeding mother-infant dyads, are in a particularly delicate situation. Before, during, and after birth mothers and their infants could be exposed to the virus. Due to fear of infection transmission, there has been an increase in separation of COVID-positive mothers and their infants and a decline in breastfeeding, despite research supporting the provision of mother’s milk for her infant. During this crisis, evidence-based education counseling and resources can support healthful infant feeding which is necessary for short- and long-term infant growth and development. Using a framework of disaster preparedness and response, we delineate operational guidelines and policy recommendations to support maternal-infant dyads during the COVID pandemic outbreak. Key recommendations include promotion of breastfeeding and milk expression, avoiding the use of formula, engaging healthcare providers in supporting lactation, and incorporating evidence-based breastfeeding and lactation protocols and practices in disaster preparedness and disaster response plans.

1. Introduction

The severe acute respiratory syndrome coronavirus 2 (COVID-19) pandemic has produced an unprecedented global health crisis. On March 11, 2020, the World Health Organization (WHO) declared COVID-19 as a pandemic [1,2]. By the end of January 2021, the Johns Hopkins Coronavirus Resource Center reported more than 106 million cases worldwide and 2.3 million deaths from reasons attributable to the virus. In the United States alone, the Center for Disease Control and Prevention (CDC) estimates that almost half a million people have died from COVID-19 and reported almost 27 million positive cases. These numbers are likely to increase as the distribution and administration of the various COVID-19 vaccines are estimated to take at least until the end of 2021 to reach three quarters of the adult population in the United States [3]. New variants of the virus, however, threaten to challenge these efforts in a struggle that has cost society the lives of millions, economic prosperity, and immeasurable loss in quality of life worldwide.

Vulnerable populations, such as breastfeeding mothers, are in a particularly delicate situation. In the United States, as reported by the CDC, there has been 64,000 confirmed cases of pregnant women infected with COVID-19, 74 of whom died from complications related to the infection by the end of January in 2021 [4,5]. Unfortunately, misconceptions, lack of information, and limited resources can negatively influence the decision to breastfeed under the uncertainties of COVID-19. The negative effects of stopping breastfeeding in infants can be hardly understated as it has been widely recognized by many institutions as a precursor of health for both infant and mother, and cognitive ability in the infant.

The COVID-19 pandemic has imposed challenges that include: 1) shortage of supplies compounded by a spike on demand (e.g., medical supplies such as personal protective equipment PPE) that was exacerbated by the halt of international trade and limitations of many regional supply chains, 2) overload of medical facilities and health professionals, especially intensive care units (ICU), and 3) lack of evidence-based information and communication by governments, health agencies, and the media. The overall situation is, however, not far from what communities might experience after a natural or man-made disaster. And such events
are not rare to occur. In fact, in the last ten years, natural and man-made disasters have killed more than half million people, affecting almost 2 billion people and have produced economic losses for about 1.7 trillion US dollars in infrastructure, productivity losses, direct and indirect costs [6]. It is reasonable to believe that the experiences, lessons learned, and tools that have been developed to prepare for and respond to disasters and catastrophic events can shed light on the policies and courses of action to support vulnerable populations, and in particular breastfeeding mothers and infant dyads. The main contribution of this paper is to use a disaster management framework to provide guidance to maternal infant health in the context of COVID-19. We provide operational and policy recommendations to support breastfeeding maternal-infant dyads during the COVID-19 pandemic.

2. Background

Breastfeeding and the provision of human milk are critical to maternal-infant health and wellness. Human milk is the optimal nutrition for infants, affording infants appropriate nutrition and protection against infection. To promote infant nutrition, health, and development, the World Health Organization (WHO) recommends exclusive breastfeeding for six months and continued breastfeeding for at least 2 years [7]. Inadequate or lack of breastfeeding are associated with increased risks of infant morbidity, including acute infections and chronic conditions, and infant mortality [8,9]. Whereas, use of human milk supports healthy growth and development including cognitive and neurologic development which contributes to the productivity of the members of society [10,11].

Financial costs have been estimated regarding inadequate and lack of breastfeeding and the potential economic benefits of providing infants with human milk [11,12]. Globally, not breastfeeding is associated with lower intelligence and economic losses of about $302 billion annually or 0.49% of the world gross national income (GNI) with losses in low-income and middle-income countries estimated at $70.9 billion (0.39% of their GNI), and losses for high-income countries at $231.4 billion (0.53% of their GNI) [12]. Researchers in Mexico estimated the cost of inadequate breastfeeding among infants under 12 months of age to be at least hundreds of millions of dollars, associated with the increased risk of acute health conditions including gastrointestinal and respiratory infections [13]. Similarly, researchers in the United Kingdom calculated the potential cost savings of over $38 million, along with the health benefits and increased lifetime productivity associated with the use of human milk among infants in the neonatal intensive care unit (NICU), where infants are at increased risk of infection and neurological impairment [14].

Maternal-infant dyads who experience disaster situations have an increased risk of premature termination of breastfeeding and exclusive breastfeeding. Disasters expose maternal-infant dyads to poor nutrition, lack of resources, and infectious diseases. Disasters also pose stress for mothers which can negatively impact infant feeding practices, especially exclusive breastfeeding. Maternal stress triggers the hypothalamic-pituitary-adrenal (HPA) axis and release of various corresponding stress-induced hormones that can be attenuated with breastfeeding and lactation [15]. Moreover, cortisol, the hormone associated with stress, suppresses the release of the hormone responsible for milk production, prolactin [16]. While it is not possible to determine cause and effect from the mixed methods study, women who experienced mass evacuation following a wildfire disaster in Canada reported that they felt stress, reduced their breastfeeding, and increased their use of formula supplementation [17].

Natural disaster emergencies such as Hurricane Katrina in 2005 have been associated with lower rates and shorter durations of breastfeeding rates among women in affected areas compared to women nationally [18]. Risk factors identified with reduced breastfeeding following various disasters include poor infant nutritional status, poor infant health, lack of privacy to breastfeed, availability of donated infant formula [19], maternal misconceptions regarding breastfeeding production or supply [19,20], maternal misconceptions regarding breast-milk quality [21], and maternal confidence regarding breastfeeding during crisis [22].

Man-made disasters, such as those experienced during times of armed conflicts, also negatively affect breastfeeding and are associated with nutritional deficiencies among infants. Infant-maternal dyads who were displaced during the conflict in Ukraine and who had terminated breastfeeding reported stress related to the conflict as the primary reason for discontinuing breastfeeding [23]. Similarly, the prevalence and duration of breastfeeding decreased during the conflict in the former Yugoslavian region in the 1990’s, especially among families living in frontline communities [24,25]. Researchers found that during times of conflict, children who were not breastfed or were prematurely weaned were more likely to be malmournished [25] and had higher mortality rates than breastfed children [26]. In contrast, breastfeeding during times of armed conflicts and oppression has been associated with infant survival and health protection [27]. Inadequate breastfeeding also increases the associated costs to the health system and government agencies, and therefore to disaster response operations.

3. COVID-19 impact on maternal-infant dyads

The current global emergency situation, that of COVID-19, has exposed maternal-infant dyads to stress, isolation, misinformation, and health complications. Identifying the evidence-based effects of the disease in mothers and their infants and the role of human milk in infant health are of critical importance to determine appropriate policies to support maternal-infant dyads during such emergencies.

3.1. Risk, incidence, and severity of COVID-19 infection

Among pregnant women with COVID-19, while a majority have mild disease, the risk of adverse maternal outcomes is significantly increased among those with more severe infection, have co-morbidities, 35 years of age or older, and whose race is black or Hispanic [28]. Recent studies have shown that vertical transmission of the COVID-19 virus from the mother to the fetus or infant is possible but unlikely, with a rate of approximately 3%–5.5% [29–31]. Among COVID-19 positive infants, the majority were asymptomatic [31] or had mild symptoms with no mortality [30]. Based on a study in Italy, researchers support the safety of rooming-in among COVID-positive breastfeeding mothers who followed practices to reduce transmission including handwashing, mask wearing, and physical distancing of 2 m when not breastfeeding or providing infant care [32], with some researchers recommending skin-to-skin care [33]. Reducing separation of the mother and her infant and encouraging skin-to-skin practice are critical to maternal-infant bonding and to neonatal physiologic stability. Separation and lack of breastfeeding increase the risk for infant infection and maternal stress and distress [33,34].

3.2. Breastfeeding during COVID-19 pandemic

While limited data-driven evidence is available regarding breastfeeding in COVID-positive mothers, reviews of the literature support direct breastfeeding or provision of pumped mother’s milk [35] as the benefits outweigh the risks [36]. In a recent study of 18 COVID-19 positive mothers, most of the milk samples contained SARS-CoV-2 specific IgA and IgG antibodies, affording breastfed infants protection from infection and supporting recommendations to breastfeed [37]. The WHO and several agencies around the world do not regard maternal suspected or confirmed COVID-19 infection as a contraindication for breastfeeding and recommend that mothers be encouraged to breastfeed [1,2,38,4,5]. They recommend that COVID-positive mothers practice general hygiene, wash hands with soap and water, use hand sanitizer with at least 60% alcohol, and disinfect surfaces and may breastfeed while wearing a
mask [4,5]. If the mother is severely ill with COVID-19 and suffers from complications that prevent her from direct breastfeeding, provision of expressed milk, preferably mother’s own milk, to the infant is recommended [1,2,38,4,5]. Mothers with COVID-19 who choose to express breast milk are recommended to use their own breast pump, wash hands with soap and water before touching the pump and supplies, wear a mask during expression, and properly clean pump after each use. In cases where the postpartum mother is too unwell to directly breastfeed, expressing breast milk to maintain lactation is important to ensure resuming breastfeeding [4,5,39].

Researchers examined milks samples of 8 mothers who had recovered from COVID-19 and 7 who were suspected of being infected found that the milk samples contained IgA specific reactivity with most demonstrating the specific antibody binding to the SARS-CoV-2 protein [40], suggesting that human milk contains antibodies to the COVID virus that may protect breastfed infants. Authors of a systematic review of 37 articles opined that there is no evidence of SARS-CoV2 transmission through human milk [41]. Furthermore, infants who were not directly breastfed, were not placed in skin-to-skin, or were not rooming-in were less likely to be exclusively breastfed in the first 3 months postpartum and [33], thereby demonstrating long-term consequences of early separation and disruption of breastfeeding.

3.3. Pregnancy, breastfeeding, and COVID-19 vaccination

Due to the lack of inclusion of pregnant and breastfeeding women in the COVID vaccine safety and efficacy trials, there is limited evidence beyond expert opinion and drawing on lessons from other vaccines to inform women and their healthcare providers regarding vaccination. While there is no population-based evidence on the safety of COVID-19 vaccines in pregnant or breastfeeding women, there is minimal biological reason to consider the vaccine as harmful as it contains mRNA (and not the virus) [42]. Transplacental transfer of antibodies is increased when pregnant women receive the mRNA vaccine [43]. The CDC [4,5] considers breastfeeding women as a group recommended to receive the COVID-19 vaccine [13,15]. With time, as pregnant and breastfeeding women are volunteering to receive the vaccine, data will be available to inform practice.

4. Breastfeeding in the context of disaster preparedness and response

It is recommended for mothers to continue breastfeeding during natural disasters. Before breastfeeding, mothers should wash hands with soap and water or use alcohol-based sanitizer. The CDC recommends learning to express breast milk by hand if there is no power or using an electric breast pump. CDC recommends staying with a child during and after a disaster as it makes it easier to keep breastfeeding [44]. Van-Wassenhove [45] describes the “five key elements” of preparedness that need to be in place for proper disaster preparedness: human resources, knowledge management, operations and process management, financial resources, and the community. Such elements require context, challenges and limitations when helping maternal-infant dyads. In addition, a systematic review evaluated the application of theoretical frameworks in published studies of overall emergency health preparedness from around the world while noting gaps such as the predominance of relevance to natural disasters and minimal discussion of mediating and cultural factors [46]. Considering the variability across countries, cultures, and disaster circumstances, it is important to offer adaptable approaches to promote maternal-infant health and breastfeeding as part of a tailored disaster response. It is also critical for the wide range of responders and agencies to work in a coordinated manner to address the many needs of the affected population.

4.1. Human resources and personnel roles

Healthcare workers and social service providers care for mothers and infants, many of whom are ill, malnourished, and traumatized by their experience. The maternal-infant dyads require the guidance of trained professionals but there is a shortage of professionals trained in supporting breastfeeding during emergency situations. It is important to dispel misconceptions that can lead to unhealthy infant feeding and disruptive maternity practices such as separating COVID-positive mothers and their infants. For effective provision of breastfeeding support, positive interpersonal communication is necessary [47].

The Infant and Young Child Feeding in Emergencies (IFE) [48] recommends that personnel of all disciplines be educated and trained in promoting optimal infant feeding during emergency situations, including the identification and incorporation of expert and evidence-based lactation assistance. The various roles and responsibilities should be defined and organized to effectively support the provision of human milk for infants. Likewise, the various personnel should be actively involved in the planning of providing care for maternal-infant dyads, capitalizing on the strengths of each discipline and minimizing health risks to this vulnerable population [49]. Among the personnel are healthcare providers, service professionals, and emergency medical logistics experts who support the procurement, transportation and distribution of medical supplies [50].

Nurses and physicians in the community are in the position to educate pregnant and postpartum women and their families to plan and prepare for disaster and emergencies, especially in communities at risk for seasonal natural disasters such as tornadoes, hurricanes, and flooding [51] and in regions where infection rates and exposure to infected individuals are high. Ideally, trained lactation consultants should be involved in guiding women in breastfeeding, in person wearing appropriate protective gear and remotely when technology-based devices are available. Where there is a dearth of lactation consultants, peer counselors should be trained in the benefits of breastfeeding and practical methods of assistance. The coordinated and complementary roles of the various personnel should contribute to the initiation and maintenance of breastfeeding support during disaster.

4.2. Knowledge management: integrating disaster preparedness for infant-mother dyads into nursing competencies

Together, the WHO and the International Council of Nurses (ICN) developed a set of core disaster nursing competencies [52] that have been recently updated [53]. The competencies address nurses’ roles in the effective prevention, preparedness, response, and recovery from disasters. Additionally, the WHO proposed a global agenda for nurses’ roles in each phase of emergency and recommended improving nurses’ skill-based, physical, and physiologic readiness to respond during disaster [7]. During the pandemic outbreak, nurses and other members of the healthcare team have been in front-line positions around the world.

Management of mother-infant dyads during disasters requires knowledge and experience of expert nurses [49]. Where there is a lack of evidence-based data-driven information such as COVID vaccination of pregnant and breastfeeding women, healthcare providers must remain updated regarding developments and research to inform care. Jorgensen, Mendoza, and Henderson [54] described emergency preparedness competency guidelines and disaster response education and training activities for perinatal and neonatal nurses. There has been a call for women’s health practitioners and midwives to prepare personally and professionally to volunteer in emergency settings and provide reproductive, maternity, and perinatal care, breastfeeding guidance, and psychological support [55]. Emergency preparedness for support of maternal-infant dyads should be integrated into nurses’ training and education globally for hospital and community-based care.
4.3. Operations and process management: information, preconceptions and logistics

Human milk, especially through breastfeeding, is the appropriate, available, accessible, affordable, utilizable, and stable food source for infants, providing food security; lack of exclusive breastfeeding contributes to the risk of infant food insecurity [56]. For mothers who are unable to breastfeed, such as those with severe COVID-19 infection who require intensive care with ventilation, pasteurized human donor milk from the Human Milk Bank is preferred for their infants [1,2,57]. Human Milk Banks screen the donor and serologically test for specific infectious diseases and collect, store, and distribute human donor milk [58]. During COVID-19 pandemic, human milk banks faced problems of inadequate staffing and lack of human milk donation, along with an increase in the demand for human donor milk due to a separation of COVID-19 infected mothers and their newborns [59]. When expressing mother’s milk or human donor milk is not possible, wet nursing should be considered, if culturally acceptable [1,2,57]. In addition, many countries lack of legislative and regulatory policies supporting donor milk sharing and wet nursing. In these countries, legislation protecting human milk sharing and wet nursing during emergencies is required [60]. In a wide range of emergency situations, healthcare providers should be educated in supporting lactation and safe infant feeding.

Along with providing personnel support, setting up breastfeeding centers is an effective means of supporting breastfeeding, as demonstrated in geographic locations around the world where natural disasters have occurred [22]. Following the earthquake in Haiti in 2010, nearly 200 breastfeeding tents were set up which served over 200,000 pregnant and breastfeeding women, offering a safe, relaxing, friendly, and comfortable space to breastfeed with professional support. Positive breastfeeding outcomes from the program included continued exclusive breastfeeding for 70% of infants and a 10% transition to exclusive breastfeeding among infants getting mixed feedings [61]. In the United States, recreational vehicles (RV) were established as lactation stations in rural eastern Oregon with lactation counselors meeting with mother-infant dyads to support breastfeeding. These mobile lactation stations travel around in a region to providing lactation counseling and educate the public on the importance of breastfeeding [62]. The mobile lactation stations and breastfeeding tents are examples of safe spaces that may be adapted for mother-infant dyads in emergency or disaster situations, depending on the geographic location and resources. These initiatives require the resources of available tents or recreational vehicles that can deliver services to maternal-infant dyads in rural or hard to reach locations. From a logistics perspective, this type of problem belongs to the location-routing problems category.

Logistics plays a key role in disaster response. This involves organizing and planning for transportation, warehousing, distribution, and procurement required for logistic support of efficient and effective resource allocation. Post-disaster humanitarian logistics aims at delivering such essential supplies as water, food, medicine, and shelter to affected populations after a disaster to mitigate damage and harm [63]. Among the challenges faced during a disaster, identifying accessible facilities that can deliver supplies or offer medical, psychological, social, and financial services is of key importance [63]. In the case of COVID vaccine distribution, countries around the world are locating feasible facilities to serve the prospective demand while considering the accessibility of the facilities under conditions of lockdown, quarantine, and limited mobility. Points of Distribution (PODs) locations serve as the physical places where people can pick up food, medicine, water or other essential supplies. Similarly, PODs can be equipped with trucks that can deliver supplies to additional demand points with determination of scheduling delivery times for the demand nodes in the affected region.

The recent experience of COVID-positive mothers around the world being separated from their infants has shown the difficulties that mothers face when intending to breastfeed [33], despite evidence that the infection is not transmitted through human milk [36]. Furthermore, separation of mothers and their infants increases risk of infection for infants and distress for mothers [33]. Therefore, the ideal situation is to offer a safe space where COVID-positive postpartum mothers who are asymptomatic or have mild symptoms can recover together with their infants, breastfeed on demand, and pump milk as needed. If possible, designate rooms in the COVID unit for mother-baby dyads with availability of a postpartum and neonatal care team, drawing on the examples of the tents and mobile lactation stations that offer safe breastfeeding spaces with professional support. The irrefutable benefits for mother and infant of breastfeeding highlight the need for supporting breastfeeding.

4.4. Financial resources

Disaster preparedness requires funding, planning, coordination, training, and identification of the necessary resources and responders. The response of federal, state, and local agencies, coordinated with community services and medical facilities, relies on planning and protocols that should be developed in partnership before the event. Memoranda of understanding should be drafted between relevant federal, state, and local agencies to clearly define roles and responsibilities in providing care for maternal-infant dyads during emergency situations [64]. Useful in guiding such plans, the United States Division of Reproductive Health Program of Emergency Preparedness has identified epidemiologic indicators and measures to help guide healthcare and public health professionals in addressing the maternal-infant needs following a disaster [65]. Additionally, the international collaborative effort of the Infant and Young Child Feeding in Emergencies (IFE) Core Group’s Operational Guidance [48] provides updated recommendations for development and adoption of policies that support breastfeeding in compliance with the WHO/UNICEF. The key to successful management of infant feeding in emergency situations is planning and preparedness ahead of disasters. As part of planning, overall and specific goals should be delineated such as support and guidance of exclusive breastfeeding in infants through six months of age and support and encouragement of continued breastfeeding in older infants.

To address infant food insecurity, there is often an inappropriate effort of donating formula supplementation, which sabotages exclusive breastfeeding and exposes infants to unclean food sources and contaminants. In Lebanon, for example, despite the awareness of the value of breastfeeding and the risks of artificial feeding, international and local agencies have been found to accept donation of formula in disaster situations [66]. Considering the many infant health and development benefits of breastfeeding, it is critical to promote and support breastfeeding, and to avoid the use of formula. Only in limited cases should formula be considered, such as severely COVID-19 infected mothers in intensive care. Keep in mind an important challenge in the use of formula in emergency and disaster situations: the potential presence of contaminants in the water used with the formula. If the use of baby formula is unavoidable, the hospital or facility must make an extra effort to ensure the quality and safety of the water to reduce the risk of infant gastrointestinal infection.

4.5. The community and breastfeeding support

Disaster preparedness for childbearing women might be included in prenatal classes, covering themes such as proper nutrition, breastfeeding and safety interventions appropriate for disaster situations [51]. Helping women who were exclusively breastfeeding prior to a disaster will preserve the breastfeeding relationship among those maternal-infant dyads. For those who were partially breastfeeding, promotion of exclusive breastfeeding will reduce the risk of infection or contamination from unclean, expired, or inadequately stored supplements. There are also psychosocial benefits of breastfeeding promotion. Despite lower breastfeeding rates and higher use of formula following the wildfire disaster, women shared positive perspectives on breastfeeding as
comfort and empowerment [17].

Cultural factors should be considered when designing any breastfeeding and infant feeding program [20]. For example, in some cultures, mother’s milk may be perceived as lacking in quality when the mother is poorly nourished or is in a poor psychosocial state, thereby preferring formula supplementation [21]. Women in some cultures also believe that poor maternal nutritional status negatively affects breastmilk quantity and production [19-21]. The acceptance of wet nurses or milk sharing between mothers is also culturally based and has evolved over time [67], assuming health and safety of the practice. For example, according to Islam, an infant who is breastfed by a different mother becomes a “milk sibling” to the other woman’s children which precludes milk siblings to marry [68]. Pasteurized donated human milk from milk banks which go through rigorous testing and careful storage is often inaccessible and cost prohibitive [69], not to mention that it poses challenges for women of certain cultural groups [70]. The limited accessibility and expense of banked milk challenge the availability of human milk for maternal-infant dyads unable to breastfeed.

Breastfeeding promotion must take the priority in disaster situations and in times of COVID-19. Governments, health professionals and the community need to understand the benefits of breastfeeding for the baby, family, community and country, as the overwhelming evidence suggests. In the event of a disaster, infant-maternal dyads require clear, evidence-based infant feeding guidelines and resources to ensure maternal postpartum recovery and infant health, development, and survival. Human milk has anti-infective properties which are critical in supporting infant health during disaster situations when the risks for infections are increased [71].

As pointed out in section 4.5 of this paper, policies, regulations, and recommendations need to consider the social, economic and cultural characteristics of the communities when promoting breastfeeding. It is widely accepted among the humanitarian community that the first responders to a disaster are the survivors themselves; the impacted community. They have been directly affected by the disaster at the same time that they are in the most advantageous position to determine the needs, impacts and potential threats immediately after a disaster. The situation is similar in the case of maternal-infant dyads; the family and community are also in a better position to help the new mother. Providing the space, supplies and resources for maternal-infant dyads to focus on the care for the baby by helping her with food and house chores can be of great help. At the same time, the community offers an opportunity to enhance healthcare of maternal-infant dyads by using the social networks present and sometimes have very strong connections. The 2011 Earthquake in Port au Prince, Haiti is a clear example of the immeasurable potential of using the social structure in disaster response. Holguín-Veras et al. [72] identified and characterized such social networks as Collaborative Aid Networks (CANs). The authors demonstrated the superiority of such social structures above Agency Centric Efforts (ACEs) and Partially Integrated Efforts (PIEs). The former would best represent the efforts by centralized health care providers when trying to help maternal-infant dyads.

5. Conclusions

Maternal-infant dyads are among the most vulnerable populations during emergency situations. Since human milk affords infants necessary fluids and nutrients for health, growth, and neurodevelopment as well as protection against infection and support for immunologic health, it is especially important to support breastfeeding and provision of human milk when there are external health threats such as emergency situations. Breastfeeding promotion as part of emergency preparedness will contribute to infant health and development, which ultimately leads to improved quality of life, return to stability, and cost containment. As direct maternal-infant health providers, nurses have the potential to make a substantial contribution to emergency preparedness for this vulnerable population. The allocation of resources and personnel dedicated to supporting breastfeeding maternal-infant dyads is challenging with economic, social, and ethical considerations. Defined roles facilitate the action and accountability of the responsible parties for the completion of the necessary tasks to address the population needs. To make equitable decisions, and to consider the precarious circumstances of vulnerable populations, there is a need to gather, process, analyze, and disseminate key data and information. This information should be available to disaster responders who make decisions in highly dynamic and uncertain environments. Even more important, this data should be incorporated into disaster preparedness. A robust, well-informed, and updated evidence-based disaster preparedness plan will facilitate an equitable and effective response.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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