Mixed Message on Formula Mixing

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One of the most basic and important things we do as parents is feed our children. As pediatricians, one of the most frequent conversations we have with parents revolves around how to do that. During the first few days and weeks of life, feeding is often the main focus of conversations both in the hospital and at subsequent office visits. Although our emphasis, shaped by Healthy People 2020 goals, is often on breastfeeding and breast milk, a significant proportion of infants are formula fed. In fact, by the age of 6 months, only approximately half of infants still receive any breast milk.[1] The choice to use formula either primarily or in conjunction with breast milk is multifactorial and can include maternal factors, parental or partner preference, barriers to personal or lactation support, difficulties sustaining pumping after returning to work, or the need for increased caloric intake.

Given the number of infants who receive formula at some point in their life, it is frustrating that the guidelines from various national and international organizations detailing how to make formula often blatantly contradict one another. They differ primarily when it comes to the temperature of water: whether one should add formula powder to boiling water, add formula powder to water that has been boiled and cooled, or never boil water at all (Table 1).

Areas of controversy arise mainly because of the bacteria *Cronobacter sakazakii* (previously called *Enterobacter sakazakii*), a gram-negative rod that can live for long periods of time in dry areas. It can contaminate formula powder during manufacturing, after pasteurization has occurred. It also has the potential to cause serious invasive infections that can kill. An investigation into a fatal case of a premature infant death in Tennessee led to the discovery of the presence of this bacterium within dry formula

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powder in 2001. A more recent outbreak spanned 4 states in 2011 and brought the concerns of contamination back to the forefront.[2]

The Food and Agricultural Organization of the United Nations and the World Health Organization (WHO) convened expert meetings in 2004 and 2006 on the specific issue of *C sakazakii* in powdered infant formula.[3] They concluded that infants, in particular those born prematurely or at <2 months of age, were at highest risk for this infection. To minimize risk, they recommended that the water added to formula should be at least 70°C (158°F) to kill any *C sakazakii* bacteria present in the powder. In the follow-up 2006 report, the WHO argued that using slightly cooler water at 50°C (122°F) increased the relative risk of an infection occurring.[3]

The resulting WHO recommendations for formula preparation involve 12 steps. Twelve steps to make formula. Twelve steps to be performed by sleep-deprived parents, often with other children to care for, up to 8 times per day. They include a statement reminding parents not to burn themselves while pouring 70°C (158°F) water into a bottle. They warn them to let the bottle cool until it is appropriate to feed and not use a microwave to heat water.

It is not surprising that various organizations such as the Centers for Disease Control and Prevention (CDC), state health departments, and Supplemental Nutrition Program for Women, Infants, and Children have followed with similar recommendations for formula preparation.[4] In fact, the organization that certifies hospitals to create an environment that is conducive to breastfeeding, Baby Friendly USA, has a specific requirement that hospital staff receive training on safe formula preparation that includes the WHO guidelines and provides instructions to parents at the time of discharge.

However, other recommendations disagree. Instructions on cans of formula recommend boiling water for 1 minute, then letting the water cool before adding the formula powder. In fact, some probiotic formulas specifically state that when the temperature of the formula is >100°F, it can impact the effectiveness of the probiotic. Letting the water cool first, remember, increases the risk of *C sakazakii* infection. These

recommendations, which are similar to those of the American Academy of Pediatrics and the Food and Drug Administration, are based on the assumption that the water supply may not be clean, not that bacteria might exist in powdered formula.[10]

Complicating these policies and official statements further, licensing regulations for child care centers, which are set at the state level, can vary. Many require already mixed or prepared formula in bottles coming to the day care each day after parents have made them at home or ready-to-feed formula only. There are WHO mixing instructions for day care settings (also 12 steps long) that can be the policy, or parents can rely on the label for instructions.

How hot should the water be? Should we let it cool before mixing? Does this change with an infant's age? No one can seem to agree.

Although the morbidity and mortality from *C sakazakii* is indeed high, the overall incidence of such infections is low. The CDC receives reports of only 4 to 6 infant infections per year in the United States.[11] Granted, this may be due to underreporting of infections. But we know the rates of burns from hot water are much higher.

The National Institute of Occupational Safety and Health estimates that 112 000 scald burns occur each year in the United States, 3000 of which lead to hospitalizations. Every day, 300 young children are taken to the emergency department for burns caused by hot water.[12] In fact, the United States has the highest rate of burns in the industrialized world, and they are the second leading cause of death for children <5 years of age.

Asking tired parents to boil water upwards of 8 times per day to prepare formula on demand makes little sense given the amount of risk involved with burns in comparison to a *C sakazakii* infection. This is especially true if we are recommending they let the water cool before adding it to the formula.

Given the evidence, it seems like the risks of frequently handling boiling water are much greater than the risks of infection for otherwise healthy term infants. This is especially true once we have confirmed

families have access to a city water supply (ie, not well water), are avoiding “nursery water” (commercially available distilled water for infants), and use tap water to prepare formula. In our quest to provide anticipatory guidance and reduce risk, we need a simple and uniform set of recommendations for formula preparation that weighs evidence and acknowledges feasibility. We should focus on what is best for the vast majority of children and families. Currently, our recommendations may be doing more harm than good.

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Table 1. Summary of Formula Mixing Recommendations

Agency or Organization	Recommendation
WHO[5]	Boil water to a rolling boil and cool to no less 70°C (158°F) for no more than 30 min, add powdered formula, and immediately cool to feeding temperature.
CDC[6,7]	Warm water to at least 70°C (158°F) and then add formula powder, followed by cooling. The recommendation includes particular mention of infants <3 mo old, premature infants, or those with a compromised immune system.
FDA[8]	Boil water for 1 min and let it cool or follow the manufacturer's label.
AAP[9]	If one is concerned or uncertain about the safety of tap water, boil the water for 1 min, let it cool to room temperature (75°F) for no more than 30 min, and add powder.
Formula cans	Boil water for 1 min, let it cool to room temperature (75°F), and add powder.

AAP, American Academy of Pediatrics; CDC, Centers for Disease Control; FDA, Food and Drug Administration; WHO, World Health Organization.