Strategies to Reduce the Devastating Costs of Early Childhood Diarrhea and Its Potential Long-Term Impact: Imperatives that We Can No Longer Afford to Ignore

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(See the article by Sobel et al. on pages 1545–51)

We have long known that adequate water and sanitation help control child mortality and morbidity associated with diarrheal diseases. In Western Europe and North America, fears of preventable diseases such as cholera in the late 1800s drove the implementation of such measures [1–3]. In tropical areas of the developing world, on the other hand, such fears drove the development and distribution of oral rehydration therapy in the late 1900s. Despite the huge life-saving impact of oral rehydration therapy, however, the morbidity associated with diarrheal diseases in developing tropical areas continues largely unabated, and, with burgeoning growth among impoverished populations, it is greater than ever [4].

In this issue of Clinical Infectious Diseases, Sobel et al. [5] combine an extensive evaluation of risk factors and protective factors noted in studies of pathogens in persons of an age group (age, 12–59 months) that is often underrepresented in studies of diarrheal illness. This study complements a report by Blake et al. [6] of children aged <12 months in a similar environment in São Paulo, Brazil. Few other studies have analyzed risk factors and protective factors according to different age groups for specific pathogens. Sobel et al. [5] describe independent risk factors for diarrhea predominantly in toddlers, such as presence of another household member with diarrhea and consumption of homemade juice. They also examine protective factors, including the boiling of baby bottles and nipples, child care at home, and piped sewage. Hand washing by caretakers after helping children defecate protected against Shigella infection, and preparing rice, beans, or soup in the morning and serving them to children after noon, without adequate storage and further heating, were associated with enterotoxigenic Escherichia coli infection.

Sobel et al. [5] estimate that 28% of diarrhea in 1–4-year-old toddlers is attributable to easily modifiable exposures, such as boiling of baby bottles and nipples, careful attention to hygienic preparation of fruit juices, targeted hand washing, and proper storage and adequate heating of specific foods. In northeast Brazil, we found that a >3-fold increase in diarrhea risk occurs when toilet facilities are lacking (no facilities vs. pit toilet facilities), and that a 5-fold increase in diarrhea occurs with the introduction of weaning foods, and an additional 2.3-fold increase occurs with cessation of breast-feeding, a potentially devastating consequence if weaning occurs early in impoverished areas [7, 8]. Therefore, addition of the suggestions of Sobel et al. [5] to those of Blake et al. [6] for infants aged <12 months indicates that breast-feeding of infants (<6 months old) and boiling household drinking water provides a full range of simple strategies for children aged <5 years old.

It is noteworthy that multivariate analysis in the article by Sobel et al. [5] showed no interaction between exposures and the age categories of case patients, despite differences in diet, mobility, immunity, and other factors among children between their second and fifth years of life. Several studies have shown that acute and persistent diarrhea is most prevalent during the first 2 years of life [9, 10], which suggests that optimal strategies should target children aged <2 years old. This could simplify public health strategies to prevent and
control cases of diarrhea, decrease costs, and increase the benefit to poor populations in developing countries.

Although risk and protective factors may vary with local environments, host factors, and specific pathogens involved in acute diarrheal illnesses, cost-effective measures to prevent childhood diarrhea morbidity and mortality are widely recognized. These include immunizations for measles and possibly rotavirus, improved water supplies and sanitation facilities, promotion of breast-feeding, and education about weaning—measures that have been estimated to cost only $5–$60 per case of diarrheal illness averted and $130–$3000 per death averted [8, 11]. Furthermore, more intensive, community-based studies have shown that education about hand washing before preparing food, preventing children from defecating in the family compound, and preventing children from putting undisposed waste in the mouth has reduced diarrhea rates by >25% (P<.0001) in more than 50 communities studied [8, 12, 13].

The report by Sobel et al. [5] cites child care outside the home during the week preceding illness as another significant risk factor for diarrhea. It is well known that day care centers are a major determinant of acute diarrhea in children, whereas family day care does not increase the infection risk [14, 15].

The strategy of boiling water, bottles, and nipples before use has limitations because it requires fuel and is time consuming for children’s caretakers; therefore, these strategies are relatively uncommon [16]. The report by Sobel et al. [5] did not mention how many children were subject to this protective behavior. Targeted hand washing is well known to reduce diarrheal illnesses [16], as well as nosocomial outbreaks [17]. Routine hand washing requires a change in behavior and continuing education, which are difficult but not impossible tasks where educated people work in controlled environments, such as day care centers, clinics, and hospitals [16, 17]. In poor communities in developing countries, a strong program on behavior changes and continuing education is badly needed to improve adherence to this simple protective strategy.

With regard to the proper storage and adequate heating of specific foods, such as rice, beans, and soup, direct observation of potentially acceptable behavior changes is needed to incorporate practical suggestions into a program for continuing education. Recent unpublished data from our cohort community studies have shown that most parents or guardians of children at a community day care center are unfamiliar with basic hygienic and nutritional principles for feeding their children. This highlights the need to implement a simple effective strategy, as proposed by Sobel et al. [5]. It should be noted that such strategies must also address the reality that many mothers in these poor communities have low levels of literacy [10].

Nutritional interventions must also address micronutrient deficiencies found in several studies to be risk factors for diarrhea [18, 19]. Diets of young children in developing countries are often deficient in multiple micronutrients, including vitamin A, zinc, and iron [18–21]. Recent studies have shown that zinc supplementation or iron plus zinc supplementations prevent diarrhea and acute lower respiratory illnesses [19, 22–25].

Finally, environmental determinants are clearly associated with diarrhea. The waterborne transmission of epidemic cholera in Peru (1991) was one of the best examples of the importance of safe water supplies for a continent at risk for epidemic cholera and other diarrheal diseases [26].

Although knowledge of effective control measures for early childhood diarrhea is not new, the growing recognition of diarrhea’s potentially devastating long-term consequences makes implementation of these measures more urgent than ever. Like childhood helminthic infections [27, 28], early childhood diarrhea is associated not only with growth shortfalls, but with impaired physical and cognitive development that extends into later life [29–32]. Furthermore, even asymptomatic enteric infections with such pathogens as Cryptosporidium species, enteroaggregative E. coli, and Giardia species can be associated with malnutrition [29, 33–36], which is in turn associated with impaired cognitive development as well [37]. Consequently, the devastating impact of readily preventable childhood diarrheal diseases and enteric infections demands that we invest in breaking this vicious cycle of diarrhea, malnutrition, and impaired child development in every effective way possible. This includes not only societal investments in improved water quality, sanitation methods, and education about hygiene and breast-feeding, but also new approaches to readily available oral rehydration and nutrition therapies. These are imperative investments that we can no longer afford to ignore.

References


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