International Journal of Infectious Diseases (2006) **10**, 298—308

http://intl.elsevierhealth.com/journals/ijid

Etiology and epidemiology of diarrhea in children in Hanoi, Vietnam

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Received 3 February 2005; received in revised form 17 May 2005; accepted 31 May 2005
Corresponding Editor: Richard Oberhelman, New Orleans, USA

KEYWORDS
Diarrhea;
Children;
Hanoi;
Vietnam

Summary
Objectives: This paper provides a preliminary picture of diarrhea with regards to etiology, clinical symptoms, and some related epidemiologic factors in children less than five years of age living in Hanoi, Vietnam.
Methods: The study population included 587 children with diarrhea and 249 age-matched healthy controls. The identification of pathogens was carried out by the conventional methods in combination with ELISA, immunoseparation, and PCR. The antibiotic susceptibility was determined by MIC following the NCCLS recommendations.
Results: Of those with diarrhea, 40.9% were less than one year old and 71.0% were less than two years old. A potential pathogen was identified in 67.3% of children with diarrhea. They were group A rotavirus, diarrheagenic *Escherichia coli*, *Shigella spp*, and enterotoxigenic *Bacteroides fragilis*, with prevalences of 46.7%, 22.5%, 4.7%, and 7.3%, respectively. No *Salmonella spp* or *Vibrio cholerae* were isolated. Rotavirus and diarrheagenic *E. coli* were predominant in children less than two years of age, while *Shigella spp*, and enterotoxigenic *B. fragilis* were mostly seen in the older children. Diarrheagenic *E. coli* and *Shigella spp* showed high prevalence of resistance to ampicillin, chloramphenicol, and to trimethoprim/sulfamethoxazole. Children attending the hospitals had fever (43.6%), vomiting (53.8%), and dehydration (82.6%). Watery stool was predominant with a prevalence of 66.4%, followed by mucous stool (21.0%). The mean episodes of stools per day was seven, ranging from two to 23 episodes. Before attending hospitals, 162/587 (27.6%) children had been given antibiotics. Overall, more children got diarrhea in (i) poor families; (ii) families where piped water and a latrine were lacking; (iii) families where mothers washed their hands less often before feeding the children; (iv) families where mothers had a low level of education; (v) families where information on health and sanitation less often reached their households.

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doi:10.1016/j.ijid.2005.05.009

Conclusions: Group A rotavirus, diarrheagenic *Escherichia coli*, *Shigella spp*, and enterotoxigenic *Bacteroides fragilis* play an important role in causing diarrhea in children in Hanoi, Vietnam. Epidemiological factors such as lack of fresh water supply, unhygienic septic tank, low family income, lack of health information, and low educational level of parents could contribute to the morbidity of diarrhea in children.

Introduction

Infectious diarrhea is a leading cause of morbidity and mortality worldwide, affecting mainly infants.[1] Approximately 12 million children in developing countries die before the age of five years, and 70% of these deaths are due to five health problems, including diarrhea.[2] Unhygienic and unsafe environments place children at risk of death.[3,4] Ingestion of contaminated water, inadequate availability of water for hygiene, and lack of access to sanitation contribute to about 1.5 million child deaths and around 88% of deaths from diarrhea per year.[3,4] In addition, there are international studies where it has been reported that a higher prevalence of diarrhea, with higher episodes of child diarrhea, are related to a low socio-economic status of the household and community, as well as to a low educational level of the child's parents.[5–8]

Diarrhea is mainly caused by enteric pathogens including viruses, bacteria, and parasites. Rotavirus and diarrheagenic *Escherichia coli* (DEC) are considered to be the most common of the many recognized enteropathogenic organisms, the former on a global scale,[9] with DEC being particularly important in developing countries.[10] Rotavirus, especially group A rotavirus, is the leading cause of infantile gastroenteritis worldwide and is responsible for approximately 20% of diarrhea-associated deaths in children under five years of age.[11]

There are six main categories of DEC identified. These are: (i) enteroaggregative *E. coli* (EAEC); (ii) enteroinvasive *E. coli* (EIEC); (iii) enterohemorrhagic *E. coli* (EHEC); (iv) enteropathogenic *E. coli* (EPEC); (v) diffusely adherent *E. coli* (DAEC); and (vi) enterotoxigenic *E. coli* (ETEC). It has been shown that there are important regional differences in the prevalence of the different categories of DEC.[12–15]

Besides group A rotavirus and DEC, the expanding list of potential enteropathogens includes *Salmonella spp*, *Shigella spp*, *Vibrio cholerae*, enterotoxigenic *Bacteroides fragilis* (ETBF), *Campylobacter spp* and *Cryptosporidium spp*. Advances in diagnostic techniques have increased our ability to detect these pathogens. The present study was undertaken with the aim of assessing the role of the enteric pathogens in relation to clinical symptoms and epidemiological factors.

Study subjects

A total of 836 children from 0 to 60 months of age including 587 children with diarrhea attending the examination rooms of three different hospitals and 249 age-matched healthy controls were studied. The healthy children were enrolled from a daycare center and a healthcare center in Hanoi, Vietnam. They had not had any diarrheal episode for at least one month before the collection of fecal samples.

The children were enrolled in the study during a one-year period starting in March 2001 and ending in April 2002. Diarrhea was characterized by the occurrence of three or more loose, liquid, or watery stools or at least one bloody loose stool within a 24-h period. An episode was considered resolved on the last day of diarrhea followed by at least three diarrhea-free days. An episode was considered persistent if it continued for 14 or more days.[16] Vomiting was defined as the forceful expulsion of gastric contents occurring at least once in a 24-h period. Fever was defined as an under-arm temperature of $>37.2\,^{\circ}C$. Thresholds of 37.2–39 °C and $>39\,^{\circ}C$ were set for moderate and high fever, respectively. Dehydration level was assessed following the recommendations of the WHO Program for Control of Diarrheal Diseases and these assessments were carried out by the pediatricians.[17]

After informed consent was obtained, a pediatrician specifically assigned to the study examined each patient and filled out the demographic data and information on clinical symptoms and illness onset on a standardized questionnaire. The healthcare workers also obtained similar information from the controls.

Some other factors related to the demography and socio-economic status of the children's parents were also obtained. Education of the parents was assessed as being at either a higher or lower level based on whether they were educated (persons finishing at least college or university) or workers, farmers, and laborers (persons educated up to high school). The living standard of the child's family was evaluated by monthly income of the whole family in Vietnamese Dong (VND). Five levels (very poor, poor, middle, fair, and rich) were ranked according to the Survey of the Center of Scientific Research for the Family and Woman carried out in Vietnam in 2001. Water sources were divided into hygienic (piped water) and unhygienic (pool or well, or rainy water) resources. A latrine was considered to be a hygienic convenience. The availability of information on health and sanitation from any source was assessed according to whether the child's family had access to this kind of information often (daily and weekly) or less often (monthly, rarely, or almost never).

Materials and methods

Sample collection

Fecal samples (one from each subject) from children without diarrhea were collected in a clean container by their parents when the children defecated. From the children with