Diarrheal Illness and Childhood Mortality: Filling Up the Half-Empty Glass

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Worldwide Distribution of Child Deaths

Each dot represents 5,000 deaths

Major Causes of Death in Children

Major Causes of Death in Children, by Region

Magnitude of Childhood Diarrheal Mortality

- 1982 estimate: 4.6 million deaths per year
- 1992 estimate: 3.3 million deaths per year
- 2003 estimate: 2.5 million deaths per year

Magnitude of Childhood Diarrheal Morbidity

- 1982 estimate: 3.0 episodes per child year
- 1992 estimate: 2.6 episodes per child year
- 2003 estimate: 3.2 episodes per child year

Consequences of Child Diarrheal Morbidity

- Malnutrition
- Impaired immunity
- Recurrent infections
- Impaired growth (stunting)
- Impaired cognitive development
- Economic loss to families
- Household transmission
Causes of Child Diarrheal Illness

- **Bacterial**
  - *Campylobacter*
  - *Escherichia coli*
  - *Salmonella*
  - *Shigella*
  - *Vibrio cholerae*

- **Viral and Parasitic**
  - *Astrovirus*
  - *Norovirus*
  - *Rotavirus*
  - *Sapovirus*
  - *Acanthamoeba*
  - *Cyclospora*
  - *Cryptosporidium*
  - *Giardia*
Vitamin A and Diarrheal Disease

• Essential nutrient added to many foods
• Fat soluble: can be administered in 4 – 6 month intervals
• Vitamin A supplementation reduces
  – Overall child mortality by 19% - 30%
  – Overall child diarrheal mortality by ~35%
  – Severity and duration of diarrheal diseases
  – Risk of stunting associated with persistent diarrhea
  – Duration of ETEC and EPEC diarrhea
  – Risk of EPEC

Zinc and Diarrheal Disease

- Essential nutrient for >300 enzymes, including immune system
- Absorbed in small intestine; blocked by cereals
- Zinc supplementation (daily) prevents pneumonia, malaria, diarrhea, and recurrent diarrhea
- Zinc treatment reduces the severity and duration of diarrheal episodes, including cholera
- Zinc deficiency may account for 14% of diarrhea deaths, 10% of malaria deaths, and 7% of pneumonia deaths

Brooks A, Lancet 2005
Diarrhea Mortality and Use of Oral Rehydration Therapy

Podewils, Seminars Pediatric Infectious Diseases, 2004
### Changes in ORT Use Between Last Two DHS (0-3 yr. old)

#### Increased
- Burkina (15%)
- Mozambique (8%)
- Egypt (10.6%)
- Philippines (6.4%)
- Eritrea (10.4%)
- DR (32.6%)
- Mali (20%)

#### Decreased
- Cameroon (-14%)
- Kenya (-32%)
- Madagascar (-7.9%)
- Nigeria (-32%)
- Indonesia (-14%)
- Jordan (-12%)
- Zambia (-7.9%)
- Malawi (-12%)
- Rwanda (-17.8%)
- Uganda (-14%)
- Colombia (-17%)

### No significant change*
- Bangladesh (3.3%)
- Ghana (-2.4%)
- Morocco (-1%)
- Vietnam (1.5%)
- Benin (-3.5%)
- Nepal (-2.8%)
- Nicaragua (-3.3%)
- Namibia (-1.5%)
- Haiti (-2.6%)
- Peru (+2.1%)

* \( p > 0.05 \)

Patricia Paredes-Jodrey, ASTMH, 2005
Worrisome Changes in Diarrheal Treatment

• Decreased use of Oral Rehydration Treatment
• Decreased use of any fluids during diarrheal disease
• Decreased use of continued feeding during diarrheal disease
• ORT, fluids and feeding lowest use among younger mothers
• Increased use of antimicrobials for child diarrhea
• Increased resistance to antimicrobials among the pathogens that cause diarrhea in children
Global Burden of Unsafe Water

- Over 1 billion persons have no access to improved water sources

- Hundreds of millions more drink unsafe water from “improved” sources
Post-Source Contamination

- Occurs during:
  - Transport
  - Household storage
Childhood Mortality and Morbidity From Unsafe Drinking Water

• Each year
  – Billions of episodes of diarrhea and other diseases are caused by unsafe drinking water
• Each year
  – 1.8 million persons die from waterborne disease
• Each day
  – 5,000 children die from diarrhea acquired from unsafe drinking water
Universal Access to Piped Treated Water

• Advantages of Infrastructure
  – Provision of reliable, quality water
  – Economic
  – Social
  – Aesthetic
  – Disease reduction
    • Increase quantity
    • Improves hygiene, sanitation

• Disadvantages
  – Cost, Time, Maintenance
Household Water Treatment: Making Unsafe Water Safer to Drink

Chlorination

Solar Disinfection

Flocculation-Disinfection

Filtration
Safe Water Storage: Keeping Safe Water Safe to Drink

CDC Vessel

Jerry Can

SODIS Vessel

Modified Clay Vessel (Kenya)
**CDC Safe Water System – Product**

**Treat drinking water at the point of use**

- Dilute sodium hypochlorite bleach

**Store treated drinking water safely**

- Narrow-mouthed, lidded 20 L vessels with spigots
CDC Safe Water System – Promotion

I use Clorin to Treat Our Water because it is Cheaper Than Boiling Water.

Treat your WATER with Clorin

Even Tap Water Can Have Germs

K10 Up to 20 L of Water

K600 to Boil 20 L of Water

CDC

WATER
CDC Safe Water System – Promotion
CDC Safe Water System – Promotion
CDC Safe Water System – Placement
CDC Safe Water System – Placement
CDC Safe Water System – SWAP

- Society for Women and AIDS Prevention, Kenya
- Delivers SWS, bednets, nutritional supplements, soap, and other items in a “basket of goods” to their neighbors
CDC Safe Water System – Clinics

- Safe Water System products and education available to health care workers and patients in clinics and hospitals in western Kenya.
Safe Water System products, handwashing stations, and education available to teachers and students in rural Kenyan schools.
Interventions to Improve Water Quality for Preventing Diarrhea

“The review covered 38 independent comparisons from 30 trials that involved more than 53,000 people. In general, such interventions were effective in reducing episodes of diarrhea. Household interventions were more effective in preventing diarrhea than those at the source.”

Clasen T, Roberts I, Rabie T, et al. The Cochrane Library, 2006 # 3
Fewtrell L, et al. Interventions to improve water quality for preventing diarrhea
Making dirty water safe to drink

A floculant-disinfectant reduced diarrhoea in under 2 year olds (p478)
Effect of Home-based Water Chlorination and Safe Storage on Diarrhea among Persons with HIV

• 509 HIV-positive individuals randomized to receive home-based water chlorination and safe water storage vessels or serve as controls
• Active surveillance for diarrhea for ~2 years
• SWS reduced diarrheal episodes by 25% (33% fewer days of diarrhea).

How Cost-effective is Household Water Treatment?

Figure 3 | Cost-effectiveness ratios under low and high assumptions in AFROD.

Effect of washing hands with soap on diarrhea risk in the community

- 17 studies (7 intervention trials) from 1981-2001

“The pooled relative risk of diarrheal disease associated with not washing hands from the intervention trials was 1.88 (95% CI 1.3-2.7) implying that handwashing could reduce diarrhea risk by 47%.”

Curtis V and Cairncross S. The Lancet Infectious Diseases, May 2003;3:275-281
Handwashing for Preventing Diarrhea

Meta-analysis included only randomized intervention trials (n=14) from 1981 – 2007

“Interventions promoting handwashing resulted in a 29% reduction in diarrhea episodes in institutions in high-income countries and a 31% reduction in communities in low-or middle income countries.”

Ejemot RI, et al. The Cochrane Library, 2008 # 1
Incidence of pneumonia in children <5 years old

Figure 2: Incidence of pneumonia in children younger than 5 years

Interventions for the interruption or reduction of the spread of respiratory viruses

- 51 studies, including 6 case-control studies of frequent handwashing

“The highest quality randomized clinical trials suggest respiratory virus spread can be prevented by hygienic measures around younger children.”

Effect of intensive handwashing in the prevention of diarrheal illness among patients with AIDS

- 148 patients with AIDS randomized to receive an intensive handwashing intervention or as controls
- Maintained daily handwashing and diarrhea diaries
- Patients assigned to the intensive handwashing intervention group washed their hands more frequently and developed fewer episodes of illness than controls

Huang DB and Zhou J. Journal of Medical Micro, 2007;56:659-663
Conclusion

• Supplementation with Vitamin A and Zinc, treatment of drinking water at the household level, and handwashing prevent diarrhea among children and provide multiple other health benefits

• ORT and Zinc can prevent death and disability from diarrheal illnesses in children when used for treatment

• These simple, inexpensive interventions are under-utilized and need to be scaled-up to achieve their maximum potential benefits
Goal 4: Reduce Childhood Mortality

Target 5: Reduce by two-thirds, between 1990 and 2015 the under-five mortality rate
COMBATING WATERBORNE DISEASE AT THE HOUSEHOLD LEVEL

The International Network to Promote Household Water Treatment and Safe Storage

World Health Organization
Thank you!