Household Water Treatment and Safe Storage: Experience from the Developing World Lessons for Rural Alaska?

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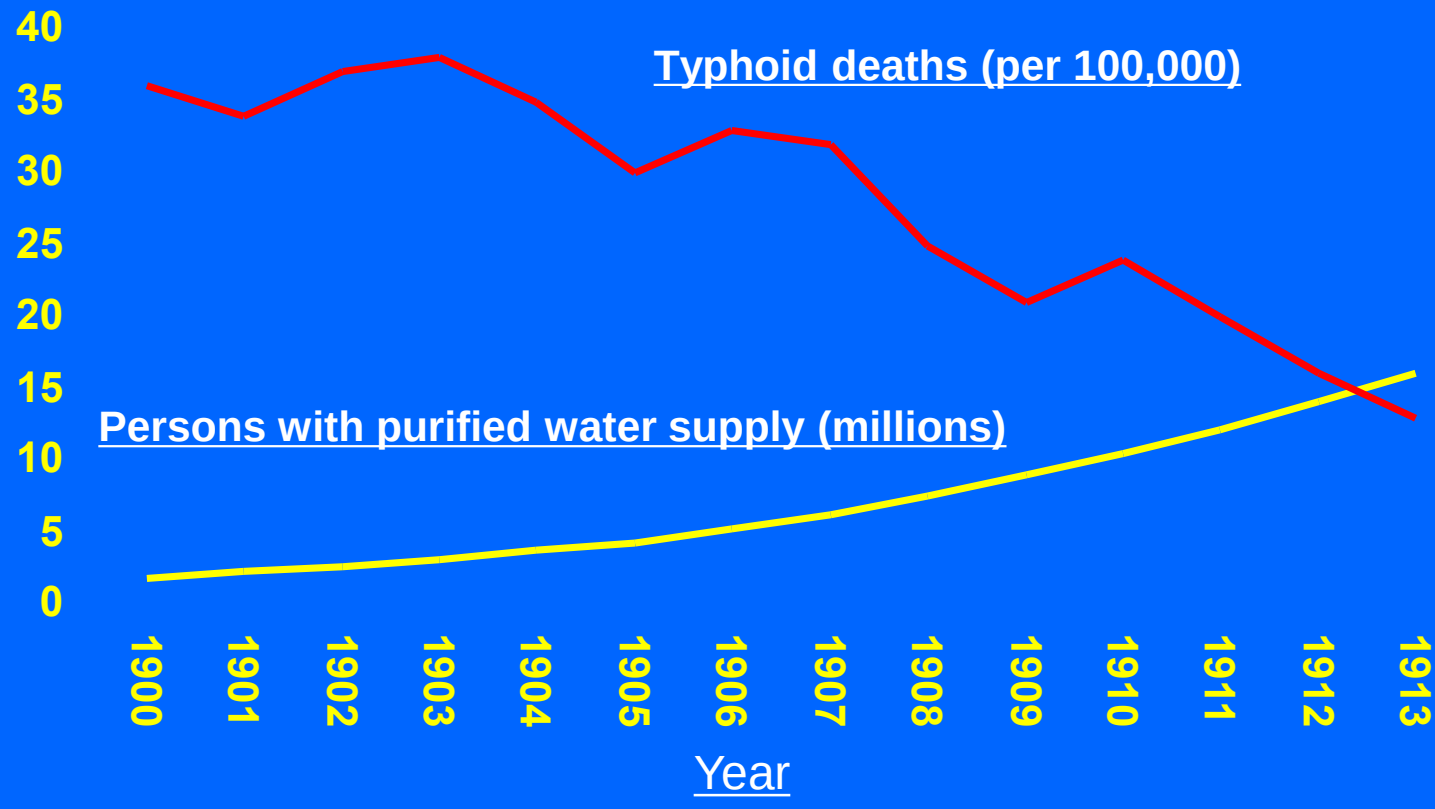
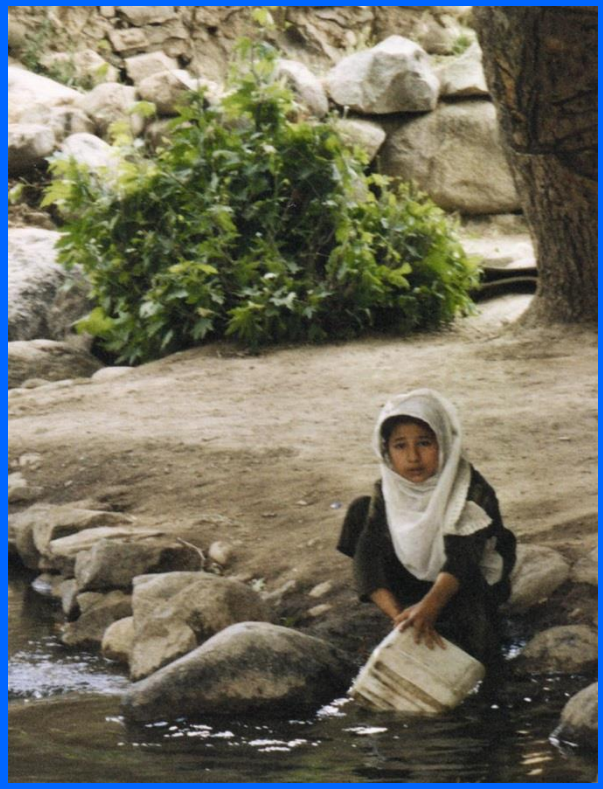
Growth of Water Purification and Decline in Typhoid Fever Deaths, United States Cities 1900-1913



Adapted from: Johnson GA. The typhoid toll. Journal of the American Water Works Association 1916; 3: 249-326

Health and Access to Safe Water in the Developing World

- Over 500,000 diarrhea deaths per year
- Over 660 million people lack access to “improved water supplies”
- At least 1.8 billion lack access to safe water
- “Improved” water supplies are not necessarily safe



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Household Connections Are Not Necessarily Safe

- Irregular treatment
- Inadequate maintenance
- Clandestine connections
- Power outages

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Community Water Supplies Are Not Necessarily Safe

- Contamination of ground water
- Recontamination of clean water through transport and storage

Barriers of Time and Effort: Daily Burdens

- Obtain food
- Collect water
- Buy or collect fuel
- Build fire
- Cook
- Care for children
- Wash clothes
- Clean house
- Care for livestock
- Tend garden crops
- Engage in economic activities

Barriers of Money: Daily Expenses

- Food
- Cooking supplies
- Water
- Fuel
- Cleaning supplies
- Seeds, fertilizer
- Transportation
- Clothing
- Medicine/health care
- School supplies
- Durable goods

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The Water People Want

- In the home
- Clean
- 24/7

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The Challenge of Providing Water Infrastructure

- Huge expense (China: $125 billion over 10 years)
- Time consuming
- Requires political stability/good governance
- Compromised distribution systems
- Maintenance/repair challenges
- The population at greatest need earns less than $2 per day
- Inadequate systems to collect money from population in need

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A Short to Medium Term Alternative: Household Water Treatment and Safe Storage (HWTS)

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Household Water Treatment and Safe Storage

Water treatment with dilute sodium hypochlorite

Safe water storage

Behavior change methods: social marketing and community mobilization

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Evidence Base

- Improve water quality in the laboratory
- Improve water quality in field settings*
- Prevent disease
  - 2006 Cochrane review**
    - Review of 33 reports
    - HWTS interventions reduce diarrhea risk by >30%
- Improve water quality and prevent disease at scale in a “real world” setting

*Wright J, et al; TMIH 2004; Vol 9: p. 106-17

Clasen T, et al. BMJ 2007; doi:10.1136/bmj**.39118.489931.BE

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HWTS Field Trials

Reduces diarrhea risk by 25-85%

Bolivia*	**1994**	**44% overall; 53% in infants**
Uzbekistan*	**1996**	**85% overall**
Zambia*	**1998**	**48% overall**
Guatemala*	**2001**	**25% overall**
Madagascar*	**2001**	**90% against cholera**
Kenya*	**2001**	**55% in children <5 years old**
Madagascar*	**2002**	**63% overall**
Pakistan*	**2002**	**73% overall**
Uganda*	**2003**	**25% in HIV-infected persons**

*publication available

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Proven Technologies: Chemicals

- Chlorine solution
- Flocculent-disinfectant
- Aquatabs
- Chlorine dispensers

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Proven Technologies: Filters

- Biosand
- LifeStraw Family
- Silver impregnated ceramic pot, situated in nested buckets with a tap

Proven Technologies: UV Light

Proven Technologies: Boiling

Unproven Technologies Abound

- Unproven technology = insufficient evidence for effectiveness and feasibility
- Many examples of unproven technologies
  - Chemical ($AgNO^2$, halogen beads)
  - Filters (hollow fiber)
  - Community systems (reverse osmosis)
- Innovation is necessary and good, but testing is essential

Estimated Scale of HWTS

- Based on JMP surveys from 67 countries (1.1 billion people)*
- Reported HWTS use by 33% (18% in Africa)
  - Boiling: 21% (4.5% in Africa)
  - Chlorine: 6%
  - Filtration: 4%
  - Solar disinfection: 0.2%
- Direct observation
  - E. coli detection in water reported to be boiled: 40-60%
  - Chlorine residual detection in water reported to be chlorinated: 5-30%

Rosa, et al. Am. J. Trop. Med. Hyg., 82(2), 2010, pp. 289–300

Why Don't People Treat Their Water?

- Hardware (ie, technology) problems
  - Poor match with population
  - Performance problems
  - Inadequate attention to maintenance and repair
  - Short lifespan
- Software problems
  - Insufficient training of implementers and target populations
  - Inadequate attention to behavior change process

Why Don't People Treat Their Water?

- Barriers
  - Cost
  - Lack of time
  - Inconvenient
  - Taste/smell issues
  - Too complicated
- Low demand
  - Lack of awareness of need for treatment
  - Belief that water doesn't need treatment
  - Ingrained practices/habits

Why Do People Adopt Interventions? Lessons from Diffusion Research

- Relative advantage
- Compatibility
- Triability or testability
- Potential for reinvention
- Observed effects

Rodgers, *Diffusion of Innovations*

Social Entrepreneurs/ Community Health Promoters

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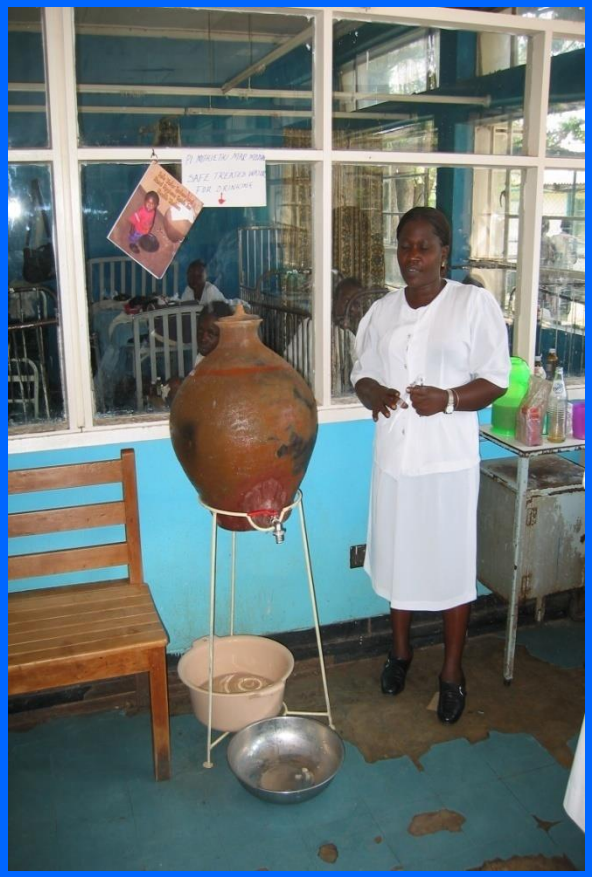
HWTS Integration in Schools

HWTS Integration in Health Facilities



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HWTS Integration with Antenatal Services

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"Consumer" Choice: An Evaluation of Technology Preferences

- Location: rural western Kenya
- Population: random sample of 400 households
- Technologies:
  - "WaterGuard" chlorine solution + improved container

  - "PUR" flocculent-disinfectant sachets, 2 buckets, cloth

  - Silver-impregnated ceramic pot

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Study Design

- Baseline survey
  - Technology preferences
- Randomized into 3 groups
  - Each group randomly assigned one of 3 technologies
  - Used technology for 2 months
  - Technologies switched every two months
  - Each group each of 3 technologies x 2 months
  - Water quality tested for each technology in each household
- End of study: each participant chose technology they preferred

Outcomes Measured for Each Technology

- Reported use
- Microbiological performance
- Reported technology preferences
  - Baseline
  - End of study
- Technologies chosen by participants at end of study

Technology Use

Technology	Reported use
WaterGuard	76%
PUR*	62%
Ceramic pot	73%

*p<0.05 compared to WaterGuard

Technology Performance: Undetectable E. coli in Treated Water

Technology	Improved water supply	Unimproved water supply
WaterGuard	53%	66%
PUR*	34%	54%
Ceramic pot*	43%	51%

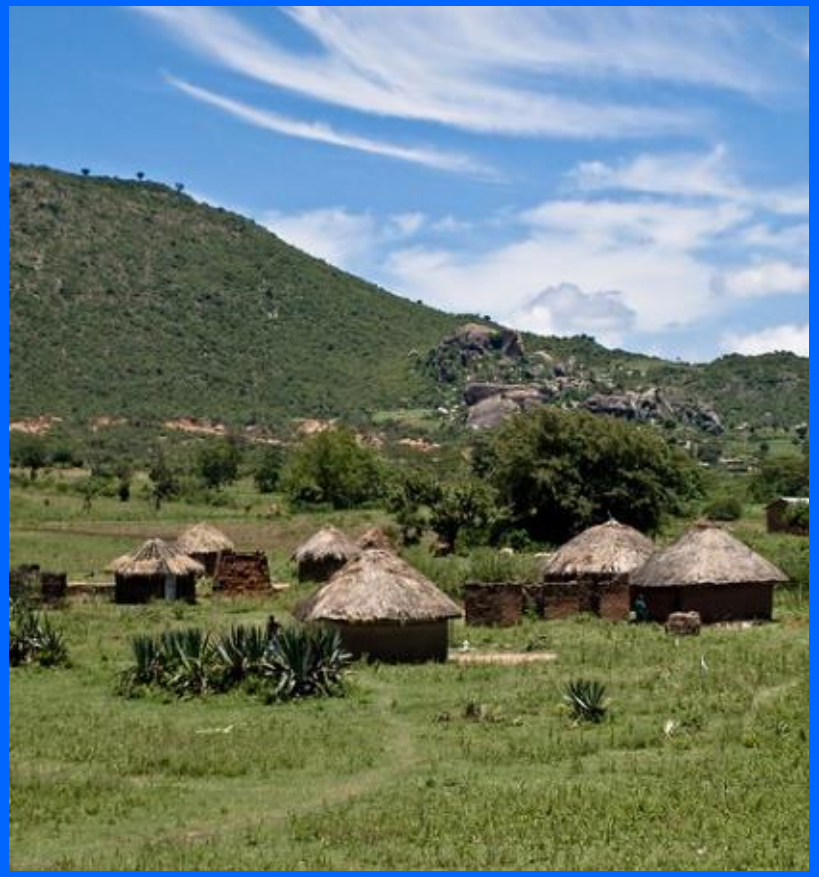
*p<.05 compared to WaterGuard

Technology Preferences

	Baseline prefer	Exit prefer	Exit choose*
WaterGuard	35%	21%	14%
PUR	18%	35%	40%
Ceramic pot	47%	44%	44%

*2% preferred soap to any technology

Western Alaska vs. Western Kenya



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A Brief Comparison

Western Alaska

- Rural and remote
- Small populations
- Economy: service and subsistence
- Poverty rates: high
- Cost of living: high
- Few roads
- Expensive electricity
- Health services: good

Western Kenya

- Mostly rural
- Large populations
- Economy: informal and subsistence
- Poverty rates: high
- Cost of living: high
- Few roads
- Little or no electricity
- Health services: poor

A Brief Comparison

Western Alaska

- Water:
  - Accessible
  - Surface sources
  - Transport and store in home
- Maintenance challenges:
  - Cold climate
  - Climate change
- Cultural links to water
- Access to financing (government, other?)

Western Kenya

- Water:
  - Scarce
  - Surface and ground
  - Transport and store in home
- Maintenance challenges:
  - Heat, dust, low water table
  - Climate change
- Cultural links to water
- Little access to financing (NGOs, development agencies)

Lessons

- Choose proven, field-tested technologies
  - Durability
  - Feasibility
  - Microbiologic effectiveness
  - Affordability
  - Sustained, consistent use
- Conduct formative research in target population
  - Current practices
  - Understanding of cultural ties to water
  - Understanding of need for water treatment
  - Technology preferences (ie, provide menu of options)

Lessons

- Community participation/ownership is vital
  - Demand for safe water supply
  - Consistent household use
  - Maintenance/repair
- Integration in health services and schools can help
- A realistic financing plan is necessary
  - Cost recovery is desirable
  - The poor may not be able to pay
  - Alternative financing strategies may be necessary
- Policy support is important
  - Local to regional to national

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Final Word

"The problems seem overwhelming. But these are all solvable problems. We just need a bigger and better response."

--William H. Foege, MD, MPH

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Thank You