

# **A conversation with Stephen Luby, December 18, 2020**

## **Participants**

- Dr. Stephen Luby – Professor of Medicine - Infectious Diseases, Stanford University
- Stephan Guyenet – Senior Researcher, GiveWell

**Note:** These notes were compiled by GiveWell and give an overview of the major points made by Dr. Luby.

## **Summary**

GiveWell spoke with Dr. Luby of Stanford University as part of its investigation into water chlorination interventions. Conversation topics included the relationships between water quality, diarrhea morbidity, and mortality; data reliability; diarrhea mortality in older children and adults; and the chlorine levels used in a study on in-line water chlorination.

## **Relationships between water quality, diarrhea morbidity, and mortality**

Water contaminated by fecal matter often contains enteric (intestinal) pathogens that can cause diarrheal disease when ingested. This is called the fecal-oral transmission pathway. Diarrheal disease is a significant cause of mortality among young children (and possibly older children and adults) in many low- and middle-income countries (LMICs). However, some data suggest that the relationships between water quality and diarrhea mortality, and between diarrhea morbidity and all-cause mortality, are not straightforward.

## **Limited global progress on water quality and hygiene**

One strategy for interrupting the fecal-oral pathway for diarrheal disease has been to promote water, sanitation, and hygiene (WASH) interventions, which include improving water quality and promoting personal hygiene behaviors.

Over the past thirty years, limited progress has been made on improving water quality in LMICs globally. Municipal water supplies in LMICs are often run intermittently, rather than continuously, which increases the risk of contamination. Analyses of global water quality have estimated that roughly 60% of drinking water contains fecal indicator bacteria (intestinal bacteria that signal the presence of fecal contamination). There has also been limited progress in promoting personal hygiene behaviors in LMICs, as many communities lack the necessary resources, such as hygiene facilities and soap.

However, over the same thirty-year period, diarrhea-specific mortality declined by about 90% globally. The large decline in diarrhea mortality, despite limited progress with WASH interventions, suggests that water quality improvement and diarrhea

mortality are not tightly linked, and that we may not fully understand the mechanisms of diarrhea mortality reduction.

### **Relationship between diarrhea morbidity and all-cause mortality**

Changes in diarrhea morbidity are unlikely to be a good proxy for changes in all-cause mortality. All-cause mortality reductions from water quality interventions may exceed the level predicted from the reduction in diarrhea morbidity. This is what some econometric studies of historical water quality improvements have reported. These studies have also reported reductions in mortality from non-waterborne causes.

#### *Comorbidities*

Diarrheal deaths tend to occur in children with additional risk factors, such as poverty, malnutrition, and respiratory disease. Some research suggests that diarrhea can increase the risk of contracting respiratory diseases. Therefore, it's possible that preventing diarrheal disease could also reduce deaths attributed to other causes, such that water quality interventions would have a larger effect on all-cause mortality than predicted from their impact on diarrhea morbidity.

#### *Non-diarrheal pathogens*

Water contaminated by fecal matter can also contain pathogens like *Salmonella typhi* and *Salmonella paratyphi*, both of which can cause typhoid fever, as well as the Hepatitis A and Hepatitis E viruses. Ingesting these pathogens can lead to deadly disease without causing diarrhea, such that water quality improvements could have a disproportionate effect on all-cause mortality by preventing deaths from non-diarrheal waterborne diseases in addition to diarrheal deaths.

#### *Mild versus severe cases*

It's possible that water quality interventions disproportionately reduce severe cases of diarrheal disease. If this were the case, a relatively modest reduction in overall diarrhea morbidity could be associated with a much larger reduction in diarrhea mortality, because severe cases are more likely to be fatal than mild ones.

One way to examine this hypothesis would be to assess whether infectious dose (the quantity of diarrhea-causing pathogens ingested) affects the severity of diarrheal disease. For example, some studies of foodborne disease outbreaks have collected data on the quantity of contaminated food consumed by participants, as well as the severity of their symptoms. Correlations found by such studies could be suggestive evidence that reducing infectious dose is a mechanism by which water quality interventions disproportionately reduce severe cases of diarrhea.

### **Data reliability**

The significant decline observed in global diarrhea mortality data is unlikely to be the result of reporting bias, as verbal autopsy data tends to be reliable since it is relatively easy to determine whether diarrhea occurred leading up to a death. In

addition, all-cause mortality data is probably more reliable than self-reported diarrhea morbidity data, because whether or not a death occurred is more clear-cut and likely to be remembered than reporting specific symptoms.

### **Diarrhea mortality in older children and adults**

Academic studies typically focus exclusively on under-five deaths, such that there is an absence of data on diarrhea deaths for older children and adults. While Global Burden of Disease data suggests that the diarrhea mortality rate is lower for children aged five to fourteen than for children under five, it also suggests that diarrhea mortality among the five to fourteen age group remains substantial and could merit further study.

### **Chlorine levels in a study on in-line water chlorination**

[Pickering et al. 2019](#), a randomized controlled trial (for which Dr. Luby was a contributing author), tested a point-of-collection intervention in which automated chlorination devices were installed at water sources within low-income communities in Bangladesh. The chlorine devices used in the trial were set to dispense a level of chlorine that doesn't consistently meet World Health Organization (WHO) chlorination guidelines.

Researchers lowered the chlorine levels in order to increase uptake of the intervention, as people in Bangladesh are not accustomed to the taste of chlorine in their drinking water and tend to dislike the flavor. Despite the lowered chlorine levels, the study found substantial reductions in fecal indicator bacteria in water sources treated by the chlorination devices, suggesting that the benefits of increased uptake may outweigh any reduction in effectiveness caused by the lower chlorination levels.

Dr. Luby initially believed that the taste-sensitivity issue associated with water chlorination was unique to communities in Bangladesh, but now thinks the problem may be more widespread.

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