

Safely-Managed Hygiene: Insights from a Risk-Based Assessment of Handwashing Water Quality

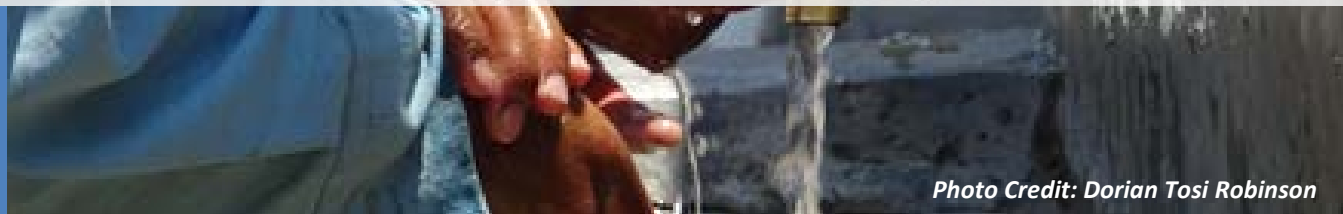


Photo Credit: Dorian Tosi Robinson

Understanding the impact of handwashing water quality on hand contamination and infection risk.

Sustainable Development Goal (SDG) Target 6.2 calls for “adequate and equitable sanitation and hygiene for all” by 2030. Under the SDGs, drinking water must be “free from contamination” to be “safely-managed,” but the core hygiene indicator does not specify requirements for handwashing water quality, and there is no “safely-managed” category for hygiene in the SDGs. The effectiveness of handwashing is likely influenced by the microbial quality of water used. Contaminated water is a likely *source* of pathogens to hands. The incorporation of risk-based water quality guidelines offers an opportunity to define “safely-managed” hygiene for the SDGs.

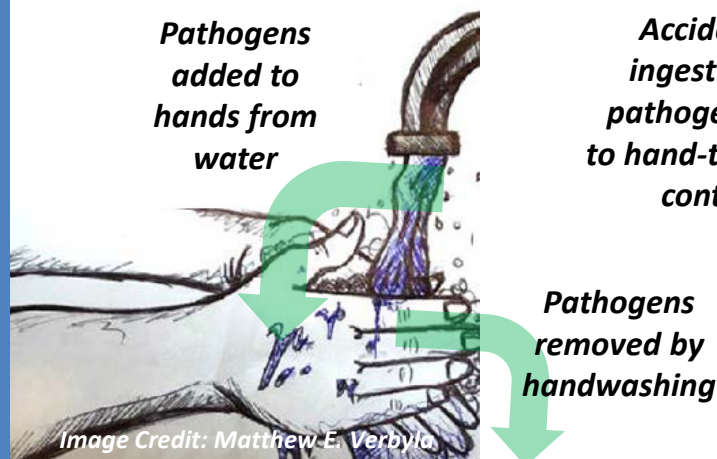
The aim of this study was to model the impact of microbial water quality on hand contamination and infection probabilities to inform risk-based guidelines for handwashing water quality.

Summary

Bayesian inference was used within a risk assessment framework to evaluate two scenarios where poor handwashing water quality would cause handwashing to fail as an effective health intervention.

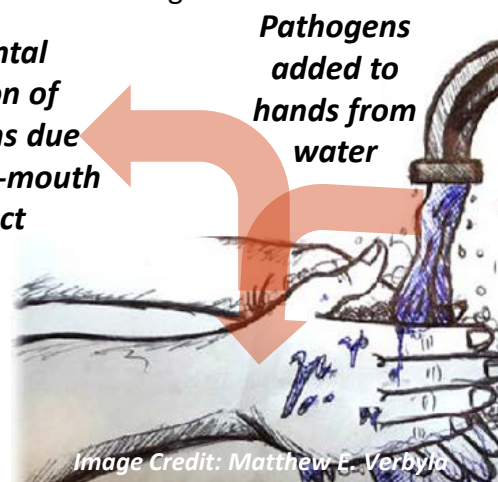
The Microbial Transfer Model

predicts the impact of fecal microorganisms in handwashing water on the net change in their concentrations (removal or increase) on a person’s hands after handwashing.



The Microbial Risk Model

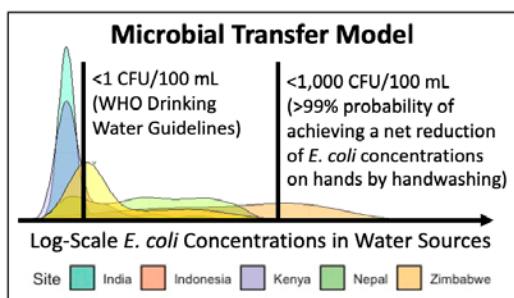
proposes maximum concentrations for the pathogens in handwashing water, based on acceptable annual infection risks caused by hand-to-mouth contacts after handwashing.



Key Findings

Microbial Transfer Model

The microbial transfer model predicted that handwashing water with less than 1000 CFU *E. coli* per 100 mL would reduce *E. coli* concentrations on hands with a high probability (>99.9%). This suggests that handwashing with non-potable water will generally provide net benefits by reducing fecal contamination on hands, unless the water is grossly contaminated. Household water sources in many countries already meet this threshold of <1000 CFU/100 mL (see below).



Microbial Risk Model

The microbial risk model suggested that, for people without any pathogens on their hands prior to hand-washing, pathogen concentrations in handwashing water must be very low (4×10^{-4} gene copies, 2×10^{-3} CFU, and 9×10^{-6} oocysts per 100 mL, respectively, for norovirus, enterotoxigenic *E. coli*, and *Cryptosporidium*) to keep risks below a 1 in 1000 annual probability of infection due to hand-to-mouth contacts after handwashing.

Policy Implications

- For some people, handwashing with non-potable water provides net benefits.** Handwashing will generally reduce microbial contamination on hands, unless (a) hands are uncontaminated by pathogens or (b) water is grossly contaminated by fecal microorganisms (our model suggests >1000 *E. coli* per 100 mL). Many household water sources have <1000 *E. coli* per 100 mL, but for households that do not meet this threshold, *handwashing interventions should address water quality to improve efficacy.*
- For other people, the chance of infection from handwashing with non-potable water may be above acceptable risk levels.** People who do not have pathogens on their hands before handwashing might experience an increased risk of infection if they wash hands with non-potable water. While handwashing water with <1000 *E. coli* per 100 mL might be an appropriate interim threshold for some communities with high existing disease burdens, the ultimate goal for handwashing water should be that it is free from fecal contamination.
- Complementary strategies may be needed in areas with a high burden of disease.** Hand contamination is understudied, yet it is an important driver of handwashing efficacy. Handwashing alone (even with potable water) will not reduce annual infection risks in areas where background pathogen contamination on hands (before handwashing) is very high.
- A safely-managed hygiene category could include handwashing water quality guidelines.** The designation of a category for safely-managed hygiene accompanied by water quality guidelines offers an opportunity to improve handwashing health benefits similar to the improvements achieved with drinking water and sanitation services within the SDGs.

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This policy brief summarizes the policy implications discussed in greater detail in the following publication:

Verbyla M.E., Pitol A.K., Navab-Daneshmand T., Marks S.J., Julian T.R. (2019). Safely-managed hygiene: A risk-based assessment of handwashing water quality. *Environmental Science and Technology*. <http://dx.doi.org/10.1021/acs.est.8b06156>

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