Small Water Supplies under the Microscope: Infrastructure Sustainability, Water Quality, and Health

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Background. Access to piped water supply is rapidly expanding globally, with small systems representing the majority of new access. Small supplies therefore play an important role in protecting public health. These systems are, however, at risk for microbiological contamination and have been implicated in a disproportionate number of disease outbreaks, particularly in under-resourced settings. This presentation provides a brief overview of microbial water quality, system operational parameters, and health risks across systems in four very different places: Vietnam, Alabama (rural USA), Cambodia, and India, revealing both particular and generalizable challenges facing rural infrastructure.

Methods. In Vietnam, we measured microbial water quality, system operational parameters, and gastro-intestinal disease across 7 water supplies serving approximately 1500 people living on less than $2 per day, with the goal of comparing the safety and reliability of under-resourced piped systems to other available sources (e.g., nearby protected wells). In Alabama, we have conducted three studies of 14 water supplies to identify factors associated with increased microbiological contamination of drinking water at the point of consumption and to determine risk of gastrointestinal illness. In Cambodia, we studied two intermittent, peri-urban water supplies in a rapidly developing area to understand parameters affecting water quality and treatment choices. In India, we measured at-tap and stored water quality in seven rural supplies, while piloting a low-cost method for water quality monitoring.

Results. In Vietnam, we found that households connected to even poorly performing piped water supplies had consistently improved drinking water quality and experienced less gastro-intestinal illness than households without a connection, despite documented operational challenges and the availability of high quality wells to unconnected households. In Alabama, we found a significant increase in gastrointestinal disease risk among individuals reporting intermittent service or other service problems, and higher than expected microbial contamination. In Cambodia, we identified that frequent and seasonal source-switching as practiced by households was a persistent challenge to water safety. In India, we demonstrated that crowdsourcing methods for monitoring water supplies holds great promise as a critical feedback mechanism that can help ensure water safety where routine monitoring is inadequate.

Conclusions. Similar and distinct operational challenges impact drinking water quality and health in the context of rural water supplies in different settings. Aging infrastructure, service expansion in rural and urbanizing areas, and resource-limited settings are associated with system vulnerabilities with measurable and actionable public health implications. We review research priorities, emerging methodological tools, and

proposed solutions that may be useful in addressing microbial safety risks that may accompany small water supplies.