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Constraints to microbial water quality testing

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Microbial water quality testing is critical for the provision of safe drinking water, yet microbial testing activity is limited in much of the developing world. This briefing note provides insight into the status of microbial testing programs in developing countries and introduces the Monitoring for Safe Water Program, a study that will examine constraints to microbial water quality testing faced by water suppliers and surveillance agencies in sub-Saharan Africa.

Microbial water quality testing is critical for public health

Contaminated drinking water is a primary route of exposure to fecal pathogens and is a leading cause of diarrheal disease. Consequently, accurate data on microbial water quality is essential for guiding activities such as water system management and public health campaigns. Water quality data is also important for evaluating the effects of water, sanitation and hygiene interventions.

In order to ensure the delivery of safe drinking water to consumers, the World Health Organization's (WHO) Guidelines for Drinking Water Quality recommend two complementary monitoring activities: 1) operational monitoring (or water quality control) by water suppliers; and 2) surveillance (or compliance) monitoring by an independent agency (WHO 2011). National regulatory agencies generally base their monitoring standards on these WHO guidelines, which not only recommend a combination of operational and surveillance monitoring, but also emphasize the health risks associated with microbial contamination.

Constraints to microbial testing

Despite the recognition of its importance for public health, microbial water quality testing is limited in many middle and low income countries (Rahman *et. al.* 2011; Steynberg 2002). In our previous research, we evaluated institutional frameworks in nine countries spanning South America, Asia and Africa. We found that national guidelines in all study countries mandate operational monitoring by formal water suppliers and that national policies designate a surveillance agency in seven out of nine study countries (Rahman *et. al.* 2011). Despite these stated institutional mandates, microbial testing by water suppliers is limited outside of major urban centres and that surveillance agencies struggle to test all supplies in their jurisdiction (Rahman *et. al.* 2011).

A number of factors appear to contribute to low compliance with mandates for microbial testing. The following observations are based on findings from field pilots of a new microbial testing kit with relevant water sector actors in a range of developing country settings (Rahman. *et. al.* 2010, Rahman *et. al.* In Preparation). First, microbial water quality testing is inherently complex and standard microbial testing techniques require a dedicated laboratory space, expensive equipment and trained technicians. As a result, few institutions are able to maintain full microbial testing laboratories. For example, surveillance agencies generally only establish laboratory infrastructure in regional offices, which are meant to cover large geographic areas. These regional offices rarely commit adequate resources to sample collection and transport.

As a result of the challenges of maintaining full microbiological laboratories, both suppliers and surveillance agencies commonly adopt portable microbial testing kits for use by decentralization field staff.

Such decentralization of testing appears to offer great potential for increasing testing and expanding geographic reach. However, decentralization requires significant management support and will only be effective if frameworks are in place for proper training to ensure quality control, if supply chains for re-supply of necessary consumables and reagents are strong, and if testing is formally incorporated into staff responsibilities (Rahman *et. al.* In Preparation). These supporting frameworks appear weak in many developing countries, likely due to low prioritization and a lack of regulatory pressure to fulfil testing responsibilities.

Overall, both centralized testing at full laboratories and decentralized testing with portable field kits present significant logistical and managerial challenges. These genuine challenges are compounded by weak regulatory pressure and competing priorities, resulting in poor performance of testing programs in developing nations (Rahman *et. al.* In Preparation).

Monitoring for safe water: identifying microbial testing constraints

In order to further explore constraints to microbial water quality testing, the Aquaya institute has launched the Monitoring for Safe Water program (MfSW), which builds on the Aquaya Institute's previous research on institutional frameworks and the potential for new technologies to support expanded microbial water quality testing (Rahman *et. al.* 2010, Rahman *et. al.* 2011).

The Monitoring for Safe Water program seeks to characterize current water quality testing activity in sub-Saharan Africa, to identify and rank factors that limit current testing, and to identify successful strategies for overcoming common constraints. We will do this by partnering with 30 - 40 individual institutions across five countries and attempting to motivate increased testing through a combination of capacity-building grants and outcome-based reward payments. In order to evaluate constraints in a range of contexts, we will select institutions that represent variation with respect to characteristics such as population served, sophistication of their existing water quality testing program, and institutional structure (for example, in some countries a single national provider oversees water provision in all major towns whereas in others individual public or private companies are licensed to manage individual water supplies). By evaluating constraints faced by a range of relevant institutions, including both public and private entities, we will assess needs and requirements for the multiple factors that influence microbial water testing: appropriate diagnostic technologies, regulations, resource allocations, technical capacity, laboratory infrastructure, and management practices.

Incentives to increase testing

To launch the Monitoring for Safe Water program we invited institutions that play an active role in water quality testing in twelve countries, but which struggle to meet testing targets, to formally apply to the program. Selected institutions will receive financial incentives (a combination of capacity building grants, per-test-payments, and performance bonuses) to increase their microbial testing activity up to specified targets. Actual targets will be based on national regulatory requirements and local perceptions of best testing practices. For institutions with limited existing capacity for microbial testing, the capacity building grants will support procurement of testing equipment, staff training, technical support for data management and other inputs that will aid in improved microbial testing.

Beyond motivating increased test numbers, the program will assess and support improvements in additional aspects of water quality testing programs. For example, we will incentivize the use of risk based sampling plans that comprehensively cover a water suppliers' network. Similarly, we will support surveillance agencies to increase testing in hard-to-reach areas of their jurisdiction. The program will also support improvements in quality assurance procedures and the development of effective information management systems.

We seek to obtain raw data from microbial testing programs and to conduct thorough, collaborative needs assessments to understand constraints. By comparing historic microbial water testing data from program partners with the WHO testing targets and with national and/or institutional testing targets, we are able to establish goals for improvement. We will document each institution's perceived constraints and the inputs identified to resolve them. Over the course of approximately sixteen months we will observe if and how testing programs change with the input of resources. In cases where participants succeed in meeting testing targets with support from the program we will document and analyze how incentives and funding were used to overcome prior constraints. Conversely, where institutions fail to meet agreed upon testing targets we will examine what barriers they continue to face despite program inputs.

Preliminary results

Baseline testing capacity

Preliminary results from 65 program applicants suggest that WHO guidelines on microbial water quality testing numbers are met for approximately 39% (23/59) of the applicants, including 51% (19/37) of suppliers and 18% (4/22) of surveillance agencies [data still being gathered for six applicants]. This preliminary data confirms our initial premise that microbial testing levels are inadequate in much of Sub-Saharan Africa.

We also find that internal institutional testing targets generally exceed the WHO minimum guidelines in terms of number of tests conducted per year. Experts recognize the WHO minimum guidelines truly as a minimum; for example, these guidelines are orders of magnitude lower than, the regulatory requirement for testing established by the United States Environmental Protection Agency's Total Coliform Rule (US EPA 1989). For example, the WHO Guidelines suggest a minimum of 12 tests per year for a water supplier serving a population of 5,000 while the US EPA requires a minimum of 72 tests for the same supplier (WHO 2011; US EPA 1989). Through this program we will evaluate whether testing beyond the WHO minimum recommended guidelines improves water management and the safety of water supplies.

Data management and analysis

In order to develop an accurate picture of baseline water quality testing, we have requested water quality testing records for an entire year from program applicants. We have found that the majority of institutions, both suppliers and surveillance agencies, manually record test results in logbooks and only some transfer this information into electronic form. Even when data is digitized, it is often kept in individual files and not entered into databases where it could be analyzed for trends. These observations suggest that there is substantial room for improvement in the management and use of water quality data.

Summary

Despite widespread acknowledgement of the importance of microbial water quality for health, our research suggests technical, managerial and motivation constraints limit microbial testing in much of the developing world. Through the Monitoring for Safe Water program we will critically evaluate these and other constraints to microbial testing. In addition, this study will document the current state of monitoring in Sub-Saharan Africa and will evaluate the extent to which water utilities and surveillance agencies meet national and international standards for water quality testing. Lessons learned through the Monitoring for Safe Water program will provide insight into effective strategies for expanding microbial water quality testing and for maximizing the use of water quality data to inform water quality management.

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