

## OPINION

# Rapid water quality field tests: Data revolution or dead end?

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Two billion people lack access to safely managed drinking water, with poor water quality being the main barrier [1], the majority of which live in rural areas. One area of action has been to increase testing of water quality to increase data available to decision makers [2]. A key area of research is the development of novel tests to reduce the time and cost of testing to meet the sector's needs [3], making tests to measure pathogens [4], fluoride [5], arsenic [6] and more available to populations considered hard to reach. These rapid tests are variously targeted at community level, local government and monitoring progress against SDG6.1, and for surveillance of drinking water utilities both externally and by regulators [3]. Rapid tests for water quality that can be deployed in the field offer opportunities to expand access to data on water quality to managers and users, democratising access to information. However, the choice of end user will influence how the data generated will contribute to addressing the water safety challenge.

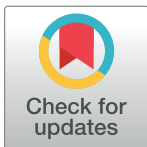
To date, large scale deployment of rapid water quality tests has been limited. A notable case is the use of arsenic test kits in Bangladesh's Multiple Indicator Cluster Surveys (MICS) where trained enumerators captured the data alongside household data collection [7]; data was only available at the national level and not made available to users and managers. The availability of rapid approaches to the identification of biological risk in drinking water can reduce the time to result to an hour or less; while a range of approaches to rapid biological detection are being tested in a number of field settings their use at scale is still to be adopted widely [8].

The devolution of COVID-19 testing to households using rapid antigen tests (RATs or lateral flow tests, LFTs) provides insights into the trade-offs associated with rapid field testing led by community members. COVID-19 RATs provide a natural experiment of how a shifting responsibility for testing, and thereby also data management, to the household changes the data available.

During the pandemic, antigen tests were critical in shifting how infection was quantified, and how risk and access to resources were triaged. In England, RATs were available from the 9<sup>th</sup> April 2021 for free to households [9], and it was the individual's statutory duty to register each test result. This shifted the way data was collected from swabs taken by the NHS (or contractors) for PCR tests, to swabs taken by end users. Two key learnings from this approach were:

## Bias in uptake

Uptake of free RATs was inequitable, with lower uptake by poor and minority groups [10] attributed to how the risk was perceived, time and access barriers to getting the tests, and the impact of outcome e.g. needing to isolate with implications for income generation. Similar



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results were reported in the United States, with RAT use varying with age, education, wealth and race [11].

## Data attrition

By July 2021, the NHS estimated that for 435 million RATs dispatched to households in England, only 91 million results were reported and recorded, a response rate of only 21% [12]. Surveys with the public in 2021 reported 64% of respondents who had used a RAT in the past week reported their test results to the government; 16% didn't report to anyone [10]. By 2022, ONS reported almost two-fifths (37%) of respondents who took part in daily testing never reported their results, while just under half (45%) said they often or always reported their results [13].

To improve drinking water safety for rural communities, we need water quality data available to key decision makers at different levels (1) water managers to take action, (2) governments to prioritise financial and practical support, and (3) users to make informed choices. Increasing devolved testing without addressing data management will not lead to a proportional increase the data available across all these different levels to support effective decision making. Research demonstrates that user access to water quality test results does not necessarily lead to appropriate water safety behaviours, especially where other competing stressors are present [14], highlighting the importance of data availability for water managers and governments.

The experience with RATs suggests two key issues need to be managed:

- Firstly, bias in uptake, even of free tests, demonstrates the potential for a devolved approach to preference the less vulnerable. Advancing water quality for the poorest and most vulnerable needs consideration of perceived self-efficacy [14] and cognitive load [15]. For managers and prioritisation of resources, if 100 tests have been provided to a rural area, with 20 results returned of which five show a risk, what decisions can they make if they are unsure if 5% are at risk or 25% or more? In part this will depend on if it is an acute hazard—e.g. detection of *E. coli* where an immediate response is required—or detection of a chronic hazard such as fluoride for which a more strategic response might be appropriate. Further research would be needed on perceptions and reporting to understand how, why and when people report to interpret the data to prioritise risks.
- Secondly, there is huge potential for loss of data. For data that is available to managers and governments to inform how we track and manage water safety, the implications are that the true costs of the data are much higher than the cost of the test kit. These costs of producing usable data, either due to data loss or through programmes to enhance conversion of results to data, should be recognised as critical to providing useful costs for novel technologies.

Furthermore, there is potential for biases to develop in what is reported. If people are more motivated to report high risk cases, the data would be skewed to over-report risks. That helps inform action but likely does not provide the full picture for planning. In this, there is potential to learn from citizen science. Rapid tests would broadly not be considered citizen science because of the lack of collaboration between scientists and the public [16]. However, there are similarities in the issues of heterogeneous and non-random sampling, false absences, false detections, and spatial correlations in the data [17].

Rapid tests offer new opportunities to gather data to inform decision making in water safety. To maximise this potential we need to ensure that rapid test data does not become ephemeral, but are embedded in reporting systems that ensure data are available to managers and decision makers in a useful way. Reporting pathways within management institutions are

already complex [2]. Increasing data availability does not increase evidence-based decision making without adequately trained and resourced regulatory systems. To advance equitable water safety, development of rapid tests has to be based in interdisciplinary research that considers the context of how evidence informs decisions to address water safety risks.

## Author Contributions

**Conceptualization:** Katrina J. Charles, Esther Shaylor.

**Writing – original draft:** Katrina J. Charles.

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