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Target product profile for a rapid diagnostic test for **surveillance of cholera**

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Contents

Acknowledgements

The development of this target product profile (TPP) document was coordinated by FIND. The TPP development leadership team consisted of Jennifer Osborn (USA), Michael Messenger (UK), Wallace White (USA), Serafina Calarco (Switzerland) and Nadia Wauquier (WHO, Switzerland). The leadership team prepared the draft documents, facilitated TPP development group meetings and collated inputs from the TPP development group and the public throughout the TPP development process.

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Declarations of interest

All members of the TPP development group completed a declaration of interest (DoI) form, according to FIND processes, that was used to assess and manage any conflicts of interest. FIND staff also checked there were no sanctions against any of the external members and conducted Google, LinkedIn and PubMed searches to identify any additional conflicts of interest that had not been declared. Interests were assessed by a FIND panel including the TPP development group leadership team and a FINDDoI committee and the decision to allow an external member to participate was made on the basis of whether any conflicts were specific, personal and/or financially significant.

All members of the TPP Development group declared they had no and were not identified as having any interests that could conflict with the objectives of the TPPs.

Two potential members were identified through searches as having a significant conflict of interest that precluded their participation.

Two members were initially part of the development group but have not been listed due to their lack of participation in the TPP development process.

List of abbreviations

GTFCC	Global Task Force on Cholera Control
IFU	instructions for use
LMICs	low- and middle-income countries
PAMI	priority area for multisectoral intervention
PCR	polymerase chain reaction
RDT	rapid diagnostic test
RUO	research use only
TPP	target product profile
WHO	World Health Organization

INTRODUCTION

Cholera is a severe diarrhoeal disease caused by the bacterium *Vibrio cholerae*. It is a major threat to global public health, with an estimated 1.3 to 4 million cases and 21 000 to 143 000 deaths occurring annually (1). The average cholera case fatality ratio reported globally in 2021 was 1.9% (2.9% in Africa), substantially above the accepted targeted rate (< 1%) and the highest recorded in more than a decade (2). Approximately 10% of individuals with cholera will develop severe symptoms, including acute watery diarrhoea and vomiting; without treatment, death can occur within hours (3).

There is thus a considerable burden of cholera cases globally. In addition, the world has been facing an acute upsurge in the seventh cholera pandemic; this is characterized by the number, size and concurrence of multiple outbreaks, the spread to areas free of cholera for decades and alarmingly high mortality rates (4). The simultaneous progression of multiple cholera outbreaks is compounded in countries that are experiencing complex humanitarian crises while relying on fragile health systems. This situation is further aggravated by climate change. The cholera pandemic thus presents a challenge to outbreak response, and there is the risk of the infection spreading further to other countries. Based on these factors, the increasing number of cholera outbreaks and their geographic expansion, in addition to the lack of vaccines and other relevant healthcare resources, the World Health Organization (WHO) assesses the current risk due to cholera globally to be very high (4).

Cholera disproportionally impacts the poorest and most vulnerable populations. Areas with poor sanitation, limited access to safe drinking water and deficient hygiene practices are at high risk for cholera transmission (3). In addition, limited access to healthcare facilities and inadequate treatment of cases are factors associated with a high level of cholera-related mortality.

The Global Task Force on Cholera Control (GTFCC) (5) and WHO continue to work with partners, including Gavi (6), at the global, regional and country levels. This work involves supporting member states in their efforts to control cholera. It comprises a long-term, multisectoral approach that integrates various interventions, including improved sanitation infrastructure, surveillance, and the introduction of oral cholera vaccine as an outbreak response and for preventive vaccination campaigns.

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Recommendations for enhanced surveillance of cholera

Ending Cholera—A Global Roadmap to 2030 (5) (hereafter referred to as "the roadmap") was launched by GTFCC in October 2017. The roadmap targets a 90% reduction in cholera deaths overall and elimination of cholera transmission in 20 countries by 2030. In 2018, the roadmap was recognized by the 21st World Health Assembly and adopted by the WHO Regional Committee for Africa.

The strategy calls on countries and partners to focus on cholera "hotspots" or priority areas for multisectoral intervention (PAMIs). These are relatively small areas that are most heavily affected by cholera; they experience cases on an ongoing or seasonal basis and play a major role in the spread of cholera to other areas.

THE ROADMAP IS BASED ON THREE STRATEGIC AXES:

1. **EARLY DETECTION** and **QUICK RESPONSE** to rapidly contain outbreaks of cholera.
2. **IMPLEMENTATION OF A MULTISECTORAL APPROACH** targeted at high-risk areas. This includes the delivery of oral cholera vaccines; basic water, sanitation and hygiene (WASH) services; epidemiology and laboratory services; case management; and community engagement.
3. **EFFECTIVE COORDINATION** of technical support, **RESOURCE MOBILIZATION**, and **PARTNERSHIP** at local and global levels.

All three strategic axes of the roadmap are heavily dependent on the availability of reliable, accurate and high-quality epidemiological and laboratory surveillance data. Such data are necessary to detect, confirm and rapidly respond to cholera outbreaks; identify high-risk areas; monitor progress; assess (and adapt) prevention and control strategies; and substantiate the absence of cholera. The rapid identification of cholera PAMIs, based on existing surveillance data, is essential to tailor the correct combination of interventions that are best adapted to each context and population.

The objective of cholera surveillance and control strategies has long been limited to responding to and mitigating major epidemics. As a result, cholera surveillance has mainly relied on the reporting of clinically suspected cases and deaths, with no or limited laboratory confirmation. Therefore, the currently available cholera surveillance data are not sufficiently reliable to adequately support the objectives of the roadmap or to identify PAMIs across and within countries. Not all actual cases of cholera are reported; conversely, not all clinically suspected cholera cases are true cases, as the clinical signs of cholera are also commonly seen with other frequently occurring diarrhoeal diseases.

In February 2023, GTFCC published updated recommendations for strengthening public health surveillance for cholera, with the aim of having better informed, more timely and appropriately targeted multisectoral interventions (7). The guidance states that laboratory testing should rely on testing strategies adapted to the prevailing cholera situation at the surveillance unit level (i.e. the presence or absence of a confirmed cholera outbreak) and to available resources; expanded use of rapid diagnostic tests (RDTs) to support the early detection of suspected outbreaks and incidence monitoring; and increased capacities for laboratory confirmation of cholera cases. Testing of suspected cholera cases should be routinely undertaken in accordance with systematic testing schemes, and again the use of RDTs should be expanded.

Current state of play of cholera RDTs

RDTs are primarily intended to be used at the primary healthcare level for surveillance purposes. They may be used as a tool for triaging samples before possible further testing in laboratories; to speed up outbreak detection in surveillance units where a cholera outbreak has yet to be confirmed; and to help monitor incidence trends of actual cholera cases in surveillance units with a confirmed cholera outbreak, through systematic testing of a representative proportion of suspected cases (7).

Although there are cholera RDTs on the market, most are designated for research use only (RUO), and a few are self-declared CE-marked in vitro diagnostic (IVD) devices; none have been prequalified by WHO. While the performances of most of these cholera RDTs have been evaluated and the results published in the scientific literature, these studies have used a variety of non-standardized approaches, meaning they are often difficult to compare. In the absence of a prequalified product, WHO and UNICEF have procured cholera RDTs (8) for use in outbreaks, based on their own selection protocols and reviews of these products. To improve the quality and availability of laboratory data for cholera and ultimately reach the targets set out in the roadmap, there is an urgent need for easy-for-use, fit-for-purpose, well-performing and validated diagnostic tests.

The role of target product profiles

Target product profiles (TPPs) are strategic planning tools for guiding the development of new diagnostic tests and other healthcare products. The primary audiences for TPPs are manufacturers, suppliers and researchers developing new assays. A TPP outlines the key performance and operational characteristics that a product should possess to meet the needs of its intended users, target population and public health programmes, in their intended settings of use. For each characteristic, a TPP states a preferred criterion that is to be achieved by product developers if feasible and a minimal criterion if the preferred criterion is not feasible.

Since 2017, GTFCC has focused on encouraging the availability and use of RDTs, developing the TPP for cholera RDTs first published in 2017 (9) and related WHO prequalification standards (10). However, since 2017, GTFCC has agreed to modify some of the previously agreed upon minimal characteristics that were deemed too stringent, thus there is a need to update the TPP accordingly. The TPP for a cholera RDT described in this document is informed by the previously developed TPP, but here we incorporate advances in the field and the most recently updated GTFCC guidelines (7). Importantly, this document has two intended goals to support cholera surveillance, relating to the minimal and the preferred criteria.

The goal of the minimal test criterion addresses the use of RDTs for detecting outbreak alerts and monitoring ongoing outbreaks, in accordance with current GTFCC guidelines, which require identification of at least *V. cholerae* O1 with performance requirements that are likely attainable based on what is known for currently available best-in-class commercial tests (7). It is assumed that the detection of *V. cholerae* O139 is less important due to the absence of O139 outbreaks over the past decade; in fact, false-positive O139 test results have become a challenge for both countries and surveillance units. Therefore, detection of O139 is only included in the preferred criterion for assay targets.

A test that meets the preferred test goal, although potentially challenging to achieve, would have the potential to supplant the current requirement for case confirmation by polymerase chain reaction (PCR) or culture through addressing the preferred criteria of additional assay targets (O139 and cholera toxin) and improved sensitivity and specificity similar to that of PCR or culture. Having an ambitious preferred test goal serves to drive innovations that would substantially improve cholera response efforts, by enabling faster and less costly cholera outbreak confirmation through the decentralization of case confirmation and removing the costs of sample transport and complex laboratory testing to confirm an outbreak. If an RDT can meet these preferred criteria at the prices described in this TPP, it would be more attractive to those programmes and procurement agencies supporting cholera responses compared with a test that only satisfies the minimal criteria. The window is currently open for manufacturers with cholera RDTs that meet the TPP to submit expressions of interest to WHO for assessment of their products for prequalification.

METHODS

This TPP was developed largely according to standard WHO procedure (11), adapted as follows.

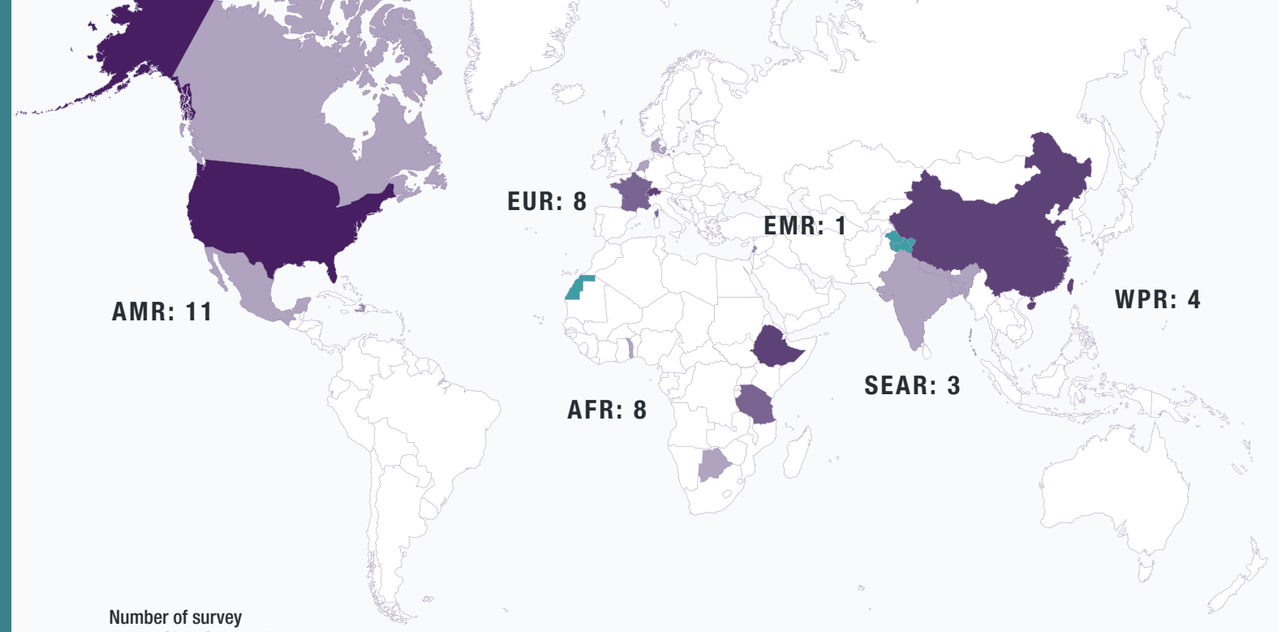
The authors confirmed that the previous TPP needed to be updated. An initial draft was developed, considering the previous TPP, similar TPPs, clinical and scientific literature and unmet clinical needs. Research, including a literature review, was conducted by the FIND staff listed in the Acknowledgements.

The authors established a TPP development group of 13 individuals, comprising scientists, experts, public health officials and representatives of intended users, who were selected according to the standard WHO procedure, with due attention paid to geographical and gender representation. The first meeting of the TPP development group involved discussions about the process and to establish the core characteristics of the TPP.

In September 2023 the development group members received a draft of the TPP and were asked to complete a Delphi-like online survey to establish their level of agreement on each minimal and preferred characteristic criterion in the TPP. Their agreement rating was determined using a 4-point Likert-type scale: 1, fully disagree; 2, mostly disagree; 3, mostly agree; 4, fully agree; members could also mark “No opinion”. Comments were requested on all items and were required when members indicated that they did not agree (Likert score 1 or 2). Of the 18 TPP development group members, 11 (61%) completed the survey. The levels of agreement (the count of responses of Likert score 3 or 4 divided by all Likert responses for a particular item), while not judged against a consensus threshold at this stage, were generally high, averaging 95%, but were substantially lower for the minimal criteria of external controls (73%) and target list price per test (64%). All the comments received were compiled and reviewed by the authors, and the TPP was jointly revised to address criticisms, incorporate suggestions and avoid misunderstandings of intent. Subsequent meetings of the TPP development group were organized to review the development group survey results and agree upon the changes proposed to the TPP.

In December 2023 a public consultation was conducted. The same format as for the development group survey was used, with the additional requirement for consensus that ≥ 75% agreement of more than five non-abstaining responses was required for each minimal and preferred criterion. Any criterion that failed to reach consensus after two rounds of Delphi survey was, at the discretion of the development group, excluded or subject to caveats, with a summary of outstanding issues; the percentage agreement, including the number of respondents; and any recommendations for further research. In the first Delphi round, 29 complete responses and 6 partial responses were received, with generally high agreement, averaging 95% and ≥ 83% (**Fig. 1** and **Fig. 2**). Consensus having been achieved, a second Delphi survey was deemed unnecessary by the development group. The TPP development group reviewed the results of the survey, with minor clarifications and edits made, to produce the finalized TPP contained in this document.

Fig. 1. The 35 respondents to the public consultation, by WHO region and country



AFR, region of Africa; AMR, region of the Americas; EMR, region of the Eastern Mediterranean; EUR, region of Europe; SEAR, region of South-East Asia; WPR, region of Western Pacific

Figure 2. Distributions of Likert scores in the public consultation

SECTION	CHARACTERISTIC	AGREEMENT: MINIMAL	AGREEMENT: PREFERRED	RESPONSE COUNT
		100% 75% 50% 25% 0%	100% 75% 50% 25% 0%	
General	Goal of the test	100%	91%	33 2
	Target population	97%	93%	27 6
	Target use setting	97%	85%	27 4
	Assay targets	100%	93%	28 3
	Test format	93%	93%	28 2
	Result display and interpretation	100%	96%	25 5
User	Target users	93%	93%	28 2
	User training	100%	92%	26 3
	Specimen type	92%	92%	25 4
Performance	Clinical sensitivity[1]	100%	100%	25 4
	Clinical specificity[1]	88%	92%	26 3
	Limit of detection	100%	100%	13 16
	Analytical specificity and assay interference	100%	96%	24 5
	Test failure (invalid) rate	92%	96%	25 4
	Specimen volume	96%	95%	22 7
Test procedure	Specimen preparation	96%	96%	26 3
	Ease of use	100%	100%	26 3
	Language support	96%	96%	27 2
	Time to result[1]	92%	96%	26 3
	Stability of valid result	100%	96%	26 3
	Internal controls	100%	95%	22 7
	External controls	88%	96%	24 5
Operational	Test kit stability and operational conditions	85%	88%	26 3
	Shipping and transport conditions	96%	100%	23 6
	Open test kit stability[1]	100%	96%	23 6
	Biosafety	100%	100%	21 8
	Waste disposal	92%	92%	24 5
Pricing and market access	Target list price per test[1]	83%	92%	23 6
	Quality management system	100%	100%	16 13
	Lead time for lot production	96%	96%	23 6
Average		96%	95%	24.6 5

FULLY AGREE
MOSTLY AGREE
AGREEMENT
MOSTLY DISAGREE
FULLY DISAGREE

GAVE OPINION
NO OPINION

Target product profile for a rapid diagnostic test for surveillance of cholera outbreaks

Please note that the numbering of notes restarts after each row.

CHARACTERISTIC	MINIMAL	PREFERRED
Goal of the test	A cholera surveillance test[1] to detect outbreak alerts and to monitor ongoing outbreaks.[2]	Same as minimal, plus the ability to confirm cholera outbreaks.[3]
	[1] According to WHO definitions of test purposes (12). The tests described under both the minimal and preferred criteria are for surveillance purposes; they are not meant to inform patient management decisions, only to identify cholera cases. [2] According to current guidelines, culture and/or PCR is required to confirm an individual case of cholera or confirm a cholera outbreak. Culture and/or PCR will likely need to be performed at a reference laboratory with the necessary laboratory capacity. [3] Test to be used on a predefined number of suspected cholera cases to enable case detection and declaration of an outbreak without the need for further laboratory confirmation by PCR/culture.	
Target population	All patients who meet the clinical definition of a suspected case of cholera (7).	
Target use setting	Primary healthcare settings, including health posts (level 0 and above).[1]	
	[1] For definitions of healthcare levels, see Table 1.	
Assay targets	Biomarkers for detection of *Vibrio cholerae* O1 (e.g. lipopolysaccharide (LPS)-O antigens) to enable surveillance for outbreak alert and monitoring.	Same as minimal, plus detection and differentiation of *V. cholerae* O139 and detection of cholera toxin to identify strains known to cause epidemics.[1]
	[1] Assay targets may be in separate tests or, preferably, combined in a single test. To satisfy the preferred goal of the test, i.e. outbreak confirmation, detection of cholera toxin is required. Additionally, the preferred criteria of the clinical sensitivity and specificity characteristics would also need to be satisfied for detection of preferred assay targets.	
Test format	A single-use, disposable test kit that requires no instruments or laboratory equipment to perform the test procedure, including specimen preparation. The test kit includes all materials required for the test procedure to test one individual, including devices, reagents and other consumables, in a packaged, self-contained kit. Additional consumables may be needed for specimen collection. (A reader as an optional tool for interpreting results is acceptable.)	Same as minimal, plus consumables required to support specimen collection included in the test kit.
Result display and interpretation	Visual interpretation of qualitative (yes/no) test results by the naked eye, with minimal instructions for interpretation by the user required. (In addition, results could be obtained via an optional reader.[1])	
	[1] Characteristics of a reader are defined in a WHO TPP for readers of RDTs (13).	
USER REQUIREMENTS		
Target users	Community health workers and healthcare providers including those involved with outbreak investigation.	
User training	A user can conduct the test correctly after half a day of training.	A user can conduct the test correctly after a brief review of the instructions for use (IFU).

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CHARACTERISTIC	MINIMAL	PREFERRED
PERFORMANCE CHARACTERISTICS		
Specimen type	Unprocessed stool specimen.	Same as minimal, or a specimen that is easier to collect, e.g. capillary blood, if new biomarkers have been identified and validated.
Clinical sensitivity[1]	≥ 90% for each assay target[2]	≥ 95% for each assay target[3]
	[1] For performance studies, see (10) [2] As recommended by the GTFCC laboratory working group (14) [3] To address the preferred goal of the test for outbreak confirmation, this preferred sensitivity level is required, which is equivalent to the minimal performance requirement of molecular tests for cholera outbreak confirmation.	
Clinical specificity[1]	≥ 85% for each assay target[2]	≥ 95% for each assay target[3]
	[1] For performance studies, see (10) [2] As recommended by the GTFCC laboratory working group (14) [3] To address the preferred goal of the test for outbreak confirmation, this preferred specificity level is required.	
Limit of detection	To be determined[1]	
	[1] Further research is needed to define the clinical reference ranges of bacterial load among infected individuals and to certify reference materials for the assay targets. Existing studies of stool specimens have found 10^7–10^8 CFU/mL in most clinical cases, with extremes of 10^2–10^9 CFU/mL (15, 16).	
Interference	No interference from *V. cholerae* non-O1/non-O139 or from biomarkers of common human diseases, especially those presenting with similar signs and symptoms, e.g. watery diarrhoea, or from common endogenous or exogenous interferents.[1]	
	[1] Interferents should be tested at clinically relevant concentrations, included in a risk evaluation and listed in the IFU (see (10)). See also CLSI EP07 (17).	
Test failure (invalid) rate	≤ 5%[1]	≤ 1%
	[1] Based on WHO guidance for other RDTs.	
TEST PROCEDURE CHARACTERISTICS		
Specimen volume	< 1 mL for stool specimens	Same as minimal, or small volumes consistent with the specimen type collected, e.g. 25–50 µL for capillary blood.
Specimen preparation	None required other than dilution steps where no precision pipetting is required. The test may support an optional step of enrichment in alkaline peptone water (APW).[1]	None required other than dilution steps where no precision pipetting is required.
	[1] The test must satisfy the minimal clinical specificity characteristic without APW enrichment. If the test supports the option of enrichment for higher specificity, the IFU must provide instructions and summarized results of performance studies with and without enrichment.	
Ease of use	Easy-to-perform test procedure and result interpretation by the intended user, with minimal steps; no precision pipetting and no timed steps (except for reading the test result). Reagent reconstitution is acceptable if simple to do and if all liquids, including water, are provided in the test kit.	Same as minimal, except no reagent reconstitution
	See (10)	
Language support	For each country of deployment, the packaging and IFU are provided in one commonly used language, such as the official language or the de facto national language, and any language mandated by local regulatory or trade compliance requirements.	Same as minimal, plus additional languages to enable use by other residents of that country.
	Relevant countries for cholera RDTs are likely to use Arabic, English, French, Spanish, Portuguese or Swahili.	

CHARACTERISTIC	MINIMAL	PREFERRED
Time to result[1]	≤ 30 min	≤ 15 min
	[1] Including time from the start of specimen preparation to test result, not including the duration of specimen collection.	
Stability of valid result	≥ 30 min (after which results may be false or invalid).	≥ 1 h (after which results may be invalid but not false).
Internal controls	Control of reagent addition and flow	Same as minimal, plus control of specimen addition and flow, of correct operation of the device, and of correct functionality of all reagents.
External controls	Positive and negative external controls are specified in the IFU and available for purchase separately.	Positive and negative external controls are included in the price of the test and are provided with the test kits.[1]
	[1] For logistics and stability, controls may be packaged separately from the test kits.	
OPERATIONAL CHARACTERISTICS		
Test kit stability and operational conditions (18)	18 months, stable at 2–30 °C and 70% humidity; any associated equipment must meet or exceed these requirements.[1]	24 months, stable at 2–40 °C and 90% humidity; any associated equipment must meet or exceed these requirements.[1]
	[1] Based on specifications in the WHO TPP for a point-of-care test for prior infection with SARS-CoV-2 (19).	
Shipping and transport conditions (18)	Temperature stress (48 h with fluctuations up to 40 °C and down to 2 °C); no cold chain required for storage or transport.	Same as minimal, except temperature stress (72 h with fluctuations up to 50 °C and down to 2 °C), and with indicator of temperature or humidity excursions that would result in invalid or low-performance results.
Open test kit stability[1]	≥ 30 min	≥ 1 h
	[1] Including time from opening the test kit to finishing the addition of specimen and reagents.	
Biosafety	None, apart from waste management and the use of non-sterile gloves.	
Waste disposal	Standard biohazard waste disposal or incineration of consumables.	All components of the kit are designed to minimize the environmental impact during standard biohazard waste disposal.
	See (20)	
PRICING AND MARKET ACCESS		
Target list price per test[1]	A test meeting the minimal goal of the test (for surveillance for outbreak alert and monitoring): < US$ 2.	A test meeting the minimal goal of the test (for surveillance for outbreak alert and monitoring): < US$ 1. A test meeting the preferred goal of the test (capable of outbreak confirmation): < US$ 3.
	[1] Pricing from manufacturers should be as low as sustainably possible while maintaining quality, based on evidence of the true cost of goods sold accounting for material, manufacturing process, operational logistics and commercialization efforts. Pricing should also include and clearly define all facets of end-to-end implementation (e.g. support, maintenance). Pricing must account for production at scale with defined volume thresholds. Ultimately pricing should intersect sustainable long-term viability for the manufacturer with affordability to support widespread access to testing in LMICs and should be transparently published. This price excludes any costs for a reader.	
Quality management system	Compliant with ISO 13485	Certified to ISO 13485 or equivalent
Lead time for lot production	≤ 3 months	≤ 1 month

Table 1. Definitions of use settings in LMICs (adapted from (21))

	SELF-TESTING	LEVEL 0 COMMUNITY	LEVEL 1 PRIMARY CARE	LEVEL 2 DISTRICT HOSPITAL LABORATORY	LEVEL 3 REGIONAL/PROVINCIAL LABORATORY	LEVEL 4 REFERENCE/NATIONAL LABORATORY
Use setting	• Self-testing	• Community outreach • Home testing	• Primary care facility	• Near-patient laboratory • Referral hospital laboratory • Emergency department testing	• Near-patient laboratory • Referral hospital laboratory • Emergency department testing	• Reference laboratory
Laboratory infrastructure	• No mains power • No water • No laboratory equipment • No environmental control, e.g. temperature, humidity, dust	• No mains power • No water • No laboratory equipment • No environmental control, e.g. temperature, humidity, dust	• No mains power (unreliable) • Minimal laboratory equipment (may not support cold chain) • BSL-1 containment • No environmental control, e.g. temperature, humidity, dust	• Mains power (may be intermittent) • Basic laboratory equipment (biosafety cabinet, centrifuge, calibrated pipettes, refrigerator) • –20 °C freezers (some) • BSL-1/2 containment (some) • Environmental control, e.g. temperature, humidity, dust (some)	• Mains power (may be intermittent) • Basic laboratory equipment (biosafety cabinet, centrifuge, calibrated pipettes, refrigerator) • –20 °C freezers • BSL-1/2 containment • Environmental control, e.g. temperature, humidity, dust	• Mains power (reliable) • Facility with a high level of infrastructure • –20 °C freezers • –80 °C freezers (some) • BSL-2/3 containment • Environmental control, e.g. temperature, humidity, dust
Operator skill	• Self-testing/lay person • Simple reagent/specimen transfer	• Nurse/pharmacist • Community health worker • Simple reagent/specimen transfer	• Nurse • Trained laboratory worker • Minimal specimen processing (≤ 3 steps)	• Laboratory technician (certified for 1–2 years) • Specimen processing with calibrated volumes (≤ 3 steps)	• Laboratory technician (certified for 1–2 years) • Specimen processing with calibrated volumes (≤ 3 steps)	• Scientific research specialist • Laboratory technician (certified for 1–2 years)
Specimen capacity	• Can process minimally invasive samples: fingerstick blood, nasal swabs, saliva, urine	• Can process minimally invasive samples: fingerstick blood, nasal swabs, saliva, urine	• Can process upper respiratory specimens; may not have capacity for lower respiratory, venipuncture or plasma specimens	• Can process most BSL-2 specimens; depends on clinic's specimen capacity	• Can process most BSL-2 specimens; depends on clinic's specimen capacity	• Can process most BSL-2/3 specimens
Test capacity	• True POC MDx (some) • RDTs	• True POC MDx (some) • RDTs	• True POC MDx • Basic microscopy • RDTs	• Near-POC MDx • ELISA with a simple reader (some) • Microscopy • RDTs • Clinical chemistry (some)	• Blood culture and microbiology capacity (some) • Near-POC MDx • ELISA with a simple reader • Microscopy • RDTs • Clinical chemistry	• Blood culture and microbiology capacity • Lab MDx/PCR/LDT • ELISA/EIA/CLIA/PRNT • Fluorescence microscopy • Clinical chemistry • Sequencing (some) • Mass spectrometry (some)

BSL, biosafety level; CLIA, chemiluminescent assay; EIA, enzyme immunoassay; ELISA, enzyme-linked immunosorbent assay; LDT, laboratory-developed test; MDx, molecular diagnostic test; POC, point of care; PRNT, plaque reduction neutralization test; RDT, rapid diagnostic test.

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