HIV rapid diagnostic test market landscape

June 2023

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Objective and Scope

Introduction and objective

The HIV testing market is at an inflection point driven by
- the increasing uptake of new test types (i.e. HIV self-tests and dual HIV/Syphilis professional use tests),
- progress towards testing goals resulting in shifting programmatic approaches,
- the expansion of testing to expand access to prevention in addition to treatment, and
- stagnant funding.

These factors have increased the complexity of the HIV testing market, making a holistic look at the market timely. For the first time, this report considers what factors from a market perspective stand in the way of reaching global testing targets.

> **"** *For the first time, this report considers what factors from a market perspective stand in the way of reaching global testing targets.* **"**

Methods and scope

The analysis includes the three most commonly used HIV rapid diagnostic test (RDT) categories: HIV-only professional use RDTs, dual HIV/syphilis professional use RDTs, and HIV self-tests (HIVST).

The report draws on a range of data sources (procurement data, HIV RDT forecasts, peer-reviewed literature, and stakeholder interviews) to understand the global donor supported market in low- and middle-income countries (LMICs). The research was primarily conducted in 2022. Five years of procurement data was collected and analysed from 109 countries; however, limited procurement information was available from several large markets. Therefore, desk research and stakeholder interviews were given more weight for South Africa and Kenya. Brazil, China, and India were excluded from the forecast due to insufficient information.

The scope of this report does not extend to an in-depth analysis of national testing policies, strategies, or programmes per country but presents key findings in aggregate.

This report highlights key market findings, identifies major market shortcomings and risks, and proposes recommendations for global HIV testing stakeholder consideration.

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The evolution of testing

Role of HIV testing

Three different roles for HIV testing continue to drive implementation: (i) case finding, (ii) engagement/re-engagement, and (iii) expansion of access to prevention.

Complexity

The scope of HIV testing has broadened to encompass both treatment and prevention objectives. In response to evolving epidemiology, programme success, and the availability of new types of RDTs, testing needs are becoming increasingly country-specific and multi-dimensional. This broader paradigm requires a robust HIV testing programme even after the achievement of the first 95* in order to expand prevention services and sustain epidemic control.

> *In response to evolving epidemiology, programme success, and the availability of new types of RDTs, testing needs are becoming increasingly country-specific and multi-dimensional.*

*95% of the people living with HIV know their HIV status by 2030

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Integrated HIV RDT Forecast

Forecasted growth

We project the HIV RDT market in LMICs to grow steadily from 2022 to 2027. This projection reflects that global testing targets have been or are close to being achieved in many countries and that funding for HIV testing will remain largely fixed. The projected average compound annual growth rate (CAGR) of the HIV RDT market is 4.5% for the period 2021-2027; it varies from 1.0% in UNAIDS region Middle East and North Africa to 6.0% in UNAIDS region Asia and Pacific.

After achievement of the first 95 target, further growth in professional-use HIV RDT volumes is only expected when a country expands pre-exposure prophylaxis (PrEP) delivery and/or increases uptake of HIVST.

" ***The projected average compound growth rate (CAGR) of the HIV RDT market is 4.5% for the period 2021-2027.*** *"*

Variation in product mix

The four product mix scenarios forecast considerable variation in the total volumes of each test type. Cumulative HIV-only RDT volumes range from 592m to 838m, dual HIV/syphilis RDT volumes range from 154 to 197m and HIVST product volumes range from 133m to 283m over the projected time period 2022-2027.

Uncertainty in product mix

The current inflection point in the HIV test market is reflected in the considerable uncertainty regarding how the product mix of test types within the market forecast will change. The dominance of any test type will depend on a variety of factors including programmatic shifts and testing policy uptake. For example, use of HIV-only professional use RDTs may decrease as programmes adopt dual HIV/syphilis RDTs (e.g. in ANC and/or for key populations) and HIVST products (e.g. for PrEP monitoring, facility-based screening).

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Professional test market: Market characteristics and challenges

Product offering

There are more than 20 professional use RDTs, including 3 dual HIV/syphilis RDTs, available in the market. However, the market is dominated by one company, whose three products comprised 84% of the market in 2021, despite a multitude of prequalified products available, many of which have lower prices. The dominance is partly explained by the leading products being among the first to market and by infrequent switching of products. Additionally, these tests are optimized for sensitivity, positioning them well to capture the largest market segment (i.e. the first assay in an algorithm, the "A1", representing ~90% of annual demand).

Procurement

While agencies procuring products know which product a country is likely to request because it is specified in the algorithm, volumes and timing of requests are inconsistent. Additionally, the source of RDT funding varies from year to year for some countries. As a result, procurers are restricted in their ability to pool volumes or to structure procurements in ways that engender price competition.

Policy and programming

Inflexible diagnostic algorithms continue to create a barrier to product switching resulting in decreased competition and contributing to the dominance of one company.

> *The market is dominated by one company's products comprising 84% of the market in 2021.*

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Professional test market: Market characteristics and challenges

Price

The weighted average price (WAP) of professional use tests is higher than it needs to be due to limited flexibility in product selection. Algorithm development processes deter countries from switching products frequently and preclude competitive tendering when only one product is selected for each spot in the algorithm. There is also a (perceived) high operational burden associated with switching RDTs.

Supply security

The requirement for three specific RDTs for a definitive HIV diagnosis creates a considerable risk of testing supply disruption. Supply or availability issues with even one of those tests could result in service interruptions. This contrasts to other RDT markets, such as malaria RDT, where products are more interchangeable and supply security has improved recently through efforts to spread market share among suppliers and to orient health workers to multiple brands of RDTs.

> " *The weighted average price (WAP) of professional use tests is higher than it needs to be due to limited flexibility in product selection.* "

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Professional test market: Recommendations

Refresh policy and procurement approaches for professional use HIV tests

Policy and procurement strategies must be developed to diversify the professional use HIV test market. A large procurement agency or donor should convene a forum comprising procurement, quality, technical, programmatic, and market stakeholders (such as the Malaria RDT Procurement Task Force) to drive and coordinate this work.

Address barriers to switching products within the national testing algorithm

The policies for algorithm development need to be revisited from a quality, technical, and market perspective to see where it is possible to build in more flexibility, enabling more frequent switching of the products used in three-test strategies. These efforts should include promotion of health worker RDT training approaches that allow flexibility in product usage while ensuring quality.

Continue to promote and facilitate the adoption of WHO policy recommendations

Current policy recommendation for countries to register and verify multiple HIV RDTs (i.e. approve 2 tests for the A1 position) should be supported. Additionally, compliance with this recommendation should be monitored. If new flexible algorithm policies are developed, their adoption and implementation should be supported.

Increase price competition and reduce supply risk through procurement

Procurement approaches that enable competitive tendering should be developed. In the near term, it is recommended to require programmes to verify multiple tests for their algorithm (i.e. two A1s and three A2/A3s), and to couple this with limited competitive tenders. Longer term, procurement strategies must adapt to fit with any algorithm policy revisions.

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HIVST market: Market characteristics and challenges

Product offering

One product (Orasure) dominates the HIVST market despite the variety of product offerings. WHO-prequalified blood-based HIVST products are acceptable to end-users and available at lower prices than oral-based HIVST products yet, having recently entered the market, uptake remains low.

Procurement

The HIVST market is growing steadily but is still niche (~15m tests) compared to professional use tests (>135m tests), partly as a result of programmatic complexity, inexperience with novel delivery channels, and sustainability concerns. Additionally, distribution in the uptake of HIVST products is uneven and concentrated in limited regions globally.

Price

The historical weighted average price paid for HIVST products is substantially higher than the professional use HIV-only RDT test price and the lowest available prequalified HIVST product price. Given unique packaging requirements, relatively fragmented demand, and the need to build the market, a modest price premium over professional use tests is expected. Newer, lower-priced HIVST products also need time and support to penetrate the market. However, price is important because programmes are concerned about sustainability within a tight funding context. Use of higher priced products may result in more limited use or a more cautious approach to scale up HIVST than is ideal given its flexibility and capability to reach those who are most reluctant to test.

Policy and programming

Policy is not a barrier to demand as the majority of countries have national policies supportive of HIV self-testing. The adoption of more ambitious testing approaches and scale-ups across geographies and population groups is however a challenge. HIVST introduction and scale-up in many settings continues to be associated with programmatic complexity in implementation. For example, building capacity, creating new distribution models, measuring impact, and orienting health workers to new product types slow the scale-up of HIVST.

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HIVST market: Recommendations

Address affordability by increasing new test market penetration

Partners should continue to share existing and emerging evidence of blood-based test acceptability and effectiveness and advocate for the adoption of less expensive blood-based tests to diversify product offerings and lower prices. Continued support for national regulatory approval of alternative and lower-cost blood-based tests is important to accelerating new suppliers' engagement in the market. The conditions for competition exists so as market demand grows and diversifies, the weighted average price of tests procured is expected to reduce.

Revitalize support for strategic programmatic implementation

Continued funding and support to expand the capacity and bandwidth of HIV testing programmes is critical so that they may nimbly respond to the latest data and address gaps. As a novel product category, self-testing requires programmes to expand their capacities, especially with respect to non-traditional testing channels. The development and implementation of tools that help determine optimal testing mixes for various contexts will support HIV testing programmes to prioritize the myriad opportunities and to build strong investment cases for new approaches. Other programmatic priorities that will support market growth include successful models of impact measurement and scale up of novel delivery mechanisms where appropriate.

> **" The conditions for competition exist, so as market demand grows and diversifies, the weighted average price of tests procured is expected to reduce. "**

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Conclusion

Increasing complexity in the market

It is an opportune time to assess the HIV testing market holistically, as testing strategies and available testing products are evolving rapidly. There is marked heterogeneity of HIV testing programmes at the national level as countries adapt testing approaches to their unique contexts; this creates considerable complexity in the global market.

Risks

Several risks have been identified that could jeopardize the attainment of testing targets and affect countries' abilities to adapt to the future of testing. Chief among them is rigidity within the procurement of and demand for HIV tests that is limiting competition, despite the availability of multiple quality products. The recent acceleration of dual HIV/syphilis RDT introduction and scale up suggest that many countries are open to algorithm updates and that it is possible to introduce healthcare workers to new products without jeopardising quality.

Opportunities

There is scope for changes that could increase competition and diversify the supply base which should result in financial savings and healthier, more sustainable markets.

Convene to find a way forward

The process of gathering and sharing the findings of this analysis has highlighted that stakeholders have divergent views on market risks and how to address them. Therefore, further dialogue on concrete next steps could create greater momentum for progress.

1

Introduction

This section introduces the HIV RDT market landscape report by reviewing the HIV testing targets, progress, and impact on the overall epidemic control. This section also establishes the methodology, limitations, and structure of the report.

Global HIV testing targets are yet to be reached

A slowing of progress

HIV testing services (HTS) are a critical intervention in the global HIV response:

1. Knowledge of status is the critical first step in ensuring that people living with HIV (PLHIV) are linked to treatment services.
2. For people who are HIV negative, testing provides access to key prevention services (e.g. pre-exposure prophylaxis (PrEP), voluntary medical male circumcision (VMMC)), reducing risk of future infection; and when focused on those with high ongoing risk it enables early diagnosis and treatment which is important to preventing new infections and improving health outcomes.

The global testing and treatment targets of the Joint United Nations Programme on HIV/AIDS (UNAIDS) were not met in 2021 and the world is off-track in its efforts to reach the 2030 95-95-95 goals as shown in the figure on the right.

Because testing affects the number of people who access treatment and prevention services, testing programme implementation has a cascading effect on progress towards other HIV programme targets. In the current environment of flat or declining funding, programmes are challenged to devise solutions that will allow them to maintain the levels of testing required. There is an equally important need for programmes to identify means to provide equitable access to testing services for those with low knowledge of status.

Rapid diagnostic tests (RDTs) are the foundation of HIV diagnosis that have expanded the reach of testing among adults in low- and middle-income countries (LMICs). While lab based methods (e.g. enzyme immunoassay (EIA)) are used in some countries, they are mostly complementary to RDTs which are used in the majority of settings.

Figure 1.01 HIV testing and treatment cascade, women (aged 15+ years) compared to men (aged 15+ years), global, 2021
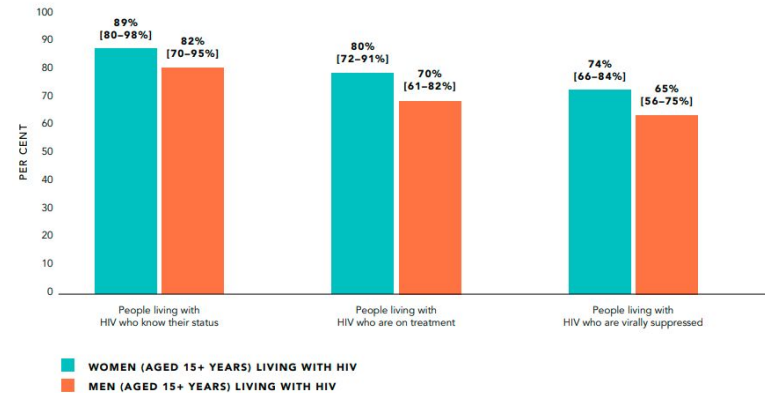
Source : UNAIDS special analysis, 2022, Figure 1.11

Introduction

Purpose

This HIV RDT market landscape report seeks to answer the question: From a market perspective, what could get in the way of achieving global HIV testing targets? The aim of the report is to provide a common understanding of factors impacting the HIV RDT market, visibility around key market challenges, and initial views on how those challenges might be addressed by identifying market solutions.

It is timely to consider the HIV RDT market holistically, as the HIV epidemic is evolving and new products like dual HIV/syphilis RDTs (dual tests), and HIV self-tests (HIVST) are being widely scaled up. For the first time, we take an integrated view of three market segments, as changes in one market can increasingly impact another segment.

This landscape builds on and complements previous market analysis and landscaping including Expanding Access to HIV Self-Testing: A Market Development Approach. PSI. 2016, the Unitaid HIVST landscape reports (2018, 2020) and the series of CHAI HIV market reports.

This report is intended for a broad audience, which includes manufacturers and test developers, national HIV programmes, implementing partners, donors, and those engaged in procurement.

Scope

This report primarily focuses on LMIC donor-funded RDT markets; therefore, it does not cover the global market, i.e. high-income country markets are excluded, and several LMIC countries that fund their HIV testing programmes domestically are excluded. Specifically, China, Brazil, and India are largely excluded; Kenya and South Africa are only partially represented. There is also limited focus on the private sector, except for nascent self-testing retail markets.

This report focuses on RDTs, the backbone of HIV testing in LMICs; as such, it excludes EIAs and other lab-based assays, recency tests, and molecular diagnostics for infants under 18 months of age. Because the focus is on donor-funded markets, the report focuses primarily on WHO prequalified (PQ-ed) tests.

Methodology and Limitations

Methodology

The methodology combines desk review and qualitative research with quantitative analysis of available aggregate data on HIV diagnostics. The research was conducted between November 2021 and December 2022, with most of the manufacturer and partner conversations occurring in quarter-2 and quarter-3 of 2022.

Desk review and qualitative components include reviewing policies, meeting proceedings, webinars, policymaker and partner reports, peer-reviewed publications, and institutional and corporate websites. This was supplemented by discussions with partners and semi-structured telephone interviews with HIV RDT manufacturers conducted in collaboration with WHO, which holds regular consultations with HIV test manufacturers. (Refer to Annex A2 for the list of interviewees).

Procurement data analysis

Procurement data analysis sheds light on trends in HIV RDT markets. Compiling, standardizing, and cleaning procurement data for the three tests included in this report constituted a major undertaking of this project. A data set comprising over 4,000 individual orders totalling 824 million RDTs in 2015-2022 was assembled from major procurers. Throughout this report, we reference "Procurement data analysis" as the source for many key findings. Annex A2 describes the data set, analysis, and limitations in more detail.

Integrated HIV RDT Forecast

An integrated HIV RDT forecast was developed to estimate how many RDTs for HIV diagnosis could be procured in LMICs over the next five years. Data used in the forecast include procurement, budget, and annual reporting of HIV indicators by countries to WHO and UNAIDS (Refer to Annex A4 for details).

To comprehensively assess market health, we applied commonly used market health frameworks such as the 5 A's (Affordability, Availability, Assured Quality, Appropriate Design, and Awareness), and Unitaid and Global Fund market frameworks. We make recommendations to address high-priority risks and challenges.

Methodology and Limitations

Methodology continued

Prices

We primarily use weighted average price (WAP) to guide our analysis as it best represents the procurement price within the market. Pricing analysis excluded those orders that were not ex-works (EXW) unless otherwise noted. Reference prices, e.g. Global Fund reference prices and WHO procurement prices, are also noted where available.

Product and company name usage

Product and company names have been simplified for ease of use throughout the report. Refer to the WHO list of prequalified products and public reports for complete names.

Limitations

Access to information and data from several markets was limited, which may affect our findings' generalizability. Because the total HIV RDT market size (global and LMICs) is unknown, it is difficult to assess the representativeness of our compiled data. Specific challenges include incomplete reporting and the unavailability of data from some countries. In particular, South Africa and Kenya, two large LMIC RDT markets, are poorly represented because they fund much of their HIV testing through domestic funds, and no mechanisms for reporting these transactions are available. Additionally, while results may be generalizable to LMICs beyond the donor-funded markets, the distinct market dynamics (e.g. a greater emphasis on domestic manufacturing and different regulatory requirements) of China, India, and Brazil make it difficult to apply a similar generalization to these large markets.

Structure of report

The landscape report is structured into sections that explore the evolution of HIV RDT testing.

Section 1 introduces the HIV RDT market landscape report by reviewing the HIV testing targets, progress, and impact on the overall epidemic control. This section establishes the methodology, limitations, and structure of the report.

Section 2 describes the goals, products, and delivery models for testing today, how these have evolved with the epidemiology, treatment, and prevention of HIV and how the needs of testing are now diverse and broad compared to 10 or 20 years ago.

Section 3 estimates future demand for HIV RDTs for a range of potential scenarios. Refer to Annex A3 for more details on forecasting methods.

Sections 4 and 5 highlight key characteristics and challenges in the HIV professional RDT (i.e. HIV-only professional use RDTs and dual HIV/syphilis RDTs) and HIVST markets, respectively. Separate consideration of these markets reflects key differences between the role these tests play in HIV diagnosis.

Specifically:

- According to WHO recommendations, three consecutive reactive tests are needed to diagnose HIV. Professional use HIV-only RDTs and dual HIV/syphilis RDTs with high clinical sensitivity and specificity are combined in an algorithm for this purpose.

- HIVST are always considered a triage test; all reactive self-tests require further testing using the national testing algorithm before a positive diagnosis can be provided.

The need to use a diagnostic algorithm has important implications for the market. Accordingly, tests governed by the algorithm (HIV-only RDTs and dual HIV/syphilis RDTs) are considered together, and HIVST are considered separately in this report.

Section 6 provides a brief perspective on the supply of HIV RDTs.

Section 7 concludes the report with a review of priority market challenges and a recommended way forward based on the analysis presented.

There are several annexes with additional background information and analysis that, while not central to the main findings, were nevertheless essential to consider in conducting a comprehensive market assessment.

Acknowledgements

2

Evolution of Testing

HIV testing programmes continue to evolve in an effort to reach global targets and contribute to broader long-term HIV treatment and prevention goals.

Multiple factors impact these programmatic shifts, including data on HIV epidemiology and programme achievements, changing perspectives on the role of HIV testing within the larger HIV arena, normative guidance, donor policies, and funding availability.

These programmatic modifications underpin demand and uptake for various types of HIV RDTs.

HIV testing programmes are using new approaches to reach PLHIV who remain unaware of their status

Who are we missing?

Despite considerable success in achieving knowledge of status among PLHIV, 15% of PLHIV globally remain unaware of their status. Groups with disproportionately low knowledge of status include:
- Midlife-older men in East/Southern Africa
- Key populations (KP) and their partners/contacts
- Children (0-14), adolescents (10-19) and young people (15-24)
- Partners of PLHIV
- People with STIs
- Family planning (FP) service attendees in high HIV burden settings

Developing an optimal strategy for each context requires country-specific approaches
National programmes determine the optimal interventions to most effectively address gaps using local data (epidemiologic and programmatic), cultural/societal contexts, and available resources, while also keeping HIV testing services as simple, affordable, and accessible as possible.

Strategies to address these gaps include
- Increasing access to new technologies (HIVST and dual HIV/syphilis RDTs)
- Expansion of service delivery points (facility and community)
- Increased use of interventions such as provider-assisted referral (index testing) and social network testing

Figure 2.01: Channels for HIV Testing Services
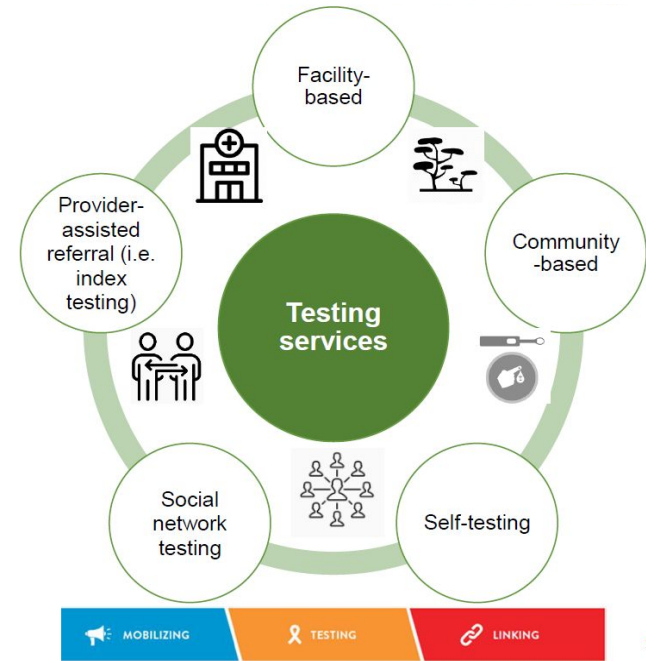
Figure credit: C. Johnson, WHO

A singular focus on testing yield may miss a significant number of PLHIV

In recent years, some funders and programmes strongly focused on increasing testing yield (i.e. proportion of new positives out of all tests conducted) in an attempt to decrease overall testing volumes and increase programmatic efficiency.

- PEPFAR testing volume targets decreased 35% between 2018 and 2020.
- Risk screening tools were introduced, especially in outpatient clinics, as an attempt to better target testing and improve yield.

New evidence suggests the risk of missing people (who otherwise would have been tested) was quite high with this approach and hampered case-finding. As seen in chart on right, analysis of PEPFAR 'Other Provider Initiated Testing and Counseling (PITC)' yield targets (the metric that primarily measures outpatient clinic testing) showed that while increasing yield targets does decrease the overall number of HIV tests conducted, it also misses a substantial number of undiagnosed PLHIV.

Most stakeholders now agree that testing must broaden to ensure diagnosis of all PLHIV; this emphasis on coverage of testing instead of yield suggests that testing volume targets will not decrease further.

WHO guidance does not recommend the use of risk screening tools that are used to "screen-out", i.e. choose who not to test. Screen-in tools can be useful for identifying missed opportunities for testing in settings where routine testing is not the norm.

Figure 2.02: Reductions in number of tests and positives based on other PITC yield targets

Achieving 4.5% yield would miss 50% HIV+ diagnoses

Achieving 10% yield overall would miss 70% HIV+
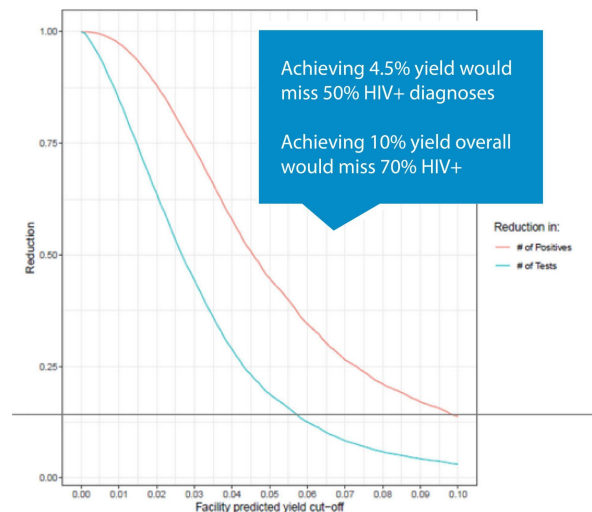
Source: C. Johnson, WHO & US CDC

Ong JJ, Coulthard K, Quinn C, Tang MJ, Huynh T, Jamil MS, Baggaley R, Johnson C. Risk-Based Screening Tools to Optimise HIV Testing Services: a Systematic Review. Curr HIV/AIDS Rep. 2022 Apr;19(2):154-165. doi: 10.1007/s11904-022-00601-5. Epub 2022 Feb 11.

The new 'Status Neutral' HIV testing paradigm expands the focus of HIV testing beyond case-finding

Status neutral means testing is promoted for PLHIV and those who are uninfected but are vulnerable to acquiring HIV. This shift includes the conventional focus on case-finding as well as using testing to facilitate re-engagement in care and linkage to prevention services.

Three distinct roles for HIV testing are emerging:

1. **Case finding:** Reaching those with undiagnosed infections and supporting linkage to treatment and care using specific targeted testing strategies
2. **Re-engagement in care:** Using HIV testing as a way to facilitate re-engagement in PLHIV who are previously diagnosed (+/- on antiretroviral therapy (ART)) but have been lost to follow-up
3. **Use in prevention:** Identifying HIV infection earlier in those with high ongoing vulnerability and ensuring that those who are uninfected stay negative through facilitating engagement of those who are uninfected with prevention services such as prevention of mother to child transmission (PMTCT) screening, PrEP monitoring, VMMC, and services for adolescent girls and young women (AGYW) and KPs.

This shift in testing direction aims to ensure a strategic mix of services that is person-centred and contributes to larger treatment and prevention goals. Finding the balance of coverage, case-finding, and prevention is challenging, and needs to be driven by the local epidemiology and context.

This broader paradigm represents a fundamental shift in HIV testing goals and requires a robust HIV testing programme even after achievement of the first 95 as a way to support prevention services and sustain epidemic control.

Figure 2.03: HIV Testing Services process

Grimsrud A, Wilkinson L, Ehrenkranz P, Behel S, Chidarikire T, Chisenga T, et al. (2023) The future of HIV testing in eastern and southern Africa: Broader scope, targeted services PLoS Med 20(3): e1004182
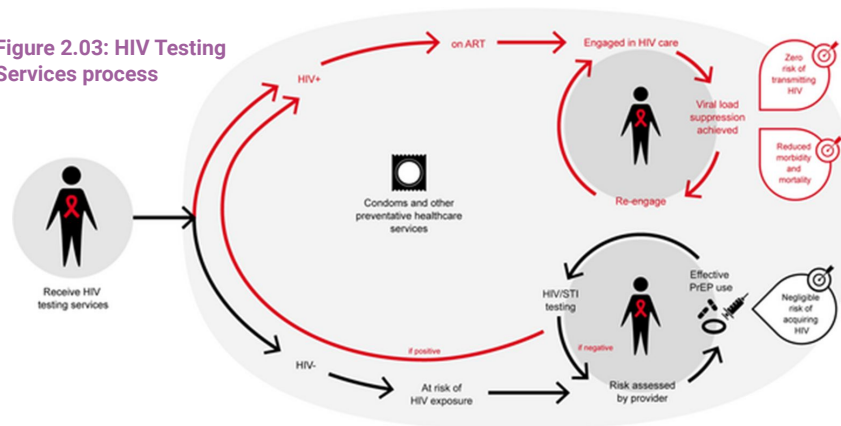
Recent WHO HIV testing guidance and potential impact on HIV RDT markets

Increased uptake of dual HIV/syphilis tests
- Dual HIV/syphilis test recommended in ANC as initial screening test (A1) (2019)
- Dual HIV/syphilis test recommended in KP as part of periodic STIs testing (2022)

Consolidated guidelines on HIV, viral hepatitis and STI prevention, diagnosis, treatment and care for key populations

Increased HIVST volumes due to expanded indications for HIVST use
- HIVST advised for use in PrEP initiation and continuation, as well as linkage (including dapivirine (DPV) and post-exposure prophylaxis (PEP))

Differentiated and simplified pre-exposure prophylaxis for HIV prevention: update to WHO implementation guidance (2022)

Guidelines on long-acting injectable cabotegravir for HIV prevention (2022)

Guidance on increasing HIVST product distribution and use
- Use of virtual interventions to scale up distribution

POLICY BRIEF - Virtual interventions in response to HIV, sexually transmitted infections and viral hepatitis (2022)
- Expansion of HIVST access through a range of delivery models (including in facilities)

WHO recommends HIV self-testing – evidence update and considerations for success (2019)

Accelerating adoption of new RDTs through support for HIV testing algorithm modification
- Standard 3-test strategy for all countries (2019)

Consolidated guidelines on HIV testing services
- Test selection and verification of national HIV testing algorithms (2021)

Toolkit to optimize HIV testing algorithms

Looking ahead:

WHO is updating the Consolidated Guidelines on HIV Testing Services with a focus on providing new recommendations on:
- New uses for HIVST
- Social network approaches
- Clinical utility of recency testing
- Multiplex testing (HIV, HBV, syphilis)
- Testing for long-acting PrEP (CAB-LA)

WHO announces the update of the Consolidated Guidelines on HIV Testing Services (update 2022–23)

Donor policies and priorities impact the type and volume of HIV RDTs procured

The major sources of funding for HIV testing programmes in LMICs are PEPFAR, Global Fund, and domestic financing. Most LMICs are supported by a combination of these, as illustrated by the figure at right.

Donor procurement policies and procedures affect the product mix available in countries. For example, Global Fund and PEPFAR funding can only be used to procure products assessed and listed through WHO prequalification, or Expert Review Panel for Diagnostics (ERPD).

Donor programmatic priorities may also impact the type and volume of HIV RDTs used in national HIV testing programmes.

- PEPFAR funding must be aligned with PEPFAR programmatic priorities and policies as directed by the Office of the Global AIDS Coordinator and outlined in the PEPFAR Annual Country Operational Plan Guidance and the Technical Considerations.
- Global Fund guidance is outlined in the Global Fund Information Notes and other specific technical area documents. Applicant Guidance Materials

Current PEPFAR and Global Fund guidance closely aligns with normative guidelines and promotes expansion of HIVST with an emphasis on provision of choice for blood-based or oral HIVST products, uptake of dual HIV/syphilis tests in ANC, and expanded testing modalities such as index testing.

Figure 2.04: HIV Funding Landscape in PEPFAR COP Countries, by Funder (%), 2020

Legend: PEPFAR | Global Fund | Other Funders | Domestic Government

Country	PEPFAR	Global Fund	Other Funders	Domestic Government
Angola	13%	27%		58%
Botswana	38%	6%		56%
Burundi	47%	45%		
Cameroon	51%	32%		17%
Cote d'Ivoire	60%	16%		23%
Democratic Republic of the Congo	27%	32%	32%	9%
Dominican Republic	35%	11%		55%
Eswatini	50%	14%		35%
Ethiopia	53%	31%		16%
Haiti	61%	37%		
Kenya	63%	23%		13%
Lesotho	45%	23%		31%
Malawi	46%	50%		
Mozambique	67%	23%		7%
Namibia	36%	8%		56%
Nigeria	45%	31%		24%
Rwanda	46%	40%		13%
South Africa	30%	7%		64%
South Sudan	44%	50%		
Tanzania	61%	23%		15%
Uganda	62%	26%		9%
Ukraine	28%	70%		
Vietnam	25%	25%		51%
Zambia	75%	12%		12%
Zimbabwe	41%	55%		
Overall	46%	22%		29%

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Most HIV testing in LMICs, including HIVST, is delivered via the public sector, making it the most important market segment

Although HIV programmes are rapidly evolving, the vast majority of HIV testing remains based in the public sector.

Within the public sector, the largest proportion of testing is conducted in facilities (e.g. general outpatient clinics, antenatal clinics, tuberculosis (TB) clinics, etc.).

Figure 2.05: Public sector HIV testing by delivery channel

PEPFAR Q2 22, Individuals tested and received results (HTS_TST)

Source: https://data.pepfar.gov/library
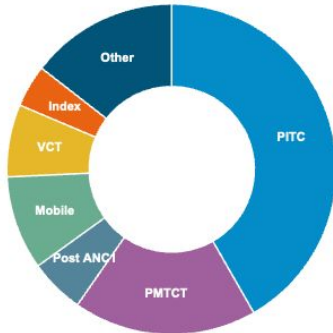
There is little data on the private sector market for HIV rapid tests. Although private clinics perform HIV testing, with few exceptions (e.g. India) their role is limited.

HIVST could potentially expand into the private retail sector, but these markets are nascent and growth is hampered by many challenges discussed later in this report.

Figure 2.06: LMIC HIV rapid testing market segments, by delivery channel, with illustrative market size estimates (by volume)

Funding is insufficient to implement the transition to status-neutral testing at scale

HIV testing is the gateway to achievement of global treatment and prevention goals and HIV testing needs are substantial: 15% of PLHIV are undiagnosed and reaching these people tends to be increasingly expensive. Additionally, testing is needed to re-engage PLHIV in care, to generate demand for prevention programmes for vulnerable populations, and to monitor prevention interventions.

HIV testing services comprise a very small proportion of overall HIV programme and response spending. Despite its foundational role for programme impact and the relatively small budget allocations, HIV testing **remains constrained by available resources**. While new products and modalities are available, taking advantage of them requires resources and innovative ways to lower costs of delivery.

> **In 2021, international resources available for HIV were 6%lower than in 2010. ... Domestic funding in low- and middle-income countries has fallen for two consecutive years, including by 2% in 2021**
>
> In Danger: UNAIDS Global AIDS Update 2022

Overall, there is limited optimism that testing resources for HIV testing will increase given the following factors:

- Current world economic outlook and expected reductions in funding for HIV that typically accompany economic declines;
- Existing gaps in funding the overall HIV response; and
- Reliance on domestic budgets, for which there are many competing priorities.

> **Countries everywhere are contending with higher demands for health and social spending, often in a context of depressed revenues and unstable public financing. Even before the Covid-19 pandemic and its associated economic disruptions, the resources available for HIV in low- and middle-income countries had been levelling off...**
>
> In Danger: UNAIDS Global AIDS Update 2022

Dual HIV/syphilis testing in ANC is highly impactful in increasing syphilis testing in pregnant women

Despite WHO guidance that all pregnant women should be tested for syphilis at the first antenatal care visit (ANC1), rates of syphilis testing are considerably lower than HIV testing.

Use of the dual test as A1 in ANC can rapidly increase syphilis testing in areas with high HIV testing coverage, as seen in Uganda.

Initial uptake of dual tests was sluggish but there has been rapid recent expansion of dual testing implementation in response to lower prices, global advocacy, and funding support.

Countries can achieve widespread ANC clinic coverage fairly quickly, leading to rapid increases in dual test procurement volumes since ANC testing represents 20-33% of all professional HIV tests performed in a country.

FIGURE 2.07: UGANDA: RAPID INCREASE IN SYPHILIS TESTING OVER ONE YEAR WITH USE OF DUAL TEST

FIGURE 2.08: DUAL TEST ALGORITHM
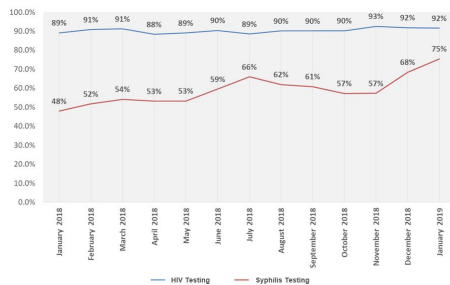
Source: Uganda MOH

https://www.thelancet.com/journals/langlo/article/PIIS2214-109X(21)00027-9/fulltext
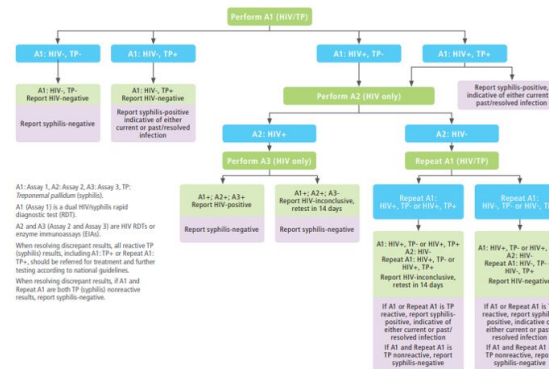
Source: Dual HIV/Syphilis Rapid Diagnostic Tests Can Be Used as the First Test in Antenatal Care. WHO. https://www.who.int/publications/i/item/WHO-CDS-HIV-19.38

3

Integrated HIV RDT demand forecast

It is timely to consider how changes in epidemiology, progress towards targets, new HIV testing policy recommendations, and new test technologies will impact HIV RDT demand.

This section presents an integrated HIV test forecast that considers HIV-only RDTs, dual HIV/syphilis RDTs, and HIVST demand for the next 5 years. In the base case, current trends are projected forward. Given the uncertainty in how the market will evolve, other scenarios reflect potential shifts in policy and market trends.

An integrated HIV RDT forecast is needed

Historically, HIV RDT forecasts were limited to one test type; however, adoption of new test types and expanded delivery modalities warrant an integrated market forecast.

Policy changes, uptake of policies, and price of products will drive the direction of this dynamic market. A timely HIV RDT forecast should account for possible variation in the mix of test types as countries adopt different policies and guidelines endorse different test types. The mix of HIV RDTs, their uptake, and level of adoption influence each other. For instance, a wide scale up of dual HIV/syphilis tests would decrease the need for professional use tests since dual tests replace an HIV-only professional use test within the algorithm.

An integrated **HIV RDT forecast** was developed to estimate how many RDTs for HIV diagnosis could be procured in LMICs over the next five years..

The forecast included three main test type categories with a focus on quality-assured tests: HIV-only professional use RDTs,, dual HIV/syphilis RDTs, and HIVST.

104 LMICs were included with the notable exceptions of China, India, and Brazil.

Figure 3.01 Integrated Forecast Total Test Volume Projections
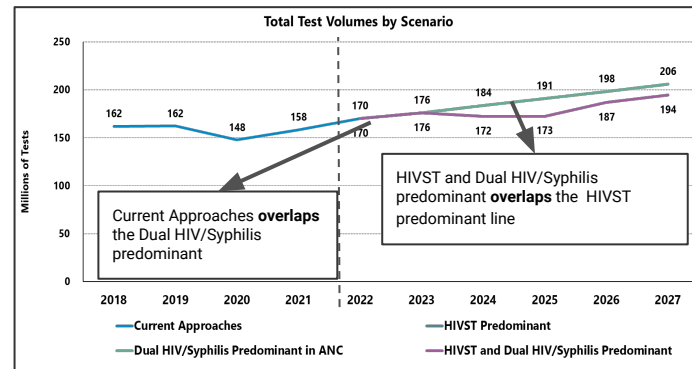
104 LMICs; China excluded; India test volumes excluded; Brazil test volumes excluded

EIC Integrated HIV RDT Forecast 2022-2027

The forecast developed four potential scenarios based on consideration of key programmatic, market, and policy shifts that could impact the type and number of HIV RDTs procured.

Forecast scenarios

1. Current Approaches Scenario
2. Dual HIV/Syphilis Optimistic Scenario
3. HIVST Predominant Scenario
4. HIVST Predominant and Dual HIV/syphilis Optimistic Combined Scenario

In the current approaches scenario, HIV-only professional screening RDTs will continue to dominate the market

The current approaches scenario assumes that current trends continue and that the future trajectory of non-ANC A1 test volumes will depend on the status of progress towards the first 95 (i.e. knowledge of status). The scenario assumes that countries with high knowledge of status among PLHIV will see minimal growth in non-ANC test volumes, and countries with low knowledge of HIV status will have more rapid growth. Once countries achieve the first 95, testing volumes will not drop significantly but will plateau as index testing and prevention-focused testing continues.

The uptake of HIVST depends on the product procurement history and future funding streams. Only countries with evidence of historical procurement (62 countries) were included in this scenario. This scenario also assumes that dual HIV/syphilis testing reaches 95% of ANC test volumes in 26 countries that have been categorized as having either "high" or "medium" likelihood of adopting and scaling up usage of dual tests in ANC settings (Refer to Annex A3 for classification of countries based on likelihood to adopt or scale-up dual HIV/syphilis RDTs).

Key takeaways

- There will be growth in the total volume of tests by 36 million in the next five years, reaching 206 million in 2027, with 82% of this growth expected in Africa and 12% in Asia

- HIV-only professional use screening RDTs still dominate the market at approximately 74% of 2022 volumes

Figure 3.02: Integrated Forecast Results for the Current Approaches Scenario

104 LMICs; China excluded; India test volumes excluded; Brazil test volumes excluded

EIC Integrated HIV RDT Forecast 2022-2027

- The product proportions change over time, with dual HIV/syphilis tests and HIVST products contributing 29% of the volumes in 2027, up from 13% in 2021.

- There will be an expansion in the HIVST market by 18 million tests; 10.5 million of this comes from East and Southern Africa (66% of which is driven by 3 countries: South Africa, Uganda, and Tanzania)

- By 2027, the A1 HIV-only market is expected to grow by 13 million tests; this is driven solely by PrEP expansion.

An additional 17 countries adopting the dual test in ANC settings could grow dual test volume to 42 million in 2027

The dual HIV/syphilis Optimistic scenario assumes that 17 more countries (classified as "low" likelihood of adopting and scaling up usage of dual tests in ANC settings), in addition to the 26 from the current approaches scenario, achieve 95% coverage of dual testing in ANC. This brings the total number of countries to 43 countries (see map on the next slide). In this scenario, assumptions applied to HIVST and confirmatory tests remain the same as in the current approaches scenario.

Key takeaways

- The dual HIV/syphilis test is a replacement of the HIV-only testing in ANC; therefore the total test volume does not change from the current approaches scenario.

- Dual HIV/syphilis tests grow to 42 million by 2027 (up from 29 million in the current approaches scenario), reflecting a change in the proportion of test type from the current approaches scenario but not in the volume of tests.

- The recent expansion of the WHO guidelines to recommend dual HIV/syphilis tests as routine tests for key populations for testing in STI clinics creates additional demand for the dual HIV/syphilis test beyond this forecast which limits uptake to ANC settings only.

Figure 3.03: Integrated Forecast Results for the Dual HIV/Syphilis Optimistic Scenario
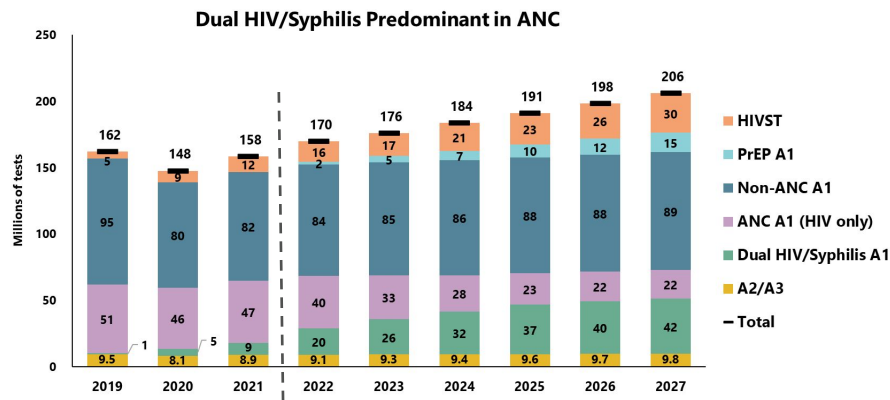
Dual HIV/Syphilis Predominant in ANC

104 LMICs; China excluded; India test volumes excluded; Brazil test volumes excluded

EIC Integrated HIV RDT Forecast 2022-2027

For more details relating to the forecast methodology and results and the EIC procurement analysis please refer to Annex A2

31

Dual optimistic scenario assumes that 43 countries* will achieve 95% coverage of dual testing in ANC, representing an estimated ~66% of ANC HIV A1 tests in LMICs

Figure 3.04: Global map of dual uptake classifications for LMICs

HIGH	MEDIUM	LOW
Burundi	Benin	Argentina
Cambodia	Cameroon	Burkina Faso
Ghana	Central African Republic	Chad
Guinea	Democratic Republic of the Congo	Comoros
Kenya	Dominican Republic	Côte d'Ivoire
Liberia	Eritrea	Eswatini
Mozambique	Indonesia	Ethiopia
Nigeria	Madagascar	Gambia (Republic of The)
South Africa	Paraguay	Lesotho
Uganda	Sierra Leone	Mali
Zambia	Somalia	Morocco
	South Sudan	Niger
	United Republic of Tanzania	Panama
	Venezuela	Papua New Guinea
	Zimbabwe	Rwanda
		Senegal
		Togo

Likelihood of achieving widespread scale-up of dual testing in ANC

- High
- Medium
- Low
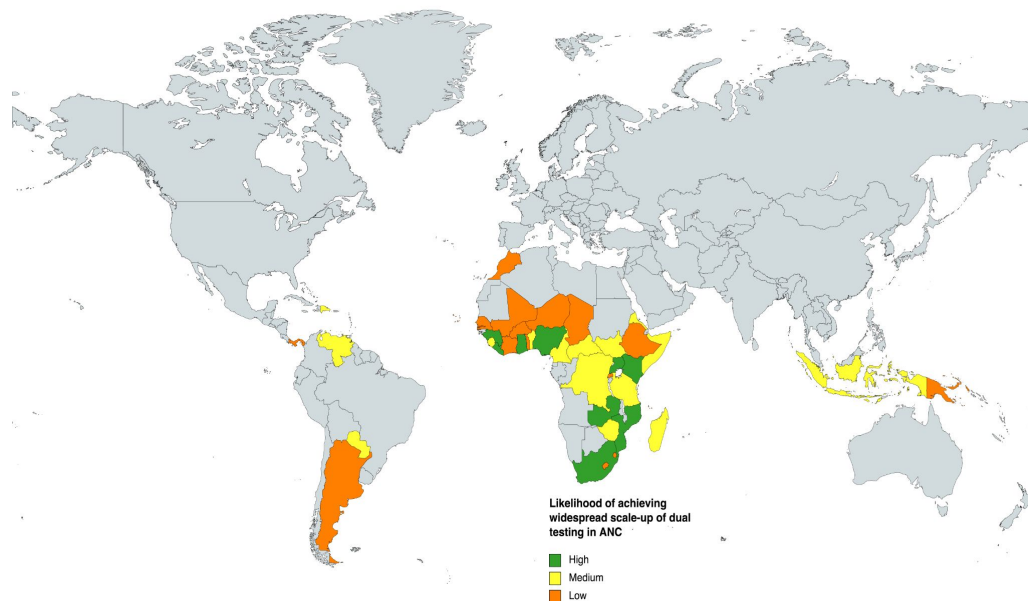
*Classifications were finalized in August 2022 and may not be reflective of any new information or changes since then.

Rapid replacement of facility testing with self-tests could increase HIVST volumes to 77m in 2027

Although HIVST policies have been widely adopted (see map on the next slide), the volumes are relatively low. The HIVST predominant scenario assumes that HIVST become the predominant programmatic approach, replacing a significant proportion of non-ANC professional use testing. The volume replacement assumes that HIVST will replace 50% of overall non-ANC testing budgets by 2026, and that the price of HIVST will decline over the same period. The procurement data analysed in the forecast indicate a current weighted average EXW price around $2 for HIVST products across all LMICs, manufacturers, and products. Taking into account the 2022 announcement of a $1 HIVST, this scenario assumes that the weighted average EXW price of all HIVST products will decline to $1 by 2026. Additionally, PrEP monitoring is transitioned in this scenario to using three HIVST and one professional RDT per user, per year starting in 2022.

Key takeaways

- HIVST replacement of professional use RDTs will increase HIVST volumes to 77 million in 2027.

- The higher price of HIVST products compared to professional use RDTs results in lower total test volumes than in the current approaches scenario as funding available for HIV RDT remains the same across scenarios.

- The total test volume shows an increase in 2026 as a result of the HIVST EXW price moving closer to $ 1, which is closer to the average price of professional use HIV RDTs (around $0.80).

### Figure 3.05: Integrated Forecast Results for the HIVST Predominant Scenario
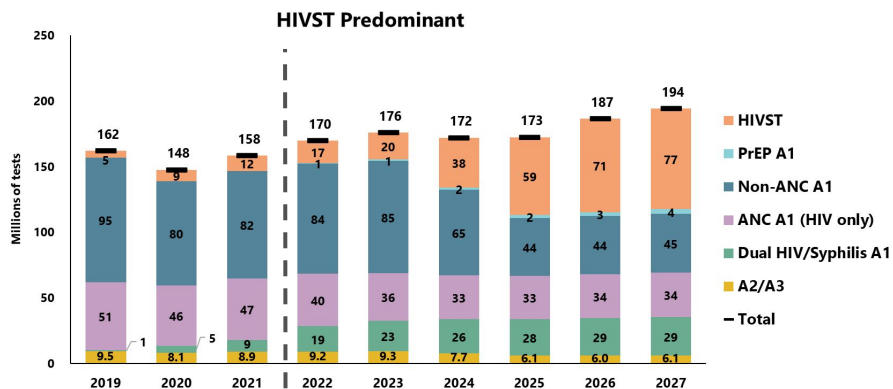
104 LMICs; China excluded; India test volumes excluded; Brazil test volumes excluded

EIC Integrated HIV RDT Forecast 2022-2027

For more details relating to the forecast methodology and results and the EIC procurement analysis please refer to Annex A2

HIV self-testing policy adoption

Figure 3.06: Global map of national policy on HIV self-testing and implementation status

Policy on HIVST implemented
Policy on HIVST but still not implemented
Policy on HIVST in development
No Policy
Data not reported
Not applicable

0   1000   2000   4000 km

Global AIDS Monitoring (UNAIDS/WHO/UNICEF) and Global HIV, Hepatitis and STIs Programmes (HHS), WHO, 2022
Map Production: WHO GIS Centre for Health, DNA/DDI
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As of July 2022:

- 98 countries have national policies supportive of HIV self-testing, of which 52 were routinely implementing the policy.

- 92 countries have products registered

- 30 countries are in the process of developing policies

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of WHO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

The combined scenario could see the dual HIV/syphilis test and HIVST contributing 61% of volumes in 2027, up from 13% in 2021

This scenario combines the assumptions of the HIVST predominant and dual HIV/syphilis optimistic scenario. Accordingly, the volumes seen here represent a shift to HIVST predominance in non-ANC settings and more countries achieving high coverage of dual HIV/syphilis in ANC settings.

Key takeaways

- The combined volume of dual HIV/syphilis tests and HIVST could grow from contributing 13% of the total volume of tests in 2021, to 61% in 2027

- The shift in testing strategy in this scenario could see the contraction of the non-ANC HIV-only professional use RDTs by 54 million A1 tests.

Figure 3.07: Integrated Forecast Results for the combined HIVST and Dual HIV/Syphilis Predominant Scenario
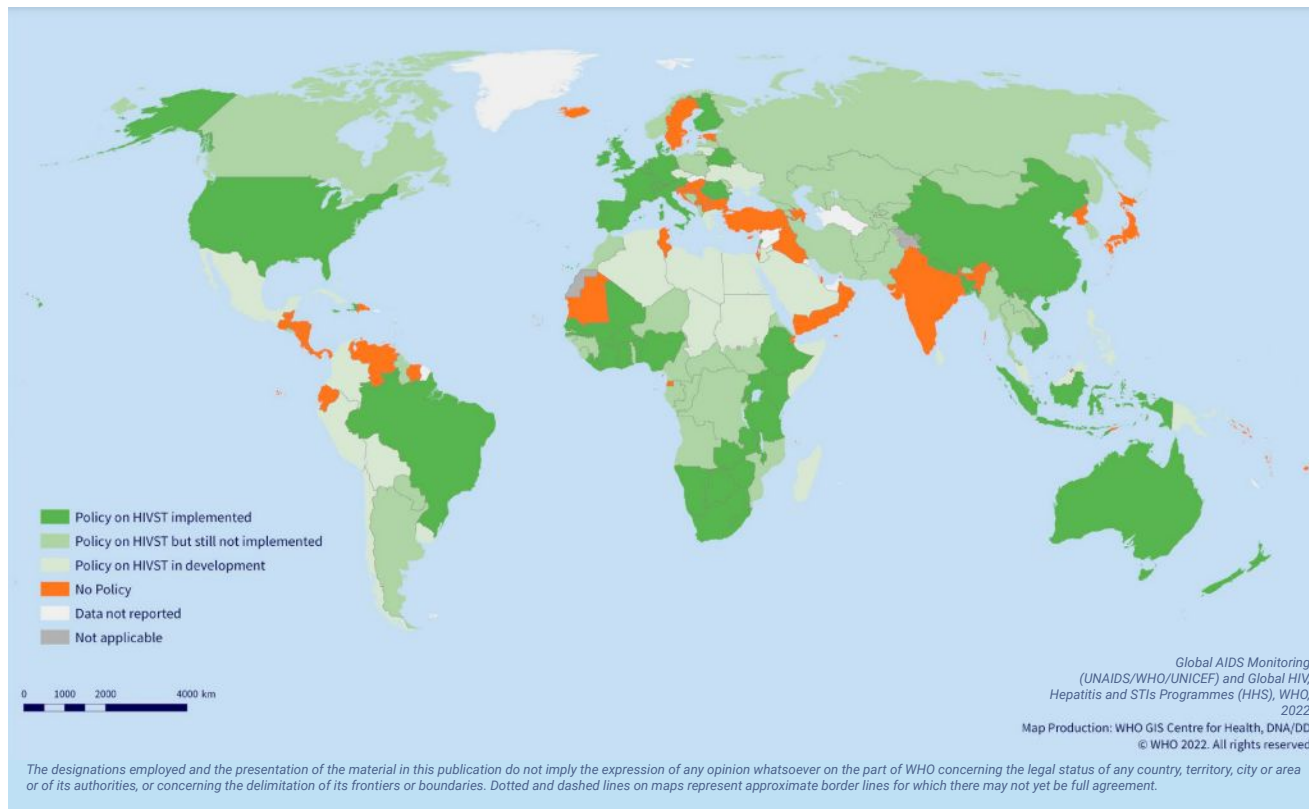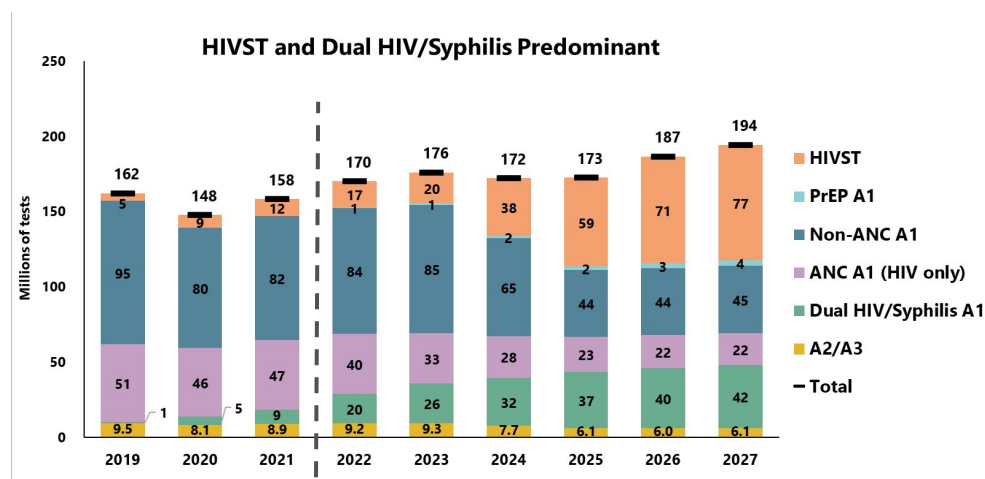

HIVST and Dual HIV/Syphilis Predominant

104 LMICs; China excluded; India test volumes excluded; Brazil test volumes excluded

EIC Integrated HIV RDT Forecast 2022-2027

Overall HIV RDT market size is projected to grow moderately over the forecast years with uncertainty about the product mix

The HIV testing market is projected to grow steadily from 2022 to 2027; the compound annual growth rate (CAGR) is 4.5% over 2021-2027. The average CAGR of 4.5% varies across regions from 1.0% in UNAIDS region Middle East and North Africa to 6.0% in UNAIDS region Asia and Pacific.

HIV testing will continue to be needed even when countries achieve 95% knowledge of status as part of a status neutral HIV testing paradigm that includes continued surveillance, case finding, prevention-focused testing, and testing as part of re-engagement in care.

The HIV RDT market size in LMICs is largely constrained by limited funding and competing priorities.

The HIV RDT market is headed to a possible inflection point as a result of the mix of HIV testing products available on the market. HIV testing policy and programmatic directions will determine the proportion of test types within the overall market.

Dual HIV/Syphilis test

The level of adoption of the dual HIV/syphilis test will be determined by funding and the adoption of policies to support the incorporation of the test into existing algorithms.

HIVST

Although many countries are adopting and implementing HIVST, the market remains relatively small. The scale of this market will depend on scale-up strategy, affordability (which is tied to market size and competition, discussed in the HIVST market section below), funding, and the impact or return on investment, such as the ability to scale-up PrEP and ART (i.e. creating a case for continued investment).

Figure 3.08: Integrated Forecast 2027 Results comparison across scenarios
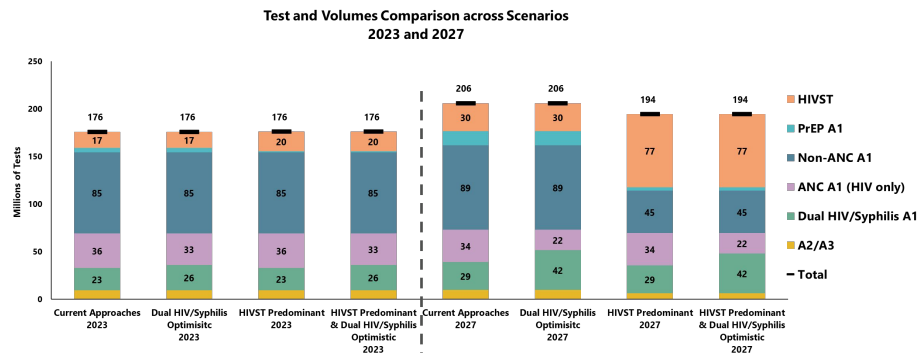
Test and Volumes Comparison across Scenarios 2023 and 2027

*104 LMICs; China excluded; India test volumes excluded; Brazil test volumes excluded

EIC Integrated HIV RDT Forecast 2022-2027

Forecast scenarios summarized

Table 3.01: Integrated Forecast scenario descriptions

HIV-only professional use RDTs ↑	Dual HIV/syphilis RDTs ↑ → HIV-only professional use RDTs ↓	HIVST ↑ → HIV-only professional use RDTs ↓	Dual HIV/syphilis RDTs ↑ HIVST ↑
Current Approaches Scenario	**Dual HIV/Syphilis Optimistic scenario**	**HIVST-predominant scenario**	**HIVST predominant and Dual HIV/syphilis optimistic**
Countries with high knowledge of status among PLHIV will see minimal growth in non-ANC test volumes, and countries with low knowledge of HIV status will have more rapid growth. Once countries reach the first 95, testing volumes will not drop significantly but will plateau as surveillance, index testing, testing for re-engagement, testing in key populations and social networks, and prevention-focused testing continues. ANC testing will remain a priority as countries strive to eliminate mother-to-child transmission.	17 more countries, added to the 36 in current approaches, are assumed to be likely to achieve 95% coverage of ANC HIV testing with the dual HIV/syphilis RDTs, hence a more optimistic approach is applied to the scope of countries that will be able to implement dual HIV/syphilis testing at scale by the end of the forecast.	HIVST becomes the preferred programmatic approach, outside of ANC settings, replacing a significant proportion of non-ANC A1 professional use testing. The model assumes a conversion of volumes from 2022 where HIVST replace 50% of overall non-ANC testing budgets by 2026. The model also assumes that PrEP monitoring is done primarily via HIVST, using three self-tests and one professional RDT per user, per year.	The assumptions of the Dual HIV/Syphilis Optimistic and HIVST Predominant scenarios are combined. Countries shift to HIVST preferentially in non-ANC settings and more countries achieve high coverage of the dual HIV/syphilis test in ANC.

4

Professional-use HIV RDT market

Professional-use HIV RDTs include traditional HIV-only RDTs and dual HIV/syphilis RDTs that test for both diseases using one sample.

These tests are performed by healthcare workers and are always part of a testing algorithm wherein multiple tests are needed to diagnose HIV infection. HIV RDTs or dual tests can be used as the first test in an algorithm ("Assay 1" or "A1"), in which case they are used in high volumes. HIV-only RDTs in the second and third spots of an algorithm (i.e. the "A2" and "A3") are used in low volumes, because only A1 reactive results are tested, and the vast majority of A1 tests will be non-reactive.

Self-tests are not part of the algorithm for diagnosing HIV. They are "tests for triage" and are usually designated as "Assay 0" ("A0"). HIVST are considered in the next section because the self-test market differs from professional RDTs in several fundamental ways, including different value propositions, distribution channels, product selection processes, and market maturity.

HIV professional RDT market overview

The professional RDT market comprises two test types 1) the more common HIV-only RDTs and 2) dual HIV/syphilis RDTs, which are increasingly replacing HIV RDTs in antenatal settings.

After years of growth, professional RDT demand dropped in 2020 due to policy changes and pandemic-related disruptions.

Although in 2022, demand is recovering, future growth is expected to be more modest, driven by testing to achieve global targets for treatment and by PrEP (see previous sections, especially forecast (Section 3) for more information).

2022 HIV RDT volumes are estimated to be ~135m RDTs, with a market value of $124m. Dual HIV/syphilis test demand is rapidly growing, from 0.8m in 2018 to ~20m in 2022. Because prices are considerably higher than HIV-only RDTs, the dual HIV/syphilis RDT market value is ~$29m.

> **" 2022 HIV RDT volumes are estimated to be ~135m RDTs, with a market value of $124m. "**

Figure 4.01: Estimated Commodities Market Value for professional RDTs based on Integrated Forecast projection

Estimated Commodities Market Value for Professional Use HIV-only and Dual HIV/Syphilis RDTs

- HIV-only RDT A1 at $0.88 per test
- HIV RDT A2/3 at $1.41 per test
- Dual HIV/Syphilis RDT A1 at $1.48 per test
- Total
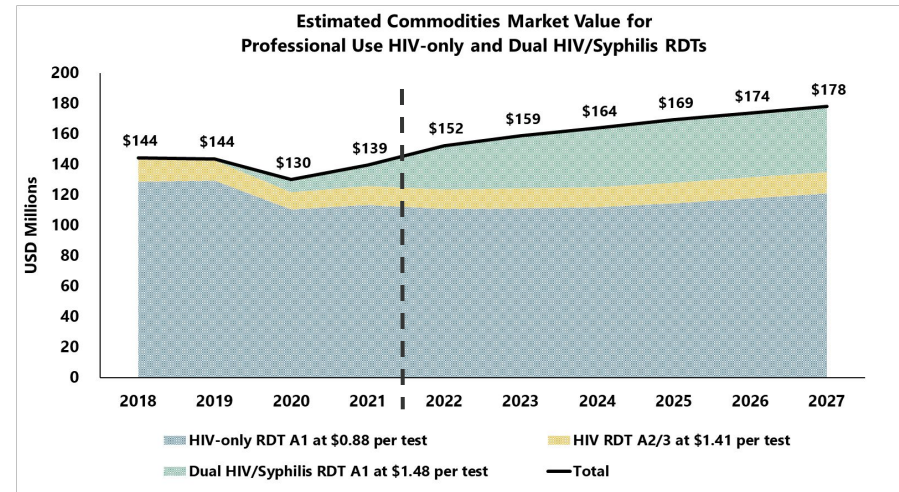
Note: Volumes from the Current Approaches scenario; excludes China, India, and Brazil
Market size assumes current weighted average prices (Prices for A1 RDTs using 2022 WAP; price for A2/3 RDT estimated at 1.6x the WAP of the HIV-only A1 RDT; multiplier also derived from EIC procurement analysis)
Sources: EIC Integrated HIV RDT Forecast 2022-2027; EIC Procurement data analysis

Three tests are needed to diagnose HIV

To ensure accuracy, an HIV positive diagnosis requires a series of three reactive HIV rapid tests.* WHO's minimum acceptable performance for an individual test is >99% sensitivity and >98% specificity. WHO further recommends that a series of tests be used to achieve at least 99% positive predictive value ((PPV), e.g., less than one false positive per 100 people diagnosed with HIV). Historically, two tests were used to diagnose HIV, however, increasingly, as HIV test positivity rates decline, WHO recommends three consecutive reactive tests to maintain this 99% PPV.

Typically, a test with the highest sensitivity serves as Assay 1 ("A1"), the first test in the algorithm, to maximize HIV detection. From a product development perspective, optimizing sensitivity often occurs at the expense of lower specificity. Thus, this first highly sensitive test will produce some false positives. The second and third tests in the algorithm are used to rule out any false positives. WHO recommends high specificity RDTs for Assay 2 and 3 ("A2" and "A3").

Countries typically have thousands of testing sites. To ensure quality and to standardize testing across all sites, a **national HIV testing strategy** outlines the order in which tests are performed and how the results inform HIV diagnosis. This testing strategy dictates how many tests are performed for a positive HIV diagnosis (i.e. two or three different assays). Once the testing strategy is established, national HIV programmes verify an **algorithm with particular brands of test kits** used in the country. WHO advises not to use products from the same legal manufacturer in the algorithm and to verify the algorithms to prevent cross-reactivity. WHO also recommends verifying alternative products (i.e., more than one A1, three products that can be A2/A3).

As part of quality assurance measures, WHO advises countries to retest using the same testing strategy to verify the HIV status before initiating ART.

THREE TEST ALGORITHM ENSURES QUALITY HIV DIAGNOSIS

Figure 4.02: Three Test Algorithm Diagram
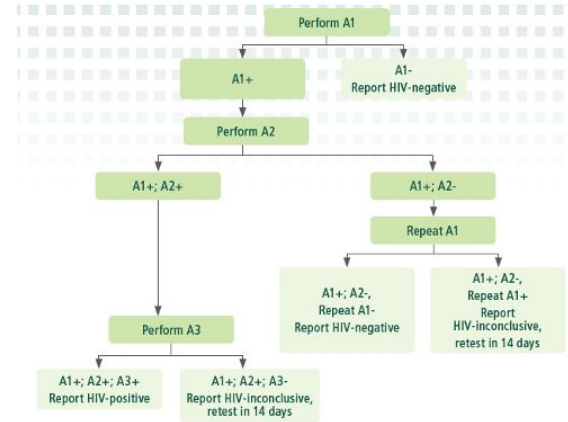
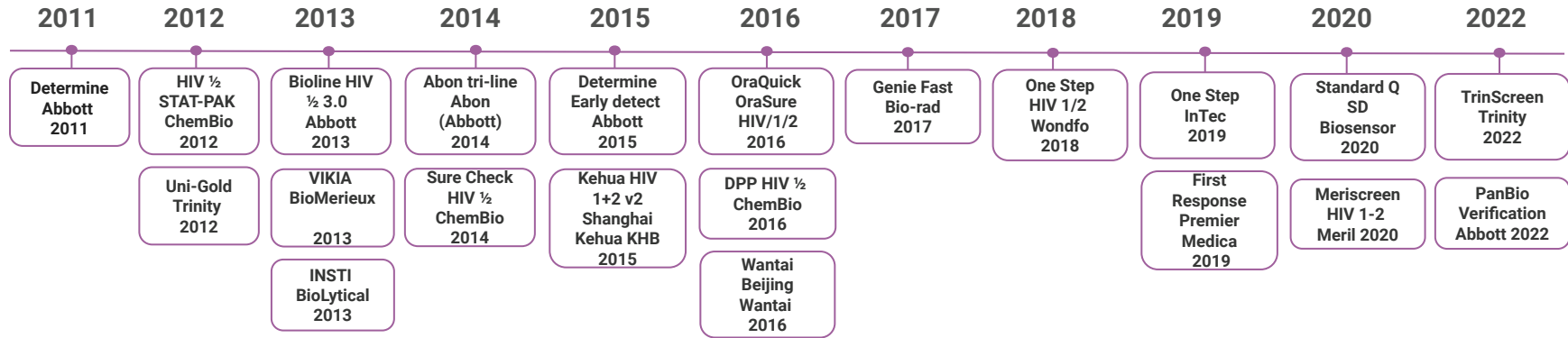Source: Consolidated guidelines on HIV testing services, WHO

There are many high quality HIV RDTs

HIV RDT Product Offering, by year of WHO Prequalification

Figure 4.03: Timeline of WHO Prequalification for HIV RDT Products

2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2022
Determine Abbott 2011	HIV ½ STAT-PAK ChemBio 2012	Bioline HIV ½ 3.0 Abbott 2013	Abon tri-line Abon (Abbott) 2014	Determine Early detect Abbott 2015	OraQuick OraSure HIV/1/2 2016	Genie Fast Bio-rad 2017	One Step HIV 1/2 Wondfo 2018	One Step InTec 2019	Standard Q SD Biosensor 2020	TrinScreen Trinity 2022
	Uni-Gold Trinity 2012	VIKIA BioMerieux 2013	Sure Check HIV ½ ChemBio 2014	Kehua HIV 1+2 v2 Shanghai Kehua KHB 2015	DPP HIV ½ ChemBio 2016			First Response Premier Medica 2019	Meriscreen HIV 1-2 Meril 2020	PanBio Verification Abbott 2022
		INSTI BioLytical 2013			Wantai Beijing Wantai 2016					

The HIV RDT market is well-established; there are many high-performing, quality-assured tests, including 20 on-market WHO prequalified RDTs. One PQ-ed test, Vikia by BioMerieux, is no longer marketed. At least one professional RDT is in the WHO PQ pipeline, an oral HIV-only professional test by Sedia.

Four products have become PQ-ed since 2020, suggesting ample business opportunity, especially for products that can trigger an algorithm update or potentially secure a sizable market share in the A1 position.

List prices for tests (EXW) range considerably; for example, WHO pricing ranges from $0.49 to $3.00 for professional tests, and Global Fund reference prices for WHO PQ-ed tests range from $0.51 to $1.32.

Differences in operational characteristics

In terms of format, most are cassette-based. Some have a single test line, while others have two lines, differentiating between HIV1 and HIV2. One of the PQ-ed RDTs uses a flow-through technology, which enables immediate results reading as opposed to the majority of tests that require 10-15 minutes of processing time. Results are usually stable for 10 minutes. However, two must be read within a 2-minute window, while the market-leading test is stable for 45 minutes. All accept fingerstick blood, and three of the PQ-ed HIV RDTs accept oral fluid. For most, processing comprises two steps, and a few are more involved (4-6 steps). While all companies pack multiple RDTs in boxes, pack sizes vary, as do options for accessory inclusion. The market-leading test has streamlined design and packaging (a sheet of perforated strips without plastic housing). (See annex for photos)

Overall the tests are reasonably fit-for-purpose, although there are shortcomings (e.g. short read time windows, large pack sizes, limited heat stability, compatibility with quality controls).

Three prequalified HIV/syphilis RDTs

Dual test product offering (by year of WHO Prequalification)

Figure 4.04: Timeline of WHO Prequalification for Dual Test Products

2015	2019	2020
Bioline **Abbott** **2015**	**First Response** **Premier Medical** **2019**	**Standard Q** **SD Biosensor** **2020**
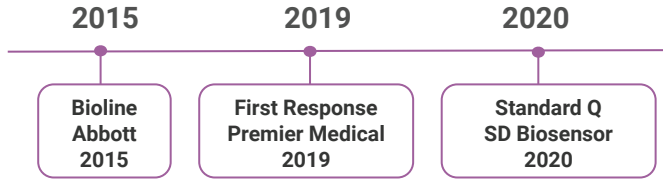
There are 3 PQ-ed dual tests. At least two additional suppliers (with PQ-ed HIV-only RDTs) are developing dual tests and plan to submit to WHO PQ in 2023/2024; the pipeline of dual tests is likely sufficient, considering the small but growing market size.

Some RDT manufacturers noted that the lack of a local market (e.g. syphilis testing in China is predominantly lab based) discourages investment in dual test development because even if they see a viable export-only business, they may still need to conduct local registrations and trials to obtain an export license.

The prices vary; for example, Global Fund Reference prices for PQ-ed dual tests range from $0.95 to $1.50 (EXW).

Global Fund reference prices for professional tests:
https://www.theglobalfund.org/en/sourcing-management/health-products/hiv-malaria-rapid-diagnostic-tests/

PQ pipeline

- none -

Pipeline

PQ-ed supplier PQ submission 23	2 additional PQ-ed suppliers
PQ-ed supplier PQ submission 24	2 additional suppliers with CE marked products (no PQ)

Likely others, QMS unknown
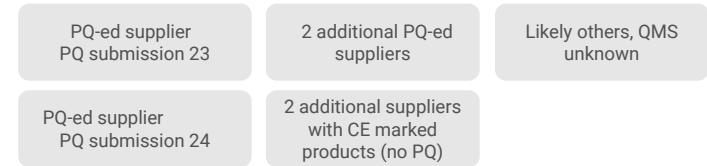
Operational characteristics

The dual tests are all cassette-based, accept capillary blood, and have two processing steps. Operational differences include:

- The number of test lines: Bioline and First Response have one HIV1/2 test line and one syphilis test line. Standard Q has 3 test result lines: HIV1, HIV2, and syphilis (See annex for photos).
- While they are all read at 15 minutes, First Response results are stable for 10 minutes, while the others must be read within five minutes.
- Standard Q is stable up to 40C, the others are stable up to 30C.

Performance of HIV RDTs and dual HIV/syphilis RDTs

HIV-only RDT performance

All prequalified HIV-only RDTs perform well. Slight differences in performance make some better suited than others for the A1 or the A2 and A3 spots in an algorithm.

These differences can be hard to appreciate. For example, all but five PQ-ed tests have 100% sensitivity, but they differ in how soon after infection they can detect HIV. Sensitivity seroconversion indices measure this, but comparable data are not available for every test. (see Annex for more details).

Additionally, one PQ-ed test (Determine Early Detect) has added detection of the p24 antigen on a separate test line, aiming to detect HIV sooner than other tests. (see Annex for more details on antigen/antibody or "4th generation" RDTs).

Specificity also varies; the most specific tests are usually used in the A2/A3 position. Optimally, A1 tests can have high specificity; more specific A1 tests generate fewer false positives requiring additional A2/A3 testing.

HIV/Syphilis RDT performance

Dual tests are always used in the A1 position, and the available dual HIV/syphilis RDTs all have 100% sensitivity for HIV. There are slight differences in their seroconversion indices (see Annex) and they all have 99.5% specificity for HIV.

Syphilis performance differs: Bioline's syphilis sensitivity in WHO product evaluations is 87%, which is at the bottom of the acceptable range.* while First Response is 99% and Standard Q is 95.5%.

For further info on suppliers and tests please refer to Annex A4, A5 and A6.

Despite many PQ-ed RDTs, one company's products dominate

Figure 4.05: Product share (by volume) of Professional HIV RDTs

Legend:
- Uni-Gold
- First response (2.0)
- OraQuick
- STAT-PAK
- Beijing Wantai RDT
- Abon Tri-Line
- Determine Ag/Ab (any version)
- Determine
- Bioline (3.0)

In the donor funded-LMIC market, HIV RDT market share (by volume) is consolidated around Abbott products (Determine, Bioline, Abon), even though over the period 2016-2022, 26 different products were procured.

The Determine test was the first to be PQ-ed (2011) and has high sensitivity (100% sensitivity and high seroconversion index), which makes it well suited for the A1 spot.

The Bioline test was initially marketed by Standard Diagnostics, a company now owned by Abbott. It is now the second-leading test by volume.

Pricing for these tests is $0.80-0.90 EXW. There are several similarly high-performing tests at lower-prices, as well as several higher-priced tests on the market.

Source: EIC Procurement data analysis

Note: Abbott and predecessor companies (e.g. Alere, Standard Diagnostics) have marketed several Ag/Ab tests. In 2009 an initial Ag/Ab RDT was introduced; it is no longer on the market. In 2015 the current Ag/Ab test was launched as the Alere HIV Combo, in 2020, it was renamed Determine HIV Early Detect. Additionally, Standard Diagnostics (now an Abbott company) marketed an Ag/Ab RDT (Bioline Ab/Ag).

The dual HIV/syphilis RDT market is growing, but highly consolidated

Figure 4.06: Product share (by volume) of Dual HIV/Syphilis RDTs
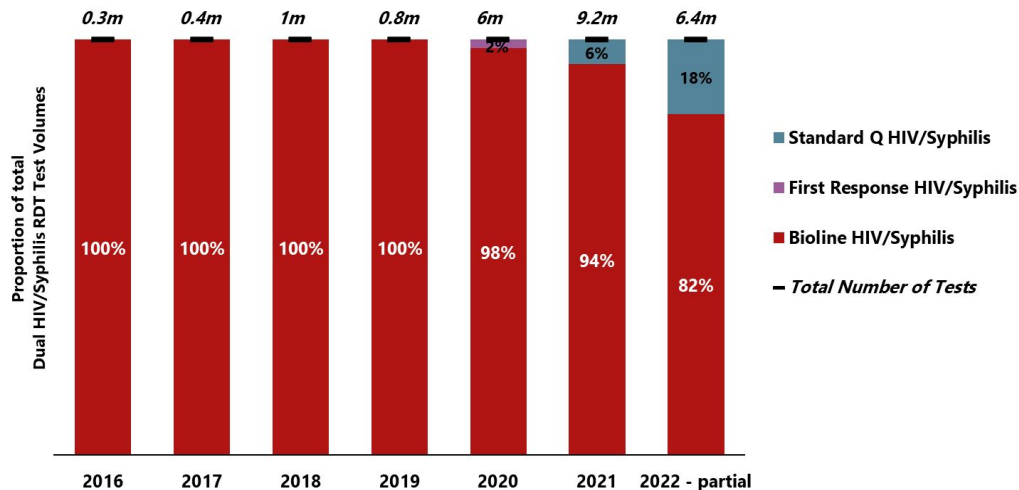
Legend:
- ■ Standard Q HIV/Syphilis
- ■ First Response HIV/Syphilis
- ■ Bioline HIV/Syphilis
- − *Total Number of Tests*

The Bioline dual HIV/syphilis RDTs currently dominate the dual test market. The Bioline dual HIV/syphilis RDT was first to market (WHO PQ-ed in 2015) and was the only option for a considerable period of time until two additional tests were prequalified in 2019 and 2020.

Bioline is the highest-priced dual test ($1.50 EXW with accessories), and while its HIV performance is high, its syphilis performance is below that of other PQ-ed tests. The First Response and Standard Q dual tests are priced below the Bioline at $1.15 and $0.95, respectively.

Despite growth in dual test markets, most countries that were early adopters of the dual test have not switched to lower-cost options, partly because a substantial lead time is associated with switching RDTs (described later).

Source: EIC Procurement data analysis

Dominance is partly explained by large market sizes for the first assay in the algorithm

The A1 test typically comprises >90% of a country's annual test volumes. Because the vast majority of people testing for HIV today will test negative, the A2 and A3 test volumes are considerably smaller than A1 test volumes. While some products tend to occupy a specific position in the testing algorithm, the procurement data also show that there are some products appearing in either the A1 and the A2/A3 positions.
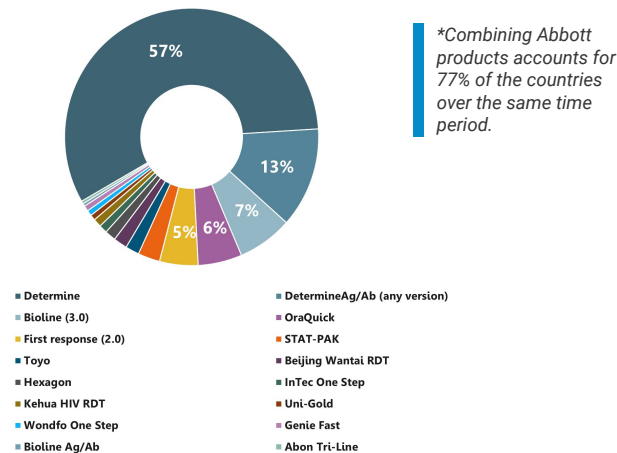
The dominance of Abbott products in the professional test market is partly explained by their being optimized for sensitivity, which is important for the first assay in the algorithm. Additionally, they are among the first-to-market products for HIV-only RDTs and dual HIV/syphilis RDTs. Additionally, Determine's flat packaging and paper housing minimize storage and waste.

Tests in the A2 and A3 positions tend to be highly specific. Leading brands are Unigold and STAT-PAK, also among the first-to-market tests, and when purchased in low volumes (i.e. A2/A3 position), two of the higher-priced tests on the market. Higher prices for the A2 and A3 position tests may be justified because volumes are low compared to A1 products. In the case of the market-leading A2 and A3 tests, higher pricing may also result from production economics (e.g. moderate-sized lateral flow production, high-cost labor).

Notably, many tests are well suited for both the A1 or the A2/A3 positions in the algorithm and these are offered at lower prices than the market leaders. These tests came to market later, and their market penetration has been limited.

See annex for procurement data analysis of price variation for market-leading products

Figure 4.07: Percentage of countries selecting the indicated product for "A1" in their algorithm, 2019-2022 (n=268 data points)

Combining Abbott products accounts for 77% of the countries over the same time period.

Legend:
- Determine
- Bioline (3.0)
- First response (2.0)
- Toyo
- Hexagon
- Kehua HIV RDT
- Wondfo One Step
- Bioline Ag/Ab
- DetermineAg/Ab (any version)
- OraQuick
- STAT-PAK
- Beijing Wantai RDT
- InTec One Step
- Uni-Gold
- Genie Fast
- Abon Tri-Line

Source: EIC Procurement data analysis

Limitation: several high volume HIV RDT countries lack accessible procurement data (e.g. South Africa, Kenya, India, Indonesia, and Brazil) therefore, they are not represented in these findings.

Dominance also explained by 'sticky' algorithms

Algorithms tend not to change

Although countries typically procure RDTs annually, algorithm reviews are less frequent, rendering **the products selected 'sticky.'** Since algorithm reviews are the only time new suppliers can engage in a country's market, so if the reviews are infrequent, it **slows the adoption of alternative products** (new technologies like dual HIV/syphilis tests, more affordable tests, etc.).

WHO recommends updating the algorithm every 3-5 years. The frequency of algorithm reviews is not formally tracked. However, some information can be gleaned from two sources: 1) Low compliance with the 2019 WHO recommendation that countries adopt a three-test strategy, and 2) country-level analysis of procurement data showing infrequent switching of the A1 test in several high-volume donor-funded countries. (See charts at right)

Information about why countries are not switching to more affordable products was limited. Anecdotally, reasons for not switching tests include the high performance of Determine and reluctance to change something that is performing well; low awareness of new products; the programmatic costs of switching tests (supply chain, training, job aids, reporting forms, etc.), especially considering the highly decentralized nature of HIV testing; and the Determine strip format and packaging which is more streamlined than other on-market cassette based tests (See Annex photo).

The 2019 WHO recommendation to adopt a three-test strategy and dual test also presents an opportunity to switch tests (as adding a dual test and moving from a two-test strategy to a three-test strategy requires algorithm verification). Compared to the past, these policies are increasing algorithm reviews. However, the pace is still slow, partly because attention was diverted during the Covid-19 pandemic

Figure 4.08: Adoption of 3-test strategy by region

87 out of 194 countries responded to question

Source: Global AIDS Monitoring (UNAIDS/WHO/UNICEF) and Global HIV, Hepatitis and STIs Programme (HIS), WHO, 2022
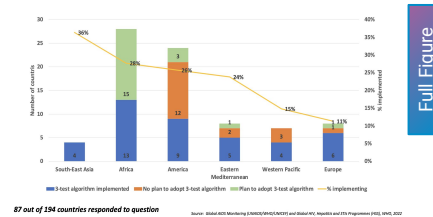
Figure 4.09: Most procured test (presumed A1) by year, for countries in procurement data set with the largest volumes of Professional HIV RDTs

Country	2016	2017	2018	2019	2020	2021	2022
Nigeria	Determine	Determine	Determine	Determine	Determine	Determine	Determine
Tanzania	Bioline (3.0)	Bioline (3.0)	Bioline (3.0)	Bioline (3.0)	Bioline (3.0)	Bioline (3.0)	-
Uganda	Determine	Determine	Determine	Determine	Determine	Determine	Determine
Mozambique	Determine	Determine	Determine	Determine	Determine	Determine	Determine
Ethiopia	First response Beijing Wantai	STAT-PAK	STAT-PAK	STAT-PAK	STAT-PAK	STAT-PAK	
Zambia	Determine	Determine	Determine	Determine	Determine	Determine	Determine
Malawi	Determine	Determine	Determine	Determine	Determine	Determine	Determine
Congo, Dem. Rep.	Determine	Determine	Determine	Determine	Determine	Determine	Determine
Cameroon	Determine	Determine	Determine	Determine	Determine	Determine	Determine
Zimbabwe	Determine	Determine	Determine	Determine	Determine	Determine	Determine
Côte d'Ivoire	Determine	Determine	Determine	Determine	Determine	Determine	Determine
Kenya	Determine	Determine (A	-	Determine	First response	Determine	Determine
Rwanda	STAT-PAK	Determine 4t	Determine 4t	Determine (A	Determine	Determine 4t	Determine 4th G
Ghana	First response	First response	First response	First response	First response	First response	OraQuick
Haiti	Determine	Determine	Determine	Determine	Determine	Determine	
Lesotho	Determine	Determine	Determine	Determine	Determine	Determine	-

Note: Procurement data do not indicate how frequently algorithms reviews are conducted because the review may result in selecting the same tests. However, it can be used to identify changes in the highest volume test, presumably the "A1" test, procured in a given year.
Limitation: several high volume HIV RDT countries lack accessible procurement data, South Africa, Kenya, India, Indonesia, and Brazil.

Source: EIC Procurement data analysis

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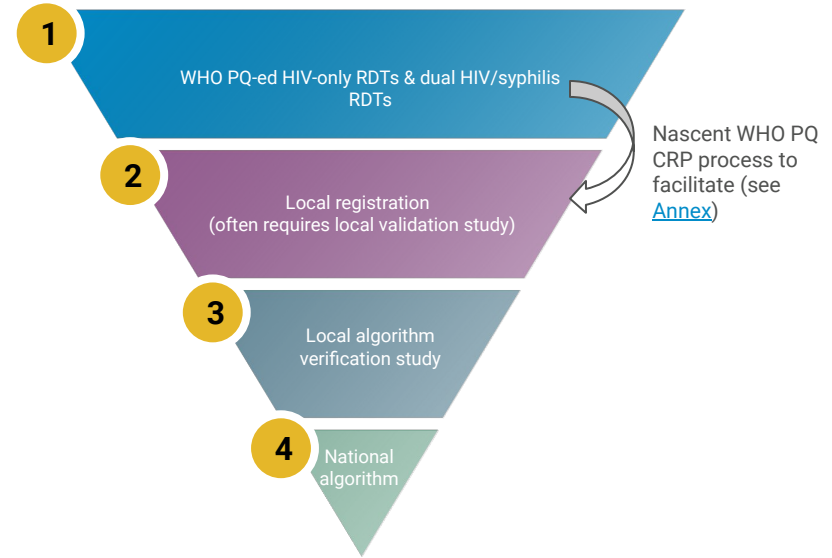# Algorithms are 'sticky' because product selection process is complex and long (1 of 2)
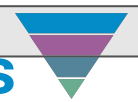
1 Generally, the WHO PQ-ed list of HIV-only RDTs and HIV/syphilis RDTs is the starting point for LMICs selecting RDTs for their national algorithm.

2 Many national programmes do not rely solely on WHO PQ review (or the manufacturer's claims); they prefer to also evaluate tests locally. Among the reason for this are concerns about how the test performs in local populations.

WHO does not recommend repeating locally clinical performance studies for PQ-ed tests as expanded post-market surveillance by manufacturers is expected to detect and act on any country-specific issues. To reduce local studies, in 2021 WHO introduced a collaborative registration procedure (CRP) whereby, with supplier permission, WHO PQ facilitates sharing the full dossier and files from its review with the local regulatory authority. This process is new in many countries and is an underutilized pathway that has yet to reach its full potential, so the impact remains to be seen. (See Annex for more information on CRP)

Figure 4.10: Process for incorporating HIV RDT into National algorithm

- **1** WHO PQ-ed HIV-only RDTs & dual HIV/syphilis RDTs
- **2** Local registration (often requires local validation study)
- **3** Local algorithm verification study
- **4** National algorithm

Nascent WHO PQ CRP process to facilitate (see Annex)

Algorithms are 'sticky' because the product selection process is complex and long (2 of 2)
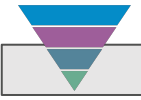
3 WHO does recommend conducting **an algorithm <u>verification study</u>** to minimize false reactivity (i.e. false positives). More specifically, the intent of algorithm verification is to minimize the probability that any specimen that is falsely reactive on the first assay (A1) is also falsely reactive on the second assay (A2) and third assay (A3). In other words, the three tests in the algorithm must be selected to minimize cross-reactivity.

The verification study involves testing 8-10 RDTs against a panel of locally derived negative samples to assess how many tests react false-positive on the same samples. The goal is to identify and select tests that do not overlap in false reactivity or to minimize shared false reactivity.

Verification studies are necessary because there are concerns that some of the on-market tests are rebranded versions of others or that they use the same raw materials. For commercial reasons, suppliers protect the source of their raw materials, i.e. the source of raw materials is not public. If an RDT in the algorithm is too similar to other tests in the algorithm, it does not actually add value when used in combination.

4 **The verification results are used to establish the principal algorithm and to identify several alternative tests.** WHO recommends countries select two RDTs for the A1 position in the algorithm (a principal test and an alternative) and three for the A2/A3 positions. Qualifying multiple suppliers is recommended for supply security purposes (WHO 2019). For simplicity, if a country uses a dual test for A1 for a given population, the A2 and A3 should be the same as they are in the conventional HIV RDT algorithm.

Ultimately, **developing an algorithm is like solving a puzzle**, where sensitivity prioritizes some tests for A1 (HIV RDT or dual), specificity drives the A2 and A3 spots, and cross-reactivity precludes some combinations of tests. Notably, **no 'off the shelf' suite of products is available. Each country's national reference laboratory must customize a suite of products working in combination.**

Given the importance of algorithm updates (e.g. having three tests for quality, introducing dual tests), WHO has developed a <u>toolkit</u> to help and is providing technical assistance to many countries.

Algorithm verifications are time consuming: procurement of tests to study is the biggest bottleneck

| Plan & purchase materials (7-16 months) | Conduct verification (1 month) | Pilot algorithm (2 months) | National rollout |

Plan & purchase materials (7-16 months)
- Develop protocol and seek ethics review board (ERB) approval
- Pre-select ~8-10 RDTs for the study, usually tests must be locally registered, which may require a local performance validation
- Develop and secure budget
- Select study sites and train staff who will collect specimens and perform testing
- **Order and receive RDTs and materials (6-15 months)**

Conduct verification (1 month)
- Train staff to collect specimens, perform testing
- Establish verification panel
- Perform verification: test each candidate product
- Analyse results
- Select algorithm

Pilot algorithm (2 months)
- Develop training materials and job aids
- Revise quality assurance (QA) plans as needed
- Revise indicators, monitoring and evaluation (M&E), and facility registers
- Run pilot
- Analyse results, acceptance, and feasibility

Experts suggest that no single product characteristic drives product selection; i.e. countries prioritize different characteristics. For example, some countries focus on heat stability profiles, while others focus on reducing costs or complexity for test operators.

Updating the algorithm, and switching tests, is resource intensive for programmes

Maintaining the quality of testing is paramount

Programmes are reluctant to switch tests because the cost of rolling out new tests can be expensive. Because quality is so critical in HIV testing, it is important for programmes to ensure health worker familiarity with each test in the algorithm. Testing networks are highly decentralized, and many test operators are lay people who have been trained in HIV testing.

The rollout of a new test algorithm may involve the following:
- Revise national testing guidelines (as necessary)
- Develop a national plan and budget for introduction that will reach thousands of healthcare workers (predominantly lay people), in a highly decentralized network, including training (usually in a dedicated session)
- Revise indicators, print new M&E forms, and facility registers
- Revise quality assurance plans as needed
- Quantify and procure, update stock management tools
- Perform training
- Distribute new tests, job aids, and M&E materials
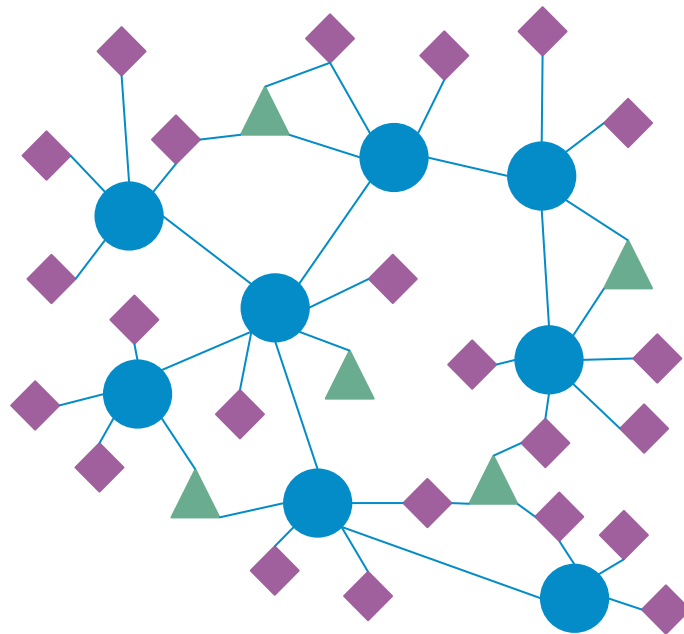
Health networks, including testing networks can be highly decentralised, which can contribute to high product and algorithm switching costs.

High average test prices, unchanged over time

Figure 4.11: Weighted Average Price per test for HIV-only RDTs and Dual HIV Syphilis RDTs
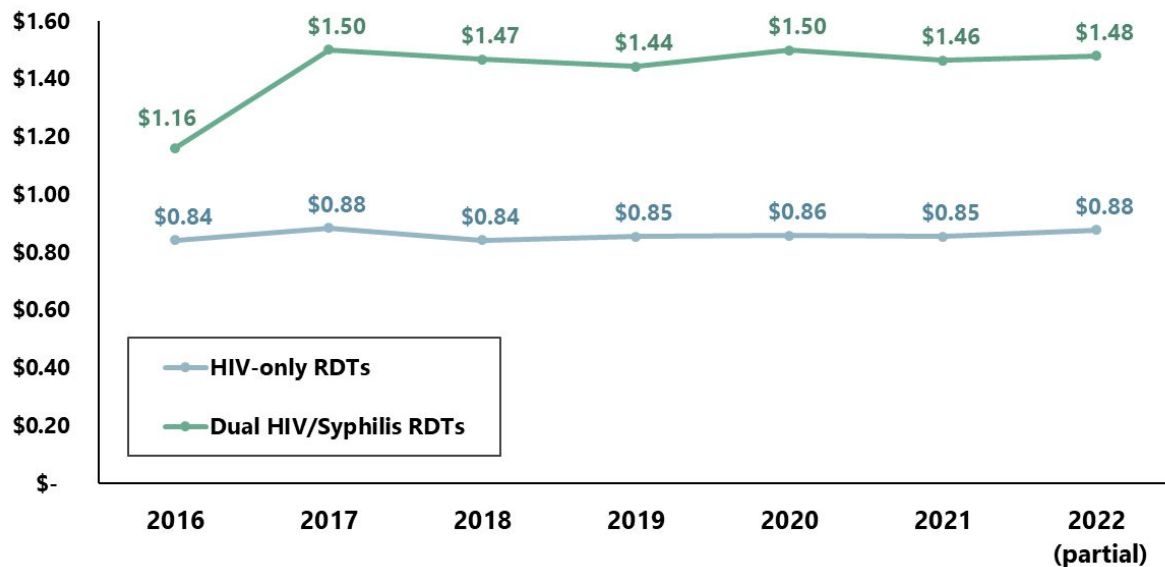
Overall, weighted average prices (i.e. based on actual procurement) in the donor-funded LMIC market for HIV-only RDTs and HIV/syphilis RDTs have remained steady over time.

Source: EIC Procurement data analysis, EXW data only

Note: 2016 dual test price is driven by one low priced order delivered to Sudan.

Lower priced HIV-only RDTs are available

Figure 4.12: HIV-only RDT Product market share, WHO pricing, and procurement weighted average prices per test (EXW, USD)

■ Product Market Share 2021   ◆ WHO Price per Test   □ Product specific WAP 2021
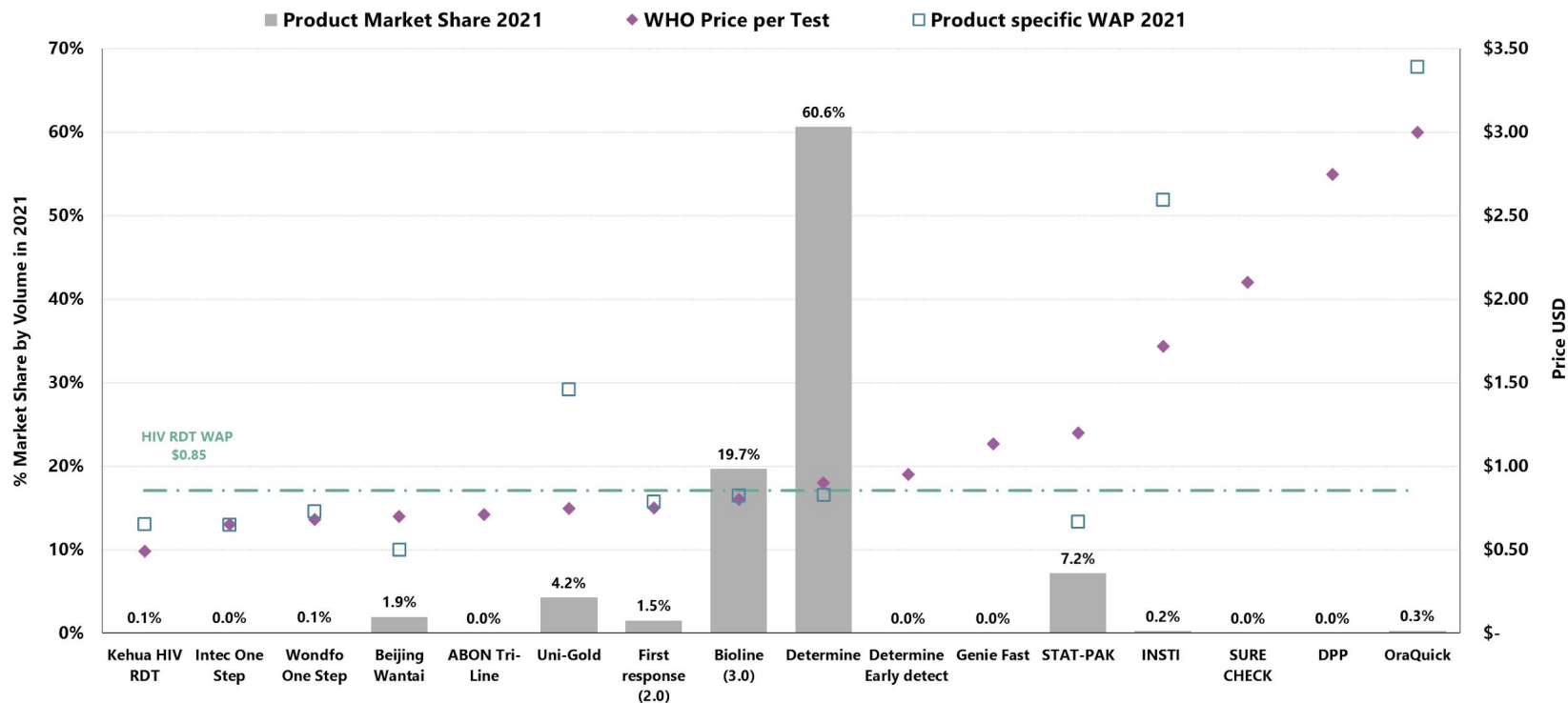
*For several new to market HIV RDTs, WHO does not have a price yet, so they have been excluded (Meriscreen, Standard Q, and TrinScreen)
*One WHO product (Geenius HIV ½ Confirmatory Assay has a price of 18.34 USD and no volume so it has been excluded from this chart to avoid distorting price axis
*Prices reported in EUR were converted to USD at an exchange rate of 1.05 USD per 1.00 EUR

Source: EIC Procurement data analysis, ex-works data only

Lower priced dual HIV/syphilis RDTs are available

Figure 4.13: Dual HIV/Syphilis RDT Product market share, WHO pricing, and procurement weighted average prices per test (EXW, USD)
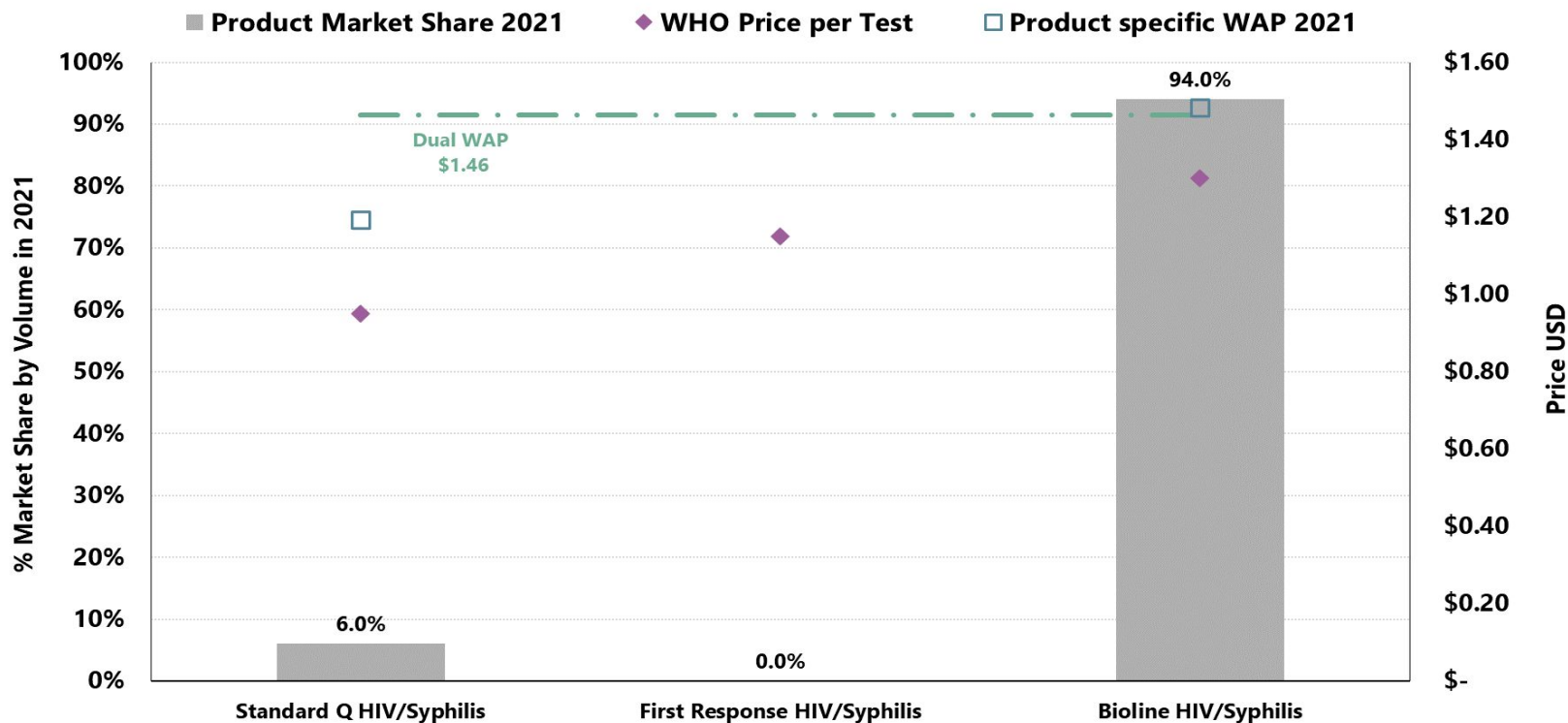
Source: EIC Procurement data analysis, EXW data only

Switching to lower priced products provides an opportunity for savings

Considering the market share (by volume), the Abbott products (Determine and Bioline) drive the WAP. Notably, alternative high-performing RDTs (e.g. 100% sensitivity and similar seroconversion indices on the WHO product evaluations) are well suited for the A1 spot and less expensive than Determine and Bioline. These have not penetrated the market, but their adoption could result in annual savings (see chart for an illustrative example).

Lower-priced professional tests

At the lower end of the price range (e.g. WHO pricing <$.80) are many tests produced by high-volume manufacturers and/or by manufacturers located in middle-income countries with strong lateral flow ecosystems (for further discussion, see supply section). The least expensive tests are all produced in China, followed by India.

Higher-priced professional tests

Tests at the higher end of the price range (i.e. WHO pricing >$1) tend to be:
- Differentiated in some way by their design features (e.g. accommodating oral samples, rapid time to results)
- Multiplex tests, i.e. HIV/syphilis tests
- Marketed in HICs as well as LMICs, and largely produced in HIC, by moderate-scale manufacturers.

Figure 4.14: Estimated savings at various HIV RDT prices

Potential Costs and Savings with price changes in HIV RDTs

| | Total Costs | Total Savings |
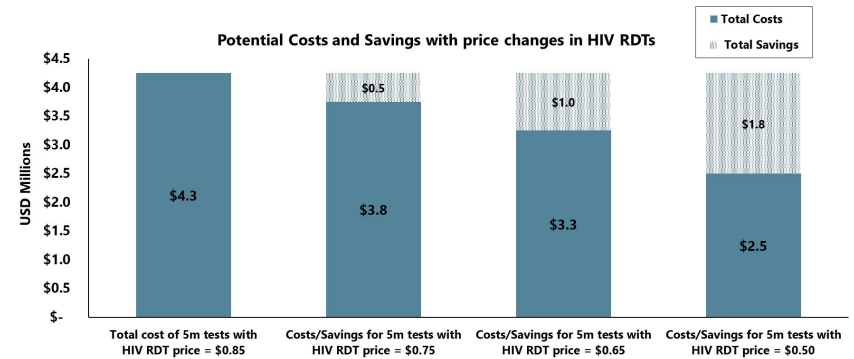
*Chart assumes a country procures 5m A1 HIV RDT.

This chart illustrates the potential savings of switching the A1 HIV RDT to a lower price for an example country that buys 5 million A1 tests/year at $0.85 per test. The savings must be considered against the programmatic costs of switching RDTs (e.g. job aids, trainings etc). Another consideration is that the increasing use of dual HIV/syphilis RDTs and HIVST in the absence of increased budgets would reduce the overall A1 RDT volumes. For example, a third of a country's A1 could be dual HIV/syphilis RDTs which have an average price higher than 0.85 USD resulting in fewer tests purchased with the same budget.

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Because three tests are needed to diagnose HIV, a market that supports a large number of tests is essential

Table 4.01: Number of countries that purchased indicated product by year (HIV RDTs)

Product	2016	2017	2018	2019	2020	2021	2022 (partial)
Determine	57	66	55	62	63	61	39
Bioline (3.0)	26	35	25	30	26	27	16
Uni-Gold	29	28	25	26	28	23	17
First response	13	17	10	12	15	12	8
STAT-PAK (regular or dipstick)	12	14	14	14	16	16	11
OraQuick	9	9	12	18	13	10	9
4th Gen Determine/Bioline (any version)	4	3	2	1	2	3	0
Abon Tri-Line	4	3	3	4	4	4	5
INSTI	1	1	3	4	5	4	5
Kehua HIV RDT	0	1	2	3	3	3	1
InTec One Step	2	0	0	1	3	5	2
VIKIA	7	3	1	2	1	0	0
Beijing Wantai RDT	0	2	2	1	3	3	4
Hexagon	1	2	0	2	2	2	1
Toyo	0	1	2	2	2	1	1
Wondfo One Step	1	1	0	1	1	2	2
Genie Fast	0	0	0	0	4	0	2
SURE CHECK	0	1	2	0	0	1	0
Capillus	0	0	0	1	0	0	0
Clearview	0	1	0	0	0	0	0
Double check	0	0	0	0	0	0	0

Analysis of the procurement data indicates that countries are buying many different tests, not just those with the largest market share. These tests have a smaller market share because they are bought:

- By programmes with low overall rapid test volumes or

- By programmes using them in the A2/A3 algorithm spots, which is <10% of the market because these tests are only used when the A1 test is reactive.

Source: EIC Procurement data analysis

Lower prices should be a priority, but need to avoid driving the price too low or suppliers will lose interest

HIV markets represent a reasonable business opportunity

The professional HIV-only RDT market is sizable, and the dual test market is growing. While it is beyond the scope of this landscape to assess margins based on Cost of Goods Sold (COGS) analysis, based on general knowledge of RDT manufacturing, the current WAPs likely offer a healthy gross margin compared to costs for high-volume RDT manufacturers.

In the WHO PQ-ed market, we see indirect evidence for this:
- The availability of several high-quality, PQ-ed products with list prices well below the WAP.
- The recent introduction of three new PQ-ed HIV RDTs, in a market characterized by limited growth, entrenched competitors, and slow penetration of new products (due to the lengthy local registration processes and infrequent algorithm reviews).

Additional insight into margins and COGS comes from domestically supplied non-PQ-ed RDTs, where large HIV RDT orders obtain per-test pricing well below $0.30. The cost of quality should not be underestimated, yet this evidence suggests there is scope for lower HIV test pricing.

Appreciate the context

The scope to reduce test prices needs to be balanced with market considerations. In particular:

1. The HIV RDT A1 market segment is contracting (i.e. HIV-only RDT replaced by dual HIV/syphilis RDT, HIVST), decreasing suppliers' willingness to reduce prices.
2. The market must support the active engagement of multiple test suppliers, including some producing small volumes of A2/A3 tests. The A2/A3 segment is small and fragmented (~10m tests a year across many countries), and higher margins are justified. Normally, a 10-20m test/year market would not support the current level of suppliers engaged in the market (e.g. >20 products) and prices would be relatively high. It is critical to have multiple HIV products and suppliers in the market, since each country requires 3 tests (plus alternatives) and dual HIV/syphilis RDTs. Suppliers may cease engaging (e.g. stop registering in key countries) if professional use RDT prices become too low.

Together, algorithm inflexibility and market dominance increase supply security risk

In the professional test markets, the algorithms would preclude a quick switch unless countries have qualified more than one product. WHO recommends that countries have two tests for the A1 and three for the A2/A3 in their algorithm validations. There are no data on how often countries verify multiple tests for the A1 and A2/A3 spots; experts suggest it is infrequently implemented. Moreover, there is concern that even if a switch were required, test operators would not be practiced with infrequently used tests.

For example, if Abbott products were to suddenly become unavailable because the company exits the market, experiences quality problems, or disaster hits one of their manufacturing facilities, the disruption would be massive. While other suppliers have the capacity to step in and make the necessary tests, the algorithms would need to be verified. The risk to supply is somewhat attenuated because Abbott produces these tests in different locations: Determine is manufactured in Japan and Bioline originates from Abbott's Korean manufacturing site.

Beyond Abbott, any other test in the algorithm, even if procured in small volumes, presents a supply security risk for HIV testing. If any test is missing, and there is no verified alternative test, HIV cannot be diagnosed until the algorithm is updated.

Despite many years of procurement and distribution experience, there are many challenges with supplying and delivering professional use RDTs at the country level. Stock-outs of any single test needed to complete the algorithm mean a site may miss an opportunity to diagnose a patient and initiate treatment. This occurs frequently, and experts suggest the challenges are multifactorial, ranging from funding/procurement cycle delays; delivery delays; changes in HTS targets that are not communicated to providers; and the complexity of managing a highly decentralized testing network (e.g. estimating the need for A1, A2, and A3 tests across thousands of sites, matching volumes and pack sizes, accounting for Quality Assurance/Quality Control (QA/QC) policies and tests consumed for QA/QC, etc.).

Procurers have limited ability to diversify the supply base or to lower prices

In global health markets, large institutional buyers such as the Global Fund and PEPFAR can diversify the supply base and engender competitive pricing through their procurement approaches. The approach and abilities differ by procurer but they often have the flexibility to pool volumes, allocate these volumes across several suppliers and negotiate lower prices. In some cases, procurers have obtained better value through multi-year supply contracts in which the procurer underwrites minimum volumes.

However, in professional use HIV RDT markets, institutional procurers' ability to influence the market is reduced because countries specify the product by brand (i.e. the algorithm), and procurers purchase on their behalf. Even though countries pick a product and tend to continue to buy it, procurers have little visibility into future volumes. On a year-to-year basis, procurement data indicate that countries do not consistently procure a similar volume of tests, nor do they use the same source of funds (i.e. many programmes switch between donors or combine PEPFAR and Global Fund). Funding and procurement cycles also complicate forecasting, with delays in one donor's procurement may result in emergency orders fulfilled by another donor. This lack of visibility limits larger procurers' ability to pool volumes effectively or to offer suppliers long-term commitments that would facilitate better pricing as they have in other product markets, or to influence the supply base by allocating volumes across multiple suppliers.

Threat of new entrants

Customer bargaining power

Supplier bargaining power

Porters 5 market forces

Threat of substitutes

Rivalry among existing competitors

Potential progress in reducing prices and diversifying the market, yet <u>timelines</u> are long

Progress	Comment
More countries reviewing algorithms than in the past	Dual HIV/syphilis test adoption, WHO policy monitoring, and technical assistance are encouraging more countries to review their algorithms and to conduct verifications than in the past. These processes have long timelines (especially procuring 8-10 tests for evaluation), which delay market impact.
Several low-priced HIV RDTs are well suited for A1 spot	Several PQ-ed HIV RDTs have strong performance and lower cost than the market leading tests. There are long timelines associated with the uptake of new tests, due to algorithm review timelines (3-5 years). Some manufacturers have an advantage in product introduction due to established LMIC footprint (e.g. strong distributors, relationships with Ministries of Health (MoH)) and knowledge of the global health stakeholder landscape (e.g. experience with PQ and knowledge of procurement practices). However, new suppliers will take time to establish LMIC distribution, relationships, and global health market know-how.
Example countries have selected non-dominant A1s and achieved lower prices	A few countries (e.g. Ethiopia, South Africa) have selected non-dominant RDTs for the A1 spot and have achieved lower prices; however, there is limited information available on their experience, in particular any impact on testing quality.
Dual HIV/syphilis test uptake is increasing	Many countries are adopting dual tests in ANC as a rapid way to increase syphilis test coverage. However, introduction is complex, and there are long timelines associated with algorithm updates.
More countries reviewing algorithms than in the past	MedAccess + SD Biosensor + CHAI volume guarantee (See next slide) reduce prices for a high performing dual HIV/syphilis RDTs Long timelines for dual HIV/syphilis RDT introduction and algorithm updates delay market impact of volume guarantee

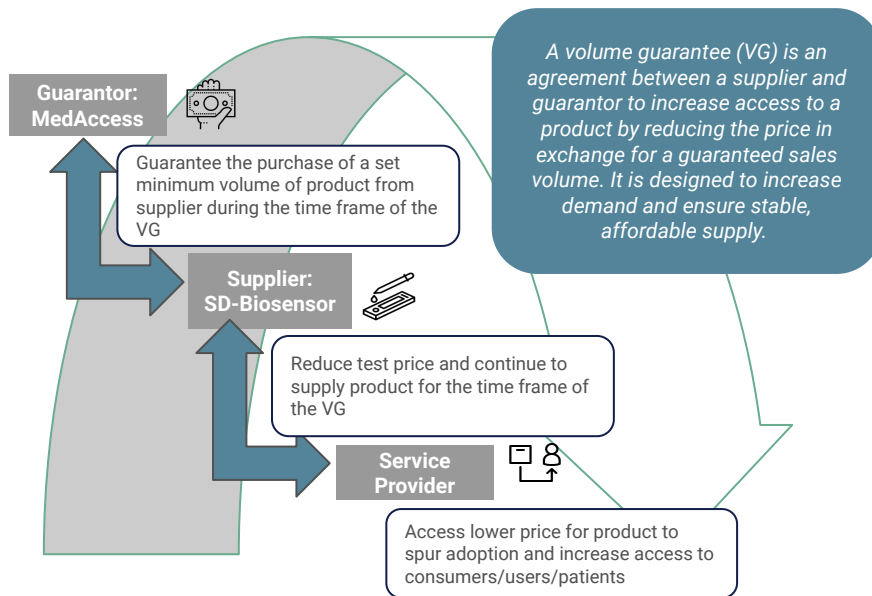# Example: efforts to diversify and reduce price take time to impact market

Volume guarantee lowers price of Standard Q Dual RDT

In dual testing, MedAccess and CHAI undertook a market shaping strategy to improve affordability. The result was a ceiling-price agreement for SD Biosensor's Standard Q dual test, in exchange for a volume guarantee (VG). SD Biosensor agreed to reduce its EXW test price to $0.95 cents (a 32% reduction) for public-sector purchasers in LMICs.

If SD Biosensor's sales volume of the Standard Q test is less than the amount guaranteed by MedAccess, then MedAccess will compensate the supplier for the shortfall. CHAI helped facilitate the guarantee and is supporting dual test adoption more broadly across countries.

The lower price is intended to reduce the cost barriers to adopting dual HIV/syphilis RDTs and stimulate competition in the market, driving down the market average prices. Improved affordability should stimulate uptake of the dual HIV/syphilis test, increasing syphilis screening in ANC. As of mid-2022 competitors had not reduced their list prices, suggesting it is too early to see the impact of this agreement on average market prices.

Figure 4.15: Volume Guarantee diagram

Guarantor: MedAccess

Guarantee the purchase of a set minimum volume of product from supplier during the time frame of the VG

A volume guarantee (VG) is an agreement between a supplier and guarantor to increase access to a product by reducing the price in exchange for a guaranteed sales volume. It is designed to increase demand and ensure stable, affordable supply.

Supplier: SD-Biosensor

Reduce test price and continue to supply product for the time frame of the VG

Service Provider

Access lower price for product to spur adoption and increase access to consumers/users/patients

5

HIV self-test market

Generally, self-testing thrived during the pandemic as populations accepted and manufacturers gained experience with self-tests. WHO anticipates an expansion of self-testing for HIV and other diseases as part of its broader self-care initiatives.

WHO recommended HIVST for the first time in 2016 to increase testing uptake, especially to reach those who may not otherwise be reached. Since then, the effectiveness has been demonstrated in many populations primarily through public health system delivery models.

The self-test market remains relatively small, but is dynamic and evolving. Several questions around optimal use, impact, and product differentiation (i.e. sample type, integrated design, time to results) will influence the market in the near term. Developing self-testing distribution outside of the health systems (e.g. retail, on-line) requires new capabilities, investment and time to develop; these will be essential if WHO's self-care goals are to be realized beyond public health systems.
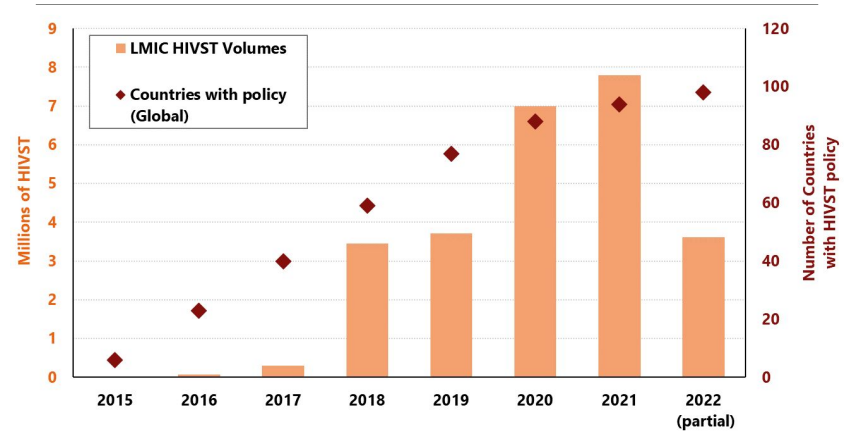
The HIVST Market is growing, but still niche

Since the first HIVST product was PQ-ed in 2017, many countries have adopted HIVST policies, and various donors and partners have actively accelerated LMIC HIVST market development. The timeline (next slide) highlights many vital activities and events in the HIVST market.

An estimated demand of 15m HIVST products is expected to be confirmed for 2022 with an overall market value of $30m. These volumes are relative small compared to HIV professional-use RDTs; the HIVST market is substantially younger and has a very different programmatic approach. The countries with the most advanced self-testing programmes and largest procurement of HIVST products include South Africa, Malawi, Zambia, Uganda, Kenya, Zimbabwe, Tanzania, Nigeria, Cameroon, Lesotho, and Eswatini. Most of these have been programmatically supported by the Unitaid Self-Testing Africa (STAR) initiative.

In many cases, **HIVST represents the first foray by LMIC health programmes towards self-care** and is helping establish new testing practices and capacities that are instrumental in providing differentiated service delivery (DSD) and laying the groundwork for anticipated future testing programmes, such as dual HIV/syphilis self-testing.

HIVST products are in the A0 or triage position in the diagnostic algorithm and positive results must be confirmed via the professional test algorithm. HIVST can drive demand for professional testing or prevention services. Given the flexibility that HIVST provided testing programmes during COVID-19 and capability to potentially save providers time in facilities, the application and role of HIVST in the future is expected to grow.
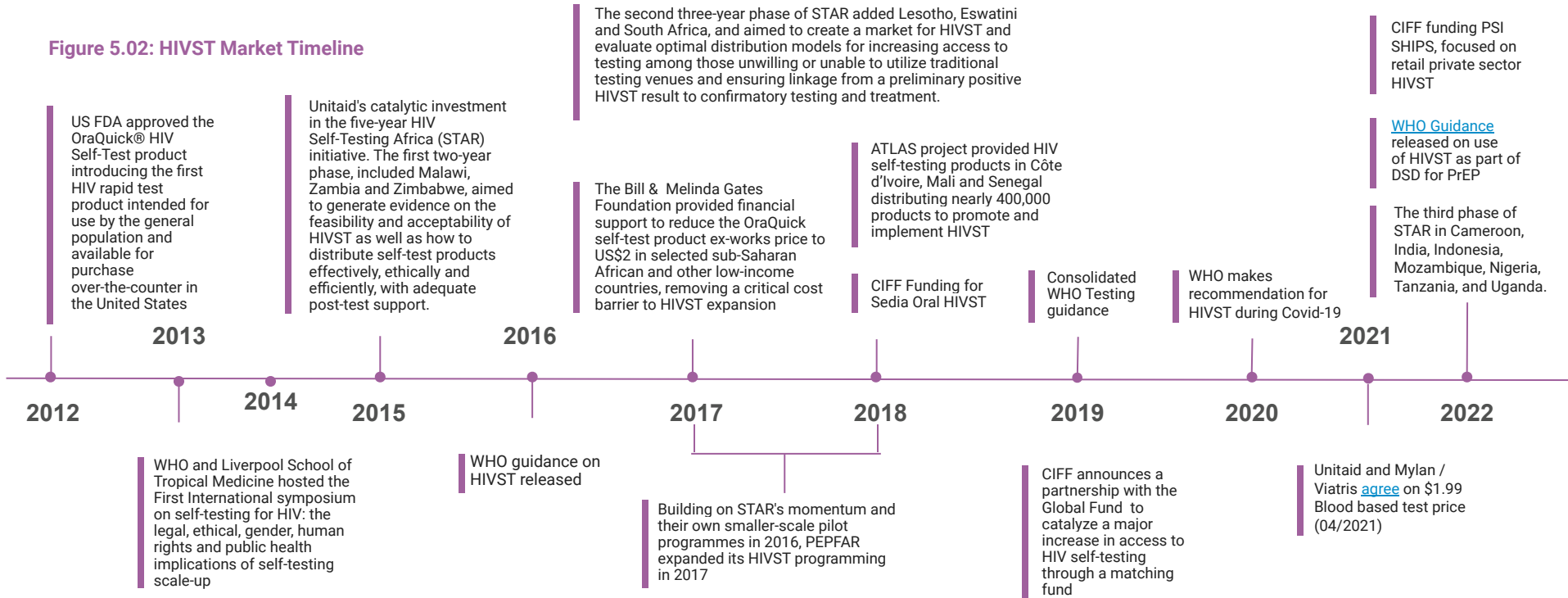
Figure 5.01: LMIC HIVST volumes procured and global number of countries with HIVST policies

Sources:
Count of country HIVST policies: WHO
LMIC HIVST product volumes: EIC procurement data analysis

For more detail on the Integrated HIV RDT Forecast refer to Section 3 and Annex A3

Partner support was critical to launch and build the HIVST market to date

Figure 5.02: HIVST Market Timeline

US FDA approved the OraQuick® HIV Self-Test product introducing the first HIV rapid test product intended for use by the general population and available for purchase over-the-counter in the United States

Unitaid's catalytic investment in the five-year HIV Self-Testing Africa (STAR) initiative. The first two-year phase, included Malawi, Zambia and Zimbabwe, aimed to generate evidence on the feasibility and acceptability of HIVST as well as how to distribute self-test products effectively, ethically and efficiently, with adequate post-test support.

The second three-year phase of STAR added Lesotho, Eswatini and South Africa, and aimed to create a market for HIVST and evaluate optimal distribution models for increasing access to testing among those unwilling or unable to utilize traditional testing venues and ensuring linkage from a preliminary positive HIVST result to confirmatory testing and treatment.

CIFF funding PSI SHIPS, focused on retail private sector HIVST

ATLAS project provided HIV self-testing products in Côte d'Ivoire, Mali and Senegal distributing nearly 400,000 products to promote and implement HIVST

WHO Guidance released on use of HIVST as part of DSD for PrEP

The Bill & Melinda Gates Foundation provided financial support to reduce the OraQuick self-test product ex-works price to US$2 in selected sub-Saharan African and other low-income countries, removing a critical cost barrier to HIVST expansion

The third phase of STAR in Cameroon, India, Indonesia, Mozambique, Nigeria, Tanzania, and Uganda.

CIFF Funding for Sedia Oral HIVST

Consolidated WHO Testing guidance

WHO makes recommendation for HIVST during Covid-19

2013

2016

2021

2012

2014

2015

2017

2018

2019

2020

2022

WHO and Liverpool School of Tropical Medicine hosted the First International symposium on self-testing for HIV: the legal, ethical, gender, human rights and public health implications of self-testing scale-up

WHO guidance on HIVST released

Building on STAR's momentum and their own smaller-scale pilot programmes in 2016, PEPFAR expanded its HIVST programming in 2017

CIFF announces a partnership with the Global Fund to catalyze a major increase in access to HIV self-testing through a matching fund

Unitaid and Mylan / Viatris agree on $1.99 Blood based test price (04/2021)

The optimal mix of HIVST distribution models varies and depends on intended populations and programme objectives

Traditional and non-traditional modalities
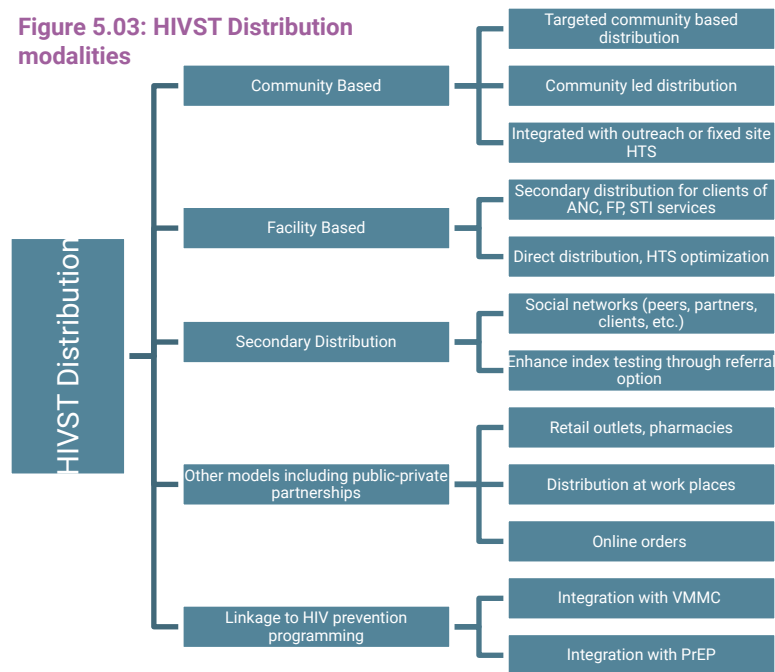
Figure 5.03: HIVST Distribution modalities

```
HIVST Distribution
├── Community Based
│   ├── Targeted community based distribution
│   ├── Community led distribution
│   └── Integrated with outreach or fixed site HTS
├── Facility Based
│   ├── Secondary distribution for clients of ANC, FP, STI services
│   └── Direct distribution, HTS optimization
├── Secondary Distribution
│   ├── Social networks (peers, partners, clients, etc.)
│   └── Enhance index testing through referral option
├── Other models including public-private partnerships
│   ├── Retail outlets, pharmacies
│   ├── Distribution at work places
│   └── Online orders
└── Linkage to HIV prevention programming
    ├── Integration with VMMC
    └── Integration with PrEP
```

Diagram adapted from
https://www.fhi360.org/sites/default/files/media/documents/epic-hiv-self-testing-guide.pdf

Because HIVST products are used outside of the professional use RDT algorithm, they can be deployed in various settings, many of them outside of professional HIV test distribution models. The graphic here outlines several traditional and non-traditional HIVST distribution models.

Distribution via existing public sector testing modalities (e.g. community testing programmes, distribution from facilities) has been the easiest to introduce and comprises most HIVST product distribution to date. In contrast, non-traditional modalities (e.g. secondary distribution through social networks, virtual outreach, vending machines, workplace testing, retail sales, etc.) require more time and resources to establish. However, some of the latter may have a greater impact in reaching the untested and/or generating demand for prevention services. For example, HIVST products distributed in Uganda's private sector (e.g. sold in pharmacies and online) has identified more positives than traditional community-based HIVST distribution strategies.

Given the variety of distribution models, each country will likely implement a mix of HIVST product distribution modalities that is best for its context and focus populations. For example, a recent South African modeling exercise showed that the optimal mix of HIVST product distribution modalities may depend on the programme's priorities (e.g. saving cost vs. cost-effectiveness) as well as factors such as distribution efficiency and linkage to care.

Programmes can review the evidence behind the different HIVST distribution approaches and consider the testing gaps specific to their epidemiological context in order to align their testing programme with the most effective distribution modalities. Evidence gaps remain for some of the non-traditional distribution modalities, and further operational research is needed (including cost-effectiveness studies) to understand the comparative benefits of different strategies and inform programme guidance. Capacity development is also needed, particularly in collaboration with the private sector, to strengthen distribution via non-traditional channels.

Note: Distribution models consist of modalities and channels. Modalities relate mostly to the final means and methods of generating demand and providing tests to consumers and end-users. Channels relate predominantly to the logistical flows and stakeholders involved in making tests available. Read more about HIVST Distribution models in Annex A7

# HIVST offers unique potential for broadening impact, but measuring its impact is complex

The flexibility of HIVST offers some distinct value propositions to consumers, providers, and programmes that have potential to reach more people, reduce the healthcare burden, and increase both the demand and the success of prevention services.

HIVST introduces new complexity when it comes to measuring impact. With self-testing, distribution of test products can be tracked relatively easily, but the linkage to treatment or prevention that generates health impact is difficult to determine directly. It may not be known whether the test was performed, the result, or if the client was linked to treatment or prevention. Furthermore, as the use of HIVST becomes increasingly "status neutral" and broadens to reach new populations, to reduce provider workload, and to engage people in prevention as well as treatment services, the metrics for monitoring will differ. For example, the metrics used to evaluate HIVST targeting high-risk untested populations will differ from metrics of HIVST's impact on workloads and testing in a busy clinic.

To address these challenges, WHO advises programmes to use the triangulation approach demonstrated by the Atlas Programme in West Africa and to tailor success measurements to the expected role of self-testing, which is more complex than simply identifying PLHIV. While debates about how to measure HIVST results and impact may have slowed self-testing scale-up, with more than 35 randomized controlled trials (RCTs) that demonstrate the impact HIVST can have, the WHO guidelines and recommendations for HIVST are well substantiated.

HIV TESTING SERVICES BECOMING INCREASINGLY 'STATUS NEUTRAL'

An expert consultation series conducted by the International AIDS Society (IAS) envisaged HIV testing as 'status-neutral' with consumers on similar prevention or treatment pathways. (For more information see detailed discussion on slide 26)
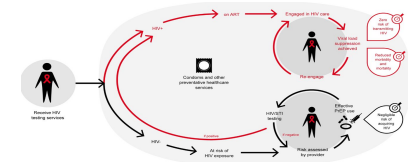
EMERGING HIVST VALUE PROPOSITIONS

Highly targeted case finding in under-tested populations	Reduction of provider workload in busy clinics
Creation of demand for prevention services	Prevention (PrEP) monitoring

Satisfaction of consumer demand for self-care

The HIV self-test product offering is varied...
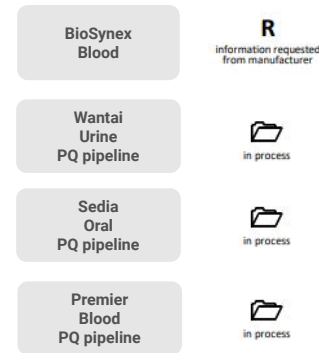
Figure 5.04: WHO Prequalified HIV self-tests

OraQuick OraSure Oral 2017 $2.00	Insti Biolytical Blood 2018 $3.00	Atomo Viatris (fka Mylan) Blood 2019 $1.99	Sure Check ChemBio Blood 2019 $2.99	CheckNOW Abbott Blood 2022 $1.79	Wondfo self-test Wondfo Blood 2022 $1.00
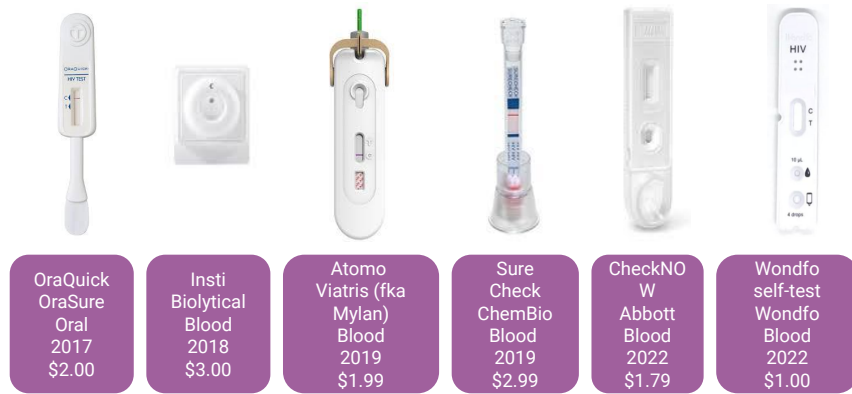
On-market self-tests include one oral test and five blood-based tests. They **vary considerably in design**; even among the blood-based tests, the form factor and degree of integration differ.

Other notable differences include the number of steps, time to results (1-20 min), stability of results (usually 5 min, one test is 20 min), and shelf life (15-30 months). Prices vary; for example, the Global Fund reference price for self-tests is EXW $1.00-3.59 (Sept 2022).

Prices are supplier quoted ex works prices or if not available, the latest year weighted average ex works price from procurement data, with one exception, the CheckNOW is the landed price.
Sources: Global Fund self-test reference prices

Figure 5.05: Products near to market PQ Pipeline and status

BioSynex Blood	R information requested from manufacturer
Wantai Urine PQ pipeline	in process
Sedia Oral PQ pipeline	in process
Premier Blood PQ pipeline	in process

There are four self-tests in the PQ pipeline and at least four in development from other suppliers. PQ pipeline tests include blood-based traditional cassette formats, as well as an oral test and urine self-test. Yet, several suppliers of traditional HIV RDTs have blood-based tests in development, likely to mirror their current cassette-based professional tests and use an accelerated PQ process. At least three are from low-cost India and China-based manufacturers, suggesting prices will be competitive.

Sources: WHO In Vitro Diagnostics Under Assessment

...but the first to market product still dominates the HIVST market.

Figure 5.06: Manufacturer share (by volume) of HIV Self-Test Products

Proportion of Total HIVST Volumes

Year	Value	Top label
2017	100%	1m
2018	99% (1%)	5m
2019	100% (0.1%)	5m
2020	99%	9m
2021	90% (5% / 4% / 1%)	10m
2022 (partial)	90% (5% / 2% / 1%)	6m

Legend:
- Other/No information
- Mylan/Atomo
- Chembio
- OraSure
- Total Number of Tests
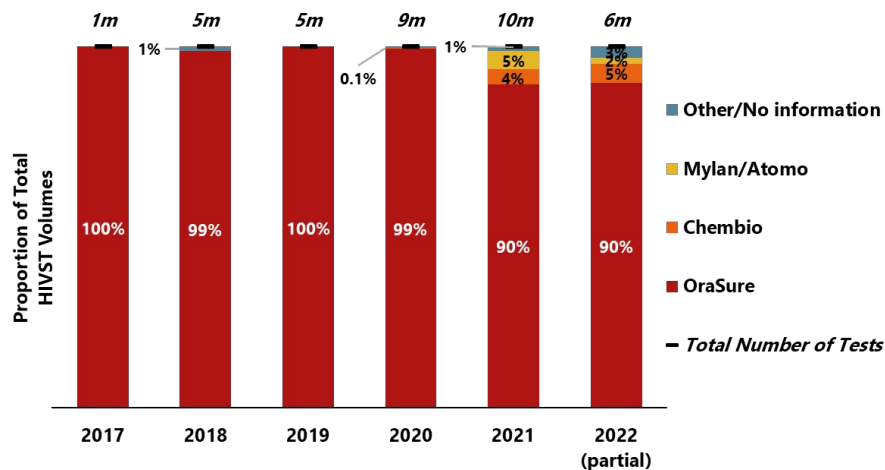
Source: EIC Procurement data analysis

There are many reasons for the continued dominance of OraSure's OraQuick HIVST product, which had a stringent regulatory authority (SRA) approval in 2012, and was the first prequalified HIVST product in July 2017. The next PQ-ed test followed in 14 months (November 2018).

OraSure quickly registered its self-test in many countries and had already been engaging with key partners to build the evidence necessary for WHO and National HIVST policy recommendations. Through these studies and pilots, national HIV programmes gained considerable experience with the OraQuick HIVST product.

During the HIVST market's formative years, OraQuick was also the most affordable test. Beginning in June 2017, OraQuick sold for $2.00, while the two alternative on-market tests were $3.00. Only 3.75 years later did Viatris, in agreement with Unitaid, reduce the Mylan/Atomo price to compete with OraSure's. In 2022, two additional companies announced lower prices for their simple blood-based tests, but these have only recently been WHO PQ-ed and are yet to see much uptake.

Some national programmes have been reluctant to introduce blood-based HIVST products, citing various concerns including acceptability, waste management, and cost. Evidence now exists addressing most of these issues: New products are available at lower prices and national programmes (e.g. Uganda) that have adopted a mix of sample types have successfully demonstrated that maintaining a mix of products is feasible and can increase testing. Therefore, the market characteristics for competition are in place and should be supported to naturally play-out.

Weighted-average prices continue to be driven by the market leader despite less expensive new entrants

Figure 5.07: Weighted Average Prices and Total Annual Volumes for HIVST Products

Legend:
- Total Test Volume
- EXW Weighted Avg Price
- All Price Types Weighted Avg Price

Data points (All Price Types Weighted Avg Price): 2017 $3.13, 2018 $2.00, 2019 $2.04, 2020 $2.07, 2021 $2.43, 2022 $2.48

Data points (EXW Weighted Avg Price): 2017 $2.53, 2018 $2.00, 2019 $2.04, 2020 $2.05, 2021 $2.12, 2022 $2.28

Total Test Volume (Millions): 2016 0.2, 2017 1, 2018 5, 2019 5, 2020 9, 2021 10, 2022 6

Callouts:
- June 2017 OraSure $2
- April 2021 Viatris /Atomo $1.99
- July 2022 Wondfo $1.00
- December 2022 CheckNow $1.79 (landed)

Procurement data analysis demonstrates that average prices paid by procurers (whether EXW or otherwise) for procured HIVST products have not dropped below the $2 Oraquick ST price.

Before 2020, the data provided/collected contain limited price information for most of the volumes. This explains why we see a higher WAP for all price terms in 2017 and then a WAP that matches EXW prices in 2018-2019.

In 2022, the WAP in the procurement data rises partly because of several higher-priced blood-based test procurements, including: $2.99 for Chembio SureCheck and $3.59 for BioLytical Insti. The OraQuick ST was procured at a WAP of $2.20 in 10 countries.

Data limitation: Most of our procurement data for HIVST products are not EXW pricing. To mitigate this, we show both EXW and all price type averages in the chart.

Source: EIC Procurement data analysis

Several factors have restrained HIVST to a niche market

Figure 5.08: HIVST Market development characteristics

HIVST demand has not scaled as broadly as expected given the level of HIVST policy adoption

Implementation challenges associated with new approaches to testing have delayed demand

Initially, HIVST role and target populations were small; currently both role and target populations are expanding

Affordability has limited role and expansion of HIVST

HIVST distribution and testing strategies are new and different to other forms of testing

Cheaper blood-based alternatives have recently been approved, but limited uptake

Programmes are heterogeneous in terms of HIVST use decisions and scale-up progress

Quality assurance, regulatory approvals, and product adoption take time

Achieving HIVST potential requires adaptation to serve multi-channel and multi-modality demand

The market characteristics for competition exist and should emerge with sustained demand

Adoption of new tests could engender more price competition

Progress has been achieved:
- Several past interventions in the market have reduced prices or stimulated demand.
- Newer tests with more cost-conscious designs
- WHO's CRP is accelerating national registration processes

High-prices have limited HIVST expansion and several initiatives have aimed to analyse and lower costs

HIVST markets have been constrained by affordability challenges at varying stages of the value chain, from EXW through to end-users. In response, partners have been working to shed light on the cost components along the value chain of HIVST self-testing products. These are described in more detail below.

Ex-works price reductions	The HIVST market has grown, however, not to the point of supporting "organic" competition on price. HIVST price reductions have occurred mainly in response to market intervention and direct negotiation with suppliers. These are noted in more detail on the next slide.
Landed costs	Differences between EXW and landed costs of HIVST can be substantial and vary considerably by country. Generally, shipping, importation, and local distribution costs from the factory gate to local warehouses can add 30-40% to the EXW price. Expedited orders and air shipping further increase these costs and pandemic-related supply chain and logistics cost inflation add further cost. PSI and CHAI have analysed landed costs across different countries to appreciate cost drivers and increase transparency. Subsequent interventions include negotiations to limit landed costs (see below) and efforts to standardize and streamline these costs.
Cost of delivery to users	As with any health intervention, the cost of delivery to users is critical to cost-effectiveness. In HIVST, the diversity of contexts and distribution modalities adds complexity to any discussion of HIVST cost and cost-effectiveness. For example, the cost per HIVST product distributed in a South African analysis ranged from $4.74 in taxi ranks to $13.04 through secondary distribution from ANC sites. In civil society organization-led models in West Africa targeted at KPs, costs in Cote d'Ivoire per HIVST product distributed ranged from $13 for female sexual workers (FSW) to $16 for people who use drugs (PWUD), while in Senegal, that range was $17 for FSW to $144 for PWUD. Many of these cost estimations reflect the initial stages of public/NGO led implementation and it is anticipated that programme efficiencies gained with experience and economies of scale realized with programme expansion will decrease these costs. Although not directly comparable, assessments of more traditional median HTS programme costs in Sub-Saharan Africa for facility distribution ($12.56) and community HTS ($13.89) have been shown to not be significantly different from median HIVST distribution costs ($13.79).

Several interventions have reduced prices of HIVST products and supported demand

June 2015 — Unitaid, PSI, and partners commence the first phase of the STAR Initiative to catalyse demand and uptake of HIVST in LMICs. Unitaid continues to catalyse and enhance demand for HIVST through additional phases of STAR and the Atlas project into 2022.

Feb 2017 — First order of PEPFAR-funded HIVST are delivered to Namibia. Shipments to 4 other countries delivered throughout 2017.

June 2017 — Bill and Melinda Gates Foundation (BMGF) and Orasure announce a 4-year pricing agreement for **$2.00 EXW HIVST pricing** for 50 LMICs, eligible to public/NGO sector buyers. BMGF commit up to $20m in payments tied to the volume of products sold and reimbursement of certain costs.

2020/21 — CIFF catalytic matching funds support substantial scale up of self-testing in five countries. The large increases in HIVST demand in these years are driven by these five countries, enabled by a CIFF donation that was channelled through the Global Fund. The initial funding commitment by CIFF is subsequently increased by more than 30% to $33m in September 2022 and is matched by Global Fund.

April 2021 — PSI, Unitaid, and Viatris announce the first Early Market Access Vehicle (EMAV) agreement. The EMAV aims to diversify the HIVST market by encouraging new entrants. In this first agreement, PSI agrees to procure 500,000 Mylan/Atomo blood based HIVST products, in exchange for a global access price **<$2 EXW price**. The agreement includes country registration commitments, and covers public sector buyers in 130 LMICs for 6 years.

Q3 2021 — Similarly, OraSure commits to **maintain $2.00 EXW price** for all purchasers intending public health distribution. In an effort to improve transparency and reduce landed costs, OraSure also commits to routinely sharing landed costs for each country.

July 2022 — MedAccess, CHAI, and Wondfo announce a volume guarantee for the recently PQ-ed Wondfo blood-based HIVST, in exchange for **$1.00 EXW** public sector pricing in 140 LMICs.

2022/2023 — PSI, STAR and Unitaid reach an agreement with Abbott for the CheckNow blood based test that PSI confirms has resulted in procurement at a final landed cost of $1.79 across LMICs in late 2022 and early 2023

Demand intervention   **Price intervention**

Buyer selection process for quality assured HIVST products is ambiguous

How national programmes, other buyers (e.g. local organizations and retail intermediaries), and ultimately consumers decide which HIVST to buy is not clear.

1 The WHO PQ list is generally the starting point for HIVST product selection. The Global Fund and PEPFAR only procure WHO PQ-ed HIVST products (different from professional use tests where GF accepts some tests with SRA approvals) For more information on the WHO PQ process for HIVST products see details in the Annex.

2 Many countries require local studies (usability studies in particular) for HIVST product registration. This requirement is being partly alleviated by the WHO PQ CRP process but still poses an issue in many countries. CRP is being under-utilized and still takes time even in the countries where implemented. However, local registration does not guarantee ordering or procurement.

3 Factors influencing ordering and procurement decisions are unclear. Until recently, OraQuick was effectively the lowest priced HIVST product. Given increasing constraints on HIV testing commodities by donors, there was little incentive to diversify procurement. However, as lower priced products come to market and experience using them grows, additional specific guidance for HIVST product buyers on the merits of different products for a variety of use-cases may be helpful in achieving market diversification.

The PEPFAR HIV SELF-TESTING OPERATIONAL GUIDE provides some considerations for HIVST product selection, but it is primarily qualitative, lacking in detail. For example, the guide recommends selecting products with:
- Good ease of use and minimal steps, especially timed steps
- >95% sensitivity and >95% specificity (presumably based on the instruction for use (IFU)
- Stability of results (>60 minutes, criteria that none of the on-market tests meet)
- Heat stability and robustness
- Associated support tools (e.g. videos, hotlines, websites, referral information)

1 WHO PQ-ed HIVST

2 Locally registered HIVST (often requires local studies)

3 ?

Nascent WHO PQ CRP process to facilitate (see Annex)

Read more about the **WHO Collaborative Registration procedure** in the annex

Uncertainty about the need for differentiated HIVST products has delayed the adoption and scale-up of blood-based tests and competition

As a category, HIVST products are highly accepted. However, there is less certainty around the need for different HIVST products, and product offerings are increasingly critical to programme planning, procurement strategies (i.e. interchangeability of products) and the market's health. There are two key questions:

First, how important is it to ensure the availability of both oral and blood-based HIVST products? To date, evidence suggests that at the population level, there is no strong preference for oral or blood-based HIVST products. WHO is in the process of conducting a systematic review and preliminary results are roughly equal; therefore the evidence suggests there is no definitive general population preference for either blood or oral tests. Overall, these findings, qualitative studies, and experience suggest that both oral and blood-based tests may be essential to meet the varying preferences of different end-users and increase the reach of testing. Thus, many programmes, including PEPFAR and WHO, recommend having both oral and blood-based HIVST products available to optimize uptake.

Second, are other forms of product differentiation valuable for reaching different types of consumers? How important is it to have tests with highly intuitive and integrated designs? Or with immediate results?

It is also essential to consider how preferences might change with time. As the market matures and people gain more experience with self-testing, preferences and use cases for different sample types and other product features may yet diminish or change.

In 2022, PSI STAR made initial procurements across several countries to increase experience with blood-based tests, yet it is too early to see many results. Uganda and South Africa stand out for their deliberate strategy and targets for the blood vs. oral fluid product mix. Through dedicated programming (e.g. health worker training, communications) these countries have seen a progressive increase in preference for blood-based tests.

Figure 5.09: Total Volume of HIVST Products for countries with procurement of blood-based HIVST, Total Volume 2016-2022 (partial)
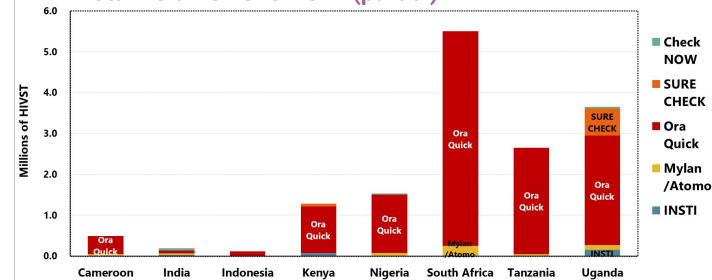
Note: 35 additional countries procured ~4m HIVST (2016-22) that were solely OraQuick. Another 11 countries procured ~15m HIVST (2016-22) that were mostly OraQuick but also included some volume of tests from an unknown manufacturer.
Source: EIC Procurement Analysis

New blood based HIVST products could help improve affordability and diversify the supply base

As the HIVST market has been highly reliant on one product, new entrants are welcome from both affordability and supply security perspectives. The recent entry of a $1.00 HIVST product suggests that, compared to the first-to-market tests, more affordable HIVST is possible

More recently approved lower-priced HIVST products tend to have simpler designs than earlier products, which incorporated design choices such as integrated lancets or sample transfer devices. The simpler designs, which are more similar to commonly used professional-use RDTs, likely allow for lower COGS and optimization across manufacturing lines.

Ultimately, market price declines depend on end-user acceptance and uptake of these newer, low-cost, simpler, blood-based HIVST. Factors that will influence the pace of potential price declines include how quickly these suppliers navigate local requirements for evidence and registration, the openness of national programmes and end-users to blood-based testing generally, and comfort with simpler testing formats. National programme support (i.e. awareness raising campaigns, refresher training for healthcare workers) for new product types is critical for uptake.

It remains to be seen whether the introduction of simpler and lower-cost blood- based tests will result in reductions in the price of oral tests, as the OraSure test is still the only oral test available in the market and has first-to market advantage. It is possible that OraSure will feel pressure to reduce prices or adjust other tactics if the cheaper tests penetrate the market and capture more of the oral test market share.

In the medium term, there are two oral tests in the pipeline, though only Sedia's oral HIVST is undergoing PQ. Sedia's launch timelines are uncertain as pandemic-related workloads have slowed the prequalification process. Moreover, Sedia is manufacturing on a small scale in the US and lacks an LMIC distribution footprint. The timeline for securing lower-cost manufacturing and distribution partners - necessary to achieve scale, affordability, and distribution - is uncertain. At least one other QA-ed supplier is developing another oral HIVST product; however, this test is further behind in product development.

Alternatively, adoption of other self-testing products (such as the development of dual HIV/syphilis self-testing) as part of the trend towards self-care may also influence manufacturing decisions and have cost implications in the longer term.

Achieving HIVST potential requires adaptation to serve multi-channel and multi-modality demand

In theory, there are large numbers of people who could benefit from HIVST who are not accessing existing (largely public sector) distribution models. Some people may prefer accessing HIVST in channels outside the healthcare system, for example in pharmacies, shops, or online or through their workplace. Indeed, channels outside of healthcare systems are particularly adept at reaching high-risk groups benefiting from frequent testing (e.g. urban men in Africa via pharmacies or workplace distribution; key populations in Asia via online platforms). People currently accessing HIVST through health systems may prefer these alternative channels too. Shifting or expanding access to them can decrease the burden on facility based services and potentially increase cost-efficiency and effectiveness of public health programmes.

Although they have a high potential impact, these channels and markets are underdeveloped. Because they differ fundamentally from health systems' distribution channels, their development will take time, resources, and new capacities.

Given the benefits of scale and pace through last mile distribution, the integration and packaging of HIVST products with other sexual reproductive health and prevention products be may be beneficial in reducing costs and increasing impact. Investments in pharmacy-based PrEP and HIVST have been made and should be leveraged in the future.

Broadly speaking, three functions are needed to sell or provide products to end users and each of these three functions needs to be designed to complement the others:

1. **Distribution channels**, i.e. logistical and stakeholder networks that facilitate getting product from the manufacturer to the end user.
2. **An organizational or programmatic modality** that supports sales or provision of tests to various HIVST product buyers, intermediaries, or users.
3. **Communications** about the product to increase awareness and generate demand, targeting buyers and end-users as well as intermediaries supporting the delivery of the product to the end-user.

In the Annex, we describe how different distribution channels are structured and the capabilities essential to distribute products through them. For illustrative purposes, we consider the examples of HIVST products delivered through the public health system and HIVST products sold to consumers in a store or pharmacy.

Alternative sourcing strategies could also help diversify procurement and engender price competition

Currently, large procurers are primarily still sole-sourcing HIVST products, which is not unusual in new markets with few products. Sole-sourcing* typically leads to higher prices because procurers are not exploiting competition between suppliers. Given HIVST market concentration, the increase in PQ-ed HIVST products, and the general desire for more affordable pricing, procurers are considering alternatives to sole sourcing that would reduce reliance on a single company and engender healthy price competition.

In other markets, Global Fund and USAID procurement agents have used long-term sourcing agreements with suppliers to reduce and stabilize prices and to increase supply security by allocating demand across several suppliers.

The ability to implement these agreements depends on products being "interchangeable" (i.e. end-users do not have a preference between different brands or types of tests). Whether interchangeability is feasible and appropriate for HIVST depends on the importance of product choice. If the sample type or other unique product features (e.g. time to results) do not matter to end-users, then procurement practices based on product interchangeability might be considered. However, if specific HIVST target populations are considerably more likely to test using a particular brand or sample type, it may be appropriate to sole-source that particular product for that particular population.

As discussed previously, available evidence suggests that some level of product choice is desirable. For large procurers (e.g. GF, PEPFAR, Unicef), honouring product preferences makes implementing supply agreements with volume allocations and reduced prices more difficult.

Other considerations affecting sourcing strategies include:
- HIVST implementers, including national programmes, have invested and become comfortable with one type of HIVST product and can incur time and financial costs (e.g. training health workers, communications) changing between testing products.
- Overall market size. Currently, the HIVST market is relatively small (16 million tests, ~$30m value) and the market needs to continue to grow if it is to achieve and sustain price reductions made possible through competition at scale.
- Although donors, procurers, and implementers work within institutional constraints, alignment around key sourcing principles is beneficial and at times essential to influencing the market. If one donor were to implement HIVST product interchangeability while others do not, programmes seeking particular products could shift HIVST budget to the donor continues sole-sourcing.
- Procurement strategies based on product interchangeability can signal to the market that affordability and supply diversity are paramount, i.e. more important than product differentiation. This may be appropriate for some markets, but it can discourage innovation and entry of suppliers into other similar product markets if not deployed carefully.

In this context, sole-sourcing means the procurer does not put orders out to bid among suppliers of the different brands of HIVST products, instead they source from a single supplier producing the particular HIVST product requested by the national programme.

Initial efforts to develop retail markets are informing the HIVST value proposition for retailers and consumers

PSI STAR supply-side activities focused on retail market development included:

- Negotiations with HIVST product manufacturers that extend public sector pricing to private sector outlets and require maintaining stock with local distributors.
- Demand-side financing programme that focuses on activating sales of HIVST products in selected Ugandan, South African, and Nigerian pharmacies. The model involves an initial donation of HIVST in exchange for pharmacy procurement of HIVST products and MOUs, capping retail margins.

PSI's SHIPS is a three-country (Kenya, Nigeria, Uganda) learning project comprising market research and pilot interventions to develop private-sector retail markets. Results from these pilot projects aim to inform investment cases and roadmaps for broader scale-up in the private sector.

Formative market research identified target customers: urban, more educated men, seeking confidentiality and convenience, some of them skeptical about the quality of free HIVST products n the public sector.

The market research informed the overarching value propositions for consumers and retailers. The central value proposition for consumers is 'take control of your health'. For retailers, the value proposition involves growing their self-care business, including bundling HIVST products with other sexual health and self-care products. Digital strategies are playing a central role in these projects. Most of the marketing and community mobilization is digital, including through social media and chat groups. However, the content of the messages is very context-dependent. PSI is supporting linkages through digital platforms as well.

A SPOTLIGHT ON STRENGTHENING HIV SELF-TESTING IN THE PRIVATE SECTOR (SHIPS)

For more information on the PSI SHIPS programme please refer to the linked spotlight article by the Self-Care Trailblazer group.
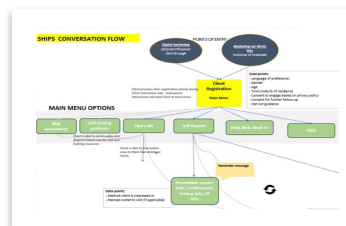
For more information on the how PSI SHIPS is being implemented in Kenya, please refer to the linked article on Medium posted by Harrizon Ayallo, a PSI Kenya HIVST Technical Field officer.

Affordability is critical to commercial HIVST market development

HIVST prices and supply chain markups put the pricing out of reach for all but upper-income earners. While price subsidies are possible, many stakeholders feel they are unsustainable in the long-term and disruptive when they end, causing consumers to blame the shop or supplier for price increases.

Whether HIVST demand could ever reach a level sufficient to support a competitive retail market where HIVST products are affordable to the vast majority is not clear, especially given that supply chain markups are usually more than double the EXW costs. The diagrams below provide an illustration from PSI's SHIPS data of how distribution and retail costs for different products in different countries can be quite a sizable cost component.

Meanwhile, retailers have little incentive to stock HIVST products, as they see little demand, low margins, and a time-consuming product education process. They prefer to stock faster-moving products.

Another challenge with retail/online HIVST product channels is the presence of unregulated HIVST products, including products without PQ or stringent regulatory approval, as well as the leakage of tests from the public sector into private markets. The presence of these tests at lower prices deters PQ-ed suppliers from engaging in the retail markets for QA-ed HIVST products.

As a result, developing these markets requires i) innovative work to increase the awareness and the value of self-testing in the minds of consumers, ii) favourable pricing (through reduced EXW costs as well as monitoring the supply chain markups) to address affordability concerns, and iii) potentially bundling of tests with other sexual reproductive health products, such as PrEP or family planning products that are not state funded.

Figure 5.10: Components of consumer prices for HIVST products, PSI SHIPS data
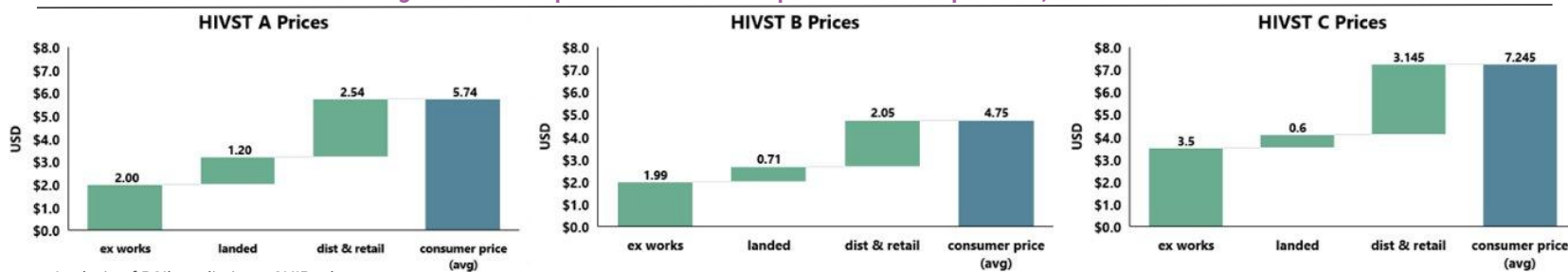
Source: Analysis of PSI's preliminary SHIPs data

Developing HIVST markets outside of health systems requires new capabilities and resources

Consumer demand for infectious disease self-tests is nascent in LMICs; even with the Covid-19 pandemic, self-testing is uncommon. Any first-of-its-kind consumer product, including HIV self-testing for consumers, has to "make the market." HIVST is pioneering the self-testing concept among consumers in LMICs by developing new distribution channels and programme modalities.

Scaling up HIVST to reach target populations, especially those least likely to come into contact with the health system, requires sizable resources, capabilities, and time. These capabilities differ fundamentally from those required by manufacturers and distributors to sell into public health systems. While LMIC supply chains serving retail outlets can be highly sophisticated and efficient, these channels are not well developed for self-testing products. Timelines for developing these markets must reflect these realities.

Additionally, the costs associated with developing these markets need to be acknowledged. In the public sector distribution, the EXW and, increasingly, the landed costs (i.e. the cost upon arrival at the national warehouse / central medical stores) of HIVST products are available. The costs of distributing HIVST products from national warehouses to the thousands of sites are generally not well known, as they are absorbed by the MoH and not paid by donors. Accounting for these costs is challenging, as the products are part of a massive supply chain system serving the entire country.

In the retail channels, distribution costs are more apparent, seen in the markups along the supply chain, resulting in a final price to the customer. Although the breakdown of costs vs. profit margin is hard to appreciate, each actor in the chain has a role to play and must be compensated for it.

There are also many costs associated with "making the market." In the public sector, these include community sensitization, training healthcare providers, disseminating job aids, etc. This market introduction work has a cost, usually an initially high multi-year budget for pilot studies, rollout, and training; with ongoing costs folded into supervision, mentoring, and monitoring systems that reinforce practices.

Similarly, in the private sector, there is a cost of "making the market" however, the messaging and skills needed to encourage private sector actors to stock tests and to promote them appropriately are harder to appreciate. Currently, NGOs like PSI are undertaking a lot of this work, with varying levels of engagement from HIVST manufacturers and their local distributors. The success or failure of these initiatives is not isolated to HIV self-testing, as there may be ramifications for self-care and self-testing in LMIC generally.

Read more about HIVST Distribution models in the annex

6

Supply overview and perspective

This section reviews the suppliers of HIV tests and provides some perspective on the supply-side of the market.

Suppliers have different strategies for marketing, quality, and investment in HIV testing

15 companies supply 23 PQ-ED professional RDTs and 6 PQ-ED HIVST products

HIV test portfolio

Most of the professional HIV-only RDT suppliers also have HIVST products or have one in development, and only one of the self-test suppliers lacks a professional HIV-only RDT. Only Abbott has all three product types (i.e. HIV-only RDTs, dual HIV/syphilis RDTs, and HIVST products), although several companies have two of the three product types.

Three suppliers have more than one PQ-ed HIV-only RDT in their portfolio: Abbott has four; Chembio has three; and Trinity has two. Having multiple tests targeting the same market is largely the result of company acquisitions and efforts to capture additional market share.

In the professional test market, selection for the A2/A3 position precludes use in the A1 position in a given country. In theory, tests from the same manufacturer could occupy the A1, A2, and A3 positions if the detection systems employed in each of the products differs (i.e. no cross-reactivity between products, the detection systems are based on using different raw materials). To date, there is little evidence to appreciate if this is the case, especially for the newer products (e.g. Abbott and Trinity).

LMIC sales and distribution

The extent of the manufacturers' experience in LMIC markets and the level of in-country support for their products varies tremendously. Some companies mainly focus on public tender markets with minimal in-country presence. Others have a substantial in-country presence, supporting a larger portfolio of products, including their HIV RDTs. A few actively deploy resources to promote their products in LMICS and develop these markets.

Quality

The donor-funded markets require PQ-ed products. Some manufacturers have multiple SRA/PQ-ed products and deep experience with quality management systems, while for others quality systems are relatively new. Some countries procure (with domestic funds) RDTs from suppliers with untested quality management systems (QMS). There are also numerous un-regulated HIVST products available to consumers.

Business size, strategy

Manufacturers range from the leading global in-vitro diagnostic (IVD) companies to several large RDT manufacturers and more moderate-sized diagnostics companies. There is one start-up and one pharmaceutical supplier partnered with a diagnostics product developer. The importance of HIV to the overall business varies; for some HIV tests are a meaningful revenue stream, while for others HIV rapid tests contribute minimally. Strategies for HIV testing also differ; some companies invest more in design, clinical evidence, or other means of differentiation, while others are more focused on low-cost, simpler products.

Despite ample lateral flow manufacturing capacity, HIV test supply is at risk

Manufacturing capacity

At the highest level, there is ample RDT manufacturing capacity across the QA-ed suppliers to meet global demand for HIV tests should there be a disruption in the supply of a leading manufacturer's product (e.g. disaster at a factory, quality problem, exit from the market).

Manufacturing capacity for lateral flow tests (RDTs) expanded dramatically during the COVID pandemic. However, as Covid-19 RDT demand wanes, manufacturers will face decisions about underutilized capacity, and this could have knock-on effects for other RDT production, including HIV. For example, some manufacturers may shutter idle capacity, some may reduce prices to fill their production lines (spreading fixed costs of investment over more tests), while others may begin producing new RDTs.

Geopolitical risk & local manufacturing

The pandemic also underscored the risks associated with global supply chains, especially for LMICs highly dependent on medical and diagnostic imports. Supporting medicines and diagnostics manufacturing in LMICs has long been a priority, and there is increasing momentum at global level among donors and stakeholders to support local manufacturing.

Some global HIV RDT manufacturers are also looking to increase their manufacturing and distribution presence in LMICs, in order to better appreciate needs, be more responsive to customers, and to take advantage of lower cost labour as relevant.

Ownership changes and market consolidation

Another business activity that can impact supply chains, competition, and the availability of diagnostics are ownership changes and market consolidation through mergers and acquisitions. For example, several current Abbott products result from acquisitions. Notably, such market activity has been ongoing at the time of publication of this landscape, with acquisition of Chembio by Biosynex.

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Recommendations

This section presents several recommendations for improving the health of the professional-use and self-test markets.

Recommendations stem from the analysis of market health presented in this report and the annexes using common market health frameworks. For high-priority risks and challenges, we make recommendations to improve the market's long-term health and sustainability.

Recommendations: Summary

CHALLENGES		RECOMMENDATIONS/CONSIDERATIONS

Professional Use

TEST SELECTION: Balancing the need for quality with supply risk, concentration, and affordability

Professional Use

I.   Review policy and procurement approaches
II. Address barriers to product switching
III. Diversify the market, increase price competition, and reduce supply risk

HIVST

LOW DEMAND FOR HIVST: HIVST products at risk of being trapped in a cycle of low demand and high prices

HIGH PRICE OF HIVST: The average price of HIVST products is considerably higher than it needs to be.

HIGH PROGRAMMATIC COMPLEXITY: The scale-up of HIVST is hindered as a new test category and associated slow adoption of novel delivery channels.

HIVST

I. Accelerate adoption and uptake of recent HIVST product entrants to improve competition and affordability
- Support uptake of blood-based tests
- Improve access to information on product offerings
- Facilitate the practice of product choice

II. Improve and facilitate efficient programmatic implementation
- Provide technical and funding support for continued programme implementation
- Support effective evidence generation and dissemination to track impact of HIVST

ALL

CONTINUED GROWTH OF HIV TESTING MARKETS: Through advocacy for the value of testing; attention to test quality; prioritizing needed innovation and localizing supply

ALL

III. Clearly articulate the evolving role and continued value of HIV testing
- Maintain a high degree of focus on test quality
- Support innovation of multiplex devices
- Consider longer term goal of regionalizing supply, and also remain cognizant of market challenges.

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Professional test algorithms support quality yet create market challenges

Balancing quality with market dominance, supply risk and affordability is challenging

Affordability

Diversity of supply

Quality via algorithm verifications
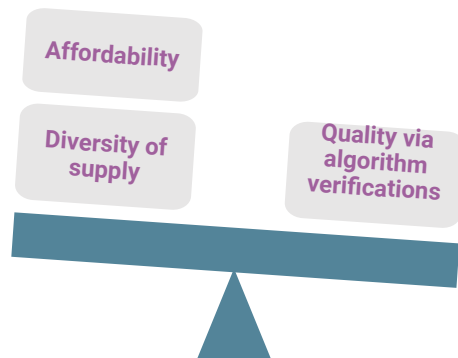
- **HIV testing is governed by an algorithm designed to support test quality.** Three tests are required to diagnose HIV, and each country establishes a national algorithm, (i.e. specifying the product brands and sequence of testing) to improve testing accuracy and standardized testing across thousands of sites. **An algorithm verification study primarily ensures** each test in the algorithm is different (i.e. avoiding possible overlap in the HIV-detecting raw materials used by the tests).

- Although many quality-assured products are available, **the market is dominated by one company**. The Abbott products (e.g. Determine, Bioline, Bioline HIV/syphilis, and Determine Early detect), were among the first to market and frequently occupy the A1 position, the largest market segment.

- **Programmes seldom review their algorithms or consider switching products; this limits opportunities for new competitive products to enter the market.** New product adoption requires an algorithm review, which occurs infrequently. Programmes are reluctant to switch professional use RDTs because of programmatic costs (e.g. retraining users, updating registers, and supply chain issues). Infrequent algorithm reviews combined with high programmatic costs of switching slow the adoption of new lower-cost tests or higher-efficacy (e.g. dual) products.

- **Supply security risk exists at the local and global levels.** The need for three specific tests, specified in the algorithm, creates a supply risk. Disruption in the supply of any one product impacts the ability to diagnose HIV. While WHO recommends that countries verify alternative tests, the uptake of this recommendation is unknown and likely limited. At the global level, relying on one company to serve most LMIC professional HIV RDT demand also contributes to supply risk.

- **Affordability could improve with procurement of different products.** HIV test prices have been affordable enough to allow for widespread use; however, average prices have not changed over time. The market-leading manufacturers have set prices and not changed them as the market has grown or in response to the entrance of lower-priced products with good performance. These new, more affordable products have not penetrated the market, and as a result programmes are spending more on HIV tests than necessary.

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Convene a consultative forum for reviewing policy and procurement approaches for HIV tests

Consultative forum: focus and participants:

- Market-related priorities for supply security and healthy competition require developing policy and procurement strategies that diversify the professional use HIV test market.
- A forum should be convened among experts with quality, technical, programme, procurement, and market experience to explore opportunities for diversifying supply and encouraging price competition.
- A large procurement agency or donor should take the lead in organizing this collaboration of stakeholders that will support a comprehensive policy review and align procurement.
- While discussions should be focused on A1 market, it is essential that the procurement approach consider the sustainability of A2/A3 market segment.

What should be the main areas of policy discussion?

- How can policies for algorithm development be revised to build in more flexibility, enabling more frequent switching of products?
- Has the need to verify tests changed over time? i.e. how have products changed, how much cross-reactivity exists among the tests that countries are most frequently using and among the currently PQ-ed tests?
- Are there alternative methods for identifying combinations of tests that work well together? Can data from verification studies be shared, can algorithms be verified at the regional or global level? Can countries forego verification if monitoring is stepped up?
- The verification process at each country is recommended largely to address risk of over-reliance on limited sources of raw materials; is there a way to map the supply? Is there a need for investment to diversify antigen supply?

What evidence will ground the discussions?

- Evidence generated through the algorithm verification studies to date, in particular, product cross-reactivity and regional trends.
- Current use of RDTs vs. ELISA tests, and whether these categories have different cross-reactivity profiles. General improvements in HIV rapid test performance over time.
- Programme experience, including:
  - Data on the number of countries that have verified alternative A1 and A2/A3 tests, reasons for not verifying alternatives.
  - Evaluation of the cost of switching products (training, supply chains etc.) from an implementation perspective vs. the potential savings borne by switching to a lower-priced product.
  - The approaches and the impact on HIV testing quality, competition, and pricing in the few countries (e.g. South Africa, Ethiopia) that have competitively procured RDTs.
  - The experience of programmes that have not performed verifications, and have gone straight to implementation with monitoring in order to appreciate why programmes may do more or less validation/ verifications in practice.
  - Analysis of products that are nationally registered for each country that are well suited for different spots in the algorithm (A1 and A2/A3).

Address barriers to switching products and monitor compliance with WHO recommendations

Streamline the algorithm verification process through:

- Developing a mechanism to facilitate procurement of RDTs for verification studies, i.e. a simple way to order 8-10 tests and quickly import them for verification studies.
- Supporting new entrants with country-level registration and product introduction so their tests are eligible for algorithm reviews, and they are aware of the key processes and timelines.
- Developing several 'off-the-shelf' suites of products that work together for programmes that do not want to perform verification studies. This might be considered on a regional level or globally.

Address programmatic barriers to switching products:

- Fund and support training health workers on multiple tests. In this way, quality is not compromised if a switch is made and a health worker's lack of familiarity with a test does not become the basis for staying with the same test.

Monitor compliance to WHO recommendation.

- The availability of alternative/backup tests is critical to reducing risk of HIV testing disruption. Countries' compliance with WHO recommendations on having multiple verified A1 and A2/A3 tests should be monitored.
- Continue to fund and provide technical assistance to countries on algorithm development.

Increase price competition and reduce supply risk through procurement

Develop procurement approaches that diversify the supply base and increase competitive tendering

- In the near term, donors/procurers can require programmes to:
    - regularly conduct algorithm reviews (at least every 3 years)
    - verify multiple tests for each spot in the algorithm, especially more than one A1 test.
- Once countries qualify more than one A1 test, procurers can run a limited competitive tender among the two (or more) qualified products to accelerate market diversification and price competition.
- Procurers should revisit their ability to forecast country demand for specific tests, including the possibility of coordinating across procurers/donors.
- Procurers must closely follow changes in WHO policy on algorithms and optimize their approaches to fit any algorithm policy revisions.

Appreciate the market context: avoid driving the price down so low that A2/A3 suppliers lose interest

- Margins in professional testing must support the active engagement of multiple test suppliers, including some producing small volumes of A2/A3 tests. Since the A2/A3 segment is small and fragmented (compared to A1), higher margins are justified. If professional test prices become too low, suppliers may cease to engage (e.g. stop registering in key countries).
- The HIV RDT A1 market segment is contracting (i.e. HIV RDT replaced by dual tests, HIVST), decreasing suppliers' scope to reduce prices.

Support new entrants

- Support should be provided for new entrants with procurer onboarding processes, country-level registration, and product introduction so their tests are eligible for algorithm reviews and new suppliers are aware of the key processes and timelines.

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Despite considerable interest, the HIVST market has not reached its potential and weighted average prices remain high

SUPPLY

- Dominated by one product, despite the availability of many
- High weighted average price, despite the lower cost options
- Little incentive to develop commercial markets, due to:
  - Lack of expertise, relationships, and capacity.
  - Limited demand.
  - Competition from less expensive non-PQ-ed HIVST products.

- Low, fragmented demand
- Limited experience and uptake with recently introduced lower-priced HIVST products.
- Slow scale-up due to:
  - Programmatic complexity related to introducing a novel test category and developing a variety of delivery modalities.
  - Need for a locally customized approach; limited experience in prioritizing among the most effective distribution models.
  - Sustainability and affordability concerns.

DEMAND

- The foundations for healthy HIVST market competition are in place, assuming continued demand growth and uptake of newer, more affordable tests (see the recommendations in the next slides)

- A notable exception is commercial HIVST markets (e.g. online and retail), which are not yet developed. For most potential LMIC consumers, the price of HIVST in these channels is too high. Low demand disincentivizes supply-side actors from investing in market development.

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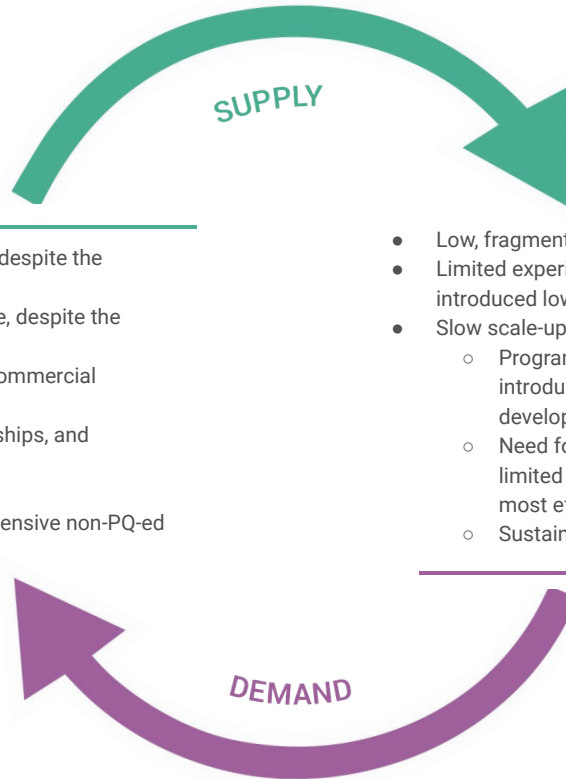
Work on affordability by increasing market penetration of new HIVST products

Support uptake of new blood-based tests

- Share existing and emerging evidence of blood-based test acceptability and effectiveness.
- Advocate for more affordable test adoption to diversify product offerings and lower prices. While the first blood-based products on the market have not seen much uptake, their prices may have been prohibitive. More affordable HIVST kits became PQ-ed in 2022; others are expected in 2023 and 2024.
- Support new entrants with market entry (e.g. country registrations and studies, inclusion in on-line procurement platforms)
- Continued support for national regulatory approval of alternative and lower-cost blood-based tests through the collaborative registration procedure.

Ensure buyers are aware of the product offering

- Consolidate product selection guidance for buyers, including a comparative summary of information on product performance, quality, usability, and other key product features. While some of this information is available via PQ websites and public reports, having it consolidated in one place and continually updated is essential to ensuring information is readily available to inform product comparisons and selections. It is important to increase awareness of any guidance and information among stakeholders (e.g. retailers) who may not be familiar with WHO and its role. Private sector supply chain actors may increasingly need this information.

Support implementation of product choice

- As with HIV professional tests, sensitize health workers and the population more broadly to the diverse product offerings and train health workers involved in HIVST distribution on different test types and brands.
- Develop deliberate strategies to increase the product offering in-country by supporting registration and usability studies and including different tests in communications materials.
- Ensure procurement approaches are responsive to the evidence about preferences and encourage product choice. The need for product choice could be emphasized by procurers, especially in larger markets where there may soon be scope for more competitive tendering in the blood-based test category.

Revitalize support for strategic programmatic implementation

Support data-driven HIVST strategies

- Country progress in HIVST implementation varies. Some countries have successfully scaled many self-testing modalities and are considering non-traditional channels whereas others are still piloting HIVST or have focused narrowly on small target populations and need to expand coverage.
- Regardless of progress in implementing HIVST, continued funding and support to expand the capacity of HIV testing programmes is critical so that programs may nimbly respond to the latest data and strategically implement testing.
- The development and implementation of tools that help determine optimal testing mixes for various contexts will support HIV testing programmes to prioritize among the myriad of opportunities and to build strong investment cases for new approaches.

Develop robust impact metrics and supporting data

- HIVST impact measurement and targets must align with the goal of HIV self-testing. Alignment on impact measurement and strengthening data collection and use is essential to demonstrating impact and using the information to inform strategy.

Support implementation and scale up

- As a novel product category, self-testing requires programmes to expand their capacities, especially if considering non-traditional testing modalities.
- Development of HIVST product distribution channels outside of the health systems may benefit some contexts. Such modalities can be resource intensive to establish, but, provide great potential to improve access to testing. It will be important to approach development of these channels through careful consideration of the context of each country and the potential for sustainability and impact. Initiatives must be adequately resourced to ensure implementation capacity (details in Annex).

Continue growing the market

Clearly articulate the evolving role and continued value of HIV testing

Testing is critical to the HIV treatment cascade, prevention, and ultimately to incidence reduction. During the current period of declining funding, it is vital to ensure testing is kept relevant at the top of the agenda. Funding to support testing is essential and requires clear articulation and demonstration of its central role and impact in different use cases.

Attention to test quality

Continued advocacy and education to buyers about rigorous quality standards and, in consumer markets, enforcement of regulations is essential.
- Some countries use professional and self-tests that, while they meet local regulatory standards, may not meet PQ /equivalent SRA standards for HIV testing. It is vital to strengthen LMIC regulatory systems; however, sole reliance on local standards may be premature in some instances given the implications of an HIV misdiagnosis.
- For HIVST, education targeting consumers, retailers, and other supply chain stakeholders on quality products should be coupled with stepped-up compliance monitoring in retail settings.
- Product selection guidance must clearly communicate information on quality test selection, including the roles and activities of different entities reviewing quality.

Innovation priorities include self-testing and co-infections,

e.g. HIV/syphilis/hepatitis B, or TP/NTP tests. Increasing visibility and confidence in demand for new products are needed to stimulate engagement. Developers will only invest in these tests in LMICs if they see a market opportunity that provides a reasonable margin in relation to demand size and reasonable time to recoup the investment. To this end, efforts to clarify and shorten the time to market are welcome, including PQ timelines, in-country registration requirements, and algorithm reviews. Perceived low demand and price pressure in the HIVST market have discouraged some suppliers from engaging in the market; this sentiment could carry over to other ST product development activities.

Consider localizing supply as a long-term goal

Geopolitical and supply chain risks are also concerns, as regions with the greatest HIV test demand rely entirely on imported products. The pandemic highlighted problems of supply not being available locally for many health commodities. The HIV test market is global, but no products are made in regions with the highest burden. Improving regional supply will take time and should be linked to broader economic development, biotech industry development, and supply chain strengthening initiatives. Moreover, timelines for developing markets for locally produced products should reflect the many complexities of the HIV markets.

ANNEXES

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Annex

List of Tables and Figures

Annex, cont.

List of Tables and Figures

Annex, cont.

ACRONYMS

A1

Acronyms

Acronym	Full Form
A0	HIV Assay 0 (used for self-testing)
A1	HIV Assay 1 (First line assay)
A2	HIV Assay 2 (Second line assay)
A3	HIV Assay 3 (Third line assay)
AGYW	Adolescent Girls and Young Women
ANC	Antenatal Care
ANC1	First Antenatal Care Visit
ANVISA	Brazilian Health Regulatory Agency
ART	Antiretroviral Therapy
BMGF	Bill and Melinda Gates Foundation
CAB-LA	Cabotegravir Long-Acting
CAGR	Compound Annual Growth Rate
CDC	Centers for Disease Control and Prevention
CHAI	Clinton Health Access Initiative
CIFF	Children's Investment Fund Foundation
COB	Community Based Organizations

Acronym	Full Form
COGS	Cost of Goods Sold
COP	Country Operational Plan
CRP	Collaborative Registration Procedure
DCGI	Drug Controller General of India
DPV	Dapivirine
EIC	Eureka Idea Co
EIA	Enzyme Immunoassay
EMAV	Early Market Access Vehicle
ERB	Ethics Review Board
ERPD	Expert Review Panel for Diagnostics
EUL	Emergency Use Listing
EXW	Ex-Works
FBO	Faith Based organization
FP	Family Planning
GHSC-RTK	Global Health Supply Chain HIV Rapid Test Kit Program

Acronyms (continued)

Acronym	Full Form
HBV	Hepatitis B Virus
HHS	HIV, hepatitis and sexually transmitted infections
HIC	High-Income Country
HIV	Human Immunodeficiency Virus
HIVST	HIV Self-Testing
HTS	HIV Testing Services
ICTCs	Integrated Counselling and Centers
KOS	Knowledge of Status
KP	Key Populations
LMIC	Low- and Middle-Income Country
M&E	Monitoring and Evaluation
MoH	Ministry of Health
MOU	Memorandum of Understanding
MoH	Ministry of Health
MSF	Médecins Sans Frontières
NGO	Non-Governmental Organization
p.a.	Per annum
PAHO	Pan American Health Organization
PEP	Post-exposure prophylaxis

Acronym	Full Form
PEPFAR	President's Emergency Plan for AIDS Relief
PFSCM	Partnership for Supply Chain Management
PITC	Provider-Initiated Testing and Counseling
PLHIV	People Living with HIV
PMI	President's Malaria Initiative
PPM	Pooled Procurement Mechanism
PPV	Positive Predictive Value
PQ	Prequalification
PQR	Price and Quality Reporting
PrEP	Pre-Exposure Prophylaxis
PSI	Population Services International
Q1	First Quarter
Q2	Second Quarter
QA	Quality Assurance
QC	Quality Control
QMS	Quality Management System
RDT	Rapid Diagnostic Test

Acronyms (continued)

Acronym	Full Form
SRA	Stringent Regulatory Authority
STAR	HIV Self-testing Africa (STAR)
STI	Sexually Transmitted Infection
TB	Tuberculosis
TWG	Technical Working Group
UNAIDS	Joint United Nations Programme on HIV/AIDS
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
US	United States
VG	Volume Guarantee
VMMC	Voluntary Medical Male Circumcision
WAP	Weighted Average Price
WHO	World Health Organization

Scope, methods and limitations

This annex contains addition detail on the scope, methods and limitations of this report, with particular focus on the procurement data used to analyse the market.

A2

Scope: donor-funded LMIC markets

The scope of this report is **LMIC donor-funded rapid test markets**. It is not a global report as high-income country markets are excluded and several LMICs that fund their HIV testing programmes domestically are excluded (discussed below in limitations). There is limited focus on the private sector, except for nascent self-testing retail markets.

This report **focuses on RDTs**, the backbone of HIV testing in LMICs. As such, this report excludes:

- Molecular diagnostics for infants under 18 months of age.

- **Recency tests** because they are used primarily for surveillance (i.e. not clinical diagnosis or patient management) and are not part of standard HIV diagnostic algorithms.

- EIAs and other laboratory immunoassays. Although used in some LMICs, experts and limited data (see Annex slide) indicate that RDTs are the backbone of HIV testing.

Because the focus is on donor-funded markets, the report centres primarily on WHO-prequalified tests.

Data were analysed over the period of November 2021 to December 2022 to identify key trends in the market and inform the market landscape report.

Methods: desk review and qualitative analysis combined with integrated forecast and procurement data analysis

Qualitative and desk review

Desk review and qualitative components include reviews of policies, meeting proceedings, webinars, policymaker and partner reports, peer-reviewed publications, and institutional and corporate websites. These reviews were supplemented by consultations with partners and semi-structured telephone interviews with manufacturers of HIV rapid test. The latter were conducted with WHO, which holds regular consultations with HIV test manufacturers.

The list of partner consultations/interviewees and manufacturers is included in this Annex. Consultations and interviews were conducted between March and November 2022.

Quantitative

Quantitative work included developing an integrated HIV forecast and procurement data analysis to assess market trends. We relied on several types of data:

- The forecast uses procurement data, budget data from donors where available, and country reports to WHO/UNAIDS (GAM and ARV Survey).

- The market trends analysis considers procurement data.

The procurement data set and analysis developed by EIC are described further in this annex.

Partner consultations and manufacturer engagement

1. Aayush Solanki, Serah Malaba, and Seth McGovern, Population Services International
2. Alex Mustetea and Ellie Marsh, Med Access
3. Andrew Storey, Christian Stillson, Gillian Leitch, Yashika Bansal, Katherine Guerra, Yogan Pillay, Azraa Mohamed, CHAI
4. Anita Sands, WHO (Post Market Surveillance)
5. Ard van Dongen, Kathy Johnson PfSCM (procurement agent for Global Fund)
6. Aziz Jafarov, Global Fund (Sourcing)
7. CHAI South Africa team
8. Cheryl Johnson, Muhammad Jamil, and Maggie Barr-Dichiara, Céline Lastrucci, Emmanuel Fajardo, WHO (Global HIV, Hepatitis and STI programme)
9. David Maman, Susana Lorente, Obi Onyekwena, Global Fund (Disease Advisors)
10. Elsa Tran, Medecins Sans Frontieres
11. Jason Williams, USAID/PEPFAR
12. Kenny Onasanya, Unitaid
13. Maaya Sundaram, Chase Mertz, Tanya Shewchuk, Peter Ehrenkranz, BMGF
14. Marcelo A. Freitas, PAHO
15. Mohammed Majam, Ezintsha research center
16. Peter Smith & colleagues, Global Health Supply Chain HIV Rapid Test Kit Program (GHSC-RTK), sourcing for PEPFAR
17. Richard Borain, Taryn Barker, Children's Investment Fund Foundation
18. Stephanie Behel, US CDC
19. Susie Brannif, Irena Prat, Mark Lanigan, Anne-Laure Page, WHO (Prequalification Unit)
20. Vincent Wong, USAID

Company	Brands
1. Abbott	CheckNow, Determine, Bioline
2. Advy	EzDx
3. Beijing Wantai	Rapid test for HIV Antibody"
4. Biolytical	Insti
5. ChemBio	DPP, StatPack, SureCheck
6. Guangzhou Wondfo	One Step
7. Invex Health	Morcheck
8. Shanghai Kehua KHB	HIV-1/2 Antibody Test
9. Orasure	OraQuick
10. Premier Medical	First response
11. SD Biosensor	Standard Q
12. Sedia Biosciences	Asante
13. Trinity	Trin-Screen, UniGold
14. Viatris (fka Mylan)	Atomo

Developing a procurement data set for market trend analysis

A large part of this project involved compiling, standardizing, and cleaning procurement data, and in some instances budget data, for HIV-only RDT, dual HIV/syphilis tests, and HIVST products. While previous efforts have focused on HIV-only RDTs or HIVST product forecasts (e.g. 2020 HIVST forecast), a combined dataset and comprehensive analysis had not been previously undertaken. The data sources, the cleaning process, and limitations are described in the next slides.

It is important to note that the data supporting the forecast and the data for market analysis differ slightly. For the forecast, budgeted amounts are included. For the market analysis (e.g. prices, market share etc.), only actual transactions are used.

1

Data set preparation

Data collection from multiple sources

Database design

Triangulation of data for validation

Data cleaning and standardization

Quality control

2

Data Analysis

Product types

Market share and growth

Pricing trends

A1 preferences

3

Review of Analysis

Understand output implications

Determine relevance and usefulness
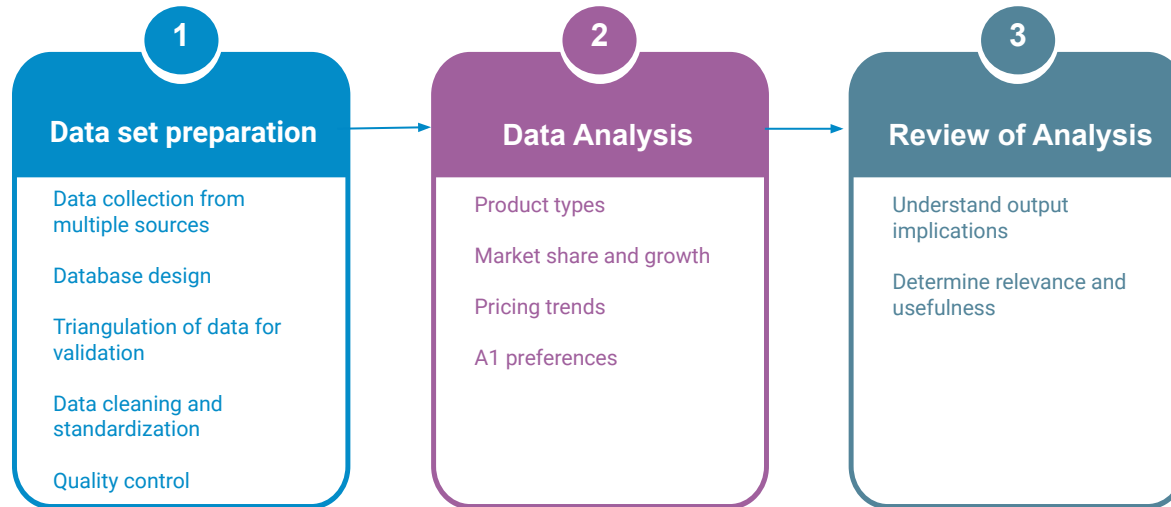
Procurement data set in detail

An original data set comprising over 4,000 individual orders totalling 824 million RDTs purchased from 2015 to 2022 was assembled from major procurers, including:
- GF price quality reporting, 2016 - Sept 2022
- PEPFAR/USAID, 2015 - Sept 2022
- UNDP, 2020
- WHO, 2020
- UNICEF, 2020 – Q2 2022
- Other: Unitaid's STAR and ATLAS projects
- Trade Atlas (Kenya)

Data come directly from the procurement agents and are assumed to be reasonably complete. The one exception is GF, which is reported by recipient countries through the Price and Quality Reporting (PQR). Timely reporting through this mechanism is often delayed, therefore, the PQR data is always incomplete at a given time of download.

To appreciate how complete the data are,
Pooled Procurement Mechanism (PPM) volumes as reported by the Global Fund can be compared to PPM volumes reported in the PQR. For 2020 and 2021, PPM reports 154m RDTs1. The PQR includes 127m RDTs across these years, suggesting a reasonable proportion of the data are available (~82%). Insight on the completeness of PQR data for orders that are not going through the PPM is not available, and they are assumed to be less complete.

The HIV RDT market understanding is also limited by the unavailability of data from some countries, largely due to the absence of mechanisms for reporting transactions that are not funded by large donors, e.g. South Africa, Kenya, India, Brazil, and the private sector. More specifically:

- South Africa and Kenya (two large LMIC RDT markets) are poorly represented in our analysis because they fund much of their HIV testing with domestic funds, and no mechanisms for reporting these transactions are available.
- No procurement data were available for China, however China reported to UNAIDS that it conducted 277 million tests in 2019, suggesting that it is a sizable market. China also tends to rely on domestic regulation and products, its inclusion in our analysis would have skewed many of the findings.
- Data for India and Brazil were limited to one or two orders, and therefore these countries were excluded from market analysis and the reported forecast results.
- Brazil, India, South Africa and Kenya did not respond to requests for procurement data.

Procurement data: primarily from Global Fund and PEPFAR

Figure A2.01: All HIV Rapid Test Volumes by Data Source (millions of tests)
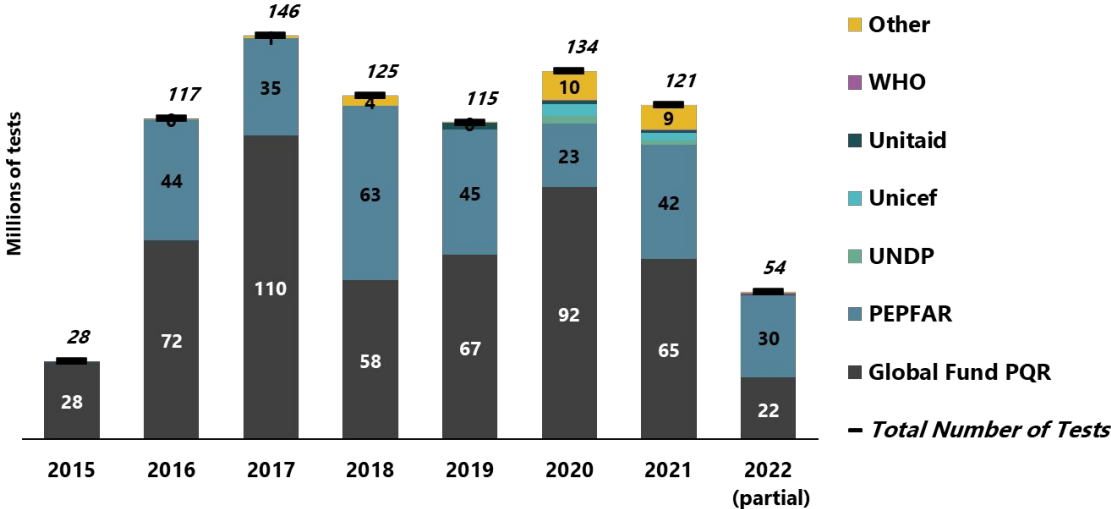
4,146 orders included in data set

Figure source: EIC Procurement data analysis

Procurement data limitations: donor funded procurement data represents only a proportion of estimated HIV testing in LMICs

Figure A2.02: Volume of HIV Rapid Tests Procured (millions of tests)
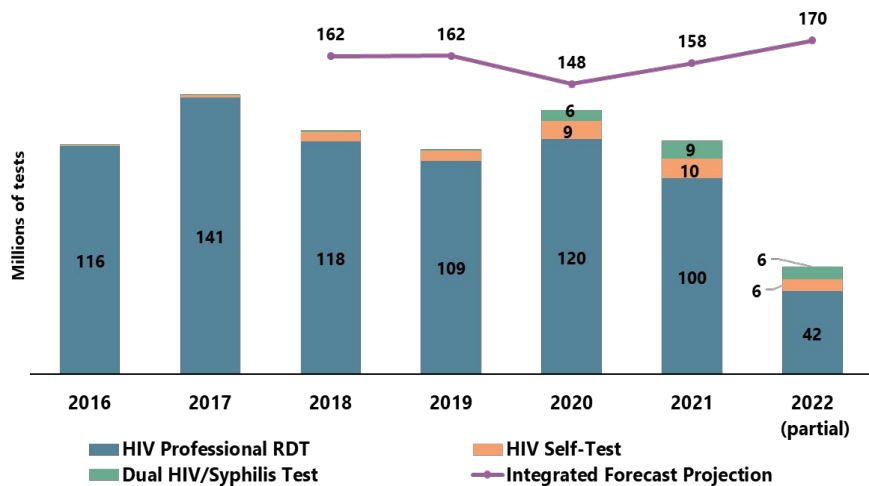
- Although procurement data for a sizable volume of tests are available, we cannot assess how representative they are of the total LMIC HIV RDT market.
- The total HIV RDT market size (global and LMICs) is unknown.
- To provide some context and sense of the completeness of the procurement data set, this chart compares the procurement data volumes (bars) to the forecasted projections (current Approaches scenario) which are underpinned by UNAIDS testing data (i.e. country reporting to UNAIDS/WHO on tests conducted each year).

Source: EIC Procurement data analysis

Procurement data is limited for some large markets

Table A2.01: Integrated Forecast scope - key country limitations

Country	Procurement data	Forecast		Forecast	Market analysis	Comment
		Budget data	Country reporting to WHO/UNAIDS - GAM/ARV survey data			
China	None	None	One year of (verified) test volume but no epi data. No knowledge of status data.	Excluded*	Excluded	China is excluded as procurement data are unavailable and UNAIDS data are patchy. Since it is a sizable market, largely served by domestic suppliers, making assumptions to fill data gaps that might be incorrect would skew findings.
Brazil	Minimal: HIV tests are domestically funded; anecdotal data with limited ability to validate	None/anecdotal	Yes	Excluded from forecast results*	Excluded from procurement data analysis	Summary slide
India	HIV tests are domestically funded; anecdotal data with limited ability to validate: Minimal (1-2 orders)	None	Yes	Excluded from forecast results*	Excluded from procurement data analysis	Summary slide
Kenya	Minimal (handful of orders)	A few procurements found in Trade Atlas; largely incomplete.	Yes	Included in forecast based on GAM/ARV survey + dual and HIVST procurement data where available	Data available are included in analysis	Assumptions based on desk research and stakeholder interviews given greater weight to improve visibility
South Africa	Minimal (handful of orders)	A few donor funded procurements (e.g. HIVST)	Yes	Included in forecast based on GAM/ARV survey + dual and HIVST procurement data where available	Qualitative/anecdotal information in summary slide	Assumptions based on desk research and stakeholder interviews given greater weight to improve visibility

*We highlight China's exclusion for scope clarity; it is not included In the model. Brazil and India are included in the model and their volumes can be added to the forecast results in the future if data availability changes.

Procurement data preparation

To **prepare** the data we:

- Standardized data and table structures (e.g. reviewed and standardized product types, and product manufacturer names). When necessary, we extracted information from procurer's free text descriptions in order to assign test type, format, pack size, brand, and vendor.
- Calculated total volumes and prices/test where necessary

To **clean** the data we:

- Reviewed data for potential duplicate entries and removed them where quantities and total costs were similar (esp. UNICEF, UNDP, and WHO overlap with Global Fund PQR)
- Searched for outliers (e.g. irregular volume and price/tests) and excluded these, or corrected obvious data entry mistakes (e.g. wrong pack size)

Challenges

The procurement data preparation process highlights challenges that potentially limit our understanding of the HIV test markets:

- The analysis relied primarily on PEPFAR and Global Fund data, information from other sources was not as readily accessible or not available for some time periods.
- There is little standardization in how data are collected and reported; for example, each procurer captures different data points and uses different nomenclature and standards for reporting (e.g. dates).
- Despite efforts to remove duplication, the lack of clarity between the different reporting systems increases the possibility of unidentified duplicates within the analysed data set or for data to have been mistakenly excluded.

Procurement data analysis

Major analysis undertaken:

- Types of RDTs procured and trends over time
- Company and product market share, by volume and value
- Market growth, by volume and value
- Brand of RDTs procured, volume, and number of countries procuring each brand
- Pricing trends, including variation by brand/product (e.g. by order size or from reference prices). Because shipping terms varied, pricing analysis generally excluded those orders that were not EXW.
- Volume of tests procured by country, by year
- A1 vs. A2/A3 segment analysis. The A1 analysis relied on procurement volume to determine a country's A1 vs A2/A3 test selection. The test type with the most volume within any one country was considered that country's preferred A1 test and volumes of all other test types were considered A2/3. While some of these data were able to be validated anecdotally, lacking a full picture of many countries' procurement behaviours meant that these preference assumptions could be inaccurate for some countries and limited the ability to analyse these segments discreetly.

Pricing analysis performed on a subset of EXW data

Weighted average price (WAP) was used to guide analysis as it best represents the procurement price within the market. Pricing analysis excluded those orders that were not EXW unless otherwise noted (e.g. HIVST).

Figure A2.03: HIV-only RDT Volumes by Price Type
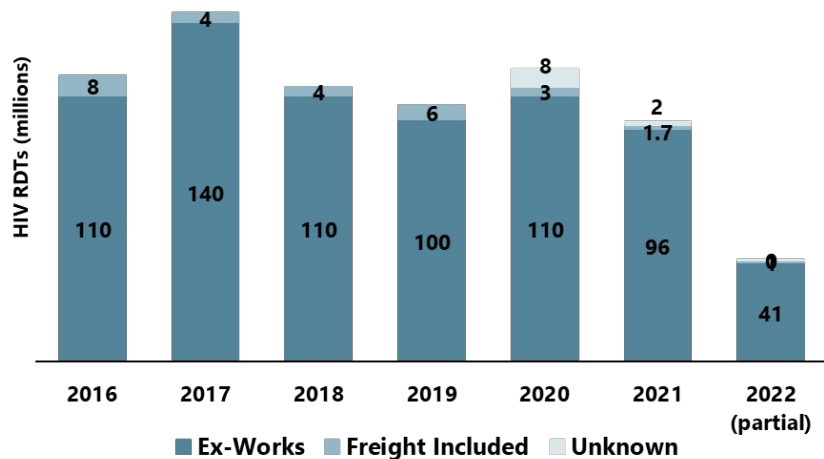
Figure A2.04: HIVST Volumes by Price Type
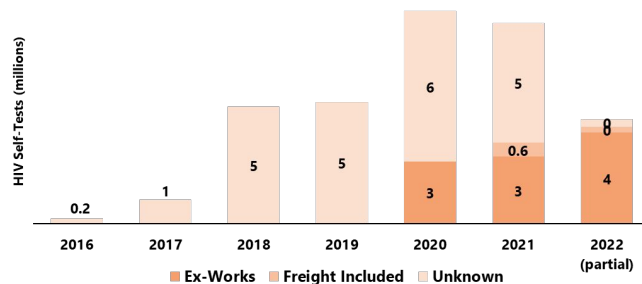
Figure A2.05: Dual HIV/Syphilis RDT Volumes by Price Type

Source: EIC Procurement data analysis
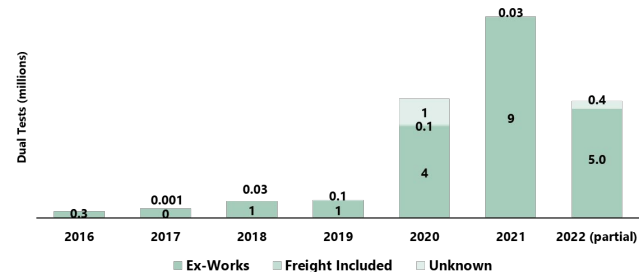
Integrated HIV RDT forecast

This annex provides additional details on how the integrated forecast was developed. It also includes additional results for the different scenarios.

Additional information will also be published in the forthcoming WHO forecast report from the October 2022 Joint WHO/UNAIDS stakeholder and manufacturer meeting.

A3

Structure of the integrated HIV RDT forecast

Combination of three interrelated modules

Figure A3.01: Integrated Forecast module components

Non-ANC

A1 HIV only screening
A2/A3 confirmatory

+

ANC

A1 HIV only screening
A1 dual HIV/syphilis
screening
A2/A3 confirmatory

+

HIV self-testing

A0 HIVST

Integrated HIV RDT Forecast

The integrated HIV RDT forecast comprises 3 inter-related modules
which are combined to present an overall estimate of future HIV RDT
test volumes by country and region for a range of scenarios.

*A1 HIV only screening=HIV Assay 1 (first line assay)
A2/A3 confirmatory=HIV Assay 2 and HIV Assay 3 (Second and third line assays)
A1 dual HIV/Syphilis=HIV/Syphilis Assay
A0=HIV Assay 0 (used for self-testing)

Integrated HIV RDT Forecast Scenarios

Table A3.01: Integrated Forecast Scenarios - projection trends

	Current approaches (Base case)	HIVST predominant in non-ANC	Dual HIV/ syphilis optimistic in ANC	HIVST predominant and dual optimistic
Non-ANC Trajectory if KOS* < 95%	All scenarios: Grow in proportion to KOS growth until 95% and then hold flat			
Non-ANC Trajectory if KOS* > 95%	Assume steady state			
ANC1 testing coverage increases (as indicated by historical trends) and is maintained until at least 2030	Dual HIV/syphilis uptake for all high and medium countries		Dual HIV syphilis uptake for high, medium, and low countries	
HIVST procurement projection (non ANC)	Remains additional / outside facility testing in most countries	Replaces facility testing	Remains additional / outside facility testing in most countries	Replaces facility testing
Testing approach for PrEP users	Uses prof. RDTs only (4 tests per annum, (p.a.))	Uses 3 self-tests p.a. and 1 prof. RDT p.a	Uses prof. RDTs only (4 tests p.a.)	Uses 3 self-tests p.a. and 1 prof. RDT p.a

*KOS = Knowledge of HIV Status
**ANC testing coverage refers to the proportion of women who are given an HIV test during an antenatal visit. Historical data is sourced from UNAIDS Spectrum estimates for "HIV testing in pregnant women."

Data Source and Volume Drivers for each Test Type

Table A3.02: Integrated Forecast Test Types - data sources and volume drivers

Forecast	Test Types	Historical Data Source	Projected Data
Non-ANC Testing	Professional Use RDTs	UNAIDS GAM: Total Number of Tests Conducted	Future trend based on projected Knowledge of Status
ANC Testing	HIV only	UNAIDS GAM: ANC1 Tests Conducted	Future trend held flat
	Dual HIV/Syphilis	Known Procurement	Projected to reach a maximum of 95% of ANC1.
HIVST	HIVST	Known Procurement	Projected on increasing trend
PrEP	Professional Use RDTs	AVAC's Global PrEP Tracker	Projected on trend to achieve 10m users by 2030
Confirmatory Testing	Professional Use RDTs	Estimated based on other volumes of tests	Based on volumes of other tests

Defined criteria for categorization of dual HIV/syphilis testing coverage in ANC within the next 5 years

Table A3.03: Integrated Forecast - Dual Test coverage in ANC classifications criteria

Criteria	High	Medium	Low	Minimal
Policy status	Policy in place for ANC	Policy in place for ANC	No policy in place for ANC but discussions ongoing	No policy in place for ANC
Confirmed procurement of dual HIV/syphilis test	>50% of estimated ANC annual test volumes	<50% of estimated annual ANC test volumes	<50% of estimated annual ANC test volumes	No known procurement
Funding secured / requested	Funding secured for dual HIV/syphilis test > 50% of estimated ANC annual test volumes	Funding applications include dual HIV/syphilis test	Funding applications include dual HIV/syphilis test	Not included in funding applications
Implementation plans	Pilot completed; scale up plans documented	Pilot underway	Pilot planned	No pilots planned

High: All 4 criteria met
Medium: Policy in place AND at least one other criteria met
Low: No policy but discussions ongoing AND at least one other criteria met
Minimal: None of the 4 criteria met

Additional forecast results

Results: HIV RDT market in LMICs is forecast to be between 194m and 206m by 2027

Figure A3.02: Integrated Forecast Results - Total Test Volumes by Scenario
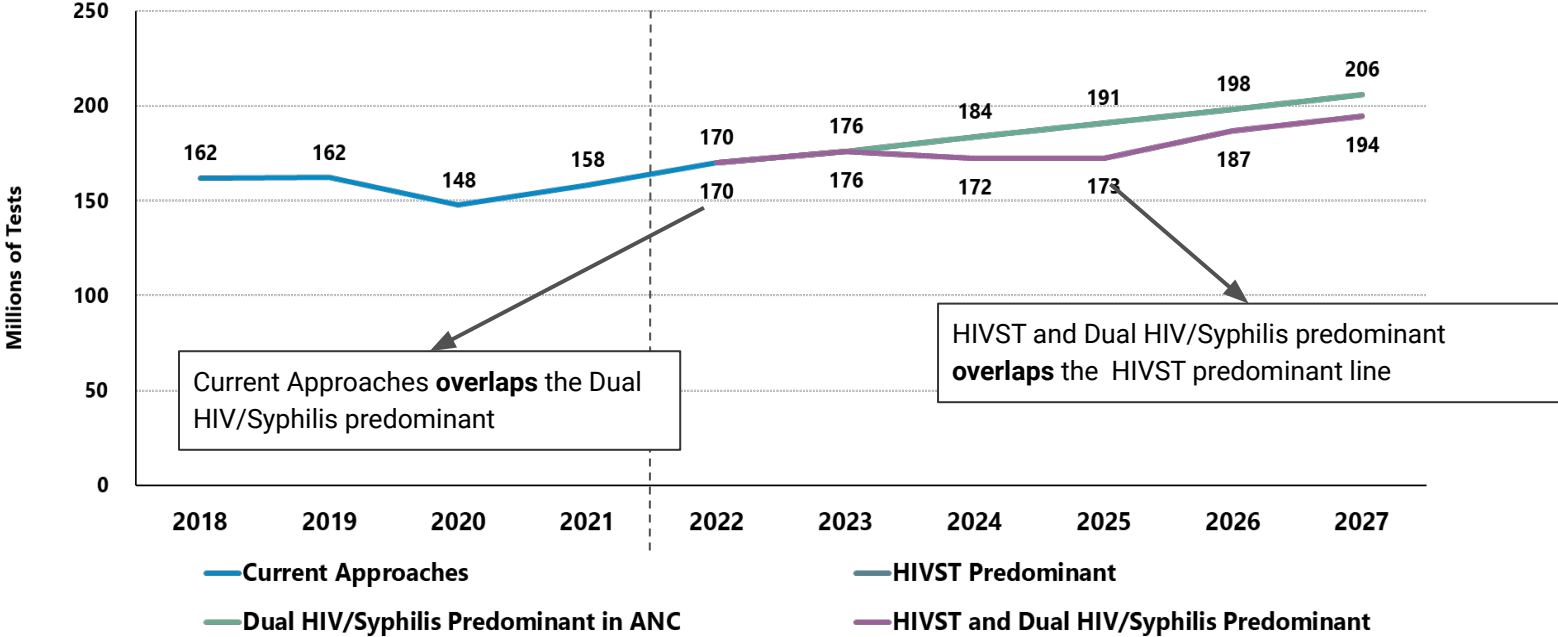
Current Approaches **overlaps** the Dual HIV/Syphilis predominant

HIVST and Dual HIV/Syphilis predominant **overlaps** the HIVST predominant line

104 LMICs; China excluded; India test volumes excluded; Brazil test volumes excluded

Current approaches: Growth of up to 40m tests expected in the next 5 years mostly in Africa (75%); some in Asia (19%)

Current approaches: Regional breakdown

Figure A3.03: Integrated Forecast Results - Total Test Volumes by UNAIDS Region for the Current Approaches Scenario
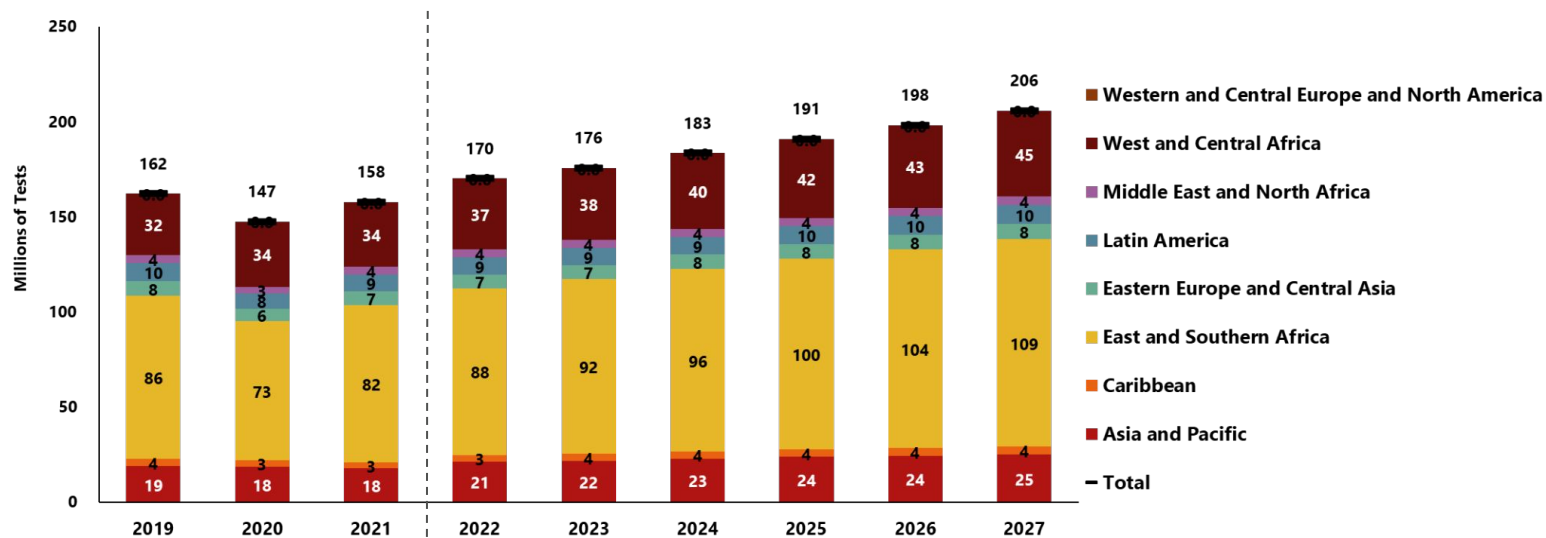
104 LMICs; China excluded; India test volumes excluded; Brazil test volumes excluded

Current approaches: A1 HIV-only RDTs represent ~75% of 2022 volumes. By 2027 this will decrease to 67% of overall test volumes, because dual HIV/syphilis RDTs and HIVST are projected to grow at faster rates. Substantial growth and geographic diversification in HIVST by 2027 are projected; however, the market is still dominated by Africa with 62% of the HIV self-tests distributed there.

Current approaches: Regional breakdown

Figure A3.04: Integrated Forecast Results - 2027 market size by product type and UNAIDS region
Current approaches scenario

2027 market size:

| 137m | 29m | 30m | 10m |

5 yr market growth p.a.:

| 1.8% p.a. | 10.0% p.a. | 18.2% p.a. | 1.5% p.a. |

Legend:
- Western and Central Europe and North America
- West and Central Africa
- Middle East and North Africa
- Latin America
- Eastern Europe and Central Asia
- East and Southern Africa
- Caribbean
- Asia and Pacific

Categories: A1 HIV Screening Assay, A1 Dual HIV/Syphilis Screening Assay, A0 HIV Self-Test Screening Assays, A2/A3 Confirmatory Assays
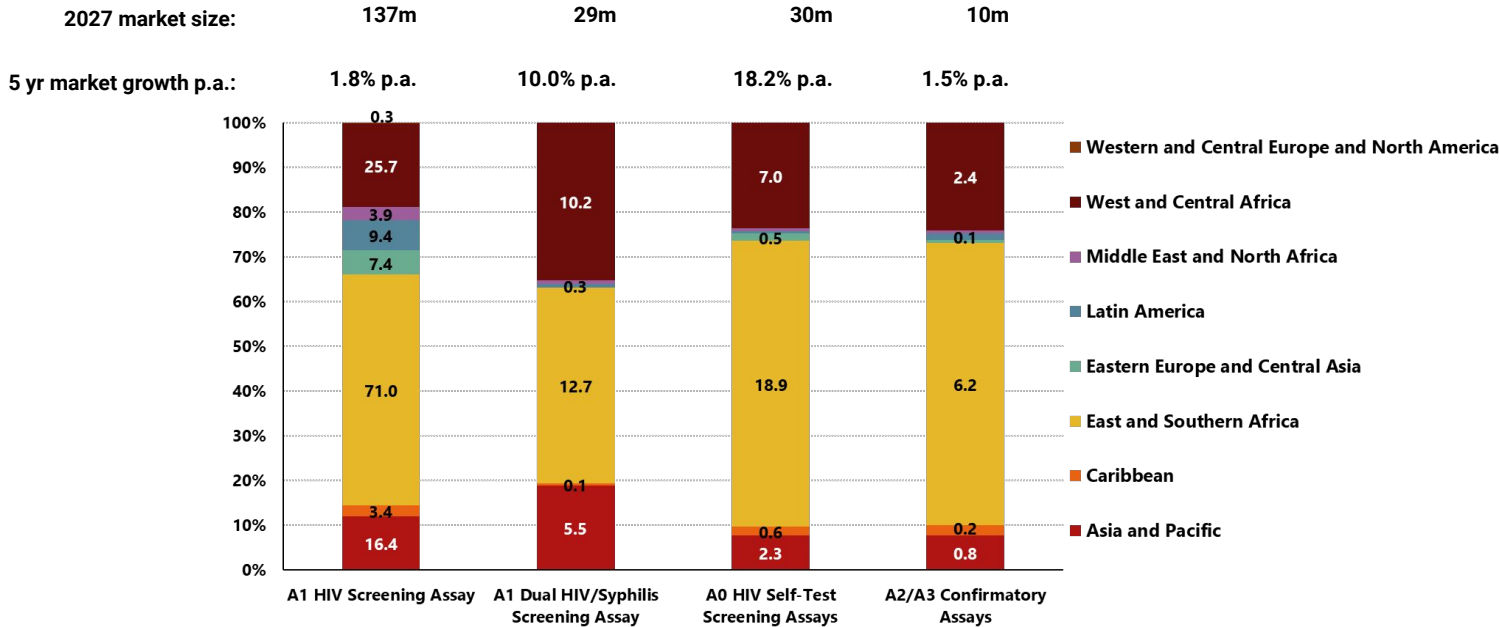
104 LMICs; China excluded; India test volumes excluded; Brazil test volumes excluded

Dual HIV/syphilis optimistic scenario: Compared to the current approaches 17 additional countries, predominantly in West and Central Africa, scale dual tests; this increases the dual test growth rate from to 10% p.a. to 21% p.a.

Dual HIV/syphilis optimistic scenario: Regional breakdown

Figure A3.05: Integrated Forecast Results - 2027 market size by product type and UNAIDS region
Dual HIV/Syphilis optimistic scenario

2027 market size:	126m	40m	30m	10m
5 year market growth:	0.1% p.a.	20.5% p.a.	18.2% p.a.	1.5% p.a.

Chart data (stacked bars, % of market, values labeled):

Region	A1 HIV Screening Assay	A1 Dual HIV/Syphilis Screening Assay	A0 HIV Self-Test Screening Assays	A2/A3 Confirmatory Assays
Western and Central Europe and North America	0.3			
West and Central Africa	19.9	16.1	7.0	2.4
Middle East and North Africa	3.8			
Latin America	8.7	0.4		0.1
Eastern Europe and Central Asia	7.4			
East and Southern Africa	66.5	17.2	18.9	6.2
(self-test segment)			0.5	
Caribbean	3.4	0.1	0.6	0.2
Asia and Pacific	16.4	5.6	2.3	0.8

104 LMICs; China excluded; India test volumes excluded; Brazil test volumes excluded

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HIVST predominant scenario: A dramatic shift to HIVST could see the contraction of the HIV-only RDTs by 55m A1 screening tests

Figure A3.06: Integrated Forecast Results - 2027 market size by product type and UNAIDS region
HIVST predominant scenario
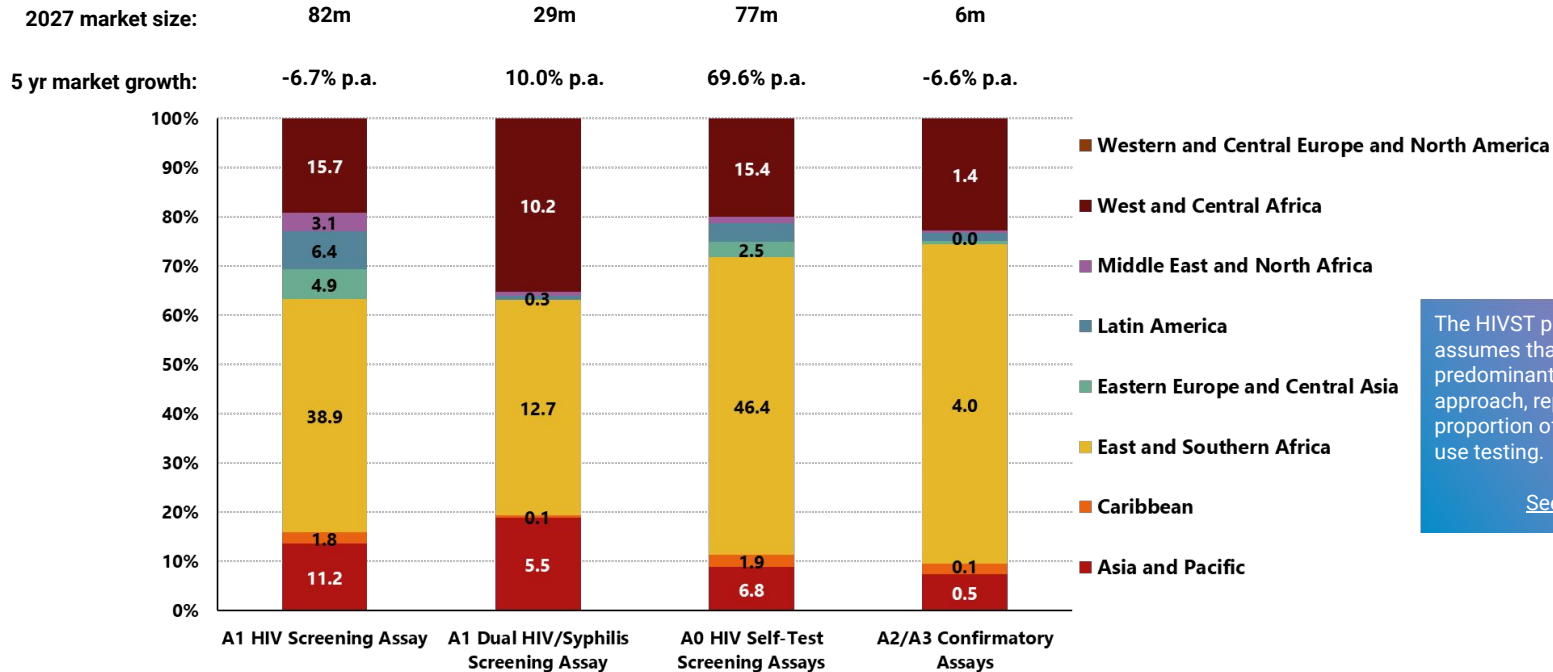
2027 market size:	82m	29m	77m	6m
5 yr market growth:	-6.7% p.a.	10.0% p.a.	69.6% p.a.	-6.6% p.a.

Legend:
- ■ Western and Central Europe and North America
- ■ West and Central Africa
- ■ Middle East and North Africa
- ■ Latin America
- ■ Eastern Europe and Central Asia
- ■ East and Southern Africa
- ■ Caribbean
- ■ Asia and Pacific

A1 HIV Screening Assay: 15.7, 3.1, 6.4, 4.9, 38.9, 1.8, 11.2

A1 Dual HIV/Syphilis Screening Assay: 10.2, 0.3, 12.7, 0.1, 5.5

A0 HIV Self-Test Screening Assays: 15.4, 2.5, 46.4, 1.9, 6.8

A2/A3 Confirmatory Assays: 1.4, 0.0, 4.0, 0.1, 0.5

The HIVST predominant scenario assumes that HIVST become the predominant programmatic approach, replacing a significant proportion of non-ANC professional use testing.

See link for details

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104 LMICs; China excluded; India test volumes excluded; Brazil test volumes excluded

Additional Background

Additional background information (e.g. regulatory, procurer, and supplier overview) pertaining to professional and self-test markets.

A4

Professional product offering

Professional tests: different mechanisms aim to ensure quality

WHO and donor policies for professional tests

From a regulatory perspective, HIV tests are generally subject to a country's most rigorous level of regulation and quality review. However, LMIC regulatory systems vary in their maturity and enforcement. As a result, many countries, large donors, and procurers rely on the WHO Prequalification Programme for in vitro diagnostics (WHO PQ) to evaluate product safety, quality, and performance.

The WHO PQ process involves dossier review, site inspection, and an independent performance evaluation. For HIV professional test performance in particular, WHO PQ: i) reviews and verifies the claims made by the manufacturers in the instructions for use (IFU) and ii) conducts a limited laboratory based performance evaluation, intended to confirm the claims and verify that the performance meets WHO criteria. The WHO PQ public reports for each test include the summary results of the performance evaluation. The span of time since the first and more recently prequalified tests precludes direct comparison of WHO PQ-ed tests as there have been changes in the evaluation panels used.

https://extranet.who.int/pqweb/vitro-diagnostics/prequalification-reports/whopr]

Major donors procuring professional HIV tests have largely aligned their policies with the WHO recommendations:

- The Global Fund procurement list includes WHO PQ-ed professional tests, as well as a few additional tests that have been approved by designated SRA authorities. https://www.theglobalfund.org/en/sourcing-management/quality-assurance/diagnostic-products/
- PEPFAR procurement lists for professional HIV RDTs also include only WHO PQ-ed products. https://www.ghsupplychain.org/ghsc-eligible-rapid-diagnostics-tests

For designated critical diagnostics that are applying to WHO PQ, the **Global Fund/Unitaid Expert Review Panel for diagnostics (ERPd)** provides an interim solution allowing procurement by the Global Fund and Unitaid. The panel considers the potential risks and benefits of diagnostics. It makes time-limited procurement recommendations, with the expectation that manufacturers will then submit products to the WHO PQ or to a stringent regulatory process. Opportunities for evaluation are initiated by the Global Fund after partner consultation; the schedule for diagnostic products tends to be ad hoc. Currently open HIV testing related ERPd's include: HIV self-tests and syphilis, hepatitis B and C tests, including those combined with HIV.

HIVST: The donor-funded markets require WHO pre-qualification for HIV self-tests

WHO and donor policies for self-tests

WHO HIV Programme recommendations. The HIV disease programme recommends that countries select only WHO PQ-ed HIVST products ([WHO, 2019 Testing Services Guidelines](#)).

Unlike professional tests, for HIVST, the WHO HIV programme does not have minimum performance criteria for self-testing in the hands of lay users, presumably because precise performance in the hands of lay users is difficult to assess and varies based on their experience with self-testing, literacy, etc. The WHO also notes that local verification studies are not necessary for HIVST: "the assay for A0 needs to be easy to use and accurate but as the testing strategy for diagnosis will commence at A1, there is far less concern about cross-reactivity among products." ([WHO, 2019 Testing Services Guidelines](#)).

The WHO Prequalification programme for HIVST. HIVST PQ requires dossier review, site inspection, and independent lab evaluation, just as any other prequalified test does. However, there are a couple of differences in HIVST PQ compared to professional test PQ.

First, PQ does not independently verify the performance of tests in hands of lay users; PQ considers the minimum performance of the test in optimal conditions, i.e. performed by an experienced lab technician. Instead, PQ reviews the manufacturer's usability studies (studies of self-testing with lay users) to support the manufacturer's performance claims in the IFU.

Second, there are some differences in the PQ-review depending on the type of test submitted. 1) When a manufacturer submits a test that is not a repurposed professional test that is already prequalified, it is subject to the full PQ review. 2) Manufacturers who are "repurposing" WHO PQ-ed professional HIV RDTs for self-testing can submit a change request, expanding the intended use of the professional test to include self-testing. This primarily involves PQ reviewing the usability studies for the test (the studies looking at performance by lay users). In this instance, PQ does not repeat a laboratory performance evaluation for the test.

The WHO PQ website includes a list of PQ-ed HIVST and their public reports. The format of the public reports differ, depending on whether the HIVST was submitted through the usual WHO PQ process or if the test is a repurposed professional use test, in which case the professional test review would only provide additional information on the self-testing claims.

The **Global Fund and PEPFAR only procure WHO PQ-ed HIVST**. In this instance, the Global Fund does not allow SRA approved products, presumably because WHO PQ considers usability in LMIC settings and populations, which may differ materially from high-income countries with stringent regulatory systems.

WHO Prequalification process overview

The WHO PQ process comprises three components:

Review of the product dossier. Evidence and studies supporting the product's performance claims are an essential component of the dossier review. In 2016 WHO published HIV Technical Specification Series (TSS) outlining the expectations for verification and validation, especially for studies establishing the analytical performance of the test (i.e. features of the test that should be validated in the lab) and the clinical performance (i.e. studies of test performance in the hands of intended users on patient samples) and the usability assessment for self-tests. For dual HIV/syphilis RDTs, the Syphilis TSS also applies.

Performance evaluation. WHO PQ conducts independent laboratory performance evaluations for all products. For HIV rapid tests, the evaluation confirms that the test meets WHO performance criteria using a geographically diverse panel. Evaluation results are included in PQ's public reports for each product. Because the number of laboratories performing the evaluations has increased, and the seroconversion panels and the benchmark test used were changed (due to commercially availability), seroconversion results are not necessarily comparable across products.

Manufacturing site assessment. WHO PQ includes manufacturing site inspections to assess compliance with the requirements of ISO13485 and the relevant TSS. The inspections are generally performed on-site; exceptionally, WHO conducts them remotely.

WHO PQ releases public reports which summarize their review. Additionally, they developed a tool kit to support HIV algorithm development.

Overall, prequalification assessment timelines have been longer than usual, including those for dossier review, and during the pandemic travel restrictions have limited WHO PQ's ability to conduct site inspections. Since 2020, SARS-CoV-2 tests have been the highest priority of WHO, and in 2022 PQ applications remain medium priority. (referencing the PQ newsletter for Q1'22) In addition to many SARS-CoV-2 Emergency Use Listing (EUL) applications, the volume of change notifications (both for PQ-ed and EUL-listed IVDs) requiring WHO PQ review increased during the pandemic, as manufacturers sought to expand their production capacity or to increase their raw materials suppliers (i.e. qualify additional "back up" raw materials suppliers). Despite the challenges, WHO has prequalified more than 20 tests since the start of the pandemic.

WHO collaborative registration procedure (CRP) aims to streamlines local registration
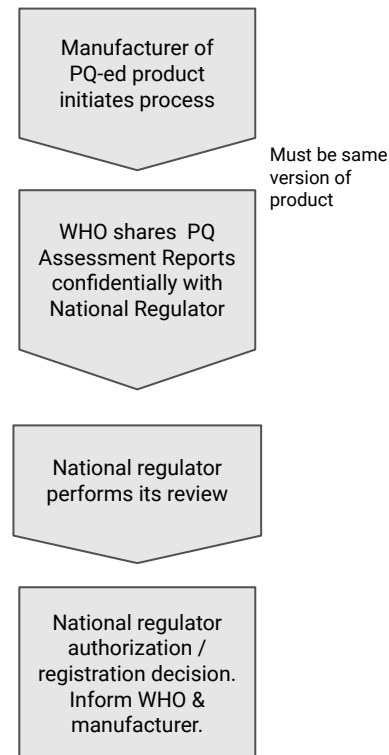
Partners and suppliers alike confirm that national registrations and product selection processes are often bottlenecks for country-level HIV test introduction.

The requirements of each country may vary, and even when a product has WHO PQ or SRA approval, local registration can require additional lab evaluations or usability studies.

To streamline the process and reduce duplication of work, WHO has begun a collaborative registration procedure (CRP) aiming to accelerate market entry of WHO PQ-ed tests. The target timeline for a national marketing authorization decision is 90 days under the CRP. In some countries, registration timelines have been reduced to 30 days. The programme has prompted local review of national registration procedures, bringing a clearer understanding of the regulatory burden and duplication of existing processes. WHO is working to increase the number of countries involved. Thus far, a variety of tests including HIV RDTs and dual tests, have been registered using the procedure, however, there has been less traction for HIV self-tests.

In November 2021 there were 13 countries that had signed up to use the WHO collaborative procedure; by April 2022 there were 20.

Figure A4.01: WHO CRP Process

Manufacturer of PQ-ed product initiates process

Must be same version of product

WHO shares PQ Assessment Reports confidentially with National Regulator

National regulator performs its review

National regulator authorization / registration decision. Inform WHO & manufacturer.

Participating countries

As of April 2022
1. Rwanda
2. Nigeria
3. Mauritania
4. Uganda
5. South Africa
6. Ethiopia
7. Tanzania
8. Zanzibar
9. Zambia
10. Mozambique
11. Ivory Coast
12. Cameroon
13. Ghana
14. Gabon
15. Bhutan
16. Kenya
17. Cabo Verde
18. Congo Republic
19. Namibia
20. Bangladesh

Global fund pooled procurement mechanism (PPM)

Global FUND PPM

Annual volumes	PPM only: 83.5-61.7m/year 2020-2022. HIV RDT proportion has declined from 77.8m to 48m (93% to 77.8%).
Agent/mechanism	PFSCM is the agent
Procurement approach	Professional HIV & HIV/syphilis RDTs and HIV self-tests are sole sourced. GF have agreements in place with suppliers, that include negotiated prices, and key performance and quality requirements. GF does not commit to any volumes, and there is no allocation of annual GF PPM volumes in the agreements. As countries request tests, individual orders are placed with the suppliers according to the price and terms in the agreements. The professional tests must be in the national algorithm.
Process	Most orders go through the WAMBO system (an online transaction tool for PPM), and delays in listing newly eligible products in WAMBO can slow uptake. GF and PFSCM on-boards qualified suppliers, and negotiates 2 year agreements with suppliers. PFSCM handles shipping/logistics/importation.
Priorities	• Professional tests: improving supply security, reducing prices. • Self-tests: competition, lower prices, and supply security, possibly through increased interchangeability of tests.
Products: Quality	List of products available based on GF QA policy. Professional HIV RDTs and HIV/syphilis RDTs: SRA/WHO PQ, ERPD Self-tests: WHO is PQ required.

PEPFAR

	PEPFAR/USAID
RDT volumes	30-40 million RDTs/year (FY18 & 19 exceptional at 50m RDTs/year) Professional HIV RDTs primarily. Some HIVST, Dual and Recency
Agent/mechanism	GHSC-RTK
Procurement approach	Indefinite delivery, indefinite quantity supply agreements, negotiated with suppliers, include a price ceiling. Contracts with suppliers are aligned with the US Government contract with GHSC-RTK, which will expire in Feb 2023.
Process	Country algorithms determine which tests are procured. Countries request specific products. GHSC-RTK on-boards supplier if not already in system. Most RDTs procured directly from manufacturer. GHSC-RTK manages procurement, fulfilment, and delivery to country stores warehouses (i.e. GHSC usually contracts 3rd party logistics providers to pick up at the manufacturer and deliver to central stores).
Priorities/changes	Improved pricing for professional and self-tests. No anticipated changes in approach.
Products: Quality	GHSC-RTK maintains a list of products, which is based on WHO PQ and (occasionally) products that are on a USAID approved list. https://www.ghsupplychain.org/ghsc-eligible-hiv-rapid-diagnostics-tests. Tests must be registered in country.

Regulatory, donor procedures, and the pandemic slow market entry of new products

The long timelines associated with PQ, country registrations, and algorithm updates push out the timing of potential sales, decreasing the overall return on investment for suppliers. New entrants are often surprised by the complexity of engaging in the HIV testing markets. Specifically:

- In-country registrations take time. Suppliers report poor alignment between PQ and local requirements, creating the need for additional evaluations and slowing market entry. While usually the timeline for PQ-ed products to complete local registrations is measured in months, one supplier reported taking three years to authorize a self-test in one South American country, while an HIV RDT local process took two years in an African country. While some suppliers are aware of WHO PQ's collaborative review procedure (CRP) and are accessing it, many countries and suppliers have little experience using it.

- The on-boarding process for large procurers differs by institution and can also take time. Suppliers often need to advocate to have their products listed in on-line or printed catalogues etc.

- The pandemic has also slowed market entry. For companies with new products, the pandemic-related travel restrictions delayed in-country registration and clinical trials. One supplier suggested that the timelines for implementing verification studies were delayed as programmes diverted staffing and attention to the pandemic. PQ timelines have often been extended. Since 2020, Covid-19 tests have been the WHO Prequalification team's priority. Additionally, suppliers reported communication slow-downs and delays in change request processing.

Low compliance with the 2019 WHO recommendation that countries adopt a three-test strategy

Figure 4.08: Adoption of 3-test strategy by region
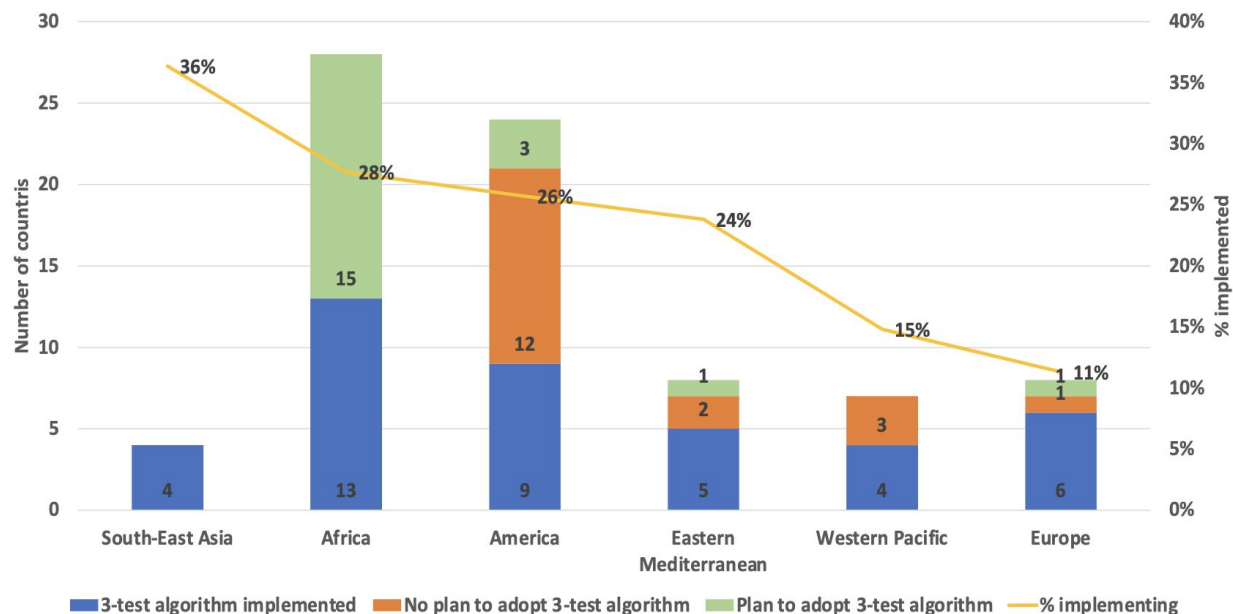
87 out of 194 countries responded to question

Source: Global AIDS Monitoring [UNAIDS/WHO/UNICEF] and Global HIV, Hepatitis and STIs Programmes (HSS), WHO, 2022

Infrequent switching of the A1 test in several high-volume donor-funded countries

Figure 4.09: Most procured test (presumed A1) by year, for countries in procurement data set with the largest volumes of Professional HIV RDTs

Country	2016	2017	2018	2019	2020	2021	2022
Nigeria	Determine	Determine	Determine	Determine	Determine	Determine	Determine
Tanzania	Bioline (3.0)	Bioline (3.0)	Bioline (3.0)	Bioline (3.0)	Bioline (3.0)	Bioline (3.0)	-
Uganda	Determine	Determine	Determine	Determine	Determine	Determine	Determine
Mozambique	Determine	Determine	Determine	Determine	Determine	Determine	Determine
Ethiopia	First response	Beijing Wantai	STAT-PAK	STAT-PAK	STAT-PAK	STAT-PAK	STAT-PAK
Zambia	Determine	Determine	Determine	Determine	Determine	Determine	Determine
Malawi	Determine	Determine	Determine	Determine	Determine	Determine	Determine
Congo, Dem. Rep.	Determine	Determine	Determine	Determine	Determine	Determine	Determine
Cameroon	Determine	Determine	Determine	Determine	Determine	Determine	Determine
Zimbabwe	Determine	Determine	Determine	Determine	Determine	Determine	Determine
Côte d'Ivoire	Determine	Determine	Determine	Determine	Determine	Determine	Determine
Kenya	Determine	Determine (A	-	Determine	First response	Determine	Determine
Rwanda	STAT-PAK	Determine 4tl	Determine 4tl	Determine (A	Determine	Determine 4tl	Determine 4th Ge
Ghana	First response	First response	First response	First response	First response	First response	OraQuick
Haiti	Determine	Determine	Determine	Determine	Determine	Determine	Determine
Lesotho	Determine	Determine	Determine	Determine	Determine	Determine	-

Note: Procurement data do not indicate how frequently algorithms reviews are conducted because the review may result in selecting the same tests. However, it can be used to identify changes in the highest volume test, presumably the "A1" test, procured in a given year.
Limitation: several high volume HIV RDT countries lack accessible procurement data, South Africa, Kenya, India, Indonesia, and Brazil.

Source: EIC Procurement data analysis

HIV test supplier overview (1 of 2)

Table A4.01: PQ-ed and PQ pipeline HIV test suppliers

SUPPLIER NAME	LOCATION of manufacturing (if known)	HIV RDT	DUAL	HIVST
Abbott	Global, HIV tests primarily made in Japan (Determine), Korea (Bioline), China (downstream RDT mfg), and Germany	Determine (2011) Bioline HIV ½ (3.0) (2013) Determine Early detect (2015) Panbio HIV verification (2022)	Bioline HIV/syphilis (2015)	CheckNow (2022)
Abon (an Abbott company)	China	Abon Tri-line (2014)		
Beijing Wantai	China	Beijing Wantai RDT (2016)		1 urine self-test under assessment
BioLytical	Canada	INSTI (2013)		INSTI self-test (2018)
Bio-rad	France (HQ)	GenieFast (2017)		
BioSynex	France (HQ)			1 self-test under assessment
Chembio	USA	STAT-PAK (2021) SureCheck (2014) DPP HIV ½ (2016)		SureCheck (2019)
InTec PRODUCTS, INC	China	One Step (Intec) (2019)		
Meril Diagnostics Pvt. Ltd	India	Meriscreen HIV 1-2 (2020)		

■ PQed   ■ In PQ Pipeline

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HIV test supplier overview (2 of 2)

Table A4.01 cont.: PQ-ed and PQ pipeline HIV test suppliers

SUPPLIER NAME	LOCATION of manufacturing (if known)	HIV RDT	DUAL	HIVST
OraSure	USA, some manufacturing in Thailand	OraQuick HIV ½ (2016)		OraQuick self-test (2017)
Premier Medical Corporation (PMC)	India, USA	First Response (2019)	First response HIV/Syphilis (2019)	
Sedia Biosciences	USA	1 oral test under Assessment		1 oral test under Assessment
Shanghai Kehua KHB		Kehua HIV RDT (2015)		
SD Biosensor	Republic of Korea	Standard Q (2020)	Standard Q HIV/Syphilis (2020)	
Trinity Biotech	Ireland	Uni-Gold (2012) TrinScreen (2022)		
Viatris / Atomo	Global, Atomo made in South Africa			Mylan/Atomo HIV self-test (2019)
Wondfo	China	Wondfo One Step (2018)		Wondfo self-test (2022)

■ PQed   ■ In PQ Pipeline

Brazil and India markets, large but limited visibility

Table A4.02: HIV RDT Market characteristics for Brazil and India

	Brazil	India
HIV RDTs/year	No centralized collection of data on tests performed, only positives are reported centrally. Likely that the public sector procure and distribute ~10-20m RDTs/year.	For 2020/21, the national programme reported 40 million people tested, including 23m at ANC. This is 7-15 fewer people than in the previous years, due to the pandemic. Additional testing also occurs through state procured RDTs. The private sector plays an important role in India's healthcare, and HIV testing in this segment is likely sizable, yet no reliable estimates are available.
Product requirements	ANVISA required WHO PQ not required	Drug Controller General of India (DCGI) registration required WHO PQ not required
Market	Domestic and global suppliers. Public sector is price sensitive and competitive, e.g. HIV RDTs for national tenders ~US$0.28	Public sector procurement largely from domestic suppliers. Public sector is highly price sensitive and competitive, e.g. 2020 dual test tender awarded at INR 12.25 (US$0.15), ~ price parity with HIV RDTs.
Algorithm	2 RDTs & Viral Load	India has a 3 RDT strategy at thousands of Stand-alone Integrated Counselling and Testing Centers across the country. In order to further decentralize testing many other sites perform only a professional screening test, referring reactive results to a Stand-alone Integrated Counselling and Testing Center for the full algorithm.
Dual test	Piloted dual, yet affordability concerns at scale	Several recent state level HIV Dual tests procurements. Dual tests are highlighted in national strategy indicating high likelihood of future scale up.
HIVST	Self-testing in retail and public sectors	No HIVST policy, no HIVST registered yet (expected in 2023) Pilot study results disseminated in September 2022; role of HIVST under consideration, cost-effectiveness is a key consideration.

Professional test product offering

Professional test HIV rapid tests differ in several dimensions. While not an exhaustive review, these next slides illustrate some key differences in WHO PQ-ed tests.

A5

Performance: sensitivity

HIV RDT sensitivity and specificity are generally quite high, and differentiating between test performances is difficult.

Sensitivity: the **majority of tests have 100% sensitivity**. Differences can be seen in their seroconversion sensitivity indexes (next slide).

Detection of subtypes: Most RDTs detect all HIV subtypes.

Table A5.01: HIV RDT product sensitivity (WHO product selection tool)

Product name	Manufacturer	Clinical Sensitivity (%)
ABON HIV 1/2/O Tri-Line HIV Rapid Test Device	ABON Biopharm (Hangzhou) Co. Ltd.	100
Bioline HIV-1/2 3.0	Abbott Diagnostics Korea Inc	100
Determine HIV Early Detect	Abbott Diagnostics Medical Co. Ltd.	100
Determine HIV-1/2	Abbott Diagnostics Medical Co. Ltd.	100
Diagnostic kit for HIV (1+2) antibody (colloidal gold) V2	Shanghai Kehua Bio-engineering Co., Ltd	100
DPP HIV 1/2 Assay	Chembio Diagnostic Systems Inc.	100
First Response HIV 1-2.O Card test (Version 2.0)	Premier Medical Corporation Private Limited	100
Genie Fast HIV 1/2	Bio-Rad	100
INSTI HIV-1/HIV-2 Antibody Test	BioLytical Laboratories, Inc.	100
ONE STEP Anti-HIV (1&2) Test	InTec PRODUCTS, INC	100
One Step HIV1/2 Whole Blood/Serum/Plasma Test	Guangzhou Wondfo Biotech Co., Ltd	100
Rapid Test for Antibody to HIV (Colloidal Gold Device)	Beijing Wantai Biological Pharmacy Enterprise Co.	100
STANDARD Q HIV 1/2 Ab 3-Line Test	SD Biosensor, Inc	100
TrinScreen HIV	Trinity Biotech Manufacturing Ltd.	100
SURE CHECK HIV 1/2 Assay	Chembio Diagnostic Systems Inc.	99.8
Uni-Gold HIV	Trinity Biotech Manufacturing Ltd.	99.8
HIV 1/2 STAT-PAK	Chembio Diagnostic Systems Inc.	99.5
MERISCREEN HIV 1-2 WB	Meril Diagnostics Pvt. Ltd.	99.4
OraQuick HIV 1/2 Rapid Antibody Test	OraSure Technologies, Inc.	99.1

Source: WHO HIV test selection tool, https://www.who.int/tools/optimizing-hiv-testing-algorithms-toolkit

Performance: seroconversion sensitivity indexes

The seroconversion sensitivity index assesses HIV RDT sensitivity in newly infected persons, when antibodies are gradually appearing. Seroconversion is the point after HIV infection when antibodies become detectable in the blood. The ability of HIV RDTs to detect these antibodies varies, especially in the early phases of infection when so few antibodies are present. The seroconversion sensitivity index is a summary result comparing the first reactive specimens detected by the RDT compared to a benchmark test (an 3rd generation enzyme immunoassay) on a predefined set of seroconversion panels. Therefore, the seroconversion index illustrates when a given RDT first becomes reactive compared to a benchmark test during the seroconversion period. For RDTs detecting both antibodies and antigens, the first reactive RDT (antibody and/or antigen) has been considered.
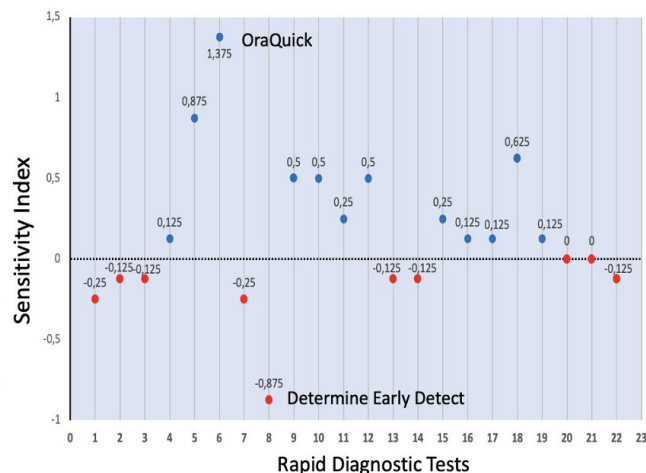
The WHO HIV RDT toolkit summarizes seroconversion indices assessed during the WHO PQ process. While some differences in performance can be seen, there are limitations to using these data:

- the data are not available for all tests
- the indices are not completely comparable across tests, primarily because it has not been possible to use the same seroconversion panels across all testing

Figure A5.01: Seroconversion sensitivity for various RDTs

RDT No	Test Name	Sensitivity Index
1	STANDARD Q	-0,25
2	First Response	-0,125
3	One Step (Guangzhou)	-0,125
4	Genie Fast	0,125
5	Geenius	0,875
6	OraQuick	1,375
7	Diagnostic Kit (Shanghai)	-0,25
8	Determine Early	-0,875
9	DPP	0,5
10	Rapid Test	0,5
11	SURE CHECK	0,25
12	ABON	0,5
13	Alere Determine	-0,125
14	VIKIA	-0,125
15	INSTI	0,25
16	BIOLINE	0,125
17	Uni-Gold	0,125
18	STAT-PAK	0,625
19	STAT-PAK Dipstick	0,125
20	First Response HIV/Syphilis	0
21	Standard Q HIV/Syphilis	0
22	Bioline HIV/syphilis	-0,125

Products discontinued

RDTs with an Index above 0 indicate that the RDT becomes reactive to specimens later compared to the benchmark test.

RDTs with an index **below 0** indicate that the RDT becomes reactive to specimens earlier compared to the benchmark test. These may be optimal tests to be used as A1.

PQ Public Report for the most recently PQ-ed RDT (Abbott's Panbio Verification PQ-ed in Nov 22): *"The seroconversion results are not directly comparable to seroconversion results of HIV tests evaluated before 2020 due to changes in the seroconversion panels and the benchmark assay."*
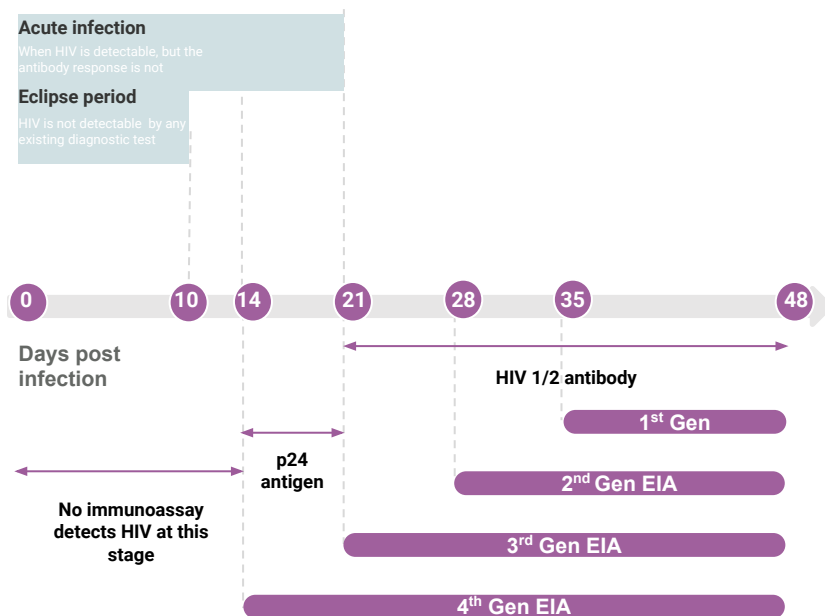
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Advances in "generations" of HIV RDTs aim to shorten the time from infection to detection

No HIV test can detect HIV immediately after infection. The period after infection when HIV is not detectable is often referred to as the window period. The length of the window period depends on the test and the marker it detects. After infection, markers of HIV appear in the following order: HIV RNA, p24 antigen, HIV IgM antibodies, and HIV IgG antibodies. The exact time markers appear depends on many factors, but the antibodies that HIV rapid tests detect usually appear around 3-8 weeks after infection. HIV RNA detection (viral load assays) can detect HIV before immunoassays (tests using antigens or antibodies); however, rapid immunoassays are preferred because of their cost, turnaround time, and ease of use advantages.

Over the 30-year history of immunoassays, technological advances have shortened the time from infection to detection. The improvements are usually first incorporated into laboratory-based immunoassays followed by RDTs. The advances have been referred to as "generations," although these are increasingly difficult to delineate, especially in RDTs. The most recent advance, called "fourth generation" or "antigen/antibody," adds detection of the p24 antigen to traditional antibody detection. By adding the p24 antigen, the test aims to reduce the window period by several days.

Figure A5.02: WINDOW PERIODS: GENERATIONS OF HIV LABORATORY-BASED IMMUNOASSAYS*

Acute infection
When HIV is detectable, but the antibody response is not

Eclipse period
HIV is not detectable by any existing diagnostic test

0   10   14   21   28   35   48

Days post infection

HIV 1/2 antibody

1st Gen

2nd Gen EIA

3rd Gen EIA

4th Gen EIA

p24 antigen

No immunoassay detects HIV at this stage

* Note: illustration is for laboratory-based assays; laboratory assays typically outperform RDTs.

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One on-market antigen/antibody ("4th generation") detecting HIV RDT

Currently, only one WHO PQ-ed RDT combining p24 antigen and HIV antibody detection is available for procurement: Abbott's Determine Early Detect. The current version of this test was launched in 2015 and PQ-ed in 2016.*

This test has two test lines: an HIV1/2 antibody detection line and a line for the p24 antigen. Reactivity on the antibody line alone, the antigen line, or both is considered a reactive result. Implementation requires additional laboratory testing to confirm anyone who tests reactive for the p24 antigen because the A2/A3 tests are antibody-based and would not be expected to pick up an infection yet because of the window period.

Compelling evidence that demonstrates additional clinical or public health benefits of antigen/antibody RDTs is lacking. For this reason, there is no current WHO recommendation for using Ag/Ab RDTs over other WHO PQ-ed RDTs.

Procurement data suggest many countries have procured small volumes of Ag/Ab RDTs, but only a few, e.g. Rwanda and Ukraine, have adopted Ag/Ab RDTs as the A1.

Figure A5.03: Ag/Ab product volumes and the proportion of countries procuring Ag/Ab test products out of all countries procuring HIV RDTs
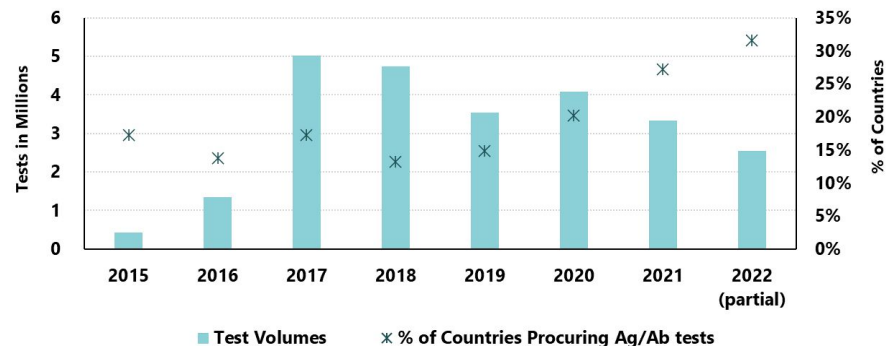
Source: EIC Procurement data analysis
Notes:
- *In 2017, Kenya had one order for 4m 4th generation tests, but none in any other years. Cameroon also had 5 orders of fourth-generation tests, totalling 3m tests, but no volumes of 4th gen products in any other years.*
- *Although the Determine Early Detect was initially priced higher than the traditional Determine test, in 2019, Abbott announced that for African countries, the price would be the same as the third-generation Determine test. This may explain the increase in countries making small procurements after 2019.*

*Abbott and predecessor companies (e.g. Alere, Standard Diagnostics) have marketed several Ag/Ab tests. In 2009 an initial Ag/Ab RDT was introduced; it is no longer on the market. In 2015 the current Ag/Ab test was launched as the Alere HIV Combo; in 2020, it was renamed Determine HIV Early Detect. Additionally, Standard Diagnostics (now an Abbott company) marketed an Ag/Ab RDT (Bioline Ab/Ag).

Performance: specificity

Specificity: Often, there is a tradeoff between sensitivity and specificity. Some of the most highly sensitive tests have lower specificity and vice versa.

More specific tests are typically found in the A2/A3 spot.

Product name	Manufacturer	Clinical Specificity (%)
Diagnostic kit for HIV (1+2) antibody (colloidal gold) V2	Shanghai Kehua Bio-engineering Co., Ltd	100
First Response HIV 1-2.O Card test (Version 2.0)	Premier Medical Corporation Private Limited	100
HIV 1/2 STAT-PAK	Chembio Diagnostic Systems Inc.	100
ONE STEP Anti-HIV (1&2) Test	InTec PRODUCTS, INC	100
One Step HIV1/2 Whole Blood/Serum/Plasma Test	Guangzhou Wondfo Biotech Co., Ltd	100
TrinScreen HIV	Trinity Biotech Manufacturing Ltd.	100
DPP HIV 1/2 Assay	Chembio Diagnostic Systems Inc.	99.9
MERISCREEN HIV 1-2 WB	Meril Diagnostics Pvt. Ltd.	99.9
SURE CHECK HIV 1/2 Assay	Chembio Diagnostic Systems Inc.	99.9
Uni-Gold HIV	Trinity Biotech Manufacturing Ltd.	99.9
OraQuick HIV 1/2 Rapid Antibody Test	OraSure Technologies, Inc.	99.8
ABON HIV 1/2/O Tri-Line HIV Rapid Test Device	ABON Biopharm (Hangzhou) Co. Ltd.	99.7
Bioline HIV-1/2 3.0	Abbott Diagnostics Korea Inc	99.7
INSTI HIV-1/HIV-2 Antibody Test	BioLytical Laboratories, Inc.	99.7
Determine HIV Early Detect	Abbott Diagnostics Medical Co. Ltd.	99.4
STANDARD Q HIV 1/2 Ab 3-Line Test	SD Biosensor, Inc	99.3
Determine HIV-1/2	Abbott Diagnostics Medical Co. Ltd.	98.9
Genie Fast HIV 1/2	Bio-Rad	98.5
Rapid Test for Antibody to HIV (Colloidal Gold Device)	Beijing Wantai Biological Pharmacy Enterprise Co.	98.5

Packaging and test format

Figure A5.04: Example packaging and test format
Determine packaging and format (top), Orasure (bottom)
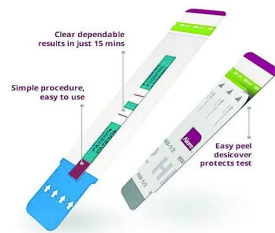
Format

Most HIV RDTs are the very familiar cassettes housing lateral flow tests. One test (Insti) uses vertical flow technology. Of the commonly procured tests in LMICs, notable exceptions to the cassette form include Determine (top 2 images in Fig A5.04) and Orasure (the only commonly used test accepting oral samples - bottom 3 images in Fig A5.04).

Pack sizes & accessories

Many suppliers offer large pack sizes, e.g. 20 tests per pack or 100 tests per pack. A few offer smaller packaging sizes.

Offering flexible pack sizes is helpful for highly decentralized settings; often packs are split, but additional buffers are needed.

Most kits are available with and without key consumables (lancets, etc.).
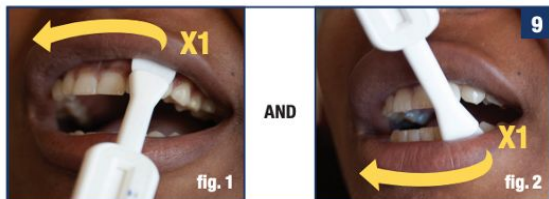
Press the **Flat Pad** firmly against your gum and swab it along your **upper gum once** (fig. 1) and your **lower gum once** (fig. 2).

Put the **flat pad** all the way into the tube until it touches the bottom.

Other operational characteristics

Time to results and stability of results

The time to test results varies considerably, as does the maximum read time. Generally, faster time to results and longer result stability is desired, the relative importance often depends on the context, (e.g. how many tests per day are done). The fastest test may be read immediately, while the longest wait times are 20 minutes. Most tests take 10-15 minutes to produce results.

In most tests, the results are stable for 10 minutes, providing health workers with some flexibility. However, two tests must be read within 2 minutes (including a leading A2/A3 test), and several are only stable for 5 minutes. Notably, the market-leading test is stable for 45 minutes.

Storage and stability

Most HIV RDTs have storage temperatures of 2-30C. One has a slightly lower temperature (27C), while only one is stable up to 40C.

Most HIV RDTs have 24-month shelf lives. While one product has a 30-month shelf life, seven have 15-18 month shelf lives.

Compared to other tests, HIV RDTs temperature requirements and shelf lives are not very robust; they are, for example, more restrictive and shorter than malaria RDTs that are also used in similar climates and decentralized settings with limited temperature control.
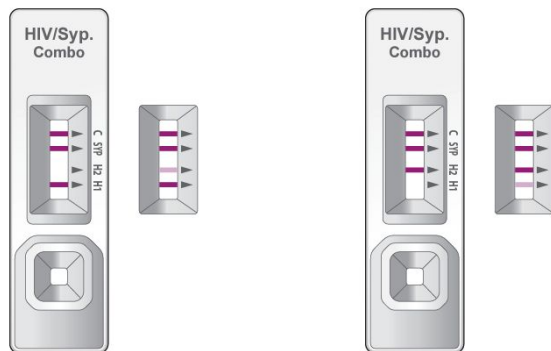
Test lines for HIV-1 and HIV-2

One-quarter of PQ-ed tests have separate lines for HIV1 and HIV2

Figure A5.05: Example dual test:
Separate HIV1 and HIV2 test lines + syphilis test line
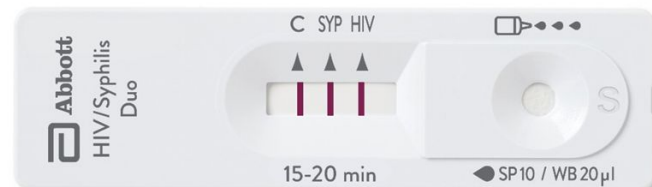
HIV-1 & Syphilis Positive   HIV-2 & Syphilis Positive

Figure A5.06: Example dual test:
Single HIV1/2 test line + syphilis test line

There are two HIV types, HIV type 1 and HIV type 2 (HIV-1 and HIV-2). Most HIV infections are HIV-1, but HIV-2 is a concern, especially in West Africa. HIV-2 infection may require different management (e.g. specific viral load tests and ART treatments, although this is less of a problem with current ART regimens).

Although most HIV RDT products have one test line, combining the detection of HIV-1 and -2 antibodies, several products have separate lines for HIV-1 and HIV-2. However, the ability of RDT products to discriminate reliably between HIV-1 and HIV-2 and to accurately identify dual infections is unreliable, so, in settings where HIV-2 is documented, WHO recommends supplemental testing to determine the virus type, i.e. separate serology assays specific to HIV-1 and to HIV-2 and virological tests.

Proportion of HIV testing that is ELISA vs. RDT

HIV testing strategies in some LMICs use RDTs exclusively, while others, may incorporate lab-based tests (e.g. ELISA). Experts suggest that LMICs, especially those with high HIV burdens, rely predominantly on RDTs. A review of limited data confirms that RDTs are the majority of tests.

Table A6.01. Summary of data availability on the proportion of lab testing vs. rapid tests

Country Classification / Income Class	# of countries w/a data point	Number of Countries who provided a Percentage for RDT Use that was within the indicated range:			
		0-25%	26-50%	51-75%	76-100%
High Income	4	3	0	0	1
Upper middle income	22	4	4	4	10
Lower middle income	24	3	1	3	17
Low income	10	2	0	0	8
Total	**60**	**12**	**5**	**7**	**36**

| UNAIDS Region	# of countries w/a data point	0-25%	26-50%	51-75%	76-100%
Asia and Pacific	11	0	2	1	8
Caribbean	7	1	0	1	5
Eastern Europe and Central Asia	8	3	0	3	2
East and Southern Africa	10	3	0	1	6
Latin America	10	1	2	1	6
Middle East and North Africa	3	1	1	0	1
West and Central Africa	10	2	0	0	8
Western and Central Europe and North America	1	1	0	0	0
Total	**60**	**12**	**5**	**7**	**36**

Table source: 2020 WHO ARV Survey Data
Notes: Data are limited to one year, the 2020 WHO/UNAIDS ARV survey reporting. Sixty-one countries participated in the survey regarding two questions on the number of ELISA and RDT tests. Only one country recorded 0 for both ELISA and RDT: Somalia (results excluded from the table above).

Alternative chart to illustrate manufacturer market share by volume of professional use HIV RDT

Figure A6.01: Manufacturer share (by volume) of Professional HIV-only RDTs
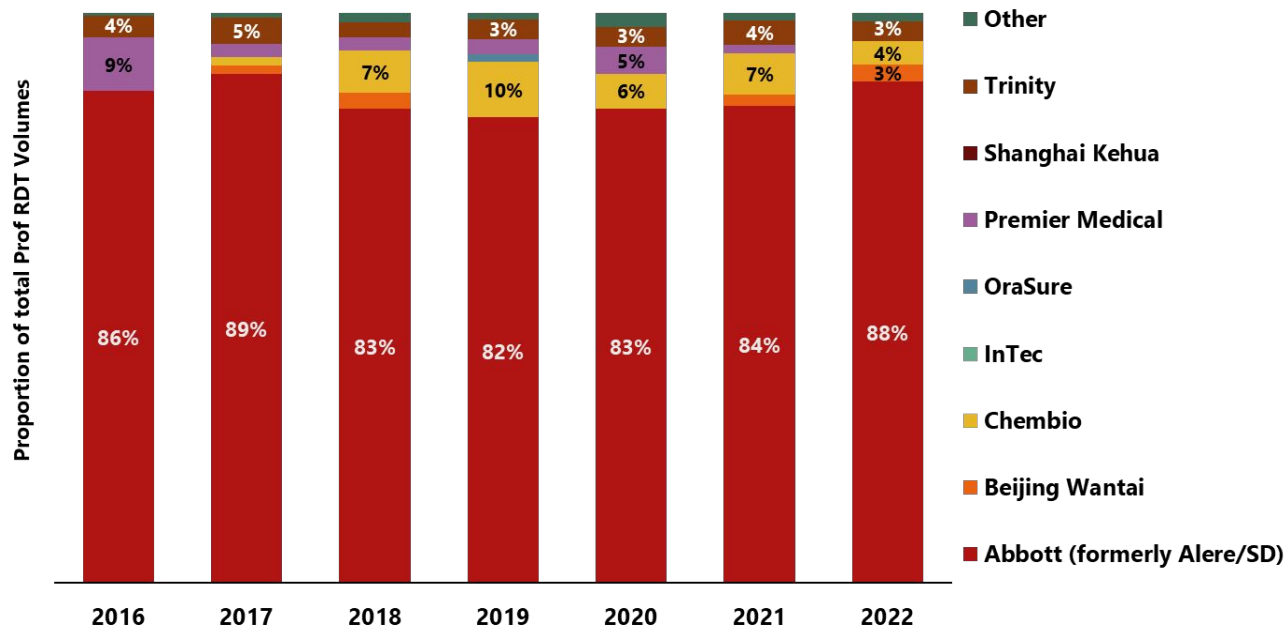
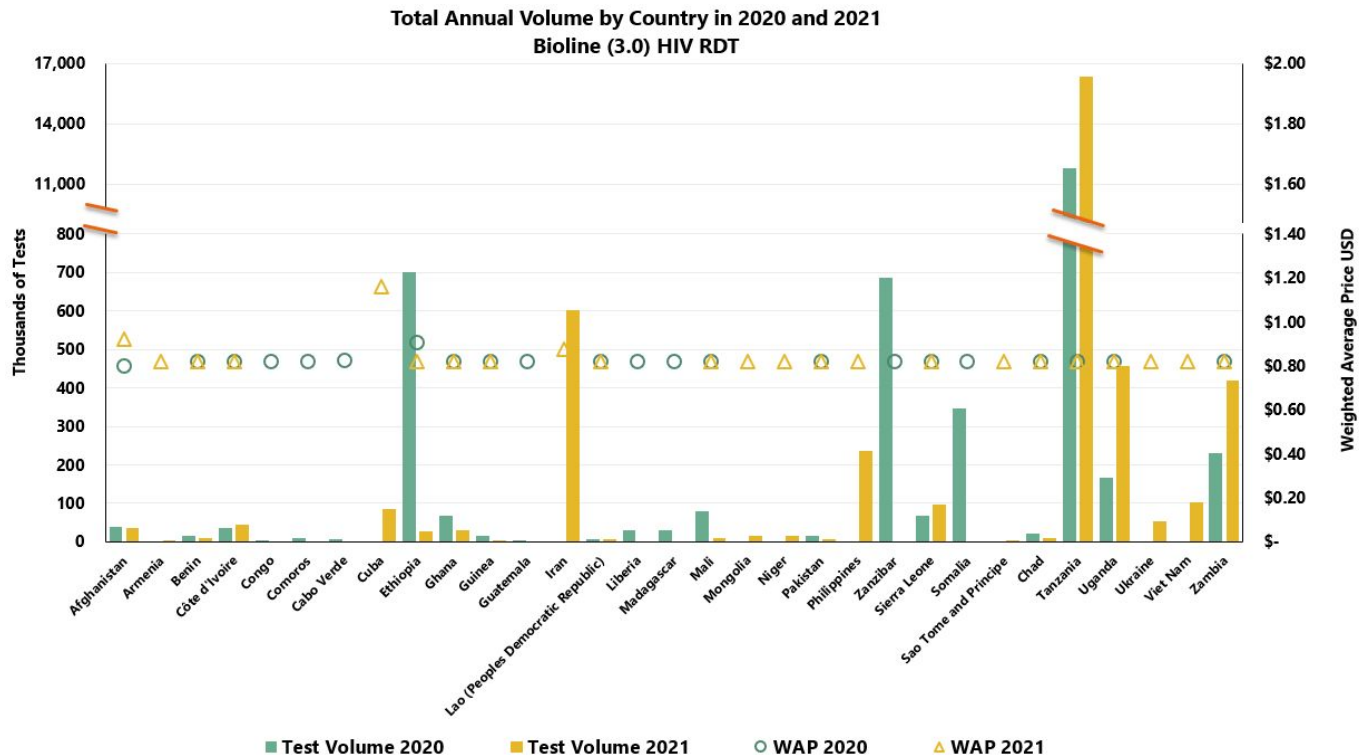Source: EIC Procurement data analysis

Price variation within specific products is moderate

- Results of the analysis of product-level price variation for the most commonly procured tests are shown in the following slides.

- Generally, the price variation within a particular product is moderate, possibly tied to volumes or strategic efforts to capture market share (e.g. STAT PAK in Ethiopia was procured in high volume and has considerably lower price than typical) or to countries with high political risk. However, overall no one trend stands out.

Product-Specific Charts illustrating Price Variation:
Bioline (3.0) HIV RDT
Determine HIV RDT
First Response (2.0) HIV RDT
STAT-PAK HIV RDT
Uni-Gold HIV RDT

Product price variation by country and volume - Bioline (3.0)
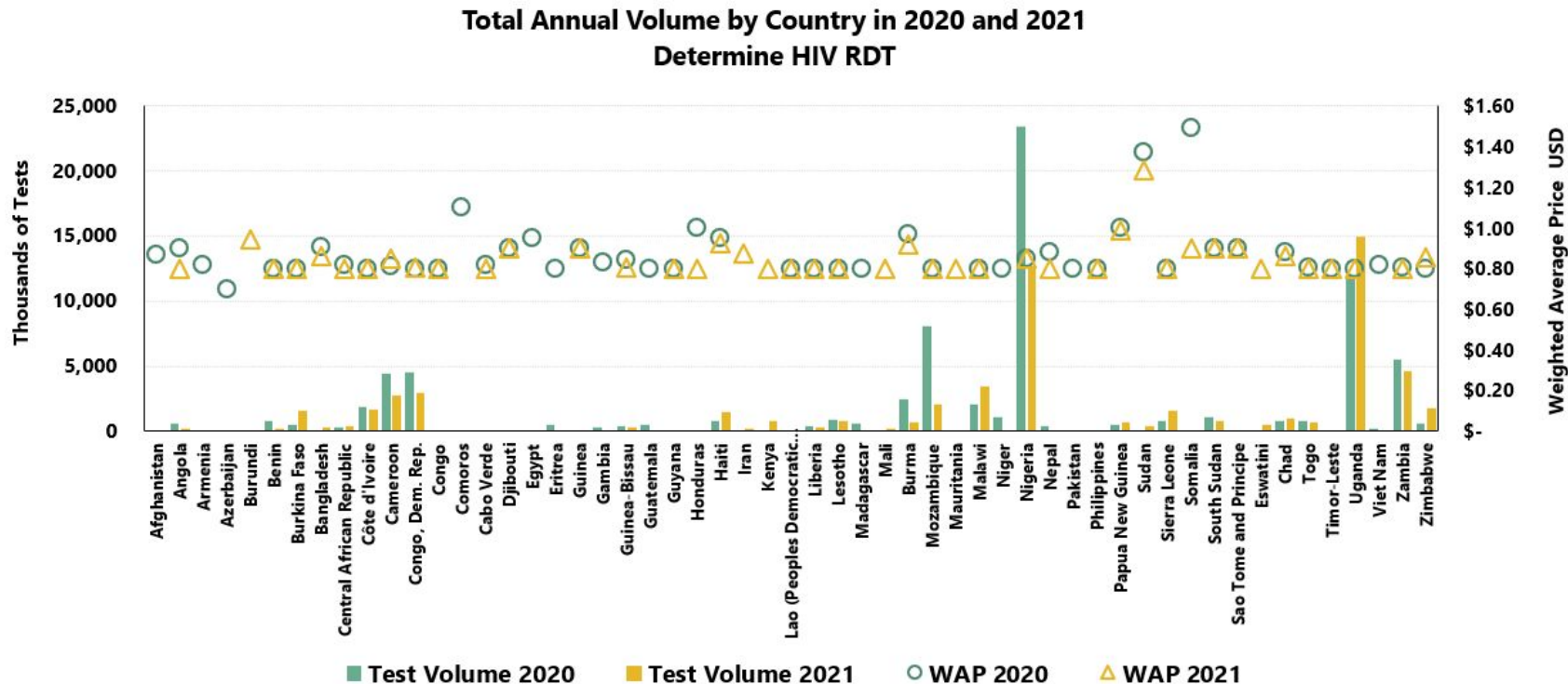
Figure A6.02: Procurement price variation and volume by country for Bioline (3.0)

Total Annual Volume by Country in 2020 and 2021
Bioline (3.0) HIV RDT

■ Test Volume 2020 ■ Test Volume 2021 ○ WAP 2020 △ WAP 2021

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Product price variation by country and volume - Determine

Figure A6.03: **Procurement price variation and volume by country for Determine**

Total Annual Volume by Country in 2020 and 2021
Determine HIV RDT

■ Test Volume 2020   ■ Test Volume 2021   ○ WAP 2020   △ WAP 2021

Source: EIC Procurement data analysis, EXW data only for prices

Product price variation by country and volume - First Response

Figure A6.04: Procurement price variation and volume by country for First Response (2.0)

Total Annual Volume by Country in 2020 and 2021
First response (2.0) HIV RDT

■ Test Volume 2020   ■ Test Volume 2021   ○ WAP 2020   △ WAP 2021

Source EIC: Procurement data analysis, EXW data only for prices

Product price variation by country and volume - STAT-PAK

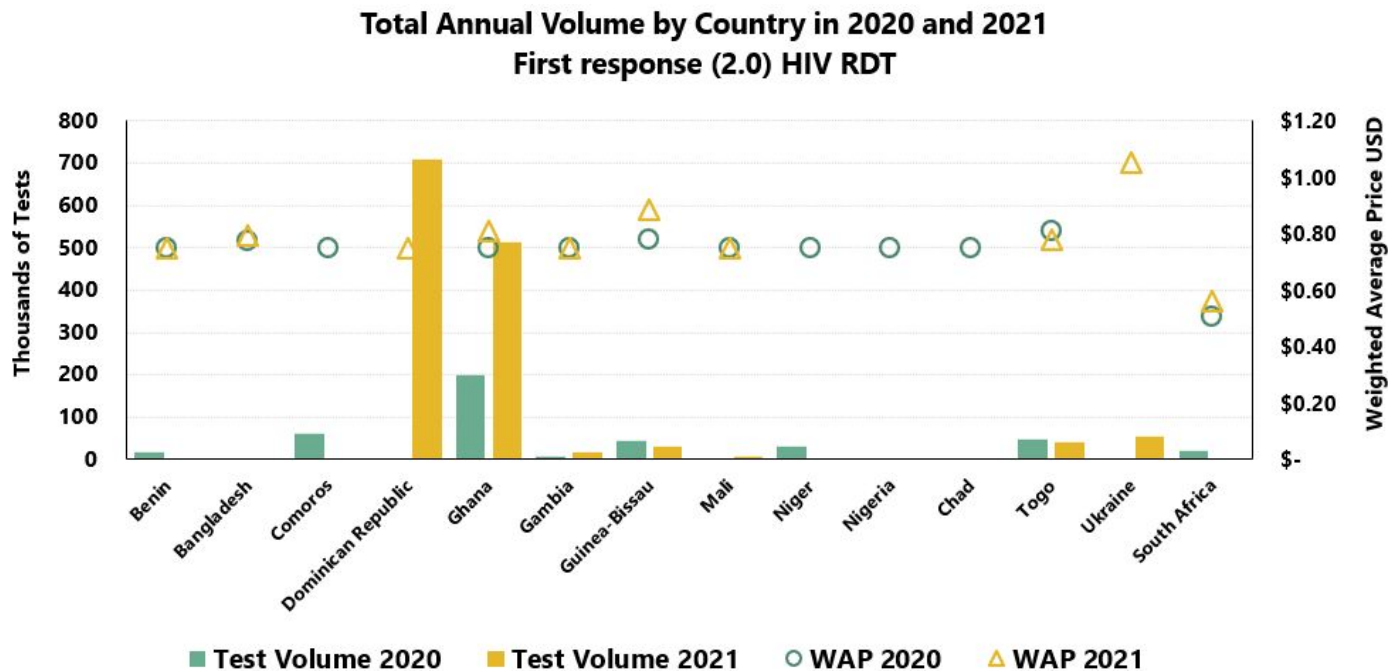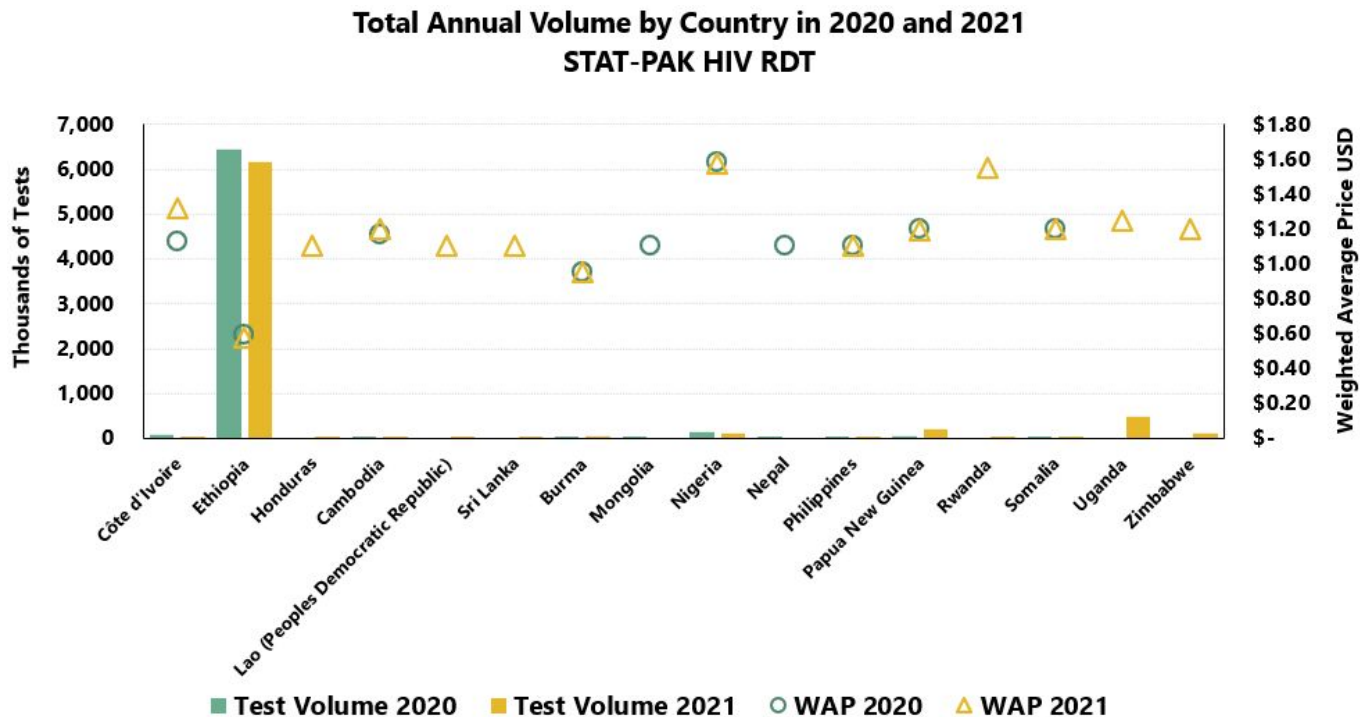**Figure A6.05: Procurement price variation and volume by country for STAT-PAK**

Total Annual Volume by Country in 2020 and 2021
STAT-PAK HIV RDT

Product price variation by country and volume - Uni-Gold

Figure A6.06: Procurement price variation and volume by country for Uni-Gold

Total Annual Volume by Country in 2020 and 2021
Uni-Gold HIV RDT

■ Test Volume 2020   ■ Test Volume 2021   ○ WAP 2020   △ WAP 2021
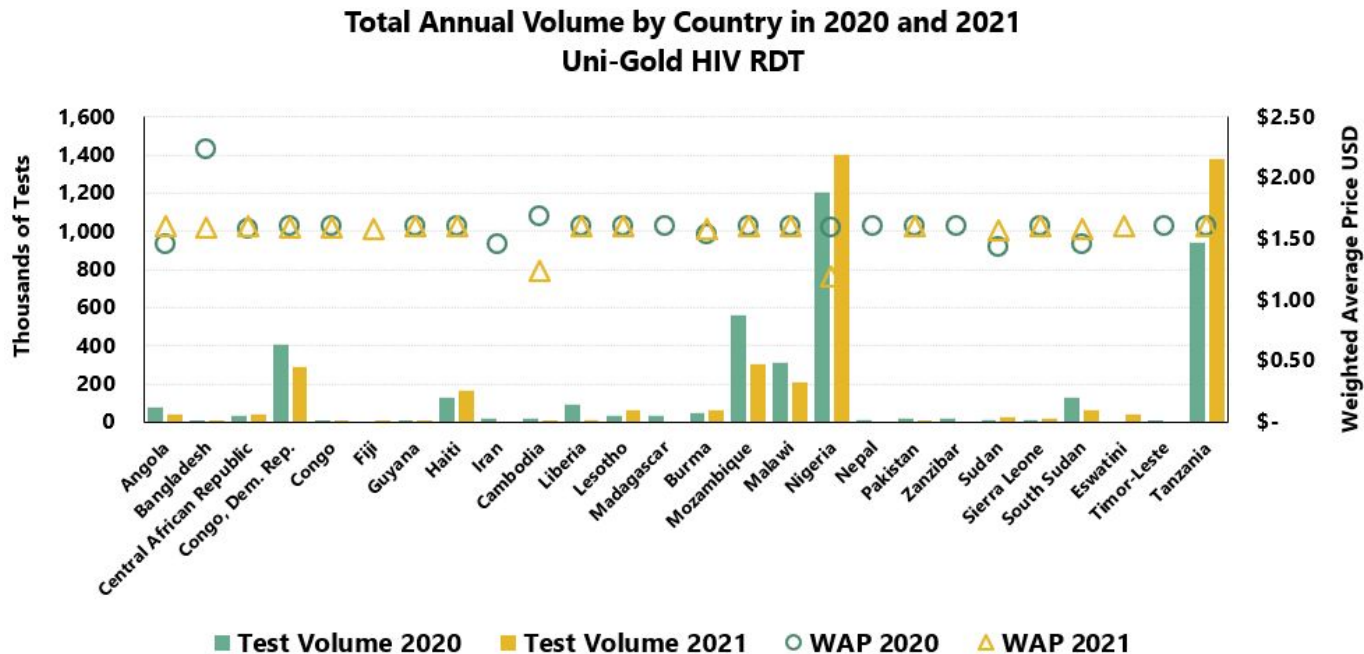
Note: Trinity's Uni-Gold WAP from the procurement data is nearly double the WHO quoted price.

Source: EIC Procurement data analysis, EXW data only for prices

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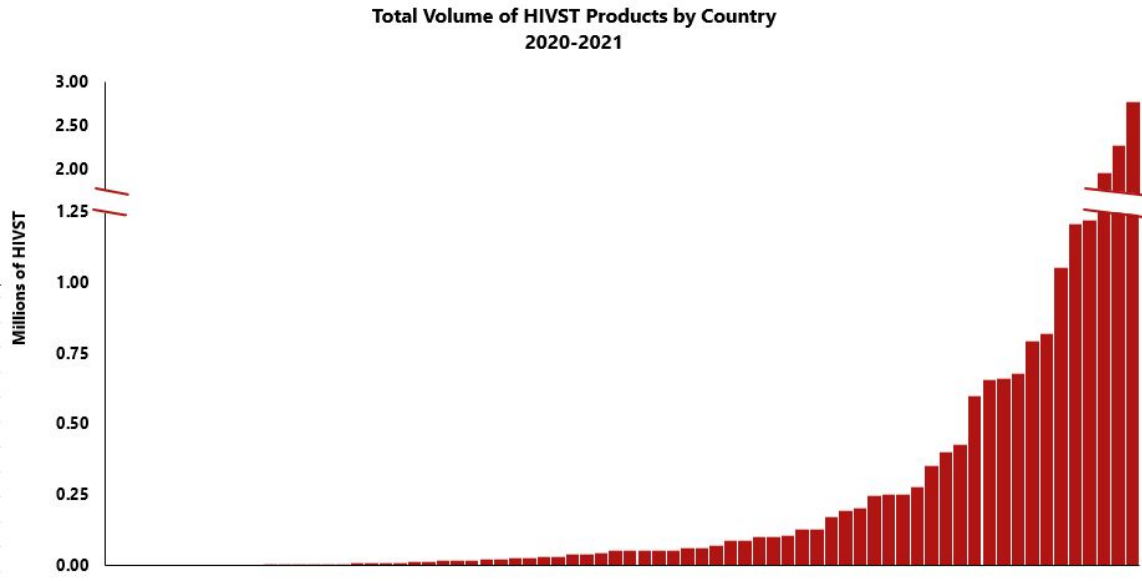Additional HIVST market analysis

A7

Fragmented HIVST demand drives up transaction costs

Total Volume of HIVST Products by Country 2020-2021

There are many programmes buying HIVST products and current annual volumes vary from 2.5 million to tens of thousands of tests. Overall the annual HIVST volumes are relatively modest, especially when compared to professional A1 tests volumes.

The relative fragmentation of HIVST demand increases per test costs, because transaction costs are spread over a small number of tests.

The HIVST market is expected to grow with increasing annual order volumes, i.e. in most countries "steady state" HIVST volumes have yet to be achieved. Yet, if a variety of products is needed to serve demand, annual HIVST demand from one country will be split between suppliers, so the economies of scale possible in the "A1" HIV market may not be realizable.

Source: EIC Procurement data analysis

HIVST distribution overview

In this Annex, we describe the structure of different HIVST distribution models and the capabilities needed to develop them.

For illustrative purposes, we consider the examples of HIVST products delivered through the public health system and HIVST products sold to consumers in a store or pharmacy. While we focus on these two models, we do not aim to be comprehensive, and acknowledge the nuances within these and the many other potential distribution models (e.g., workplace models, online platforms).

A8

Optimum HIVST distribution models require both new channels and modalities to be developed at a national level

New distribution channels are needed to facilitate logistical support for new types of distribution modalities, involving a variety of new stakeholders, including different kinds of distributors, private sector market players, and organizations that are not part of the traditional health product distribution sector. We explore these channels in the subsequent slides.

New modalities are required to ensure that the unique convenience and privacy of self-testing can be leveraged to reach people at risk who do not test regularly through traditional modalities.
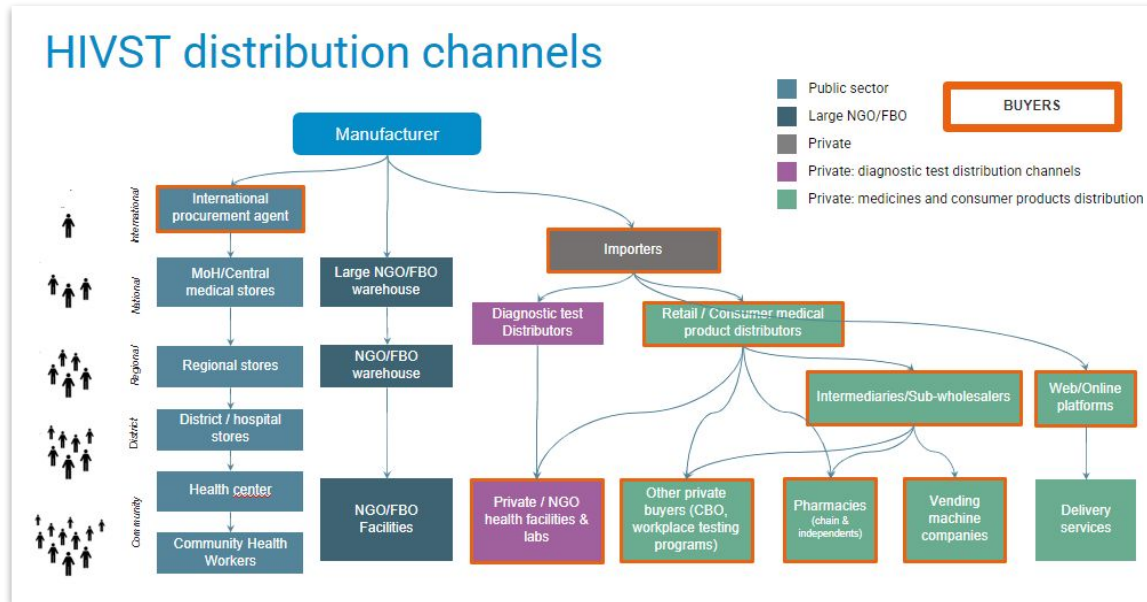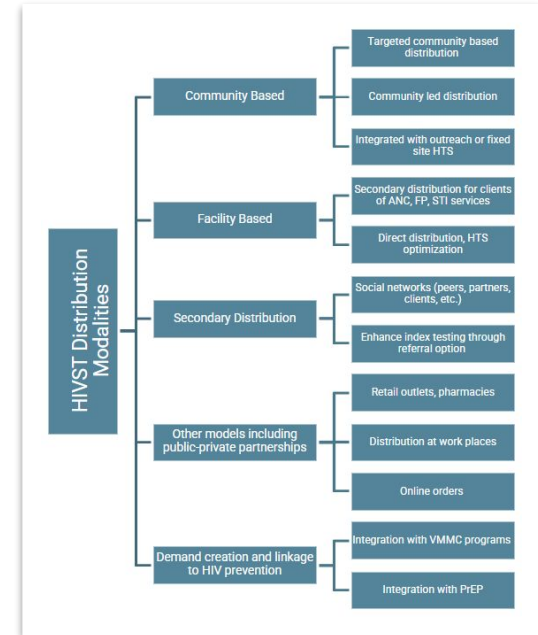

See next slide for enlarged figure

Figure 5.03 from section 5

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HIVST distribution channels

Figure A8.01: HIVST Distribution channels network

Legend:
- Public sector
- Large NGO/FBO
- Private
- Private: diagnostic test distribution channels
- Private: medicines and consumer products distribution

BUYERS

Manufacturer

International
- International procurement agent

National
- MoH/Central medical stores
- Large NGO/FBO warehouse
- Importers

Regional
- Regional stores
- NGO/FBO warehouse
- Diagnostic test Distributors
- Retail / Consumer medical product distributors
- Intermediaries/Sub-wholesalers
- Web/Online platforms

District
- District / hospital stores

Community
- Health centre
- NGO/FBO Facilities
- Private / NGO health facilities & labs
- Other private buyers (CBO, workplace testing programmes)
- Pharmacies (chain & independents)
- Vending machine companies
- Delivery services
- Community Health Workers

End-consumer / user of HIVST

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HIVST distribution through healthcare systems differs fundamentally from other channels (e.g. pharmacies, on-line)

The image above illustrates the different distribution channels for HIV tests, which broadly falls into two groups 1) healthcare system based distribution and 2) retail distribution. Distribution system complexity differs across countries depending on market conditions, and the approaches to two types of distribution require different capabilities and resources.

Healthcare system based distribution

Diagnostic test distribution in public and private facility based healthcare systems is generally well-established. It is not resource intensive for RDT manufacturers and their local distribution partners to service. Manufacturers deliver HIVST to central medical stories, MoH takes over all distribution from there.

- In the public sector, the MoH supply chain distributes tests down to the community level. HIVST has leveraged this existing supply chain system.
- NGO, FBO, and private health providers typically have their own supply chains also reaching the lowest level facilities.
- In these large health systems, the manufacturer's local distributor plays a very small role, e.g. handling the initial registration of the product, supporting customs clearance, and responding to any issues as needed.

Retail and other private buyer distribution

Different supply chains serve pharmacies and drug stores and specialized channels like web/online platforms or private buyers. Pharmacies and shops are generally served by medicine or consumer products supply chains, not necessarily the distributors specialized in diagnostics with whom RDT manufacturers sometimes partner. Retail supply chains typically involve several layers of intermediaries, i.e. a product may pass through importers, distributors, sub-wholesalers, and other intermediaries before reaching the retail outlet or private buyer.

Establishing these distribution capabilities in retail is resource intensive for RDT manufacturers and many of their existing local distribution partners. Suppliers must know where target customers prefer to purchase tests, i.e. which pharmacies and shops, and then identify and engage the relevant supply chains serving these pharmacies, including contracting with the importers and distributors at the top of these supply chains (national level).

In a healthcare facility, testing protocols, algorithms, and trained providers usually drive product usage. In retail distribution, marketing and user awareness drives product usage.

HIVST buyers differ considerably, requiring different commercial setups

The different distribution channels for HIV tests have a variety of potential buyers, ranging from procurement bodies sitting at global and national levels to individual customers. HIVST suppliers must be set up to accommodate various potential HIVST buyers. Key differences in HIVST buyers and the implications for selling to them include:

Healthcare system based distribution channels

- In the public health sector, buyers sit at the national level (e.g. donors, MoH) and buy large quantities of HIVST. They procure HIVST through processes that are similar to how they buy other RDTs, and most HIVST suppliers already sell other tests to them.
- Because there are relatively few national-level buyers, HIVST manufacturers sell to them directly, usually out of their headquarters. The sales resources required are low: suppliers must maintain relationships with large buyers, governments, and donors and be familiar with their procurement requirements and processes.

Retail and Other private buyer distribution channels

- Consumers purchase single HIVST in pharmacies and shops for personal use. Given the sheer number of potential customers, it is impractical for HIVST manufacturers to serve individuals from the HQ level. Instead, they must partner with intermediaries (distributors, wholesalers, pharmacy networks) to reach consumers.
- Moreover, for an HIVST to sit on a shop's shelf for a consumer to buy, the HIVST has already been bought and sold by several supply chain intermediaries, each intermediary buying in increasingly smaller quantities as the test moves down the supply chain.
- Each buyer and intermediary has different risks and costs that they need to offset, and so each requires a certain profit margin.

HIVST buyers, including supply chain intermediaries, have different appetites for risk

As with any new product, HIVST uptake is very uncertain. A key difference between the health system channel and retail channels is the willingness to take on the risk of product uptake.

In the public sector, the MoH buys HIVST based on its predictions about HIVST uptake. In doing so, the MoH assumes all the risk that the tests it procures will be distributed and used before they expire. (Similarly, the MoH assumes the risk of stockouts if they do not buy enough HIVST to meet demand).

In the retail and private buyer supply chain, distributors, wholesalers, and retailers buy HIVST and hold them in inventory until they sell. In doing so, they assume the risk that the HIVST will sell before expiring. They also tie up working capital funds (i.e. cash) and shelf-space in this inventory; these funds and shelf-space could be used to buy and sell other products.

As private companies, retail and supply chain intermediaries markup the price to cover the risk they are taking on and the use of working capital funds. Critically, they must consider whether the final price to consumers after these markups is within the range of what potential consumers would be willing to pay. If the price is too high, the test will not sell fast enough, and therefore it is not worthwhile to stock.

Although there are mechanisms to share risk or incentivize supply chain intermediaries and retailers to stock HIVST, these are not necessarily standard practices for diagnostics and would need to be set up. For example:

- The volume of HIVST in stock at any one level of the supply chain can be minimized if resupply is rapid and reliable. Increasingly, some national-level HIVST distributors have expanded in-country HIVST stocks to facilitate resupply.
- Suppliers (or others) can extend financial credit to retailers and supply chain intermediaries so that they do not have to expend their own funds to buy HIVST stocks; this can be important in small businesses and in economies where credit is limited.
- Consignment is another option. HIVST can be provided to retailers and retailers only pay when the HIVST is sold. This is being piloted for some global health products using point-of-service sales kiosks to track inventory and sales.
- Promotions giving an initial volume of tests to retailers for free are another option for incentivizing retailers to stock HIVST by reducing retailer risk.

From an HIVST supplier perspective, setting up and managing these types of activities require considerable sales capability and experience that most would not have in house.

Communications and messaging must be multi-layered and differ by channel

Self-testing represents a paradigm shift with high communications needs. In most countries, the MoH supports and designs campaigns to raise awareness and educate the population about HIVST including where and when to obtain a test. The MoH and partners have also trained many healthcare providers on self-testing, and some HIVST product suppliers contribute to these campaigns and training.

Beyond general messaging, specific communications and messaging needs depend on the sales channel and need to target each of the varying HIVST buyers, including end-users. The communication also needs to be supported with an appropriate organizational model.

Table A8.01: Messaging and communication for HIVST

Messaging and communications needs	Healthcare system	Retail and other private buyers
Value proposition: why they should consider buying / offering / stocking HIVST	Health systems stakeholders have largely bought into the value of HIVST, although some programmes and distribution modalities are more advanced than others.	Consumers, retailers, and supply chain intermediaries each need tailored messaging and value propositions. For example, consumers may want to check their status privately and conveniently, or have higher trust in an HIVST that they purchased. Messaging to retailers may appeal to a desire to support public health, but ultimately retailers need to consider profits. Thus, messaging to retailers needs to speak to potential HIVST demand or the role HIVST could play in differentiating their store, or draw customers in to buy other products. Similarly, each supply chain intermediary needs to be convinced of the value of stocking HIVST.
Education on self-testing generally, as well as HIVST product offering and quality.	MoH do not need much education on the product offering; at the procurement level, they have educated lab and clinical staff who are knowledgeable about diagnostic tests, conversant in the quality standards, and familiar with the national policy and guidelines.	Consumers, intermediaries, and retailers all lack experience with self-tests and require tailored educational messages, especially about the quality of tests. While some intermediaries and outlets selling self-tests may have a pharmacist or nurse selecting the products that they carry, it is also possible that they are not familiar with the HIVST product offering (the different brands) and the quality standards.
Education to encourage HIVST use among target populations	Healthcare workers promote and distribute HIVST to target populations, and MoHs have guidance and training for HCW on how and when to distribute the tests, perform them, and do post-test follow up. Monitoring and supervision serve as ongoing reminders (reinforcing messages) about HIVST.	Retailers may benefit from training and detailing visits to shops to coach staff on how to promote, display, and support HIVST uptake.
Brand promotion	RDT manufacturers and their national level distributors will promote their brand(s) through meetings with health sector stakeholders.	Advertising campaigns are needed to increase brand awareness and to promote brand among target consumers, retailers, and intermediaries.

Market health analysis

The following framework and analysis was designed and deployed to inform the development and findings of the report.

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Market health framework

Realization of demand

The expected use of test kits materializes at the country level.

Frameworks can be used to assess the health of a market and its ability to sustainably delivery quality product at affordable prices. Frameworks can help ensure a comprehensive analysis.

Predictability of demand

The quantity and timing of demand can be accurately predicted and sustained by countries.

Supplier base risk

The supplier base will be unable to supply expected test kits (considering supplier buffer capacity, sustainability, technical risks, diversity, and portfolio viability).The test kits cannot be released or exported from the country of production.

Adoption and demand

The product choices for countries, programmes, providers (including retailers), and end-users are data-driven, value-based; the extent of demand for products & timely uptake of new innovative products.

Affordability

The product is offered at the lowest possible price that is sustainable for suppliers and does not impose an unreasonable financial burden on governments, donors, individuals, or other payers.

Market sustainability & attractiveness

The market remains sufficiently attractive for incumbent suppliers to be competitive or for new suppliers to enter.

Innovation

Ongoing innovations address unmet priority needs and may be adopted by countries in the future.

Quality

The product meets stringent regulatory standards for quality and there is reliable information on the quality of the product, including its components.

Supply meets demand

The overall supply availability of test products meets demand. Supply chain systems (including procurement, storage, and distribution) function effectively to ensure that products reach end users in a reliable and timely way.

User product preferences

The available supplies meet individual and country product choices.

Source: Framework adapted from Unitaid, Global Fund, and GAVI

Market health overview: professional tests

What market challenges could impede achievement of global targets

Good/met	Medium/partly met/unknown	Poor/unmet

Realization of demand
- No issues. HIV professional tests are well-established and well-used.
- Dual tests have insufficient uptake, but CHAI/MedAccess has a volume guarantee programme designed to support uptake.

Predictability of demand
- Few issues. HIV professional test demand has historically been accurately predicted and funding is largely sustained.
- Occasional issues related to disruption in service during the pandemic and changes in country targets/focus on yield.

Adoption and demand
- Barriers to entry are high as the product selection process and algorithm verifications are complex and infrequent, slowing the adoption of new lower cost, higher efficacy products (e.g. dual tests). Product switching is infrequent; many of the higher volume countries do not switch their A1 test very often, staying with Determine in the A1 spot.

Affordability
- HIV test prices have been affordable enough to allow for widespread use. However, with resources increasingly limited, lower prices would allow more testing.
- Average prices have not changed over time, despite market growth. The leading product manufacturers have set prices and not changed them, despite the entrance of lower-priced products with good performance. These products however are slow to penetrate the market given the product selection and algorithm processes.
- The scope for lowering prices has to balance manufacturing costs and margin with the need to maintain a high number of suppliers in the market in order to fill each of the three spots in the algorithm, and the relatively small demand associated with the A2/A3 market segments.
- Dual tests are high price, though the volume guarantee could help to reduce the price and increase competition.

Market health overview: professional tests (continued)

Good/met Medium/partly met/unknown Poor/unmet

Quality
- HIV RDTs are available at a stringent quality standard, and reliable information is available, primarily in the WHO tool kit and PQ website. There is scope for improving communication around how WHO PQ evaluates product performance and how to use the PQ laboratory evaluation product IFU claims.
- A few high-volume countries procuring outside of donor channels use domestically produced tests that are not WHO-PQed or SRA-approved, raising concerns about quality.

Supply meets demand
- Globally, there are few issues; supply is generally adequate to meet the demand in this well-established professional test market.
- Suppliers may lack visibility into demand for new products (e.g. dual tests), increasing the perception of market risk.
- Occasional stock-outs in country-level supply chains.

User product preferences
- Professional products largely meet programme needs. There is some scope for incremental improvement in professional tests (e.g. dual test performance, read time windows, and packaging). Incentives, however, for this type of innovation are dampened by the algorithm process.

Supplier base risk
- The need for three tests, specified by the algorithm, creates a supply security risk, as disruption in the supply of any one product impacts the ability to diagnose HIV in a country. While WHO recommends alternative/backup tests, the uptake of this recommendation is unknown.
- The professional test market is highly concentrated and dominated by Abbott products (Determine, Bioline, Bioline HIV/Syphilis, and Determine Early detect), frequently occupying the A1 position, the largest market segment.
- Geopolitical risk is also a concern, as regions with the largest HIV test demand rely entirely on imported products, mitigated somewhat as they are manufactured in different parts of the world.
- There is no information on the degree of concentration in the key raw materials used by HIV tests, however, the algorithm verification process is in place to address the risk of overreliance on a limited number of raw materials.

Market health overview: professional tests (continued)

Market sustainability & attractiveness

- The market offers relatively attractive margins; however, delays and complexity of penetrating the professional test market are a disincentive to engage.

Innovation

- Incentives to innovate priority public health products (e.g. multiplex HIV tests and self-tests for HIV, hepatitis, STIs), are reasonable for tests that multiplex with HIV, but stand-alone STI- and hepatitis-only tests are more challenging, as there is less funding for these programmes.
- Some incremental improvements to professional tests are desirable, but the algorithm process dampens incentives for innovation. A product improvement may help a company's product be selected for the verification study, but ultimately how the test interacts with several other tests will influence if it is selected or not.
- Some of the market structures (algorithm) may increase incentives to develop products that are not aligned with public health priorities but have been developed primarily for commercial interests, e.g. those that are outside the algorithm or designed to secure A1 market share (recency tests, 4th generation tests).

Market health overview: HIVST

Good/met   Medium/partly met/unknown   Poor/unmet

Realization of demand

- Demand is materializing, especially in more conventional distribution channels; yet, as with other novel product introductions, there is uncertainty about demand growth. In some countries several of the "unconventional" or novel delivery channels have yet to be tested; it is not clear if demand will materialize in these channels given the limited resources available to set them up. Additional work to articulate HIVST health/patient benefit and demonstrate distribution effectiveness would likely engender more focus on new channels.
- While HIVST distribution data are readily trackable, metrics for impact of HIVST are not well developed yet; this uncertainty hinders their adoption for some use cases, especially those that are less conventional.
- Metrics that are well aligned with evolving HIVST value propositions would likely support HIVST investment cases, resulting in additional HIVST demand.

Predictability of demand

- Most HIVST initiatives are in the pilot stage, or if more established, transitioning to scale. Therefore, steady state demand has not been realized yet.
- Existing funding for HIVST is likely to be sustained, yet, overall, the outlook for additional funding is less predictable. After >$150m catalytic investments (Unitaid, CIFF, BMGF) programmes are transitioning to domestic and scale up partner funding, and it is not clear whether there are sufficient resources to expand testing to all potential channels.

Adoption and demand

- There is little information about how national programmes (and other buyers) are selecting HIVST, and limited product selection guidance available to countries.
- Appreciating the product offering is also challenging; end users, providers, procurers, and retailers struggle to make informed decisions about HIVST product selection. There is no reference summarizing the product offering, including the performance data and key characteristics (sample type, ease of use, turn around time, IFU languages) of each HIVST. While WHO PQ maintains a list of HIVST, accessing product details (including performance information) requires navigating the PQ website and understanding their processes. While the product offering is occasionally available via published HIVST landscape reports, these become outdated quickly in a market that changes rapidly (quarterly).
- While purchase quantities are known and tracked, true demand from consumers has yet to be quantified in many markets.

Market health overview: HIVST (continued)

Affordability

- HIVST demand has been constrained by affordability, both at the national programme level and for consumers who can not afford retail prices.
- From the funding side, both domestic and donor resources are limited partly by uncertainty around measuring the impact of HIVST; without consensus on the impact, less conventional modalities will struggle to show their value.
- From the supply side, several factors (ranging from product-related costs, printing in multiple languages, and serving fragmented demand) increase the cost of HIVST when compared to other rapid tests. While there may be scope for some suppliers to reduce costs, these tests may never achieve full parity with other rapid tests, in particular not until the market achieves a size that affords more economies of scale and competition from low-cost manufacturers.
- Prices have not reduced 'organically' through market growth and competition; rather, market interventions have promoted and accelerated HIVST price declines.

Quality

- HIVST are available at a stringent quality standard (WHO PQ), and reliable information is available on the products via the PQ website. As noted above, there are gaps in accessing full information.
- Unregulated HIVST are available in the retail sector which is harmful to end-users and a disincentive for suppliers of QA-ed HIVST.

Supply meets demand

- Globally, supply is generally adequate to meet the demand.
- As expected for new product/new channel development, in-country supply chains are nascent and imbalances between supply and demand occur.

User product preferences

- The importance of different product features (both in sample type and other differentiating features) is hard to appreciate. Evidence to date suggests both oral and blood tests are needed to expand the reach of HIVST. As additional experience is gained with various HIVST products additional evidence should be monitored.

Market health overview: HIVST (continued)

    Good/met	 Medium/partly met/unknown Poor/unmet

Supplier base risk

- Given the small market size and relative flexibility to switch products, theoretically having six prequalified products suggests that risk of supply security is relatively low. However, the market is highly concentrated around the OraQuick self-test; if supply were disrupted, transition to other HIVST is possible assuming acceptance of the similar- or lower- priced blood-based tests.

Market sustainability & attractiveness

- Assuming simple blood-based tests are widely accepted, margins appear reasonable and capable of attracting new lower-cost products and suppliers.
- The price point for more innovative products may be less attractive, as evidenced by the need for push funding to support Sedia's oral test development.

Innovation

- There is risk that investment in innovative delivery methods and developing new channels for HIVST distribution will not continue at the current pace with catalytic programmes like STAR coming to an end in 2023. Additionally, margins are not sufficient for most manufacturers to invest heavily in developing novel retail channels for HIVST, including raising consumer awareness and WTP for HIVST.
- The incentives for innovation are modest, with some suppliers (mostly lower cost producers) engaging in the market while others see too much pressure on price.