G6PD testing in the private sector: Summary of findings from India, Indonesia, and Vietnam

PATH

Assessing knowledge of G6PD deficiency, practice of treating patients with G6PD deficiency, and perceptions about point-of-care G6PD deficiency tests

Background

Glucose-6-phosphate dehydrogenase (G6PD) deficiency is a common enzyme deficiency prevalent in many malaria-endemic countries. G6PD-deficient individuals are susceptible to hemolysis when exposed to certain medications, including 8-aminoquinoline drugs (primaquine and tafenoquine) used to fully cure *Plasmodium vivax* malaria patients by killing the malaria parasites that lie dormant in the liver. As a result, the World Health Organization recommends conducting a G6PD test prior to initiating this “radical cure” treatment.

Community health workers in Vietnam during a training session on the use of a POC test for G6PD deficiency. Photo: PATH/

Manufacturers working with the malaria community have been making progress in developing, introducing, and scaling simple point-of-care (POC) tests for G6PD deficiency, which would enable wide-scale radical cure treatment of patients with *P. vivax* malaria and accelerate elimination of the disease. However, the demand for POC G6PD tests for malaria is not large, currently estimated to be between 0.5 and 1 million units per year at the market peak. Additional market opportunities and demand will be needed to ensure their sustainability. Therefore, PATH initiated a research study among private-sector providers in India, Indonesia, and Vietnam to assess local understanding of G6PD deficiency, clinical practice for identifying and managing patients with G6PD deficiency, and perceptions of POC G6PD tests in order to determine the private-sector market potential for these tests in low- and middle-income countries.

Methodology

India, Indonesia, and Vietnam all have sizable private health care markets. In collaboration with the Federation of Obstetric and Gynaecological Societies of India and EOS International, PATH researchers conducted interviews from June to August 2021 in India and from April to May 2021 in Indonesia and Vietnam. Interviewees included medical professionals such as general practitioners, obstetricians, gynecologists, neonatologists, and hematologists in both urban and rural geographies (Table 1 below), selected by screening a larger pool of physicians based on their knowledge of and experience in treating patients with G6PD deficiency and using or ordering G6PD tests. The study included both primary and secondary research, and all interviews were conducted via telephone.

Table 1. Numbers and types of respondents in each study country.

	Obstetrician/ gynecologist	Neonatologist/ pediatrician	General practitioner	Hematologist	Other	Total
India	11	8	3	0	8	30
Indonesia	0	21	20	4	0	45
Vietnam	0	17	15	3	0	35

Limitations

Due to the COVID-19 pandemic, it was difficult to recruit interviewees who were able to provide specifics when asked the market research questions. This was particularly true for India, where PATH identified 30 respondents, but many were not able to provide answers: average response rates were less than 30% for questions related to knowledge of G6PD deficiency, 27% for those related to practice, and 18% for questions related to perceptions.

Key findings

Assessing provider knowledge about G6PD deficiency, commonly used G6PD deficiency tests, common use cases for G6PD deficiency tests, and country policies and guidelines regarding G6PD testing.

Respondents in all three countries had a theoretical understanding of G6PD deficiency and considered it to be a serious health concern. However, understanding of the prevalence of G6PD was significantly lacking in India, and responses from interviewees in Indonesia and Vietnam varied greatly. This may be attributable to a lack of national guidelines in these countries. Screening for and treating G6PD deficiency is typically based on physicians' knowledge and/or experience. Several respondents in Indonesia and Vietnam mentioned that the facilities in which they work have their own protocols for screening and treating G6PD-deficient patients.

Medial staff in AIIMS Hospital discussing the project. Photo: PATH/Ruhani Kaur

All respondents in Indonesia and Vietnam recognized the importance of identifying G6PD deficiency. Approximately 60% of respondents in Indonesia suggested that a spectrophotometer test is an appropriate test for identifying G6PD deficiency, and about 70% of the respondents in Vietnam identified a fluorescent spot test as appropriate. Many respondents in Indonesia and Vietnam stated that G6PD tests are commonly used prior to administering antimalarial therapeutics and to identify patients with jaundice or anemia. In India, although most respondents recognized the importance of identifying G6PD deficiency, none could name types of commonly used G6PD tests and most were not able to comment on common use cases for G6PD tests.

Understanding provider practice, G6PD deficiency tests currently used, frequency and locations of use.

In Indonesia, G6PD tests were ordered/administered for an average of 0.3% and 0.5% of adult and pediatric patients, respectively, in the previous year (Table 2). Patients were charged an average of

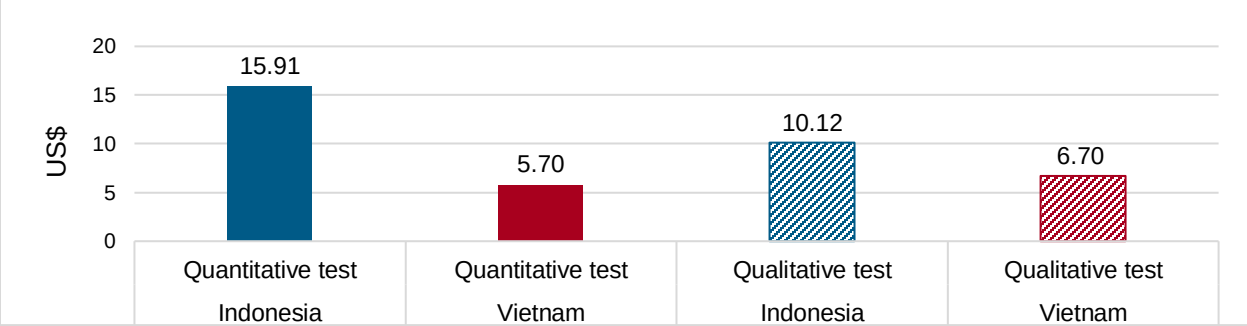
US$15.91 for quantitative tests and $10.12 for qualitative tests (Figure 1), in addition to an average $13.73 consulting fee. In Vietnam, G6PD tests were ordered/administered for an average of 0.5% and 1.3% of adult and pediatric patients, respectively, in the same year (Table 2). Patients were charged an average of $5.70 for quantitative tests and $6.70 for qualitative tests, in addition to an average $11.80 consulting fee (Figure 1). This indicates the current market for G6PD tests is not significant in Indonesia and Vietnam. Additionally, it was interesting that in Vietnam patients were charged a higher amount for qualitative tests than for quantitative tests. The amount charged to patients included other expenses and does not directly reflect the cost of a test.

In India, only two people mentioned testing fees ($6.80 to $8.20 for qualitative tests; $16.40 to $20.50 for quantitative tests). Based on the data that PATH collected from four laboratories that conduct G6PD tests in another project, patients were charged between $7.00 and $17.00 for quantitative tests. Although the data is limited, it appears that there is a significant difference in testing fees charged to patients in that country.

Table 2. Average number of patients seen and G6PD tests ordered in Indonesia and Vietnam in the year prior to the study (unable to obtain data for India).

	Number of patients		Number of G6PD tests ordered		Number of G6PD tests ordered as a percentage of number of patients	
	Adult	**Pediatric**	**Adult**	**Pediatric**	**Adult**	**Pediatric**
Indonesia	1,383	1,557	7	7	0.3%	0.5%
Vietnam	973	2,375	4	19	0.5%	1.3%

Figure 1. Fees charged to patients for quantitative and qualitative testing in Indonesia and Vietnam in the year prior to the study (unable to obtain data for India).



The respondents believed that the most common reasons for recommending G6PD testing in their respective countries included determining the cause of jaundice in newborns and understanding the etiology of anemia. While identifying G6PD status among patients with malaria was one of the top three reasons noted for recommending G6PD testing in Indonesia and Vietnam, this was not mentioned in India.

Approximately 70% of respondents in Indonesia and Vietnam suggested that testing is done at external laboratories, and 40% of respondents in India stated that G6PD testing is conducted at in-house laboratories. Quantitative tests are used more regularly than qualitative tests in India and Indonesia. In Vietnam, qualitative tests are slightly more regularly used. This response was consistent with those regarding the use of appropriate tests. Respondents in Indonesia and Vietnam identified the types of tests they are using/ordering as appropriate for use in their respective countries.

Cutoff values to determine G6PD deficiency (as provided by those respondents ordering quantitative tests) were extremely varied in Indonesia and Vietnam. This might be due to the absence of national guidelines and/or low level of provider involvement in interpreting results, since most G6PD tests are conducted in laboratories. No respondents in India could answer this question.

Determining provider perceptions about point-of-care G6PD deficiency tests, their perceived value and willingness to adopt, and potential factors that could drive or hinder adoption.

Awareness of POC G6PD tests was low among the respondents in all three countries: 57%, 55%, and 77% of respondents in India, Indonesia, and Vietnam, respectively, did not know any of the POC G6PD tests currently available in their countries.

However, the quantitative and qualitative POC G6PD test concepts (see box) were well accepted among the respondents, especially in Indonesia and Vietnam. Fast turnaround of results was the preferred attribute, allowing for less waiting time for providers and patients, timely care, and less time needed for follow-up. The overwhelming majority of respondents in Indonesia and Vietnam stated they would adopt POC G6PD tests, and most preferred quantitative tests due to the quantitative nature of the results. Respondents in India were more ambivalent: 30% stated they would adopt POC G6PD tests, but 17% answered "No" and 20% answered "Unsure," as many believe there is not a strong need to test for G6PD deficiency because of its low prevalence.

Point-of-care G6PD test concepts provided to interviewees

The point-of-care quantitative G6PD test consists of a battery-operated small instrument and assay kit. It is intended for the simultaneous quantitative measurement of red blood cell G6PD activity and hemoglobin in fingerstick or venous whole blood. Some sample preparation is required (e.g., mixing a sample with reagents). After a sample is applied, the instrument presents the results in less than 5 minutes on a small display. The results are expressed as the ratio of units per deciliter of G6PD activity per gram of hemoglobin per deciliter (G6PD U/g Hb) to normalize G6PD activity for hemoglobin level and a stand-alone quantitative hemoglobin measurement in g/dL. The instrument also has capability to store results.

The point-of-care qualitative G6PD test is a lateral flow test intended to provide binary results from fingerstick blood (whether patients are G6PD deficient or not). After a sample is applied, the test presents results in 10 minutes by changing colors in a window.

The best use case scenarios for quantitative POC G6PD tests mentioned by respondents in Indonesia included testing patients prior to administration of drugs contraindicated for G6PD deficiency, followed by screening large populations in malaria-endemic regions and screening newborns. In Vietnam, the best use cases included newborn screening, followed by understanding the etiology of anemia and testing patients prior to administration of drugs contraindicated for G6PD deficiency. G6PD deficiency testing prior to administration of antimalarial medication was not mentioned as a use case for POC G6PD tests in Vietnam. This is contrary to what was stated in response to a question regarding common use cases for G6PD tests in the country.

Cost of the tests and lack of general awareness of G6PD deficiency and POC G6PD tests were consistently mentioned in all three countries as barriers to adoption. Respondents noted that overcoming these barriers while promoting product attributes would be important in driving adoption.

Implications for point-of-care G6PD test introduction

This market research study suggests that there is market potential for POC G6PD tests in the private sector and the need for POC G6PD deficiency tests was well accepted by all respondents, especially in Indonesia and Vietnam. Quantitative tests were preferred over qualitative due to the result presentation and fast result turnaround. However, it was clear that providers in all three countries lacked an understanding and awareness of G6PD deficiency and its prevalence.

Establishing understanding of the prevalence of G6PD deficiency and advocating for standardized testing and treatment practice through development of national guidelines could be a critical step in raising

awareness and generating demand. Some private-sector facilities appeared to have their own protocols. A standardized testing protocol could be established in collaboration with private-sector facilities that already have appropriate protocols for G6PD testing and local professional organizations.

While the current fees charged for quantitative testing ($15.91 in Indonesia and $5.70 in Vietnam) might cover the disposables of quantitative POC G6PD tests, it would likely take several years to reach a break-even point if the cost of the instrument is added. This incremental cost might not justify procuring quantitative POC G6PD tests for use at each physician's office.

The study identified that G6PD deficiency testing is currently conducted in-house or at external laboratories. Quantitative POC G6PD tests could still be deployed at laboratories until the demand for G6PD deficiency tests increased. There may be demand for quantitative POC G6PD deficiency tests at small- to mid-sized laboratories, although large laboratories may still prefer batch tests. Additional market research with laboratories may be warranted to articulate their perceptions and demand for quantitative POC G6PD deficiency tests, as well as to better understand target market segments.

Acknowledgments

This research was conducted in collaboration with the Federation of Obstetric and Gynaecological Societies of India and EOS International, which conducted the interviews in Indonesia and Vietnam. The work was funded by a grant from the United Kingdom's Foreign, Commonwealth & Development Office, grant number 204139, and Bill and Melinda Gates Foundation [OPP1107113].

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