Adaptation of lot quality assurance sampling to monitor seasonal malaria chemoprevention delivery performance

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Malaria Consortium supports delivery of seasonal malaria chemoprevention (SMC) to children ages 3–59 months using sulfadoxine–pyrimethamine plus amodiaquine. Lot quality assurance sampling (LQAS) was adapted as a cost-efficient method for end-of-cycle SMC monitoring surveys across supported countries and an implementation challenges reporting system was established in Nigeria. We present a case study of its application in Nasarawa State. LQAS facilitated timely local performance assessment across 16 indicators. Development of new reporting tools has played a key role in stimulating national-level discussions on improvements to SMC supervisory processes and implementer training and provided a framework for engagement with local stakeholders.

Keywords: healthcare quality assessments, lot quality assurance sampling, malaria, prevention and control

Introduction

Seasonal malaria chemoprevention (SMC) is recommended by the World Health Organization to provide protection to children aged 3–59 months against Plasmodium falciparum malaria. SMC is safe, feasible and cost-effective in reducing the incidence of malaria in areas with high seasonal transmission.1

Malaria Consortium has supported national malaria programmes in implementing SMC since 2013 and typically delivers SMC in annual rounds of either four or five monthly cycles through door-to-door campaigns by community distributors. This involves administration of a dose of sulfadoxine–pyrimethamine (SP) and an initial dose of amodiaquine (AQ) (‘day 1 SPAQ’). Two further doses of AQ are administered by caregivers once daily over the subsequent 2 days (‘day 2 AQ’ and ‘day 3 AQ’). Community distributors provide instructions to caregivers on how to administer and record doses on SMC Child Record Cards.2

Malaria Consortium typically conducts monthly end-of-cycle surveys to gather data on indicators specified in its monitoring and evaluation (M&E) framework to assess programme performance relative to defined aims and objectives.3

Data are uploaded into one centralised database and formatted into an overall indicator framework with dashboards for visualisation and reporting.

Lot quality assurance sampling (LQAS) is a methodology for monitoring and improving process and/or programme quality. It involves taking a small random sample from each lot, or from smaller functional areas referred to as ‘supervision areas’ (SAs), and testing whether they meet a quality standard.4 LQAS is an economical tool requiring relatively small samples per SA to conduct hypothesis testing for whether a standard for a specific outcome has been met to inform remediation actions. LQAS can provide indicator results for larger geographic areas equivalent to those from cluster randomised surveys when data are pooled across multiple units.6 Supplementary Boxes S1 and S2 show key LQAS terminology and summarise the methodology as applied.

This article presents a case study from Nasarawa State, Nigeria, where SMC was introduced in 2021, describing the adaptation of LQAS to assess the quality of SMC delivery and inform actions for improvement, including the tools developed, implementation challenges identified and lessons learned.
Methods

The LQAS methodology was initially employed by Malaria Consortium in end-of-cycle SMC coverage surveys in 2018. These were designed based on a lot size of 19 per SA and decision rule of 13, to detect whether SMC coverage (defined as receipt of day 1 SPAQ) had fallen below 50% based on a target of 80% coverage. However, this design was not reflective of coverage achieved (typically >90%) and made no use of hypothesis testing to identify areas not meeting targets or opportunities for programme improvements.

A new multiple-objective, clustered LQAS strategy was adopted in May 2020 to address actionable and relevant targets and decision criteria. During consultations across country implementing teams, participants defined 16 indicators (household with SMC-eligible children visited, SPAQ administered to eligible child [day 1], eligible child received 3-day complete course of SPAQ [including day 2 and day 3 AQ], SPAQ administration observed by distributor [day 1], SMC Child Record Card retention, all SPAQ doses received marked on SMC Child Record Card, caregiver accepted SMC administration [not refused], SMC awareness [heard of SMC], SMC knowledge [purpose of SMC], SMC knowledge [age eligibility for SMC], SMC knowledge [importance of age eligibility for SMC], SMC knowledge [importance of administering AQ on days 2 and 3], SMC knowledge [what to do in case of an adverse event], confidence in SMC efficacy, caregiver reported distributor wore mask, and information on COVID-19 prevention received) and assigned each targets and decision criteria (Supplementary Table S1). Lot sizes for each indicator were determined using the UNICEF LQAS Sampling Plan Calculator based on maximum tolerable \( \alpha \) and \( \beta \) errors of 10%.\(^5\) A sample of 25 households was identified as the smallest lot size to facilitate hypothesis tests (using binomial tests) for all indicators. Decision rules were defined for each indicator by lot size (Supplementary Box S3, Supplementary Table S2).

SAs were defined best approximating the level at which implementation challenges could be addressed. In Nasarawa, these corresponded to health facility catchment areas, which were selected using a simple random method from among the 543 facilities across 13 Local Government Areas (LGAs). Three communities were randomly selected in each SA using local sampling frames. Twenty-five households were selected randomly in each SA, distributed between three clusters. All surveys employed SurveyCTO version 2.70 (Dobility, Cambridge, MA, USA) on mobile devices. A full description of survey methods is available elsewhere.\(^6\)

After data collection, the number of children and caregivers in each SA meeting the criteria for each outcome indicator were copied into an Excel spreadsheet (Microsoft, Redmond, WA, USA), with formulae that automatically performed hypothesis tests and generated messages diagnosing implementation challenges when decision rules were not met. Implementation challenges were placed into four categories (coverage; SMC Record Card; knowledge, awareness and attitudes; and COVID-19) and then prioritised based on the SMC programme logic model. Indicators representing outcomes earlier in the logic chain were given higher priority; e.g. ‘households with eligible children visited’ was assigned a higher priority than ‘day 1 SPAQ administration observed by distributor’, as the latter could not have occurred without the former (Supplementary Box S4). Formulae automatically generated key messages identifying the highest-priority implementation challenge in each category, giving a succinct overview for each SA (Supplementary Box S5).

Results were communicated to decision makers at the SA level and above, who were engaged to take actions to address implementation challenges identified and improve SMC delivery locally in subsequent SMC cycles.

The Nigeria SMC implementation team developed a LQAS results reporting tool for all states, including key findings, recommended actions, responsible persons for execution, deadlines for completion of recommended actions and a state-level reporting form developed for M&E managers to track results of actions taken in response to LQAS hypothesis tests (Figure 1). Challenges and lessons learnt were discussed at the end of each cycle in a state-level review meeting and relayed to LGA-level teams who recommended remediation actions at the SA level, including refresher training for relevant personnel.

At the same time, LQAS surveys were designed to yield state-level estimates in Nigeria for key outcome indicators by cycle (Supplementary Box S6).\(^7\) Post hoc survey weights (based on SA catchment populations in Nasarawa) were used to ensure representativeness of state-level outcome estimates.

We summarised implementation challenges identified in each of the SAs with four monthly cycles of follow-up from June to September 2021 and estimated eight of the key outcome indicators by cycle for Nasarawa.

Discussion

The adapted LQAS methodology facilitated timely monitoring and assessment of local implementation challenges. The UNICEF LQAS Sampling Plan Calculator was helpful in adapting the methodology to SMC delivery; LQAS targets and decision criteria could be customised appropriate to the setting. It can also be used in areas where SA populations are small, using a hypergeometric sampling distribution. While the methodology has commonalities with the Supervisors’ Coverage Tool\(^6\) for preventive chemotherapy for neglected tropical diseases, the following differences and adaptations should be noted: LQAS surveys were designed to give a representative sample of respondents at the state level, thereby allowing estimation of SMC coverage with high accuracy; LQAS surveys were multi-objective and specific tools and processes were developed to facilitate data interpretation and implementation of action plans to improve local SMC delivery in subsequent cycles.

SAs corresponded to individual health facilities, which represented the level at which most implementer training and supervision occurs, allowing appropriate targeting of remediation actions in response to specific implementation challenges identified. The tools developed provided a framework for dissemination of survey results to stakeholders and to record and track decision making with the objective of preventing the recurrence of implementation challenges. The findings of LQAS surveys have stimulated discussions within the Nigerian National Malaria Elimination Programme on improvements to SMC delivery and supervisory processes at the national level, and reporting forms have promoted transparency and accountability at the local level.
Results have been fed into the M&E framework to assess SMC outputs and outcomes. Supplementary Tables S3 and S4 show summaries of the implementation challenges identified in each cycle in each of the 11 SAs with four cycles of consecutive follow-up, and state-level estimates of key indicator outcomes by cycle.

Decision makers were encouraged to identify potential causes for the combinations of SMC implementation challenges identified. LGA-level implementation teams intensified distributor training and supervision in SAs that reported challenges and partnered with local leaders to mobilise communities and enhance awareness of SMC. Over time, this process has the potential to improve programme-level processes indirectly, as they are adapted to address common implementation challenges. Meanwhile, data from LQAS surveys provided accurate and representative state-level outcome estimates—thanks to the use of randomised SA sampling, sufficient sample size and post hoc use of population weights—to inform programme management.

Our adaptation of LQAS had some limitations. The number of data collectors was insufficient to survey all SAs in each cycle due to constraints on funding and trained personnel, thereby preventing follow-up between cycles in most SAs. Most survey indicators were based on self-reporting.

Areas for potential further adaptation of the LQAS methodology to SMC include tailoring survey designs to new delivery models and the development of real-time data tools. Further work is also needed to construct a reporting framework for LQAS survey-based studies. Although the Consensus-Based Checklist for Reporting of Survey Studies may provide a model, no specific reporting framework currently exists.

**Conclusions**

LQAS is a rapid, cost-effective and statistically sound methodology for in-process programme implementation assessment applicable to a range of settings. Our experiences from adaptation of LQAS to SMC and the tools developed highlight the flexibility of the LQAS approach, demonstrate its adaptability and provide a potential model for other implementers in SMC and other interventions. They also highlight the key role of engaged local
partners in implementing LQAS reporting systems and addressing implementation challenges.

**Supplementary data**

Supplementary data are available at *Transactions* online.

**Authors' contributions:** SR conceived the study, designed the methodology, led its introduction in SMC programme countries and drafted the manuscript. TI operationalised surveys employed in this study. DO and COquama provided overall supervision to surveys and monitoring and evaluation in Nigeria. COkoronkwo and ES were responsible for planning SMC programme improvements in Nigeria. DS developed the UNICEF LQAS Sampling Plan Calculator. KB, MAC, AR and CN reviewed the manuscript for its intellectual content and suggested substantive revisions. CR provided overall programme supervision. All authors read and approved the final manuscript prior to publication.

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**Competing interests:** None declared.

**Ethical approval:** End-of-cycle LQAS surveys in Nigeria were developed in collaboration with and approved by the Nigerian National Malaria Elimination Programme and the Federal Ministry of Health. Patient consent for publication was not applicable, as data employed comprised only variables based on aggregated data at the SA level.

**Data availability:** End-of-cycle LQAS survey data used in this study and the tools for LQAS hypothesis testing and implementation challenge reporting will be shared upon reasonable request to the corresponding author.

**References**


