Identifying Quality Constraints of Inpatient Data in U.S. President's Malaria Initiative Partner Countries

Literature Review Synthesis

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CONTENTS

TABLES

ABBREVIATIONS

CIN	Clinical Information Network
DHIS2	District Health Information Software, version 2
DRC	Democratic Republic of the Congo
HIS	health information system
HMIS	health management information system
ICD	International Classification of Diseases
M&E	monitoring and evaluation
NMCP	national malaria control program
PMI	President's Malaria Initiative
PMM	PMI Measure Malaria
SME	surveillance, monitoring, and evaluation

ABSTRACT

Quality inpatient data, specifically for severe malaria and malaria mortality, are essential for understanding the true burden of the disease in malaria endemic countries and for enabling decision makers to provide effective and contextual responses to the gaps and challenges observed in their countries. Inconsistencies in reporting practices and interpretation of cases, including misclassification, overestimation, and underreporting, are among observed challenges in the quality of inpatient data in U.S. President's Malaria Initiative (PMI) Measure Malaria (PMM) countries. A review of the published and grey literature and key informant interviews with PMM surveillance, monitoring, and evaluation (SME) advisors and national malaria control program (NMCP) stakeholders informed the findings presented in this synthesis. The literature suggests that inpatient malaria data are not consistently and routinely reported, thereby complicating the estimation of malaria trends and use in making programmatic decisions. Instead, inpatient data may be used to understand the clinical manifestations of severe malaria, to study case management and quality of care, and to examine the causes of hospital deaths and the quality of hospital cause of death data. Interviews with PMM SME advisors and country stakeholders also confirm the challenges in the quality of inpatient data, which they attribute to diverging reporting practices and differences in reported data, especially in the data coming from a lower level compared to the data reported at the national level.

BACKGROUND

The need for high-quality inpatient data on severe malaria and malaria mortality is clear. While patients with uncomplicated cases of malaria are generally handled as outpatients, those diagnosed with severe malaria are treated as inpatients. When effective, countries' routine health information systems (HIS) that report inpatient malaria data can provide near real-time data for disease management and surveillance and program monitoring and evaluation (M&E) (Okello et al., 2019). "Such data are important for tracking the progress of malaria control, advocating for adequate investments, supporting appropriate allocation and targeting of resources, and for disease surveillance (Okello et al., 2019, p. 2).

The 2021 World Malaria Report highlighted that "Understanding the variation in the clinical manifestations of severe malaria by age and transmission intensity is essential in implementing effective interventions" (World Health Organization, 2021, p. 38). Collecting, reporting, and using severe malaria data for action are particularly important in a context of declining transmission, because although overall malaria burden may decline, "the age-immunity patterns change and older children may become increasingly susceptible to severe malaria" (World Health Organization, 2021, p. 38).

This underscores the importance of reporting quality inpatient data in U.S. President's Malaria Initiative (PMI) partner countries, especially data on severe malaria cases and deaths. Key challenges that have already been observed regarding the availability of quality inpatient malaria data are that the required data elements are captured at different points in the patient flow, which makes data reconciliation difficult, and that inconsistencies in numerators and denominators for mortality data result in reports of more deaths, at times, than the number of inpatients recorded.

A robust understanding of severe malaria data elements—including referral practices, case management practices (protocol, prereferral, treatment), and data reporting practices—is essential for interpreting and improving the quality of malaria inpatient data. Having a good account of malaria mortality cases, especially in the context of other fever-related illnesses—such as COVID-19—through inpatient data, will help decision makers manage the differential burden of malaria at all levels and allow them to adjust interventions for optimal impact.

This review aims to synthesize the availability and quality of inpatient malaria data in PMI Measure Malaria (PMM) countries, especially data on severe malaria and malaria mortality, to assess and understand reporting practices and challenges of these data across subnational and national levels. It will provide recommendations on where further analysis will be beneficial to address observed data quality gaps and improve current data reporting systems for effective usage of malaria inpatient data through informed interventions.

METHODOLOGY

Literature and Document Search

Published Literature

The database search utilized a two-pronged approach. First, the PMM team searched the Cochrane Library for review papers and metanalyses on severe malaria and malaria mortality data. Second, the team conducted a structured literature search using Google Scholar and PubMed. Search terms were used for Google Scholar searches (Table 1), and based on the number of duplicate results from the Google Scholar searches, the terms were streamlined for the PubMed search (Table 2). Database searches were limited from 2017 to the present, in alignment with the following literature review inclusion criteria:

- Publications and documents are from the last six years (2017–2021)
- Language of publication or document is English or French
- Publication or document addresses data management; quality (improvement); analysis; or interpretation of inpatient malaria data, severe malaria data, or malaria mortality data

Database searches used the following steps:

1. Three pages of results were reviewed for each set of search terms
2. Results of each search were screened by title
3. Titles that seemed relevant were opened and their abstracts were read
4. If the abstract was relevant and appeared to meet the inclusion criteria, the full article was read
5. Full articles and their citations were downloaded into EndNote, and each PDF article was saved using the "Author YEAR" naming convention

A total of 52 articles were identified as potentially relevant during abstract screening (Step 4). Additional articles were suggested or shared directly by stakeholders to include in the review, and the World Malaria Report 2021 was also included following its publication.

After the full article review, a total of 26 articles met the inclusion criteria for the synthesis. Many publications that were ultimately excluded were those that addressed quality of care for severe malaria and determinants of severe malaria outcomes (e.g., poor adherence to treatment protocols). Few articles focused on severe malaria or malaria mortality data quality or use.

Table 1. Google Scholar search terms

Search terms					
Severe malaria	AND	Inpatient data	AND	Country	Angola, Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Democratic Republic of the Congo (DRC), Ethiopia, Ghana, Guinea, Kenya, Liberia, Madagascar, Malawi, Mali, Mozambique, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Tanzania, Uganda, Zambia, Zimbabwe
Severe malaria	AND	Routine data	AND	Country	Angola, Benin, Burkina Faso, Cameroon, Côte d'Ivoire, DRC, Ethiopia, Ghana, Guinea, Kenya, Liberia, Madagascar, Malawi, Mali, Mozambique, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Tanzania, Uganda, Zambia, Zimbabwe
Malaria mortality	AND	Inpatient data	AND	Country	Angola, Benin, Burkina Faso, Cameroon, Côte d'Ivoire, DRC, Ethiopia, Ghana, Guinea, Kenya, Liberia, Madagascar, Malawi, Mali, Mozambique, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Tanzania, Uganda, Zambia, Zimbabwe
Malaria mortality	AND	Routine data	AND	Country	Angola, Benin, Burkina Faso, Cameroon, Côte d'Ivoire, DRC, Ethiopia, Ghana, Guinea, Kenya, Liberia, Madagascar, Malawi, Mali, Mozambique, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Tanzania, Uganda, Zambia, Zimbabwe
Cause of death	AND	Routine data	AND	Country	Angola, Benin, Burkina Faso, Cameroon, Côte d'Ivoire, DRC, Ethiopia, Ghana, Guinea, Kenya, Liberia, Madagascar, Malawi, Mali, Mozambique, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Tanzania, Uganda, Zambia, Zimbabwe
Mortality data	AND	Quality	AND	Country	Angola, Benin, Burkina Faso, Cameroon, Côte d'Ivoire, DRC, Ethiopia, Ghana, Guinea, Kenya, Liberia, Madagascar, Malawi, Mali, Mozambique, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Tanzania, Uganda, Zambia, Zimbabwe
Malaria mortality	AND	Reporting	AND	Country	Angola, Benin, Burkina Faso, Cameroon, Côte d'Ivoire, DRC, Ethiopia, Ghana, Guinea, Kenya, Liberia, Madagascar, Malawi, Mali, Mozambique, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Tanzania, Uganda, Zambia, Zimbabwe
Severe malaria	AND	Reporting	AND	Country	Angola, Benin, Burkina Faso, Cameroon, Côte d'Ivoire, DRC, Ethiopia, Ghana, Guinea, Kenya, Liberia, Madagascar, Malawi, Mali, Mozambique, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Tanzania, Uganda, Zambia, Zimbabwe

Table 2. PubMed search terms

Search terms					Results
Severe malaria	AND	Inpatient data	AND	Sub-Saharan Africa	22
Severe malaria	AND	Routine data	AND	Sub-Saharan Africa	41
Malaria mortality	AND	Inpatient data	AND	Sub-Saharan Africa	19
Malaria mortality	AND	Routine data	AND	Sub-Saharan Africa	49
Cause of death	AND	Routine data	AND	Sub-Saharan Africa	37
Mortality data	AND	Quality	AND	Sub-Saharan Africa	890
Malaria mortality	AND	Reporting	AND	Sub-Saharan Africa	36
Severe malaria	AND	Reporting	AND	Sub-Saharan Africa	65

Grey Literature Review

Grey literature—including national malaria control program (NMCP) strategy documents and treatment protocols, and malaria surveillance system assessment reports—from PMM countries were screened in English and French. A total of 18 documents (Appendix 1) were reviewed and determined to be relevant for this synthesis.

Key Informant Interviews

The PMM activity lead conducted brief (30 minute) informal interviews with each PMM country malaria surveillance, monitoring, and evaluation (SME) advisor. Some interviews were replaced with short questionnaires and follow-up emails to ease language barriers. The PMM activity lead and malaria SME advisors (Appendix 2) interviewed additional country stakeholders, including those working on the health management information system (HMIS) and integrated disease surveillance and response (IDSR) system, implementing partners supporting case management, and healthcare providers at health facilities (primary and referral hospitals). The interviews focused on inpatient malaria data reporting practices, data quality, and contextual information in each country.

QDA Miner Lite version 2.0.8, a qualitative data analysis software program for storing, coding, indexing, retrieval, and analysis, was used to analyze the data by thematic areas. During the process of coding, data were analyzed using thematic areas from the interview guide as a predetermined concept. The coded data were refined to represent the participants' perspectives on the subject matter for each theme. The synthesis of the information from the interviews with each PMM country malaria SME advisor identified four main themes on inpatient malaria data, especially on severe malaria cases and mortality: data reporting practices, data reporting gaps and challenges, data quality, and other related contextual factors on inpatient malaria data.

FINDINGS

Literature and Document Review

Availability and Use of Inpatient Data

A limited amount of published literature examines the status, quality, management, and use of inpatient data on severe malaria and death. Many countries' routine malaria data are limited to outpatient data (with some notable exceptions, such as Liberia). In the countries that do have inpatient data captured in their malaria surveillance systems, the data are of varied quality. The lack of quality inpatient data accessible in malaria surveillance systems means that inpatient malaria data are often extracted from the source (at individual facilities) for specific studies, but they are not consistently reported nor subsequently used to estimate malaria trends and make related programmatic decisions. Some uses of inpatient malaria data were found in the World Malaria Report 2021, which used inpatient malaria surveillance data as a proxy to measure severe malaria trends (World Health Organization, 2021).

Case Definition and Clinical Manifestation

Some published literature discusses inpatient data in the context of understanding clinical manifestations of severe malaria. A case of severe malaria is difficult to reliably define, and thus directly measure (Camponovo et al., 2017; World Health Organization, 2021). The variation in definitions of severe malaria within and between countries may also impact inpatient admission rates (Camponovo et al., 2017). Severe anemia is the most common manifestation (World Health Organization, 2021), although data on severe anemia are not consistently available. When hemoglobin measurements were not available in the data, data indicating the order of a blood transfusion have been used as a measure of severe malaria anemia (Alegana, et al., 2020; World Health Organization, 2021).

In advance of the RTS,S malaria vaccine rollout in Kenya, Akech et al. (2020) conducted a study investigating the profile of pediatric malaria admissions in western Kenya. Malaria phenotypes were identified from routine malaria surveillance data from 2015–2018, but there were likely misclassifications of some cases because the system was not designed to capture all characteristics of severe malaria (e.g., hypoglycemia and hyperparasitemia) (Akech et al., 2020).

Paton et al. (2021) paired malaria hospital admission data with community parasite infection survey data to examine the relationship of parasite prevalence on severe malaria phenotypes (severe malaria anemia, respiratory distress, and cerebral malaria) in east Africa. Mpimbaza et al. (2020) used malaria surveillance data to compare rates of pediatric malaria hospitalization and different parasite exposure levels in Uganda. Standardized medical record forms were used to record data, and in 2016, the forms were integrated into District Health Information Software, version 2 (DHIS2) for real-time data entry (Mpimbaza et al., 2020). The medical record forms did not capture prostration, hyperparasitemia, whether a child had a seizure during an illness episode, or multiple convulsions within 24 hours (Mpimbaza et al., 2020). Investigators also found incomplete hemoglobin results on malaria admissions, so severe malaria anemia was classified if there were

hemoglobin results, or as a proxy if a child received a blood transfusion or presented with clinical signs of severe pallor (Mpimbaza et al., 2020). The outcome of admission was incomplete across all hospitals, so it was not possible to calculate case fatality rates (Mpimbaza et al., 2020).

Case Management and Quality of Care

The published literature uses inpatient malaria data to study case management and quality of care, exposing gaps in those data. Using data from 2013, Ssempiira et al. (2018) assessed the effect of facility readiness (measured by Service Provision Assessment data) on severe malaria and malaria death outcomes from HMIS data in Uganda. HMIS data were the cumulative number of malaria deaths and severe malaria cases leading to hospitalization; neither indicator was defined in the paper (Ssempiira et al., 2018). Higher facility readiness was found to be associated with a reduced risk of severe malaria outcomes (severe malaria cases and malaria deaths) (Ssempiira et al., 2018).

Kenya's Clinical Information Network (CIN) was established as a learning health system to improve the quality of care in Kenya's hospitals (Irimu et al., 2018). CIN focal persons are responsible for improving data collection and medical record documentation in hospitals (Irimu et al., 2018). CIN conducted an audit and feedback intervention to improve inpatient pediatric hospital admission data (Gachau et al., 2017). Improvements were found for 23 of the 34 indicators assessed, including non-classified malaria and artesunate for malaria (proxy for severe malaria). CIN found that the introduction of standardized clinical forms was more important to the improvements than the provision of feedback (Gachau et al., 2017). Data from the CIN database were used to evaluate the adoption of treatment recommendations for severe malaria and identified that delays in blood transfusion increased mortality (Irimu et al., 2018).

In 2016, a biannual monitoring survey was conducted in 47 county referral hospitals in Kenya to assess facility readiness and inpatient malaria case management (Zurovac et al., 2018). At each hospital, 30 malaria admission patient files were reviewed and data elements from each file were extracted, including age, sex, weight, dates of admission and discharge, assessments and laboratory tests performed with results recorded, diagnoses made, and treatments prescribed (Zurovac et al., 2018). By the second round of monitoring, 49 percent of admission files had at least one documented feature of malaria severity at admission (prostration, alteration of consciousness, respiratory distress, convulsions, shock, pulmonary edema, abnormal bleeding, jaundice, hemoglobinuria, acute renal failure, severe anemia, hypoglycemia, hyperlactatemia), and overall inpatient malaria case management had improved (Zurovac et al., 2018).

Assessing Cause of Death

Some publications examined inpatient data to assess causes of hospital deaths and quality of hospital cause of death data. Fitzgerald et al. (2018) conducted a pediatric death audit at Kamuzu Central Hospital in Malawi through a retrospective charge review from November 2014–November 2015. The audit found that medical record keeping was inconsistent, there were no electronic medical records, deaths were recorded in a ledger by an administrative layperson, and the presumed cause of death noted was diagnosed by the evaluating clinician (Fitzgerald et al., 2018). Malaria was the most common cause of death (26.1%), but this was likely an overestimate, given that the

assignment was based on the record for a positive malaria rapid diagnostic test (Fitzgerald et al., 2018). Further, some symptoms of severe malaria (anemia/blood disorder and renal failure) were recorded as a cause of death but the cases were not diagnosed as malaria or did not attribute cause of death to malaria (Fitzgerald et al., 2018).

Mremi et al.'s (2018) retrospective analysis of data from 39 hospitals in Tanzania found that cause of death was not accurately reported. Poor data management, including outdated forms, inadequate human resources, and lack of planning for storage of forms, as well as non-adherence to International Classification of Diseases, 10th Revision classifications, contributed to the inaccuracies (Mremi et al., 2018). A retrospective study of 2017 mortality statistics from Ola During Child's Hospital in Sierra Leone found no coordinated quality assurance or cross-checking of data between hospital entities (Ragab et al., 2020). Four avenues of mortality data collection were performed at Ola During Child's Hospital: the M&E department uploaded mortality data to a national database; and nursing superintendents collated mortality data from nursing ledgers, death certificates, and hospital mortuary records (Ragab et al., 2020). Although both M&E data and death certificates show malaria as the leading cause of death, there was significant variation in mortality rates between the M&E report and mortuary and nursing admission records (Ragab et al., 2020)

In Mozambique, Maputo Central Hospital conducted a study of minimally invasive autopsy against clinical records and verbal autopsy to estimate malaria deaths (Rakislova et al., 2021). The minimally invasive autopsy was found to have 100 percent specificity and sensitivity for identifying malaria as a cause of death, whereas in clinical records, two out of six malaria-specific deaths were missed (Rakislova et al., 2021).

Quality of Data—Malaria Surveillance Assessment

Multiple reports and peer-reviewed publications present results of malaria data quality assessments and surveillance system assessments. Malaria-focused data quality assessments have been implemented in multiple countries, but the scope of HMIS data captured and reviewed typically did not include inpatient data or any severe malaria or inpatient malaria mortality data (Adane et al., 2021; Davlantes et al., 2019; Njuguna et al., 2020; Ye et al., 2020; PMI Measure Malaria, 2021). A vital statistics performance index was used to assess the quality of death notifications in Antananarivo, Madagascar. The index captured six dimensions of quality: (1) quality of case of death reporting, (2) quality of age and sex reporting, (3) internal consistency, (4) completeness of death registration, (5) level of cause-specific details, and (6) data availability and timeliness (Masquelier et al., 2019). Malaria was found to be a leading cause of death, but these deaths were not differentiated by age or location of death (i.e., hospital or home) (Masquelier et al., 2019).

Rumisha et al.'s (2020) data quality assessment in Tanzania assessed the availability and use of HMIS tools and completeness and accuracy of indicators at each level of the reporting system for both outpatient and inpatient data. The inpatient indicators reviewed included anemia and malaria, and common for both was entry of diagnosis without indication of severity of disease (Rumisha et al., 2020). Severe anemia was overrepresented in tally sheets and inpatient report forms, compared to registers (Rumisha et al., 2020). The poor quality of data was attributed to insufficient human

resources, poor infrastructure, lack of resources for supportive supervision, low motivation and incentives, and a lack of standard operating procedures (Rumisha et al., 2020). A qualitative assessment of malaria surveillance in Kilosa District, Tanzania looked at the number of complicated and uncomplicated malaria cases (Mboera et al., 2017). The assessment found that data were used for monitoring trends and drug forecasting at the facility level and priority setting and planning at the district level (Mboera et al., 2017). However, the assessment found that data management was poor and there was inconsistent reporting and a lack of analysis capacity (Mboera et al., 2017).

In Ethiopia, where the malaria burden is heterogeneous and seasonal, the malaria surveillance system is robust; inpatient and outpatient data are captured and disaggregated at the woreda level (smallest subnational level). Malaria surveillance data trends, including inpatient malaria data, were assessed over a five-year period (2013–2017) in Benishangul Gumuz Region, Ethiopia (Assefa et al., 2020). Data reporting completeness improved over the five-year period, and both the number of inpatient malaria cases and deaths decreased over the period (Assefa et al., 2020). In 2017, Thomas et al. (2020) conducted a pilot study using a mobile application at 16 sentinel surveillance sites across Togo to improve the accuracy of the malaria surveillance system. Although only hospitals recorded malaria deaths, peripheral healthcare units referred all severe malaria cases to a hospital during the study period, and data were available in paper forms, but there was a delay in entering the data into the online platform (Thomas et al., 2020). A malaria surveillance system assessment in Uganda found that inpatient monthly summary forms were available in nearly all (99.4%) facilities offering inpatient services, but no information about dimensions of quality for inpatient forms were reported (Ye et al., 2017).

Reporting on Severe Case

National strategies, protocols, and guidelines from PMM countries align with World Health Organization treatment guidance and strive to strengthen routine data reporting and malaria surveillance. Most PMM countries do not include indicators that measure severe malaria in their national strategic plans or implementation frameworks, with the exception of Kenya and Sierra Leone (Programme National de Lutte Contre le Paludisme, 2016, 2017, 2018, 2019, 2020; Ministry of Health and Sanitation, 2020; National Malaria Control Programme, 2019a, 2019b; National Malaria Control Program, 2020).

One of the strategies in the Kenya Malaria Strategy 2019–2023 is to strengthen the capacity for case management of severe malaria (National Malaria Control Programme, 2019b). The objective of strengthening "malaria surveillance and use of information to improve decision making for programme performance" does not include any specific focus on inpatient malaria data, severe malaria data, or malaria mortality data (National Malaria Control Programme, 2019b, p. 19). The Kenya Malaria Strategy performance framework measures progress against the Kenya Malaria Strategy goal, with two inpatient malaria indicators sourced from routine surveillance/HIS data: total inpatient malaria deaths per 100,000 persons/year and total inpatient malaria cases per 100,000 persons/year (National Malaria Control Programme, 2019b; National Malaria Control Programme, 2019a). The framework also measures severe malaria case fatality rate to inform the malaria case management objective (National Malaria Control Programme, 2019a). The malaria M&E plan

supports the implementation of International Classification of Diseases (ICD) and inpatient data reporting in select Level 5 health facilities with the goal of reaching quality inpatient morbidity and mortality data (National Malaria Control Programme, 2019a).

Sierra Leone's National Malaria Elimination Strategic Plan 2021–2025 impact indicators include inpatient malaria deaths per year, malaria mortality, and proportion of inpatient deaths due to malaria (Ministry of Health and Sanitation, 2020). The HMIS provides the data on inpatient malaria deaths (Ministry of Health and Sanitation, 2020).

Key Informant Interviews

This section provides a detailed synthesis of data obtained through qualitative interviews of key stakeholders from PMM operating countries based on the reporting practices for inpatient severe malaria and malaria mortality data, challenges and gaps regarding these data, and perspectives on data quality.

Data Reporting Practices

Varied responses were collected from PMM countries regarding data reporting practices. Liberia, for instance, indicated that it does not have a routine reporting system that captures data on severe malaria cases and mortality. It was observed, however, that Cameroon, Madagascar, Mali, and Sierra Leone use a monthly data reporting system that captures data using either monthly summary hospital inpatient forms or other HIS forms. Niger uses a weekly reporting system to capture data on severe malaria and mortality.

Data Reporting Gaps and Challenges

Several data reporting gaps and challenges associated with severe malaria were identified, which vary across PMM countries. Paramount among these challenges is that some countries fail to correctly verify and ascertain whether cases that are classified as severe malaria are in fact severe malaria cases and not uncomplicated malaria cases or other diseases with similar symptoms, in addition to deaths that are classified as severe malaria-induced deaths. PMM countries also reported data inconsistencies if data from a lower level are compared to aggregate data at a higher level. It was also noted that some service providers do not comply with national guidelines on severe malaria diagnosis and treatment, leading to overestimation of severe malaria cases. Our synthesis of the findings from the key informant interviews showed that some severe malaria cases are usually underreported, because most health facilities may not report them at all, and thus their cases are not factored in the national estimates.

Data Quality

PMM countries' SME advisors and stakeholders had mixed reactions to data quality issues. Some reported good data quality, and others believed that data quality on severe malaria cases is improving over time. That notwithstanding, data quality remained a major challenge in the PMM countries, because there are still issues with data completeness, timeliness of submitting data from the district to the regional level, and large discrepancies between severe malaria data that are recorded from the registers and those that are captured in electronic health records. Some of the

factors contributing to poor data quality include inadequate health personnel to conduct data collection at the hospital level, frequent stockouts of reporting tools, and lack of computers and internet access for data entry at the hospital level.

Other contextual factors contributing to poor inpatient malaria data quality include a lack of attention from data managers and policy makers to the quality of severe malaria data from health facilities and, in a few countries, the lack of inclusion of private health facilities in the HMIS. Several interventions have been implemented to improve the data quality of severe malaria cases and deaths. For instance, some countries have included routine data quality assessment visits at the district level, with a focus on severe malaria cases and mortality, which has contributed to improving data quality.

Table 3 provides information on the country-specific data reporting practices, data reporting gaps and challenges, data quality, and other contextual information obtained through the key informant interviews.

Table 3. Synthesis of key informant interview notes

NOTE: Bold text indicates the codes generated from the text. Numbers in parentheses indicate the frequency of the code.

Theme	Synthesis by theme
Data reporting practices	**No routine reporting system (1)** SME participant from Liberia: *When we came in we realized there were no specific placeholders in the system for severe malaria cases; they weren't even talking about severe malaria.* **Monthly reporting system (3)** SME participant from Sierra Leone: *The current data reporting practices for inpatient malaria data are guided by using the hospital monthly summary forms called Monthly Summary Hospital Inpatient.* SME Mali: *Severe malaria and malaria deaths are reported monthly through the health information system by peripheral health facilities.* SME Madagascar: *Inpatient data are reported monthly by referral districts, regional hospitals, and university hospitals using a specific monthly reporting form.* **Weekly reporting system (1)** SME participant from Niger: *Weekly data is recorded in standardized weekly forms and forwarded to health district level where it is consolidated in an Excel sheet and sent to the region*. **Routine system of data collection (1)** SME participant from Cameroon: *The inpatient and mortality data are collected specifically in routine system through the health facilities/hospitals.*
Data reporting gaps and challenges	**Data verification issues (2)** SME participant from Madagascar: *Some deaths reported at health center level or community level are not supported by confirmation test but classified as malaria death.*

Theme	Synthesis by theme
	SME participant from Mali: *Triangulation of referrals, hospital admissions, severe cases, deaths, and use of commodities, and like most HIS data, timeliness of reporting and data accuracy are major challenges. It is impossible to differentiate severe anemia (anemia not measured) from cerebral malaria cases in HIS data.* **Misclassification (2)** SME participant from Liberia: *Cannot rely on outpatient diagnostics; misclassification is quite frequent*. SME participant from Cameroon: *Data quality is the key challenge for severe malaria: around 50% of all malaria cases that are reported monthly are classified as severe, this is very high compared to other countries but in fact, at least 80% of the cases reported do not align with severe malaria characteristics.* **No disaggregation of severe malaria cases (1)** SME participant from Niger: *No disaggregation into severe and uncomplicated malaria cases. Discrepancies exist between weekly and monthly data*. **Overestimation (1)** SME participant from Mali: *The first challenge is quality of severe diagnosis which results in overestimation of severe malaria cases. Many service providers do not comply with severe malaria diagnosis and treatment national guidelines. Patients tend to be diagnosed with severe malaria to justify use of injectables to increase income as part of the cost recovery system*. **Underreporting (1)** SME participant from Kenya: *Currently reporting rates are 51% in the whole country, only 51% of facilities, so not representative*.
Data quality	**Below-quality data (1)** SME participant from Madagascar: *Hospital reporting completeness is still suboptimal (73% in 2021*). **Getting better (1)** SME participant from Liberia: *Right now, it is much getting better as compared to what we had a few months ago.* **Good quality (1)** SME participant from Niger: *Inpatient data is often well recorded in the primary documents (registers) at health facility level*. **Quality data not assessed (1)** SME participant from Sierra Leone: *Malaria data quality for inpatient malaria and mortality data are not routinely conducted*. **Not good (3)** SME participant from Kenya: *The lack of completeness in terms of the proportion of health facilities reporting and completeness in terms of the data itself. Lots of missing fields when downloaded for analysis.* SME participant from Mali: *For the time being, severe malaria data in Mali is not good as it accounts for over 30% of all malaria cases. As mentioned above, accuracy of HIS data including severe malaria data is not good (more data reported on the HIS form than recorded in the registers).*

Theme	Synthesis by theme
	SME participant from Cameroon: *The artesunate injectable are used improperly due to economic reasons then the health facilities increase the number of severe malaria cases.*
Other contextual information	SME participant from Mali: *Data consistency check programs were developed in DHIS2, but not sufficiently used for data quality assurance. Quarterly data quality review meetings are being conducted at the district levels, but do not pay much attention to the quality of severe malaria data*. SME participant from Liberia: *As we speak now the decision makers feel more confident to use data for planning purposes—for example to forecast drugs; before people used to doubt, but now more confident because of the triangulation that have been put in place with the reporting form*. SME participant from Cameroon: *The data quality assessment visits are currently decentralized at the district level (conducted by the health district team) with focus on severe malaria and mortality*. SME participant from Kenya: *The biggest gap we've found, especially when it comes to analysis, is that it is difficult for countries to quickly analyze data from DHIS2 tracker. Both in terms in dashboards that can automatically analyze data for DNMP and in terms of the software for DNMP to analyze data that they download; the more steps needed the less likelihood of the data being used.* SME participant from Madagascar: *Most private hospitals are not yet included in DHIS2 leading to underestimation of severe malaria cases at national level. Effort is currently undergoing to include private sector in DHIS2 reporting.* SME participant from Niger: *There is no data dictionary, therefore even the NMCP ignore the definition of some data elements/indicators in the DHIS2, data is not frequently analyzed; consistency and quality checks are not systematic, it is not always possible to assign mortality data to a specific geographic area, e.g., when there is no District Hospital, severe cases are referred to the nearest District hospital and inflates mortality in that health district.* SME participant from Niger: *The new tools include some changes that can streamline reporting such as reducing the age groups from 24 to 3 (<5; >=5, and pregnant women), grouping key information on malaria on the same page, etc….We need time to appreciate the effect of these changes.* SME participant from Sierra Leone: *Inadequate health personnel to do data collection at the hospital (quite number of available staff are volunteers). Frequent stockout of reporting tools, Lack of ICT (computer, internet access) for data entry at the hospital, poor/non-reporting of private hospitals in the DHIS2*. SME participant from Sierra Leone: *In reality, NMCP signed MoU with hospitals and private clinics to address this data gap. In order to improve reporting on inpatient malaria and malaria deaths, hospitals and private clinics will receive malaria commodities for free. However, the data collected are not entered into the DHIS2. These data are stored in a standalone excel spreadsheet*.

DNMP=Division of National Malaria Program, MoU=memorandum of understanding, MRDQA=malaria routine data quality assessment, RDT=rapid diagnostic test, USAID=United States Agency for International Development

DISCUSSION

When timely and accurately reported, inpatient data on severe malaria cases and deaths provide reliable tools for disease monitoring and surveillance and program evaluation to malaria control policy makers, practitioners, and program implementers. Additionally, inpatient data that meet data quality standards and are made available in countries' routine HIS may help improve the effectiveness of such systems in equipping users with robust and complete data to ensure optimal usage.

The published literature indicates that inpatient data are not consistently and routinely reported to estimate malaria trends and make programmatic decisions. Inpatient data are discussed to understand the clinical manifestations of severe malaria. In some countries, inpatient data are used to study case management and quality of care, and in others, such data serve to examine the causes of hospital deaths and the quality of hospital cause of death data.

Key informant interviews revealed different reporting practices on severe malaria cases and mortality in PMM operating countries. For instance, Cameroon, Madagascar, Mali, and Sierra Leone have a monthly reporting system that uses monthly hospital inpatient forms to capture data. Niger, on the other hand, uses a weekly reporting system. Moreover, there are significant gaps in the reporting and quality of severe malaria cases and mortality data. Many countries' routine malaria data are limited to outpatient data and typically do not include inpatient data or severe malaria or inpatient mortality data. In terms of quality, many PMM operating countries share inconsistencies in reported data coming from a lower level, compared to aggregate data at a higher level. Severe malaria cases are usually underreported, and many health facilities may not report at all.

Key informants also shared the challenge in PMM countries to verify and ascertain real cases of severe malaria, compared to uncomplicated cases of malaria or other diseases with similar symptoms, in addition to deaths that are classified as severe malaria-induced deaths. Additionally, most PMM countries do not include indicators that measure severe malaria in their national strategic plans or implementation frameworks.

The challenge in PMM countries to capture high-quality inpatient data on severe malaria cases and mortality may not only affect how severe malaria is understood and treated across and within countries, but it may also impact how these data are made available in their surveillance systems and used by decision makers, researchers, evaluators, and practitioners to monitor and evaluate trends in the disease and to design effective policies and interventions.

There are a few limitations to note in this synthesis. Publication bias in the scientific literature review may have yielded limited results for publications for non-statistically significant studies or from less experienced authors. Key informant interviews were conducted with a small, purposively selected sample, so perspectives shared may not be representative of all individuals engaged in severe malaria and malaria mortality data collection, analysis, and use. There is potential bias in key informant interview responses and limited generalizability of those data.

CONCLUSION

Although the literature review and key informant interviews provide insights into the challenges related to the quality of and gaps in inpatient data, especially those related to severe malaria and malaria mortality, they do not quantify the scope of these constraints, which would have provided a better tool for taking effective corrective actions to improve the quality of malaria inpatient data.

A detailed and rigorous analysis of inpatient data will be beneficial for evaluating and quantifying the depth of PMM countries' reported malaria data quality challenges. For instance, it will be useful to ascertain the primary similarities and differences observed across PMM countries when comparing inpatient data at the health facility level with those at the national level. Such analysis may help identify true causes of discrepancies and quality control issues and enable PMM countries to provide a contextual response to these challenges. A targeted response will improve the quality of the data, which will impact the usage of such data and provide decision makers with complete information to design more effective interventions.

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APPENDIX 1. GREY LITERATURE DOCUMENTS

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APPENDIX 2. KEY INFORMANT INTERVIEW RESPONDENTS

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Olivier Kakesa	PMM SME Advisor	Cameroon
Patrick Konwloh	Health Information Systems Director	Liberia
Celestin Kouambeng	PMM SME Advisor	Niger
Yahaya Mahamadou	Chef de Division Informatique et Base de Données	Niger
Jahdoul Nkongolo	PMM Senior SME Specialist	Democratic Republic of the Congo
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