

Anti-Malaria Recommendations for Sub-Saharan Africa During the COVID-19 Pandemic

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Abstract

Because of COVID-19, the vulnerable healthcare systems of many African countries have faced additional burdens. As governments divert resources towards COVID-19 efforts, researchers and international organizations have voiced concerns on how the pandemic would affect malaria incidence, especially in malaria-endemic regions. In this study, we searched relevant keywords on PubMed to systematically review the existing literature on malaria recommendations and malaria outcomes during COVID-19. Special attention was brought to the malaria recommendations in Nigeria, The Democratic Republic of Congo, and South Africa, as these three countries vary in malaria and COVID-19 incidence. We included 20 relevant publications that highlight the importance of chemoprevention, vector control, and rapid diagnostics in decreasing malaria incidence in the context of COVID-19. We also examined how malaria recommendations vary among the three countries of interest. We found that while both insecticide-treated nets and antimalarials are essential to preventing additional malaria cases, continuous supply of antimalarials is especially important in preventing hundreds of thousands of additional malaria deaths. Certain countries like South Africa still use chloroquine against *Plasmodium vivax*. Unwarranted use of chloroquine against COVID-19 not only increases chloroquine resistance but decreases supplies available against *P. vivax*. To encourage community safety and compliance, additional protection is recommended for indoor-residual spraying delivery teams and seasonal malaria chemoprevention campaign community health workers. Finally, mass drug administrations are recommended only for urban regions with low malaria endemicity, and malaria rapid diagnostic tests should be used together with COVID-19 diagnostics. Continued funding and government efforts are required to implement these recommendations and prevent additional malaria drug resistance, cases, and deaths during the COVID-19 pandemic.

Background

In 2019, 94% of the world's malaria cases occurred in the World Health Organization (WHO)-defined region of Africa, leading to 409,000 deaths (1). 67% of malaria deaths are among children under the age of 5 (1). Unfortunately, many countries in this region are now additionally facing the COVID-19 pandemic, which has the potential to severely disrupt malaria management and increase the burden of infectious diseases.

COVID-19 and malaria can be difficult to clinically diagnose without proper testing, as the two illnesses share manifestations such as myalgia, headache, fever, fatigue and difficulty breathing (2,3). These could easily be mistaken for each other if not differentiated through microscopy or molecular testing. Due to this overlap of early and general symptoms, regions where COVID-19 testing is limited or unavailable could severely underestimate the virus' incidence, with healthcare professionals choosing instead to diagnose

and treat patients for malaria (4). Similarly, malaria patients may be overlooked for malaria treatment and quarantined under the assumption of COVID-19.

Furthermore, many countries in sub-Saharan Africa have limited healthcare resources, including personnel, hospital capacity, and equipment (5). Government diversion of personnel and resources away from existing prevalent diseases to COVID-19 exacerbates the limited healthcare capacity, leading to a reduced ability to manage both non-infectious diseases and infectious diseases like malaria (5). The COVID-19 pandemic also has the potential to severely increase malaria burden in endemic countries by causing disruptions to health interventions, as was seen with the 2014-2016 Ebola outbreak in West Africa (3). A study in Guinea, for instance, showed a 24% decrease in treatment with oral antimalarial drugs and a 30% decrease in injectable antimalarial drugs in health facilities during this period (6).

Due to the 50% reduction of anti-malaria services during the Ebola crisis, another study estimated an excess malaria death rate of 48% in Guinea alone (7). If appropriate measures are not taken during the present pandemic, sub-Saharan Africa could see an increase in malaria deaths of up to 99% (8).

To date, sub-Saharan Africa has reported concerns regarding patients' difficulties accessing primary health centres (5). The Global Fund to Fight AIDS, Tuberculosis, and Malaria found in a June 2020 survey that 73% of 106 countries faced malaria program disruptions as a result of COVID-19 (9). Therefore, it is important for malaria-endemic countries to modify their public health policies to navigate both communicable diseases. The impacts of malaria and COVID-19 incidence, however, are unevenly distributed over the African continent. In this review, we explore and compare malaria recommendations and outcomes in four African countries with different malaria and COVID-19 prevalence.

South Africa - Low Malaria and High COVID-19

Malaria transmission in South Africa is concentrated around its border areas, carried in by migrant populations from neighbouring countries (10). However, malaria is also endemic to certain provinces within South Africa, namely Limpopo, Mpumalanga, and KwaZulu-Natal (10). Overall, an estimated 10% of the population, or 4.9 million people, are at risk for contracting malaria, but South Africa is on its way to eliminating malaria, as outlined in their 2019-2023 malaria strategic plan (11,12). South Africa's larger threat is COVID-19, as it faces the highest burden of COVID-19 infections among all African countries at over 1,564,000 cases as of April 17th, 2021 (12, 13). Thus, while South Africa has largely contained malaria, it faces a high burden of COVID-19 infections.

Nigeria - High Malaria and High COVID-19

Over the past several years, Nigeria's malaria burden has been devastatingly high. The World Malaria Report cites that this country alone accounted for 27% of malaria cases and 23% of malaria deaths worldwide in 2019 (1). In an effort to reduce morbidity and mortality, the WHO, alongside the RBM Partnership to End Malaria, have worked to implement effective anti-malaria strategies in the High Burden to High Impact response since 2018 (1). Unfortunately, Nigeria has also been affected by the global COVID-19 pandemic, surpassing 164,000 confirmed cases of the virus as of April 2021 (13, 14). The disease burden is likely amplified as COVID-19 was not contained before the malaria transmission season (June to October), leading to unallocated vector control equipment (15). Therefore, it is critical that the country has sufficient supplies of malaria control resources before the next transmission season.

Democratic Republic of Congo - High Malaria and Low COVID-19

The Democratic Republic of Congo (DRC) struggles with

malaria year-round, with 97% of its population living in zones where malaria transmission is stable during 8-12 months of the year (16). Malaria represents the equatorial nation's leading cause of death and illness, as well as 11% of global malaria cases. Unfortunately, the DRC is also currently combating epidemics of measles, cholera, and Ebola, alongside the newly emerging threat of COVID-19 (17,18). Until now, the reported number of COVID-19 cases in DRC (28,859 cases as of April 17th, 2021) is relatively low compared to other African nations and the rest of the world (13). However, the nation's difficult health situation, compounded by violent conflict, political instability, low funding, lacking infrastructures, and geographical remoteness, have made it extremely difficult to accurately test, isolate, and treat cases of COVID-19 in the DRC (19-21). Thus, the total number of COVID-19 cases in the country is likely underreported.

Methods

Academic papers on the malaria situation and malaria recommendations during COVID-19 were identified through a systematic literature review. An initial search was conducted on PubMed using terms (COVID-19 OR coronavirus OR CoV-2 OR CoV2) AND (malaria* OR plasmodium) AND (DRC OR "Democratic Republic of Congo" OR "South Africa" OR "Nigeria" OR Africa). The 90 English articles that resulted underwent an abstract screening for malaria and COVID-19 information. Twenty articles were included in this review because they explored malaria recommendations under COVID-19 in their results and discussion. Additional searches on Google Scholar were conducted to identify relevant publications from intergovernmental organizations, non-profit organizations, and government websites. Background information on country-specific malaria situations and on malaria recommendations were extracted by reviewing reference lists of relevant papers and WHO reports.

Results and Discussion

Using our search methods, nine sources made recommendations for vector control methods, including nine for insecticide-treated nets (22-30) and two for insecticide-residual spraying (5,30). Seven sources made recommendations for chemoprevention methods, including three for seasonal malaria chemoprevention (23,30,31), three for mass drug administration (32-34) and one for intermittent preventive treatment (35). Nine sources made recommendations for other measures, include three for rapid diagnostic testing (34-36), five for mitigating antimalarial-resistance (26,29,30,39,40) and one on preventing chloroquine and hydroxychloroquine misuse (30).

Vector Control Recommendations

Insecticide-treated nets

Deploying insecticide-treated nets (ITNs) is a highly effective

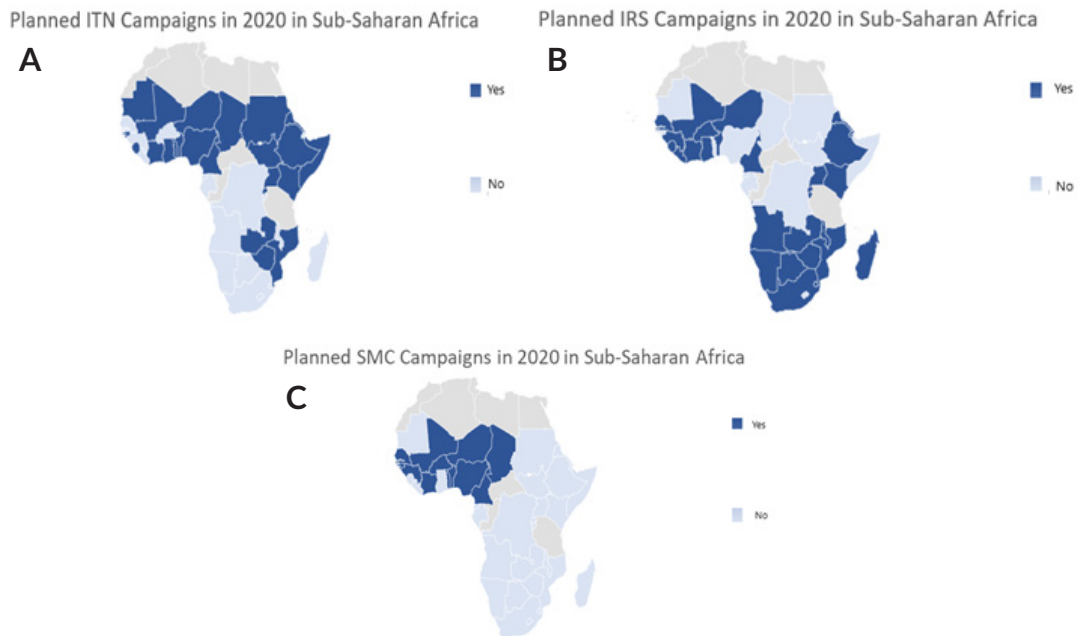


Figure 1. Distribution of anti-malaria campaigns planned for 2020 in sub-Saharan Africa. (A) Planned ITN Campaigns (B) Planned IRS Campaigns (C) Planned SMC campaigns. Source: The potential impact of health service disruptions on the burden of malaria, World Health Organization (8)

malaria prevention method which have contributed to substantial declines in malarial disease and overall mortality (41). Pyrethroid-only long-lasting insecticidal nets are the standard ITNs recommended by the WHO and are more effective than conventional ITNs which are less durable and require regular chemical retreatment (42,43). WHO recommends that LLINs be distributed through a combination of continuous distributions and free mass net campaigns, typically once every three years (22). Both mechanisms can be conducted through channels such as antenatal care, expanded programmes on immunization, and schools.

To prevent overburdening vulnerable healthcare systems with both malaria and COVID-19 cases, several papers have highlighted the need to prioritize ITN maintenance and distribution (22–30). To minimize exposure to COVID-19, the WHO recommends that rural settings with high malaria transmission be prioritized over urban regions with low malaria rates but higher risk for COVID-19 transmission (30). Twenty-seven of the 47 malaria-endemic countries in sub-Saharan Africa planned for LLIN campaigns in 2020 (Fig. 1a), resulting in a projected 228 million LLINs delivered (44). However, LLIN distribution efforts likely overlapped with COVID-19-related service disruptions (8). According to modelling by Sherrard-Smith et al., more stringent COVID-19 regulations, which will very likely disrupt ITN supply chain and distribution, will increase malaria deaths in sub-Saharan Africa (23). Similarly, Weiss et al. predict that

halting ITN mass distribution campaigns and reducing regular distribution by 25% alone would lead to 15 million additional malaria cases and 29,000 additional deaths (29). Weiss et al. found that disruptions to mass ITN distribution campaigns are more detrimental to malaria efforts than disruptions in routine ITN distributions. This demonstrates the importance of ITN campaigns to achieving universal ITN coverage not only during baseline years but also co-occurring health crises (29). As of September 2020, five countries with scheduled mass ITN distribution campaigns reported COVID-19-related delays. In the first half of 2020, 90.7 million ITNs were procured; this figure is lower compared to the average quarterly net procurement in 2019 of 53 million nets (45).

According to data from The Alliance for Malaria Prevention, Nigeria distributed 17.4 million of the 22.7 million ITN nets in the 2020 mass distribution plans (44). However, only 2.5 million nets were distributed in the first half of the year, implying that malaria service disruption may have overlapped with malaria transmission season, which varies slightly across the nation and peaks in September (45). Despite ITN distribution shortcomings, modelling by WHO shows that even with no ITN mass distribution and a 75% reduction in continuous distribution in 2020, Nigeria will experience a 4% increase in malaria cases and 4.3% increase in deaths. The limited impacts of ITN service disruption may be due to the continuous annual supply of ITNs from international donors. However, this may change soon, as the ITN deficit is projected

to increase in 2021 with the number of ITNs supplied by the President's Malaria Initiative cut in half (46). As COVID-19 continues to infect millions 2021, the increasing disruption to ITN services could cause greater malaria disease and mortality.

Meanwhile, the DRC distributed 29.4 million nets in 2020, slightly more than in 2019 (44). The DRC also benefited from a surplus of over 3 million nets in 2020, although this surplus is projected to decrease in the upcoming years (46). No ITN campaigns were planned for South Africa in 2020 and no data has been published on the number of nets distributed in South Africa.

Insecticide-Residual Spraying Recommendations

Insecticide-residual spraying (IRS) is a critical component of malarial control and, along with ITNs, accounts for 60% of global investment in malaria control (47). IRS involves the application of a long-lasting residual insecticide onto the walls, ceilings, or any surface that mosquito vectors may rest on (47). Spraying occurs one to two times a year, usually before peak transmission season. To be effective, IRS applications must be high-coverage such that >85% of all surfaces within a community are sprayed (47).

Early in the pandemic, WHO noted that several IRS campaigns have been suspended due to COVID-19 and urged countries to continue core malaria control interventions, including IRS (5). Suspension of IRS campaigns may put vulnerable populations like children and pregnant women at risk and further burden the healthcare system with malaria patients (48). Thus, in April 2020, WHO urged for the acceleration of IRS campaigns in sub-Saharan Africa before COVID-19 cases soared, highlighting the window of opportunity to ensure malaria protection through IRS while minimizing the risk of COVID-19 transmission to spray teams (48). Additionally, WHO recommended that several protection measures be taken during spraying to ensure the safety of both the IRS delivery team and the IRS recipients (30). Key recommendations include increasing handwashing stations available at operation sites, sending daily reminders to spray teams to take COVID-19 precautions, performing morning health checks and temperature checks for spray team members, and disinfecting commonly touched surfaces (30).

Consequent to the WHO recommendations, 33 countries in sub-Saharan Africa (Fig. 1b) reported an intent to continue IRS rounds for 2020 (8). However, of the three countries of particular interest in this paper, only South Africa decided to continue IRS campaigns.

The impact of COVID-19 on IRS campaigns is apparent at several stages of the IRS management cycle. This cycle consists of 4 general phases: identification of at-risk populations, pre-seasonal planning and procurement, seasonal implementation of IRS, and end of season evaluation (47). IRS

campaigns faced financial and technical difficulties during the pre-seasonal planning stage, such as the cost of additional protective equipment, slower equipment deliveries, and the prioritisation of producing medical equipment for COVID-19 (26). Furthermore, additional challenges were faced during the seasonal implementation of IRS such as decreased community acceptance of IRS for fear of viral contagion and difficulty mobilizing the spray team due to social distancing and movement restrictions (45).

Chemoprevention Recommendations

Seasonal Malaria Chemoprevention

Seasonal malaria chemoprevention (SMC) refers to the administration of antimalarial treatments to young children in regions where malaria is seasonal and highly transmissible during the rainy season. As per guidelines released by the WHO in 2012, children aged 3-59 months should receive monthly treatments of amodiaquine plus sulfadoxine-pyrimethamine (AQ+SP) during the high transmission season (39). Yearly SMC campaigns are highly recommended in the Sahel sub-region of Africa, as they experience a 3-4-month peak malaria season. In 2019, 13 countries implemented SMC, leading to 21.5 million children receiving at least one treatment dose (1). These campaigns are largely beneficial to the countries in which they are implemented, as these treatments have been shown to provide 75% protection, thus greatly decreasing malaria-related morbidity and mortality in children under 5 (1,49).

During the COVID-19 pandemic, where adequate resources for malaria prevention and treatment may be disrupted, SMC campaigns can play a crucial role in reducing excess malaria cases and deaths. One study by Sherrard-Smith et al. predicted that, in a scenario where COVID-19 is mitigated and where long-lasting insecticidal net distribution along with malaria case management are suspended, continuing scheduled SMC implementation could reduce the number of excess malaria deaths by 40% (23). The authors also noted that, in this same scenario, providing SMC for children up to 10 years or 15 years of age, rather than only to those up to 5 years of age, would lead to 13 500 or 22 500 fewer deaths respectively (23).

The WHO recognizes this intervention as highly important in the Sahel and has therefore recommended that the 13 countries with scheduled SMC campaigns in 2020 proceed with them (Fig. 1c). Some countries planned to expand their SMC coverage by age or by geography, and the WHO has encouraged them to do so when sufficient commodities are available, so long as appropriate training and supervision is feasible (30). The WHO also outlines general guidelines for community health workers who administer the treatments, such that campaigns can occur safely and in line with COVID-19 restrictions. These include implementing daily hygiene reminders and health checks for community health

workers, organizing campaigns in a manner that allows minimal gathering and physical contact, and limiting non-essential in-person activities (30). The RBM Partnership to End Malaria also strongly recommended SMC during the COVID-19 pandemic and provided a detailed guide for adapting programs to the circumstances during their planning, supplying, community engagement, training, antimalarial administration, and monitoring stages (31).

Of the four countries of focus in our review, Nigeria is the only one located in the Sahel and, therefore, the only one that places a heavy focus on SMC for malaria control. Nigeria implements yearly campaigns and, as per WHO recommendations, has completed its scheduled 2020 programs (24,50). Data on the impact of this achievement as it relates to malaria mortality and morbidity is not yet available, but the completion of Nigerian SMC campaigns is promising and suggests the feasibility of similar strides in other countries in the region. According to recent reports from the U.S. President's Malaria Initiative, Nigeria is also presently on track to have a sufficient supply of treatments for its target population in 2021, an encouraging sign for campaigns during the remainder of the pandemic (46).

Mass drug administration

Mass drug administration (MDA) is a chemoprevention strategy which involves the systematic distribution of antimalarial drugs to every member of a population, whether infected or not, within a specified, intentional timeframe. Usually reserved for isolated endemic areas or non-isolated low-endemic areas to avoid reintroduction of the malarial parasite after treatment, MDA can occasionally be employed to combat an epidemic of malaria and alleviate overburdened health systems (32). However, concerns about the difficulty of fully administering the treatment to entire populations were raised, as it could be opening the door for greater drug resistance (33); thus, MDA is only recommended in very specific instances of near-elimination and complex emergencies (34).

MDA is also more effective in low-transmission areas, such as urban areas, since transmission is highest in forested areas (33). These include the remote and sylvan regions of several sub-Saharan nations such as the DRC, the country with the largest closed forest area on the continent (51). In these regions, MDA could lose its effectiveness, both clinically and financially. Indeed, past studies using MDA in high transmission areas showed an early decrease in incidence after mass administration, followed by a later increase in incidence (52). Thus, it is recommended that the use of MDA be paired with other malaria prevention interventions, as their effectiveness alone in regions of moderate-to-high transmission remains unclear (32).

Nevertheless, just as MDAs were deployed in 2014 to avoid overwhelming health facilities during the Ebola outbreak,

they could again be used to fill the gaps in malaria treatment as healthcare turns its attention to the ongoing COVID-19 pandemic (53). If ever MDAs are to be used during the COVID-19 pandemic, recommendations include investing in community engagement, as MDA typically requires the compliance of >80% of a population to obtain observable results (33). This compliance is all the more crucial in sub-Saharan Africa, where transmission is high and MDA's effectiveness could be jeopardized.

Intermittent preventive treatment

Intermittent preventive treatment (IPT) is another form of malarial chemoprevention and refers to the administration of a full course of an antimalarial drug, usually sulfadoxine-pyrimethamine, to an entire category of asymptomatic individuals repeatedly over a determined period of time (32). It is distinguished according to the population of interest, identified as IPT_p when administered to pregnant women, IPT_i when administered to infants, and IPT_{sc} in school-aged children. Pregnant women are at higher risk of malarial infection due to a decreased immune memory of malaria, as well as the Plasmodium parasite's targeted attack on the placenta (32). For this reason, IPT_p is a crucial malaria prevention tool, and the WHO recommends IPT_p treatment for all expectant mothers as early as possible during the second trimester of pregnancy, and at least 3 times over the course of her pregnancy (35).

Additionally, IPT must remain an option available for paediatric use in order to prevent malaria morbidity and mortality; in studies conducted in Senegal and the Gambia, IPT in infants and children was found to decrease overall child mortality by 40% (54). Even in areas where resistance is emerging and quintuple or sextuple mutant strains of malaria are prevalent, the WHO recommends to continue administering these drugs (35,55). For these populations, IPT should continue to be administered as necessary during the COVID-19 pandemic, despite the possibility of resistance to sulfadoxine-pyrimethamine (35).

Other Recommendations:

Rapid Diagnostic Tests

Rapid diagnostic tests, or RDTs allow the detection of malarial antigens in human blood without the need for microscopy or advanced diagnostic tools. They present relative sensitivity and specificity, often making them a method of choice for sub-Saharan malaria interventions (56). Due to their antigenic nature, however, RDTs tend to fail to recognize the distinction between active malarial infections and recently overcome infections (57).

Nonetheless, they remain the most widely used tool for the diagnosis of malaria in sub-Saharan Africa, and recommendations for their use during the COVID-19 pandemic note that their production should not be foregone in favour of COVID-19 RDTs. Spare production capacity of

malaria and HIV tests could allow for the production of SARS-CoV-2 RDTs in cassettes, the format preferred by healthcare workers, with only minor modification to production lines, thus mitigating the damage of radically pulling funds or manufacturing demand away from malarial production (36,38,56). As the foremost tool for malaria detection, mRDTs are also recommended to be coupled with COVID-19 screening to avoid misdiagnosis, presumptive treatment, associated costs, and increased resistance to antimalarial drugs (37).

Antimalarials

Antimalarials encompass a broad group of medications that treat or prevent malaria. Most malaria-endemic countries administer a select few treatments depending on malaria severity, prior treatment failure, or pregnancy status. The WHO recommends artemisinin-based combination therapies (ACT) as a first-line treatment against uncomplicated malaria (58). Artemisinin resistance is an emerging issue in malaria-endemic countries and results from inadequate treatment practice, widespread use of artemisinin monotherapies, and poor patient adherence (59).

According to the literature on recommended malaria interventions during the COVID-19 pandemic, access to antimalarial drug treatments remains a priority. Notably, reducing antimalarial drug coverage could worsen the malaria situation, especially by increasing malaria deaths, more so than decreasing ITN coverage across malaria-endemic countries. Weiss et al. predict that a 75% reduction in antimalarial drug coverage would result in an additional 27.1 million cases and 328,700 deaths (29). Antimalarials are particularly effective because they not only prevent transmission by infected individuals but also reduce mortality by minimizing the number of uncomplicated cases that develop into critical ones over time. Modelling done by the WHO also shows that preventing additional malaria deaths during COVID-19 strongly depends on antimalarials. If access to effective antimalarials is reduced by 75%, Nigeria, DRC and South Africa could experience a 93.4%, 88.1%, and 135% increase in malaria deaths, respectively. The importance of antimalarials, compared to ITNs, was demonstrated in every country included in the WHO analysis. Additional reports recommend that for regions facing RDT stockouts and shortages of health workers to perform malaria testing, interventions should include presumptive malaria treatment. As such, suspected malaria cases would be treated with antimalarials in the absence of diagnostic confirmation (30).

However, presumptive malaria treatment is not recommended when malaria testing capacities have not faced serious reductions. In a study on COVID-19 patient characteristics admitted to Clinique Ngaliema in the DRC, 44% of patients reported receiving malaria treatment before hospitalization, raising concerns about antimalarial overuse (4). In malaria-

endemic countries such as the DRC and Nigeria, the WHO also highlights that it is important for suspected malaria patients to receive early treatment with effective antimalarials despite the risks of visiting health facilities during COVID-19 (30). Artemisinin-based therapies, which have been proposed for COVID-19 treatment, have not been clinically proven to be effective against SARS-CoV-2 and as such should not be used for COVID-19 (40).

In South Africa, it has been recommended that hospitals stock intravenous artesunate for severe malaria cases to reduce the demand on critical care beds in an overwhelmed healthcare system (26). For patients with mild COVID-19 infection and uncomplicated malaria, Raman et al. recommend a standard weight-based artemether-lumefantrine treatment; for severe malaria cases, the authors recommend IV artesunate (40). Both suggestions align with standard antimalarial policies in South Africa.

Preventing Chloroquine and Hydroxychloroquine misuse

Once widely used for the WHO's global malaria eradication campaign, chloroquine is generally not administered for *P. falciparum* infections today due to widespread drug resistance. However, it is still used against *P. vivax*, *P. ovale*, and *P. malariae* in certain countries (60).

Currently, there is indiscriminate promotion of chloroquine (CQ) and hydroxychloroquine (HCQ), a CQ derivative, as COVID-19 treatments. While CQ and HCQ showed activity against SARS-CoV-2 in vitro, randomized clinical trials comparing CQ/HCQ to standard supportive therapy did not demonstrate additional benefit for using either drug (61). The high demand for off-label use of CQ and HCQ has led to growing concerns of falsified CQ and HCQ circulating in African markets, which generally have weak drug monitoring systems (62,63). Indiscriminate use of CQ and HCQ has not only led to fatal-overdoses but could increase chloroquine-resistance and affect drug availability in countries like South Africa, which still administers chloroquine against *P. vivax* infections (64). The WHO encourages countries with endemic *P. vivax* to procure additional chloroquine medications in case of supply-side shortages (30).

Conclusion

Even with resource shortages and concerns of COVID-19 transmissions, the literature on the synergistic epidemic of malaria and COVID-19 supports continued efforts against malaria in Africa. Recommendations and malaria interventions vary based on the disease burden characteristics of each country (Table 1). MDA were recommended only for urban areas with low malaria endemicity. Additionally, off-the-shelf CQ and HCQ use are especially problematic in countries, such as South Africa, that still use these antimalarials against *P. vivax*. Inappropriate deployment of either MDA against

malaria or CQ/HCQ against COVID-19 raises concerns about increased drug resistance.

For countries like Nigeria and the DRC that heavily rely on international funding to combat malaria, it is essential that supply-side shortages do not occur. Over the next two

years, Nigeria and the DRC are projected to face shortages in intravenous artesunate, ITNs, and RDTs (46). Western funding initiatives and international organizations should continue to provide malaria support during the COVID-19 pandemic in order to prevent millions of additional malaria cases.

Table 1. Summary of malaria recommendations and outcomes in sub-Saharan Africa during the COVID-19 pandemic

	Recommendation	Outcome
ITN	<p>ITN distribution should be prioritized, in particular mass distribution campaigns</p> <p>Emphasize the importance of continued ITN use to public as COVID-19 is expected to reduce non-compliance rates</p>	<p>27/46 malaria-endemic countries in sub-Saharan Africa planned for LLIN distribution in 2020, resulting in 228 million LLINs being delivered</p> <p>As of September 2020, 5 countries with scheduled mass ITN distributions reported COVID-19 delays</p> <p>ITN deficit is projected to increase in 2021 potentially leading to more malaria cases and mortality in the upcoming year</p> <p>PMI ITN distribution expected to drop by half</p>
IRS	<p>In April 2020, WHO urged for the acceleration of IRS campaigns to be completed before COVID-19 cases rose in Africa</p> <p>WHO recommended several protection measures during spraying, including increasing handwashing stations, sending daily reminders to spray teams about COVID-19 precautions, and disinfecting commonly-touched surfaces</p> <p>Additional efforts to raise public awareness is crucial for IRS campaigns to be successful</p>	<p>33 sub-Saharan African countries reported an intent to continue IRS rounds in 2020</p> <p>Of the four countries of focus, only South Africa continued IRS campaigns</p> <p>IRS campaigns faced additional difficulties this cycle, including increased campaign cost, difficulties acquiring equipment, difficulties mobilizing sprayers, and decreased community acceptance</p>
SMC	<p>WHO and RBM Partnership to End Malaria recommended the continuation of SMC campaigns in 2020, especially in the Sahel region, where SMC is particularly effective</p> <p>WHO outlined several general guidelines for community health workers administering SMC, including ensuring campaigns occur safely and in line with COVID-19 restrictions, minimizing gatherings and physical contact, and limiting non-essential in-person activities</p>	<p>Of the countries focused on in this study, only Nigeria is located in Sahel and relies on SMC</p> <p>Nigeria completed its scheduled 2020 program</p> <p>Nigeria is also on track to have sufficient supplies for the 2021 SMC cycle</p>
MDA	<p>MDA is most effective in isolated areas or low-endemic areas, which does not apply to most African countries</p> <p>MDAs may be used during the COVID-19 pandemic to fill in the gaps of malaria prevention</p>	

	Recommendation	Outcome
IPT	<p>IPT use is highly recommended to continue for pregnant women and children, populations that are particularly susceptible to malaria</p> <p>Areas with emerging resistance to sulfadoxine-pyrimethamine should continue IPT use regardless</p>	
RDT	<p>Malaria RDT production should not be foregone in favour of COVID-19 RDT production</p> <p>Malaria RDT should be coupled with COVID-19 screening to prevent misdiagnosis</p>	
Antimalarial drugs	<p>Antimalarials are essential to preventing malaria deaths</p> <p>There should not be indiscriminate use of antimalarials such as artemisinin and chloroquine against COVID-19</p> <p>If malaria testing cannot be performed, presumptive treatment may be performed in malaria-endemic countries</p>	

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