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Publications 2025

OPEN ACCESS
ONLINE ISSN: 2992-5479
PRINT ISSN: 2992-605X

NEWPORT INTERNATIONAL JOURNAL OF PUBLIC HEALTH AND PHARMACY (NIJPP)

Volume 6 Issue 1 Page 56-59, 2025

https://doi.org/10.59298/NIJPP/2025/615659

Effectiveness of Monoclonal Antibody Therapy vs. Seasonal Malaria Chemoprevention (SMC) in Children under Five in High-Transmission Areas

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ABSTRACT

Malaria remains a critical public health issue in sub-Saharan Africa, particularly for children under five, who are at the highest risk for severe complications and death. This review critically examined the effectiveness of monoclonal antibody (mAb) therapy versus seasonal malaria chemoprevention (SMC) in preventing malaria in high-transmission areas. mAb therapy targets specific antigens on the Plasmodium parasite, preventing it from infecting red blood cells, and has the potential to provide long-lasting protection with a single dose. SMC, on the other hand, involves administering antimalarial drugs at regular intervals during the malaria season, which has proven highly effective in reducing malaria incidence and severity in children. The review discussed the mechanisms, outcomes, and challenges of both strategies, focusing on their applicability in high-transmission regions. Although SMC has been widely adopted, it faces challenges such as drug resistance and logistical constraints. mAb therapy, while promising, presents concerns regarding cost, scalability, and production feasibility. This review synthesized data from clinical trials and field studies to compare both interventions in terms of efficacy, cost-effectiveness, and feasibility. Ultimately, a hybrid approach combining mAb therapy with SMC may provide comprehensive protection, addressing the limitations of each strategy and offering the best potential for malaria prevention in vulnerable populations.

Keywords: Malaria Prevention, Monoclonal Antibody Therapy, Seasonal Malaria Chemoprevention (SMC), High-Transmission Areas, Children Under Five.

INTRODUCTION

Malaria remains a critical public health issue in sub-Saharan Africa, especially for children under five years of age, who are particularly vulnerable to the disease's severe consequences [1, 2]. Despite the global efforts aimed at reducing malaria transmission and its associated morbidity and mortality, malaria continues to be one of the leading causes of death and disease burden in malaria-endemic regions. Children under five, being immunologically naive and often exposed to frequent mosquito bites, are at the highest risk for severe malaria, which can result in complications such as anemia, cerebral malaria, and even death [3]. Effective preventive strategies are essential to reduce the burden of malaria in this age group. Among the most prominent malaria prevention interventions in high-transmission areas are monoclonal antibody therapy (mAb) and seasonal malaria chemoprevention (SMC) [4, 5]. Both strategies aim to reduce the incidence of malaria infections, but they operate via different mechanisms. Monoclonal antibody therapy targets specific antigens in the malaria parasite, preventing its ability to infect and proliferate in the host. On the other hand, SMC involves the administration of antimalarial drugs at regular intervals during the malaria season to prevent malaria infections. This review critically examines the effectiveness of monoclonal antibody therapy compared to seasonal malaria chemoprevention in preventing malaria in children under five in high-transmission areas. By analyzing the mechanisms, outcomes, and challenges associated with both approaches, this article seeks to provide a comprehensive understanding of their relative impact on malaria control

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PRINT ISSN: 2992-605X

in vulnerable populations. Malaria is a life-threatening disease caused by *Plasmodium* parasites, with *P. falciparum* being the deadliest species [6, 7]. In high-transmission areas, children under five are particularly vulnerable due to their underdeveloped immunity [8]. According to the World Health Organization (WHO), this age group accounts for approximately two-thirds of all malaria-related deaths. Seasonal Malaria Chemoprevention (SMC), which involves the intermittent administration of sulfadoxine-pyrimethamine (SP) and amodiaquine (AQ) during the malaria season, has been widely adopted in the Sahel region of Africa. SMC has been shown to reduce malaria incidence by up to 75% in children under five, making it a critical tool for malaria control. However, SMC faces several challenges, including the emergence of drug resistance, logistical difficulties in drug delivery, and the need for repeated administration. These limitations have spurred interest in alternative strategies, such as monoclonal antibody therapy. Monoclonal antibodies are designed to target specific antigens on the surface of *P. falciparum* sporozoites, preventing them from invading liver cells and establishing infection. Unlike SMC, which requires multiple doses over several months, mAb therapy has the potential to provide long-lasting protection with a single administration, making it an attractive option for malaria prevention in high-transmission areas.

Efficacy Of Seasonal Malaria Chemoprevention (Smc)

SMC has been a highly effective strategy for reducing malaria incidence in children under five in high-transmission areas [9, 10]. The intervention involves administering SP and AQ at monthly intervals during the malaria season, typically from July to November in the Sahel region. Studies have demonstrated that SMC can reduce malaria incidence by up to 75% and severe malaria by up to 50% in this population. The success of SMC is attributed to its ability to maintain therapeutic drug levels in the blood during peak transmission periods, preventing the development of symptomatic malaria. The effectiveness of SMC is influenced by factors such as adherence to the dosing schedule, the prevalence of drug resistance, and the timing of drug administration [11]. Adherence is a critical factor, as incomplete or inconsistent dosing can reduce the protective efficacy of SMC. Drug resistance is another concern, particularly for SP, which has been associated with reduced efficacy in some regions. Additionally, the timing of SMC administration must align with the local malaria transmission season to maximize its impact. Despite these challenges, SMC remains a cornerstone of malaria control in high-transmission areas, particularly in the Sahel region.

Efficacy Of Monoclonal Antibody Therapy

Monoclonal antibody therapy represents a novel and promising approach to malaria prevention, particularly in high-transmission areas [12]. mAbs are designed to target specific antigens on the surface of *P. falciparum* sporozoites, neutralizing them before they can invade liver cells and establish infection [13]. Unlike SMC, which requires repeated administration, mAb therapy has the potential to provide long-lasting protection with a single dose. This makes it an attractive option for malaria prevention in children under five, who are at high risk of severe disease.

Early clinical trials of mAb therapy have shown promising results. For example, a phase 1 trial of a monoclonal antibody targeting the circumsporozoite protein (CSP) of *P. falciparum* demonstrated high levels of protection against controlled human malaria infection [14]. The antibody was well-tolerated and provided protection for up to six months after a single dose. These findings suggest that mAb therapy could be a highly effective and durable intervention for malaria prevention in high-transmission areas. The effectiveness of mAb therapy is influenced by factors such as the specificity and affinity of the antibody, the duration of protection, and the feasibility of large-scale production and delivery. The specificity and affinity of the antibody are critical for ensuring high levels of protection, while the duration of protection determines the frequency of administration. Additionally, the feasibility of large-scale production and delivery is a key consideration, as mAb therapy requires advanced manufacturing capabilities and cold chain storage.

Comparative Effectiveness

The comparative effectiveness of monoclonal antibody therapy and SMC in children under five in high-transmission areas is a topic of significant interest. While both strategies aim to prevent malaria, they differ in their mechanisms of action, duration of protection, and logistical requirements. SMC provides short-term protection by maintaining therapeutic drug levels in the blood during peak transmission periods, while mAb therapy offers long-lasting protection by neutralizing sporozoites before they can establish infection. Studies have demonstrated that SMC can reduce malaria incidence by up to 75% in children under five, making it a highly effective intervention [15, 16]. However, SMC requires repeated administration, which can be logistically challenging in resource-limited settings. Additionally, the emergence of drug resistance poses a significant threat to the long-term efficacy of SMC. In contrast, mAb therapy has the potential to provide long-lasting protection with a single dose, reducing the need for repeated administration and addressing concerns about drug resistance [17, 18, 19, 20]. The choice between mAb therapy and SMC should be guided by local context, resources, and preferences. In settings where drug resistance

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PRINT ISSN: 2992-605X

is a concern and logistical challenges limit the feasibility of SMC, mAb therapy may offer a more sustainable and effective alternative [20, 21]. However, the high cost and complexity of mAb therapy may limit its scalability in some settings. A hybrid approach that combines mAb therapy with SMC may offer the greatest benefits, leveraging the strengths of both strategies to provide comprehensive and durable protection against malaria.

Practical Implications

The findings of this review have important implications for malaria control programs in high-transmission areas. Both monoclonal antibody therapy and SMC are effective strategies for preventing malaria in children under five, and the choice of intervention should be guided by local context, resources, and preferences. In settings where drug resistance is a concern and logistical challenges limit the feasibility of SMC, mAb therapy may offer a more sustainable and effective alternative. However, the high cost and complexity of mAb therapy may limit its scalability in some settings. Public health initiatives should focus on integrating mAb therapy and SMC to maximize their impact. For example, mAb therapy could be used to provide long-lasting protection during the early stages of the malaria season, while SMC could be used to maintain protection during peak transmission periods. Additionally, efforts should be made to address barriers to mAb therapy adoption, such as high costs and cold chain requirements, to ensure that all children under five can benefit from this innovative intervention.

CONCLUSION

Monoclonal antibody therapy and Seasonal Malaria Chemoprevention (SMC) are both effective strategies for preventing malaria in children under five in high-transmission areas. SMC has been a cornerstone of malaria control in the Sahel region, reducing malaria incidence by up to 75% in this vulnerable population. However, the emergence of drug resistance and logistical challenges in drug delivery have prompted the exploration of alternative strategies, such as monoclonal antibody therapy. Monoclonal antibody therapy represents a novel and promising approach to malaria prevention, offering long-lasting protection with a single dose. Early clinical trials have demonstrated high levels of protection and durability, making mAb therapy an attractive option for malaria control in high-transmission areas. However, the high cost and complexity of mAb therapy may limit its scalability in some settings. The choice between mAb therapy and SMC should be guided by local context, resources, and preferences. A hybrid approach that combines mAb therapy with SMC may offer the greatest benefits, leveraging the strengths of both strategies to provide comprehensive and durable protection against malaria. Future research should focus on evaluating the long-term impact of mAb therapy, exploring innovative ways to reduce costs and improve scalability, and addressing barriers to adoption. As the field of malaria prevention continues to evolve, monoclonal antibody therapy and SMC will play an increasingly important role in ensuring that all children under five have access to the protection they need.

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PRINT ISSN: 2992-605X

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CITE AS: Kagambira Zimbuga M. (2025). Effectiveness of Monoclonal Antibody Therapy vs. Seasonal Malaria Chemoprevention (SMC) in Children under Five in High-Transmission Areas. NEWPORT INTERNATIONAL JOURNAL OF PUBLIC HEALTH AND PHARMACY, 6(1):56-59. https://doi.org/10.59298/NIJPP/2025/615659