Editorial

ANNALS OF MEDICINE & SURGERY

OPEN

The potential of smart inhaler for asthma management in Sub-Saharan Africa

Emmanuel Kokori, MBBS[a], Gbolahan Olatunji, MBBS[a], Mubarak Jolayemi Mustapha, MBBS[a], Praise Fawehinmi, MBBS[f], Adrian Onyia, MBBS[b], Oluwatobi Omoworare, MBBS[c], Olufemi Akinmeji, MBBS[d], Samuel Solomon, MBBS[a], Ayobami Olafimihan, MBBS[g], Damilola Ologbe, MBBS[h], Nicholas Aderinto, MBBS[e,*]

Introduction

Asthma, affecting 262 million people globally, according to the WHO[1], is a particularly pressing concern in sub-Saharan Africa (SSA). Alarmingly, over 80% of asthma-related deaths occur in this region[2], signalling a significant shortfall in current asthma management. Despite the global goal of ensuring a satisfactory quality of life and optimal symptom control[2], the 2018 World Asthma Report exposes a substantial prevalence of uncontrolled asthma in SSA, pointing to a regional deficiency in asthma care[3,4].

The variables contributing to inadequate asthma control in SSA are diverse, ranging from urbanisation challenges to a lack of public education and understanding of asthma[5,6]. Notably, patient-related factors such as poor awareness, rejection of inhaler medication, and concurrent allergic rhinitis pose additional barriers to effective asthma care[2]. Although asthma is underdiagnosed in SSA[7], literature addressing the specific challenges and opportunities within this unique context remains limited[8]. Existing studies often need a comprehensive exploration of socio-economic, environmental, and healthcare access factors contributing to uncontrolled asthma[7,8].

Moreover, while smart inhaler technology holds promise globally, its potential impact on SSA requires a dedicated exploration[9]. Understanding smart inhalers' feasibility, acceptability, and effectiveness within SSA's socio-cultural and healthcare infrastructure is critical for evidence-based interventions. This paper seeks to fill this gap by reviewing the potential advancement of asthma management in SSA by applying smart inhaler technology.

Evolution of inhaler technology

In asthma treatment, inhaled therapy has been a pivotal approach for over 50 years, with its efficacy recognised as early as the 20th century[10]. The popularity of inhaled therapy surged in the 20th century with the introduction of pressurised metered dose inhalers (PMDIs), marking a milestone in delivering therapeutic agents for airway diseases[11]. Inhalation, the most preferred and effective route for anti-asthma and chronic obstructive pulmonary disease (COPD) medications, ensure prompt onset of action and the advantage of smaller, yet efficacious, doses[11]. Over time, inhaler technology has evolved, introducing various devices tailored to achieve optimal drug delivery.

Traditional inhalers fall into three primary categories: metered dose inhalers (MDIs), nebulisers, and dry powder inhalers (DPI). The development of dry powder inhaler technology in 1971 by Bell and colleagues provided a notable alternative to metered dose inhalers[10]. Unlike traditional inhalers requiring synchronisation of inhalation and drug administration, dry powder inhalers operate on an "inspiratory-dependent" technology, minimising drug deposition in the oropharynx, a common challenge with metered dose inhalers[12].

Soft mist inhalers (SMIs), a non-pressurised type of MDI, offer a unique advantage with a prolonged mist duration compared to aerosol counterparts. This prolongation reduces the need for precise synchronisation of inhalation and drug administration, contributing to successful inhalation[13]. Despite the advancements, challenges persist with pressurised MDIs, including difficulties in synchronisation, incomplete drug delivery to the lungs, and the need for rigorous patient training[11]. Nebulisers, utilising ultrasonic and vibrating mesh technologies, present alternative options for managing asthma. Vibrating mesh nebulisers, while offering precision and portability, demand regular maintenance due to their intricate design[14].

Smart inhalers in SSA

In resource-constrained settings, the challenge of maintaining drug adherence persists, often leading to patients being lost to follow-up[3]. However, the introduction of smart inhalers marks a transformative shift, empowering patients to participate actively in their healthcare and providing timely updates to overseeing physicians, thereby enhancing healthcare outcomes[15].

Smart inhalers offer a spectrum of functionalities, ranging from simple monitoring of usage times to advanced features such as environmental trigger detection[4]. Their primary advantage

[a]Department of Medicine and Surgery, University of Ilorin, Ilorin, [b]College of Medicine, University of Nigeria, Nsukka, [c]Department of Medicine and Surgery, Lagos State University College of Medicine, Lagos, [d]Department of Medicine and Surgery, Olabisi Onabanjo University Teaching Hospital, Ogun,, [e]Department of Medicine and Surgery, Ladoke Akintola University Teaching Hospital, Ogbomoso, Nigeria, [f]Southern Illinois University Edwardsville, Edwardsville, [g]John H. Stroger Jr Hospital of Cook County, Chicago, IL and [h]William Harvey Hospital, Kennington Rd, Willesborough, Ashford, Kent, UK

Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

*Corresponding author. Address: 20152, PMB 5000. Tel.: +234 816 772 4987. E-mail: Nicholasoluwaseyi6@gmail.com (N. Aderinto).

Annals of Medicine & Surgery (2024) 86:2408–2410

Received 17 January 2024; Accepted 19 March 2024

Published online 4 April 2024

http://dx.doi.org/10.1097/MS9.0000000000002009

lies in objectivity, enabling unbiased assessments of inhaler use patterns and identifying non-adherence, distinguishing between intentional and unintentional lapses[5]. These devices contribute to an improved quality of life for patients, fostering bronchospasm control and promoting therapy compliance [36]. Real-time data empower patients to manage symptoms actively, facilitating informed discussions with healthcare providers[16].

Studies have shown how asthma patients optimise their care with smart inhalers[16,17]. Respondents frequently note that these devices instil a sense of accountability for their medical conditions, making them active participants in their care. This heightened patient involvement aligns with the potential development of patient-adjusted care, enabling individuals to tailor care routines to their personalities, thereby enhancing long-term adherence[15]. Smart inhalers are pivotal in improving adherence through reminders and cues[7]. Studies indicate that patients receiving reminders exhibit higher drug adherence rates, particularly among children[8,15]. Real-time feedback and reports from healthcare providers further enhance adherence, as demonstrated in trials such as the E-Monitoring of Asthma Therapy to Improve Compliance in Children (e-MATIC) and the STAAR research[18].

Insights into inhaled corticosteroid use suggest that adjustable administration of steroids can be as beneficial as regular maintenance doses, especially in mild to moderate asthma[19]. This signals a potential shift toward anti-inflammatory reliever therapy, potentially replacing short-acting beta-agonists as a guideline-recommended treatment for mild asthma[20].

The data from treatment monitoring through smart inhalers prove invaluable for optimising care in patients with chronic obstructive respiratory diseases[14]. However, achieving this optimisation necessitates a collaborative effort involving the health sector, the ICT department, and policy-making bodies[13]. Despite potential challenges in acquiring smart inhalers in low-income SSA countries, the anticipated long-term return on investment, including reduced hospital admissions and improved clinical stability, suggests potential cost-effectiveness[14]. Beyond adherence, smart inhalers offer insights into inhalation behaviour, with models like INCA identifying inaccuracies through audio recordings[18]. Emerging technologies integrate environmental triggers with patient location, predicting the likelihood of exacerbations and promoting proactive management[20].

Challenges and future directions

While compelling evidence supports the safety and efficacy of virtual health self-directed therapies for asthma, integrating these innovations into daily routines remains limited, particularly in impoverished regions where accessibility to such gadgets is a significant hurdle[3]. The management of diseases is multifaceted, influenced by factors such as the availability of healthcare staff, salaries, education levels, medication accessibility, family behaviours, and the understanding of the illness. Regional variations, such as air contamination and inadequate healthcare amenities, can alter patient perceptions and hinder effective asthma management. Despite the myriad advantages of virtual healthcare, its acceptance is still budding in several SSA nations compared to other countries[4]. Successful adoption depends on uninterrupted power supply, reliable telecommunication services, and internet access. Acceptance of smart inhalers hinges on the understanding and endorsement of key stakeholders, including healthcare management, health authorities, and professionals. However, inadequate funds allocated for healthcare in developing countries pose a significant obstacle to integrating these modern treatments, as patients may refrain from available care due to deep-rooted impressions of illnesses.

Recommendations from various studies in low-income countries propose solutions. International health bodies should organise training sessions and workshops to enlighten health professionals and stakeholders about implementing virtual health in Africa, emphasising its potential to elevate healthcare standards. Governments can incentivise using smart inhalers by reducing customs duties on e-health and virtual healthcare equipment. Policymakers and the WHO can encourage prioritising technologically advanced treatments through strategic policies.

Furthermore, challenges like sparse airway restriction assessments, cost implications, and timing hindrances in asthma treatment facilities lead to underutilisation. Asthma policy regulations focus on symptom management, risk reduction, minimising drug complications, and controlling disease effects. Assessing asthma control is crucial, with various measures like the asthma control questionnaire and the GINA assessment used for decision-making. Local partnerships should be leveraged for connectivity and affordability to implement smart inhalers successfully in SSA, especially with Bluetooth technology. Strategies should include integrating SMS or app-based reminders and culturally relevant educational content. Policy recommendations should advocate for including smart inhalers in public healthcare programs, propose tax incentives, and emphasise integration into existing healthcare infrastructure. A sustainable business model considering maintenance and support should be developed, with opportunities for local job creation in technology support and maintenance services. Equipping healthcare providers, patients, and care assistants with proper training and education is crucial for effectively utilising this modern-day technological system in SSA nations.

Conclusion

The burden of asthma in SSA is substantial, with high prevalence rates, a notable lack of controlled asthma, and limited access to effective management. The existing challenges, including underdiagnosis, inadequate healthcare infrastructure, and socio-economic factors, contribute to the region's struggle to address asthma effectively. While significant in asthma management globally, traditional inhaler technologies face limitations in SSA, where factors such as poor inhaler technique, inadequate healthcare resources, and socioeconomic barriers impede their efficacy.

The emergence of smart inhaler technology presents a promising avenue for transforming asthma management in SSA. These devices offer objective medication adherence monitoring, provide real-time data, and empower patients with tools for better self-management. The advantages of smart inhalers, including patient-directed feedback, reminders, and the potential to personalise treatment regimens, could significantly improve asthma control in the region. However, the successful integration of smart inhalers in SSA faces unique challenges. Issues such as limited access to technology, low health literacy, and financial constraints must be addressed. Policy recommendations, educational initiatives, and strategic partnerships are crucial for

overcoming these barriers and ensuring the region's sustainable implementation of smart inhaler technology.

Future studies should focus on understanding prevalent respiratory conditions, identifying environmental triggers, and tailoring interventions to the specific needs of SSA. Additionally, efforts should be directed toward advocating for the inclusion of smart inhalers in public healthcare programs, exploring tax incentives, and developing business models that ensure long-term support and maintenance.

Ethical approval

Not applicable.

Consent

Not applicable.

Sources of funding

No funding was received for this editorial.

Author contribution

N.A.: conceptualization. All authors: writing of first and final draft.

Conflicts of interest disclosure

There are no conflicts of interest to declare.

Research registration unique identifying number (UIN)

Not applicable.

Guarantor

Nicholas Aderinto.

Data availability statement

No new datasets were generated for this editorial.

Provenance and peer review

Not commissioned, externally peer-reviewed.

References

[1] van Gemert F, van der Molen T, Jones R, *et al*. The impact of asthma and COPD in sub-Saharan Africa. Prim Care Respir J 2011;20:240–8.
[2] Mphahlele RE, Kitchin O, Masekela R. Barriers and determinants of asthma control in children and adolescents in Africa: a systematic review. BMJ Open 2021;11:e053100.
[3] Asher MI, Rutter CE, Bissell K, *et al*. Worldwide trends in the burden of asthma symptoms in school-aged children: Global Asthma Network Phase I cross-sectional study. Lancet 2021;398:1569–80.
[4] World Asthma Report. 2018. Accessed 31 December 2023. https://ginasthma.org/wp-content/uploads/2022/07/GINA-Main-Report-2022-FINAL-22-07-01-WMS.pdf.
[5] Magwenzi P, Rusakaniko S, Sibanda EN, *et al*. Challenges in the diagnosis of asthma in children, what are the solutions? A scoping review of 3 countries in sub Saharan Africa. Respir Res 2022;23:254.
[6] Global Strategy for Asthma Management and Prevention. 2022. Accessed 31 December 2023. https://ginasthma.org/wp-content/uploads/2022/07/GINA-Main-Report-2022-FINAL-22-07-01-WMS.pdf.
[7] Skevaki C, Ngocho JS, Amour C, *et al*. Epidemiology and management of asthma and atopic dermatitis in Sub-Saharan Africa. J Allergy Clin Immunol 2021;148:1378–86.
[8] Amorha KC, Ayogu EE, Ngwoke BA, *et al*. Knowledge, attitudes and quality of life of caregivers towards asthma in their children: a Nigerian perspective. J Health Sci 2020. doi:10.17532/jhsci.2020.860
[9] Mpairwe H, Tumwesige P, Namutebi M, *et al*. Asthma control and management among schoolchildren in urban Uganda: results from a cross-sectional study. Wellcome Open Res 2019;4:168.
[10] Kassa E, Kebede RA, Habte BM. Perceptions towards childhood asthma and barriers to its management among patients, caregivers and healthcare providers: a qualitative study from Ethiopia. BMC Pulm Med 2022;22:184.
[11] Rose S, Paul C, Boyes A, *et al*. Stigma-related experiences in non-communicable respiratory diseases: a systematic review. Chron Respir Dis 2017;14:199–216.
[12] Vargas PA, Robles E, Harris J, *et al*. Using information technology to reduce asthma disparities in underserved populations: a pilot study. J Asthma 2010;47:889–94.
[13] Bousquet J, Khaltaev N, Cruz AA, *et al*. Allergic rhinitis and its impact on asthma (ARIA) 2008. Allergy 2008;63:8–160.
[14] Adeloye D, Chan KY, Rudan I, *et al*. An estimate of asthma prevalence in Africa: a systematic analysis. Croat Med J 2013;54:519–31.
[15] Beasley R. Worldwide variation in prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and atopic eczema: ISAAC. Lancet 1998;351:1225–32.
[16] Kirenga BJ, de Jong C, Katagira W, *et al*. Prevalence and factors associated with asthma among adolescents and adults in Uganda: a general population based survey. BMC Public Health 2019;19:227.
[17] Kirenga BJ, de Jong C, Mugenyi L, *et al*. Rates of asthma exacerbations and mortality and associated factors in Uganda: a 2-year prospective cohort study. Thorax 2018;73:983–5.
[18] Abebe SM, Andargie G, Shimeka A, *et al*. The prevalence of non-communicable diseases in northwest Ethiopia: survey of Dabat Health and Demographic Surveillance System. BMJ Open 2017;7:e015496.
[19] Motala C, Green RJ, Manjra AI, *et al*South African Childhood Asthma Working Group. Guideline for the management of chronic asthma in children-2009 update. S Afr Med J 2009;99:898–912.
[20] Hooper LG, Dieye Y, Ndiaye A, *et al*. Estimating pediatric asthma prevalence in rural Senegal: a cross-sectional survey. Pediatr Pulmonol 2017;52:303–9.