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Patient tracking and retention with Malawi's electronic medical records system in antiretroviral treatment clinics

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Abstract

Background Leveraging the widespread availability of the Electronic Medical Records System (EMRS) in Malawi, the Clinic Missed Appointment (CMA) reporting tool was introduced in April 2021 to support the identification and reintegration of antiretroviral treatment (ART) clients who miss scheduled clinic appointments, thereby enhancing patient care and retention. This study examined the impact of the CMA tool on patient retention.

Methods Using a before–after study design, we conducted trend analysis of nationally program ART data. EMRS data from October 2020 to June 2023 were analyzed using descriptive statistics to compare periods before and after the implementation of the CMA tool. Trends in patient retention were assessed, including treatment interruptions, clients alive on ART, and successful ART restarts. Additionally, these retention indicators were stratified by sex and age-group to examine differences in the proportions of clients interrupting treatment and returning to treatment.

Results From October 2020 to June 2023, quarterly cases of ART treatment interruptions decreased by 45%, while the number of clients alive on treatment increased by 11%. However, the rate of return to care following ART interruption declined by 70%. The proportion of clients interrupting ART was consistently higher among males (4.2%) than females (3.4%), while return-to-care rates after interruption did not observably differ significantly by sex. ART interruption and return-to-care rates also varied by age, with the highest interruption rates observed among children aged <1 year and the lowest among adults aged >50 years.

Conclusions Following implementation of the EMRS CMA reporting tool, there was a correlated observed decrease in ART interruption and improved retention in care. The system's capacity to quickly and correctly generate follow-up lists might have optimized time for client tracing. Sex- and Age-sensitive interventions may be important to enhance treatment adherence and retention.

Keywords Electronic medical record system, Interruption in treatment, Return to treatment, Missed appointment

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Introduction

Malawi, like many countries in sub-Saharan Africa, faces a substantial HIV/AIDS burden but has made substantial progress in expanding access to antiretroviral therapy (ART). [1] In 2017, an estimated one million people were living with HIV (PLHIV). [2], yet only 688,970 were receiving ART, prompting efforts to improve coverage. By 2023, nearly one million PLHIV were enrolled in ART across 800 sites, reflecting major gains in treatment availability [3].

A key driver of this progress has been the widespread adoption of electronic medical record systems (EMRs), which have transformed HIV service delivery [4]. Approximately 98% (915,233) of PLHIV on ART were managed within EMRs deployed at 96% (746) of ART sites [5], underscoring the central role of digital tools in strengthening care [6]. EMR coverage expanded from 190 sites in 2018 to 746 sites by Q2 2023 [5]. (Fig. 1), demonstrating strong government and partner commitment to digital health. Since 2019, the Elizabeth Glaser Pediatric AIDS Foundation (EGPAF) has supported the Government of Malawi in scaling and enhancing EMRs, including improving point-of-care systems and introducing the electronic Mastercard (eMC). The eMC enables digitization of paper-based clinical records, incorporates validation and data-cleaning tools, and generates automated reports, improving data accuracy, completeness, and efficiency [6–8].

Evidence consistently shows that EMRs improve client outcomes, strengthen data quality, and enhance health system performance [6, 9–12, 13] For example, a systematic review by Garg et al. [11] highlighted improvements in data completeness, accuracy, and continuity of care associated with EMR use in sub-Saharan Africa. While challenges persist such as infrastructure limitations, workforce capacity, and interoperability issues [14] these are outweighed by the substantial benefits of EMR adoption [15, 16].

Before EMRs introduced automated tools, providers struggled to determine which clients had missed appointments by more than 14 days because some clients often came early or late for drug refills. Manual reconciliation was time-consuming and error-prone, leading to misclassification, and inefficient tracing resulting in increased treatment interruptions, and more clients returning to care. To address this, the digital Clinic Missed Appointment (CMA) report was introduced in April (Q2) 2021, particularly benefiting high-volume sites.

We evaluated the CMA tool across 704 facilities by analyzing national quarterly trends in client retention

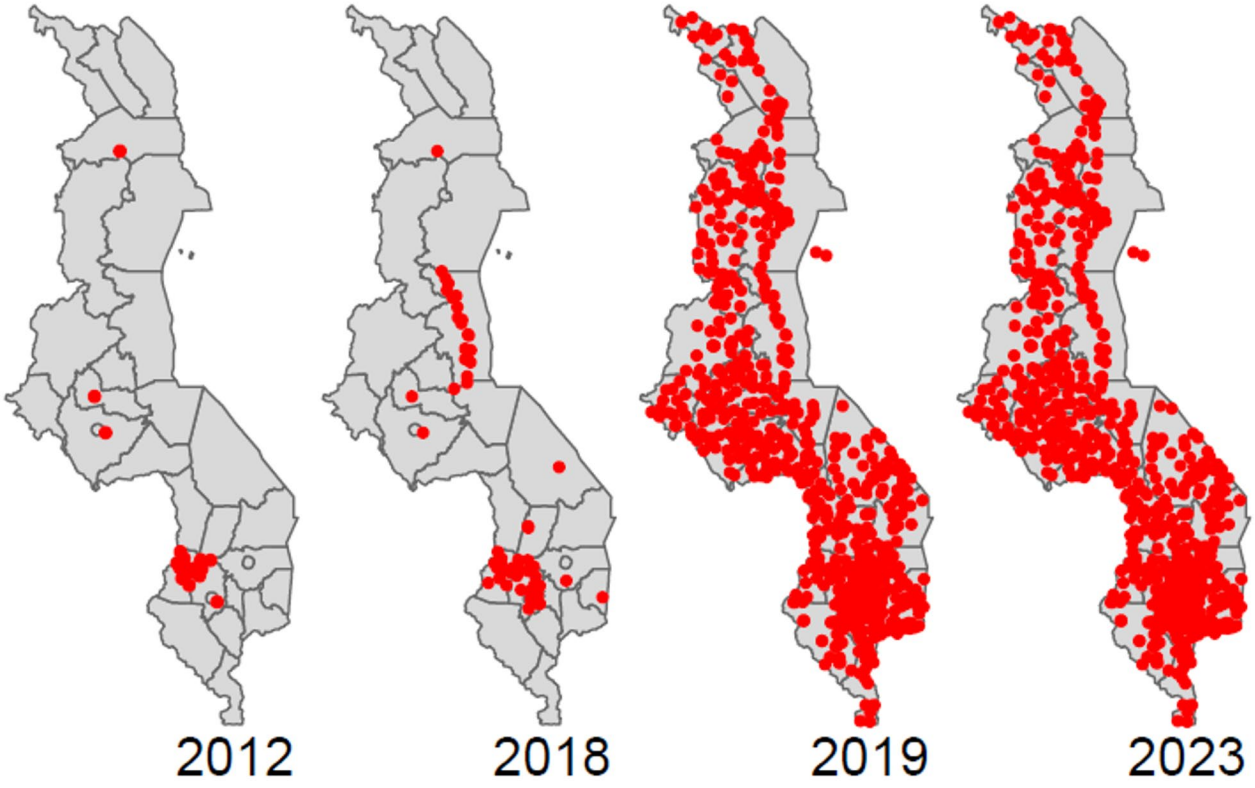

Fig. 1 Progress Map of facilities deployed and using ART EMR system between 2012 and 2023. *Note The maps were generated from the MAP and are free to use without copyright restriction

indicators before and after implementation, including interruptions in treatment, clients alive on ART, and ART restart.

Methods

Intervention description

The EMRs implementation in Malawi initially focused on the ART program, but has since expanded to encompass other essential health care services. These services now include antenatal care (ANC), outpatient services (OPD), cervical cancer screening, and HIV testing services (HTS). The primary goals with the EMRs are to facilitate the collection of real-time, age- and sex-disaggregated data for reporting purposes and to enhance client care through embedded decision support tools developed in alignment with clinical guidelines. In April (Q2) 2021, the CMA reporting tool was introduced in the EMRs, with the purpose of generating lists of clients who missed clinic visits, to optimize time spent on client outreach by health care workers in health facilities. This tool consolidates a list of clients who have missed their clinic appointments and require follow-up interventions, excluding clients who have visited the clinic for their drug refill within 14 days before or after their scheduled appointment date. This ensures accuracy in identifying missed appointments and optimizes resource allocation for client outreach and support efforts. Table 1 provides an example of the system generated report that flags a list of clients who missed appointments.

As shown in Table 1, the number of days since a missed appointment is a key criterion used by tracers to prioritize client follow-up. Clients who have missed appointments for >28 days are classified as high priority, as timely tracing is critical to facilitate their return to treatment (RTT). For those with <28 days, Care and Treatment implementing partners (IPs) apply varying standard operating procedures: most do initiate tracing at ≥14 days, while a few begin as early as 7 days of missed appointment. This early action supports re-engagement before clients reach the 28-day threshold, which meets the President's Emergency Plan for AIDS Relief (PEPFAR) definition of interruption in treatment.

Study design

This was a before–after analysis examining trends in selected ART program indicators. Using routine national ART data, client retention was retrospectively evaluated by quarterly periods from October 2020 (Q4 2020) to June 2023 (Q2 2023). The EMR CMA tool was introduced as part of EMR updates in Q2 2021. This timeframe allowed assessment of temporal patterns and trends in key indicators both before and after the implementation of the CMA tool.

Analysis sample population

During the study period, two sites were closed due to floods, five sites had missing data, and 35 sites had newly deployed EMRs. Therefore, the analysis was restricted to sites with complete quarterly data throughout the study period, resulting in 704 sites included out of the 746 facilities which had the EMR CMA tool by Q2 2023. The study population comprised adults and children enrolled in ART programs at these sites.

Outcome indicators

The EMR system captures all HIV program outcomes that measure service provision performance. These outcomes are Clients alive on treatment, transferred out, interrupted treatment, stopped treatment, died, viral load coverage, and suppression rate. However, the analysis only focuses on outcome indicators related to CMA tool; treatment interruption, currently/alive on treatment, and returned to treatment. "Treatment interruption" refers to individuals who had not had any clinical contact for more than 28 days since their last expected clinical encounter or ART pick-up date. "Currently on treatment" represents the total number of adults and children actively receiving ART during the study period, providing insight into the current client population engaged in treatment. And, "returned to treatment" reflects the number of ART clients who had experienced an interruption in treatment during any previous reporting period, successfully restarted ART within the reporting period under consideration, and remained on treatment until the end of that reporting period [17].

Table 1 Example of Clinic Missed Appointment Report Tool on 01/01/2024

ARV#	Sex	DOB	Appointment date	Days missed	Current outcome
Patient 1	Male/Female	dd-mm-yy	dd-mm-yy	20	On antiretrovirals
Patient 2	Male/Female	dd-mm-yy	dd-mm-yy	3	On antiretrovirals
Patient 3	Male/Female	dd-mm-yy	dd-mm-yy	13	On antiretrovirals
Patient 4	Male/Female	dd-mm-yy	dd-mm-yy	41	Defaulted
Patient 5	Male/Female	dd-mm-yy	dd-mm-yy	2	On antiretrovirals
Patient 6	Male/Female	dd-mm-yy	dd-mm-yy	2	On antiretrovirals

Note: Prioritization ensures resources are focused on clients at highest risk of treatment interruption, while also supporting early re-engagement for those with shorter missed intervals

Data management and analysis

The EMR system featured a comprehensive array of built-in reports, categorized into data cleaning tools, clinic reports, Ministry of Health (MOH) reports, and the PEPFAR reports, classified based on ART use and/or where the reports were submitted. Selected Clinic, MOH, and PEPFAR reports were systematically generated and transmitted to a central point via a Validation Box (vBox), a centralized platform built by the health information system (HIS) project for validating reports before they are submitted for further review. The vBox automates the validation process by flagging any inconsistencies or gaps in the reports, allowing users to address these issues promptly. It flags any internal or external inconsistencies within the reports. Once discrepancies were identified and rectified, the reports were electronically submitted to a centralized repository for storage and consolidation, ensuring the reliability of the aggregated data. These aggregated data were then visualized on the Malawi Analytic Platform (MAP), with dashboards updated quarterly upon the completion of each reporting cycle, facilitating ongoing monitoring and analysis of ART program indicators.

A detailed descriptive analysis of routine national ART program data was conducted using data extracted from the MAP portal, with a focus on quarterly trends in clients alive on treatment, clients with interrupted treatment, and clients who returned to treatment over the study period. Quarterly analyses stratified by sex were conducted not to assess the effect of the CMA tool, but to examine whether treatment interruptions and return to care consistently varied by sex. However, only data from the most recent quarter were analyzed by age group to determine whether treatment interruption varied across age groups.

Descriptive analysis of quarterly trends of proportion of treatment interruption and returned to care were done. The proportion (%) of clients interrupting treatment during a given quarter was calculated by dividing the number of clients who interrupted treatment during that quarter by the number of clients alive on treatment in the previous quarter. Similarly, the proportion (%) returning to care was calculated by dividing the number of clients who returned to care during the quarter by the number of clients who had interrupted treatment in the previous quarter. All sites that deployed the EMR system during or after the study period, as well as those with missing data for any of the three outcome indicators, were excluded from the analysis. This resulted in a final dataset of 704 sites.

Results

The quarterly analysis showed a 45% decline in treatment interruptions from October 2020 (Q4 2020) to June 2023 (Q2 2023) (Fig. 2). The largest drop occurred between Q4 2020 and Q2 2021, coinciding with the introduction of the CMA tool, after which interruption levels stabilized even as the number of clients alive on treatment grew. Overall, the treatment cohort increased by 11% (794,805 to 880,018) from Q4 2020 to Q2 2023. Meanwhile, returns to care after an interruption fell by 70%, declining from 56,821 in Q4 2020 to 17,030 in Q2 2023.

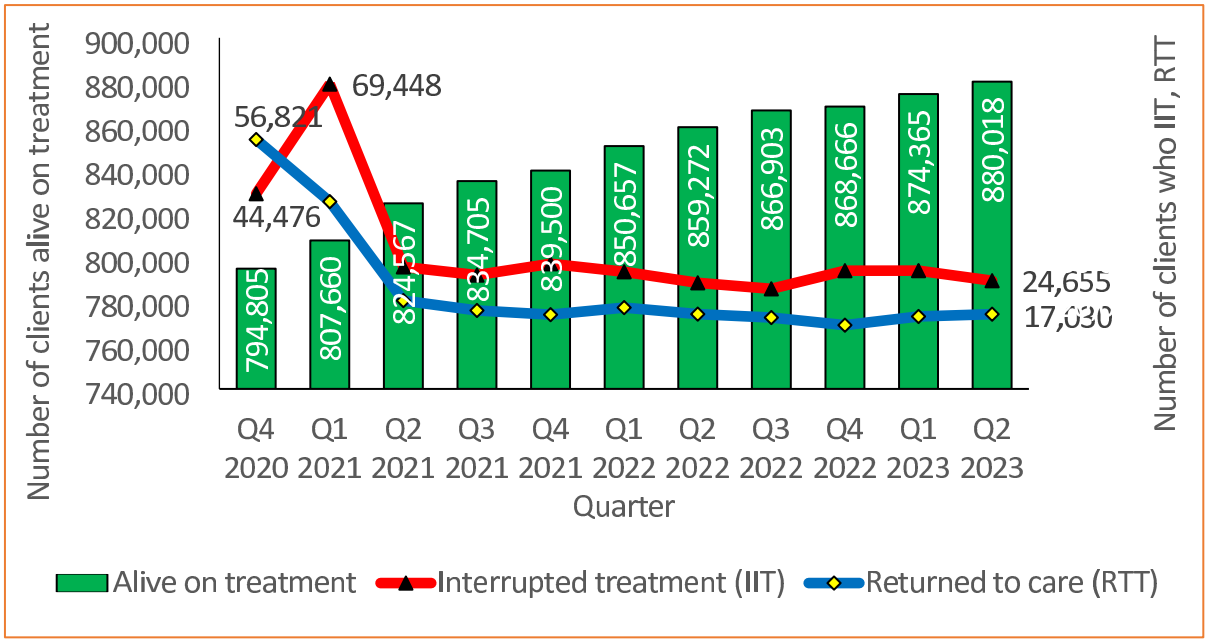

Fig. 2 Quarterly trend of clients alive on treatment, interrupted treatment, and returned to treatment; Q4 2020 - Q2 2023. *Note The surge in Q1 2021 was largely driven by the peak in COVID-19 cases and deaths during that period

Table 2 Quarterly proportion of ART Clients interrupting treatment and returning to treatment

Quarter	Alive on treatment	Interrupted treatment	Returned to treatment	% Interrupted treatment (pct_ML)	% Returned to treatment (pct_RTT)
Q4 2020	794,805	44,476	56,821		
Q1 2021	807,660	69,448	42,670	8.7%	95.9%
Q2 2021	824,567	27,801	20,122	3.4%	29.0%
Q3 2021	834,705	25,941	17,878	3.1%	64.3%
Q4 2021	839,500	28,517	16,921	3.4%	65.2%
Q1 2022	850,657	26,689	18,529	3.2%	65.0%
Q2 2022	859,272	24,175	17,045	2.8%	63.9%
Q3 2022	866,903	22,804	16,261	2.7%	67.3%
Q4 2022	868,666	26,937	14,526	3.1%	63.7%
Q1 2023	874,365	26,951	16,506	3.1%	61.3%
Q2 2023	880,018	24,655	17,030	2.8%	63.2%

Note: Proportion(%) of treatment interruption = Interrupted treatment /alive on treatment in previous quarter X 100%; and Proportion(%) returned to treatment = returned to treatment / treatment interruption in previous quarter X 100%

Table 3 Clients alive on treatment, interrupted treatment, returned to treatment, % Interrupted treatment, and % returned to treatment by quarter and sex

Quarter	Female					Male				
	Alive on treatment	Interrupted treatment		Returned to treatment		Alive on treatment	Interrupted treatment		Returned to treatment	
		n	%	n	%		n	%	n	%
Q4 2020	519,851	27,620		36,403		274,954	16,856		20,418	
Q1 2021	528,259	41,439	8.0%	26,044	94.8%	279,401	28,009	9.9%	16,626	99.2%
Q2 2021	536,055	16,550	3.1%	12,139	29.3%	288,512	11,251	4.0%	7,983	28.5%
Q3 2021	542,322	15,361	2.9%	10,598	64.0%	292,383	10,580	3.7%	7,280	64.7%
Q4 2021	544,946	16,859	3.1%	10,063	65.5%	294,554	11,658	4.0%	6,858	64.8%
Q1 2022	551,363	15,908	2.9%	10,975	65.1%	299,294	10,781	3.7%	7,554	64.8%
Q2 2022	556,352	14,456	2.6%	10,201	64.1%	302,920	9,719	3.3%	6,844	63.5%
Q3 2022	560,046	13,414	2.4%	9,681	67.0%	306,857	9,390	3.1%	6,580	67.7%
Q4 2022	563,155	15,892	2.8%	8,656	64.5%	305,511	11,045	3.6%	5,870	62.5%
Q1 2023	566,721	16,116	2.9%	9,713	61.1%	307,644	10,835	3.6%	6,793	61.5%
Q2 2023	570,411	14,631	2.6%	10,246	63.6%	309,607	10,024	3.3%	6,784	62.6%

Note: % returned to treatment is those returned during the quarter /those interrupted in previous quarter

During the study period, the proportion of clients interrupting ART dropped from 8.7% to 2.8%, while the share of those who interrupted treatment and later returned to care declined from 96% to roughly 62% (Table 2).

About 65% of ART clients were female, with minimal variation over the study period (Table 3). Females consistently had lower rates of treatment interruption than males; however, the proportion returning to treatment did not meaningfully differ by sex in most of quarters.

Table 4 shows the distribution of clients on ART and the percentage experiencing treatment interruptions by age group in Q2 2023. Overall, 2.8% of clients interrupted treatment. Interruption rates declined with age, ranging from 9.1% among infants (<1 year) to the lowest levels in adults aged 50+. Among children, those aged 10–14 had the lowest interruption rate, while among adults, the 20–24 age group had the highest at 5.4%.

Discussion

In our analysis, we observed a decrease in the number of clients experiencing interruptions in treatment between Q4 2020 and Q2 2021, when the EMRs CMA tool was implemented, with subsequent stabilization despite an increase in numbers of patients on treatment. This is particularly notable given the COVID-19 outbreak was peaking in 2020–2022. This trend suggests the potential positive influence of targeted interventions facilitated by the national HIV EMRs and CMA tool [12, 15].

Interruption in treatment was defined as no clinical contact for more than 28 days after the last expected appointment. As the number of clients alive on treatment increases, the number of ART clients missing clinic appointments typically rises each quarter. This leads to a corresponding increase in treatment interruptions.

Table 4 Clients alive on treatment and interrupting therapy by age group in Q2 2023

Age group	Alive on treatment	Interrupted treatment	%Interrupted treatment
< 1 year	315	29	9.0%
1–4 years	4381	263	6.0%
5–9 years	11,055	363	3.3%
10–14 years	19,988	447	2.2%
15–19 years	26,259	848	3.2%
20–24 years	38,889	2092	5.4%
25–29 years	67,404	3232	4.8%
30–34 years	90,060	3420	3.8%
35–39 years	129,010	3974	3.1%
40–44 years	149,234	3687	2.5%
45–49 years	126,361	2580	2.0%
50–54 years	89,718	1585	1.8%
55–59 years	55,510	945	1.7%
60–64 years	35,327	541	1.5%
60 + years	36,508	651	1.8%
Overall	**880,018**	**24,655**	2.8%

However, the observed decline in treatment interruptions over time suggests improved client management. Use of the EMR CMA tool may have contributed to more timely and accurate identification of clients who missed their clinic appointments, supported prioritization of clients for tracing, and may have increased the time available to health workers for tracing. These actions may have supported the return of clients to care within 28 days, potentially preventing classification as treatment interruption.

Returned to treatment reflects the number of ART patients who had experienced an interruption in treatment > 28 days during any previous reporting period and successfully restarted ART within the reporting period. The proportion of clients returning to care decreased from 96% in Q1 2021 to 29% in Q2 2021 and subsequently stabilized at approximately 63%. The lower estimates of return to treatment observed after CMA implementation may suggest that the tool supported providers in identifying clients who missed appointment and facilitating earlier tracing, before interruptions exceeded 28 days. This likely reduced the number of clients classified as having treatment interruptions and, consequently, the proportion returing to care. The sharp decline in return to care in Q2 2021 may be attributed to COVID-19 pandemic. During this period, Malawi experienced peak COVID-19 incidence, and Ministry of Health policies restricted community-based patient tracing as part of efforts to control transmission. The remaining proportion of clients classified as having interrupted treatment and not returning to care may represent a harder-to-reach population requiring more intensive or tailored interventions. Further research is needed to assess the characteristics of clients who do not return to care in order to inform the design of targeted strategies to support treatment re-initiation.

Treatment interruptions showed some sex disparities, with fewer females interrupting ART than males. However, return-to-care rates were similar for both sexes, suggesting tracing efforts were equally effective. Children had the highest interruption rates, indicating the tool can help providers prioritize tracing for this age group, especially those under five, and underscoring the need for child-sensitive clinical care to reduce interruptions.

Several challenges are known to occur when utilizing paper-based lists for community tracing of clients with missed clinic visits. These challenges include incomplete client locator details, compromised data security if the list is lost, and the potential for incomplete updating of tracing outcomes in the EMR system. To address these gaps, we propose to develop a "Back to Care Mobile Application", which would electronically receive the list of clients to be traced. It will have advantages for including more comprehensive locator details to assist in clients' identification and tracing, and for automatically updating the facility EMRS immediately as tracing outcomes are documented by health workers. However, the implementation of such a solution would require substantial resources, technological infrastructure, and stakeholder buy-in.

Several limitations should be acknowledged in our study. First, the analysis relies solely on aggregate data obtained from the national HIV EMRs, which despite data correction, components of the EMR may be subject to data entry errors, missing data, or inconsistencies. Second, the observational nature of the study limits our ability to establish causality between EMRs CMA tool utilization and observed trends in treatment interruption rates. The focus on aggregated data may not fully capture the complexities of HIV care at the individual patient

level. Thirdly, the observed improvements post intervention might be due to other factors such as improved counselling, increased staff and resources for tracing, and program management. Fourthly, the study did not measure the CMA tool utilization across the sites. Despite these limitations, our study provides the strong potential correlation between of CMA introduction and reduction of treatment interruption rates among PLHIV and underscores the need of targeted interventions to improve retention in care. Future research should aim to address these limitations through prospective studies, comprehensive patient-level assessments, and innovative solutions to enhance tracing efforts in the community.

Conclusion

In conclusion, this study highlights the important role of EMRs in HIV care in resource-limited settings such as Malawi. EMR-generated reports, including the CMA tool, may support the identification and consolidation of ART clients who miss clinic appointments, enabling timely tracing and re-engagement in care. Our findings suggest that proactive follow-up of missed appointments using EMR data can effectively return clients to treatment and improve continuity of care. Overall, the use of EMR reports shows strong potential to enhance the quality of care for people living with HIV in resource-limited settings.

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Author contributions
MC, SM, VS, HK, and TM conceptualized the study design, development of CMA tool in EMR, and training of system users. MC, SM, and GS supported and led data abstraction processes and data analysis. GT, ML, MC, VS, and HK played pivotal roles in interpreting the table shells and results and in drafting the manuscript. All authors, including SM, MC, GS, VS, ML, GM, HK, and TM, actively reviewed and approved the final manuscript before submission.

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Data availability
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request. Access to the data may be subject to institutional or ethical restrictions.

Declarations

Ethics approval and consent to participate
All methods were performed in accordance with the relevant guidelines and regulations. Permission and ethical clearance for this study were obtained from the Malawi National Health Science Research Council (NHSRC) – protocol % 25/01/4574, Center for Disease Control and Prevention (CDC) - CGH-MAL-7/16/25-aa355, and Advarra Institutional Review Board (Pro00090545) in the United States. Since this was a retrospective study based on the abstraction of secondary data records, the ethics committees/institutional review boards that approved the protocol waived the need for informed consent. This study was conducted in accordance with the ethical principles set out in the Declaration of Helsinki.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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Publisher's note