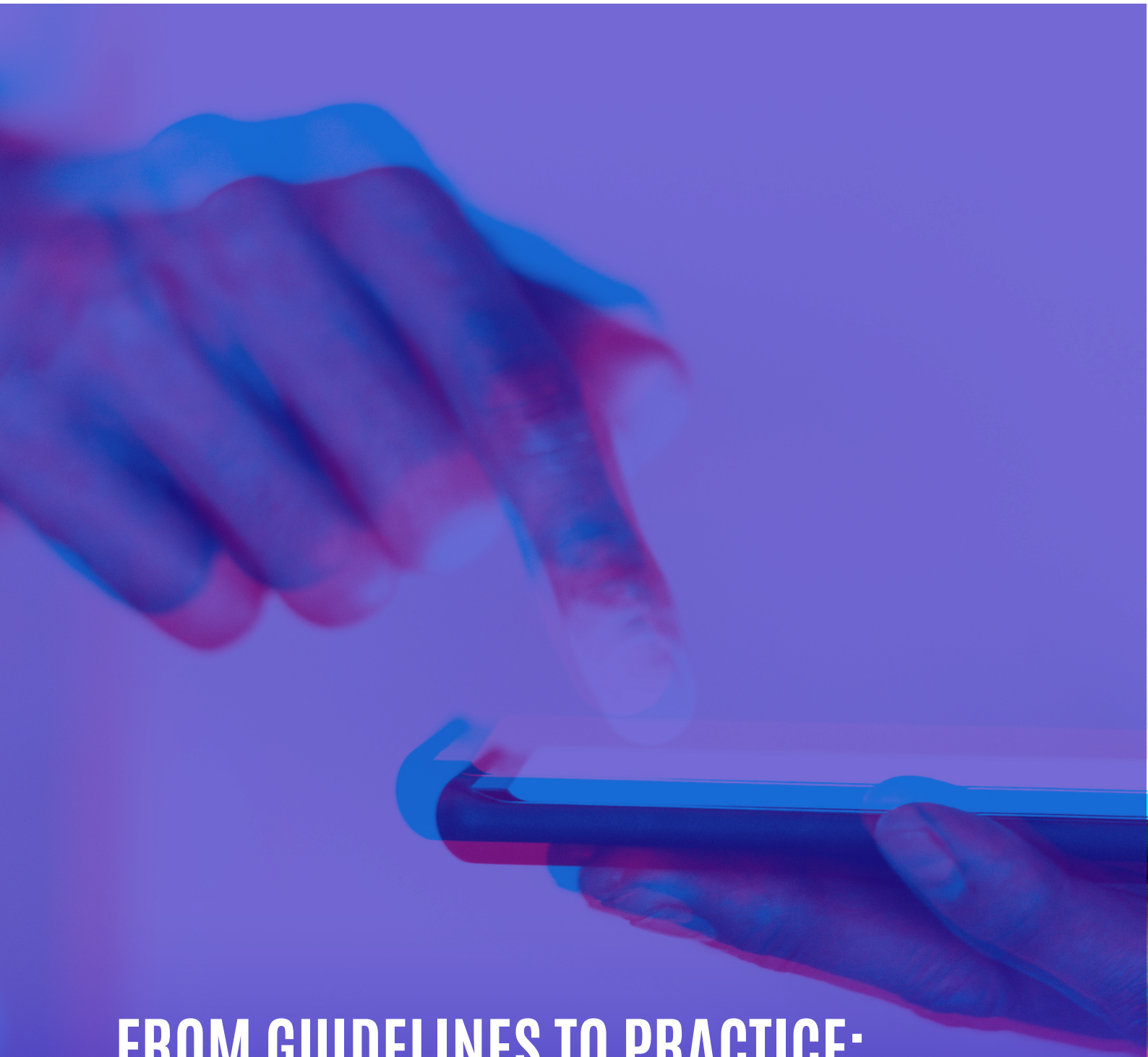
MEDTRONIC **LABS**



FROM GUIDELINES TO PRACTICE:

QUALITY IMPROVEMENT AT THE POINT OF CARE THROUGH DIGITAL NUDGES

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EXECUTIVE SUMMARY

Clinical inertia represents a major challenge in chronic disease management globally. The Empower Health program in Kenya, powered by the SPICE digital platform revealed clinical inertia as a key barrier to quality diabetes care: 54% of patients with Type 2 diabetes with documented prescriptions had persistent uncontrolled blood glucose (>3 months), with nearly half (46%) having no evidence of treatment adjustment despite medication adherence. The situation was more severe for Type 1 diabetes: among those with documented insulin prescription and persistent uncontrolled blood glucose, 70% experienced no dose adjustments. Beyond medication management, critical monitoring tests were severely underutilized, with only 5% of patients having received HbA1c testing since enrolment. In public sector facilities, where clinician rotation is common and continuity of care is not guaranteed, providers often lacked awareness of when annual tests like renal function or lipid profiles were due.

To address these gaps, we implemented a basic, rule-based clinical decision support system designed to deliver evidence-based digital nudges to clinicians at the point of care. The system was co-designed with frontline clinicians and embedded into the SPICE platform to align with real-world workflows. Implemented across four African countries (Ghana, Kenya, Sierra Leone, Tanzania), the system generated 2,449 treatment intensification alerts, with 1,417 (58%) prompting clinical review and 831 (59%) of those reviewed resulting in documented treatment adjustments. Laboratory investigation prompts (n=1,193) had 76% review rates but only 35% led to test orders and 17% resulted in completed tests, highlighting infrastructure and cost constraints that clinical reminders alone cannot overcome.

Patients whose treatment was adjusted following system prompts were nearly three times more likely to achieve glycaemic control over 3-6 months compared to those whose management remained unchanged (34% vs. 12%, $p<0.001$). Clinician feedback affirmed the system's usability, noting that the alerts supported adherence to best practices without disrupting their workflows. However, the fact that only 34% of intensified patients achieved control suggests additional factors beyond medication adjustment, including lifestyle modification and practical factors such as insulin injection techniques and storage challenges require attention. Further, the nudges were designed to prompt action, but did not suggest which medications or doses would be most effective, potentially resulting in suboptimal intensification choices

Future iterations should evolve beyond generic alerts to provide specific guideline-aligned treatment recommendations such as suggesting particular medications, doses, and titration schedules, while preserving clinician autonomy to override these suggestions based on their clinical judgment and patient context. Systems should also address infrastructure barriers to monitoring and integrate lifestyle support and patient education. Systematic investigation into the reasons for clinician non-response to nudges is critical. Understanding why 40% of clinicians deferred acting on the alerts, whether due to valid clinical judgment or other barriers is essential for optimizing system design. As healthcare systems scale these interventions to address the full complexity of chronic disease care, artificial intelligence will become essential for generating personalized, context-aware recommendations that can process multiple guidelines, drug interactions, and patient factors simultaneously while maintaining transparency and clinical interpretability.

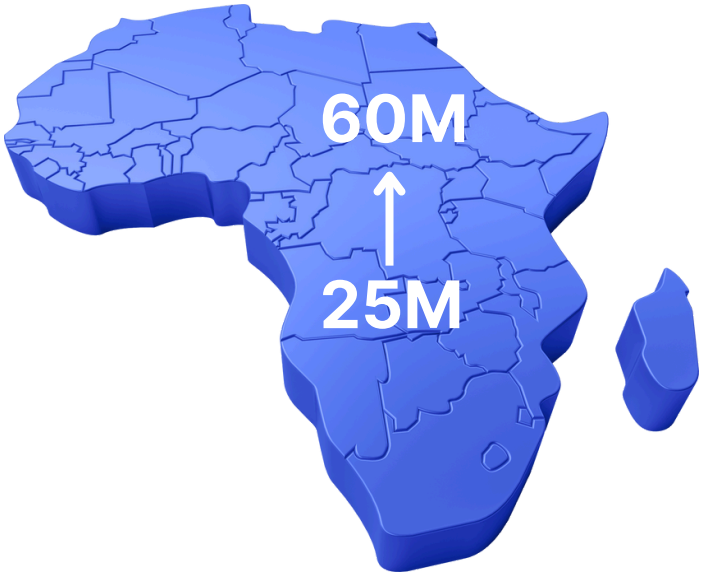
INTRODUCTION

The Crisis of Uncontrolled Diabetes in Africa

Diabetes affects an estimated

589M Adults globally | **11.1%** Prevalence → **853M** Adults globally | **13%** Prevalence

by 2050



By 2050

Africa is projected to have the highest increase in the number of people with diabetes at 142%, from 25 million in 2024 to 60 million by 2050.[1] Yet, despite expanding treatment options and regularly updating guidelines, achieving glycemic targets remains frustratingly elusive. A systematic review and meta-analysis of glycemic control in sub-Saharan Africa from 2012 to 2022 found that only 30% of patients achieved glycemic control targets, ranging from 10%-60% across settings.[2] Uncontrolled diabetes leads to debilitating complications, premature deaths and exorbitant economic burden.[1,3,4] The disconnect between available therapies and patient outcomes reveals a fundamental implementation gap in healthcare delivery.

Clinical Inertia: The Hidden Driver of Uncontrolled Diabetes

Described as the failure to initiate or intensify treatment when indicated, clinical inertia represents a fundamental breakdown in care quality that directly drives poor glycaemic control.[5–8] This encompasses failures across all aspects of guideline-recommended care, not only medication adjustments (therapeutic inertia) but also diagnostic testing, screening procedures, specialist referrals, and preventive care measures.[6]

Clinical Decision Support: Promise and Evidence

Clinical Decision Support Systems (CDSS) have emerged as promising quality improvement tools. They are meant to integrate medical knowledge with patient-specific information, to assist clinicians make the right care decisions.[9,10]
CDSS can take various forms: standardized protocols, alerts for allergies and drug interactions, reminders for overdue appointments, dose calculators, and point-of-care guidance.[11] Each targets different aspects of clinical decision-making with varying effectiveness. The theoretical appeal is particularly compelling in Africa, where there are limited physicians relative to patient population.

However, evidence shows mixed success. Systematic reviews and meta-analyses of CDSS have found that while many studies showed improvements in process measures (like ordering appropriate tests), fewer demonstrated improvements in clinical outcomes.[12,13] Some studies of diabetes-specific CDSS found modest but significant glycaemic improvements.[14,15] These mixed results suggest that effective CDSS design and implementation are critical. Research has identified key success factors such as seamless integration into routine workflows, delivering actionable recommendations at the right time, and ensuring users accept and trust the system. When CDSS are well-designed and context-appropriate, they can serve as a reliable assistant to the care team, augmenting clinicians' capabilities and enabling more proactive, personalized patient care.[10]

This case study presents our experience and findings from implementing digital nudge-based CDSS across four African countries to address clinical inertia in diabetes management. It provides important insights for policymakers, healthcare workers, and development partners working to address Africa's diabetes crisis through digital innovations.

Our Approach: Implementing Digital Nudges

Setting and Context

We implemented the digital nudges across four African countries: Ghana, Kenya, Tanzania and Sierra Leone between June 2024 and March 2025. Programs delivered through the SPICE digital platform had been supporting routine diabetes care for 2-5 years (depending on the country) before this intervention. Despite this structured care delivery, glycaemic control had improved only marginally. For instance, in Kenya, glycaemic control over 12-months post-enrolment had improved by 4 percentage points. This minimal improvement prompted investigation into underlying barriers, revealing clinical inertia as a major obstacle. Specifically, 54% of patients with Type 2 Diabetes with documented prescriptions had persistent uncontrolled blood glucose (>3 months), with nearly half (46%) having no evidence of treatment adjustment despite medication adherence. The situation was more severe for Type 1 Diabetes: among those with documented insulin prescription and persistent uncontrolled blood glucose, 70% experienced no dose adjustments. Beyond medication management, critical monitoring tests were severely underutilized, with only

46%
of patients

with Type 2 Diabetes with persistent uncontrolled blood glucose experienced clinical inertia.

When CDSS are well-designed and context-appropriate, they can serve as a reliable assistant to the care team, augmenting clinicians' capabilities and enabling more proactive, personalized patient care.

Understanding Local Needs

The nudge development process began with understanding local barriers to guideline implementation. Healthcare providers in co-design sessions revealed critical quality challenges at the point of care. "I sometimes have to see like thirty patients on my own," noted one clinician, highlighting time pressures that compromise quality. Another admitted, "We are not very well trained to prescribe insulin," revealing knowledge gaps affecting quality of care.

Quality continuity emerged as particularly problematic in facilities with rotating staff. Clinicians explained they "generally forgot to order tests that required long intervals before repeating, such as lipid profile," especially when seeing patients for the first time. Without systematic tracking, guideline-recommended monitoring was overlooked until complications arose, a fundamental quality gap aligned with findings by Zafar et al.[16]

By mapping the full patient journey, the team identified key integration points, such as consultation screens within the SPICE platform, where decision support prompts could be embedded without disrupting care delivery. Health workers welcomed the idea of real-time, data-driven reminders integrated into the patient electronic record. They suggested that alerts for when to intensify treatment (e.g. add or up titrate medications for elevated readings) or when to order overdue investigations would help prevent oversights and ensure more consistent care.

Design of the Nudge System

The design of the nudge features reflected these point-of-care realities. The system was configured to continuously monitor each patient's longitudinal data in SPICE and trigger alerts based on evidence-based rules (Table 1), aligned with the WHO HEARTS-D Technical Package,[17] and adapted to local context and guidelines.

Table 1: Decision rules implemented to trigger nudges

If	Then	What Happens in SPICE	Workflow
If ((HbA1C >7%, FBG ≥7 mmol/L or RBG ≥10 mmol/L) & (No Prescription change >3 months; patient adherent)	Then	Alert displayed while opening the prescription tab: "Considering the patient is not at target, would you like to intensify the treatment?"	Medical Review/Prescription
If (It has been more than three (3) months) & (Last HbA1c was done more than three (3) months ago)	Then	Alert displayed while opening the investigation tab: *"It has been three months since the patient went through the HbA1c test. Would you like to recommend another round of HbA1c test?"*	Medical Review/Lab investigation
If (It has been more than twelve (12) months) & (Last Lipid profile and Renal function test was done more than twelve (12) months ago)	Then	Alert displayed while opening the investigation tab: *"It has been one year since the patient has gone through Lipid profile and the Renal function test. Would you like to recommend another round of Lipid Profile and Renal function test?"*	Medical Review/Lab investigation

The nudge system operated through two primary mechanisms:

(1)Treatment intensification nudges – The system continuously tracked patients' glycaemic control over time. When a patient had persistent uncontrolled blood glucose (>3 months) with readings above target (HbA1C >7%, FBG ≥7 mmol/L or RBG ≥10 mmol/L) despite medication adherence, it generated an alert on the prescription tab with rationale e.g., "It has been three months and the patient has not achieved control would you like to **intensify the treatment**?" (Figure 1)

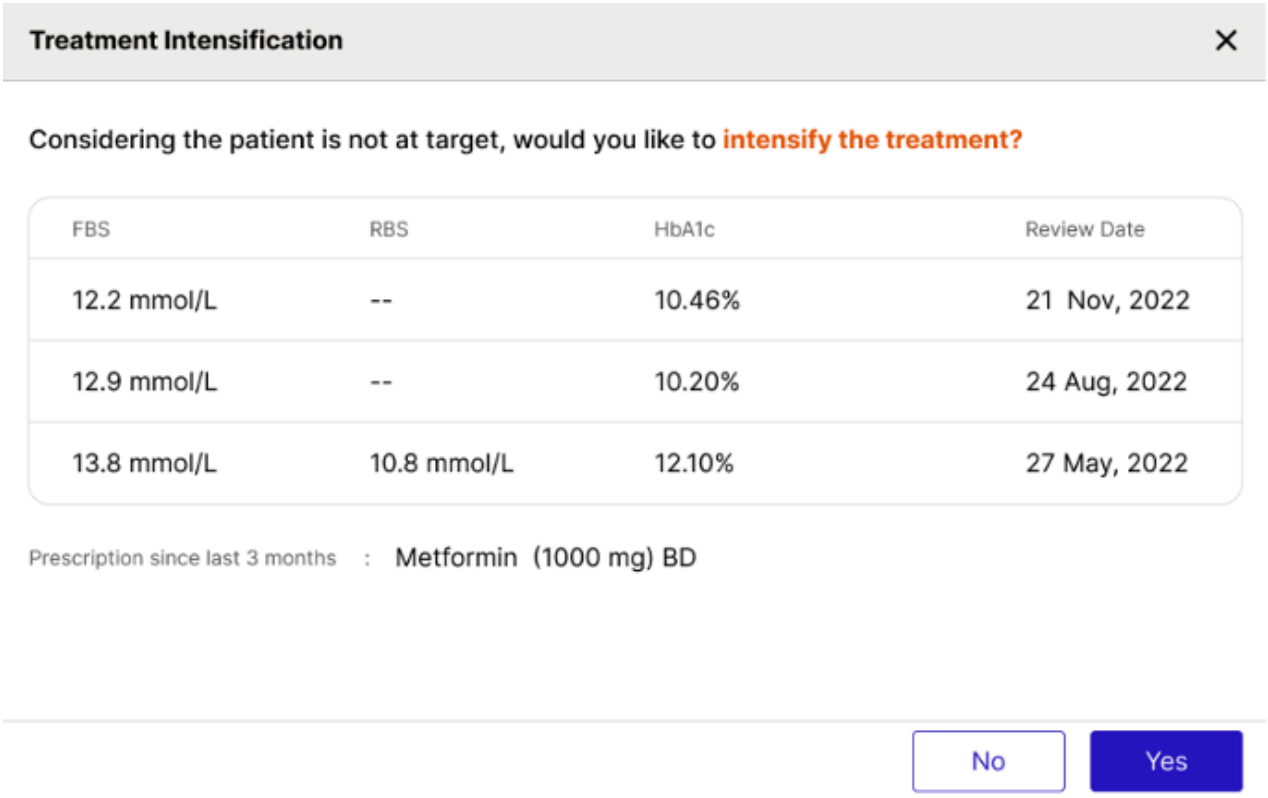


Figure. 1: Treatment intensification nudge

(2)Laboratory reminder notifications – The system tracked when key investigations were last performed, and triggered reminders to order recommended tests (such as HbA1c, renal function tests and lipid profile) if they were overdue as per guidelines. Each alert was presented within the digital platform interface along with a brief rationale and suggested actions e.g., "It has been one year since the patient has gone through the Renal Function Test and Lipid Profile. ***Would you like to recommend another round of Lipid Profile and Renal Function Test?"*** (Figure 2).

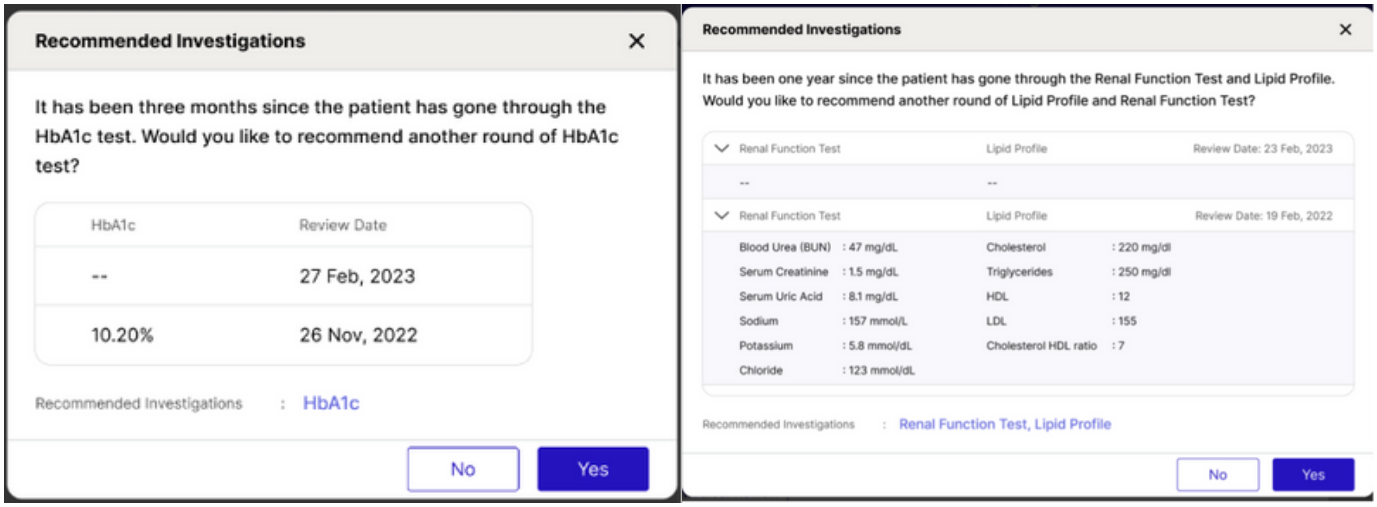


Figure 2. Laboratory tests reminder notifications

Importantly, the system was designed to be non-intrusive: alerts were integrated into the clinician's medical review workflow, that is; appearing on the main review screen on the prescription and investigations tab, rather than as disruptive pop-ups. Clinicians could accept the suggestion (triggering a laboratory investigation request or medication change) or dismiss it.

The goal was to reduce cognitive load and provide timely checks to augment clinical judgment, not to replace it. Throughout implementation, we emphasized that the nudges were recommendations, not mandates.

This iterative design process, from problem identification to rule-setting, to testing with user feedback ensured the CDSS was context-appropriate, user-friendly, and aligned with both clinician and health system needs. By the time of deployment, the CDSS was effectively embedded in routine practice, with clinicians oriented on its use and purpose.

SPICE automatically logged every CDSS nudge event and subsequent clinical actions, enabling subsequent analysis for quality improvement purposes.

KEY FINDINGS

Effect on Clinical Inertia and Glycaemic Control

Over 10 months, the system generated 2,449 treatment intensification nudges for patients with persistent uncontrolled diabetes and 1,193 laboratory investigation reminders. When treatment intensification nudges reached clinicians at the point of care, 59% resulted in medication adjustments, demonstrating that making clinical inertia visible prompts action. Among the patients whose treatment was intensified following nudges and who had follow-up data at 3-6 months, 34% achieved glycemic control. This compared to 12% achieving control among those whose treatment was not adjusted despite nudges, a near threefold difference ($p<0.001$) as demonstrated in Figure 3.

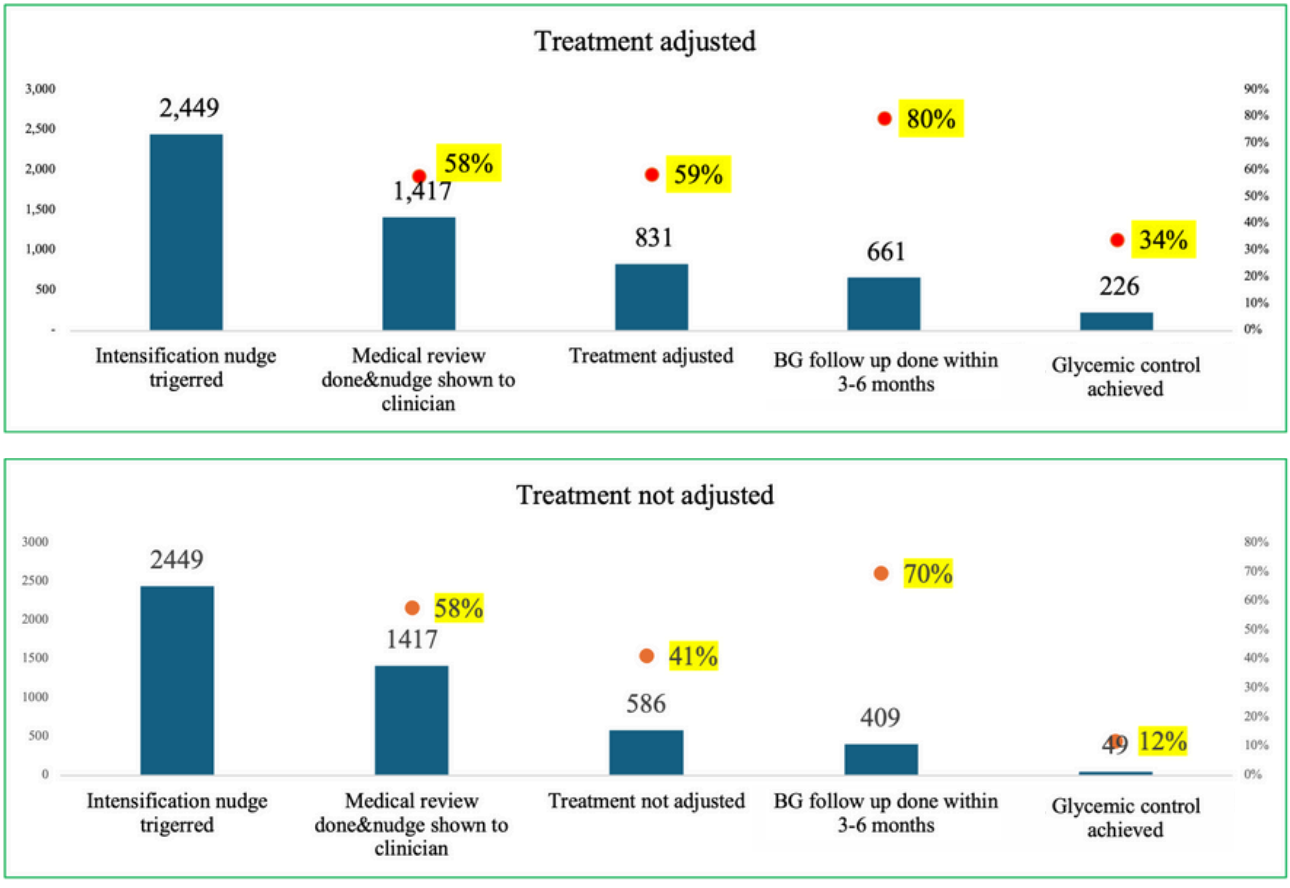


Figure 3. Treatment intensification nudge response to glycemic control cascade

Differential Effects Across Quality Dimensions

While medication-related nudges showed reasonable success, diagnostic monitoring faced greater challenges. The attrition from awareness (76%) to action (35%) to completion (17%) shown in Figure 4 reveals that clinical inertia in diagnostic monitoring faces additional barriers beyond clinician behaviour.

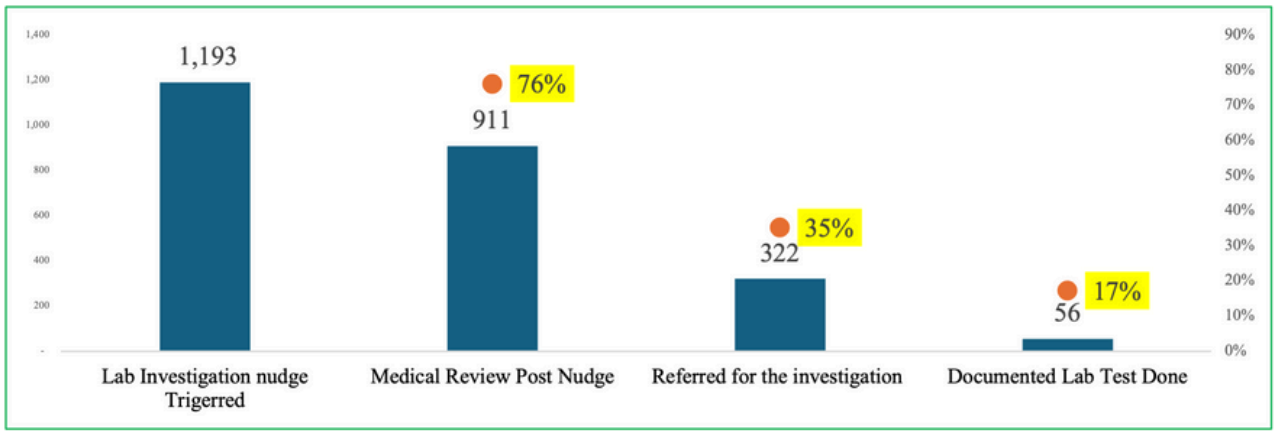


Figure 4. Lab investigations nudge response to test completion cascade

Qualitative insights

Qualitative feedback from the healthcare providers (n=15) was largely positive. Providers reported that the nudges helped standardize care. Many noted that prior to the nudges, care could be inconsistent; for instance, whether medication was intensified might depend on the individual clinician's diligence or memory of guidelines under the pressure of a busy clinic. With the digital nudges, there was a consistent prompt to take the appropriate next step, which reduced variability. One clinician remarked, "The system acts like a second pair of eyes. It reminds me when I might otherwise overlook something during a hectic clinic." This sentiment was common: the nudges were seen as a safety net that brings evidence-based recommendations to attention in real time. Several providers mentioned that seeing objective data trends e.g. graphs of blood glucose trends over time alongside the nudge reinforced the rationale for action and gave them confidence in making changes. Clinicians also highlighted improved adherence to clinical guidelines. They appreciated that the system prioritized high-risk patients, those with persistent poor control or overdue tests, allowing more efficient allocation of their limited time. On the low laboratory test completion rate, they highlighted operational barriers, such as patients not doing the test due to cost constraints, or tests being unavailable.

However, some downsides were also reported: some clinicians expressed concern that the nudges could contribute to alert fatigue if they became too frequent or if many patients were uncontrolled. However, at the current scale, they found the frequency reasonable, and a motivating indicator of how many patients needed closer attention. Regarding investigation reminders, clinicians worried that repeatedly alerting for tests that might not be available (e.g., due to stock-outs) could frustrate patients. Interestingly, some adaptations in practice occurred: clinicians would note the alert and schedule the test for a future date when supplies were expected or use the alerts as justification to advocate for restocking during facility meetings.

DISCUSSION AND IMPLICATIONS

The Potential of Digital Nudges

This real-world implementation contributes to a growing evidence base that digital nudges, when contextually adapted and embedded into routine clinical workflows, can drive quality care in low-resource settings. When the nudges reached clinicians at the point of care, 59% resulted in treatment adjustments, demonstrating provider responsiveness to quality improvement prompts. Most significantly, patients whose treatment was intensified following nudges were nearly three times more likely to achieve glycemic control. This aligns with global findings on the importance of overcoming therapeutic inertia in diabetes care and underscores the value of decision support tools in prompting actionable, guideline-based care.[10,18] Key to the system's success was its user-centered design and seamless integration into routine workflows. Built in close collaboration with frontline health workers, the nudges prioritized relevance, ease of use, and clinical trust. The CDSS delivered timely, context-specific, and actionable prompts, leading to high alert acknowledgment and satisfaction among clinicians.

Understanding the Limitations

Why generic nudges are not enough

While the nudges effectively prompted intensification, 66% of patients remained uncontrolled despite treatment adjustment. This reveals fundamental limitations of the current approach.

The nudges suggested to providers to intensify treatment, but did not specify how. Literature suggests that achieving control often requires not just timely intensification, but adequate intensification, such as appropriate medication type, dosing, and combination strategies,[19] factors not explicitly guided by the current version of the nudges. Generic prompts, without specific clinical recommendations or titration support, may lead to inconsistent treatment actions and suboptimal therapeutic responses, a scenario Pantalone et al term as 'intensification inertia'.[20] Refining the nudge system to offer more specific and tailored treatment and escalation guidance while embedding feedback loops to assess treatment impact could enhance its precision and effectiveness.

The role of lifestyle and practical patient barriers

Post facility visit factors such as lifestyle, social determinants, appropriate medication administration and adherence likely influenced the observed outcomes but were not captured in the system. The weak lifestyle support in the program represents a critical gap, given how foundational this is to diabetes management.[21] Future iterations should integrate lifestyle nudges alongside medication management. A patient appropriately prescribed insulin will remain uncontrolled if the insulin is degraded from bad storage or poorly absorbed due to incorrect injection technique.[22] These practical interventions may complement treatment intensification in settings where basic diabetes education is suboptimal.

There is also need to enhance patient engagement by integrating with mobile health tools and telemedicine platforms. For instance, an SMS could remind a patient to do a recommended test, or ask for the test during a clinician appointment, or adhere to prescribed intensified medication.

Health system infrastructural barriers

Laboratory investigation prompts had 76% review rates but only 35% led to test orders and 17% resulted in completed tests, highlighting infrastructure and cost constraints that clinical reminders alone cannot overcome as observed from the qualitative design interviews. Technology amplifies good systems but cannot compensate for fundamental gaps in supply chain and health financing, requiring holistic approaches to quality improvement initiatives.

Nudge non-responsiveness

Additionally, not all eligible patients had their treatment intensified despite receiving a nudge, highlighting variability in clinician response.

40%

of clinicians

who did not respond to nudges represents both a challenge and an opportunity.

While perceived patient readiness, comorbidities, or concerns about side effects may have contributed, further research would help understand the clinical decision-making behind nudge uptake to design more effective interventions.

The Artificial Intelligence Imperative

As African health systems scale quality improvement to meet the NCD crisis, the limitations of simple nudge systems become apparent. Quality care requires evaluating medications and interactions across multiple drugs, assessing comorbidities, individualizing treatment targets, adapting to local formularies, incorporating patient education and lifestyle factors, accounting for cost constraints, and learning from previous quality gaps to improve future care. Creating rule-based nudges for every clinical scenario would require thousands of conditional rules, becoming difficult and inefficient to maintain as guidelines continuously update.

Artificial intelligence (AI) offers transformative potential for next-generation quality improvement tailored to African contexts. AI can process entire patient histories, generating quality-optimized recommendations considering multiple guidelines while adapting to local resource availability. Natural language processing could work with locally spoken languages, enabling queries from clinicians in their preferred language. Machine learning can identify patterns specific to African populations, including genetic factors affecting drug response and optimal care for resource-limited settings. Crucially, AI should maintain transparency while managing quality complexity, providing clear rationales, citing relevant guidelines, and presenting multiple evidence-based options.[23] However, as the CDSS framework is expanded to be more patient-centric, careful design considerations need to balance integration across multiple conditions while preventing alert fatigue.

Formal evaluation through robust controlled trials

While the nudges were associated with higher rates of treatment intensification and improved glycaemic control, these findings represent associations rather than causal effects. Robust evaluation methodologies would help control for other unmeasured factors such as clinician judgment, concurrent quality improvement initiatives, or patient characteristics which may have contributed to the observed outcomes. These studies should also evaluate AI integration, track long-term endpoints (e.g. complications, mortality) and include cost-effectiveness analyses.

CONCLUSION

Integrating even basic CDSS into routine diabetes care across multiple countries enhanced clinical practices and improved patient outcomes. By providing real-time nudges during consultations, the CDSS empowered healthcare providers to intensify treatment and monitor patients with uncontrolled diabetes more effectively, leading to higher rates of glycemic control among patients who received therapy adjustments. Frontline health workers reported that the nudges standardized care and aligned decisions with guidelines, all without disrupting workflows. The system's relatively high uptake and positive reception highlights its feasibility in resource-limited settings, particularly when designed with local user needs in mind. As digital health evolves, CDSS tools like this hold immense promise for scaling precision care and transforming chronic disease management by making actionable data readily available at every patient encounter. Future work should explore rigorous research, broader disease applications, AI integration, patient engagement and address health system infrastructure barriers to fully realize the potential of CDSS in strengthening data-driven healthcare delivery.

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