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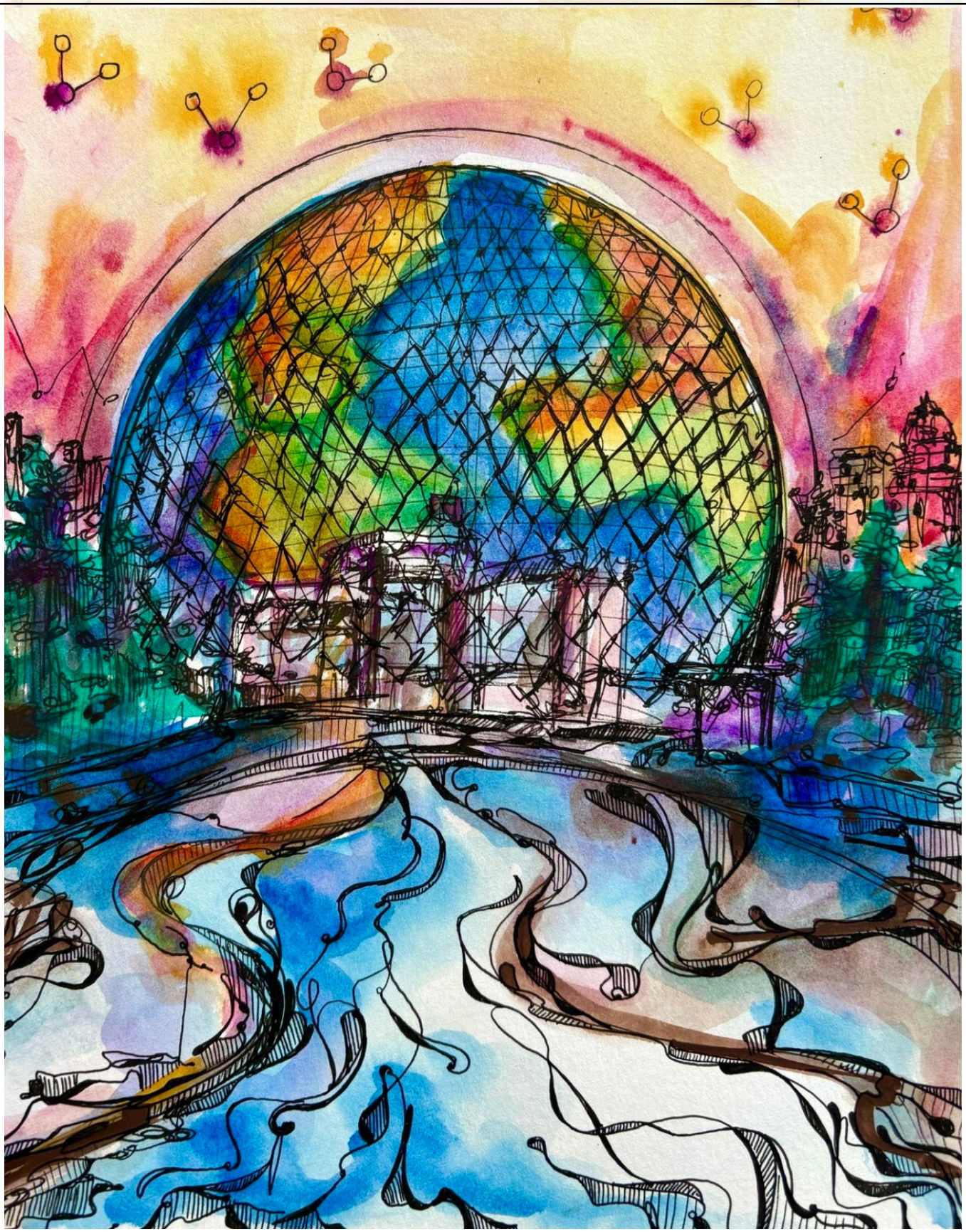

Case Study

Development, Implementation, and Evaluation of a Health Information System for a Rural Clinic in Pakistan: A Pilot Model for Low-Resource Settings

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Abstract

Background: Health information systems (HIS) play a pivotal role in modern healthcare by improving patient outcomes, enhancing data management, and supporting public health initiatives. Despite these benefits, HIS adoption remains limited in rural areas of low- and middle-income countries (LMICs), where healthcare challenges are more pronounced. This study describes the development, implementation, and evaluation of a clinician led HIS model in a rural clinic in Sadwal Kalaan, Punjab, Pakistan. **Methods and Materials:** A structured four-step approach was used in developing, implementing and evaluating the HIS: 1) assessing the need for a HIS through interviews and focus group discussions with the clinic manager, physicians, and auxiliary healthcare staff; 2) designing a system tailored to the clinic's context; 3) implementing a patient intake form designed using a survey questionnaire; and 4) evaluating adoption guided by iterative feedback from key stakeholders and impact on healthcare delivery. **Results:** The HIS was successfully integrated into the clinic's workflow, facilitating patient follow-up by enabling retrieval of previous medical visits. Data was collected from 3,900 patient encounters on demographics, medical presentation, management, and overall patient satisfaction. Nearly all (99.8%) of respondents provided sufficient information regarding their condition and treatment. The system enhanced clinic operations by facilitating data-driven decision-making, optimizing resource allocation, and informing medication stock management. Despite initial resistance from staff regarding additional documentation workload, structured training and workflow adaptations ensured successful adoption. **Conclusion:** Overall, the findings demonstrate that implementing a clinician-led HIS in rural Pakistan is feasible and beneficial, offering scalability for similar settings in other LMICs.

Keywords: Health information systems; Community healthcare; Healthcare delivery; Healthcare innovation; Pakistan

Introduction

Health information systems (HIS) play a critical role in modern healthcare by leveraging technology to facilitate efficient, accurate data collection that enables data-driven improvements inpatient care, workflow efficiency, operations management, and public health surveillance in a sustainable and streamlined manner, enhancing health outcomes [1-4]. These systems provide a comprehensive framework for managing various aspects of healthcare, including administrative, financial, and clinical decision support processes.

In low- and middle-income countries (LMICs) like Pakistan, the adoption of HIS is particularly essential due to the potential to achieve significant improvements in healthcare delivery. Despite the growing recognition of their benefits, the implementation of HIS in LMICs faces several barriers. These include high upfront costs, technological challenges, inadequate training, and issues related to data security and confidentiality [5-6]. However, there are also facilitators, such as clinician-led co-development and evaluation of HIS, which can enhance the integration of digital platforms into existing health systems and overcome these obstacles [5-6]. By engaging clinicians in the development and evaluation process, HIS can ensure that the system meets the needs of healthcare providers and enables sustainable and effective data collection and management.

The importance of HIS in improving health outcomes cannot be overstated. They enable the effective collection and management of patient data, which is crucial for both individual patient care and broader public health initiatives [1, 7]. In hospitals, HIS have demonstrated the ability to reduce medical errors, improve the accuracy and readability of data, and facilitate faster data retrieval. These improvements contribute to better patient outcomes and more efficient healthcare delivery [7]. In Pakistan, the healthcare system faces significant challenges, including limited government spending on health, outdated infrastructure, and a lack of coordination among various health information systems [8]. These barriers hinder the adoption of HIS in Pakistan, yet there is a clear and well-established need for a robust health information management system to support data-driven decision-making and improve healthcare outcomes [8-9].

Developing and implementing a model HIS for clinics in rural Pakistan is essential to address the information deficit and enhance healthcare delivery in these remote and resource-limited settings [10-11]. This paper describes a four-step approach to designing, implementing, and evaluating an HIS in rural Pakistan and provides insights into technological and organizational factors affecting its adoption to improve healthcare delivery and patient outcomes in Pakistan.

Methods and Results

2.1 Study Setting

We sought to establish a HIS in a rural community-based medical clinic in Sadwal Kalaan, Punjab, Pakistan. The clinic, named Assa Clinic, was launched in 2019 as a non-profit medical institution aimed at offering free basic health services (e.g., consultation, prescriptions, labs, request for imaging and specialist evaluation) to low-income families in rural Gujrat, and reduce the burden on the Punjab Health Commission and consequently, the nation. The clinic serves 120 patients/day (both pediatric and adult), manages various acute and chronic conditions, has access to a lab with limited operational capacity, one ECG machine, four patient beds, and primarily outpatient medications. At the time of this study, there were two primary care physicians and one auxiliary healthcare worker who took the role of patient flow management, registration and triaging, primary assessment, medication administration, and discharge planning, as well as another auxiliary healthcare staff to function as a laboratory technician and reduce the overall burden on the clinic where necessary.

2.2 Ethics Approval

Ethical approval was obtained from the Assa Clinic to use data from the patients' intake form. Formal research ethics board approval was not required for this quality improvement and implementation project, as no identifiable patient information was collected or analyzed, and the intervention was embedded in standard clinic operations. All data were obtained from patients who voluntarily agreed to complete the intake form as part of routine clinical care and consented to its use for quality improvement and evaluation purposes. Data were de-identified prior to analysis to protect patient confidentiality, and access was restricted to study coordinators.

2.3 Study Approach

This study followed a four-step structured approach to develop, implement, and evaluate the HIS, as outlined below:

2.3.1 Understanding the Need for a HIS at Assa Clinic - Step I

A two-week period between July 1–July 14, 2023 was dedicated to assessing the need for a HIS.This involved conducting structured interviews and focus group discussions with clinic management, physicians, and auxiliary healthcare staff to determine key priorities and system requirements. The first step for need assessment was to establish buy-in between the clinic administration. To do so, a series of interviews with clinic management, physicians, and healthcare staff were conducted separately and in groups to inquire about the vision and determine the need for a HIS most suitable for the clinic. A qualitative thematic coding approach, employing an inductive methodology, was utilized to analyze data collected throughout the study. No qualitative software was employed, thematic patterns were manually identified based on direct feedback from clinic staff and workflow assessments. The following themes emerged during interactions with the aforementioned stakeholders regarding the role and impact of the HIS at the Assa clinic:

2.3.1.1 Data Collection and Management: Implementing a HIS at the Assa clinic would streamline data collection and management processes. Patient records are traditionally maintained manually, which can lead to errors and inefficiencies, with no system to enable data retrieval during follow-up assessments. A user-friendly and cost-effective electronic health records (EHR) system can help ensure that patient demographics, medical history, and management information are accurately recorded and easily accessible. This digital transformation would enhance the continuity of care and reduce redundant tests and treatments [12-13].

2.3.1.2 Accuracy and Readability of Data: Digital records improve the accuracy and readability of patient information, eliminating the challenges associated with handwritten notes. This clarity is particularly crucial in a high-volume and resource-limited outpatient setting, where quick and accurate information retrieval is necessary for effective patient management [12,14]. Although no documentation on the patient encounter was available prior to this study, the staff at the clinic voiced attempts to do so via paper charting but their efforts were not sustainable due to the existing infrastructure (limited storage, technological capacity, and staff) concerns regarding perceived usefulness and increase in workload with little return on investment.

2.3.1.3 Faster Data Retrieval: A HIS facilitates faster data retrieval, enabling providers to quickly access a patient's medical history, lab results, and previous treatments. This efficiency is essential in a busy clinic like Assa clinic, where reducing wait times can improve patient satisfaction and increase clinic throughput [13, 15]. A major area of improvement identified by the host site was to enable patient follow-ups which will require retrieval of data around past medical visits at the clinic. Prior to the study, the clinic was serving primarily as an urgent care facility, but its vision was to transition to preventative care with periodic health visits and follow-ups.

2.3.1.4 Improvement in Health Outcomes: With comprehensive and accurate patient data, healthcare providers can make better-informed decisions, leading to improved health outcomes. The clinic serves a low-income community with limited access to healthcare. Many patients rely on the Assa clinic as their primary source of medical care. By

implementing a HIS, the clinic can offer more reliable and comprehensive care, ultimately improving the health and well-being of the community. Monitoring trends in patient demographics, common conditions, and treatment outcomes can help the clinic identify areas for improvement in its operations to allocate resources more effectively [12, 16].

2.3.1.5 Addressing Information Deficit: In Pakistan, where the healthcare burden is high and resources are limited, a HIS can address significant information deficits. Centralizing and digitizing patient data ensures that essential health information is accessible to providers, researchers, and policymakers, improving healthcare delivery and supporting public health initiatives [13-14, 16]. Buy-in was re-enforced with establishment of leadership by the clinic physicians to help implement the HIS and adapt as needed.

2.3.2 HIS Design and Development - Step II

Over the subsequent two weeks (July 15–July 31, 2023), a clinician-led HIS was designed based on iterative stakeholder feedback through structured interviews. A prototype system was developed as a patient-intake form, enabling data collection on patient demographics, medical history, clinical encounters, and overall patient experiences. Training materials for users were also prepared to facilitate implementation. The key elements of the HIS agreed upon by all groups included data collection on 1) patient demographics; 2) the medical encounter; 3) management of patient presentation and underlying medical condition; and 4) overall patient experience. Table 1 presents the details of the patient intake form. Various electronic data collection software and interfaces were presented to the team at the Assa clinic. Based primarily on familiarity, access, and ease of use for the healthcare staff at the Assa clinic, the Forms feature of Google was used as the data entry interface and Microsoft Excel as the data management tool. The liaison (RA) was offered to explore other options, to which they rated this set-up as the most favorable. A 2-hour training session regarding data collection and management was organized between the study investigators (RA) and the physician lead at the Assa clinic. To ensure survey completion, the survey responses were confidential although not anonymous. All experimental data was kept in a password-protected Excel file in the primary investigator's key-restricted office and only shared between study coordinators. All data was anonymized before being sent to a statistician excluding from data collection for analysis.

2.3.3 Implementation and Data Collection - Step III

The patient-intake form was implemented at the Assa clinic over six months (August 1, 2023 – January 31, 2024). Iterative feedback from clinic staff and healthcare providers was incorporated to refine the system. An organized process for implementing the HIS (patient-intake form) without disrupting patient flow was established. Patient registration to collect information on demographics and begin the medical encounter was done at an area deemed most suitable for access to patients and workflow of the healthcare liaison (RA). The medical encounter and management of patient presentation was handwritten by the physician and subsequently transcribed by the healthcare liaison (RA) to the electronic HIS interface. Data collection on the patient's experience was completed at time of discharge from clinic by the liaison (RA). Data collection was done using the Forms feature of Google and Microsoft excel. Regarding facilitators and barriers to implementation of the HIS, a qualitative thematic coding approach employing an inductive methodology was utilized. Thematic patterns were manually identified based on direct feedback from clinic staff, observations of patient-provider interactions, and workflow assessments. Emerging themes are discussed in the "Evaluation" section under "technological", "organizational", and "acceptability".

Table 1. Patient Intake Form: The HIS

Information Category	Data Collected
Part 1: Patient demographics	Name, age, gender, address, phone number
	Education status, housing status, transportation available
Part 2: Medical encounter	Reason for visit, past medical history
	New patient or follow-up
	Pregnant (yes or no) +/- access to pre-natal care
Part 3: Management of medical problem	Diagnosis and management plan
Part 4: Patient experience	Received information about health burden/condition
	Overall satisfaction with visit

2.3.4 Evaluation (February 1 – February 14, 2024) - Step IV

Data from 3,900 patient encounters were analyzed, enabling sustainable data collection to guide patient follow-up and management of the clinic's operations and resources.

2.3.4.1 Adoption: The HIS platform was successfully adopted at the Assa clinic since piloting its implementation in July 2023. From August 1, 2023-January 31, 2023, data was collected on 3900 patients, all of whom agreed to complete the patient intake for the purpose of this study and quality improvement and operations management of the clinic, including 3 attending physicians licensed with the College of Family Medicine Pakistan. Key participant demographics included gender (64.9% female, 35.1% male), education level (67.1% attended an educational institution; 52.4% did not complete secondary school), and residence in one of 17 unique communities within the clinic's catchment area. Data on patient follow-up was collected on 16% (624) of the population that had already completed a patient intake form, collecting the same information as their initial visit: gender, age, social determinants of health, past medical history, access to pre-natal care (if pregnant), previously established diagnosis and management plan. The HIS allowed for retrieval of prior clinical encounters, which was not previously feasible in the clinic's paper-based system. This improvement in continuity of care was a key indicator of enhanced follow-up. Information on patient experience collected at time of discharge demonstrated that 99.8% of

respondents affirmed receiving sufficient information regarding their condition and treatment, while 99.9% confirmed that their expectations for the visit were met.

The HIS also enabled management of the clinic's operations and resources as per feedback from clinic staff. Data collection on the burden of disease allowed clinic staff to redistribute healthcare resources toward these priority areas. The HIS facilitated data-driven decision-making, leading to informed medication stock management and adjustments in physician scheduling to accommodate high-demand services.

2.3.4.2 Technological: The proposed HIS was designed to meet the specific needs of a rural clinic with limited technological infrastructure. Recognizing the varying levels of digital literacy among clinic staff, the system was designed to be intuitive, with minimal reliance on complex software interfaces. The auxiliary healthcare worker responsible for data entry received hands-on demonstrations and ongoing virtual training to ensure competency. The HIS incorporated clinical documentation and basic decision-support tools, enabling efficient data collection and retrieval without significantly disrupting workflow. Compared to more comprehensive HIS models, such as those proposed by Malik et al. [8], this system was simplified to prioritize usability and sustainability in a resource-limited setting. Key considerations included ensuring offline data entry capacity, minimizing hardware requirements, and maintaining compatibility with the clinic's existing infrastructure. While advanced features such as automated clinical decision support, electronic discharge summaries, and computerized provider order entry were recognized as beneficial, they were excluded due to implementation constraints and stakeholder preferences.

2.3.4.3 Organizational: A clinician-led approach to system design ensured that the HIS remained adaptable, reliable, and responsive to evolving clinical needs. The HIS was developed with a focus on sustainability and seamless integration into the clinic's operational framework. Key organizational constraints, such as minimal storage space, unreliable internet access, and limited human resources, were addressed by designing a low-cost, scalable solution using Google Forms for data entry and Microsoft Excel for storage and analysis. Feedback from clinic administrators indicated that the HIS implementation aligned with budgetary constraints and demonstrated a favorable return on investment through improved patient data management and operational efficiency. This improvement in continuity of care was a key indicator of enhanced follow-up. Information on patient experience This improvement in continuity of care was a key indicator of enhanced follow-up. Information on patient experience clinical value, helping to sustain engagement and ensure long-term compliance. These organizational adaptations highlight the feasibility of HIS adoption in similarly resource-limited settings.

2.3.4.4 Acceptability: The HIS received strong acceptance from key stakeholders, including clinic administration, physicians, and healthcare staff, due to its perceived usefulness and ease of integration into routine workflows. Early engagement with stakeholders and iterative feedback sessions facilitated buy-in and minimized resistance to change. Training sessions were designed to be accessible and practical, allowing users with varying levels of technological proficiency to navigate the system effectively. A notable aspect of acceptability was the adaptability of intake processes to minimize disruption to clinical encounters. While some patients, particularly those with limited digital literacy, initially expressed concerns about providing additional information, these were addressed through clear communication by clinic staff. Intake data collection was strategically conducted during waiting periods to minimize workflow interruptions. Overall self-report patient experience was deemed excellent, a marker of strong acceptability of the HIS by patients. Despite initial concerns about increased workload, post-implementation evaluations confirmed that data entry tasks remained manageable. The HIS significantly enhanced patient follow-up, improved data-driven decision-making, and optimized resource allocation, reinforcing its overall value to the clinic.

Discussion and Conclusion

The implementation of a clinician-led HIS in a rural Pakistani clinic demonstrates the feasibility and benefits of digital health solutions in resource-limited settings. By enabling structured patient data collection, improving follow-up care, and enhancing clinic operations without overburdening staff, the HIS proved to be an effective and sustainable intervention. Key factors contributing to its success included a user-friendly interface, strategic workflow adaptation, and ongoing training, which minimized resistance and optimized usability. Stakeholder engagement and phased implementation further facilitated adoption, allowing the system to integrate seamlessly into existing clinical workflows. Challenges such as manual data entry burdens, sustainability beyond initial study periods, and generalizability to diverse clinical settings remain significant.

This study has several limitations. First, the sample selection bias may have influenced the findings, as participants were limited to those who sought care at a single rural clinic, limiting generalizability. Training staff to incorporate this HIS into the host site requires language proficiency from the principal investigators, which may also hinder generalizability to other regions or LMICs. Second, interviewer bias may have been introduced during qualitative data analysis, as thematic coding was conducted manually without the use of qualitative analysis software, leading to potential subjectivity in theme identification. Third, challenges in maintaining objectivity arose due to the clinician-led nature of the HIS implementation, which may have resulted in confirmation

bias among participants and socially desirable responses in feedback. To mitigate these biases, iterative stakeholder discussions were conducted, and patient satisfaction surveys were self-administered to ensure anonymity. Another major limitation of this study was a methodological design that did not allow for a robust evaluation of the HIS' impact.

Future efforts will integrate advanced data analytics and user-friendly electronic interfaces to enhance the interpretation of patient-reported information and facilitate patient participation in data collection, ultimately supporting patient-led health service improvement. To broaden the impact of the HIS model, we aim to export it to additional rural clinics in Pakistan and other healthcare settings. Strategic collaborations with governmental and non-governmental health organizations will be pursued to facilitate a national rollout strategy, enabling wider adoption in low-resource healthcare settings. Future research will focus on scaling up HIS implementation by incorporating automated analytics and exploring efficient patient-led data entry methods. Long-term success will be ensured through multisite evaluations to expand HIS adoption, alongside continued collaborations with governmental and non-governmental organizations.

This study provides a model for HIS adoption in similar low-resource settings, underscoring the transformative potential of digital health in strengthening healthcare delivery and improving patient outcomes in LMICs.

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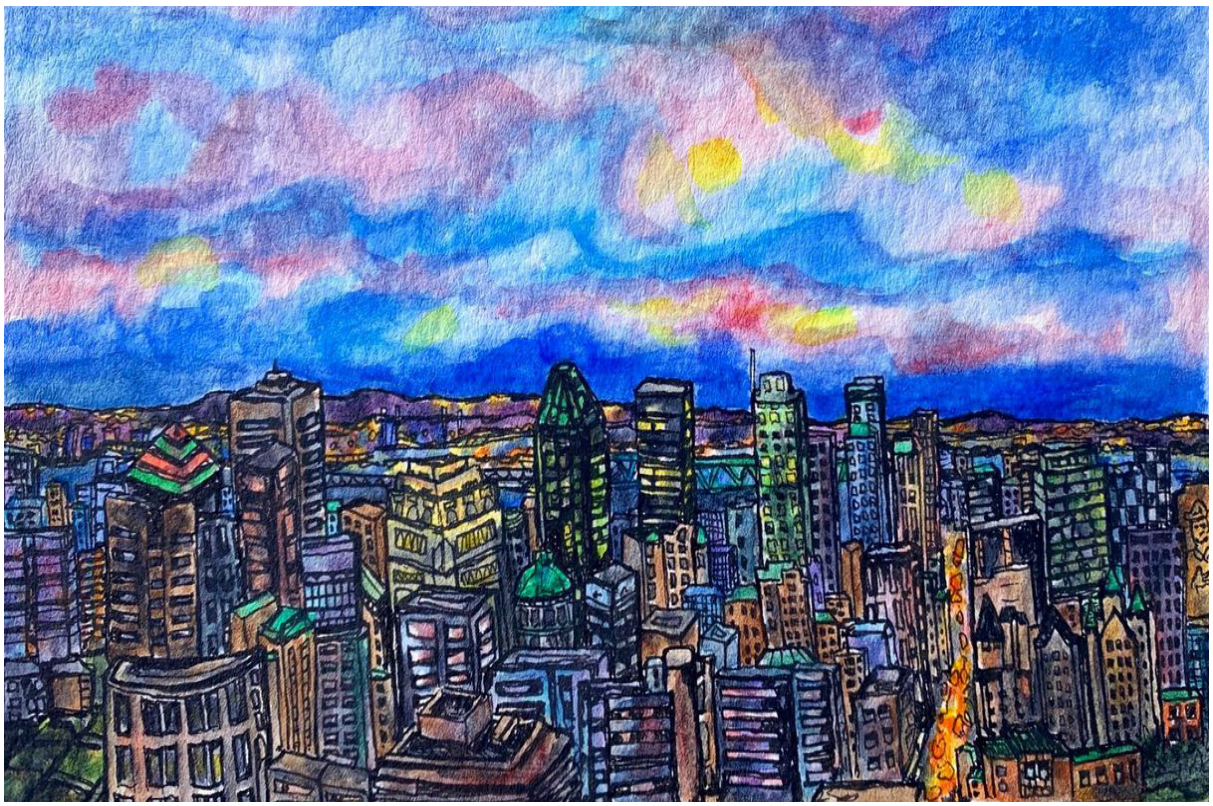

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