## **Bridging Diagnostic Gaps in STI Care: Development of a Lightweight Clinical Decision Support App for Syndromic Management**

## **Abstract**

**Background:** Sexually transmitted infections (STIs) remain a significant public health challenge, particularly in low- and middle-income countries (LMICs) where limited access to laboratory diagnostics necessitates the use of syndromic management. While practical, the syndromic approach often leads to diagnostic inaccuracies, overtreatment, and missed infections due to overlapping symptom profiles. Digital tools offer a promising avenue for enhancing decision-making, but few are tailored to frontline workflows in resource-limited settings.

**Objective:** To design, develop, and evaluate a lightweight, rule-based digital application-**Elomi STI Care App**-that supports syndromic diagnosis of seven priority STIs and prepares for future integration of artificial intelligence (AI) and real-world clinical deployment.

**Methods:** We employed a user-centered, modular development process using Python and the Streamlit framework. The app was built to support structured patient data entry, real-time rule-based diagnosis, and exportable clinical recommendations based on WHO syndromic algorithms. A synthetic dataset of 30 STI case scenarios was generated and used to evaluate the app’s diagnostic outputs in comparison with GPT-4. Agreement rates and diagnostic consistency were assessed and visualized using Python libraries.

**Results:** The Elomi STI Care App successfully generated standardized diagnoses across all simulated cases. Diagnostic agreement with GPT-4 was observed in 80% of cases. Mismatches primarily occurred in presentations with ambiguous or overlapping symptoms. The system demonstrated clear logic pathways, transparency in output reasoning, and readiness for iterative improvement. The app is publicly accessible via Streamlit Community Cloud and optimized for mobile use.

**Conclusion:** The Elomi STI Care App demonstrates the feasibility and potential of a digital, rule-based clinical decision support tool tailored for syndromic STI management in LMICs. Its architecture supports integration of AI and local health system features, offering a scalable solution for enhancing STI diagnosis and treatment. Future work will focus on real-world validation, multilingual support, and machine learning enhancements.

**Keywords:** STIs, syndromic management, digital health, clinical decision support, low-resource settings, Elomi, AI in healthcare, rule-based diagnosis

## **Background**

Sexually transmitted infections (STIs) continue to pose a major global public health challenge, with the World Health Organization (WHO) estimating over 1 million new curable STI cases daily. These infections, which include Chlamydia, Gonorrhea, Syphilis, and Trichomoniasis, along with viral STIs such as HIV, HPV, and Hepatitis B, contribute significantly to morbidity and mortality worldwide. Beyond the immediate symptoms, untreated STIs can lead to long-term complications such as infertility, chronic pelvic pain, cervical cancer, adverse pregnancy outcomes, neonatal infections, and an increased risk of HIV acquisition and transmission.

The burden of STIs is disproportionately concentrated in low- and middle-income countries (LMICs), particularly in sub-Saharan Africa. In these settings, healthcare systems often face severe constraints in infrastructure, trained personnel, diagnostic laboratories, and access to treatment. These limitations have necessitated reliance on the syndromic approach for STI management — a method that identifies clinical syndromes (e.g., vaginal discharge, urethral discharge, genital ulcers) and provides empirical treatment based on symptom clusters without laboratory confirmation.

While syndromic management is practical and accessible, it is also inherently limited. Many STIs share overlapping symptom profiles, and a significant proportion of infected individuals are asymptomatic. As a result, syndromic algorithms often lead to diagnostic inaccuracies, including overtreatment, missed infections, and inappropriate antimicrobial use. These shortcomings not only impact patient outcomes and public trust in care services but also contribute to the escalation of antimicrobial resistance, particularly in STI pathogens such as Neisseria gonorrhoeae.

In recent years, digital health technologies have emerged as promising tools to strengthen health systems in LMICs. Mobile health (mHealth) solutions and clinical decision support systems (CDSS) can improve diagnostic accuracy, standardize care protocols, facilitate training, and bridge the expertise gap at the point of care. However, many existing tools are either too complex for field use, require robust internet connectivity, or are not tailored to the syndromic management model used in primary care settings in Africa and other LMIC regions.

To address these challenges, the **Elomi STI Care App** was conceived as a lightweight, modular, and locally adaptable digital tool designed specifically for syndromic STI diagnosis. The app supports frontline health workers by offering a streamlined interface for entering patient symptoms, demographic data, and risk factors, then delivering instant diagnostic suggestions and clinical recommendations based on standardized algorithms. Developed using Python and Streamlit, the application is fully functional on web and mobile platforms and does not require internet access after deployment. Its modular architecture supports future integration with AI models, local language interfaces, and secure case-tracking databases.

The Elomi STI Care App aims to fill a critical gap in STI care by enhancing the accuracy and consistency of syndromic diagnosis, reducing unnecessary treatment, and laying the groundwork for digital surveillance and learning health systems in resource-limited environments. This paper details the development process, architectural design, and preliminary validation of the app using synthetic case data and comparative evaluation with GPT-generated diagnostic reasoning.

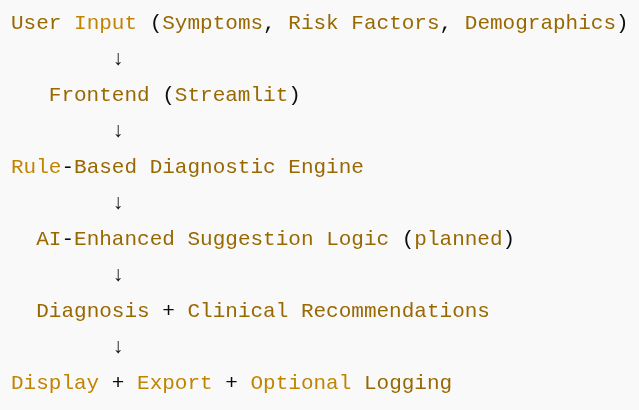
## **Methodology**

### **Needs Assessment and Design Rationale**

The development of the Elomi STI Care App followed a structured, iterative, and user-centered approach aimed at creating a lightweight, AI-enhanced clinical decision support tool tailored for syndromic STI management in low-resource settings. The app was conceptualized to address a critical gap in the diagnosis and triage of sexually transmitted infections (STIs) in low- and middle-income countries (LMICs), where syndromic management remains the dominant approach due to limited diagnostic capacity. Through an initial landscape analysis, seven high-priority STIs were selected for coverage: Chlamydia, Gonorrhea, Syphilis, Trichomoniasis, HIV, HPV, and Hepatitis B. The design emphasized three principles: clinical utility, technological simplicity, and scalability.

### **System Architecture and Functionality**

To implement the core functionality, the app was designed using a layered system architecture. The user interface was responsible for collecting patient demographic details, symptom descriptions, and behavioral risk factors through structured forms and free-text fields. Input data were then parsed and standardized before being processed by a rule-based diagnostic engine. This engine applied predefined clinical logic aligned with WHO syndromic management algorithms to determine the most probable and an alternative diagnosis. Based on these outputs, the system generated tailored treatment and referral recommendations, which were then presented interactively to the user along with options for export or documentation. This modular design ensured flexibility and compatibility with future integrations, including AI modules and health data systems.



### **Development Process and Tools**

The development process was agile and iterative. It began with defining a focused clinical scope and rapidly prototyping a basic rule engine. Development was carried out entirely in Python 3.10, leveraging Streamlit for web interface construction. Streamlit’s simplicity and responsiveness made it ideal for fast prototyping, especially with its support for dynamic components, markdown rendering, and mobile-friendly deployment. To manage patient data and symptom logic, the pandas library was used extensively, providing the core structure for transforming inputs and producing rule-based outputs. The logic was kept transparent and editable, allowing for easy updates as syndromic guidelines evolve.

Visualization and evaluation components were implemented using matplotlib and seaborn, which enabled internal testing and visual review of diagnostic patterns. Although not yet integrated into the live version, Plotly was identified as a future addition for interactive visualization and dashboard capabilities. The application codebase was version-controlled using Git and hosted on GitHub, following a clean branching model that separated stable releases from ongoing feature development. Dependency management was handled via a requirements.txt file, ensuring that all environments could be consistently replicated.

### **Deployment and Hosting**

Deployment was done through Streamlit Community Cloud, which provided a seamless hosting solution directly integrated with GitHub. This allowed rapid testing, version updates, and public access to the prototype for stakeholder feedback. The app is currently live and optimized for both desktop and mobile browsers (https://elomi-sti-care-ajc47a3s5xbkrtpt5xojos.streamlit.app/).

### **Planned Enhancements**

The current rule-based system has been intentionally structured to allow for transition into a more intelligent platform. Planned enhancements include machine learning integration using models such as LightGBM, explainable AI techniques such as SHAP and LIME, and database support through Supabase (PostgreSQL) for user authentication and case logging. Additional features under consideration include multilingual support, voice-assisted input (e.g., in Amharic), and packaging of the tool as a Progressive Web App (PWA) to enable offline functionality.

### **Evaluation Using Synthetic Data**

To evaluate the prototype, a synthetic dataset of 30 fictional STI cases was generated. Each record simulated a patient profile with demographic information and symptom presentations. The same dataset was analyzed by both the Elomi STI Care App and GPT-4, with outputs compared for diagnostic alignment. An agreement rate of 80% was observed, with discrepancies primarily attributed to symptom ambiguity or varying prioritization logic. The findings were visualized to inform further optimization of the rule-based engine and to guide future AI enhancements.

### **Ethical Considerations**

All data used in testing were synthetic and anonymized. The planned real-world deployment of the app will adhere to strict data protection protocols, including user authentication, privacy-preserving data logging, and compliance with ethical standards governing digital health tools.

This integrated approach—combining clinical insight, computational efficiency, and modular scalability-positions the Elomi STI Care App as a practical tool to support STI diagnosis and triage in challenging healthcare environments, with a clear pathway for future growth and sophistication.

## **Discussion**

The Elomi STI Care App represents a timely and practical innovation in the landscape of syndromic sexually transmitted infection (STI) management, particularly for low-resource settings where laboratory diagnostics are scarce and syndromic algorithms remain the standard of care. The development and early evaluation of the app highlight the feasibility and potential impact of leveraging digital health tools to improve clinical decision-making and streamline the diagnostic process at the point of care.

One of the core strengths of the Elomi STI Care App lies in its alignment with the operational realities of healthcare systems in sub-Saharan Africa and other low- and middle-income countries (LMICs). By incorporating standardized syndromic logic based on WHO guidelines into an easy-to-use, mobile-responsive interface, the tool enables even minimally trained health workers to arrive at structured and evidence-informed treatment decisions. This feature is particularly valuable in rural or under-resourced clinics where clinicians often work in isolation and without immediate access to supervisory guidance.

The use of synthetic patient data in evaluating the app’s diagnostic performance, particularly in comparison with a general-purpose language model like GPT-4, offers early but insightful validation. The observed 80% agreement rate underscores the app's consistency with general clinical reasoning while also highlighting opportunities for refinement. Cases of diagnostic mismatch between the app and GPT often involved overlapping symptomatology or less clearly defined syndromes, such as pelvic pain without discharge, which reinforces the known limitations of syndromic management. Importantly, this also signals where machine learning and probabilistic modeling may add value in future iterations of the tool.

While the current rule-based architecture provides transparency, interpretability, and stability, it is not without limitations. Rule-based systems can become rigid and may fail to capture the nuance of atypical or co-infectious presentations. In addition, the current app does not yet support probabilistic reasoning, adaptive learning, or integration of longitudinal patient data. These limitations underscore the need for planned enhancements, including machine learning classifiers, natural language processing for free-text inputs, and explainable AI frameworks such as SHAP and LIME to preserve clinician trust.

Furthermore, the evaluation relied on synthetic data rather than real-world patient records. Although synthetic testing is a necessary first step in system validation, it does not fully reflect the diversity of symptom reporting, linguistic variation, or behavioral nuances encountered in clinical practice. Future field studies involving real-time use of the app in clinical settings will be essential to assess usability, diagnostic accuracy, and patient outcomes. Such studies should also explore the app’s integration into broader health system workflows, including case reporting, follow-up mechanisms, and interoperability with existing digital platforms such as DHIS2 or OpenMRS.

Another critical consideration is the role of localization. STI prevalence patterns, cultural stigma, and health-seeking behaviors vary widely across contexts. The app must therefore support country-specific adaptations in diagnostic algorithms, language, and health system pathways while maintaining its core logic and architecture. Planned features such as multilingual interfaces (e.g., Amharic), offline access via Progressive Web App (PWA) packaging, and secure authentication will be instrumental in enhancing adoption and trust among users.

In conclusion, the Elomi STI Care App demonstrates a promising direction for digital support tools in public health STI management. By grounding its logic in syndromic care guidelines while maintaining adaptability for future AI integration, the app bridges a critical gap between clinical necessity and technological feasibility. Continued development, contextual validation, and stakeholder engagement will be essential in realizing its full potential as a scalable, ethical, and effective digital health intervention for STI control in LMICs.