Antenatal Medical Records System

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Abstract - This study aims to improve the delivery and management of antenatal care (ANC) services in resource-limited settings by developing a digital Antenatal Medical Records System integrated with SMS alert and live support functionalities. The general objective is to reduce maternal and neonatal health risks caused by inefficient manual record systems, missed appointments, and poor communication between patients and healthcare providers. The research employed the Agile software development methodology, incorporating requirement gathering, iterative system design, and incremental module testing. The system was built using PHP, MySQL, JavaScript, and integrated with the Twilio SMS API and Tawk.to live chat for communication features. Usability testing and simulated data were used to assess system functionality and user interaction. Key findings indicate that the system effectively reduces missed appointments through automated SMS reminders, improves access to accurate patient records, and facilitates real-time support for pregnant women. It also enhances provider workflow and decision-making by ensuring timely data access and structured communication. The implications of these findings suggest that implementing such a digital solution can significantly strengthen ANC delivery in developing regions. It is recommended that healthcare providers adopt scalable, low-cost digital systems to improve maternal health outcomes and align with Sustainable Development Goal 3 (Good Health and Well-being). Further studies are encouraged to expand the system for broader maternal and child healthcare services.

Keywords: Antenatal, Medical Records, Software Engineering, Agile, Health Systems.

Introduction

Antenatal care (ANC) is one of the most critical components of maternal and child healthcare services. It involves a series of systematic medical checkups, health education, and interventions provided to pregnant women to ensure a safe pregnancy and delivery. ANC services aim to monitor and promote the health of both the mother and the unborn child, detect early signs of complications, provide nutritional advice, and offer psychological support. According to the World Health Organization [1], antenatal care significantly reduces maternal and perinatal morbidity and mortality by facilitating timely diagnosis and management of pregnancy-related risks. The WHO recommends a minimum of eight ANC visits during pregnancy to enhance maternal and fetal outcomes. These visits provide the opportunity for healthcare providers to educate expectant mothers about pregnancy danger signs, childbirth preparation, breastfeeding, and postnatal care.

However, in many developing countries, especially in sub-Saharan Africa, the

delivery of antenatal care services faces numerous challenges. A key issue is the reliance on traditional, paper-based medical records systems, which are often inefficient, prone to errors, and susceptible to damage or loss. These manual systems make it difficult for healthcare providers to accurately track patient history, monitor appointment attendance, and ensure continuity of care. Moreover, patients in rural and underserved communities often experience long travel distances to healthcare facilities, inadequate transportation, financial constraints, and forgetfulness regarding scheduled visits — all of which contribute to poor ANC attendance and missed appointments [2]. In such settings, the absence of efficient reminders and communication between patients and healthcare providers leads to fragmented care and increases the risks of pregnancy-related complications.

Digital technologies have emerged as a promising solution to address the limitations of manual systems and improve maternal healthcare delivery. The integration of electronic medical record (EMR) systems in healthcare facilities allows for accurate and efficient storage, retrieval, and updating of patient information. EMRs reduce the administrative burden on healthcare providers, minimize the risk of data loss, and support better clinical decision-making by providing a comprehensive view of a patient's health history. More importantly, digital systems can be programmed to include automated appointment scheduling, reminders, and alerts, which enhance patient compliance and service delivery.

Among the various digital health interventions, the use of Short Message Service (SMS) alerts has gained popularity due to its affordability, simplicity, and wide reach. SMS reminders serve as an effective tool for notifying patients about upcoming appointments, test results, medication adherence, and health education messages.

Studies have shown that SMS-based health interventions can significantly improve patient engagement, reduce missed appointments, and increase the utilization of ANC services. For instance, authors [3] reported that implementing SMS reminders in a rural Nigerian community led to a 30% increase in ANC attendance. Similarly, a study by authors [4] found that SMS-based interventions were associated with improved maternal and newborn health outcomes in low- and middle-income countries.

Despite the critical role of antenatal care (ANC) in reducing maternal and infant mortality, many healthcare facilities in developing countries still rely on outdated paper-based systems that are inefficient, error-prone, and lack tools for proactive patient engagement. This leads to missed appointments, poor communication, and preventable complications—especially in rural areas where mobile phone access is high but underutilized for health communication. To address these challenges, there is an urgent need for an integrated digital system that stores antenatal records electronically, sends automated SMS reminders, and provides real-time live support for pregnant women.

1. **Inefficient Record Management:** Patient records are often poorly organized or maintained manually, leading to difficulties in retrieving accurate and timely information.

2. **Missed Appointments Due to Lack of Reminders:** Patients frequently miss scheduled appointments because there is no effective reminder system in place, affecting continuity of care.

3. **PoorPatient–Provider Communication:**Communication between patients and healthcare providers is often inadequate, resulting in

misunderstandings, delayed responses, and reduced patient satisfaction.

4. **Low Antenatal Care (ANC) Attendance and Adherence:** Many expectant mothers do not attend or complete the recommended antenatal care visits, increasing health risks for both mothers and infants.

5. **Limited Access to Medical History:** Healthcare providers often lack quick and easy access to comprehensive patient medical histories, which hinders informed decision-making and quality care delivery.

   The aim of this project is to design and implement an antenatal medical records system that automates patient data management and sends SMS alerts to patients for appointment reminders and other important health notifications. The Objectives are itemized below:

i. To develop a digital system for securely storing and managing antenatal medical records.
ii. To implement an SMS notification feature that reminds patients of upcoming antenatal appointments and key health alerts.
iii. To integrate a live support feature that enables real-time communication between patients and healthcare providers for guidance, inquiries, and follow-up care.
iv. To create a user-friendly interface for both healthcare providers and patients to interact with the system.
v. To ensure the system is scalable and adaptable to various healthcare environments.
vi. To evaluate the effectiveness of the system in improving antenatal care management and patient compliance.

   This study is significant because it addresses persistent challenges in the delivery and

management of antenatal care services, particularly in low-resource settings where maternal and infant mortality rates remain high.

Although a growing body of literature highlights the benefits of digital technologies in enhancing antenatal care (ANC), several important gaps persist in both research and practice, particularly in low- and middle-income countries like Nigeria. While individual components such as electronic medical records (EMRs), SMS-based reminders, and mobile health (mHealth) applications have been explored, there is a lack of integrated systems that combine these features into a single, unified solution tailored specifically for ANC.

One notable gap is the **limited integration of SMS and live support systems with electronic medical records**. Authors [4] and [5] focused on either SMS alerts to improve ANC attendance or on EMR systems for data storage and retrieval. However, few solutions simultaneously offer real-time communication (live chat) with healthcare providers, which is essential for addressing patient questions, emergencies, and ongoing health concerns between clinic visits.

Another gap lies in the **insufficient application of live chat or interactive communication platforms in ANC**, especially in the context of sub-Saharan Africa. While live support has been adopted in mental health and HIV counseling [6], its application in maternal healthcare remains limited or undocumented. As a result, many expectant mothers—especially first-time mothers or those in rural areas—lack timely access to health guidance outside scheduled appointments, which can delay life-saving decisions [7].

Additionally, existing systems often lack

scalability, low-cost design, and contextual adaptability for use in rural or resource-constrained environments. Many advanced systems are either donor-funded pilot projects or designed for urban health centers, making them difficult to replicate or sustain in the long term without significant financial investment [8]. This raises a need for affordable, open-source-based solutions that can be easily deployed and managed by local health facilities.

Furthermore, **limited user-centered design** is a recurring challenge in many existing solutions [9], [10]. Some digital systems are developed without involving end users—both healthcare providers and pregnant women—resulting in low adoption due to complexity, language barriers, or poor user experience. There is a clear need for systems that prioritize usability, simplicity, and accessibility.

Methodology

The methodology adopted for this work is the **Agile Software Development Methodology**, specifically tailored to ensure flexibility, user involvement, and rapid iterative development.

To collect accurate and relevant information about the current antenatal record management process, the following data gathering methods were employed:

i.   **Interviews:** Structured interviews were conducted with healthcare providers, including antenatal nurses, midwives, and hospital administrative staff. These interviews provided insights into the workflow, common challenges, and user expectations.

ii.   **Observation:** Direct observations were made in selected health facilities to study how patient records are created, stored, and retrieved. This helped identify inefficiencies in the existing system.

iii.   **Document Review:** Existing patient forms, appointment logs, and registry books were examined to understand the data types being recorded and the frequency of updates.

Most antenatal clinics still use **manual, paper-based systems** for patient registration, appointment scheduling, and record-keeping. These records are stored in physical files and updated during patient visits. Communication with patients is informal and typically conducted verbally or through handwritten notes. Figure 1 shows the flowchart of the existing system.
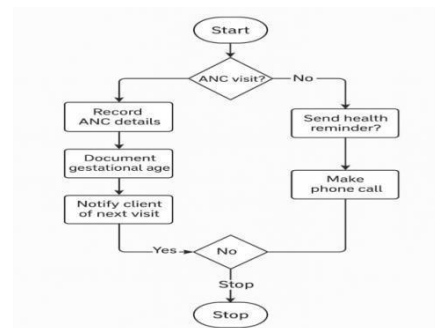
**Fig. 1:** Flowchart of the existing system

The new system is a **web-based antenatal records platform** with three core modules as listed below and figure 2 shows the flowchart of the new system.

1. **Electronic Medical Record (EMR) Module** – for registering and storing patient data.

2. **SMS Notification Module** – for sending automated appointment and health alerts via Twilio API.

3. **Live Support Module** – for real-time patient-provider communication using Tawk.to or WebSocket integration.
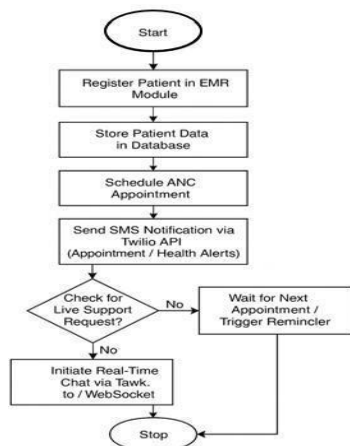
Fig. 2: Flowchart of new System

Figure 3 depicts the system architecture of the system.
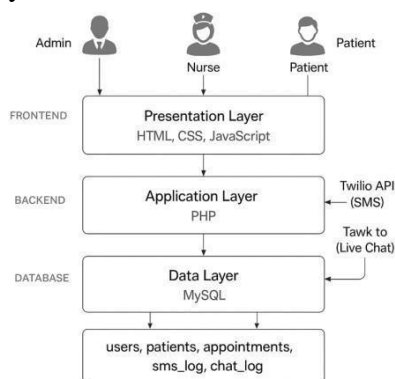
Fig. 3: Three- Tier System Architecture of the Antenatal Medical Records System

The new system is designed to address the core limitations of the existing manual process. It will allow healthcare workers to register patients digitally, schedule appointments, send SMS reminders, and engage in real-time communication. All records will be stored in a secure database with backup options and quick retrieval functionality. Key features include;

i. Searchable digital records
ii. SMS alert automation
iii. Live chat for guidance and follow-up
iv. User authentication and data security
v. Scalable and mobile-responsive design

System Design

The **main menu** as depicted in Figure 4, serves as the central navigation interface of the system and is presented upon successful login by an authorized user (e.g., doctor, nurse, or admin). It is designed to provide quick access to the core functionalities of the application in a clean and user-friendly manner.
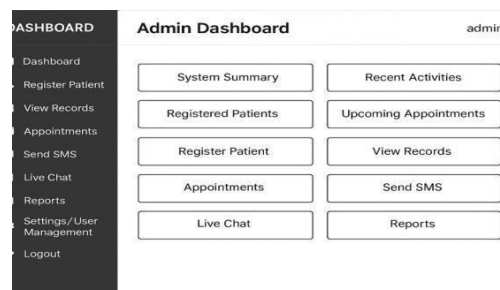
Fig. 4: Atenatal Medical Records System with SMS Alert and Live Support Main menu design

As reflected in the current admin dashboard prototype, the main menu includes the following options:

i. **Dashboard:** Displays system summary, recent activities, and key statistics such as number of registered patients and upcoming appointments.

ii. **Register Patient:** Opens the form used to input new patient details into the system database.

iii. **View Records:** Allows the admin to search, view, update, or delete patient records.

iv. **Appointments:** Enables appointment creation, tracking, and editing.

v. **Send SMS:** Interface for configuring and sending SMS alerts (manually or automatically).

vi. **Live Chat:** Provides access to real-time messaging between the provider and registered patients.

vii. **Reports:** Generates downloadable reports on attendance, appointment history, and system usage.

viii. Settings/User Management: Allows admin to manage users, roles, permissions, and system configurations.

ix. Logout: Ends the user session securely. The main menu is structured for **role-based access**, meaning some items may be visible only to specific users (e.g., only admins can access user management). Icons, dropdowns, and color-coded indicators are used to enhance usability and reduce cognitive load.

Program Module Design

The program module design describes the functional architecture of specific system components, focusing on how each module operates and interacts with other parts of the system. This section highlights two core modules of the proposed antenatal medical records system: the **SMS Module** and the **Live Support Module**. These modules are designed to improve patient communication, enhance appointment compliance, and support real-time engagement with healthcare providers.

SMS Module

The SMS module is designed to automate the process of sending appointment reminders, health education tips, and other important alerts to patients via text messages. This module ensures that patients receive timely notifications, reducing the likelihood of missed antenatal visits and increasing compliance with scheduled care.

Functional Features:

I. Template Management: Predefined SMS templates are used for common notifications (e.g., ―Your antenatal appointment is scheduled for [DATE] at [TIME]‖).

II. Automated Scheduling: SMS reminders are automatically triggered based on appointment data stored in the database.

III. Manual SMS Sender: Allows healthcare staff to send custom messages to individual patients when necessary.

IV. Bulk Messaging: Enables broadcast messages to a group of patients, useful for health campaigns or service alerts.

V. Delivery Tracking: Integrates with Twilio's delivery reports to confirm whether each SMS was sent and received successfully.

VI. Logs and Auditing: Each message is stored in a message log with timestamp, recipient number, content, and status.

Technology Used:

i. **Twilio SMS API**

ii. **PHP (for backend integration)**

iii. **MySQL (to store messages, status, and configurations)**

Workflow Overview:

1. Appointment is created or updated in the system.

2. Scheduler checks for appointments due within the notification window (e.g., 24–48 hours ahead).

3. Predefined SMS is selected, personalized, and sent to the patient's registered phone number.

4. Delivery status is logged and viewable by admin users.

LiveSupport Module (WebSocket or Chat API Integration)

The Live Support Module enables real-time communication between patients and healthcare providers through a web-based chat interface. It is designed to improve patient-provider engagement by providing a direct, on-demand support channel outside of physical clinic visits.

Functional Features:

i. **Real-Time Messaging:** Patients and staff can send and receive messages instantly.

ii.   **Online Status Monitoring:** Indicates whether a healthcare staff member is available for chat.

iii. **Session Management:** Manages multiple concurrent chats and ensures privacy by isolating each conversation.

iv.   **Chat History:** Logs all chat interactions for future reference, patient follow-up, and quality assurance.

v.   **Push Notifications:** Alerts staff when a new message arrives to ensure timely responses.

vi.   **Mobile and Desktop Support:** Responsive design for access across multiple devices.

Technology Options:

i.   **WebSocket (for real-time communication)**

ii.   **Firebase Realtime Database (alternative for low-latency chat integration)**

iii. **Tawk.to (embedded chat widget for low-code implementation)**

Integration Approach:

- **Option1: WebSocket Implementation**
  A custom backend service using PHP and a WebSocket server (e.g., Ratchet) to enable low-latency communication. Suitable for in-house hosting and full customization.

- **Option 2: Tawk.to Integration**
  A third-party, plug-and-play chat widget embedded directly into the system interface. Offers real-time chat, offline messaging, and automatic email forwarding when staff are unavailable.

Workflow Overview:

1. Patient logs into the system and clicks on "Live Chat."

2. A request is routed to the live chat interface.

3. A healthcare provider responds, initiating a two-way conversation.

4. Messages are exchanged in real-time.

5. On chat closure, logs are stored in the database or the chat API service dashboard.

Both the **SMS Module** and the **Live Support Module** are critical to the effectiveness of the proposed system. The SMS module ensures that patients stay informed and reminded of appointments, while the live support module enhances communication, reduces information gaps, and increases overall trust in healthcare services. Together, they support patient engagement and contribute to safer, more consistent antenatal care.

System Implementation

The implementation of the Antenatal Medical Records System followed the Agile software development process, using iterative sprints to build and test key modules. The system was implemented using PHP for the server-side logic, MySQL for database management, HTML/CSS for frontend layout, and JavaScript for interactivity. Visual Studio Code served as the primary development environment, and XAMPP was used to host the application locally and later on hosted online to enable SMS and live chat functionality.

The implementation was phased, beginning with core modules like user authentication and patient records, followed by SMS alerts, live chat integration, and reporting tools.

The login input form as shown in Figure 5 is a form that will enable the Admin to have access to the system.
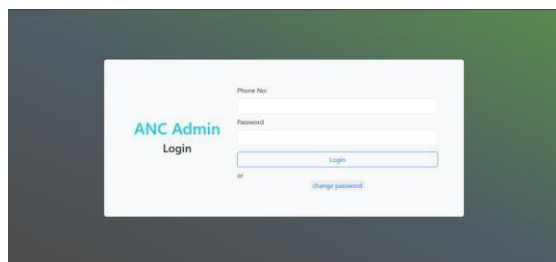
Fig. 5: Login Input Implementation

The admin Dashboard page implementation as shown in Figure 6 provides all the activities of the user in the system.
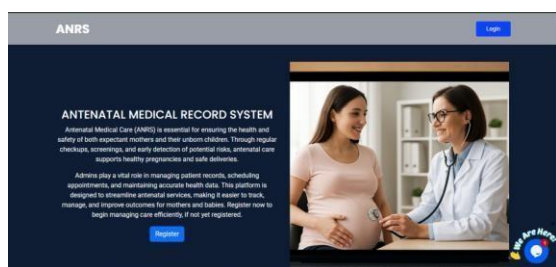
Fig. 6: Admin Dashboard page implementation

System Testing

System testing for the Antenatal Medical Records Systemwith SMS alert was conducted to ensure the system operates as designed, meets the specified requirements, and provides a secure and reliable environment for administrative users. The testing process was carried out to identify any potential bugs, evaluate the system's stability, and ensure its seamless operation. The results in table 1 were observed and compared to the expected outcomes.

Table 1 : Expected Results versus Actual Results

Test Conducted	Expected Result	Actual Result
Admin login	Admin should access the system securely.	Admin successfully logged in with valid credentials.
Record entry	Admin should input and save medical records.	Records saved and displayed correctly in the admin dashboard.
SMS Alert on Appointment	System sends SMS reminder to the patient.	SMS successfully sent with correct appointment details.
Update medical record	Admin should update patient details.	Updates reflected in the system and displayed correctly.
System performance	System should handle large amounts of data.	System handled large data inputs without lag or errors.

Conclusion

The successful design and implementation of the Antenatal Medical Records System with SMS alerts demonstrates its potential to significantly enhance the management of antenatal care. By automating patient record management and providing timely SMS notifications, the system improves both the efficiency of healthcare providers and the overall patient experience.

The system's ability to securely store sensitive medical data, along with its user-friendly interface, ensures that administrators can manage patient records efficiently. Additionally, the SMS alert feature contributes to better patient compliance by reminding them of important appointments and health notifications.

Overall, this project showcases the importance of integrating technology into healthcare systems to streamline processes, reduce human error, and improve patient outcomes. The system provides a scalable solution for healthcare facilities looking to improve their antenatal care management.

To ensure the long-term success and continuous improvement of the Antenatal Medical Records System with SMS alerts, the following recommendations are made:

i. Regular Updates and Maintenance: Implement periodic updates to enhance system security, address bugs, and introduce new features as needed.

ii. Mobile Application Development: Developing mobile applications for administrators could increase system accessibility and allow healthcare

providers to manage records and send alerts on the go.

iii. Integration with Electronic Health Records (EHR) Systems: Integration with existing EHR systems would enable seamless data transfer between different healthcare platforms, improving efficiency and reducing manual data entry.

iv. Enhanced User Interface: Improving the system's interface to provide additional features such as patient health tracking or analytics tools could make it even more beneficial for administrators.

v. Multilingual Support: Adding multilingual support to the system would make it accessible to a wider range of healthcare facilities, especially in regions with diverse populations.

vi. Expanded SMS Integration: Integrating SMS services with additional features such as two-way communication for patient queries or health alerts would further enhance patient engagement.

vii. Cloud-Based Deployment: Hosting the system on the cloud would ensure easy scalability, secure data storage, and better data access for healthcare providers across various locations.

viii. Training for Healthcare Providers: Organizing training sessions for administrators and healthcare staff to ensure effective system use and understanding of its features.

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