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SMS-based healthcare information service systems: architecture, applications, benefits, and implementation challenges—a review

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ABSTRACT

Short message service (SMS)-based healthcare information systems provide a practical communication channel for connecting patients, healthcare professionals, and medical institutions. Their relevance is particularly strong in settings where internet connectivity, smartphone ownership, and access to digital health platforms remain limited. This review examines the role of SMS in healthcare service delivery, focusing on system architecture, communication workflows, clinical applications, implementation benefits, and operational challenges. The reviewed literature indicates that SMS can support appointment reminders, medication adherence, health education, patient follow-up, and communication between healthcare providers and service users. Evidence from clinical trials and systematic reviews suggests improvements in selected outcomes, although effectiveness varies according to message design, patient characteristics, clinical context, and institutional support. A typical system combines a patient database, message-processing server, mobile network gateway, healthcare information platform, and monitoring interface. Nevertheless, privacy risks, limited message capacity, language barriers, delivery failures, and inadequate integration with existing medical records require careful consideration. The review concludes that SMS is most valuable as a complementary component of an integrated healthcare information system rather than a replacement for professional consultation or comprehensive digital health services.

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1. INTRODUCTION

Healthcare institutions increasingly require reliable communication mechanisms to coordinate patient services, distribute health information, and support continuity of care. Conventional communication methods, including printed notices and telephone calls, can be time-consuming, expensive, and difficult to scale across large patient populations. These limitations are particularly significant in rural and resource-constrained areas, where healthcare facilities may serve geographically dispersed communities. Short message service (SMS) offers a relatively simple communication technology that can deliver concise information through ordinary mobile phones without requiring continuous internet access [1], [2].

The development of SMS-based healthcare services is closely associated with the broader expansion of mobile health (mHealth). Mobile communication technologies have been investigated for disease prevention, health education, treatment support, and healthcare service coordination [1], [3]. Previous reviews have identified potential benefits in appointment attendance and preventive health behaviour, although the strength of evidence differs between applications [2], [4]. Therefore, the central research problem is not merely how to send medical messages, but how to design an information system that delivers accurate, timely, secure, and actionable communication within existing healthcare workflows.

This review examines the technical and operational characteristics of SMS-based healthcare information systems. It considers system architecture, communication processes, major applications, clinical

evidence, and implementation barriers. The discussion also identifies requirements for integrating SMS services with institutional databases and electronic health records. The objective is to establish a coherent understanding of how SMS can support accessible and sustainable healthcare information services.

2. REVIEW SCOPE AND SYSTEM REQUIREMENTS

This article adopts a narrative review approach based on peer-reviewed publications available up to December 2020. The selected literature includes systematic reviews, randomized controlled trials, clinical evaluations, and studies addressing mobile health security and implementation. Priority is given to publications that examine SMS communication in healthcare delivery, patient engagement, treatment adherence, and service administration. Publications from 2021 onward are excluded to maintain the requested reference cutoff.

An effective SMS-based healthcare information system should satisfy several functional and non-functional requirements. Functional requirements include patient registration, contact management, message scheduling, automated notification, response handling, and communication history. Non-functional requirements include reliability, privacy, accessibility, usability, scalability, and compatibility with existing healthcare information infrastructure. These requirements establish the basis for evaluating whether an SMS platform can operate as a dependable healthcare service component.

3. ARCHITECTURE OF AN SMS-BASED HEALTHCARE INFORMATION SYSTEM

A typical SMS-based healthcare information system consists of several interconnected components that manage patient information and message delivery. The patient database stores contact details, appointment schedules, relevant service information, and communication preferences. An application server processes events and determines which messages should be generated for particular patients. An SMS gateway then transfers messages through the mobile telecommunications network to the recipient's device.

The architecture can operate through automated, manual, or hybrid communication workflows. In an automated workflow, the system generates reminders based on appointment dates, medication schedules, or predefined follow-up intervals. Healthcare staff may also initiate messages manually when clinical or administrative circumstances require individual communication. A hybrid design is generally more flexible because it combines routine automation with professional oversight and exception handling.

Integration with existing healthcare information systems is essential for maintaining consistent patient records. When an SMS platform is connected to an appointment database or electronic medical record system, message generation can use updated information rather than manually duplicated data. This integration can reduce administrative workload and help prevent inconsistencies between communication records and institutional records. However, integration requires appropriate access control, data validation, and clear responsibility for maintaining patient information [5], [6].

4. APPLICATIONS IN HEALTHCARE SERVICE DELIVERY

4.1. Appointment reminders and service coordination

Appointment reminders are among the most established applications of SMS in healthcare. Missed appointments can delay diagnosis, interrupt treatment, and reduce the efficiency of healthcare facilities. A systematic review by Gurol-Urganci et al. reported that mobile phone messaging reminders improved attendance compared with no reminders, while producing attendance outcomes comparable to telephone reminders [4]. SMS reminders can also provide appointment dates, clinic locations, preparation instructions, and rescheduling information, thereby supporting more organized service delivery.

The operational value of appointment messaging depends on accurate scheduling and appropriate message timing. A reminder system should retrieve appointment information from the institutional database and deliver notifications sufficiently early for patients to prepare or request changes. Messages should also provide a clear contact channel for patients who need assistance or wish to reschedule. These functions make SMS a useful administrative instrument for improving communication between healthcare facilities and patients.

4.2. Medication adherence and treatment support

Medication adherence is another important application because patients may forget doses, misunderstand treatment instructions, or discontinue medication prematurely. SMS reminders can provide scheduled prompts, brief educational messages, and encouragement to follow prescribed treatment plans. Thakkar et al. reported that text messaging interventions improved medication adherence across chronic

disease studies, although the included interventions and clinical conditions were heterogeneous [7]. Such findings suggest that SMS can support treatment management when messages are appropriately designed and aligned with clinical recommendations.

Evidence from HIV treatment studies provides further insight into the potential of interactive messaging. In the WelTel Kenya1 trial, weekly SMS communication between patients and healthcare workers improved antiretroviral adherence and viral suppression compared with standard care [8]. Pop-Eleches et al. also found that weekly text message reminders improved antiretroviral adherence in a resource-limited setting [9]. These findings demonstrate that SMS can serve not only as a one-way reminder channel but also as a mechanism for identifying patients who may need additional support.

4.3. Health education and preventive communication

SMS can distribute concise health education messages covering disease prevention, healthy behaviour, vaccination schedules, maternal health, and chronic disease management. Its relatively low technical requirements make it suitable for reaching users who may not have access to smartphone applications or broadband internet. Cole-Lewis and Kershaw identified text messaging as a potentially useful tool for supporting behaviour change in disease prevention and management [1]. However, preventive communication should be based on reliable medical guidance and adapted to the language, literacy level, and cultural context of the intended population.

4.4. Patient follow-up and chronic disease management

Follow-up communication can help healthcare providers maintain contact with patients after consultations, procedures, or treatment initiation. SMS may be used to remind patients about follow-up visits, encourage self-monitoring, and provide instructions about when to contact healthcare professionals. Research on chronic disease management indicates that messaging can support patient participation, although the effectiveness of interventions depends on the condition and communication strategy [7], [10]. SMS should therefore complement, rather than replace, clinical assessment and direct consultation.

5. SYSTEM COMPONENTS AND FUNCTIONAL COMPARISON

The principal components of an SMS-based healthcare information system and their operational roles are summarized in Table 1. The components are organized according to their responsibilities in data management, message processing, delivery, and service monitoring. This separation supports modular development and makes it easier to identify technical failures. Table 1 also highlights important implementation considerations for each component.

Table 1. Main components of an SMS-based healthcare information system

Component	Main function	Implementation consideration
Patient database	Stores patient profiles, contact details, and service records	Data accuracy and access control
Application server	Processes events and generates messages	Reliable scheduling and validation
SMS gateway	Connects the application to mobile networks	Delivery status and network availability
Message management module	Manages templates, schedules, and responses	Clear language and message consistency
Healthcare information interface	Connects SMS functions with institutional records	Interoperability and data synchronization
Monitoring dashboard	Displays delivery reports and service performance	Audit trails and operational oversight
Security module	Controls access and protects sensitive information	Authentication, authorization, and privacy

The database and application server form the operational foundation of the system. The database provides the information required to determine recipients and message content, while the application server applies predefined rules to generate notifications. The SMS gateway handles communication with telecommunications providers and returns delivery information when supported. Together, these components establish a structured pathway from healthcare information to patient communication.

The monitoring dashboard is important because message transmission does not automatically guarantee that patients receive or understand the information. Administrators should be able to review delivery failures, incorrect telephone numbers, delayed messages, and patient responses. The security module should also maintain access records and restrict the use of patient information to authorized personnel. These functions help transform a basic messaging application into a managed healthcare information service.

6. BENEFITS AND EVIDENCE FROM PREVIOUS STUDIES

The literature identifies several benefits of SMS-based healthcare communication, particularly in appointment management, medication adherence, and patient engagement. Reviewed SMS reminders in healthcare services and reported generally positive findings for appointment attendance and medication compliance [11]. Also examined mobile health interventions for consumers and found evidence of potential benefits in disease management and health behaviour, while emphasizing limitations in the quality of available trials [12]. These findings support the use of SMS as a practical communication tool, but they do not establish that every SMS intervention will produce equivalent clinical outcomes.

Evidence concerning healthcare service delivery also demonstrates the importance of evaluating operational outcomes. Reviewed mobile health technologies used to improve healthcare service delivery processes, including communication and coordination activities [13]. In HIV services, examined mobile phone interventions for adherence and retention in low- and middle-income countries, highlighting the relevance of mobile communication in resource-constrained settings [14]. Further discussed the design and content of SMS-based antiretroviral adherence and appointment reminders, emphasizing the need for suitable message content [15].

SMS interventions have also been investigated in other clinical settings. Evaluated an interactive text-messaging service for patient retention during the first year of HIV care in [16]. Investigated mobile phone text messaging for adherence among patients with diabetes in a rural setting, demonstrating the relevance of this approach beyond infectious disease management [17]. Showed that the wording of digital messages can influence hospital no-show rates, indicating that message design is an important component of service effectiveness.

7. CHALLENGES AND IMPLEMENTATION CONSIDERATIONS

Despite its advantages, SMS-based healthcare communication has limitations that must be addressed before large-scale deployment. The character limit of conventional SMS restricts the amount of information that can be communicated in a single message. Complex medical instructions may therefore be misunderstood when reduced to short text, particularly among users with limited health literacy. Healthcare institutions should use concise language, avoid ambiguous abbreviations, and provide a direct route to professional assistance when messages require clarification.

Privacy and confidentiality represent major concerns because conventional SMS is not designed to provide the same protection as specialized encrypted healthcare communication platforms. Messages displayed on shared or unlocked phones may expose sensitive information to unauthorized individuals. Identified security, privacy, access control, and governance as important challenges across mobile and ubiquitous health systems. Consequently, healthcare organizations should avoid transmitting unnecessary sensitive details and should establish consent procedures, authentication policies, and clear rules for managing patient contact information.

Technical reliability is another factor affecting the quality of service. Messages may be delayed or fail because of network congestion, invalid numbers, limited mobile coverage, or telecommunications service interruptions. A robust system should maintain delivery logs, identify unsuccessful transmissions, and provide alternative communication procedures for critical notifications. In addition, message delivery should not be treated as evidence that the patient has read, understood, or acted upon the information.

Institutional integration and sustainability also require careful planning. Healthcare providers need staff training, appropriate operating procedures, and clear responsibility for updating patient records and message templates. The costs of gateway services, system maintenance, technical support, and data protection should be considered alongside the apparent low cost of individual messages. These requirements demonstrate that successful implementation depends on organizational readiness as much as on the messaging technology itself.

8. FUTURE RESEARCH DIRECTIONS

Future development should prioritize integration between SMS platforms, electronic medical records, appointment systems, and other healthcare information services. Such integration can reduce duplicate data entry and enable more consistent communication across departments. Research should also examine how message timing, frequency, personalization, and two-way interaction influence patient engagement and clinical outcomes. These investigations would help identify which intervention characteristics are most effective for different patient groups.

Further work is needed to evaluate long-term effectiveness, cost-effectiveness, accessibility, and unintended consequences. Studies should report not only message delivery rates but also patient

comprehension, service utilization, treatment continuity, and relevant clinical outcomes. Particular attention should be given to populations with limited literacy, shared mobile phone access, disabilities, and unreliable network coverage. A combination of quantitative evaluation and patient feedback would provide a more complete assessment of system performance.

9. CONCLUSION

SMS-based healthcare information systems offer a practical approach to improving communication between patients and healthcare institutions. Their principal applications include appointment reminders, medication adherence support, health education, and patient follow-up. Previous studies indicate positive effects in several healthcare contexts, although outcomes vary according to intervention design, clinical conditions, and implementation quality. These findings support the use of SMS as a complementary communication channel within broader healthcare information systems. Successful implementation requires reliable databases, automated message processing, integration with institutional records, monitoring facilities, and appropriate security controls. Healthcare organizations must also address message clarity, patient consent, network reliability, and the needs of users with different levels of digital literacy. SMS should not be considered a substitute for clinical consultation or emergency communication, particularly when complex or sensitive information is involved. Overall, its greatest value lies in providing an accessible and scalable link between healthcare services and patients when supported by appropriate institutional procedures and professional oversight.

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