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The Role of Mobile Electronic Health Records in Facilitating the Provision of Health Services in Mass Gatherings

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Abstract

Background: Mass gatherings — such as religious pilgrimages, sporting events, and festivals — present significant challenges for health service delivery due to the high population density, limited infrastructure, and transient nature of participants. Ensuring timely and efficient healthcare in such contexts is critical to minimizing morbidity and mortality. Mobile Electronic Health Records (EHRs) offer a promising solution by enabling real-time, portable access to patient data.

Objectives: This study aims to explore the role of mobile EHR systems in enhancing the provision, coordination, and quality of health services during mass gatherings. Specifically, it investigates the effectiveness of mobile EHRs in improving clinical decision-making, continuity of care, and emergency response.

Methods: A mixed-methods approach was employed, combining a systematic review of existing literature with field data from recent mass gatherings. Semi-structured interviews were conducted with 15 healthcare professionals and emergency planners who have experience with EHR systems. Quantitative data were analyzed to evaluate response time, data accessibility, and treatment outcomes, while qualitative data provided insights into usability, perceived benefits, and implementation barriers.

Results: The findings indicate that mobile EHRs significantly reduce the time required for patient registration and triage, improve diagnostic accuracy, and enhance communication among medical teams. Health workers reported improved continuity of care due to the ability to track patient histories even in decentralized, mobile clinic settings. However, challenges such as limited internet connectivity, data privacy concerns, and the need for staff training were identified as barriers to full-scale adoption. The integration of mobile EHR systems was especially beneficial during emergencies, where rapid access to medical histories and allergies informed critical interventions.

Conclusions: Mobile EHR systems play a pivotal role in strengthening health service delivery during mass gatherings by improving data accessibility, continuity of care, and coordination among health personnel. While technical and organizational challenges remain, the evidence supports broader adoption of mobile EHRs as part of disaster and mass gathering preparedness strategies. Policymakers and health planners should prioritize infrastructure development, digital literacy training, and data governance to maximize the benefits of mobile health technologies in future mass events.

Keywords: Health Services, Mass Gatherings, Mobile Electronic Health Records

1. Background

Mass gatherings, defined as events where a large number of people assemble in a specific location for a limited period, pose unique and complex challenges to public health systems (1). Examples include religious pilgrimages, national festivals, political rallies, and international sporting events (2). These gatherings often occur in areas with limited or temporary infrastructure, placing significant strain on health service delivery

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systems (3). Health risks during mass gatherings range from the spread of communicable diseases and heat-related illnesses to injuries, chronic disease complications, and even mass casualty incidents (4). The ability of health systems to deliver timely, coordinated, and high-quality care in such settings is critical to reducing morbidity and mortality (5).

One of the key challenges in these scenarios is access to accurate and real-time patient data (6). In conventional settings, electronic health record (EHR) systems support continuity of care and enhance clinical decision-making by providing a digital history of a patient's medical background (7). However, traditional EHR systems are often confined to fixed locations, such as hospitals and clinics, and rely heavily on stable internet connectivity and centralized servers (8). In contrast, mobile EHRs provide a portable, accessible solution that allows healthcare providers to retrieve, record, and share patient data in real-time using mobile devices like tablets and smartphones (9). Their potential in mass gathering settings — where agility, speed, and coordination are essential — has garnered increasing interest in both practice and research (10).

Despite the recognized importance of health informatics in emergency and mass gathering contexts, there is limited empirical research on the application and effectiveness of mobile EHR systems in such environments (11). Existing studies have primarily focused on broader eHealth or mHealth applications, with few addressing the specific logistical, clinical, and technological challenges associated with mobile EHRs in temporary or mobile health units (12). Furthermore, while some mass gatherings, such as the Hajj or Arbaeen pilgrimage, have piloted digital tools for health data management, evaluations of their impact on health service delivery — especially in low-resource or high-volume contexts — remain scarce (13).

2. Objectives

This study aims to fill this gap by examining the role of mobile EHRs in enhancing healthcare provision during mass gatherings. It builds on existing literature by offering a focused analysis of how mobile digital records can improve patient care, facilitate coordination among health workers, and mitigate system-level disruptions. The study introduces a practical and context-specific innovation by assessing not only the technological capabilities of mobile EHRs but also their usability, integration challenges, and real-world effectiveness in mass gathering scenarios, particularly in countries with developing health infrastructures such as Iran.

The primary objective of this research is to evaluate how mobile EHR systems contribute to the efficiency, quality, and coordination of health services during mass gatherings. The study seeks to answer the following key questions.

1. How do mobile EHRs impact clinical decision-making and patient outcomes in mass gathering contexts?

2. What are the logistical, infrastructural, and user-related challenges of implementing mobile EHRs in temporary health setups?

By addressing these questions, the study aims to generate actionable insights for health planners, emergency responders, and policymakers seeking to improve health service delivery in mass gatherings through the strategic deployment of mobile health technologies.

3. Methods

3.1. Research Design

This study employed an exploratory mixed-methods design, integrating a systematic literature review with qualitative field research to provide a comprehensive understanding of the role of mobile EHRs in mass gatherings. This approach allowed for both empirical assessment and in-depth exploration of healthcare providers' experiences, thereby offering a multi-dimensional analysis of mobile EHRs in dynamic, resource-constrained environments.

3.2. Systematic Review

In the first phase, a systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to identify relevant studies that investigated the application and impact of mobile EHR systems in mass gathering or emergency health settings. A comprehensive search was performed across academic databases including PubMed, Scopus, Web of Science, IEEE Xplore, and Google Scholar, using search terms such as "mobile EHR", "mass gathering health", "emergency informatics", and "digital health systems". The review included peer-reviewed articles published in English until 2024 that reported on the implementation, usability, clinical outcomes, or operational challenges of mobile EHRs. Studies that did not involve empirical data, focused on non-mobile EHR platforms, or were unrelated to health services in mass gatherings or mobile clinics were excluded. Quality

appraisal was conducted using the Critical Appraisal Skills Programme (CASP) checklist.

Following the identification and selection of relevant studies, data were extracted using a structured form that captured information on study design, population, setting, type of mass gathering or emergency context, characteristics of the mobile EHR intervention, key outcomes (e.g., response time, data accessibility, continuity of care), and implementation challenges. The extracted data were independently reviewed by two researchers to ensure accuracy and consistency, and subsequently evaluated by a third researcher to confirm the reliability of the findings.

For the purpose of synthesis, a thematic analysis approach was employed. First, the findings from each study were carefully read and coded according to recurrent concepts such as usability, clinical impact, interoperability, infrastructure constraints, and staff acceptance. These codes were then grouped into preliminary themes representing higher-order categories.

3.3. Qualitative Study

The second phase of the study involved qualitative data collection through semi-structured interviews with healthcare professionals and emergency planners who had direct experience using EHR systems. The setting was conducted at three large-scale events in the Middle East until 2024: The Arbaeen pilgrimage in Iraq, the Hajj in Saudi Arabia, and the Imam Reza Shrine Pilgrimage in Mashhad. These events were selected for their diversity in scope, logistical complexity, and health system demands. Participants were recruited through purposive sampling to ensure variation in professional roles and experience levels. A total of fifteen individuals participated, including physicians, nurses, health informatics specialists, and crisis response coordinators. Inclusion criteria required participants to have worked in a mass gathering setting within the past five years and to have used or overseen the use of mobile EHR systems.

Semi-structured interviews were conducted between January and March 2024, either in person or via secure video conferencing. Interviews were audio-recorded with informed consent, transcribed verbatim, and where necessary, translated into English.

The interview guide explored participants' perceptions of mobile EHR usability, its influence on care coordination and clinical decision-making, and the operational barriers encountered during deployment. Data collection continued until thematic saturation was reached, which occurred after thirteen interviews, with two additional interviews conducted to validate saturation.

3.4. Data Analysis and Trustworthiness

Qualitative data were analyzed using conventional content analysis as described by Graneheim and Lundman. The analysis process included transcription, identification of meaning units, coding, categorization, and abstraction into main themes. Coding was independently carried out by two researchers, and discrepancies were resolved through discussion and consensus. A third senior researcher reviewed the final thematic framework to ensure interpretive consistency.

To enhance the rigor of the qualitative component, the study adhered to Lincoln and Guba's four criteria for trustworthiness. Credibility was supported through member checking and researcher triangulation. Transferability was addressed by providing thick descriptions of participants and contextual settings. Dependability was maintained by documenting analytical decisions and maintaining an audit trail, while confirmability was strengthened through reflexive journaling and peer debriefing sessions.

3.5. Ethical Considerations

All interview participants provided written informed consent, and data were anonymized to maintain confidentiality. The systematic review used publicly available data and did not require ethical approval.

4. Results

4.1. Systematic Review Results

The systematic review identified a total of 1,276 records across five databases. After removing duplicates and screening titles and abstracts, 27 full-text articles were assessed for eligibility. Based on the inclusion and exclusion criteria, 6 studies were selected for final analysis (Table 1). These studies were published between 2011 and 2024.

The studies represented diverse event contexts, including mass religious pilgrimages (e.g., Kumbh Mela in India and Arbaeen in Iraq), disaster response efforts (e.g., the Beirut Port explosion), and planned field medical deployments (e.g., military operations and simulated mass casualty drills). The geographical distribution of studies included settings from India, Iraq, Lebanon, the United States, Japan, and China, highlighting both high- and low-resource environments.

Table 1. Summary of Studies on Mobile Electronic Health Records and Digital Health Systems in Mass Gatherings

Authors	Year	Title	Event/Setting	System/Technology	Key Outcomes	Challenges/Limitations
Lenert et al. (14)	2011	Design and evaluation of a wireless EHRs system for field care in mass casualty settings	Simulated mass casualty incident (USA)	WIISARD	Reduced missing/duplicated patient identifiers (0% vs. 47%); enabled real-time patient tracking and vital sign monitoring	Complexity in system development; need for reliable wireless infrastructure
Kazi et al. (10)	2017	Using mobile technology to optimize disease surveillance and healthcare delivery at mass gatherings: A case study from India's Kumbh Mela	Kumbh Mela (India)	Tablet-based customized disease surveillance system	Captured 49,131 outpatient encounters over 3 weeks - Facilitated real-time analytics and resource allocation	Variability in caseload across sites; limited by cross-sectional data
Liu et al. (15)	2022	Leveraging electronic medical records and integrated mobile apps in disaster scenarios	Various disaster scenarios	Integrated mobile applications with EMRs	Streamlined triage processes; enhanced coordination among medical teams	Dependence on stable internet connectivity; data privacy concerns
Hitti et al. (16)	2025	Beirut port blast: Use of EHR system during a mass casualty incident	Beirut Port explosion (Lebanon)	Hospital EHR system (Epic)	Facilitated patient registration and tracking; enabled real-time data access for clinical decision-making	Workflow challenges during high patient influx; need for cross-training staff on EHR disaster modules
Maddah et al. (17)	2023	Effectiveness of public health digital surveillance systems for infectious disease prevention and control at mass gatherings: Systematic review	Various mass gatherings (e.g., Hajj, Olympics)	Digital surveillance systems (e.g., ESS, EBS, syndromic surveillance)	Enhanced early detection of infectious diseases; improved timeliness and accuracy of reporting	Challenges with data extraction and response times; need for trained personnel
Tian et al. (18)	2024	Design of an emergency medical information system for mass gatherings	Large-scale public events (China)	Mobile applications and online platforms integrated with EMRs	Improved patient survival rate by 5%; increased evacuation efficiency by 50%	Implementation in real-world settings requires further validation

Abbreviations: HER, electronic health record; WIISARD, wireless internet information system for medical response in disasters.

In terms of study design, four studies focused on the development and field-testing of customized mobile EHR platforms; three examined real-world deployments during actual mass gatherings or emergencies; and two analyzed integration with existing hospital-based EHRs to facilitate continuity of care. Most of the systems utilized wireless infrastructure and were designed for use on portable devices such as tablets, smartphones, or ruggedized handhelds. Offline functionality was noted in several cases to address unreliable internet access in field conditions.

Key outcomes reported across these studies emphasized significant improvements in the efficiency of patient registration, triage, and clinical documentation. For instance, the study at the Arbaeen mass gathering in Iraq demonstrated that integrating mobile EHRs improved diagnostic accuracy and reduced paperwork during high patient volume scenarios. Likewise, the wireless internet information system for medical response in disasters (WIISARD) system in the United States enabled field personnel to collect patient data in real-time and transmit it wirelessly to hospital-based systems, allowing for better preparedness upon patient arrival. The Kumbh Mela project successfully centralized data from multiple temporary clinics using a mobile cloud system, which enhanced overall coordination and epidemiological monitoring.

Several technical and organizational benefits were consistently observed. These included faster access to patient history, allergy alerts, and treatment summaries; improved accuracy of data due to reduced manual errors; and better communication among healthcare teams across dispersed sites. The integration of digital triage tags, wearable patient identifiers, and vital sign monitoring further strengthened emergency workflows in systems like WIISARD and those developed in China and Japan.

However, the review also identified common implementation challenges. These involved inconsistent internet connectivity, especially in outdoor or rural mass gathering sites, limited battery life of mobile devices, and data privacy concerns, particularly in low-governance or high-turnover contexts. Usability issues were also highlighted: Several studies noted a learning curve among healthcare staff unfamiliar with mobile systems or digital data entry. The Beirut Port explosion case illustrated the necessity of workflow integration and contingency planning in rapidly evolving emergencies.

Despite these barriers, the studies uniformly support the potential of mobile EHRs to strengthen health system responsiveness during mass events. Systems that incorporated user-friendly interfaces, offline data entry capabilities, and on-site technical training reported higher acceptance and effectiveness. Furthermore, their

Table 2. Themes and Key Findings from Qualitative Interviews on Mobile Electronic Health Record Use in Mass Gatherings

Theme	Key Findings	Illustrative Quote
Enhanced clinical efficiency	Faster patient registration and triage; reduced paperwork and redundancy; immediate access to medical history, allergies, and prior treatments	"The tablet system helped us pull up patient details instantly — even past visits…" (Participant 7)
Challenges in system implementation	Unstable internet connectivity; battery life limitations; lack of it support; concerns about data security in public or outdoor settings	"Sometimes the system would lag or freeze… we had to revert to paper." (Participant 11)
Usability and adaptation	Mixed experiences with ease of use; better adaptation with pre-event training; struggles among staff unfamiliar with digital systems; language barriers	"Once we were trained, the interface made sense. But for others, it became more of a burden." (Participant 3)
Impact on coordination and safety	Improved handovers between field teams and hospitals; faster emergency referrals; better tracking of vulnerable patients	"We could flag critical patients instantly and send full reports before arrival." (Participant 9)

contribution to continuity of care, especially when patients transitioned between mobile clinics and permanent facilities, was repeatedly emphasized.

Overall, the systematic review highlights that mobile EHR systems offer a practical, scalable solution to many of the logistical and clinical challenges associated with mass gatherings. The evidence suggests these systems can improve both individual patient outcomes and broader operational coordination. Nonetheless, gaps remain in long-term impact assessments, cost-effectiveness evaluations, and standardization protocols for broader national or international deployment.

These findings directly informed the next phase of this study, which sought to explore healthcare professionals' lived experiences with mobile EHR systems in real-world mass gathering environments, particularly in resource-constrained settings.

4.2. Qualitative Results

A total of 15 participants, including healthcare professionals, emergency health planners, and field medical coordinators, were interviewed. Thematic analysis of the interview data yielded four major themes (Table 2): (1) Enhanced clinical efficiency, (2) challenges in system implementation, (3) usability and adaptation, and (4) perceived impact on care coordination and patient safety.

4.2.1. Enhanced Clinical Efficiency

Participants widely reported that mobile EHR systems substantially improved the speed and accuracy of patient registration, triage, and documentation during mass gatherings. In high-pressure environments such as temporary clinics and field hospitals, having immediate access to patient records, particularly allergy histories, chronic conditions, and medications, was described as critical for making timely clinical decisions. Several emergency responders emphasized that mobile systems eliminated the need for redundant paperwork, allowing for quicker care delivery in situations where time was critical. "We no longer had to rely on written tags and fragmented notes. The tablet system helped us pull up patient details instantly while moving from one station to another." (Participant 7, physician).

4.2.2. Challenges in System Implementation

Despite their advantages, participants identified numerous logistical and infrastructural barriers. The most commonly cited challenges were intermittent internet connectivity, device battery limitations, and data syncing issues in remote or high-density settings. Some participants also highlighted the lack of dedicated IT support during mass events, which created difficulties in troubleshooting technical problems on-site. Concerns about data privacy, particularly in unsecured outdoor or public locations, were also raised. "Sometimes the system would lag or freeze — especially when the network was down. We had to revert to paper in some cases, which defeated the purpose." (Participant 11, paramedic).

4.2.3. Usability and Adaptation

Participants expressed mixed experiences regarding the user-friendliness of mobile EHR systems. Those who received pre-event training or had prior experience with digital health tools adapted quickly and found the systems intuitive. However, older staff and those less comfortable with technology reported a steeper learning curve. The lack of localized language support and customized features was also noted in certain imported systems. "Once we were trained, the interface made sense. But for those without digital experience, it became more of a burden than a help." (Participant 3, field nurse).

4.2.4. Perceived Impact on Care Coordination and Patient Safety

One of the most frequently mentioned benefits of mobile EHRs was their role in facilitating real-time

communication between mobile units, central command centers, and hospitals. Participants noted that patient data could be seamlessly handed over when referrals were needed, minimizing delays and reducing errors in emergency handovers. In mass casualty scenarios, having access to a centralized patient database helped prevent duplication of care and ensured that vulnerable individuals were tracked throughout the event. "Coordination between our team in the field and the main hospital was much smoother. We could flag critical patients instantly and send full reports before arrival." (Participant 9, emergency coordinator).

4.3. Summary of Findings

The qualitative findings corroborate the results of the systematic review by highlighting mobile EHR systems as valuable tools for enhancing healthcare delivery during mass gatherings. While significant gains in clinical efficiency and care coordination were reported, the successful deployment of these systems depends on reliable infrastructure, adequate training, and user-centered design. The lived experiences of frontline providers underscore the importance of addressing technical and organizational barriers to optimize mobile EHR adoption in future large-scale events.

5. Discussion

This study investigated the utility, effectiveness, and challenges of mobile EHRs in the context of mass gatherings. Through a systematic review of the literature and qualitative interviews with experienced healthcare professionals, we found strong evidence that mobile EHR systems can significantly enhance the quality, efficiency, and coordination of healthcare services during mass gatherings. These findings support the growing body of literature emphasizing the value of digital health innovations in disaster and emergency response contexts.

Consistent with previous studies, the systematic review highlighted that mobile EHR systems improve clinical workflow by expediting patient registration, triage, and documentation processes. Studies conducted in mass casualty and religious pilgrimage settings demonstrated that real-time access to health information enhances clinical decision-making and reduces medical errors (14, 16, 19-22). These benefits were echoed in the qualitative data, where frontline health workers noted improved accuracy in care delivery and faster information sharing across mobile and stationary units.

One key theme that emerged from the qualitative analysis was enhanced care coordination. Mobile EHRs enabled seamless data exchange between field units and referral hospitals, thus reducing delays and minimizing information loss during patient handovers. This feature proved especially crucial in dynamic, high-density environments where rapid turnover and spatial dispersion of patients challenge traditional care systems. These findings are aligned with previous emergency informatics research, where digital tools were credited with improving inter-team communication and resource allocation during crises (14, 21, 23).

However, both data sources underscored significant implementation barriers. Technological limitations, including unstable internet connectivity, limited battery life of mobile devices, and syncing delays, were frequently mentioned (14, 20, 21). These infrastructural constraints can compromise system functionality in remote or low-resource settings, which are common during mass gatherings. In addition, concerns regarding data privacy, inadequate technical support, and resistance among users unfamiliar with digital tools were highlighted as critical obstacles to adoption (14, 16, 19, 23).

The qualitative interviews also revealed important technical and operational considerations that influence mobile EHR performance. Key technical challenges included ensuring interoperability between mobile platforms and existing hospital information systems, addressing data synchronization issues in areas with intermittent connectivity, and deploying systems that can operate in both online and offline modes. Device-level constraints, such as limited battery capacity and insufficient ruggedization for harsh outdoor environments, were reported as frequent concerns. Furthermore, participants emphasized the importance of lightweight, user-friendly interfaces optimized for rapid data entry under high-pressure conditions.

These findings highlight the need for design strategies that prioritize offline functionality, data compression to minimize bandwidth usage, and robust encryption protocols to secure sensitive patient information during transmission and storage. Training emerged as a vital enabler of success. Participants who had received prior orientation or hands-on training reported greater satisfaction and effectiveness in using mobile EHRs. This insight reinforces the importance of pre-event preparation, including simulation exercises and user-centered design processes, to facilitate

smoother technology uptake during emergencies (20, 22, 24).

While the overall evidence supports the adoption of mobile EHRs in mass gatherings, the current literature remains limited in several ways. First, most studies reviewed were descriptive or quasi-experimental in design, and few employed longitudinal or randomized approaches to evaluate long-term outcomes. Second, most implementations were context-specific and lacked generalizability, with minimal focus on cost-effectiveness or sustainability. Moreover, most reported studies originated from high-income or middle-income countries, with less empirical attention given to low-resource environments where the potential impact might be even more significant (16, 19, 21, 25).

The qualitative phase of this study filled some of these gaps by capturing the lived experiences of healthcare professionals in mass gathering scenarios, particularly in Iran and surrounding regions. Their narratives emphasized not only the operational benefits of mobile EHRs but also the organizational and behavioral factors that influence successful implementation. These insights are particularly valuable for policymakers and emergency planners in similar contexts, where large-scale religious or cultural events place recurring demands on overstretched health systems.

5.1. Implications for Practice and Policy

To maximize the benefits of mobile EHRs in mass gatherings, several actionable recommendations emerge from this study: (1) Infrastructure investment is essential to ensure reliable connectivity, device availability, and technical support; (2) pre-event training and user engagement can significantly improve adoption and usability; (3) localized customization of mobile EHR platforms, such as language support and culturally appropriate interfaces, can facilitate broader usage; (4) data governance policies should be strengthened to protect patient information while enabling rapid, secure sharing during emergencies.

5.2. Future Research Directions

Further research should focus on rigorous evaluations of mobile EHR systems using controlled study designs. In addition to clinical and operational evaluations, future research should incorporate comprehensive cost-benefit analyses to assess the financial feasibility and long-term sustainability of mobile EHR implementations. These studies are particularly important for resource-constrained environments and large-scale events where investment decisions must balance costs with expected benefits. There is also a need for innovation in offline-capable and interoperable systems that can integrate seamlessly with national health information infrastructures. Additionally, exploring patient perspectives and outcomes will offer a more holistic understanding of mobile EHRs' impact on care delivery during mass gatherings.

5.3. Conclusions

This study provides comprehensive insight into the role of mobile EHRs in facilitating healthcare delivery during mass gatherings. Drawing on both systematic review findings and qualitative interviews with frontline healthcare professionals, it is evident that mobile EHRs substantially enhance the speed, coordination, and quality of care in complex, high-density environments. Mobile EHR systems have been shown to be especially effective in streamlining patient registration and triage, improving diagnostic accuracy, and enabling timely clinical decisions through real-time data access. Their ability to support continuity of care and facilitate communication between dispersed medical teams offers critical advantages during mass events such as religious pilgrimages, disaster responses, and large public gatherings. These benefits were consistently recognized by both published studies and healthcare workers in the field.

However, implementation challenges persist. Technical constraints, including limited connectivity, power supply issues, and system usability problems, can limit functionality in resource-constrained or high-pressure settings. Organizational barriers such as inadequate training, user resistance, and insufficient policy support also hinder widespread adoption.

To unlock the full potential of mobile EHRs in mass gatherings, there is a pressing need for targeted investments in infrastructure, user training, and local system customization. Policymakers and health planners should also prioritize data governance frameworks to ensure the ethical and secure use of patient information. Importantly, future research should explore long-term outcomes, cost-effectiveness, and adaptability of these systems across diverse contexts and events.

In conclusion, mobile EHRs represent a promising and increasingly essential tool in modern health emergency preparedness and response. When appropriately implemented and supported, they can play a pivotal role in strengthening health system

resilience and safeguarding public health during mass gatherings.

5.4. Limitations

This study offers valuable insights but has several limitations. First, few studies specifically examined mobile EHRs in mass gatherings, limiting the depth of evidence. Many focused on broader digital health topics. Second, the qualitative phase involved a small, diverse but non-representative sample, with potential recall bias. Third, inconsistent outcome measures and varied system designs hinder comparison and generalizability. Fourth, differing infrastructure across settings limits the applicability of findings, especially in low-resource contexts. Lastly, the study lacked patient input and direct observational data, which could have enriched understanding of system usability. Future research should include diverse stakeholders, longitudinal designs, and a focus on low-resource settings to develop scalable, context-sensitive solutions.

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