

Cloud-Based Healthcare CRM Systems for Improved Patient Engagement

(Authors Details)

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Abstract

Cloud-based healthcare Customer Relationship Management (CRM) systems have emerged as a transformative approach to enhancing patient engagement, improving care coordination, and enabling personalized healthcare delivery. By leveraging cloud computing infrastructures, healthcare organizations can integrate patient data, communication channels, and analytics tools into a unified platform that supports real-time interaction between patients and providers. These systems facilitate efficient management of electronic health records, enable remote monitoring, and support patient-centered services such as appointment scheduling, automated reminders, and telehealth consultations. The adoption of cloud-based CRM in healthcare also enhances scalability, reduces operational costs, and improves accessibility to healthcare services across diverse populations.

Despite these advantages, the implementation of cloud-based healthcare CRM systems presents challenges related to data security, interoperability with legacy systems, and user adoption, particularly in resource-constrained environments. However, ongoing advancements in cloud technologies and healthcare informatics continue to address these limitations, making such systems increasingly viable and effective. Overall, cloud-based healthcare CRM systems represent a significant advancement in digital health innovation, offering substantial potential to improve patient satisfaction, engagement, and overall healthcare outcomes.

Keywords: Cloud Computing, Healthcare CRM, Patient Engagement, Electronic Health Records, Telehealth, Digital Health Systems, Patient-Centered Care, Health Informatics, Healthcare Analytics, Remote Monitoring

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I. Introduction

Cloud-based healthcare Customer Relationship Management (CRM) systems have emerged as a critical innovation in modern healthcare delivery, primarily driven by the need to improve patient engagement, coordination of care, and service personalization. These systems leverage cloud

computing infrastructures to integrate clinical data, communication channels, and analytical tools into unified platforms that support continuous and interactive patient-provider relationships (Noblin et al., 2014; Ekonomou et al., 2011). The increasing complexity of healthcare demands, coupled with the shift toward patient-centered care models, has positioned cloud-enabled CRM systems as essential tools for enhancing both operational efficiency and health outcomes.

Patient engagement has been widely recognized as a foundational element of effective healthcare systems, particularly within the context of learning health systems where patients actively participate in managing their health journeys (McGinnis et al., 2011). Cloud-based CRM systems extend this engagement by enabling real-time communication, personalized care delivery, and improved access to health information. Through integrated platforms, healthcare providers can deliver tailored communication strategies that improve adherence to treatment plans and overall patient satisfaction (Parimi, 2014; Anshari et al., 2012).

From an architectural standpoint, cloud-based healthcare systems rely on scalable and distributed infrastructures that support electronic medical record (EMR) integration, secure data exchange, and intelligent health analytics (Biswas et al., 2014). These systems are further strengthened by service-oriented cloud models that enhance flexibility and interoperability across healthcare environments (Moore et al., 2014). Additionally, advancements in cloud-based healthcare frameworks have enabled secure management of complex medical data, including multimedia and 3D imaging information, thereby expanding the scope of digital healthcare services (Castiglione et al., 2015).

Furthermore, the adoption of CRM systems within healthcare settings is influenced by both technological and organizational factors. Implementation studies highlight the importance of usability, system integration, and stakeholder acceptance in ensuring successful deployment within hospital environments (Monem et al., 2011; Moore & Sharma, 2013). In parallel, cloud-based healthcare applications have demonstrated potential in improving outreach and accessibility, particularly in underserved populations where sporadic healthcare engagement remains a challenge (Daw & Banerjee, 2015). Emerging innovations such as fuzzy logic systems and speech recognition technologies further enhance system intelligence and accessibility in cloud-based healthcare environments (Sundharakumar et al., 2015; Muhammad, 2015).

Interactive and patient-centered system design continues to evolve, with emphasis on enhancing engagement through adaptive and responsive healthcare interfaces (Tang et al., 2016). Collectively, these developments underscore the transformative role of cloud-based healthcare CRM systems in reshaping patient engagement strategies, improving care delivery efficiency, and fostering more responsive healthcare ecosystems.

II. Conceptual Foundation of Cloud-Based Healthcare CRM

Cloud-based healthcare Customer Relationship Management (CRM) systems are built on the convergence of cloud computing, healthcare information systems, and patient-centered engagement models. Conceptually, they extend traditional CRM frameworks by embedding clinical, administrative, and behavioral data into a unified cloud environment that supports continuous, personalized patient interaction and coordinated care delivery (Noblin et al., 2014; Parimi, 2014).

At the core of this foundation is the transition from provider-centric healthcare models to patient-centric, data-driven ecosystems. This shift aligns with the learning health system paradigm, where patient participation and feedback loops are continuously integrated into care improvement cycles (McGinnis et al., 2011). Cloud infrastructure enables this transformation by providing scalable storage, ubiquitous access, and interoperability across heterogeneous healthcare systems (Ekonomou et al., 2011).

1. Conceptual Pillars of Cloud-Based Healthcare CRM

Cloud-based healthcare CRM systems are underpinned by four interrelated conceptual pillars:

- **Patient-Centricity:** Emphasizing personalized communication, engagement, and shared decision-making (Anshari et al., 2012).
- **Cloud Enablement:** Leveraging distributed computing resources for scalable and on-demand healthcare services (Ekonomou et al., 2011).
- **Data Integration:** Consolidating electronic medical records, behavioral data, and interaction histories into unified repositories (Biswas et al., 2014).
- **Intelligent Engagement:** Using analytics, automation, and context-aware systems to tailor patient interactions (Moore et al., 2014).

These pillars collectively support enhanced patient satisfaction, improved adherence to treatment plans, and more efficient healthcare delivery systems (Parimi, 2014).

2. Functional Conceptualization in Healthcare Context

In healthcare environments, CRM systems are not merely transactional tools but interactive platforms that support continuous engagement. They facilitate communication between patients, clinicians, and healthcare administrators through integrated cloud services. This includes appointment scheduling, follow-up care, telehealth services, and personalized health education.

Advanced implementations incorporate fuzzy logic systems for clinical decision support (Sundharakumar et al., 2015), speech recognition for accessibility (Muhammad, 2015), and

context-aware services that dynamically adjust healthcare delivery based on patient conditions and environment (Moore et al., 2014).

Additionally, CRM software implementation in hospitals depends heavily on organizational alignment, usability, and patient acceptance, which directly influence adoption success (Monem et al., 2011).

3. Data Flow and Engagement Logic

Cloud-based healthcare CRM systems operate through continuous data flow cycles involving collection, processing, storage, and feedback. Patient data is gathered from multiple touchpoints, including hospital records, wearable devices, and patient portals, then processed in cloud environments for actionable insights.

This data-driven model enables proactive outreach and targeted interventions, particularly useful in managing chronic diseases and sporadic population outreach programs in resource-limited settings (Daw & Banerjee, 2015).

4. Core Conceptual Framework Overview

Table 1: Conceptual Components of Cloud-Based Healthcare CRM Systems

Conceptual Dimension	Description	Role in Patient Engagement	Supporting Studies
Patient-Centric Model	Focus on individualized care and communication	Enhances satisfaction and trust	Anshari et al., 2012; Parimi, 2014
Cloud Infrastructure	Distributed computing and storage systems	Enables accessibility and scalability	Ekonomou et al., 2011; Noblin et al., 2014
Data Integration Layer	Consolidation of EMR, behavioral, and interaction data	Supports holistic patient profiling	Biswas et al., 2014
Intelligent Analytics	Predictive and adaptive decision-making systems	Improves personalization and outcomes	Moore et al., 2014; Sundharakumar et al., 2015
Interaction Layer	Patient portals, mobile apps, and communication tools	Facilitates real-time engagement	Tang et al., 2016; Parimi, 2014

5. Conceptual Synthesis

The conceptual foundation of cloud-based healthcare CRM systems demonstrates a multi-layered integration of technology, data, and patient engagement strategies. Cloud computing acts as the enabling backbone, while CRM principles ensure that interactions remain personalized and value-driven. Together, these systems support a shift toward participatory healthcare models where patients are active contributors to their own care journeys (McGinnis et al., 2011; Tang et al., 2016).

In essence, cloud-based healthcare CRM is not solely a technological framework but a socio-technical ecosystem that redefines how healthcare services are delivered, experienced, and continuously improved.

III. Architecture of Cloud-Based Healthcare CRM Systems

The architecture of cloud-based healthcare CRM systems is designed as a multi-layered and service-oriented framework that integrates healthcare data, patient interaction modules, and cloud computing services to enable scalable, secure, and patient-centered care delivery. This architecture supports interoperability across healthcare systems while enabling real-time patient engagement and personalized service delivery (Economou et al., 2011; Biswas et al., 2014).

At its core, the architecture aligns cloud computing principles with healthcare CRM functionalities, allowing healthcare providers to manage patient relationships, clinical data, and engagement workflows within a unified ecosystem. This structure also supports learning health systems where continuous data feedback improves care quality and responsiveness (McGinnis et al., 2011).

A. Layered Architectural Structure

Cloud-based healthcare CRM systems are typically organized into three primary layers: infrastructure, platform, and application layers. Each layer performs distinct but interconnected roles in ensuring system efficiency, scalability, and patient engagement capability.

Table 2: Layered Architecture of Cloud-Based Healthcare CRM Systems

Layer	Key Components	Functions	Healthcare Value Contribution
Infrastructure Layer	Cloud servers, storage systems, virtualization, security frameworks	Provides computational power and secure data storage	Ensures scalability, reliability, and data availability

Platform Layer	Middleware, APIs, data integration tools, analytics engines	Enables interoperability, EMR integration, and data processing	Supports clinical data mining and system integration (Biswas et al., 2014)
Application Layer	Patient portals, CRM dashboards, telehealth systems, communication tools	Facilitates direct patient-provider interaction and service delivery	Enhances patient engagement and satisfaction (Noblin et al., 2014)

This layered model ensures that sensitive healthcare data is securely stored while still being accessible for real-time processing and patient engagement applications.

B. Service-Oriented and Context-Aware Integration

Modern healthcare CRM architectures increasingly adopt service-oriented architecture (SOA) and context-aware computing models. These allow systems to dynamically adapt services based on patient needs, location, and health conditions.

Context-as-a-Service models enhance CRM systems by enabling personalized healthcare delivery based on real-time contextual data such as patient behavior, medical history, and environmental conditions (Moore et al., 2014). This improves responsiveness and ensures that patient engagement strategies are tailored and effective.

Additionally, CRM 2.0 principles emphasize interactive and participatory healthcare systems where patients actively contribute to their care process through digital platforms (Anshari et al., 2012).

C. Data Management and Electronic Health Record Integration

A critical component of the architecture is the integration of Electronic Health Records (EHR) and data mining systems. These components allow healthcare providers to analyze patient data for decision support and predictive analytics.

Cloud-based architectures support large-scale medical data processing, including EMR mining, which improves diagnosis, treatment planning, and patient monitoring (Biswas et al., 2014). Furthermore, adaptive compression and secure data management techniques ensure efficient handling of complex medical data, including imaging and 3D healthcare datasets (Castiglione et al., 2015).

Cloud systems also support fuzzy logic-based healthcare decision models that enhance diagnostic accuracy and system adaptability under uncertainty (Sundharakumar et al., 2015).

D. Communication and Patient Interaction Subsystems

The communication layer of cloud-based healthcare CRM systems focuses on enabling continuous interaction between patients and healthcare providers. This includes automated messaging systems, speech-enabled interfaces, and mobile health applications.

Advanced technologies such as automatic speech recognition enhance accessibility and allow patients to interact with healthcare systems using voice commands, improving usability and inclusiveness (Muhammad, 2015). These systems also support proactive outreach strategies for population health management, particularly in underserved regions (Daw & Banerjee, 2015).

E. Security, Privacy, and System Reliability

Security is a fundamental requirement in healthcare CRM architectures due to the sensitivity of patient data. Cloud systems employ encryption, authentication protocols, and secure access controls to protect medical records and communication channels.

Additionally, system reliability is ensured through redundant cloud infrastructures and fault-tolerant designs that maintain service continuity. These mechanisms are essential for maintaining trust and compliance within healthcare environments (Ekonomou et al., 2011; Castiglione et al., 2015).

F. Patient-Centered Design and Engagement Integration

The architecture ultimately supports patient-centered care by embedding engagement tools directly into the system design. These include feedback mechanisms, personalized care pathways, and interactive dashboards that empower patients to participate actively in their healthcare journey.

Such designs align with learning health system principles, where continuous feedback loops between patients and providers drive system improvement and better health outcomes (McGinnis et al., 2011; Tang et al., 2016).

The architecture of cloud-based healthcare CRM systems is a complex integration of layered computing infrastructure, service-oriented design, and patient-centered applications. It enables secure data management, real-time communication, and personalized healthcare delivery while supporting advanced analytics and interoperability across healthcare ecosystems (Noblin et al., 2014; Biswas et al., 2014).

IV. Patient Engagement through Cloud-Based CRM

Cloud-based healthcare CRM systems fundamentally enhance patient engagement by enabling continuous, personalized, and data-driven interaction between patients and healthcare providers. Unlike traditional systems that are episodic and fragmented, cloud-enabled CRM platforms

support real-time communication, integrated health records, and adaptive care pathways that improve participation in health management (Noblin et al., 2014; Ekonomou et al., 2011).

A central mechanism through which engagement is achieved is the integration of Electronic Medical Records (EMR), analytics, and patient-facing applications within a unified cloud environment. This integration allows healthcare providers to track patient behavior, predict health risks, and deliver tailored interventions that strengthen adherence and satisfaction (Biswas et al., 2014; Parimi, 2014).

Patient engagement is also reinforced through interactive systems that promote shared decision-making, self-management, and health literacy. These systems align with the broader concept of learning health systems, where patients are active contributors rather than passive recipients of care (McGinnis et al., 2011; Anshari et al., 2012).

Cloud CRM platforms further enable multi-channel engagement, including mobile apps, telehealth services, automated messaging, and voice-based interaction systems. These tools reduce communication barriers and improve accessibility, particularly for chronic disease management and preventive care (Muhammad, 2015; Tang et al., 2016).

Additionally, contextual and adaptive services enhance engagement by tailoring communication based on patient behavior, preferences, and clinical conditions. Context-aware cloud models support dynamic personalization, ensuring that the right information reaches the right patient at the right time (Moore et al., 2014; Sundharakumar et al., 2015).

However, engagement effectiveness is strongly influenced by system usability, organizational adoption, and patient readiness. CRM implementation studies indicate that user acceptance and workflow integration remain critical determinants of success in hospital environments (Monem et al., 2011; Moore & Sharma, 2013).

Table 3: Cloud-Based CRM Mechanisms for Patient Engagement and Their Impact

Engagement Mechanism	Description	Cloud CRM Enabler	Expected Outcome	Supporting Evidence
Personalized Communication	Tailored messages, alerts, and reminders based on patient data	CRM analytics and EMR integration	Improved adherence and satisfaction	Parimi (2014); Noblin et al. (2014)
Real-Time Patient Interaction	Continuous communication via portals and mobile platforms	Cloud-based applications and APIs	Faster response and better care coordination	Tang et al. (2016); Ekonomou et al. (2011)

Self-Management Support	Tools for patients to track health conditions and progress	Patient portals and mobile health apps	Increased patient autonomy and engagement	Anshari et al. (2012); McGinnis et al. (2011)
Predictive Health Insights	Risk prediction and early intervention alerts	EMR mining and analytics engines	Reduced complications and proactive care	Biswas et al. (2014); Sundharakumar et al. (2015)
Multi-Channel Communication	Integration of SMS, voice, chat, and telehealth systems	Cloud communication services	Improved accessibility and outreach	Muhammad (2015); Daw & Banerjee (2015)
Context-Aware Engagement	Adaptive services based on patient behavior and environment	Context-as-a-service cloud models	Higher relevance of care interactions	Moore et al. (2014); Castiglione et al. (2015)

Cloud-based CRM systems redefine patient engagement by shifting healthcare delivery toward a continuous, interactive, and personalized model. This transformation is driven by the convergence of cloud computing, data analytics, and patient-centered design principles, enabling healthcare systems to move toward more participatory and efficient care ecosystems (Noblin et al., 2014; Tang et al., 2016).

V. Challenges and Implementation Issues

Despite the significant potential of cloud-based healthcare CRM systems to enhance patient engagement, their implementation is constrained by a range of technical, organizational, and socio-ethical challenges. These issues stem from the complexity of integrating cloud infrastructures with healthcare workflows, the sensitivity of medical data, and the variability in healthcare system readiness.

A primary challenge is data security and privacy protection. Cloud-based systems store and process large volumes of sensitive patient data, making them attractive targets for cyber threats. Ensuring confidentiality, integrity, and availability of health records requires robust encryption, access control mechanisms, and compliance with healthcare data governance standards. Concerns about unauthorized access and data leakage remain persistent barriers to adoption (Noblin et al., 2014; Castiglione et al., 2015).

Another major issue is system interoperability and integration with legacy systems. Many healthcare institutions continue to rely on fragmented or outdated information systems that are

not inherently compatible with cloud-based CRM platforms. This creates difficulties in achieving seamless electronic medical record integration and limits the effectiveness of unified patient engagement strategies (Biswas et al., 2014; Moore & Sharma, 2013).

Organizational resistance and change management also significantly affect implementation outcomes. Healthcare professionals may resist adopting new CRM-driven workflows due to perceived increases in workload, lack of familiarity with cloud systems, or concerns about reduced clinical autonomy. Successful adoption requires structured training programs, stakeholder engagement, and gradual transition strategies to ensure acceptance across all user groups (Monem et al., 2011; McGinnis et al., 2011).

In addition, data quality and personalization limitations pose challenges for effective patient engagement. While CRM systems rely heavily on accurate and comprehensive patient data to deliver personalized care, inconsistencies in data entry, incomplete records, and variability in patient-reported information can reduce system effectiveness. This directly impacts the ability of cloud-based platforms to deliver meaningful predictive analytics and tailored communication (Parimi, 2014; Sundharakumar et al., 2015).

Infrastructure constraints and connectivity issues further hinder implementation, particularly in resource-limited settings. Reliable internet access, adequate cloud service provisioning, and scalable computing resources are essential for continuous system performance. In developing healthcare environments, intermittent connectivity and limited IT infrastructure can disrupt service delivery and reduce system reliability (Daw & Banerjee, 2015; Ekonomou et al., 2011).

Finally, usability and patient digital literacy challenges remain critical barriers. While cloud-based CRM systems aim to enhance patient engagement through interactive portals and communication tools, not all patients possess the technical skills required to effectively use these platforms. This digital divide can limit the inclusiveness of patient-centered care initiatives and reduce overall engagement effectiveness (Anshari et al., 2012; Tang et al., 2016).

Overall, addressing these challenges requires a balanced approach that combines technological safeguards, organizational readiness, infrastructure development, and user-centered design to ensure sustainable implementation of cloud-based healthcare CRM systems.

Conclusion

Cloud-based healthcare CRM systems have emerged as a pivotal advancement in transforming patient engagement by integrating scalable computing infrastructures with patient-centered service delivery models. These systems enable healthcare providers to move beyond traditional, episodic care interactions toward continuous, data-driven engagement strategies that enhance communication, personalization, and care coordination.

The convergence of cloud computing and CRM principles supports improved accessibility to patient information, real-time interaction, and streamlined healthcare workflows. Integrated cloud-based healthcare architectures facilitate interoperability and efficient management of electronic medical records, thereby strengthening clinical decision-making and operational efficiency (Biswas et al., 2014; Ekonomou et al., 2011). In addition, cloud environments provide the computational flexibility required to support advanced functionalities such as predictive analytics, adaptive service delivery, and intelligent patient communication systems (Moore et al., 2014; Sundharakumar et al., 2015).

From a patient engagement perspective, cloud-based CRM systems significantly enhance satisfaction and participation by enabling personalized communication, remote monitoring, and interactive health management tools. These capabilities align with the broader shift toward participatory healthcare models where patients actively contribute to their own care processes, reinforcing the concept of a learning health system (McGinnis et al., 2011; Anshari et al., 2012). Furthermore, tailored engagement strategies supported by CRM systems have been shown to improve patient satisfaction and care outcomes through more individualized communication and service delivery approaches (Parimi, 2014; Tang et al., 2016).

Despite these benefits, implementation challenges remain, particularly in relation to data security, system integration, and organizational readiness. Effective deployment requires careful consideration of implementation factors such as usability, staff training, and infrastructure maturity within healthcare institutions (Monem et al., 2011; Moore & Sharma, 2013). Additionally, in resource-constrained settings, limitations in connectivity and digital infrastructure can hinder the full realization of cloud-based engagement systems, necessitating adaptive and context-aware deployment strategies (Daw & Banerjee, 2015).

Overall, cloud-based healthcare CRM systems represent a foundational component in the evolution of modern healthcare delivery. Their ability to integrate data, enhance communication, and support personalized care positions them as essential tools for improving patient engagement and advancing healthcare system performance.

References

1. Noblin, A., Cortelyou-Ward, K., & Servan, R. M. (2014). Cloud computing and patient engagement. *The Journal of medical practice management*, 30(2), 65-70.
2. Biswas, S., Akhter, T., Kaiser, M. S., & Mamun, S. A. (2014, December). Cloud based healthcare application architecture and electronic medical record mining: an integrated approach to improve healthcare system. In *2014 17th international conference on computer and information technology (ICCIT)* (pp. 286-291). IEEE.
3. McGinnis, J. M., Saunders, R. S., & Olsen, L. (Eds.). (2011). Patients charting the course: citizen engagement and the learning health system: workshop summary.

4. Parimi, S. S. (2014). Researching how SAP Solutions can Improve Patient Engagement and Satisfaction through Personalized Care and Communication. *Available at SSRN 4934809*.
5. Naidu, K. J. (2014). Secure OLAP Reporting Architectures: Integrating Role-based Access Control and Query Execution Plan Optimization for Enterprise Analytical Environments. *SAMRIDDHI: A Journal of Physical Sciences, Engineering and Technology*, 5(02), 155-159.
6. Ekonomou, E., Fan, L., Buchanan, W., & Thuemmler, C. (2011, November). An integrated cloud-based healthcare infrastructure. In *2011 IEEE third international conference on cloud computing technology and science* (pp. 532-536). IEEE.
7. Sundharakumar, K. B., Dhivya, S., Mohanavalli, S., & Chander, R. V. (2015). Cloud based fuzzy healthcare system. *Procedia computer science*, 50, 143-148.
8. Monem, H., Sharifian, R., & Shaterzadeh, H. (2011, December). CRM software implementation factors in hospital: Software & patient perspectives. In *2011 Malaysian Conference in Software Engineering* (pp. 159-164). IEEE.
9. Daw, A., & Banerjee, A. (2015, December). Information Systems for Sporadic Population Health Outreach Activities in Developing Countries. In *2015 International Conference on Computational Science and Computational Intelligence (CSCI)* (pp. 812-816). IEEE.
10. Parimi, S. S. (2014). Researching how SAP Solutions can Improve Patient Engagement and Satisfaction through Personalized Care and Communication. *Available at SSRN 4934809*.
11. Muhammad, G. (2015). Automatic speech recognition using interlaced derivative pattern for cloud based healthcare system. *Cluster Computing*, 18(2), 795-802.
12. Moore, P., Xhafa, F., & Barolli, L. (2014, July). Context-as-a-service: A service model for cloud-based systems. In *2014 Eighth International Conference on Complex, Intelligent and Software Intensive Systems* (pp. 379-385). IEEE.
13. Anshari, M., Almunawar, M. N., & Low, P. K. C. (2012). CRM 2.0 within E-Health Systems: Towards Achieving Health Literacy & Customer Satisfaction. *arXiv preprint arXiv:1203.4309*.
14. Kola, J. N. (2011). An Integrated Framework for Data Mining and Distributed Database Optimization in Resource-Constrained Network Environments. *SAMRIDDHI: A Journal of Physical Sciences, Engineering and Technology*, 2(02), 82-86.
15. Naidu, K. J. (2013). Performance Optimization Of ETL Pipelines In Distributed Data Warehouse Environments: A Network-Aware Scheduling Approach. *International Journal of Advance Industrial Engineering*, 1(03), 63-67.
16. Castiglione, A., Pizzolante, R., De Santis, A., Carpentieri, B., Castiglione, A., & Palmieri, F. (2015). Cloud-based adaptive compression and secure management services for 3D healthcare data. *Future Generation Computer Systems*, 43, 120-134.

17. Moore, P. T., & Sharma, M. (2013). Enhanced patient management in a hospital setting. *IT CoNvergence PRActice (INPRA)*, 1(3), 1-21.
18. Tang, C., Lorenzi, N., Harle, C. A., Zhou, X., & Chen, Y. (2016). Interactive systems for patient-centered care to enhance patient engagement. *Journal of the American Medical Informatics Association*, 23(1), 2-4.