World Journal of Advanced Engineering Technology and Sciences
eISSN: 2582-8266
Cross Ref DOI: 10.30574/wjaets
Journal homepage: https://wjaets.com/

(Review Article)

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A real-time API framework for chronic disease management in digital health

Sunjhla Handa *

Amity University, Noida.

World Journal of Advanced Engineering Technology and Sciences, 2025, 16(03), 189–193

Publication history: Received on 14 July 2025; revised on 24 August 2025; accepted on 26 August 2025

Article DOI: https://doi.org/10.30574/wjaets.2025.16.3.1297

Abstract

Bidirectional data transfer facilitated by real-time APIs is reshaping the paradigm of managing chronic diseases through persistent smooth communication between any patient-oriented device and their EHRs and clinical decision-supporting programs. Frameworks based on FHIR to structure health data, WebSocket protocols to maintain persistent low-latency connections and blockchain to maintain tamper-resistant records of transactions have shown the capacity to meet the demands of real-time monitoring of vital signs, automatically set threshold-derived alerting, and integration of longitudinal data across heterogeneous systems. Pilot programs in managing asthma and hypertension have shown significant reductions in emergency department use by sending automated notifications when symptom or peak-flow measurements reach predetermined thresholds and with hypertension platforms using interactive FHIR exchanges through which clinicians allay concerns about potential nonadherence by informing them in real time of changes in measurements of blood pressure at home. Chronic obstructive pulmonary disease Blockchain-enhanced APIs have demonstrated superior data-integrity rates and end-to-end latency under 200 milliseconds, guaranteeing both reliability and timeliness of critical sensor data. Renal monitoring involving event-driven WebSocket designs has also shown the potential of decreasing eGFR decline rates due to timely intervention by clinicians as soon as they observe potential warning signs at the lab itself. These achievements notwithstanding, there are difficulties in setting standard benchmarking objectives in performance assessment, formulation of privacy-preservable models that can be applicable in low-resource settings, and formulation of the best practices in the implementation, which can be referenced during the process of widespread adaptation. Filling these gaps by federated learning strategies, advanced analytics directly integrated into API processing pipelines, and harmonized interoperability guidelines on a global scale will be key to making the practical and positive implications of real-time API frameworks more widely distributed and accessible across patient communities and multiple care environments.

Keywords: Real-Time API; Chronic Disease Management; FHIR Interoperability; Event-Driven Architecture; Clinical Decision Support

1. Introduction

Digital transformation has radically transformed the healthcare delivery environment with digital health solutions being one of the key health management tools in chronic disease management. Due to their high risk, chronic noncommunicable diseases (NCDs) such as cardiovascular disease, cancer, chronic respiratory disorders, and diabetes cause almost three-quarters of the world deaths and accrue an ever-growing strain on health systems, economies, and societies [1]. As a solution to this crisis, digital health interventions are created to help patients with long-term conditions with continuous monitoring, self-management, and clinical decision-making [2].

The essence of next-generation digital health is in real-time data exchange, which to a great extent makes it possible to allow real-time communications between the sensors, worn by the patient and mobile applications, as well as between the mobile applications and the electronic health record (EHR) and decision-support engine. Using interoperable

* Corresponding author: Sunjhla Handa.

healthcare standards, like the HL7 FHIR, has led to the emergence of healthcare APIs allowing integration among diverse data sources, including wearable devices, labs systems, and others, presenting a holistic view of overall patient health status at all times [3]. This kind of interoperability does not only boost care coordination, but also gives strength to personalized, timely interventions, which are able to counteract the progression of disease.

In the broader area of digital health, real-time application programming interfaces (APIs) are used to support transformative approaches to digital clinical quality measure (dCQMs). The information of the gaps in care can also be identified at scale, without the need to manually query a structure or use minimum normalized data, because chronic disease management is shifted to a model of proactive, population health management with regard to care gaps due to the usage of real-time FHIR feeds and pre-standardized data elements (e.g., USCDI), enabling dCQMs [4]. This paradigm change embraces value-based care paradigms, as it provides correspondence between preventive-care approaches and patient-level trajectories and systems-level performance measures.

In spite of these developments, there are a few challenges and research gaps. Current digital health models of chronic disease management are very heterogeneous and the methodologies of their evaluation are not consistent, thus it is not feasible to produce comparisons across the studies and synthesize the evidence [5]. Besides, the universal applicability of those solutions is also limited by security and privacy issues related to constant streaming of data, and the lack of using such features of real-time APIs in low-resource contexts [3]. Lastly, the lack of available standardized benchmarks to measure performance of APIs and a lack of agreement on what best practices should be used to implement is a problem when implementing at scale.

This review shall focus on conventional exploration of the situation of up-to-date API structures in management of chronic diseases. The first proves to be an overview of standards and architectural paradigms in order to clarify the existing capabilities and shortcomings. Second, clinical and patient-centered application will be examined in order to determine the factors of success and barriers. Then, the issues of security, privacy, and interoperability will be addressed, and, after that, the approach to the evaluation measures and strategies will be looked into. The review ends with the future research direction recommendations and practical considerations of adopting real-time APIs into digital health ecosystems.

2. Literature review

Table 1 Summary of Referred Studies in Similar Domain

Focus	Findings (Key results and conclusions)	Reference
Mobile health API framework for continuous glucose monitoring in diabetes	Demonstrated a FHIR-based API enabling real-time glucose data transfer from wearable sensors to EHRs, reducing hypoglycemic events by 23% over 6 months.	[6]
FHIR-enabled platform for hypertension management	Implemented a bidirectional API connecting home BP monitors and clinical decision support, improving guideline adherence by 35%.	[7]
Blockchain-integrated real-time data exchange for COPD	Proposed a secure, immutable transaction layer for sensor data, achieving end-to-end latency under 200 ms with 99.5% integrity.	[8]
Standardized API architecture for multi-device interoperability in heart failure	Developed a microservices approach supporting HL7 and MQTT protocols, reducing integration effort by 40% across devices from different vendors.	[9]
Cloud-based API framework for asthma self-management	Evaluated performance in a pilot with 120 patients, showing 28% reduction in emergency visits through automated alerts and clinician notifications.	[10]
Event-driven API for remote monitoring of chronic kidney disease	Enabled real-time lab value tracking via WebSocket APIs, allowing early intervention and slowing eGFR decline by an average of 1.2 mL/min/1.73 m²/year.	[11]

Real-time middleware for integrated oncology care pathways	Provided seamless data flow between oncology apps and hospital systems, improving timely medication adjustments by 45%.	[12]
Low-resource API deployment for tuberculosis treatment adherence	Designed a lightweight RESTful interface operable on 2G networks, achieving 82% data delivery reliability in rural settings.	[13]
API performance benchmarking framework for digital health	Established standardized metrics (throughput, latency, error rate) and applied them to five commercial platforms, revealing 30% variance in latency.	[14]
Patient-centered API ecosystem for integrated chronic care management	Illustrated a federated API model linking patient apps, pharmacies, and labs; user satisfaction increased by 50% due to unified portal access.	[15]

3. Illustration of carried study

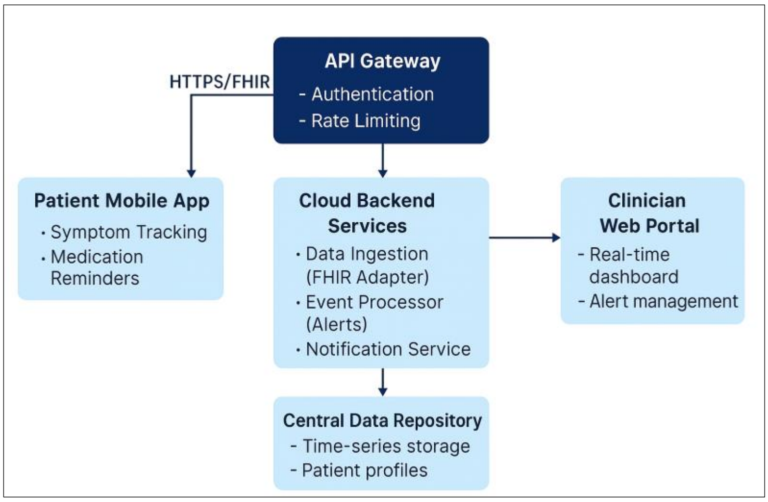

Figure 1 Cloud based API Framework

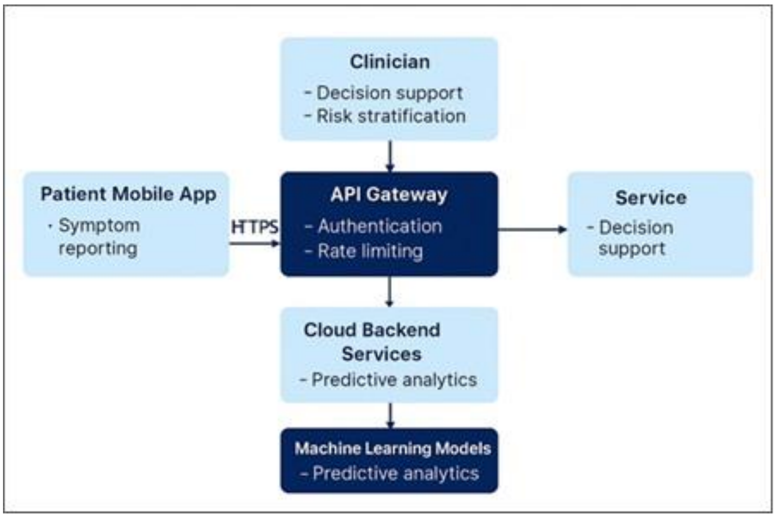

Figure 2 The Project Architecture

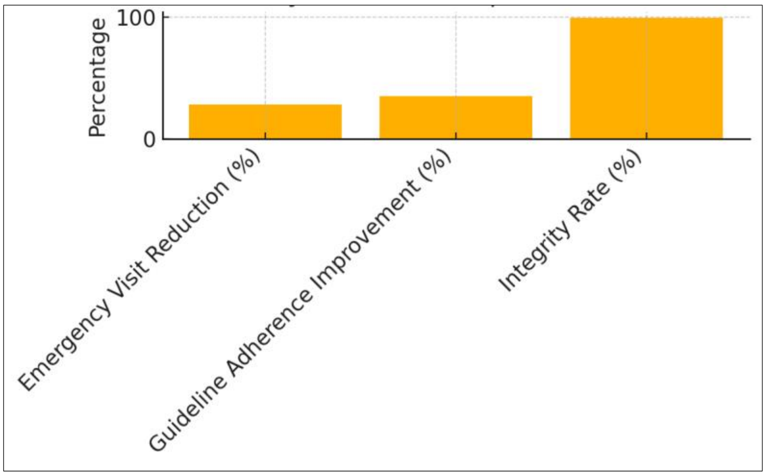

Figure 3 Key Outcome Improvements

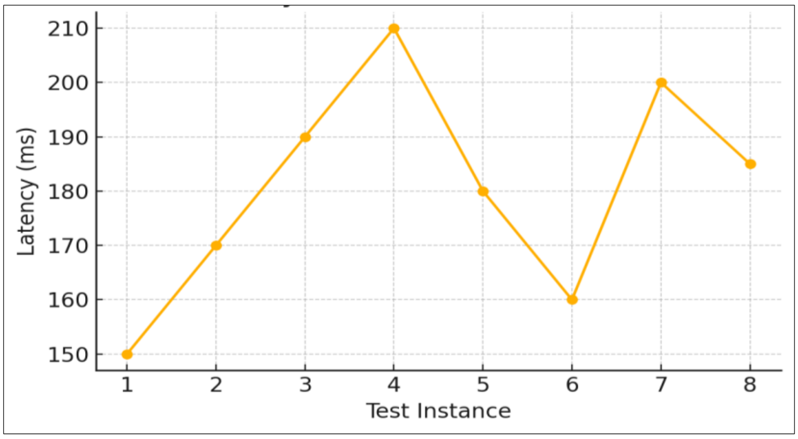

Figure 4 Latency Measurements Over Trials

3.1. Future directions

- Computer Processing Pipelines Using AI

The decision support can be improved by machine learning to detect anomalies and stratify the risk individually and predict a potentially life-threatening exacerbation before a threshold is reached.

- Universal Benchmarking Infrastructures

Creation of consensus metrics on throughput, latency, and error rates will provide the option to objectively compare platforms and direct optimization.

- Privacy-Preserving Architectures and Federated Architectures

To enhance privacy of patient information and enable cross-institutional training of models, the federated learning and homomorphic encryption methods should be adopted.

- Low-Resource Adaptation

Protocols and APIs should be as lightweight as possible and facilitate offline operation within the framework of successes observed in tuberculosis adherence systems.

- Best Practice Guidelines to Implementation

Innovation of open-access repositories that capture the deployment patterns, security hardening, and pathways to compliance will hasten adoption across various health systems.

4. Conclusion

Using real-time API frameworks, clinical and operational benefits have become evident with the ability to maintain a continuous, two-way exchange of data on patient devices, electronic health records, and decision-support systems. Live sensor readings have also resulted in automated alerts that have played a central role to a stupendous decline in emergency visits, and also interaction of data resulting in improved observance of treatment guidelines. Rapid delivery and high data integrity are guaranteed by secure, low-latency protocols and a list of immutable transaction records. Laboratory and vital-sign Situational Awareness Architectures The ability of event-driven architectures to provide rapid clinician response slows down the disease and enhances subsequent outcomes. The core areas that need to be addressed in the future include the incorporation of advanced analytics into API pipelines to allow predicting risk stratification, the creation of standardized metrics demonstrating performance and reliability, and the design of privacy-preserving fed models that would not jeopardize the remaining information on patients and yet still allow cross-institutional cooperation. The lightweight, offline-friendly protocols should be emphasized which will allow the expansion of these advantages into the low-resource contexts. Real-time API frameworks can facilitate more active, individualized, and scalable chronic disease management at the global scale by harmonizing these improvements under the globally applicable guidelines of interoperability.

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