Title: AIoT-HSC: A Conceptual Framework for Intelligent and Resilient Healthcare Supply Chains

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1 Introduction

Healthcare supply chains (HSCs) play a critical role in ensuring the availability, quality, and timely delivery of essential medical products [1]. However, they remain vulnerable due to cold-chain fragility, uncertain demand, logistical delays, and counterfeit threats. Traditional approaches lack real-time visibility and rely on fragmented decision processes. To overcome these limitations, digital technologies IoT, AI, edge computing, and blockchain enable real-time sensing, predictive analytics, and automated decision support. The convergence of AI and IoT (AIoT) represents a transformative paradigm. This extended abstract reviews IoT, AI, and AIoT literature in HSCs, highlights challenges, and proposes a conceptual AIoT framework to enhance visibility and resilience.

2 Background

2.1 Healthcare Supply Chain Challenges

The HSC is multi-tiered (production, storage, distribution, delivery) and highly sensitive. Recurring issues include shortages, cold-chain failures, delays, and human error. These underscore the need for predictive and real-time decision-making.

2.2 Bibliometric Insights

A bibliometric analysis of 3,120 articles (2010–2026) shows:
- USA, India, China, Europe dominate.
- Four clusters: healthcare delivery, optimization, clinical systems, COVID-19 logistics.

3. AI and IoT in the Healthcare Supply Chain

3.1 IoT for Real-Time Visibility

IoT devices (RFID, GPS, sensors) enable monitoring of product conditions and movement. Issues include interoperability and data heterogeneity[2]

3.2 AI for Predictive Decision-Making

AI (machine learning, reinforcement learning, optimization) improves forecasting, routing, and anomaly detection. Raises ethical, regulatory, and environmental concerns.[3]

4. Convergence of AI and IoT (AIoT)

AIoT addresses visibility gaps, cold-chain integrity, and coordination issues. It is particularly impactful for vaccine supply chains.[4]

5. Challenges and Limitations of AIoT in HSC

AIoT adoption faces several barriers: Interoperability issues, cybersecurity & privacy risks , scalability & infrastructure limitations, human/organizational barriers, fragmented research landscape

6. Proposed AIoT Framework

In this work, we propose a conceptual AIoT framework designed to improve visibility, intelligence, and resilience across the healthcare supply chain. The framework integrates four functional layers:(i) an IoT Layer that captures real-time operational data from sensors, RFID, GPS, and connected medical assets; (ii) a Data Layer that ensures secure storage, aggregation, and traceability through cloud/edge infrastructures and blockchain mechanisms; (iii) an AI Layer that transforms raw data into actionable insights using machine learning, predictive analytics, and optimization; and (iv) an Application Layer that delivers decision-support, monitoring dashboards, and automated workflows to healthcare stakeholders. This multi-layer structure establishes a unified AIoT architecture capable of supporting cold-chain integrity, demand forecasting, routing, and inventory optimization in healthcare logistics.

7. Conclusion

This extended abstract highlights the potential of AIoT technologies to transform the healthcare supply chain by enabling real-time visibility, predictive intelligence, and data-driven operational decisions. By combining IoT sensing, secure data infrastructures, and AI-based analytics, the proposed framework addresses critical vulnerabilities in healthcare logistics such as cold-chain failures, demand uncertainty, and fragmented coordination. Future work will focus on empirical validation and the development of lightweight, interoperable protocols to facilitate real-world adoption.

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