

Medication Interoperability: A Complete Medication History

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Abstract— The fragmented nature of the U.S. healthcare system lacks medication interoperability, causing preventable Drug-to-Drug Interactions (DDIs) and Adverse Drug Reactions (ADRs). This problem's features are indicative of the Byzantine Generals Problem (BGP). We propose a standards-based solution that leverages Byzantine Fault Tolerant consensus algorithms.

Clinical Relevance— Discrepancies in medication history cause increased healthcare provider burden, higher medical costs, and reduced patient health. Exploring this problem could inform prototype solutions based on community feedback. This could then inform a standards-based solution based in FHIR, CDS-Hooks, and NCPDP SCRIPT that would provide practitioners with a complete patient medication history, thereby mitigating unnecessary ADRs and DDIs.

I. INTRODUCTION

Patients that visit many prescribers and pharmacies that use disjointed technical infrastructure create a vexing problem: how to lessen the risk of conflicting prescription medication. At present, industry lacks an effective way to view the full medication history of a patient. Most Pharmacy and Electronic Health Record (EHR) systems are limited to medication histories that are internal to the system as they lack the proper external cross communication. Often the burden is placed on a patient to remember and self-report all the medications they are taking, which is cumbersome and prone to error.

Research shows >20% of ADRs [1] result from a lack in medication reconciliation and account for 7,000 to 106,000 deaths annually, costing between \$30.1 [2] to \$136 billion [3]. These consequences therefor necessitate the investigation of this problem and warrant an analysis of the intricate nature of its features to inform the development of a solution.

II. RESEARCH QUESTIONS

- 1) *How can a medication exchange standard be designed to work with current industry systems?*
- 2) *How can existing standards/algorithms be used to improve patient care and reduce healthcare burdens/errors?*

III. PROPOSED INVESTIGATION

We propose re-envisioning the ADR problem within EHR systems as a version of the BGP. A patients full medication history can be fragmented amongst EHRs with variable communication. Similarly, the BGP asks how consensus can be achieved between entities that have disjointed knowledge and unreliable communication. Consensus algorithms address

these problems in fault-tolerant distributed systems involving multiple services agreeing on values [4].

IV. RAFT CONSENSUS ALGORITHM

RAFT is a Byzantine Fault Tolerant consensus algorithm, which provides a reliable and simple solution to node synchronization. The algorithm outlines a method for defining consensus of values within a system as well as determining trusted entities. Raft has been implemented across industries and has proven to be reliable and accurate [5]. The algorithm separates the key elements of consensus, such as leader election, entity history replication, coherency, and safety [5].

V. DISCUSSION & CONCLUSION

A prototype built with standards (FHIR, CDS-Hooks, and NCPDP SCRIPT) modeling the medication history exchange workflow using RAFT can be used to inform an interoperable standards-based solution. Future research, specifically collecting stakeholder feedback, is needed to define a standard. Nationwide adoption of an interoperable standard encouraging complete patient medication history would mitigate the high incidence of medication errors and in turn reduce stakeholder burden, reduce costs, reduce medical claims, improve healthcare literacy, and improve patient health outcomes.

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