Integration of Laboratory Data into a National Electronic Health Record (EHR)

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Abstract. This paper discusses the development and implementation of an API to integrate external laboratory information systems with a national e-health operator using LOINC codes as a standard measurement vocabulary. The integration provides many benefits, including reduced risk of medical errors, unnecessary tests, and administrative burden on healthcare providers. Security measures were implemented to prevent unauthorized access to sensitive patient information. The "Armed eHealth" mobile application was developed to allow patients to access their lab test results directly on their mobile devices. The implementation of the universal coding system has improved communication, reduced duplications, and improved the quality of care for patients in Armenia. Overall, the integration of the universal coding system for lab tests has had a positive impact on the healthcare system in Armenia.

Keywords. ehealth, REST API, universal coding system, healthcare quality improvement, laboratory, integration

1. Introduction

Our paper discusses the challenges faced by healthcare providers in Armenia due to the lack of integration between different laboratory information systems. To address this issue, the Armenian government has established a national Electronic Health Record (EHR) operator (ArMED) [1] which aims to integrate data from various healthcare systems and services, including laboratory information systems, into a unified ecosystem. We developed an API (application programming interface; facilitates communication between ArMED and other systems) to integrate external laboratory information systems with ArMED and mapped local coding systems to LOINC (Logical Observation Identifiers, Names and Codes), which is widely used internationally [2,3]. The integration provides many potential benefits, including reduced risk of medical errors, unnecessary tests, and administrative burden on healthcare providers [4-6]. Our paper describes the design and implementation of the API, the challenges faced during development, and the benefits of the integrated system.

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2. Methods

2.1. Integration API Development

To enable the integration of external laboratory information systems into the national EHR, an API was developed using PHP (web development programming language). The API uses LOINC codes as a standard measurement vocabulary to ensure compatibility between different systems. One of the main challenges was that private laboratories were using their own coding systems for measurements, making it difficult to map their results to the standard LOINC codes. To solve this problem, we translated approximately 16,000 LOINC codes into Armenian and provided them to the laboratory information system (LIS) developers, who mapped them to the internal coding system used by the LIS.

![Figure 1. Mapping of LOINC codes for laboratory information systems.](image)

2.2. Security

Security was a crucial consideration during the development of the API to prevent unauthorized access to sensitive patient information. To access the API, laboratories must first be registered in the Armenian national e-health operator database, and laboratory staff must also be registered. The laboratory staff who perform lab tests must create their logins in the e-health operator and can only log in using two-step verification. The LIS developers provided an internal interface for laboratory workers to log in to the e-health operator. After login, the LIS system receives a token that is valid for 24 hours and must send this token in all subsequent requests to verify the request.
2.3. Patient portal

By integrating with the Armenian national e-health operator, patients can access their lab test results directly on their mobile devices. This allows users to easily view their lab results through a user-friendly patient portal. The "Armed eHealth" mobile application was designed with patient convenience and accessibility in mind. The application allows patients to see if their lab test results are abnormal or within the normal range through a color-coded UI, which empowers them to take a more active role in managing their own health. Providing patients with access to their lab test results allows them to track their progress and discuss any concerns with their healthcare provider. Overall, this mobile application represents a step forward in leveraging technology to improve patient engagement and healthcare outcomes.

3. Results

The implementation of laboratory data has resulted in the integration of 76 laboratories (around 27%) into the EHR. The patient portal application has been downloaded over 530,000 times on Google Play, with an average rating of 4.0 out of 5.0. On the Apple Store, it has been downloaded 248,000 times, with an average rating of 3.5 out of 5.0. There are 720,000 unique users of the app, out of which 180,000 are verified users who passed the liveness check.

Additionally, the translation of approximately 16,000 LOINC codes into Armenian and their provision to the laboratory of the universal coding system allowed for the integration of all labs within the national e-health system. This integration has improved communication and collaboration between healthcare providers and labs, resulting in a more efficient and effective healthcare system. Overall, the implementation of the universal coding system for lab tests has had a positive impact on the healthcare system in Armenia. It has improved communication, reduced duplications, and improved the quality of care for patients.

4. Discussion

The implementation of a universal coding system for lab tests provides many benefits for healthcare providers and patients. In Armenia, the integration of different laboratory information systems into a unified ecosystem has been challenging due to the use of different measurement vocabularies and coding systems. The development of an API using LOINC codes as a standard measurement vocabulary and mapping local coding systems to LOINC has addressed this issue.

The integration of the universal coding system allowed for the efficient storage and exchange of lab test data within the country, improving the quality of care for patients. Healthcare providers now have access to a patient's complete lab test history, allowing for better diagnosis and treatment. The integration of different laboratory information systems into a unified ecosystem has improved communication and collaboration between healthcare providers and labs. The universal coding system has allowed for the efficient storage and exchange of lab test data within the country, providing healthcare providers with access to a patient's
complete lab test history. This has improved the quality of care for patients by enabling better diagnosis and treatment. However, there were several challenges during the development of the API. One of the main challenges was the use of different coding systems by private laboratories, which made it difficult to map their results to the standard LOINC codes. Another challenge was ensuring the security of patient information, which was addressed by requiring registration and two-step verification for laboratory staff and providing a token-based authentication system.

5. Conclusion

In conclusion, the integration of different laboratory information systems into a unified ecosystem using a universal coding system has improved the healthcare system in Armenia. The development of an API using LOINC codes as a standard measurement vocabulary and mapping local coding systems to LOINC has addressed the issue of different measurement vocabularies and coding systems. The integration has improved communication and collaboration between healthcare providers and labs, resulting in reduced duplication of lab tests and administrative burden on healthcare providers. The patient portal has improved patient engagement and healthcare outcomes by providing patients with access to their lab test results. The challenges faced during the development of the API were addressed by ensuring the security of patient information and providing a token-based authentication system. The implementation of the universal coding system has had a positive impact on the healthcare system in Armenia and can serve as a model for other countries seeking to integrate different laboratory information systems into a unified ecosystem.

References