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Transforming Patient Check-in/Registration with a Fast Healthcare Interoperability Resources (FHIR) Integrated QR Code System and Mobile App

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**Transforming Patient Check-in/Registration with a Fast Healthcare Interoperability
Resources (FHIR) Integrated QR Code System and Mobile App**

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Capstone Project

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Abstract

The aim of the project is to examine the implementation of universal quick response (QR) codes issued by health insurance providers for patient identification within electronic health records (EHR). The integration of QR codes into EHR using Fast Healthcare Interoperability Resources Application Programming Interface (FHIR API) can help standardize the identification process, making it more efficient and reducing medical errors. These improvements can lead to a reduction in waiting time, improved patient satisfaction and coordination of care. The paper will provide insights on the possibility for widespread adoption of QR codes for patient identification in healthcare and its impact on the overall quality of patient care. The paper will compare current methods of patient identification with the new approach of using universal QR codes, outline the objectives, project timeline, and deliverables. The findings of this project will be important not only for patients but for healthcare providers, health insurance providers, and policymakers.

Keywords: universal QR code, health insurance, EHR, patient identification, FHIR

Transforming Patient Check-in/Registration with a Fast Healthcare Interoperability Resources (FHIR) Integrated QR Code System and Mobile App

Efficient and streamlined patient registration and check-in processes are crucial for improving the overall patient experience in healthcare (Patient Engagement HIT, 2021). According to Riplinger et al. (2020), traditional methods of patient identification, such as manual entry of patient names or medical record numbers, are prone to errors and inconsistencies, and are also time-consuming. Riplinger et al. stated some healthcare organizations are implementing corrective measures such as training for staff on proper patient identification practices, using standardized forms and templates for data entry, and leveraging technology solutions such as biometric identification. Implementing a universal QR code for each registered member provided by health insurance companies combined with FHIR application; these tools could facilitate efficient patient identification and hassle-free check-in, which aims to minimize errors, decrease waiting time, and ultimately improve the patient experience.

Quick Response Codes: The Small Solution to Big Healthcare Problems

According to Perdana et al. (2019), QR codes are two-dimensional barcodes that can store information both horizontally and vertically, allowing them to hold more data while being only 10% the size of a barcode. Perdana et al. stated QR codes can correct errors up to 30% and can be scanned even if partially damaged or distorted. According to Gandolf (2023), QR codes improve patient identity management. Gandolf stated that implementing this technology into a secure hospital workflow can simplify patient management processes and enhance patient outcomes. Gandolf further added that doctors, nurses, and healthcare providers are familiar with using mobile devices and do not need extra time or training to use QR codes. The QR code allows healthcare providers to quickly access critical patient information such as name, date of birth, gender, phone, address, social security number, photo, medical history, vaccination records, emergency contacts, current medications and dosage, admission and discharge information, aftercare instructions, and lab results.

Health insurance companies can offer a unique identifier to each person by providing a universal QR code; the development of a FHIR application integration with EHR systems can facilitate access to patient information. This combination of technologies will streamline the process of accessing patient information for interoperability, reduce errors due to manual entry, and speed up the process of care delivery.

Population, Intervention, Comparison and Outcome Question

In today's fast-paced healthcare environment, patient registration and check-in can be a time-consuming and frustrating process. Patients are often required to fill out forms and wait in long lines before they can receive medical care. To determine the effectiveness of a universal QR code for patient registration and check-in, the following Population, Intervention, Comparison and Outcome (PICO) question was formulated; In patients enrolled in a health insurance plan (P), how does the implementation of a universal QR code (I) given by health insurance providers affect patient registration/check-in and waiting time compared to traditional methods (C), and what are the expected outcomes (O) on patient satisfaction, medical errors, and healthcare system efficiency?

Literature Review

We will discuss the studies related to the registration module of Hospital Information Management Systems (HIMS), Health ID cards, use and benefits of QR codes in healthcare settings. Finally, the review will explore the potential of HL-7 FHIR (Fast Healthcare Interoperability Resources) as a way to improve data exchange and interoperability between different healthcare systems and technologies.

Hospital Information Management Systems

According to Rai et al. (2022), the registration module of HIMS is the first point of contact for patients visiting hospitals for treatment. The registration module manages patient's demographic information. Patient registration data are also used for patient billing and hospital resource planning. Nasrudin et al. (2023) stated the current healthcare system still relies on a

manual registration process that is time-consuming for hospital administrators and causes long waiting times for patients. This can lead to patient dissatisfaction, especially for those with children or senior citizens who encounter limited seating options in crowded waiting areas.

Health ID Cards

Louisiana Healthcare Connections have started printing QR codes containing member ID number on their member cards to expedite check-in and administrative processes at provider offices. The new card no longer includes the Medicaid number printed on the card to protect privacy. This member ID number is used for calling, scheduling transportation, or registering on the website (Louisiana Health Connect, n.d.). Qryptal (n.d.) technology allows health insurance customers to have a card with a scannable QR code containing their individual details, photo, and policy information. This allows for easy verification and access to services by scanning the code, and updates can be made remotely, ensuring up-to-date information for the policy holder. A tamperproof identifier helps to prevent unauthorized access to patient information, reducing the risk of medical identity theft. This ensures the right patient receives the right care.

QR Codes for Secure Medical Information Transmission and Patient Identification

Perdana et al. (2019, as cited in Rai et al., 2022) proposed a QR-based solution to embed clinical records in a QR code. Hedau et al. (as cited in Rai et al., 2022) proposed a mobile app-based queue management system for patients to book appointments and minimize waiting times at the ambulatory care clinic and outpatient department. Pandeewari et al. (2022) suggested using QR codes to securely transmit medical information between hospitals and proposed creating a medical information network that uses QR codes for patient identification. Pandeewari et al. reviewed previous works in Zimbabwe and Turkey that used QR codes for storing and retrieving medical records, finding them to be advantageous. QServi (2021 as cited in Gandolf, 2023), is a HIPAA-compliant digital identity and credentialing platform. QServi proposed secure linking of patient's protected health information to their identity using temporary, dynamic QR codes. These codes change every time they are scanned, making it

difficult to counterfeit. This technology uses cryptographic hashing to transfer protected health information securely, which involves converting plain data into unique encrypted text using a sophisticated encryption algorithm. This adds an extra layer of security and reduces the risk of data breaches or unauthorized access.

QR Code Technology: A Game Changer in Healthcare Coordination and Cost Reduction

Imam (2018) suggested that a personal health card accessible through QR code technology can improve coordination of care, reduce medical costs, and improve patient outcomes. Imam further added that by integrating QR code technology with a mobile messaging app, communication and data sharing between healthcare providers, caregivers, and patients can be improved. According to the Imam, implementing such a system on a nationwide scale might result in \$240.1 billion yearly savings as uncoordinated care leads to higher medical costs and poor patient outcomes. The author further added that QR codes may also be helpful in disaster situations such as floods, tornados, earthquakes etc. Medical support staff at evacuation centers could quickly authorize and access patient medical records, allowing them to provide appropriate medical services faster.

HL-7 FHIR: The Future of Healthcare Information Exchange

Health Level Seven International (HL-7) FHIR is a standard for exchanging healthcare information electronically. Epic's FHIR API is a web service that allows external applications to access data from an Epic EHR system using the FHIR standard. Epic's FHIR API allows developers to create custom applications that can retrieve and update patient data from an Epic EHR system, such as medical records, lab results, medication lists, and more (Epic, n.d.).

The literature review discusses the benefits of implementing QR code technology in healthcare, particularly for patient identification and information sharing. With the help of FHIR, a custom application can be created that includes the universal QR code for quick access to patient information. The FHIR standard assures that data transmitted between the app and the

EHR system is safe, accurate, and up to date `improving care coordination and patient outcomes.

Objectives

The goal of implementing the universal QR code is to improve healthcare delivery with the following objectives:

- **Improved Patient Identification:** The QR code will provide a simple and efficient way to accurately identify patients, improve patient safety, and reduce the risk of medical errors.
- **Streamlined Information Exchange:** The use of a standard FHIR-based QR code will enable healthcare providers and insurers to easily exchange patient information, which can improve the continuity of care and reduce administrative burdens.
- **Enhanced Data Security:** By using strong encryption methods, implementing robust authentication and authorization processes, and complying with relevant regulations, the QR code will protect patient data from unauthorized access and data breaches.
- **Increased Patient Control:** By obtaining patient consent and providing clear information about how their data will be used and protected, the QR code will give patients greater control over their health information and privacy.
- **Cost Reduction:** By streamlining administrative processes and improving the accuracy of patient identification, the QR code has the potential to reduce healthcare costs and improve overall healthcare efficiency.

The goal is to create an FHIR-based application that contains a universal QR code encoded with patient data from the insurance database that can be shared with the EHR, resulting in an efficient system for patient registration, check-in and information exchange that benefits both patients and healthcare providers.

Plan of Action

The project scope for implementing a universal QR code system in healthcare includes the following parts:

1. Conduct a feasibility study to determine the technical and operational requirements.
2. Develop and test the QR code system, including the encryption and security measures.
3. Healthcare providers, insurers and EHR vendor collaboration to ensure that the QR code system can be integrated with existing EHR and insurance systems.
4. Establish clear guidelines for patient consent and information sharing. Educate patients to ensure they understand the purpose and use of the universal QR code.
5. Conduct testing and evaluation to ensure that the QR code system is functioning as intended and meeting the desired outcomes.

Project Timeline

A communication plan should be in place to ensure that patients, healthcare providers, and relevant stakeholders are informed about the implementation and maintenance of QR codes for patient identification during check-ins. Table 1 shows the project timeline.

Table 1

Timeline for QR Code System Development and Implementation

Phase	Timeline	Activities
Planning and preparation	2-3 months	Identify specific needs and requirements for the project, conduct a thorough analysis of existing patient registration, check-in and identification systems, and determine the resources required for implementation.
Design and development	3-6 months	Design and develop the QR code system, including the integration with EHR systems and the creation of a mobile app.
Testing and quality assurance	2-3 months	Test the QR code system to ensure it meets the established criteria for accuracy, reliability, and user experience.
Deployment and implementation	1-2 months	Deploy and implement the QR code system in healthcare facilities, including training for healthcare providers and patients.
Evaluation and monitoring	Ongoing	Continuously monitor and evaluate the QR code system to ensure it continues to meet the needs of healthcare providers and patients and to identify areas for improvement.

Work Breakdown Structure and Gantt Chart

The Work Breakdown Structure (WBS) for implementing a universal QR code includes five main task categories: Project Management, Feasibility Study, QR Code System Development, Integration with Existing Systems, Patient Consent and Information Sharing.

Table 2

Work Breakdowns Structure (WBS) outlines the project's major categories and the corresponding tasks for each category.

Level	Category	Tasks
1	Project Management	<ul style="list-style-type: none"> - Develop project plan - Identify key stakeholders - Establish project team and roles - Schedule meetings and reporting - Manage budget and resources
2	Feasibility Study	<ul style="list-style-type: none"> - Identify technical and operational requirements - Assess legal and regulatory considerations - Conduct market analysis - Identify potential risks and mitigation strategies
3	QR Code Development	<ul style="list-style-type: none"> - Develop FHIR-based QR code format - Establish encryption and security measures - Design authentication and authorization process - Conduct testing and validation
4	Integration with Existing Systems	<ul style="list-style-type: none"> - Healthcare Provider and Insurer Collaboration to integrate QR code system with EHRs and insurance systems - Provide ongoing support for users
5	Patient Consent and Information Sharing	<ul style="list-style-type: none"> - Develop clear guidelines - Develop patient education materials - Obtain patient consent - Establish communication channels for patient data sharing

The Gantt chart in Table 3 is used to outline the timeline for completing the tasks listed in the WBS.

Table 3

Gantt chart shows the timeline for completing WBS tasks.

Task	1	2	3	4	5	6	7	8	9	10
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Project Management	X	X							
Feasibility Study	X	X							
QR Code Development			X	X					
Integration with Existing Systems					X	X			
Patient Consent & Information Sharing						X	X		
Testing and Evaluation						X	X	X	
Finalize Implementation and Rollout									X

Deliverables

The following are the key deliverables of the project:

- FHIR-based QR code system and app
- Integration with Existing Systems: Integration with EHRs and insurance systems to enable seamless adoption and use of the QR code system
- An authentication and authorization process that ensures that only authorized individuals can access patient data
- Clear guidelines for patient consent and information sharing that protect patient privacy

Design and Functionality of the App

The application system's architecture includes RESTful APIs, QR code technology, and security, enabling automation and connection with EHR system. Users can log in as a new account or returning user, view their QR code image, and by scanning it within the app, display their general medical, caregiver, and primary care physician information. In addition, the app can also serve as a patient portal, allowing patients to securely access their health information, schedule appointments, request prescription refills, and communicate with their healthcare providers. Patients would present the code printed on their insurance cards or on mobile app for registration and check-in. This would reduce wait times and improve patient experience. For healthcare providers, this will decrease administrative burden and allow them to spend more

time on patient care. The app will help healthcare organizations to streamline workflows, improve care coordination, and provide patients with better access to their health information.

Patient Registration and Check-in Workflow

See Appendix A and Appendix B for traditional and QR code method of patient registration/check-in workflow respectively. The steps for patient data management via universal QR Code system are:

- Step 1: Encoded patient identification QR code data stored in the Secure Database
- Step 2: Universal QR code scanned at the registration/check-in desk using QR scanner
- Step 3: Patient's information uploaded and populated to provider's EHR system using API
- Step 4: Eliminating the need for manual data entry reducing waiting time at counter

Metrics

Various measures will be used to assess the effectiveness of implementing QR codes and the app.

1. Accuracy of Patient Identification and Reduction in Medical Errors: This metric will measure the success rate of accurately identifying patients using QR codes and the no. of medical errors will be compared to traditional methods. The data will be collected through the EHR system and analyzed to measure the effectiveness of QR codes in improving patient safety.
2. Patient Satisfaction: This metric will measure the level of satisfaction among patients after implementation of QR codes and the app. This can be evaluated through surveys or questionnaires.
3. Healthcare System Efficiency: This metric will measure the impact of QR codes on the efficiency of the healthcare system. This can be evaluated through the reduction of wait times, improved coordination of care, and increased productivity.

Conclusion

Implementing a universal QR code for efficient patient data management is a simple and effective solution. The utilization of QR code and HL-7 FHIR technology has the capability to make this solution a reality, and the benefits for both patients and healthcare providers are clear. By investing in this technology, healthcare providers can demonstrate their commitment to improving the quality of patient care.

Maintenance Steps

Maintenance steps are essential to ensure the smooth functioning of any system or technology. For healthcare providers, maintenance steps for QR code technology are crucial to ensure data security, compatibility, and effective usage.

Firstly, regular software updates are necessary to maintain security and compatibility with current software systems. Additionally, healthcare providers must be properly trained in how to use the QR code system effectively, and support should be readily available for any questions or issues that may arise. It is also important to monitor and evaluate the system's performance to identify areas for improvement. Finally, regular audits and assessments should be conducted to ensure the data is protected and to maintain the system's data security and privacy. By prioritizing these factors, healthcare organizations can ensure the successful implementation and ongoing operation of a QR code technology system.

Future Recommendations

As technology continues to evolve, the use of QR codes in healthcare is becoming increasingly common. These codes provide a simple and efficient way to access important patient information. However, patient engagement and education are essential for patients to fully understand the benefits of this technology. The QR code system can be expanded across the entire healthcare system, including long-term care facilities, clinics, and emergency departments, among others. Interoperability with other EHR systems is crucial to ensure that patient information is accessible and up-to-date across all systems, even if a patient changes

healthcare providers. Moreover, the integration of wearable devices such as smartwatches and fitness trackers can provide real-time access to patient information, enhancing patient care. By incorporating these elements, the use of QR codes with an app can revolutionize the way healthcare providers deliver patient care, ultimately leading to better patient outcomes.

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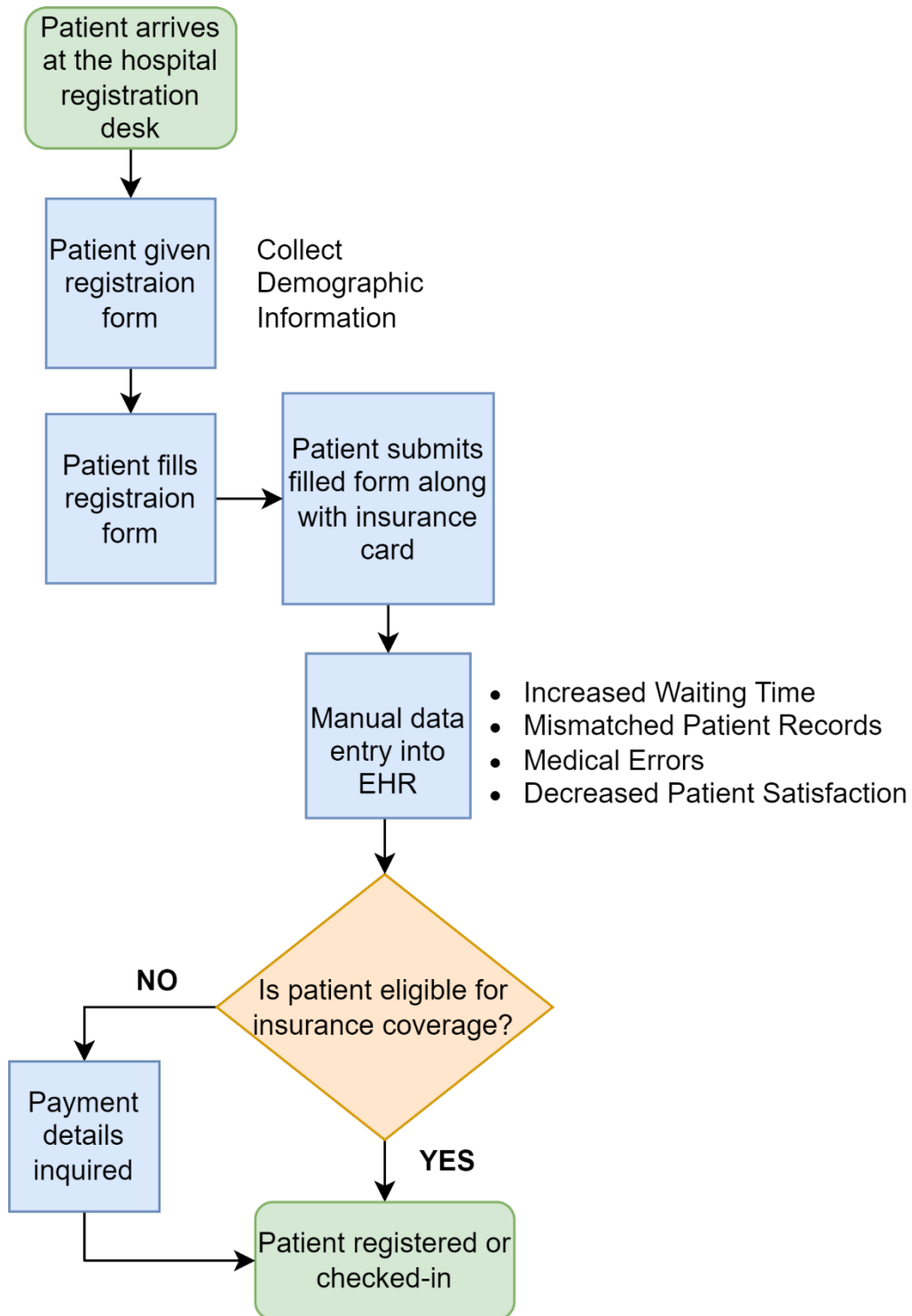
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Appendix A

Patient Registration/Check-in Workflow: Traditional Method



Appendix B

Patient Registration/Check-in Workflow: QR Code Method

