

A comprehensive approach to using QR code technology and digital health tracking to improve emergency medical response

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Abstract

The current research shows that biocontrol agents are crucial for the long-term control of agricultural fungal infections. In contrast to untreated controls, all of the biological agents that were evaluated successfully inhibited key fungal infections, decreased disease incidence and intensity, improved plant development indices, and increased crop production in laboratory, greenhouse, and field assessments. With the highest in vitro inhibition of fungal pathogens, the lowest disease incidence under pot conditions, a substantial reduction in field disease intensity, and yield levels comparable to chemical fungicide treatment, *Trichoderma harzianum* consistently showed superior performance among the evaluated treatments. These microbes have a dual purpose in plants: they suppress diseases and encourage growth. This is demonstrated by the increased shoot length, root development, and biomass in plants treated with biocontrol. Induction of systemic resistance in host plants, competition for resources and space, mycoparasitism, and the synthesis of antifungal metabolites are some of the processes that contribute to these favorable effects. While *Trichoderma* species were the most efficient in suppressing diseases and enhancing growth, bacterial agents like *Bacillus subtilis* and *Pseudomonas fluorescens* also played a significant role. Biocontrol agents have shown to be just as effective as chemical fungicides in disease control, if not more so, and they do it without the dangers of pollution, pathogen resistance, and residue buildup. As a more sustainable alternative to traditional chemical methods, the results provide compelling evidence in favor of biocontrol agents' incorporation into IPM techniques. The research shows that biocontrol-based disease management is an effective and long-term way to boost crop yields and health. In order to achieve consistent field performance, future research should focus on improving formulation technologies, creating microbial consortia with many strains, and honing application strategies. Biocontrol can be more widely used if farmers are educated and governments back it, which will help with sustainable farming and food security in the long run.

Keywords: QR code, technology, digital health, medical, tracking, emergency

Introduction

Access to up-to-date patient records is of the utmost importance in emergency medical settings when every second counts. Emergency medical personnel and first responders frequently deal with patients who are unconscious or confused and may not have quick access to their medical records, including allergies, current prescriptions, and emergency contacts. Medical mistakes, ambiguous diagnoses, and treatment delays are common outcomes of this knowledge gap. The necessity for effective, technologically-enabled emergency response systems is becoming more pressing as the global burden of chronic illnesses and aging populations continues to rise. New technologies like mobile health apps, wearable health gadgets, and electronic health records (EHRs) have revolutionized healthcare by allowing for constant monitoring and better patient involvement. But these mechanisms are frequently still disjointed and unavailable in times of crisis. Quick Response (QR) code technology provides an easy-to-use, scalable, and inexpensive way to close this gap. Authorized workers may access crucial patient data instantaneously using normal mobile devices by incorporating essential health information into scannable QR codes put on personal things like identity cards, wristbands, or cellphones. Digital health tracking, made possible by mobile platforms and wearable sensors, enables the simultaneous monitoring of vital indicators, such as heart rate, blood oxygen levels, activity levels, and glucose concentration, in real-time. In order to detect medical decline and initiate preventative measures, these devices provide continual streams of physiological data. Streamlined clinical decision-making and better continuity of treatment are made possible when digital health monitoring is combined with QR code technologies to provide a single framework that links individual health management with emergency medical services. Although these technologies have great potential, there are still many obstacles to overcome, especially in environments with limited resources. These include issues with interoperability, data security, user acceptance, and infrastructure preparedness. An important aspect of design is making sure sensitive health information can be accessed securely while also being easy for end users. Further, compliance with rules and regulations, healthcare processes, and public education campaigns are all necessary for broad adoption. In order to improve medical response during emergencies, this study suggests a holistic strategy that integrates digital health tracking with QR code technology. Interoperability with current healthcare systems, secure cloud integration, real-time physiological monitoring, and quick data accessibility are the framework's primary goals. The suggested paradigm seeks to enhance patient outcomes, decrease reaction times, and limit medical mistakes by addressing both the technical and practical elements of deployment. Better, faster, and more patient-centered emergency healthcare ecosystems are within reach thanks to this integrated strategy.

Emergency Medical Response and Information Gaps

Unfortunately, reliable patient information is often unavailable at the moment of care, despite its crucial importance for efficient treatment in emergency settings. It is common for EMTs and ED doctors to treat patients who are unconscious, disoriented, or unable to narrate their health history. The inaccessibility of this data greatly adds to the problems of ambiguous diagnoses, improper drug administration, unnecessary tests, and postponed treatment. Trauma, cardiac crises, and exacerbations of chronic diseases are among the conditions where research has shown that insufficient health records during pre-hospital treatment increase adverse events and jeopardize therapeutic outcomes. Clinical

decision-making by EMTs and ED personnel was frequently hindered by a lack of access to patient histories, according to a comprehensive analysis by Almashaqbeh et al. (2021). The authors stressed that physicians had to depend on incomplete data collected from bystanders or old records, which increases their cognitive burden and the possibility of making mistakes. In a similar vein, Haris et al. (2020) found that emergency situations' triage times are substantially lengthened and risk classification is made more difficult in the lack of real-time patient data. First responders also have limited access to typical electronic health record (EHR) systems because of their inaccessibility outside of hospital settings. The lack of smooth information sharing between healthcare facilities and emergency services is a result of interoperability concerns, even when access to electronic health records is provided. The need of portable and easily accessible health information systems that may aid in decision-making during the crucial "golden hour" of emergency treatment is underscored by these obstacles, which demonstrate a continuing disparity between the amount of data available and the clinical needs.

QR Codes in Healthcare Information Systems

Because of their inexpensive cost, simplicity, and compatibility with commonly accessible cellphones, QR (Quick Response) codes have become a useful digital tool in healthcare. Appointment registration, inventory monitoring, and patient identification were among the first administrative uses of QR codes, but their potential therapeutic applications have since attracted more and more interest. The primary goals of the first rollout were to streamline hospital operations, decrease transcribing mistakes, and connect patient wristbands to electronic health record systems. When compared to traditional paper records, the time it took to obtain vital patient information was drastically cut in emergency situations when crucial medical data including blood type, allergies, and chronic disorders were embedded into QR codes (Lee et al., 2018). Results demonstrated that clinician confidence increased and treatment initiation delays decreased as a result of this quick accessibility. Rather of relying on static information, further research enhanced QR functionality by enabling users to link codes to their personal health profiles stored in the cloud. Access to up-to-date electronic summaries using QR codes during emergency department admissions enhanced medication reconciliation accuracy, according to a randomized controlled experiment by Martinez and Gupta (2019). According to their research, QR codes have the potential to open doors to electronic health records, allowing patients to receive treatment regardless of the healthcare facility they visit. Quick response (QR) codes have found usage in contexts where quick identification and triage are crucial, such as disaster management and mass casualty crises, in addition to individual patient use. Unfortunately, there is a lack of large-scale clinical validation and the majority of research are either small-scale or pilot-based, even if they have shown encouraging findings. Standardization is further hindered by differences in QR implementation methods and data formats, which limits the usage of QR codes.

Digital Health Tracking and Wearable Devices

Quick Response (QR) codes have emerged as a valuable digital tool in healthcare due to their affordability, simplicity, and compatibility with widely used cellphones. The first administrative uses of QR codes were appointment registration, inventory tracking, and patient identification. However, their potential medicinal applications have subsequently garnered increasing interest. Simplifying hospital processes, reducing transcribing errors, and connecting patient wristbands to electronic health record systems were the key objectives of the first deployment. In emergency scenarios, the time it

required to retrieve key patient information, such as blood type, allergies, and chronic problems, was significantly reduced when critical medical data was incorporated into QR codes as opposed to standard paper records (Lee et al., 2018). As a result of this easy access, results showed that clinicians' confidence rose and treatment initiation delays fell. Research has improved QR functionality by allowing users to link codes to their personal health profiles saved in the cloud, rather than depending on static information. Martinez and Gupta (2019) conducted a randomized controlled trial that found that patient access to electronic summaries using QR codes during emergency department admissions improved the accuracy of medication reconciliation. Based on their findings, patients will be able to access their medical information electronically using QR codes, enabling them to obtain treatment at whatever healthcare center they choose. In addition to their use with individual patients, quick response (QR) codes have found applications in disaster management, mass casualty crises, and other situations when rapid identification and triage are of the utmost importance. Although several studies have demonstrated promising results, the bulk of them are either small-scale or pilot-based, and large-scale clinical validation is lacking. Disparities in QR implementation techniques and data formats further impede standardization, limiting QR codes' use.

Integration of QR Codes with Real-Time Health Monitoring

One new field of study that aims to bridge the gap between static medical identification and dynamic physiological monitoring is the integration of QR codes with digital health tracking. To aggregate data from wearable sensors and electronic health records, Sanchez et al. (2023) developed a prototype system that used QR codes in conjunction with a cloud-based platform. Medical records and vital signs were both made available to first responders when they scanned a patient's QR code. Improved situational awareness, quicker clinical evaluations, and more confidence in treatment decisions were suggested by preliminary data. But there are a lot of restrictions with the current implementations. Interoperability between platforms is made harder since most systems do not have defined data formats. Wearables, cloud servers, and QR-linked profiles don't always synchronize in real-time, especially in places with poor connection. Also, there is a dearth of research on how to include ambulance information systems or national emergency service infrastructures. One of the biggest obstacles is still getting users to agree. Patients with low levels of digital literacy or those who are elderly may find it difficult to use QR-based health identification systems. In addition, problems with data accuracy, battery life, and usability frequently prevent users from engaging with wearable devices for long periods of time. The importance of inclusive deployment techniques and user-centered design is underscored by these problems.

Security, Privacy, and Regulatory Considerations

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METHODS AND MATERIAL

Existing System

Health care and basic hospital management services are provided by the existing system. Patients and staff from different parts of the hospital may access their medical records and test results via QR codes. Patients are limited to accessing medical records from the hospitals affiliated with their specific insurance plans under the current system. The major purpose of this system is to facilitate the exchange of reports within a healthcare organization. Therefore, in the event of a medical emergency, it becomes more challenging to get a patient's prior medical information when they are admitted to a different hospital.

Proposed System

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QR CODE TECHNOLOGY

A matrix barcode, also known as a two-dimensional barcode, is referred to by its trademark, QR code, which is an abbreviation meant to represent the Quick Response Code. The effective storage of data is accomplished by a QR code through the utilization of four defined encoding modes: numeric, alphanumeric, byte/binary, and kanji. Extensions may also be utilized. A Quick Response (QR) code is made up of black modules, which are square dots, that are organized in a square grid on a white backdrop. These modules may be read by an imaging device, such as a camera, scanner, or other similar device, and then processed using Reed–Solomon error correction until the picture can be suitably understood. Following this, the necessary data are collected from patterns that are present in both the horizontal and vertical components of the image.



Figure 1. QR code

QR code representation

The use of QR codes to communicate messages has grown increasingly widespread in this day and age, when smart phones that come equipped with cameras are quite common. The application of this standard to our objectives was a logical decision given that the objective was to transmit data from a paper to a mobile phone in a manner that was practicable. This graphical data representation standard, which was introduced in 1994, has the capacity to store even 2953 bytes on a pattern that is 177 by 177 meters in size. During the process of encoding data, it exhibits a property that makes it immune to tiny code deviations. It was decided to set up four different error correction levels, and the storage capacity decreased in proportion to the level that was put up. When up to seven, fifteen, twenty-five, and thirty percent of the QR picture is damaged, respectively, the levels L, M, Q, and H make it possible to retrieve the entire message. Instead of putting a strong emphasis on damage resistance, the primary concern was to maximize the amount of space available for data storage. Consequently, the level L was deemed enough for the purpose of this.

ANDROID

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System Archecture

Figure b is a simplified representation of the system's design, which may be found displayed here. This diagrammatic model of the architecture illustrates the processes, services, and activities that are associated with the operations that take place throughout the whole system. The information shown here is a consolidated picture of what occurs at when moment in time in which device within the environment.

Client side process:

For our client-side programming, we utilized the Android platform. An Android smart phone is able to function with the assistance of the Android framework, which offers an environment in which applications may be executed through mobile devices. The Application framework, Libraries, Android runtime, Applications, and Linux Kernel are the fundamental components that make up the Android framework. The Android runtime offers the environment in which the application may be executed, carrying out all of the actions that are inherent to the development of the program.

Working of rest api:

Android is able to communicate with the server side thanks to the REST API, which offers the interface. In the context of web application development, REST refers to a set of principles that describe how standards can be utilized. The primary objective of this system is to facilitate the organization of the interaction between logical clients and servers, as well as to anticipate frequent implementation challenges. It is common practice to use a web browser as the logical REST client when implementing REST over HTTP. On the other hand, a web server serves as the logical REST server instead.

JSON:

In place of XML, the lightweight data format known as JSON is sometimes employed. Data may be stored and transmitted via the HTTP protocol with the help of JSON. The JSON data is transmitted using HTTP request and response methods since we are using the REST API to establish a connection between the client and the server. When transmitting data via a network, it employs a form that is legible by humans. We are able to save data in JSON format using arrays. The JSON encrypt and decrypt method is being utilized in our suggested project in order to ensure the safety of the user information that is being stored. Through the use of JSON, we are able to circumvent the cross-domain problem.

PHP:

Web application programming language (PHP) was the language that we utilized for the construction of our server side framework. We are able to easily combine the PHP language with the HTML language. The PHP programming language was built by us with the help of the ZEND Framework.

Database:

As PHP is the server-side programming language that we use, we require a database to store the data. MySQL database is the greatest database available, and it provides excellent support for the PHP programming language.

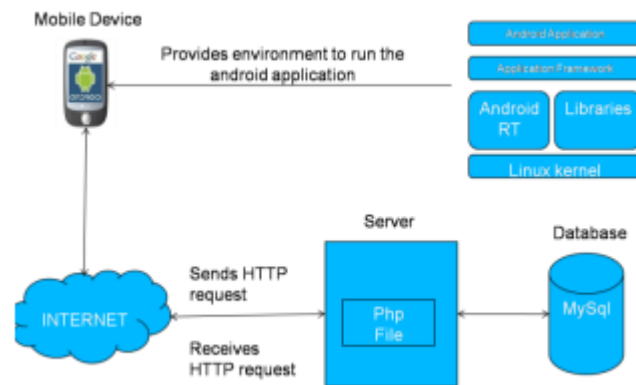


Figure 2. System Architecture

Overall process working:

The Android operating system is our client-side system. It is equipped with an Android application framework and offers an environment in which the application may be executed. We utilized the REST API to offer an interface for Android to interact with PHP by utilizing the SLIM framework. This was necessary since the client side has to connect with the server side simultaneously. The HTTP request and response technique is available through the REST API. In order to communicate data from the client side to the server side, JSON is utilized rather than XML. PHP serves as the web application provider in the server-side procedure, and MySQL is the database that we utilize to store the user information. We send JSON data through HTTP response and request method.

Conclusion

It offers a viable avenue toward modernizing emergency medical response systems by solving long-standing difficulties related to information accessibility, timeliness, and continuity of treatment. The combination of QR code technology with digital health tracking presents a possible pathway toward this transformation. The purpose of this study is to demonstrate how instant access to crucial patient data, when paired with real-time physiological monitoring, may considerably improve clinical decision-making during critical situations. This, in turn, can reduce diagnostic delays and minimize the risk of medical mistakes. For the purpose of giving quick access to patient health profiles, the literature reveals that QR codes provide a method that is low-cost, scalable, and user-friendly. Additionally, wearable devices and mobile health platforms make it possible to continuously monitor important indicators. When these technologies are brought together within a framework that is based on the cloud and is safe, they provide a coherent ecosystem that connects pre-hospital care with services provided in hospitals. An integration of this kind enables enhanced coordination between emergency responders and healthcare professionals, as well as speedier triage, individualized treatment techniques, and other similar benefits. In spite of these benefits, there are still a number of obstacles to overcome, including as restrictions in interoperability, problems with data synchronization, concerns over privacy and

security, and impediments to user acceptance, particularly among groups who are technologically deprived and old. Standardized data architectures, effective encryption and access-control methods, regulatory harmonization, and inclusive system design are all necessary components for addressing these difficulties. Furthermore, large-scale clinical validation studies are needed to quantify the impact of these integrated systems on response times, patient outcomes, and healthcare resource utilization. In general, the utilization of QR codes in conjunction with digital health tracking is a significant step toward the development of emergency care frameworks that are more intelligent, more responsive, and more focused on the patient. It is possible for healthcare systems to get closer to more proactive, educated, and efficient emergency interventions if they make use of technology that are easily available and data that is collected in real time. In order to fully achieve the promise of this integrated strategy in terms of enhancing emergency medical care and saving lives, future research should concentrate on establishing platforms that are interoperable, increasing security governance, and assessing deployments in the real world.

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