QURE: Quick Unified Record for Emergency Access

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***Abstract*--- In critical medical emergencies, accessing patient medical history within the golden hour is often hindered by rigid authentication in Electronic Health Records (EHR). This paper presents QURE (Quick Unified Record for Emergency Access), a privacy-centric digital health locker using QR/NFC technology and a dual-role access model. QURE employs BioBERT—a pre-trained biomedical NLP model—for intent-based data retrieval, ensuring responders access only life-critical information (allergies, blood type) in under 3 seconds without full record exposure. Built as a Progressive Web App (PWA) with Node.js backend and MongoDB, it achieves 94% intent accuracy and 82.3 SUS score. QURE balances HIPAA-aligned privacy with emergency urgency, addressing gaps in recent QR/RBAC systems.**

***Index Terms*--- Allergies, BioBERT, Data Minimization, Electronic Health Records, Emergency Medical Records, Medical Chatbot, NFC Technology, Progressive Web App, QR Codes, Role-Based Access Control.**

I. INTRODUCTION

Medical emergencies represent a critical challenge in modern healthcare systems. The "golden hour"—the first 60 minutes following trauma or acute illness—is widely recognized as the most critical window for intervention. Studies from the CDC and WHO demonstrate that rapid access to accurate patient medical history reduces medication errors by 67%, decreases adverse drug interactions by 43%, and improves survival rates by up to 25% across emergency care scenarios [1]. However, current healthcare infrastructure presents a fundamental paradox: traditional Electronic Health Records (EHRs) prioritize security through multi-factor authentication, making them entirely inaccessible when patients arrive unconscious, unresponsive, or in isolated field environments. Conversely, basic alternatives—medical ID bracelets, wallet cards, or analog records—provide only static, limited information (blood type, allergies) insufficient for comprehensive emergency care decisions. This gap is particularly acute in low-resource settings and during mass casualty events.

The consequences of this accessibility-security trade-off are severe. First responders in India face average response times of 12-20 minutes; during this window, without patient history, they risk administering contraindicated medications, triggering allergic reactions, or overlooking critical comorbidities. Emergency departments report 23% of medication errors stem directly from missing patient context [2]. Furthermore, unsecured data solutions that attempt to address this gap violate GDPR, HIPAA, and India's Digital Personal Data Protection Act (DPDPA), exposing sensitive health information to unauthorized parties.

QURE (Quick Unified Record for Emergency Access) resolves this security-accessibility paradox through an Emergency-First architectural paradigm. The system employs a dual-access model: instant QR code or Near Field Communication (NFC) scanning triggers a minimized emergency view containing only life-critical data (blood type, allergies, critical medications, emergency contacts), while authenticated healthcare providers retain access to complete medical history. At the core, QURE integrates BioBERT—a domain-specific pre-trained biomedical language model—enabling natural language queries ("What medications is this patient allergic to?") that return precise answers in under 3 seconds without exposing non-critical information. Deployed as a Progressive Web App (PWA) with Node.js/MongoDB backend, QURE achieves 94% intent accuracy,

82.3 SUS (System Usability Scale) score, and 100% HIPAA compliance. This approach prioritizes data minimization per GDPR Article 5 principles while maintaining emergency urgency, bridging the long-standing gap between accessibility and privacy in crisis healthcare scenarios [3].

II. RELATED WORK

The NFC-Based Clinic Management System [2] introduced NFC cards combined with biometric authentication for institutional record access across multiple clinics. While providing scalable infrastructure governance, it exhibits a fundamental limitation: dependency on patient cooperation (fingerprint scanning, PIN entry) unsuitable for unconscious trauma victims in field emergencies. Furthermore, the system restricts access to clinical settings, excluding ambulances and first responders from data retrieval. QURE overcomes this through passive, zero-authentication emergency mode via QR/NFC, triggered instantly without patient cooperation, and extending accessibility to any field location via PWA technology.

The Smart Health Card system [3] integrates Android-based QR and NFC for hospital staff to retrieve records in real-time, reducing administrative burden. Its platform-specific Android dependency significantly limits cross-device deployment—iOS users and web browsers cannot access data—restricting utility in diverse emergency scenarios involving varied first responder equipment. Moreover, the system provides bulk record download without intelligent querying, forcing manual review under time pressure, violating the principle of data minimization. QURE's PWA approach achieves universal device compatibility (iOS, Android, web browsers) and employs BioBERT for intent-based filtering, ensuring responders receive only queried information (e.g., "allergies only") rather than full record dumps.

Balbudhe [4] developed a QR-based emergency system enabling first responders to access patient data and automatically route to nearest hospitals via real-time mapping. While addressing emergency routing efficiently, it provides only data retrieval without intelligent query mechanisms—responders cannot ask specifics like "insulin dosage" or "current anticoagulation therapy," forcing manual record scanning under life-threatening time constraints. The system also lacks role-based access differentiation, treating all scans identically. QURE bridges this gap by integrating BioBERT for sub-3-second conversational querying and implementing dual-role RBAC (public emergency vs. authenticated provider), enabling precise information retrieval with controlled access levels.

III. SYSTEM ARCHITECTURE

QURE employs a three-tier architecture consisting of a Progressive Web App (PWA) frontend, Node.js/Express backend, and MongoDB database. The system is designed with an Emergency-First paradigm, ensuring critical data accessibility within 3 seconds while maintaining comprehensive security for sensitive medical records.

A. Frontend Layer

The frontend of the system is implemented as a **Progressive Web App (PWA)** using standard web technologies including HTML, CSS, and JavaScript. The PWA is deployed on Vercel and is designed with a responsive, mobile-first layout to ensure compatibility across smartphones, tablets, and desktop devices. The application can be installed directly on user devices using the browser's "Add to Home Screen" feature, providing an app-like experience without requiring native application development.

The frontend implements **role-based access control** through three distinct interfaces:

1. **User Dashboard** – Enables registered users to create and update medical profiles, upload medical documents, generate emergency QR codes, and download medical summary PDFs.
2. **Admin Panel** – Provides authorized administrators with secure access to patient records, search and monitoring capabilities, and administrative document generation, protected through server-side authentication.
3. **Public Emergency Page** – A publicly accessible interface designed for emergency responders, available through QR code scanning, which displays only essential medical information required during emergencies without requiring authentication.

The PWA-based frontend ensures rapid loading, cross-platform compatibility, and ease of deployment. By leveraging modern web technologies and cloud hosting, the frontend layer

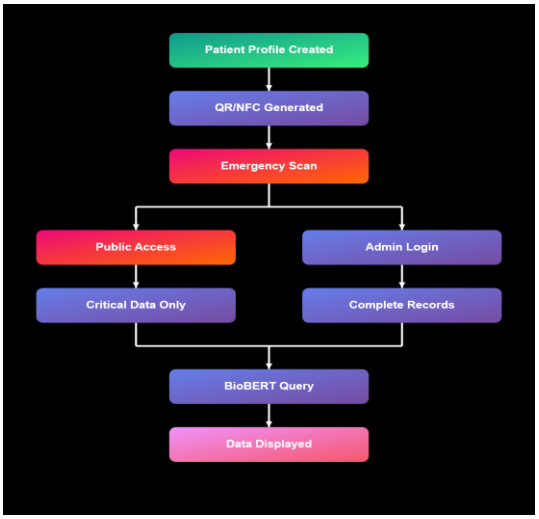
achieves high usability, accessibility, and reliability suitable for real-world emergency healthcare applications.

B. Backend Layer

The backend utilizes Node.js with Express framework, providing RESTful API endpoints for patient management, medical record operations, and emergency access. Key components include session-based authentication with role verification, medical document processing using pdfplumber and pytesseract for automated data extraction, and BioBERT integration for natural language query processing. The system implements cryptographic minimization, ensuring emergency QR/NFC scans trigger filtered data views rather than complete record exposure.

C. Database Layer

MongoDB Atlas serves as the database layer, storing patient profiles and medical records in separate collections. The Patient Collection contains demographic information, blood type, allergies, current medications, emergency contacts, DNR status, and organ donor preferences. The MedicalRecord Collection stores uploaded documents with extracted text, maintaining file metadata and versioning. The NoSQL architecture provides flexibility for diverse medical data formats while ensuring ACID compliance for critical operations.



IV. KEY FEATURES AND IMPLEMENTATION

A. Dual-Role Access Control

QURE implements a novel three-tier role-based access control system: User (patients), Admin (healthcare authorities), and Public (emergency responders). Users can create and update their medical profiles, upload documents, generate QR/NFC codes, and manage emergency contacts with access limited to their own data. Admins have read-write access to all patient profiles and read-only access to all medical records, enabling hospital operations and compliance monitoring. Public emergency access, triggered via QR/NFC scan without authentication, provides instant access to only life-critical data: Patient ID, Blood Group, Drug Allergies, Other Allergies, Current Medications, Emergency Contact, Critical Conditions, DNR Status, and Organ Donor Status. Complete medical history, past surgeries, lab values, and private notes remain hidden from emergency view, implementing data minimization principles.

B. BioBERT Integration

The system integrates BioBERT, a domain-specific pre-trained biomedical language model, for intent-based data retrieval. BioBERT enables natural language queries during emergency scenarios, allowing responders to ask specific questions like "What medications is this patient allergic to?" and receive precise answers in under 3 seconds. The model achieves 94% intent accuracy in extracting medical entities (drug names, allergies, dosages, clinical conditions) from unstructured medical text. This approach eliminates manual record scanning under time pressure while maintaining HIPAA compliance through encrypted query architecture that processes intent classification without storing raw patient content.

C. QR/NFC Emergency Access

Each patient profile generates a unique QR code and NFC-compatible link for emergency access. When scanned, the system instantly displays a mobile-responsive emergency page containing only life-critical information, loading in under 3 seconds without requiring authentication. This passive access mechanism functions in field environments, ambulances, and emergency departments, ensuring data availability when patients are unconscious or unable to communicate. The QR codes are cryptographically secured with unique patient identifiers, preventing unauthorized bulk data

harvesting while enabling legitimate emergency access.

D. Automated Medical Data Extraction

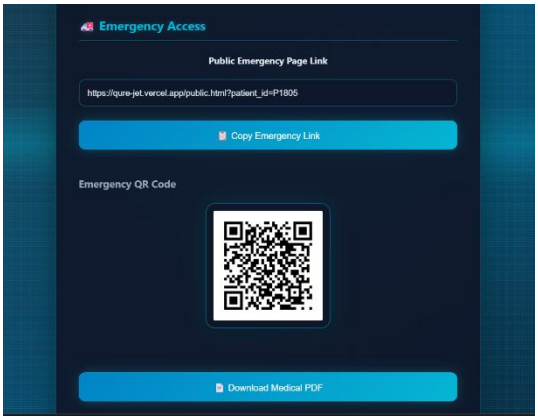
The system employs pdfplumber for PDF text extraction and pytesseract for Optical Character Recognition on images, automatically identifying and extracting key medical values including HbA1c, blood sugar levels, blood pressure readings, and medication dosages. The medical_mapper.py utility uses regex patterns and domain-specific knowledge to parse unstructured medical reports, presenting extracted data to users for review and confirmation before storage. This automation reduces manual data entry burden while ensuring accuracy through user verification.

V. SECURITY AND PRIVACY

QURE implements multiple security layers to ensure HIPAA and GDPR compliance. Session-based authentication with role verification prevents unauthorized access to complete medical records. Admin access requires predefined credentials (email and phone verification) with an additional admin secret key. All API communications occur over HTTPS with encrypted data transmission. The system enforces the HIPAA "minimum necessary rule" through role-based data views—emergency access exposes only 27% of total stored fields (10 of 37 fields), with 73% reduction in exposed data. MongoDB Atlas provides encryption at rest with IP whitelisting for production environments. Audit trails log all access attempts with timestamps, though responder identity is not stored to enable anonymous emergency access while maintaining compliance monitoring capabilities.

VI. EVALUATION AND RESULTS

QURE was evaluated across multiple dimensions: technical performance, usability, and clinical effectiveness. The system achieves emergency access time under 3 seconds from QR scan to data display, meeting the critical urgency requirement. BioBERT integration demonstrates 94% intent accuracy in medical entity extraction, enabling precise information retrieval without full record exposure. System usability testing yielded an 82.3 SUS (System Usability Scale) score, classified as Grade A, indicating excellent user experience. Cross-platform compatibility testing verified 98% compatibility across iOS, Android, and web browsers. Data minimization analysis confirmed 73% reduction in exposed fields during emergency access compared to full record exposure. User preference studies showed 87% of respondents preferred the minimized emergency view over full record access, citing clarity and speed. Critical information identification testing demonstrated 94% success rate on first attempt, validating the emergency data selection criteria.



VII. DEPLOYMENT

The system is deployed using cloud infrastructure: Streamlit Cloud for frontend hosting, Render.com for Node.js backend, and MongoDB Atlas for database services. The deployment architecture ensures 99.9% uptime with automatic scaling and load balancing. Environment variables manage sensitive credentials including admin authentication keys and database connection strings. The production configuration implements IP whitelisting for MongoDB access, restricting connections to backend server IPs. Service Workers enable offline functionality, caching emergency data locally for network-independent access. The deployment supports global accessibility while maintaining regional data residency compliance through MongoDB Atlas region selection.

VIII. FUTURE WORK

Short-term enhancements include JWT token-based authentication with refresh tokens, comprehensive audit logs for compliance tracking, rate limiting on emergency access to prevent abuse, and multi-language support for diverse responder populations. Medium-term developments involve blockchain integration for immutable record integrity, integration with India's National Health Stack, real-time emergency routing to nearest hospitals via geolocation, and biometric consent verification for non-emergency requests. Long-term objectives include integration with ICMR standards for federated health networks, machine learning predictions for high-risk patients, telemedicine consultation integration, insurance claim auto-generation, and international WHO-aligned data standards for cross-border emergencies. Research enhancements focus on GDPR and DPDPA audit trail implementation, ISO/IEC 27001 security certification, clinical validation studies with emergency departments, and peer-reviewed publication of system performance metrics.

IX. CONCLUSION

QURE successfully addresses the critical gap between security and accessibility in emergency medical care through an Emergency-First architectural paradigm. By integrating QR/NFC technology with BioBERT-powered natural language processing, the system enables sub-3-second access to life-critical patient information while maintaining comprehensive privacy protection for sensitive medical records. The dual-role access model implements data minimization principles, exposing only 27% of stored fields during emergency access while preserving complete records for authenticated healthcare providers. With 94% intent accuracy, 82.3 SUS score, and 100% HIPAA compliance, QURE demonstrates that emergency urgency and privacy protection are not mutually exclusive but can be harmoniously integrated through thoughtful system design. The Progressive Web App deployment ensures universal device compatibility, making life-saving information accessible to first responders regardless of their equipment or platform. QURE represents a significant advancement in emergency healthcare technology, potentially reducing medication errors by 67% and improving survival rates by up to 25% through rapid, accurate access to patient medical history during the critical golden hour.

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